DIESEL/VEGETABLE OIL HYBRID VEHICLES
Systems for the conversion of diesel engines to mulit-fuel use.
CHRISTOPHER GOODWIN MOTORSPORT, SPECIAL VEHICLES DIVISION
1218 10th Ave. Seattle, Wa. 98122 PH: 206.322.6242
WWW.FRYBRID.COM

INSTALLATION MANUAL
Version 6.5

Disclaimer:

While Frybrid has made every effort to completely research the use of Vegetable Oil as an alternative fuel for diesel vehicles, installation of the "Frybrid Kit" requires that the vehicles owner understand that they are engaging in experimentation. As such we encourage independent research and provide a constantly updated list of research papers (www.frybrid.com/docs.htm) as well as an interactive "Forum" (www.frybrid.com/forum/) to aid in this independent research.

While users of our system, other commercial systems and dozens of home-made systems have logged hundreds of thousands of mile running all manner of diesel engines on Vegetable Oil without any issues; others have lasted only a few hundred miles. A properly installed and maintained Frybrid system should outlast and outperform your vehicle with no reduction in engine longevity; I however routinely see conventional vehicles with less than 30,000 miles on the odometer which have been completely destroyed by lack of maintenance or abuse. Installing a Frybrid System should only be done with the complete understanding that you are modifying the vehicle, just as the installation of performance components modifies a vehicle, and in the same way, improper installation or use may result in damage to the vehicle.

Frybrid is constantly researching this technology and attempting to improve our products which we considered an "evolving system". As can clearly be deducted by reading the research papers on our web site, papers generated at a cost of millions of dollars by world governments and Universities, the use of Vegetable Oil as an alternative fuel in Diesel (Compression Ignition) engines is possible, doing so without compromising the engines longevity however, requires that all the criteria of a properly function system are met. The Frybrid system has been designed to meet or exceed these criteria while preventing the user from inadvertently or intentionally operating the engine on vegetable oil outside these limits.

We highly advise that the user of this system establish a regular vehicle maintenance schedule before the installation of this system and that they have at lease two oil analyses performed before installation. This will provide a baseline against which future analyses can be judged. Be sure that your vehicle is running the proper oil and anti-freeze and that the engine is in proper working order before modifying or driving any vehicle.

Please share your experiences with other on the "Forum" and remember, you are a pioneer in a new science and a Frybrid ambassador to those who do not yet understand this field. We will do everything in our power to help you in your experimental vehicle research.

Sincerely,

Christopher Goodwin
FRYBRID

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Initial preparation:

Begin with the vehicle cold and on level ground. You will need to have access to the underside of the vehicle, we strongly advise that you jack the vehicle and place jack stands under the vehicle if you do not have access to a lift. DO NOT CRAWL UNDER A VEHICLE WHILE IT IS ON A JACK OR WHEEL RAMPS.

If you do not have a manual for your vehicle we strongly recommend that you get one. A general cooling system diagram can be found in Fig.1 for reference, you will need to locate the coolant lines connecting the vehicles heater core to the engine, one line feeds hot coolant from the engines head to the heater core in the dash, the other returns coolant to the engine, you will be tapping into these lines with the provided “T” fittings, the fitting with the temperature sensor will be spliced into the feed line and the fitting without the sensor will be spliced into the return line. It is important that these connections are made between the engine and any coolant shut off valves, which may be in the system.

A coolant flow diagram can be found in Fig.1, this diagram shows how the various components will be connected to insure proper coolant flow. The various components need to be plumbed as shown in this diagram, do not deviate from it. The system is plumbed to allow the hot coolant to heat the components in the following order; Final fuel heat exchanger, fuel filter, fuel feed line, in-tank heat exchanger and finally the fuel return line. This insures that the hottest coolant heats the final fuel heat exchanger first and the temperature sensor senses the coolant temperature as it is fed into the system.

Installation:

Set the fuel tank in position and determine the best routing for the fuel lines to exit the trunk being sure there is sufficient room to route the lines without kinking them. Once you have decided on this point, drill two 1 3/8” holes side by side. Using a file or saw cut the triangles from the top and bottom of the holes to form a single oval hole. Cut a 10” section of 3/8” fuel line, cut one side of the fuel line lengthwise with a razor knife, use this piece of line to cover the metal edges on the hole you have made, this will protect the coolant lines. Refer to Fig.2

