



EFII Installation Instructions And User Guide

Introduction

This document is intended to serve as a guide for the installation and use of the EFII Electronic Engine Management System for Lycoming engines.

Installation of this system requires modification to the fuel system, electrical system, and engine components of the aircraft.

The EFII system is a complete electronic engine management system for Lycoming engines. This includes electronic fuel injection (EFI) and high energy electronic ignition for all spark plugs. The EFII system is the same type of engine management that you would find on any modern automobile. When properly installed and operated, the EFII system will improve engine reliability, efficiency and horsepower output as well as reduce pilot workload.

Description

The EFII system consists of an Electronic Control Unit (ECU), ECU Programmer, crank trigger wire harness, sensors, coils, electronic fuel injectors, Iridium spark plugs, spark plug adapters, spark plug wires, fuel pumps, fuel filters, fuel pressure regulator, and all mechanical adapters required for the Lycoming installation. The only significant components not included are fuel lines and a duplex fuel valve (if required).

The EFII system displaces a number of parts that would otherwise be used on a Lycoming engine. Parts no longer used are the magnetos, aircraft spark plugs, mechanical fuel pump, carb or injector servo, and any mechanical injection components including the fuel spider and mechanical injectors.

Flying with the EFII system is very easy. Once the system is tuned, the pilot no longer needs to worry about fuel mixture or any other aspect of the engine operation except where the throttle should be set. We recommend running a wide band oxygen sensor and gauge to give you a continuous readout of the air/fuel ration present in your engine. This combined with one or more EGT readings gives you a very good idea of how your EFI system is operating. PLX Devices makes a nice wide band O2 sensor and gauge kit. They can be found at:

www.plxdevices.com (Part No. DM-6 SM-AFR combo).

The EFII system has proven to provide about 10% more horsepower for your aircraft. This is due to the greater efficiency of always having the right amount of fuel delivered in combination with a high energy ignition and proper spark timing curve. The ignition system built in to the EFII system can easily jump a 1" spark gap in free air. This is in stark contrast to the tiny anemic spark available from magnetos. As a consequence, we can run a much larger spark gap and burn more of the available fuel with the EFII system, again contributing to better power and efficiency. More complete combustion also helps minimize lead fouling and engine wear.

EFII engine management systems are available for all four and six cylinder Lycoming engines. The EFII system is extremely reliable and built from the best components available. This is exemplified by our billet crank triggers, environmentally sealed Tefzel wire harness, Walbro fuel pumps, Bosch sensors, Siemens fuel injectors, and NGK Iridium spark plugs. The quality and reliability of our base systems can not be matched by any other aircraft engine electronics manufacturer. In addition to our standard systems we also offer dual ECU, fully redundant versions of our systems for our customers who fly over wilderness or water and require the maximum level of redundancy possible.

EFII systems variations:

<u>Part Number</u>	<u>Description</u>
EFII-4	Full EFII system for 4 cyl Lycoming
EFII-4R	Dual ECU, Full EFII system for 4 cyl Lycoming
EFII-6	Full EFII system for 6 cyl Lycoming
EFII-6R	Dual ECU, Full EFII system for 6 cyl Lycoming

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Limited Warranty and Liability Agreement

Though we at EFII will attempt to be as thorough and helpful as possible in educating customers about the safe installation and use of this system, the ultimate responsibility for proper installation, maintenance, and use of this system can only be provided by the person performing the installation of components and maintenance of the aircraft.

It is the responsibility of the aircraft owner and system installer to ensure that the components provided by EFII are applicable and safe for your application. It is also the responsibility of the aircraft owner and system installer to ensure that this system is operated and maintained in a safe fashion. EFII cannot guarantee any aspect of the installation, maintenance or safe use of this system.

EFII limits warranty solely to the replacement of components provided by us which may have been delivered with a factory defect. We in no way guarantee or warranty any other systems, components, aircraft or other property, or personal injury that may result after the installation of this system.

Fuel System

Fuel system components included with the EFII kit include:

Fuel Pump Module with 2 Walbro electric fuel pumps.

1 FF-1 Post-filter, 10 micron, mounts after fuel pumps.

1 FF-2 Pre-filter, 90 micron, mounts before pumps.

1 Aeromotive fuel pressure regulator.

2 (or 4 for six cylinder) Precision length fuel lines to connect adjacent injectors.

2 AN -6 Male to Female 90s.

4 (or 6 for six cylinder) EFII injector assemblies with -6 fittings.

4 (or 6 for six cylinder) Lycoming intake pipes with injector bases welded in.

The EFII system requires a full return type fuel system. This is a fuel system that is capable of supplying fuel at a minimum of 25gph to the engine area and returning excess fuel back to the selected fuel tank or to a header tank. Our Fuel Pump Module including two high quality Walbro fuel pumps is included in your EFII kit. One fuel pump will serve as the primary fuel pump, the other pump will serve as a backup in case of primary pump failure. The included FF-1 post filter is designed to be mounted after the pumps to keep fine particulates from getting into the fuel injectors. The included FF-2 pre-filter is designed to be mounted before the pumps to catch any large particulates that may come out of the fuel tank. A gascolator is not required or desired with this type of system.

There are two common schemes for plumbing the fuel system.

1. **(Refer to DRAWING 3)** If you have a low wing plane or a high wing plane you have the option of using a duplex fuel valve that selects both a supply line from each tank as well as a return line back to each tank. This method uses a stacked fuel valve that contains two valves in one housing. The best choice for this is the duplex valve from Andair, part no. FS2020-D2-M (www.andair.co.uk).



Andair duplex fuel valve with AN -6 fittings.

2. **(Refer to DRAWING 2)** If you have a high wing plane you have the option of gravity feeding a fuselage mounted header tank from the wing tanks and using a simple ON/OFF fuel valve between the header tank and the engine. The header tank should be at least five gallons so that the heat gathered by the fuel as it circulates through the engine area can be sufficiently dissipated into the cold fuel in the header tank after the fuel returns to the header tank from the engine. Smaller header tanks will tend to experience fuel heating which in the worst case can cause vapor lock. A popular header tank location is in the bottom of the baggage area. If a custom tank is fitted to this area, it generally can be as little as 3 to 4 inches thick on the baggage area floor and take up very little room. Header tanks need to have their own independent vent line running to a high point in the plane similar to the wing tank vent tube routing. If a header tank is not properly vented, air cannot easily get out of the header tank and the tank may not completely fill with fuel.

For either fuel system layout, the fuel lines should be AN -6 (3/8") throughout, AN -4 (1/4") is adequate for vent lines. Fuel lines residing forward of the firewall should be fire sleeved and

routed as far as practical from exhaust components. If fuel pumps are mounted forward of the firewall, they should have a heat shield installed to deflect direct exhaust pipe radiation.

Please refer to **DRAWINGS 2 and 3** for sample fuel system layouts

Return line installation in wing tanks – If you are installing fuel return fittings into wing tanks, make sure the return fuel dumps into the tank at least 4 inches from the fuel pickup tube in the tank. This will allow any bubbles that are in the return fuel to percolate out without being sucked into the pickup tube.

Fuel pressure regulator mounting



The Fuel Pressure Regulator is typically mounted to the firewall and fed from the fuel line leaving the fuel injectors. The side port is the INLET to the regulator. The bottom port is the OUTLET from the regulator that will then return to the header tank or fuel selector return plumbing.