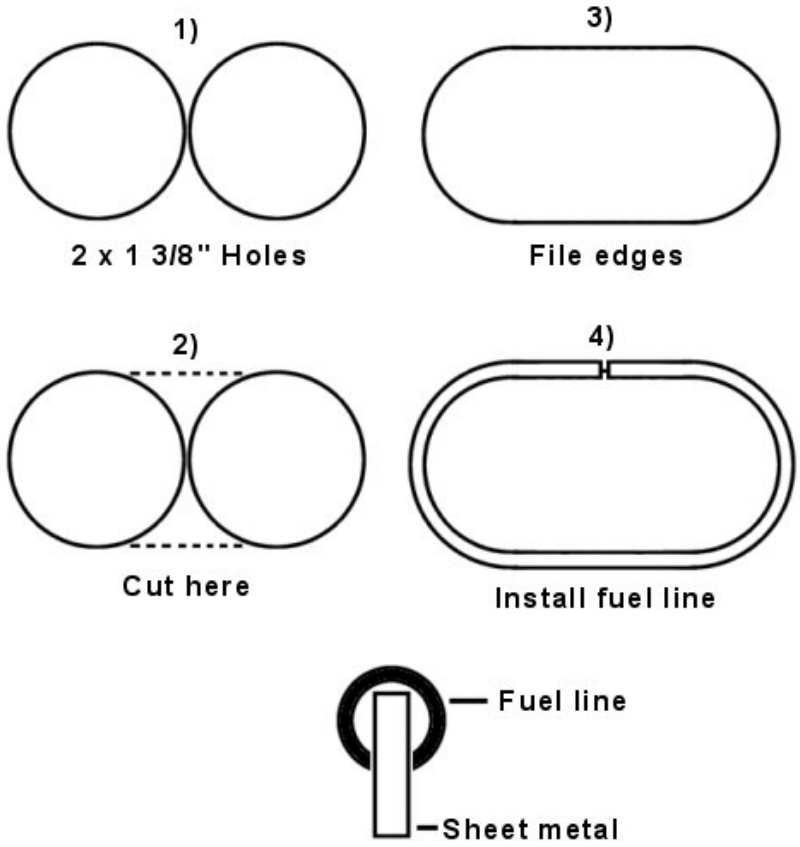


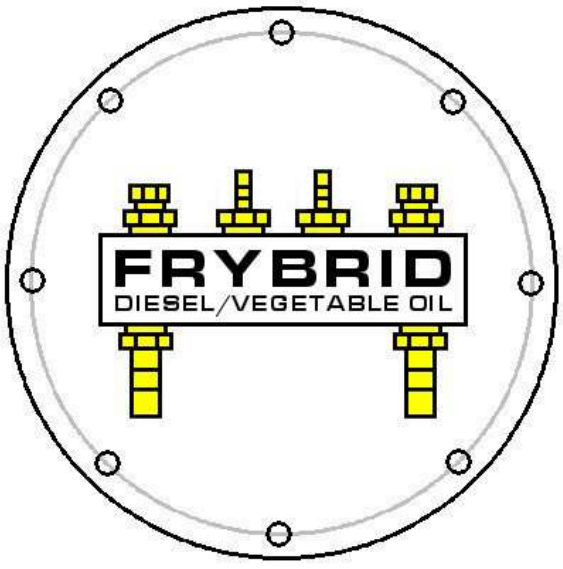
Fig.2

In the engine compartment determine the best locations for the final fuel heat exchanger, filter, fuel valves and coolant “T” fittings. When doing this consider hose routing between components. (Refer to Fig. 1). Test the locations you have selected by routing coolant hose between the components and simply holding it in place, if the bends are so severe that the hose kinks, you clearly need to find an alternate location, If necessary look for factory components, which can be relocated to make the room required. It is important to consider that the fuel valves should be located as close as possible to the injection pump inlet and return fittings to minimize the amount of fuel which needs to be purged. Check and re-check your coolant and fuel routing diagrams and try alternate locations until you have decided on a final location for the components and mount them in place.

Once you have decided on the location of the required components, you must decide on the routing of the two ¾" lines which will run from the engine compartment fittings to the fuel tank. Re-check the routing and be sure that you will not kink the hose and that it is clear of the exhaust and moving parts such as the drive line and suspension components. When this has been done, you will feed the ¾" line from the engine compartment, along the proposed route to the fuel tank, do not cut the coolant line until you are absolutely sure of the routing. When you are sure connect the free end of the coolant line to the tank hose barb with no hose clamp, When you are absolutely sure of the routing, determine where the line needs to terminate in the engine compartment and cut the ¾" hose 24" past where you believe it will need to end. Repeat the procedure with the second line.

Note: Fill a spray bottle with water and dish soap, use this to lubricate the ¾" lines when sliding them through the hole in the trunk so that the lines will not stick to the fuel line insulating the holes edges.

Now remove the coolant lines from the vehicle noting the routing you have chosen. Lay the cut lines on the ground and feed the aluminum line through the lines one at a time. Filing the end of the aluminum line or wrapping it in tape will make it easier to feed the line through the hose. Spraying it with soapy water will and keeping both lines as straight as possible will also help. You should have 18" of aluminum line extending from the fuel tank end of the coolant hoses and 12" from the engine compartment end. Remember you can always cut lines if they are too long, you cannot however add line to lines already cut. Once the aluminum line is in place inside the coolant line, wrap the end of the coolant line with tape to hold the aluminum line in place.



In-tank heat exchanger cap

Fig. 3

In the trunk, decide what direction you want the tank heat exchanger fittings to point to simplify the line routing (lift the heat exchanger from the tank far enough to clear the bolts, turn the heat exchanger to any of the 8 possible positions and

lower it back onto the bolts). Once you are sure of the position, coat both sides of the exchanger gasket with “Gasgacinch” gasket sealer and securely tighten the exchanger to the tank taking care to seal even the threads of the mounting bolts with sealant. Do not over tighten the 10mm nuts holding the heat exchanger to the tank, or tighten it so far that it pushes the gasket out.

Begin feeding the lines one at a time from below the vehicle into the trunk compartment where the fuel tank is located. Once in the trunk the tape holding the aluminum line to the coolant line should be removed, remove the compression fittings from the exchanger cap opposite the ¾” hose barbs. The aluminum line should be routed through the ¾” hose barbs on the exchanger and out the compression fitting holes, slide the coolant line firmly over the hose barb, install and tighten hose clamps to hold the coolant lines to the barbs. It may be easier to partially remove the tank from the vehicle and “slide” the tank and exchanger onto the lines until in place.

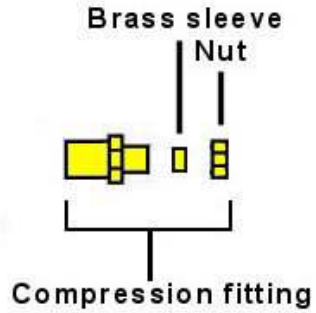


Fig. 4

Remove the nut and nylon sleeve (brass in older systems) from the compression fittings you have removed, coat the first 4 threads of the fittings large end with the provided thread sealant and slide them over the aluminum lines and tighten securely into the heat exchanger taking care not to damage the exchanger. Slide the nylon sleeve and nut over the aluminum line and tighten it by hand. When you are certain that the aluminum fuel line is in place, tighten the compression fittings securely – remember they need only be tightened enough to seal. When both lines are attached, tighten the hose clamps on the coolant lines. Now cut the aluminum line leaving at least 2” of aluminum line protruding from the compression fittings. Attach fuel line to this 2” of aluminum line and loop it to connect to one of the hose barbs on the center of the heat exchanger cap, either one will work at it may be easier to cross the lines. Refer to fig 5. It does not matter which one you choose.

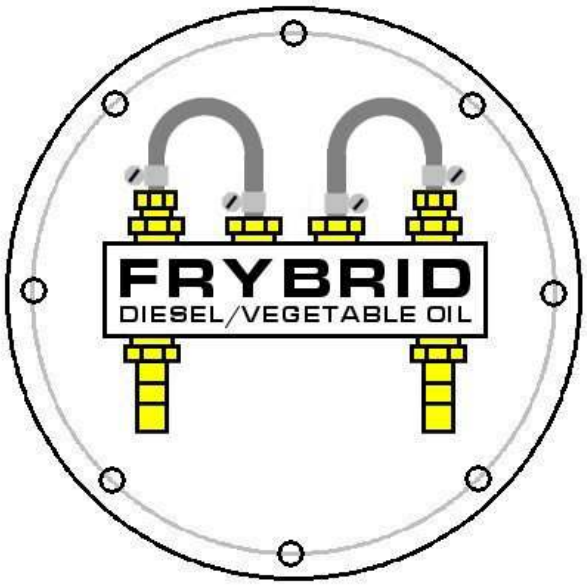


Fig. 5

Carefully route the lines along the predetermined route to the engine compartment, taking care not to kink the coolant line. Since the internal aluminum line can be bent far more sharply than the outer coolant line, if the coolant line is not kinked, the internal line is not kinked. Secure the line in place with the “P” clamps and self-tapping screws provided from the rear to the front of the vehicle terminating them in the engine compartment. Take special care not to route the line against the exhaust, drive lines, sharp edges or any engine or transmission component which may vibrate when the engine is running.

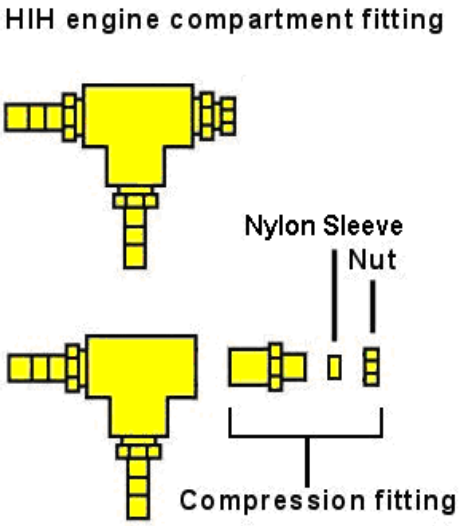


Fig. 6

From the engine compartment, remove the nuts and brass sleeves from the compression fittings on the HIH engine side fittings, slide the HIH engine side fittings over the aluminum line and trim the coolant line so that the end hose barb slides securely into the hose and the fittings are in the location you desire. When in place tighten the hose clamps on the coolant lines securing them. Remove the

nut and brass sleeve from the compression fittings you have removed, coat the first 4 threads of the fittings large end with the provided thread sealant and slide them over the aluminum lines and tighten securely to the HIH engine side fittings then slide the Brass sleeves and nuts over the aluminum lines to the compression fittings and tighten them securely. Now you can cut the aluminum line where desired leaving enough line to allow you to slide and clamp flexible fuel line over the end.

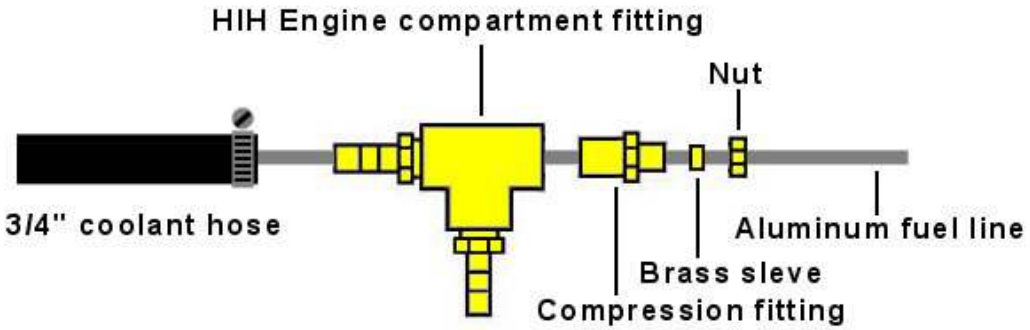


Fig.7

Following the layout in Fig.1 connect the various components with coolant line, fuel line and hose clamps.

Tip 1: You should fill the VO filter with diesel fuel before installing to lessen the amount of air, which must be bled from the system before starting.

Tip 2: You can pre-fill the VO filter and lines with diesel by connecting the VO feed line to the diesel return connection on the return valve and running the vehicle for 3 minutes at idle. Then re-connect them according to Fig.1.

Tip 3: Disconnect the 5/8” coolant lines connected to the HIH Engine Compartment Fittings, hold a garden hose to one fitting and force water through the system until it runs freely from the other fitting. This will pre-fill the systems lines and heat exchanger with water.

Tip 4: On VW and Mercedes vehicles you can simply cut the hard lines attached to the various banjo fittings 2” back from the fitting, the 3/8” fuel line may then be slipped over this section of factory hard tube and clamped in place.

Your system is now installed except the electrical portion, the fuel tank should be filled with **only** 2 gallons of diesel fuel. **Do not run the engine for more than a few minutes until the installation is complete. Allowing the system to come up to temperature with diesel in the tank will cause the diesel to be heated which can cause complications.**

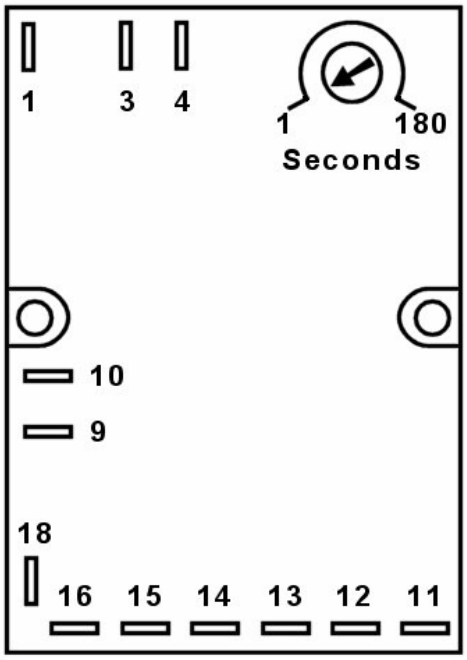
Installing the FRYBRID GEN-3 Microprocessor

Find a suitable location to install the unit. It should be installed away from electromagnetic fields such as those created by electric motors, speakers and amplifiers (ie; Do not mount the unit adjacent to a stereo speaker or on a fan or wiper motor housing) and should be in a clean dry location. Under the dashboard is ideal.