Fuel pressure is set by adjusting the set screw on the end of the Fuel Pressure Regulator. Turning the screw clockwise will increase the fuel pressure, counter clockwise will decrease the pressure. After completing the installation of your fuel system, you can set the fuel pressure by running one fuel pump with the engine stopped and adjusting the regulator until the fuel pressure is 35 psi. It is best to use a mechanical pressure gauge temporarily installed in the fuel rail to make this measurement. You can calibrate the fuel pressure readout of your engine monitor at the same time. It is not wise to assume that the fuel pressure readout of your engine monitor is correct without double checking it with a mechanical pressure gauge at least once to verify calibration of the monitor.

The Fuel Pressure Regulator has a vacuum nipple on the side. This should be connected to one of the manifold pressure sources on your Throttle Body Sump Adapter. Only use heavy wall vacuum line tie wrapped on at all fittings.

Electrical Supply System

When operating an aircraft that relies upon the continued operation of critical engine electronics such as the EFII system, we strongly recommend using a redundant essential bus power system to guarantee that a good source of +12v is available at all times to power the engine electronics. The simplest way to implement a protected essential bus is to use the EFII Bus Manager product which provides a triple redundant essential bus using two batteries. The Bus Manager also incorporates automatic backup fuel pump monitoring and activation as well as a number of other useful functions. Please read more about the Bus Manager at: www.flyefii.com

Grounding the vehicle systems (Refer to DRAWING 1)

Proper operation of modern vehicle systems demands a good electrical grounding system. The airframe should never be considered an electrical path.

The airframe should be grounded at **ONLY** one point to the vehicle ground system, typically at the firewall. All other vehicle systems should **not** rely on a connection to the airframe as a method of completing the ground circuit. All vehicle systems should have ground returns to a ground bus which is in turn connected to the battery ground with an appropriate gauge return wire. The engine needs to have a large gauge ground wire connected to a secure bolt on the engine case or block. Never use a motor mount bolt as a ground cable connection point to the engine. Motor mount bolts experience a great deal of stress and movement and can be the source of a grounding problem if the engine ground is connected to them. The engine ground cable should be the same gauge wire that connects the main +12V power feed to the starter motor.

If a ground bolt is used as a main ground pass through on the firewall, this is also a convenient place to tie in the ground bus which all vehicle systems will be grounded to. The ground bus can be electrically connected to the firewall ground bolt with a number 8GA wire.

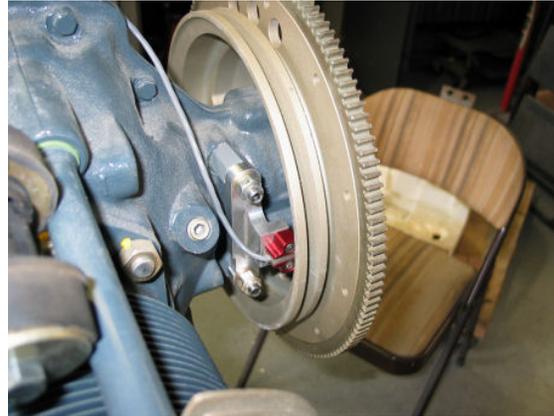
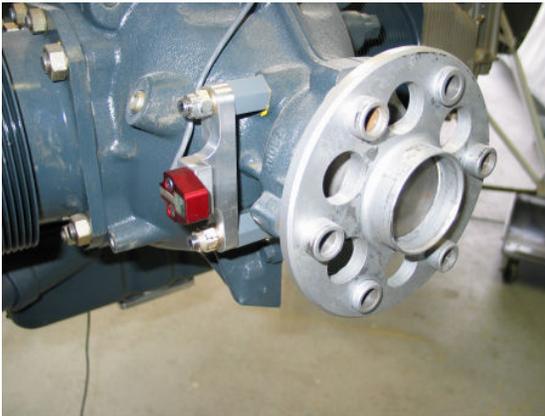
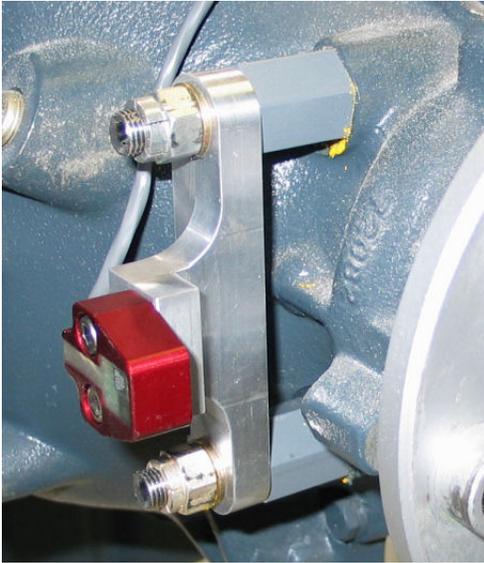
The single ECU EFII systems require three +12V circuits and associated circuit breakers. The dual ECU systems require an extra breaker for the second ECU. If you plan on using an EFII Bus Manager, you may also need panel space for a Fuel Pump Mode Switch, and Start Battery Select Switch. The circuit breaker requirements for the different versions of the EFII system are listed below:

<u>System</u>	<u>ECU breaker(s)</u>	<u>Ignition breaker</u>	<u>Fuel Pump breaker</u>
EFII-4	5A	10A	10A
EFII-4R	5A (x2)	10A	10A
EFII-6	5A	15A	10A
EFII-6R	5A (x2)	15A	10A

Engine Component Installation

Crank Trigger

Your EFII kit includes a billet aluminum, Hall effect crank trigger assembly as shown below:



The crank trigger mounts onto the front two engine case bolts that are above and below the crankshaft. Remove the nuts and washers from the right side of these two bolts. Locate the two one inch long threaded hex standoffs in your crank trigger kit. Screw the standoffs onto the case bolt ends and make sure the bolts go no more than $\frac{1}{2}$ " into the standoff when assembled. If the bolts are too long, shorten them or add washers as necessary under the bolt head. Using red loctite, install the threaded hex standoffs onto the end of each case bolt. Torque the standoffs to 300 in. lbs.

Locate the two stainless $\frac{3}{8}$ "-24 x 1 $\frac{1}{2}$ " set screws included with the crank trigger. Ensure that there is approx $\frac{1}{2}$ " of available thread depth in the hex standoffs installed in the last step. Install the two set screws into the ends of the threaded standoffs using red loctite and torque them to 200 in. lbs.

Position the crank trigger assembly onto the installed set screws and secure with the included all metal lock nuts (never use Nylock nuts on the engine) and AN washers. Torque the lock nuts to 200 in. lbs.

Carefully test fit your flywheel onto the engine. Make note of the indexing (larger) prop dowel position on the prop flange and the flywheel. The flywheel will only go on one way. With the flywheel properly clocked to the crankshaft, carefully slide it onto the end of the crankshaft and watch for any interference with the crank trigger assembly. With the flywheel fully seated, there

should be an air gap between the flywheel and the crank trigger of approx .030" to .050". A drill bit makes a good gauge to measure the airgap. If the airgap is too small, material must be machined off the threaded hex standoffs to increase the airgap.