The Gen-3 has two mounting holes in the unit, sheet metal screws, tec screws or small bolts can be used to mount the unit. It may also be mounted with heavy duty Velcro or even glued in place. Be sure nothing will accidentally make contact with the electrical connections on the unit.

Once the wires from the temp sensor, switches, lights, a fused constant battery + (not switched by the ignition switch) and a switched battery + (only on when the ignition is on) have been run to the mounting location, you can begin to crimp ¼" spade connectors on to the wires and connect them to the terminals on the GEN-3 as shown below.

1 = Purge button
3 = +12vdc ignition ON
4 = Coolant temp switch
9 = Vehicle ground
10 = +12vdc constant (Batt+)
11 = To supply valve
12 = To return valve
13 = To buzzer+
14 = Diesel indicator+
15 = VO indicator+
16 = Pugre indicator+
18 = +12vdc constant (Batt+)



Connections:

1) Purge button. This lead comes from the purge button, the other lead from the purge button can be connected to terminal #3 which is supplied with 12vdc+ only when the ignition is on or to terminal #10 which has constant 12vdc+.

3) 12vdc+ Ignition on. This lead must come from the ignition switch or fuse panel and should have power only when the ignition switch is in the on position. Stereos commonly use a switched power lead, and many vehicle accessories are also switched. You can find a switched lead with a test light by testing connections with the ignition off, then again with the ignition on. Test lights are available at any auto parts store for around $5.00. One side of the “Purge” button should also be connected to this terminal; the other side goes to terminal #10.

4) Coolant temp switch. This lead comes from the coolant temp switch, the other lead from the coolant temp switch should be connected to terminal #4 which is supplied 12vdc+ switched (12vdc+ with ignition on only)

9) Vehicle ground, this lead connects to any of the sheet metal on the vehicle (possibly the GEN-3 mounting screws).

10) 12vdc+ constant. This lead should come directly from the battery with the fused lead supplied with the kit. Be sure to use a grommet if this lead will pass through any sheet metal so that the metal will not wear through the wires insulation over time and short the fuse.

11) Power to the Supply solenoid valve (Valves have two wires; one connects to vehicle ground, the other to power).

12) Power to the Return solenoid valve (Valves have two wires; one connects to vehicle ground, the other to power).

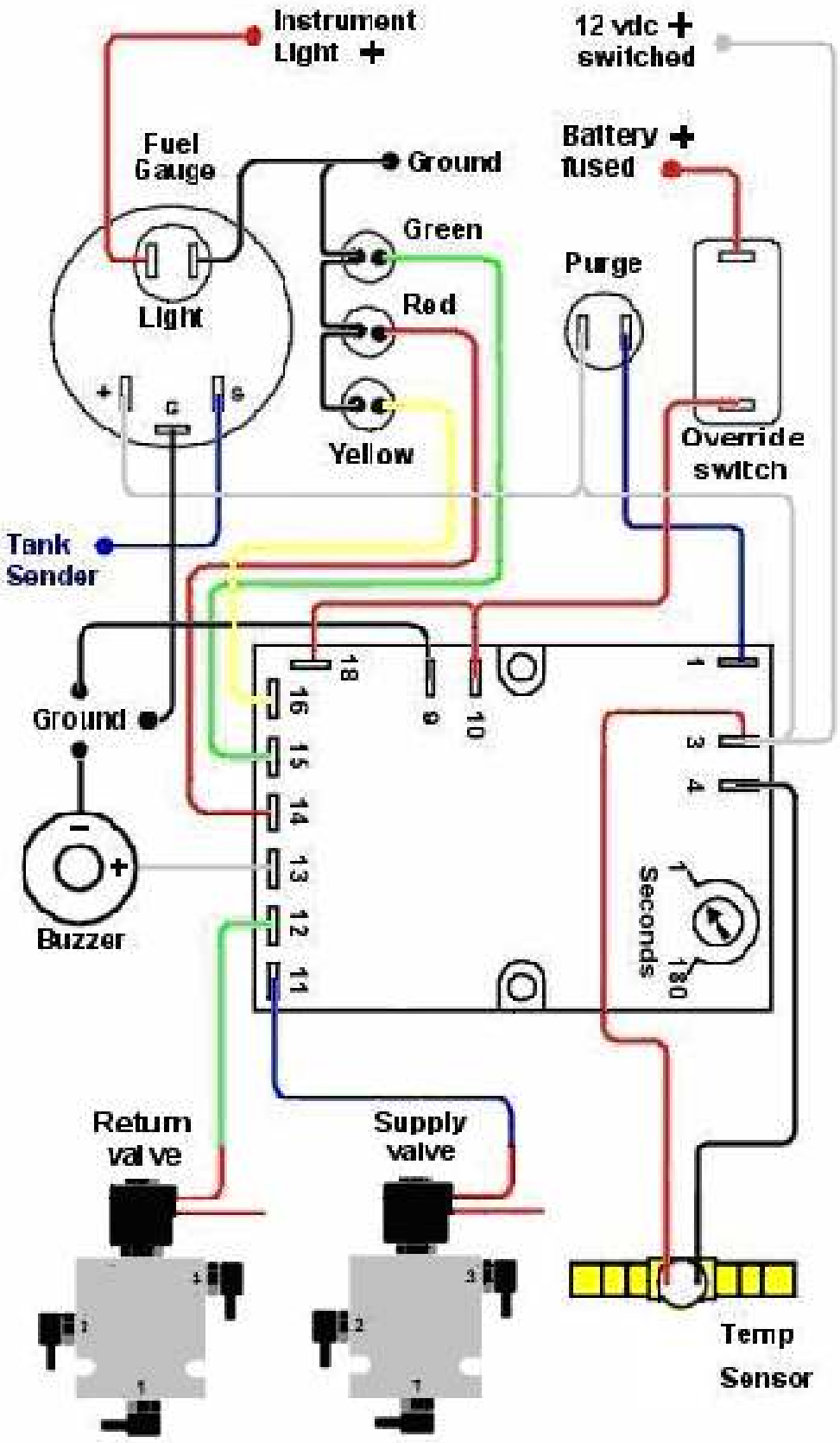
13) Power to the + (red) lead on the warning buzzer. The buzzers other lead (-, Black) should be connected to vehicle ground.

14) Power to the + (red) lead on the Diesel indicator light (Red light). The indicator lights other lead (-, Black) should be connected to vehicle ground.

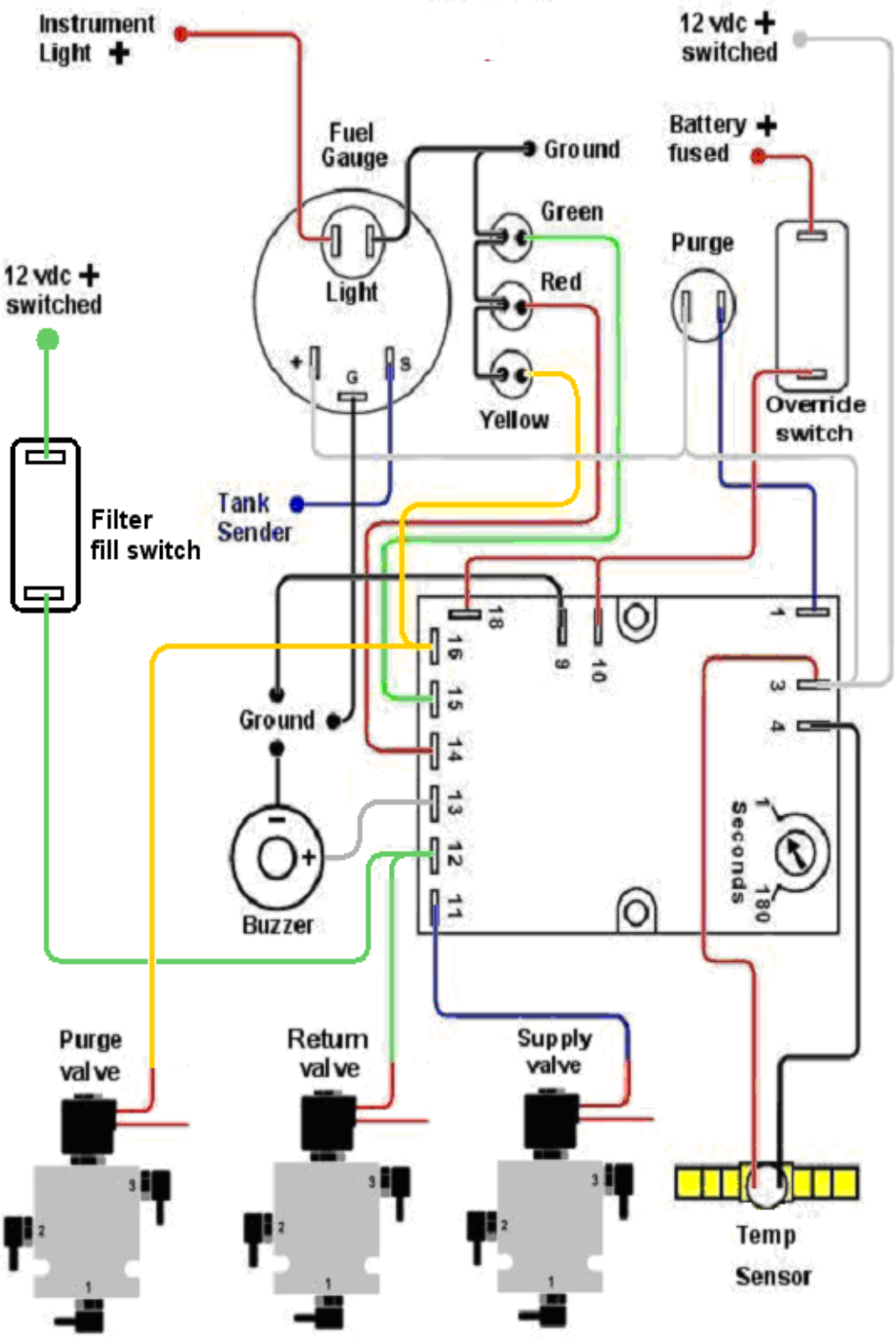
15) Power to the + (red) lead on the VO indicator light (Green light). The indicator lights other lead (-, Black) should be connected to vehicle ground.

16) Power to the + (red) lead on the Purge indicator light (Yellow light). The indicator lights other lead (-, Black) should be connected to vehicle ground.

18) 12vdc+ constant. This lead should come directly from the battery with the fused lead supplied with the kit, or simply be jumped from terminal #10.



General Gen-3 wiring diagram



Gen-3 wiring diagram for 3 valve controlled loop system with filter fill switch

(To use the filter fill switch after changing a filter, run the vehicle in diesel mode and close the switch, this will backfill the filter and lines with diesel. Wait 30 seconds, then crack open the VO feed line at the feed valve until no air comes out. **BE SURE TO SET THE SWITCH BACK TO ITS OPEN POSITION OR YOU WILL PUMP YOUR DIESEL TANK INTO YOUR VO TANK**.)

It is recommended that all soldered connections are covered with heat-shrink tubing. Wires should be run in a neat bundle and wire tied in place. Take care in the routing of wires to avoid hot items such as exhaust components and moving components such as steering and throttle linkage. Remember, “Measure twice, cut once”.

Tip: When running several wires together, you can pre-cut the wires longer than you need, insert one end of the wire bundle into the chuck of a drill and hold the other end of the bundle with vise-grips or a vice. Slowly turn the drill motor to twist the bundle together, when tightly twisted, release the wire and you will have a neatly twisted bundle.

Tip: Always use a rubber grommet when putting wires through a hole in metal to protect the wires from the metal wearing through the insulation and shorting the wire.

Final stage:

Setting the system

Turn the ignition on. The systems Red diesel indicator should light and remain lit.

Switching the override switch should turn the red light out.

The fuel gauge light should come on when the headlights are turned on.

The fuel gauge should move up slightly when the ignition is turned to the ON position.