Once the crank trigger is installed, route the crank trigger cable over the center of the top of the engine. Support the crank trigger cable using adel clamps attached to the top case bolts. (retorque 1/4" case bolts to 75 in. lbs.)

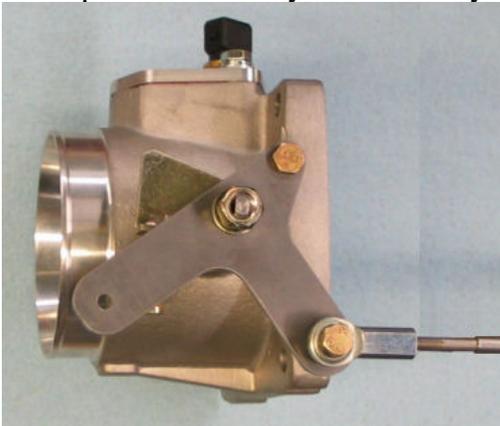
Throttle Body

Locate the throttle body assembly in your kit. There is a 1" thick Lycoming sump adapter plate included with the throttle body. Separate the sump adapter from the throttle body. The sump adapter has two 1/8" npt pressure ports on one side. These are included as a pick off point for manifold pressure lines. Manifold pressure lines will have to connect to your MAP sensor as well as to the fuel pressure regulator. The sump adapter can be rotated in any direction to facilitate manifold line connections. Below is a picture of a mounted sump adapter:



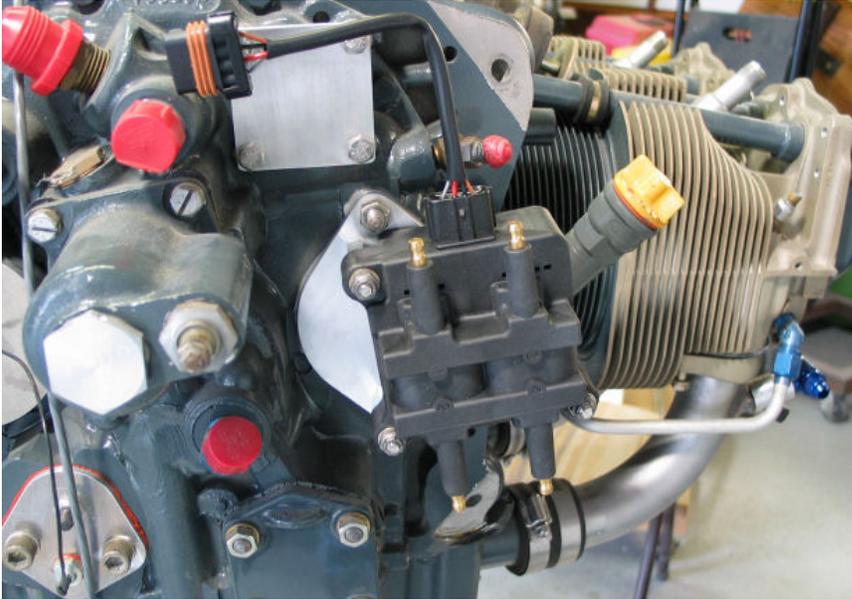
Attach the sump adapter to your engine sump using the included 5/16"-24 x 1 1/4" socket head screws. Use Ultra Black Silicone Gasket Maker between the engine sump and the sump adapter. Use blue loctite on the 5/16" allen head screws and torque to approx 180 in. lbs.

The throttle linkage will generally be located on the left side of the throttle body. The throttle body has a universal linkage plate that can be easily connected to your throttle linkage whether the throttle body is mounted in a vertical or horizontal fashion. It is acceptable to cut off the unused arm of the linkage adapter plate if desired. Apply Ultra Black Silicone Gasket Maker between the throttle body and sump adapter. Attach the throttle body to the sump adapter using the supplied hex bolts, lock washers and nuts. Below are pictures showing throttle linkage hookup for horizontally and vertically mounted throttle bodies:



Ignition Coils and Magneto Block Plates

Typically, the ignition coils are mounted to magneto block off plates which serve to cover up the magneto holes in the accessory case. In some cases, it may be more convenient to mount the ignition coils to the firewall. EFII can provide magneto block off plates that do not include the coil mounting features if this suits your installation. Below is a picture of typical ignition coil mounting on the accessory case:



It is important to make sure there is clearance between the motor mount and the coils.

It is highly recommended to hang the motor mount onto the engine when fitting the coils.

In some cases, the impulse coupling spacer that typically sits under the left mag can be used to space one of the coils out about .8" away from the motor to improve clearances. When mounting the coils with the magneto block off plates, the left coil will mount with its connector pointing down and the right coil will mount with its connector pointing up (as seen in the picture above).

After you have test fitted the coils and motor mount, apply Ultra Black Silicone Gasket Maker between the magneto block off plate and the accessory case and permanently mount the coils.

Spark Plugs and Adapters

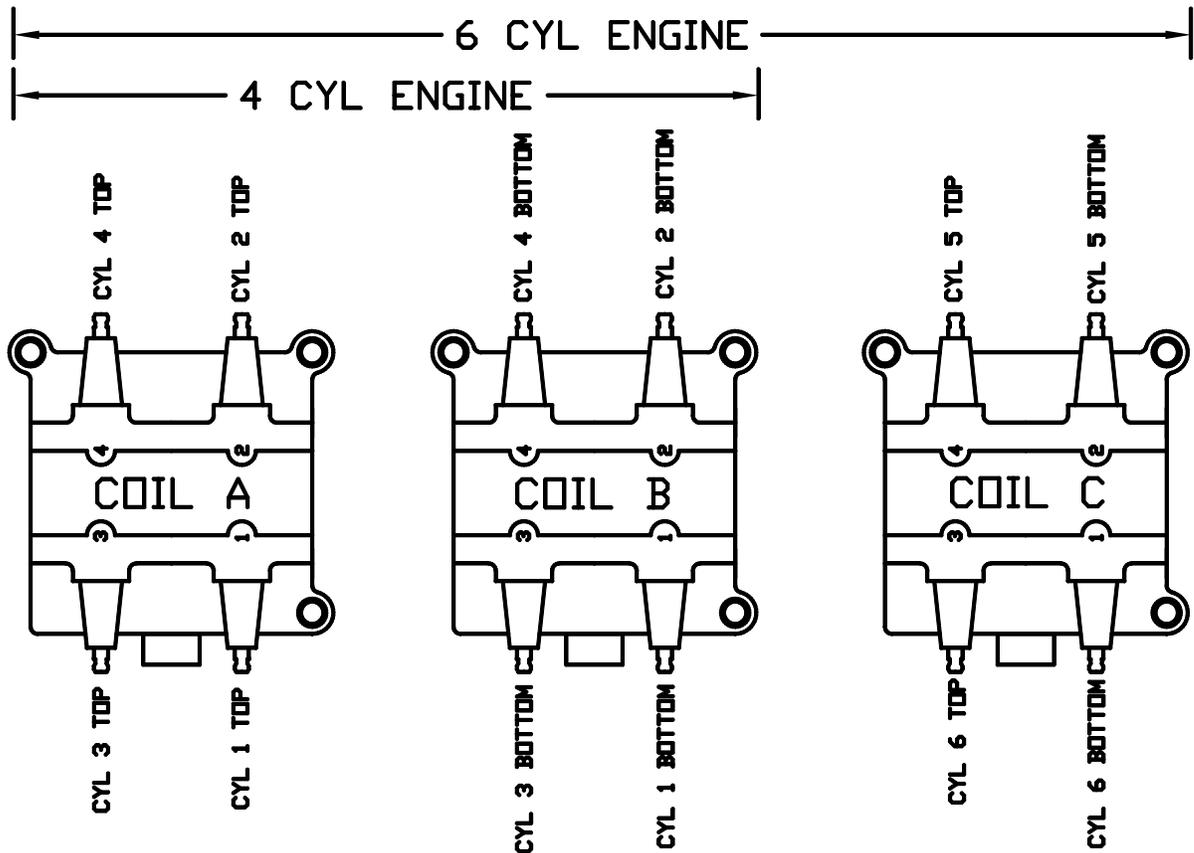
Your kit comes complete with Iridium spark plugs and spark plug adapters for all plug locations.