Be sure there are fuses in the in-line fuse holders.

1) Once you have the fuel lines and coolant lines bled of air (Refer to Tips 1,2 & 3) and 2 gallons of diesel fuel in the VO tank you will need to establish that the system can be switched between the fuel tanks without incidence. The simplest method to do this is to use a 3’ jumper wire. Connect one end to the positive battery clamp, being sure not to allow the loose end to contact any metal on the vehicle.

Start the engine and once running touch the loose end of the jumper wire to the contact on the FEED valve for about a second. This will momentarily switch the fuel feed from the stock tank to the fuel in your VO tank. Do this several times for about one second each time to allow any trapped air to be bled into the fuel system without stalling the motor. When you are confident that no air remains in the system, touch the jumper wire to the connector for 30 seconds. If the engine runs without faltering, all air is purged from the system, and you may continue.

2) Locate the purge cycle timing adjustment on the Gen-3 Controller (small blue knob labeled “1-180”) and turn it counterclockwise gently until it stops.

Locate terminals #4 & #10 on the Gen-3 Controller. Clip one end of your jumper wire to terminal #10 taking care that it does not contact any of the other terminals. With the ignition ON and the red (diesel) indicator lit on the control panel, touch the loose end of the jumper momentarily to terminal #4 – This will trigger the controller to switch to VO mode – The red light will go out and the Green VO indicator will light – The vehicle is now drawing and returning fuel to and from the VO tank.

Press the “Purge” button and both the red and green indicators will go out and the yellow (purge) indicator will light for a moment, then go out and the red (diesel) indicator will again light. Shut the engine off and remove the key from the ignition. Now adjust the purge cycle timer to roughly 30 seconds.

3) Pour the supplied dye into 1 gallon of diesel fuel and mix it well. Pour the dyed fuel into the VO fuel tank; this will dye all fuel in the VO fuel tank blue.

4) Have an assistant start the engine and depress the accelerator to run the engine at 1200 – 1500 RPM and hold it there, again momentarily connect the jumper between terminals #10 and #4 switching the system to VO mode (Green light lit). Watch the fuel-viewing window installed in the return line until you can see the blue dyed fuel in the window. Placing a white business card behind the window and illuminating it with a flashlight may help this process.

Now, while watching the fuel window have your assistant press the purge button, this will switch the supply from the VO tank to the diesel (un-dyed fuel) tank. Count how long it takes for the fuel in the window to turn clear and note this time. As soon as the fuel is clear have the assistant in the car switch the override switch off and turn the motor off.

What has happened is the following:

By touching the jumper to terminal #4 you have tricked the controller into believing it has received a signal from the temperature sensor telling it to switch to VO from diesel. This caused the feed and return valves to switch to the VO tank containing dyed fuel, which you saw in the fuel-viewing window.

Pressing the “Purge” button told the controller to run a purge cycle, the feed valve changed to the diesel tank (not dyed), and you counted how many seconds it took for the dyed fuel to be purged from the system. You then had your assistant override the controller and stop the motor.

5) If you counted to 6 seconds before the fuel in the fuel-viewing window was clear, you will now need to set the purge cycle timer to 6 seconds. Once this is done, start the engine and again momentarily connect the jumper between terminals #10 and #4 switching the system to VO mode (Green light lit). Now press the “purge” button and count the number of seconds the yellow light remains lit before going out, this should be the same number of seconds as you

counted in step 2 (example was 6 seconds). Continue adjusting the purge cycle timer and testing until pressing the purge button lights the yellow light for this time period.

6) You have now completed the set up of the controller and your system should function as follows: Start the engine and the red (diesel) indicator is lit, run the engine until the coolant temp reaches 180F the red (diesel) indicator should go out and the green (VO) indicator should light, when the purge button is pressed both the red and green indicators should go out and the yellow (purge) remain illuminated for the duration of the purge cycle, then go out and the red indicator light again.

If the system is now functioning as described, fill the VO tank with VO and go for a drive! If not repeat steps #4 & #5 until it does.

Trick: If terminal #1 is supplied with +12vdc, permanently or momentarily after the system has switched to VO, the Gen-3 will initiate a purge cycle.

Trick: If terminal #4 is supplied with +12vdc, permanently or momentarily, the Gen-3 will switch from diesel mode to VO mode. (if you want to be able to manually switch to VO mode, you can connect a “normally open” push button to this terminal – However the system is designed to automatically switch as soon as it is capable of doing so, switching before this point can cause engine damage due to insufficiently heated oil.

Tip: The system is designed to lock out completely once a purge cycle has been completed. You can override this feature by cutting power to the controller with the “Override” switch momentarily. So if you want to run several purge cycles without turning the motor off, you can simply cycle the override switch between cycles.

Note: Depending on the fuel injection system you have, purging completely may not clear VO from the injectors themselves. If you notice hard starting in the morning, or white smoke on startup which was not present before using VO, run the purge cycle 30 seconds before shutting the motor down, if still present try 1 minute and so on until you find your systems requirements. Alternately if you find hard starting and/or white smoke on startup, try running a on diesel and shutting down on diesel, if the issue remains, it is not VO related.

Congratulations! You have successfully installed the Frybrid Diesel/Vegetable Oil system. You vehicle will now warm-up and shut down on Diesel, but run on 100% Vegetable oil!.