CAUTION- Always install the brass spark plug adapters onto the spark plug first and then install the assembly into the cylinder. Never torque the spark plug adapters into the cylinder without a spark plug installed – this could damage the spark plug adapter. With spark plugs and adapters installed into the cylinders, torque the spark plug only to 30 ft lbs. This will seat the washers on both the adapter and the spark plug with one step.

Your plugs should be gapped at .032" to .035". If you adjust the gaps, be very careful not to damage the thin center electrode (don't pry against it). Install the adapters and plugs in all plug locations.

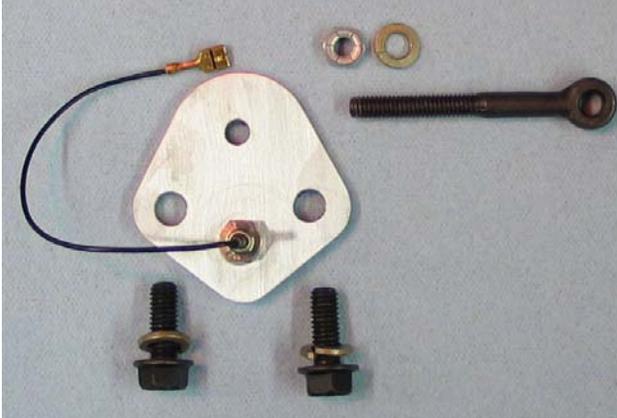
Spark Plug Wires

It is best to wait on spark plug wire assembly until the motor is on the motor mount and all engine accessories and baffling are mounted. This will ensure when you establish wire lengths and routing that everything fits well. When you are ready to prepare the spark plug wires, follow the instructions that come with the included spark plug wire set. A pair of spark plug wire crimpers are handy to have available. If you don't have access to proper crimpers, you can get them from summitracing.com pn TAY-43390. Below is a diagram showing which coil outputs should be connected to which spark plug: (note – there are numbers molded into the ignition coils below the spark plug towers that correspond to the correct cylinder number for each spark wire connection for four cylinder engines. For six cylinder engines, follow the diagram below for the remaining cylinders).

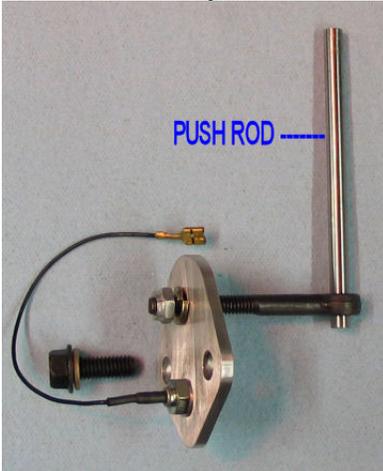


Engine Temp Sensor and Mechanical Fuel Pump Block Plate

The EFII system does not use the Lycoming mechanical fuel pump. A block off plate is installed over the accessory case opening where the mechanical fuel pump would be mounted. This block off plate is a convenient location for the engine temperature sensor. NOTE - Some EFII kits have the engine temp sensor mounted on one of the ignition coil mounting plates. Locate the fuel pump block plate / engine temp sensor assembly in your kit. Below is a picture of this assembly:



The mechanical fuel pump block plate includes a capture bolt which is used to secure the fuel pump push rod which is inside the accessory case. The capture bolt extends into the accessory case and slips over the fuel pump push rod. After the block plate is tightened onto the accessory case, the nut on the capture rod is gently tightened until the lock washer is compressed. When the fuel pump push rod is all the way down in its bore, it will stick through the capture bolt about 1/4" as shown in the picture below:

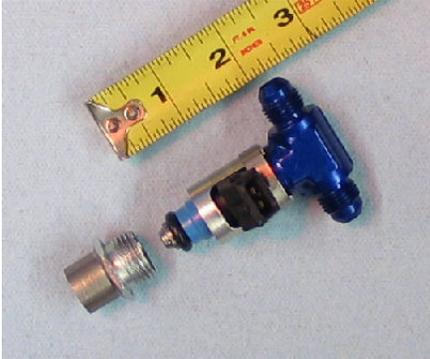


Make sure the push rod is all the way down in its bore and the capture bolt is slipped over the rod as shown before tightening up the block plate and capture rod.

If your motor is being assembled, you can have your engine shop leave out the fuel pump push rod. This alleviates the need for the capture bolt. In this case, we can supply a block plate without the capture bolt hole, or you can seal the hole with a short bolt and locknut.

Electronic Fuel Injector Assemblies

Your EFII kit includes 4 (or 6 for six cylinder engines) of our ultra compact electronic fuel injectors with mounting hardware and weld-in bases. Your weld-in bases are typically installed by us. The injector mount consists of the weld-in base, threaded mid housing, and the -6 upper housing. The weld-in bases are typically installed on the outside of the intake pipes, positioning the injector assemblies just under the rocker covers as shown below:



Install your intake pipes onto the engine using appropriate gaskets at the cylinder head. Apply a small amount of grease to the exposed o-ring on each injector assembly and wind an injector onto each intake pipe. Wind each injector down onto its weld-in base until it begins to get tight, then turn the injector counterclockwise until the -6 fittings point fore and aft on the engine and the injector plug is rotated to the bottom of the assembly. The injector does not need to be bottomed out tightly against the weld-in fitting.

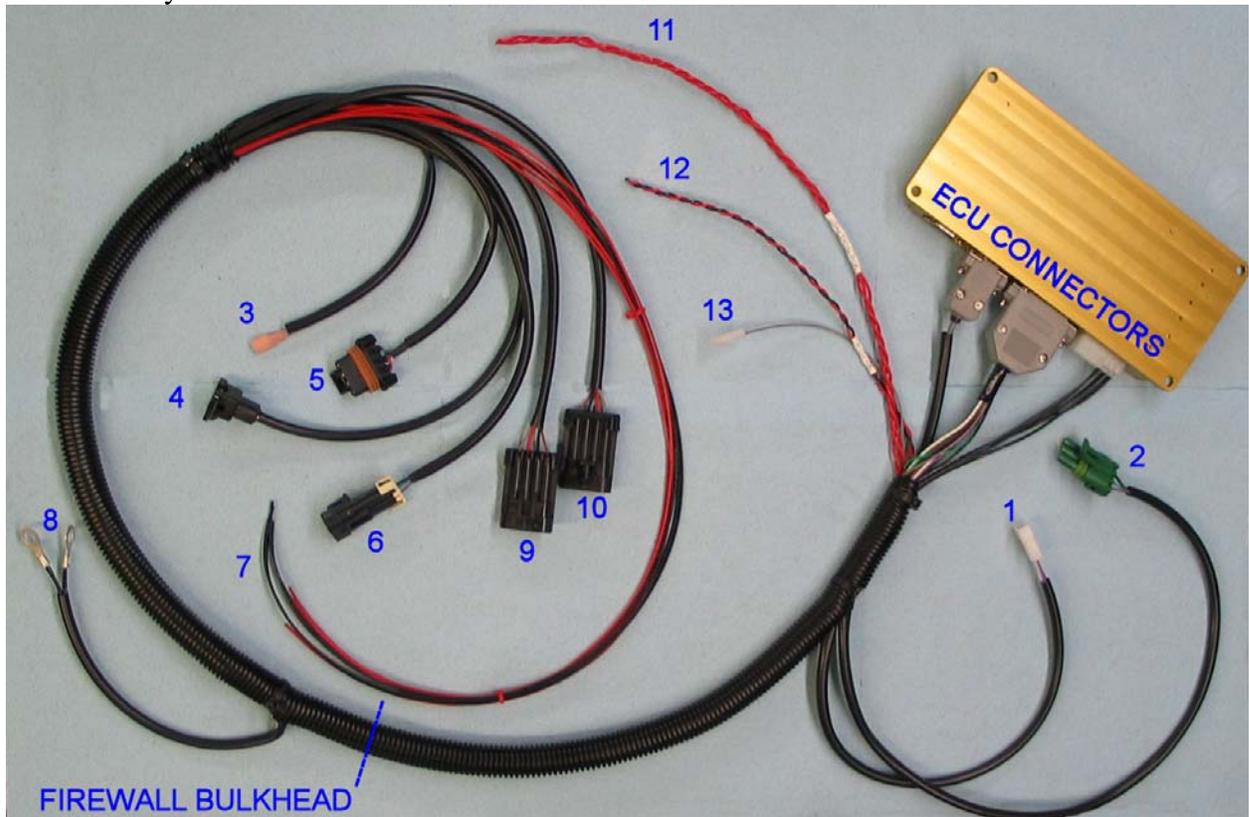
The high pressure portion of the fuel system consists of the fuel path that starts at the outlet of the fuel pumps, goes to the rear injector on one side of the engine, continues to the adjacent injector on the same side of the engine, crosses over, under the front of the crankshaft to the forward injector on the opposite side of the engine, continues to the adjacent injector rearward and then back to the firewall to the fuel pressure regulator. Refer to **DRAWING 4** for a depiction of the fuel rail.

2 (or 4 for six cyl systems) precision length fuel lines are included in your kit along with 2 AN-6 male to female 90 fittings. The precision length lines should be installed between adjacent injectors on each side of the engine. The 90 fittings should be installed on the forward side of the two front injectors. These fittings provide a good entry point for the custom fuel line that will cross over from one front cylinder on one side of the engine to the front cylinder on the other side of the engine.

Fuel lines. All engine area fuel lines should be fire sleeved AN -6 teflon lines. No lines should be stretched tight between fittings. There should always be some droop to each installed line to account for engine growth and movement. All lines should be secured every six inches with adel clamps or other suitable cushioned hose mount hardware.

Wire Harness

Your EFII kit includes a prewired Tefzel wire harness. All necessary connectors are preinstalled except for the injector connectors. Below is a picture of the harness with the connectors referenced by number:

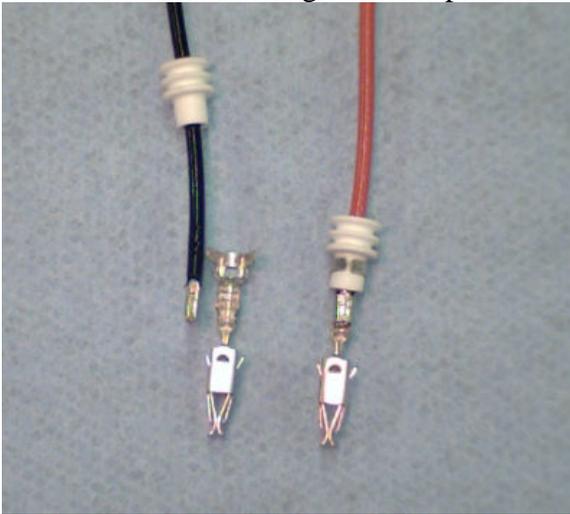


Harness Connectors

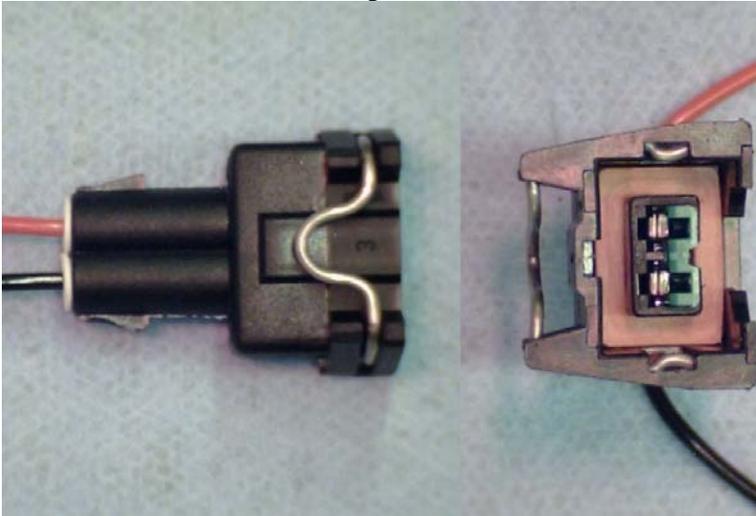
1. Mixture Adjust Knob (in cabin).
 2. MAP sensor (in cabin).
 3. Engine temperature sensor (on fuel pump block plate or coil mount plate).
 4. Intake air temperature sensor (on throttle body).
 5. Crank trigger.
 6. Throttle position sensor (on throttle body).
 7. Injector wires (customer installed terminals).
 8. Ignition and injector ground wires (engine side of firewall).
 9. Ignition coil.
 - 10 Ignition coil.
 11. Ignition power (these wires stay bundled and fed from a separate IGNITION breaker).
 12. ECU power (black to ground bus, red to 5A ECU PWR breaker).
 13. Tach output (connects to your engine monitor or tachometer).
- (not shown) – there is also a Fuel Flow wire in the harness located near the tach wire. The fuel flow wire is connected directly to one of the injector trigger wires within the harness. This output can be used directly by Grand Rapids or MGL engine monitor systems. Other engine monitors may require the use of separate fuel flow sensors in the fuel lines.

Fuel Injector wiring. Number 7 in the picture on the previous page is the fuel injector wires. There is one black wire and one red wire for each injector. The EFII system is a batch fired system, meaning all injectors fire simultaneously. With the harness laid into position on the engine and the other connectors attached to their respective devices, route one black wire and one red wire to each injector – which one you select does not matter. It is recommended to use -4 fire sleeve on the injector wires for added heat protection. After you have routed the injector wires, trim the wires to length and attach the injector connectors. The injectors are non polar, meaning that it doesn't matter which terminal gets the red wire and which gets the black wire, they will work either way.