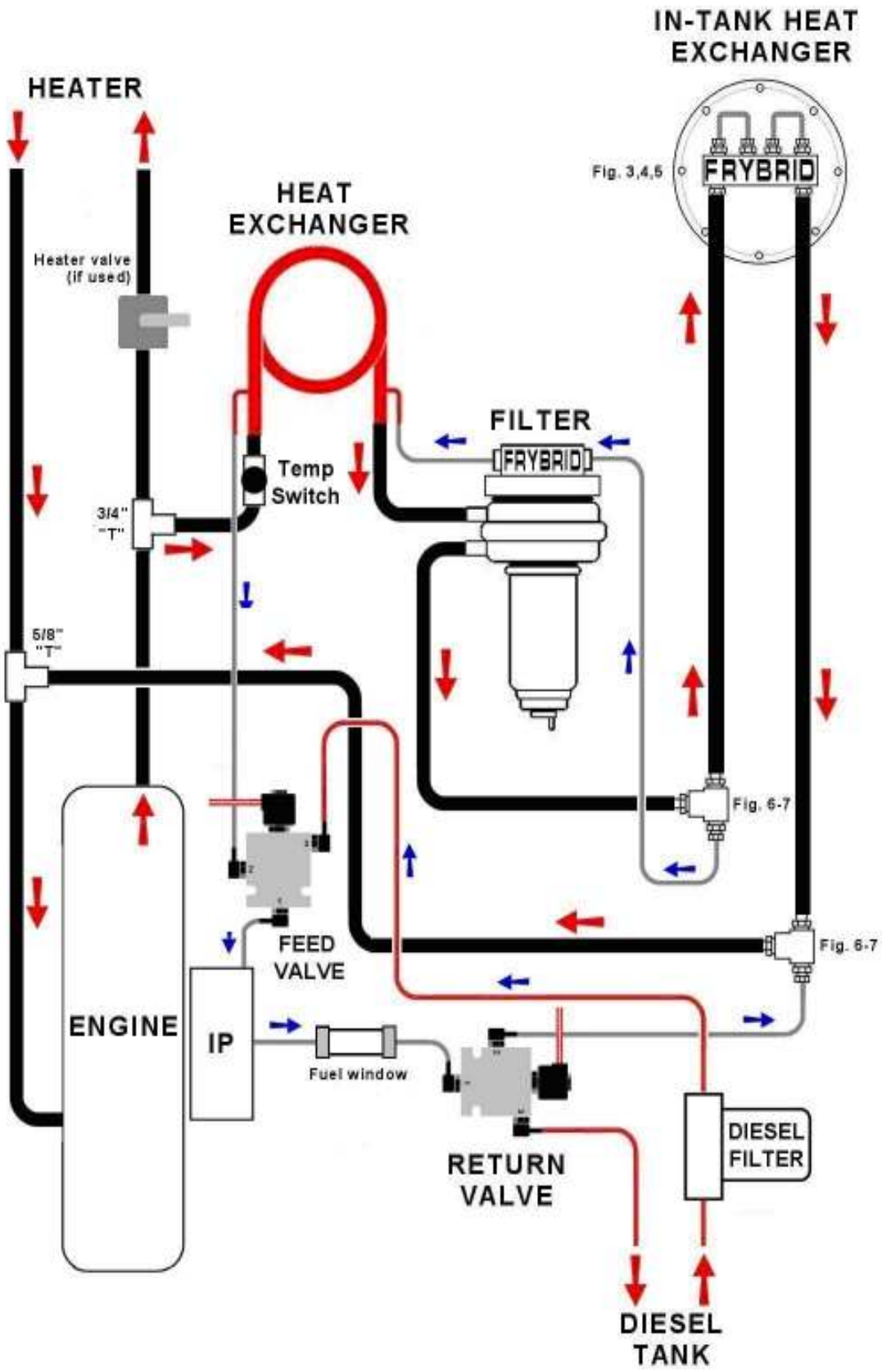
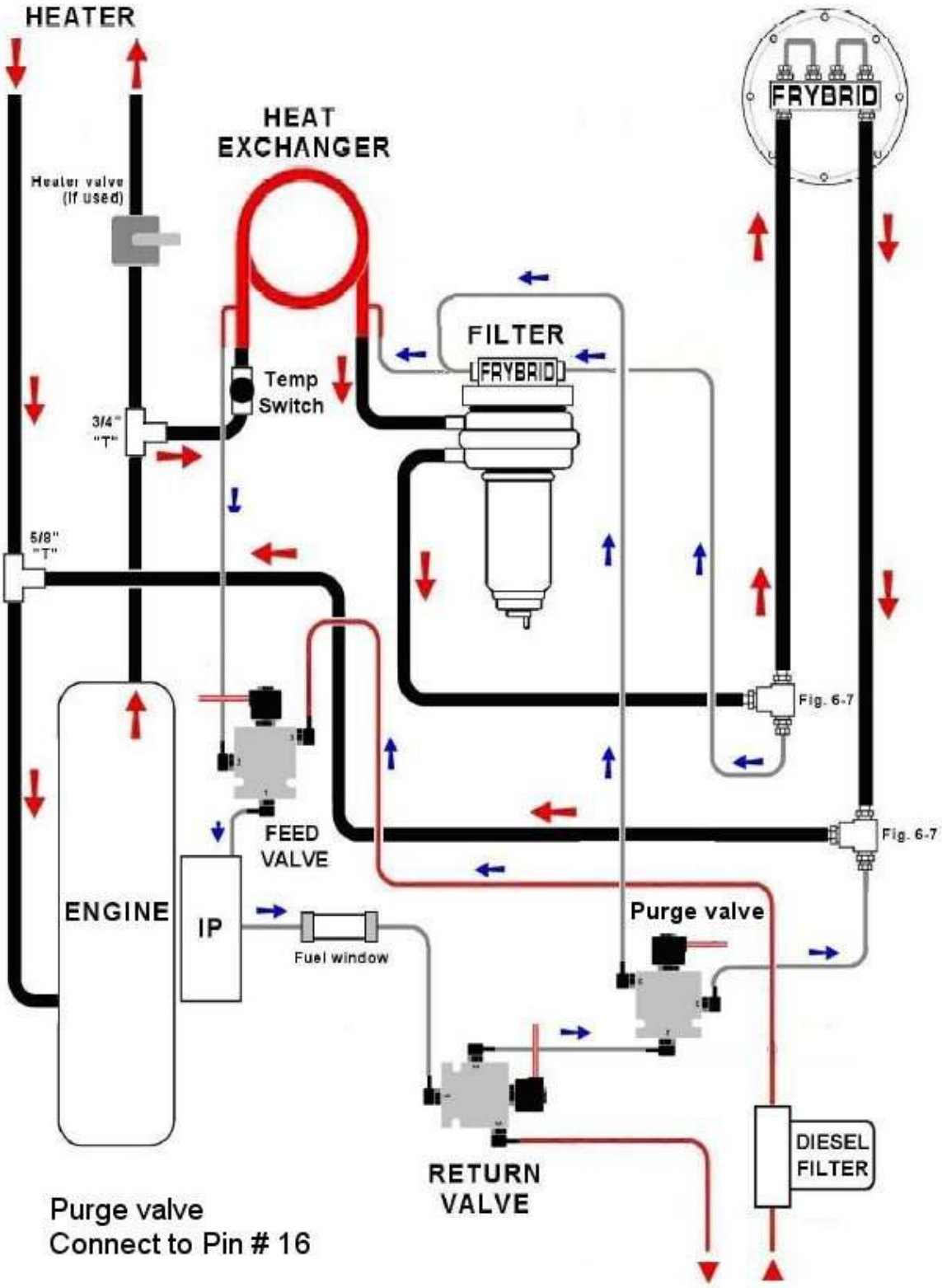