To install the injector terminals, first push the wire through a rear rubber seal as shown below. Strip the wire back approx 3/16" and lay the wire and rubber seal into the connector. Carefully close the small barrel of the connector around the stripped portion of the wire with a pair of needle nose pliers and close the large barrel of the connector around the rubber seal as shown below. Now carefully solder the portion of the terminal that is crimped onto the stripped area of the wire. If soldering is not your best skill, this would be a good place to get help from someone familiar with assembling wire components.



After soldering the terminals onto the wires, push them into the back of the connector housing until the terminals click into position. The finished result should look something like below:



ECU, Programmer and Mixture Knob

The EFII system uses the popular SDS ECU. This EFI computer has been used in countless vehicles and is well known for its extreme reliability and ease of use. The ECU fuel map and ignition timing can be modified by the end user to tailor the operation of your EFII system to the specific requirements of your vehicle. The ECU is typically mounted under the instrument panel, not far from the firewall. It is best to mount the ECU such that the connectors can easily be accessed for the sake of attaching the wire harness. The ECU should be mounted such that moisture cannot find its way into the ECU enclosure – the enclosure is not waterproof.

Your EFII kit also contains the SDS Aviation Programmer. This is a 3 1/8” instrument that gives you access to all the parameters of your ECU. The Programmer also has four Gauge Pages, that give you direct access to the values coming from each of the sensors attached to your EFII system. The EFII system can be flown without the Programmer present, though most people prefer to have it mounted in the instrument panel for easy access to EFI data and programming. The Programmer portion of your kit includes a DB9 serial cable for connection between the Programmer and the ECU. Plug the mating end of the cable into the Programmer first and then plug the remaining end of the cable into the mating connector on the ECU. The remaining DB9 connector on the ECU is for your crank trigger. The Programmer is powered through the serial cable and requires no additional connections.

A Mixture Adjust potentiometer (Mixture Knob) is included with the EFII kit. This potentiometer should be mounted on the instrument panel in a location where it won't accidentally get bumped. The Mixture Knob plugs into a white three pin connector on the main harness off the ECU. The Mixture Knob allows global modification to the fuel map. This is useful for tuning your engine during initial running of the system. It is also a safety feature that allows for a fuel trim from +50% to -50% of the normal fuel delivery. This would come in handy if an EFI sensor was not working correctly and the fuel delivery was in error. The Mixture Knob could then be turned in this emergency to temporarily correct the fuel delivery until the problem can be fixed.

Choose panel mounting positions for the 3 1/8” Programmer as well as the Mixture Adjust knob. In the picture below, you can see an installation of the Mixture knob, the programmer, and a PLX wide band air/fuel ratio monitor (lower right). Note the placard on the Mixture knob for 'leaner' and 'richer'



Explanation of the Sensors

There are five sensors associated with your EFII system as follows:

1. Crank trigger – importance **ESSENTIAL** – The crank trigger is a four wire sensor that mounts to the front two bolts of your engine case that reside above and below the crankshaft centerline. This sensor gives rpm and ignition timing information to the ECU. We have installed three magnets (four magnets for six cylinder engines) into the ID area of your flywheel, under the alternator belt pulley flanges. Four cylinder engines have two timing magnets 180 degrees apart and one sync magnet. Six cylinder engines have three timing magnets 120 degrees apart and one sync magnet. The crank trigger is actually a dual element sensor. One element senses the timing magnets and one element senses the sync magnet.

2. Manifold Absolute Pressure Sensor (MAP) – importance **ESSENTIAL** – The MAP sensor is a three wire sensor that is typically mounted aft of the firewall. The MAP sensor tells the ECU how much air pressure is in the engine intake manifold. The combination of the MAP sensor and the rpm information from the Crank Trigger are the most critical inputs to your ECU. So please mount and hook up both of these sensors with care. A manifold pressure source must be routed to the MAP sensor. A pressure source directly from the sump adapter plate is preferred since this will be a more steady pressure signal than from one of the cylinder heads. Your system includes a vacuum hose kit which has heavy wall line and barb fittings to make the pressure line connections to your MAP sensor and fuel pressure regulator. Tie wrap the vacuum line on at all fittings.

3. Intake Air Temp Sensor (IAT) – importance **IMPORTANT** – The IAT is a two wire sensor that is mounted on the side of the throttle body. The information from the IAT sensor allows the ECU to make an air density correction to compensate for the temperature of the intake air. Though the IAT signal is important, the engine will still run if this sensor has a problem. The IAT is a two wire sensor that is mounted on the side of the throttle body. In the picture below, you can see the IAT sensor sitting at the top of the throttle body and the TPS sensor on the side of the throttle body.



4. Throttle Position Sensor (TPS) – importance **LOW** – The TPS sensor is a three wire sensor mounted on the butterfly shaft of the throttle body. The throttle position sensor serves only to provide a simulated accelerator pump function when the throttle is moved rapidly. Whenever the ECU senses a rapidly opening throttle movement, it adds some additional fuel to keep the engine from stumbling during the ensuing engine acceleration. The level of TPS fuel enrichment can be adjusted through the Programmer to fine tune this function.

5. Engine Temp Sensor (ET) – importance LOW - The ET is a single wire sensor that is typically installed in the mechanical fuel pump bock plate or coil mounting plate. The ET sensor lets the ECU know if the engine is cold or if it has warmed to operating temp. When the engine temp is below 100 degrees F, the ET sensor input causes the ECU to enrich the fuel delivery to help the cold engine run smoother. Once the engine is warm, this sensor no longer affects the fuel delivery. The heat sensed by the ET sensor is from oil splash in the accessory case.

EFI Pre Start System Checks

All elements of your EFI system should be checked for proper operation before starting your engine. Below is a checklist to aid in this process.

Fuel system

- Double check fuel selector valve function and positions
- Fuel pump function, primary and backup pump control
- Check and set fuel pressure (35psi with one pump running, engine stopped)
- Fix any leaks, check tightness of all fuel lines

ECU

- Verify power and ground
- Check and set ECU parameters
- Verify function of sensors
 - Crank trigger
 - (check for 'magnet seen' and 'sync seen' indications on programmer while turning engine by hand only – not running)
 - MAP (check gauge page on programmer, should read atmospheric pressure)
 - IAT (should read about ambient temperature)
 - TPS (should increase with application of throttle)
 - Engine temp (should be near ambient temperature)

Ignition

- Verify injector power (red wires should have +12V when ignition power is on)
- Check injector plugs (make sure they are all fully plugged in)
- Verify coil power if necessary (red wires should have +12V when ignition power is on)
- Check spark plug wires installed correctly
- Verify spark plugs are tight

Throttle

- Verify full travel of butterfly with movement of throttle.

Batteries

- Check battery voltages, charge or replace if necessary.

Starter

- Check starter and starter solenoid wiring for proper operation

Using the EFII System

The EFII system is very easy to use. After you have carefully verified that all components are properly installed and working, it is time to start the engine. If fuel and ignition power are present, the engine should start fairly easily. You can add or take away fuel from the starting process by turning the Mixture Knob. If you find that the engine would like more or less fuel than it gets with the supplied mapping, this can be adjusted by modifying the START CYLCES and START FUEL values using the Programmer.