IN-TANK HEAT EXCHANGER
HEATER
Fig. 3,4,5
FRYBRID
HEAT EXCHANGER
Heater valve (if used)
FILTER
FRYBRID
Temp Switch
3/4" "T"
5/8" "T"
Fig. 6-7
Fig. 6-7
FEED VALVE
ENGINE
IP
Fuel window
RETURN VALVE
DIESEL FILTER
DIESEL TANK

Fig.1



This diagram is for a 3 valve controlled loop system

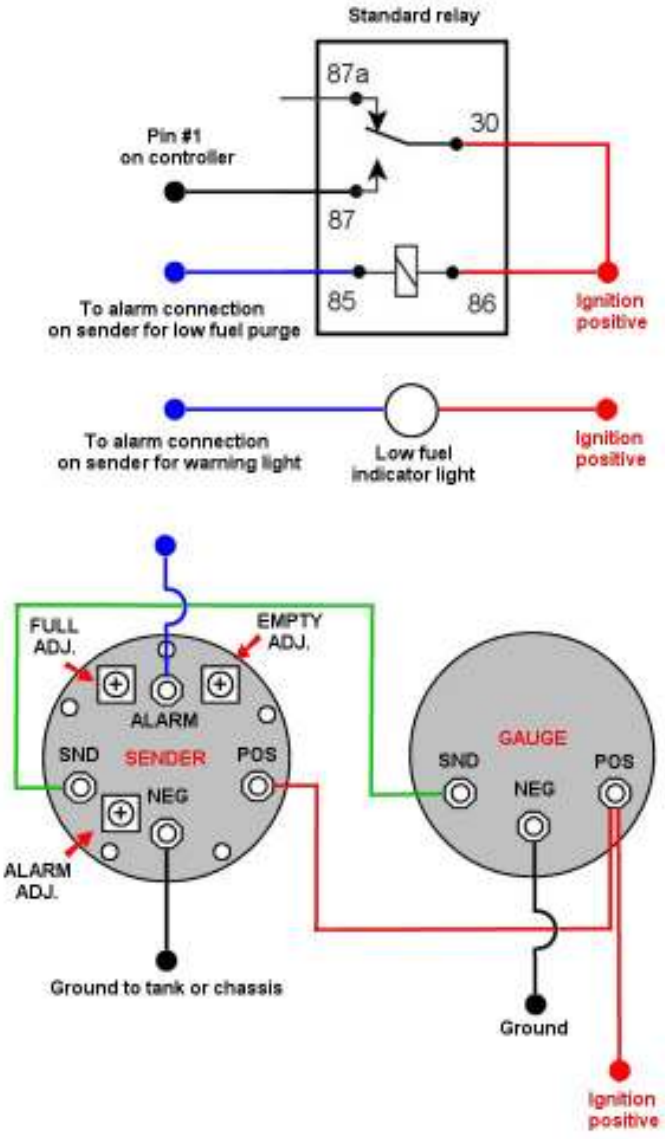
Calibrating and wiring of the inductive fuel level sender and low fuel warning/auto purge

Introduction:

We have discovered that polymerized oil can build-up on the standard fuel level sender body and float arm causing it to malfunction, the float are can be very difficult to adjust properly giving inaccurate fuel level readings and some customers expressed a desire for a system which would automatically default to diesel and auto purge in the event of low fuel in the VO tank.

To solve these issues and meet the expectations of our customers we have introduced a new inductive fuel level sender with no moving parts, made from non-reactive metals with a low fuel indicator which can be used to auto-purge the system or simply to light a low fuel indicator light on the dash.

Wiring the inductive level sender:



Calibrating the inductive sender:

We strongly recommend that the sender be calibrated outside the fuel tank. When calibrating senders we use a plastic bottle filled with vegetable oil. This allows you to make the various adjustments before the tank is installed in the vehicle and the adjustment screws are difficult to access.

Once adjusted it is suggested that the adjusters be sealed in position with silicone sealer or a waterproof epoxy.

Calibration
Make the wiring connections as shown on the wiring diagram. Turn on the ignition switch. Turn the FULL and EMPTY adjustment screws located on top of the sender to the full CW (clockwise) position.

Alarm/purge calibration:
Turn the EMPTY adjustment counterclockwise until the needle on the fuel gauge is at the desired alarm/purge point; we set this just above the "E" mark maybe 1/16". Now adjust the alarm adjustment until the light just comes on (the alarm circuit goes to ground).

Now while the alarm light is on (or the circuit has gone to ground) slowly adjust the EMPTY adjustment to move the needle above the trip point and the alarm light should go out (the circuit opens), then again turn the EMPTY adjustment so that the needle drops below the set point to verify that the setting is correct.

Setting the Empty
This must be done with tank empty or with the sensor completely out of the fluid.

Slowly turn the EMPTY screw CCW (counter clockwise) until the needle on the meter just stops moving downward. The needle should be on or just below the empty mark. Now turn the screw CW (clockwise) to make sure the needle starts moving upscale immediately, and then turn CCW until the needle just stops moving downward again. This is the EMPTY reference mark. Repeat this step until you are sure the EMPTY reference is where you want it.
Setting the Full

Turn the FULL screw CCW until the needle indicates the liquid level in your tank. For best results, the tank should be full or the sensor submerged all the way to the plastic housing in vegetable oil. If you accidentally adjust below your tank level, turn the FULL screw full CW and repeat this setting.

END