After you get your engine running and all portions of your system are working correctly, it is time to make ground power runs to fine tune your system. You can tune all aspects of your system without leaving the ground. This will require making full power test runs of the engine. If you can't safely do this using the aircraft brakes to hold the vehicle, then tie the aircraft to a secure anchor point for this testing. Flight testing should only be done after all systems have been tested and verified through ground running.

While on the ground, test your aircraft at all different power levels. Your air/fuel ratio should remain near a 13:1 air fuel ratio. A higher air/fuel number is a leaner mixture. A lower air/fuel number is a richer mixture. Never let your air/fuel ratio get into the 14s at high power levels. This could lead to a dangerous lean condition that could damage your engine. At the higher power levels, an air/fuel ratio around 13:1 is good.

The Mixture Knob can be used to add or take away fuel at different power levels. Look at the KNOB value on your Programmer gauge page to see exactly what percent plus or minus, the knob is set to. If you find that at a certain rpm, the mixture requires plus 10 percent fuel to get the desired air/fuel ratio, you can use the Programmer to scroll through the fuel map values until you get to the RPM FUEL section. Find the rpm of interest and simply modify the stored number until it is 10 percent greater.

You should not have to alter any other parameters in your ECU other than the RPM FUEL values. Your ECU has been supplied with a set of base values that should have you close to the desired air/fuel ratio already.

After making your ground runs and satisfying yourself that all systems are working correctly, it is time to make a test flight. Never fly an aircraft with engine systems that are not working 100 percent correctly – systems will not fix themselves in the air if they don't work on the ground. That may sound obvious, but too many people in the experimental world have decided to make test flights on incomplete aircraft – this isn't good for anyone.

FLYING

Flying behind the EFII system couldn't be easier. Your mixture and timing will always be correct and your engine will always run strong.

During run-up, check for a minimum oil temperature – at least 120 F. Check your fuel pressure – should be 30 - 32psi at idle. Get your other systems ready and that's about it.

During flight an occasional check of your air/fuel ratio will give you confidence that your engine is healthy and happy. The air/fuel ratio should be in the low 13s. EGTs will generally be in the low 1300s.

The EFII system requires very little pilot monitoring or intervention so that you can focus on the more enjoyable aspects of flying your airplane.

Dual ECU system addendum

The following two pages describe the features and differences of the Dual ECU version of the EFII systems.

EFII systems can be optionally ordered with redundant Engine Computers (Dual ECUs). The following explains the differences found on the Dual ECU systems.

The EFII Dual ECU systems are redundant systems that can sustain engine operation in the event of a complete failure of one ECU. Each ECU has its own crank trigger, MAP sensor, Intake Air Temp sensor, and power supply connections to allow for fully independent operation of each ECU.

The two ECUs are labeled "88" and "71". This corresponds to the crank trigger pulse position in crankshaft degrees for each ECU. The "88" ECU receives a timing trigger pulse 88 degrees before top dead center from its crank sensor. The "71" ECU receives a timing trigger pulse 71 degrees before top dead center from its crank sensor. The 88 ECU is the primary ECU in the system, the 71 ECU is the backup ECU. Normal flight ops and primary engine tuning should be done using the 88 ECU.

The dual ECU EFII harness has connectors labeled as 88 or 71 to reference which ECU each connector corresponds to. The dual ECU EFII harness has the same connections as the single ECU harness along with several redundant connectors for the secondary ECU.

Sensor treatment in the dual ECU EFII system:

1. Crank Trigger - each ECU has its own crank trigger.
2. MAP sensor - each ECU has its own MAP sensor.
3. Intake Air Temp sensor (IAT) - each ECU has its own IAT sensor.
4. Throttle position sensor (TPS) - There is one shared TPS.

The primary ECU (88) supplies power and ground wires to the TPS.

The signal wire from the TPS is split and runs to both ECUs. The TPS signal is not critical and serves only to provide a simulated accelerator pump function to smooth engine rpm transition upon rapid application of the throttle. If power is lost to the primary ECU, the engine will run without issue in the absence of a TPS signal to the backup ECU.

5. Engine Temp sensor - There is one Engine Temp sensor in the system connected only to the primary ECU (88). The Engine Temp sensor is a non-critical sensor that is used only for warm up enrichment. Once the engine has some heat in it, the Engine Temp sensor has no effect on fuel delivery. Engine start, warm up, and normal ops should be conducted with the primary ECU (88) selected. The secondary ECU (71) has a fixed value of approx. 200 degrees on its Engine Temp Sensor input.

TACH signal wire - The TACH signal is a 12V square wave signal that is driven by the primary ECU.

Mixture Adjust Knob input - The Mixture Adjust Knob is a dual element potentiometer.

One element is wired to the primary ECU. The second element is wired to the secondary ECU. This gives full independence to the wiring of the Mixture Adjust Knob with only one cockpit knob required for the function.

ECU Select Switch - The ECU Select Switch controls which ECU is connected to the fuel injectors. This is a panel mounted toggle switch that is wired directly into the EFII system harness.

Theory of operation

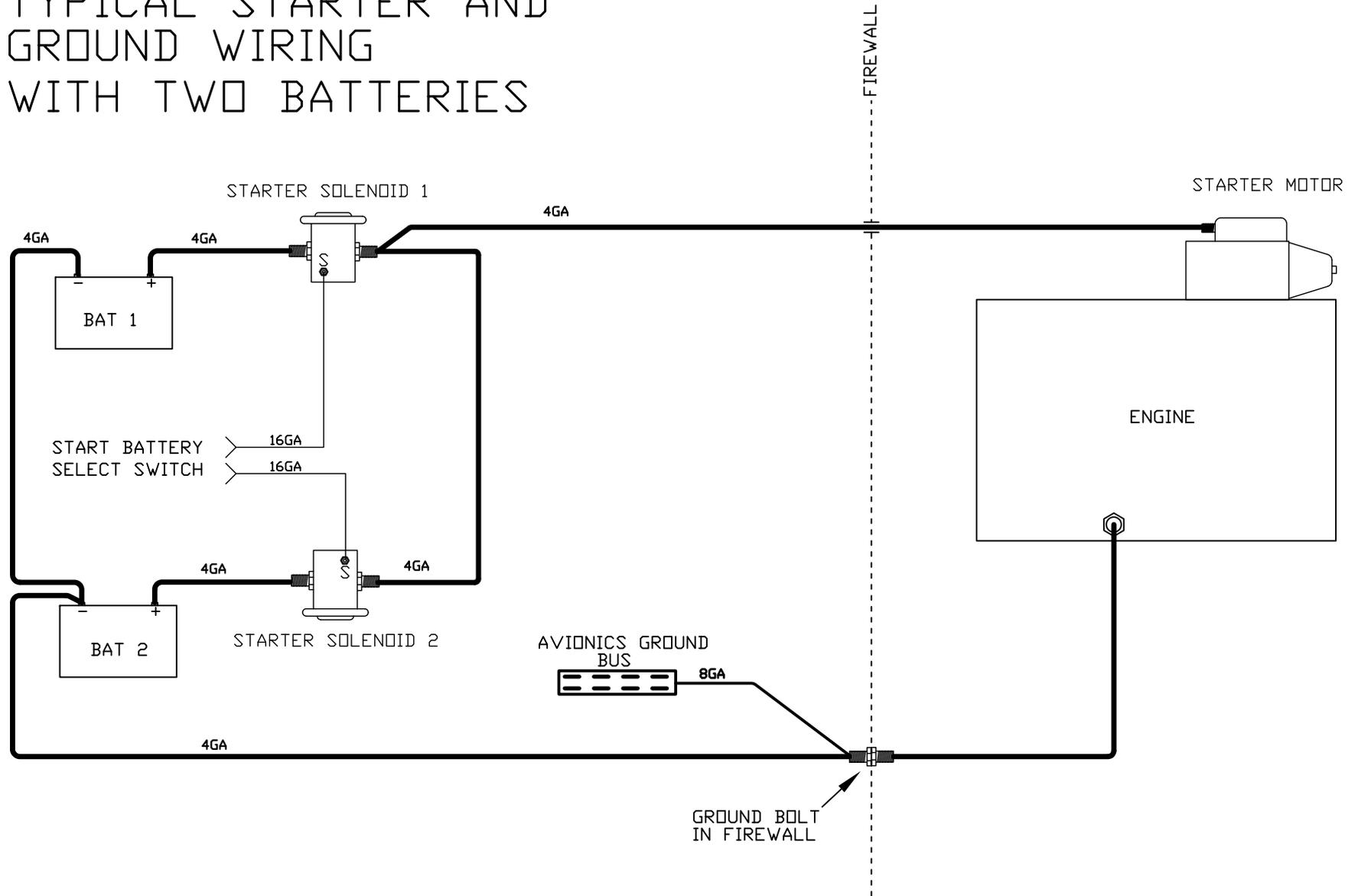
The Dual ECU EFII system consists of two independently triggered ECUs that are always powered and running. One ECU is wired to control the ignition coils for the top spark plugs, the second ECU is wired to control the ignition coils for the bottom spark plugs. The fuel injector trigger wires are switched between the ECUs by means of the ECU Select Switch.

Normal operations and primary tuning should be done with the primary ECU (88) selected. Upon initial installation and tuning, the Programmer should be plugged into the primary ECU. After primary fuel map tuning is complete, the values in the primary ECU should be transferred over to the secondary ECU manually by plugging the Programmer into the secondary ECU and manually adjusting the fuel map values to match those used in the primary ECU. After this is done once, you can plug the Programmer back into the primary ECU and use it for normal operations. If desired during runup, the ECU Select Switch can be set in each position to verify running operation of each ECU.

Primary ECU failure - If the primary ECU were to lose power or otherwise fail, simply switch the ECU select switch over to the secondary ECU. This will pass full injector control and fuel delivery to the secondary ECU. If the primary ECU is without power you may lose either the top or bottom spark plugs (whichever are connected to the primary ECU). The other half of the spark plugs and all injectors will continue to function normally. Due to the high energy output of the EFII ignition system, very little horsepower is lost when one set of spark plugs is not running. Hence, if you were to lose power to one ECU and switch engine injector control to the secondary ECU, engine operation and power output will be affected only slightly.

DRAWING 1

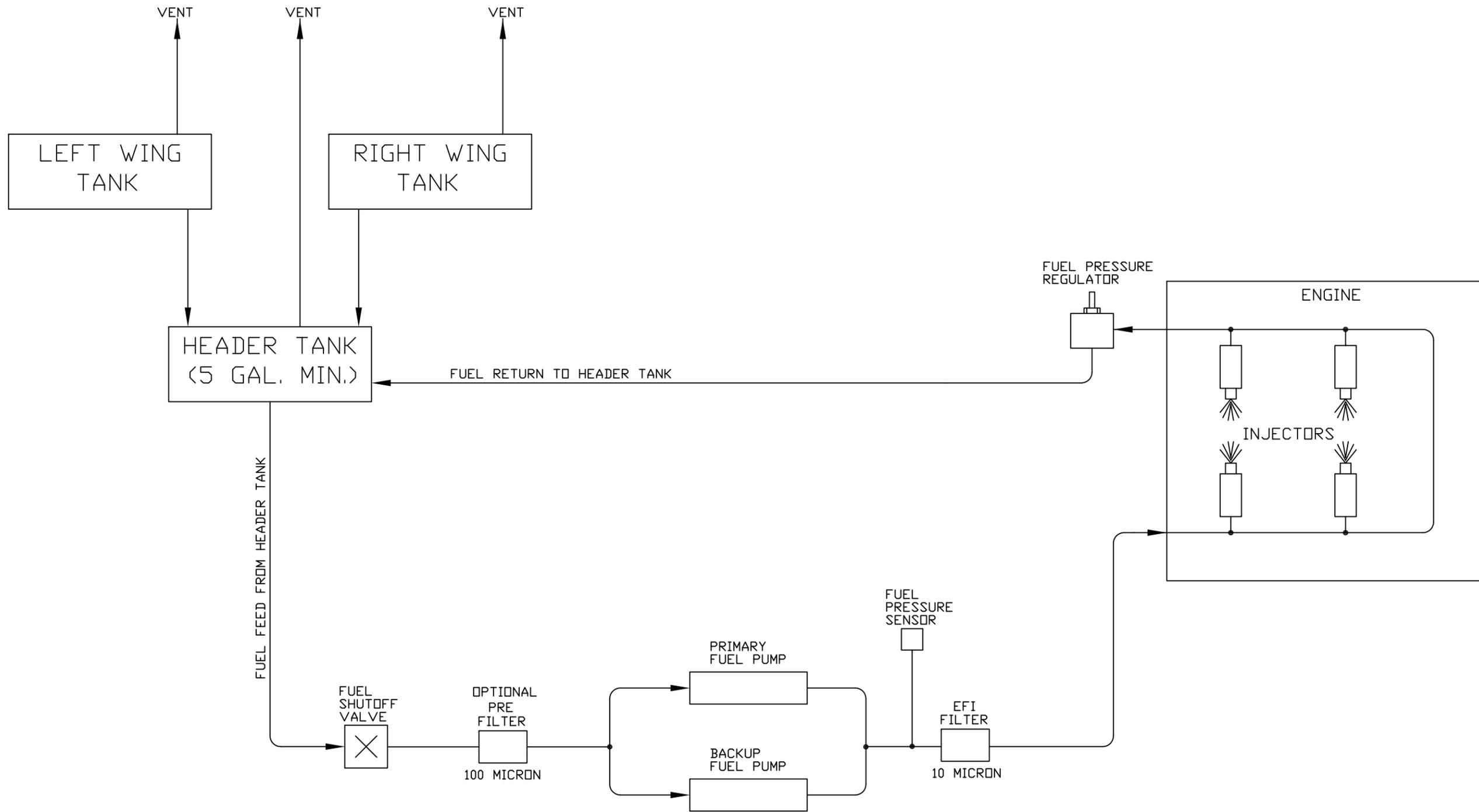
TYPICAL STARTER AND GROUND WIRING WITH TWO BATTERIES



DRAWING 2

SAMPLE FUEL SYSTEM USING HEADER TANK

- NOTES:
1. VENT LINES - USE 1/4" (-4) TUBING
2. FUEL FEED AND RETURN LINES
USE 3/8" (-6) TUBING



DRAWING 3

SAMPLE FUEL SYSTEM WITH RETURN TO EACH TANK

- NOTES:
1. VENT LINES - USE 1/4" (-4) TUBING
2. FUEL FEED AND RETURN LINES
USE 3/8" (-6) TUBING

