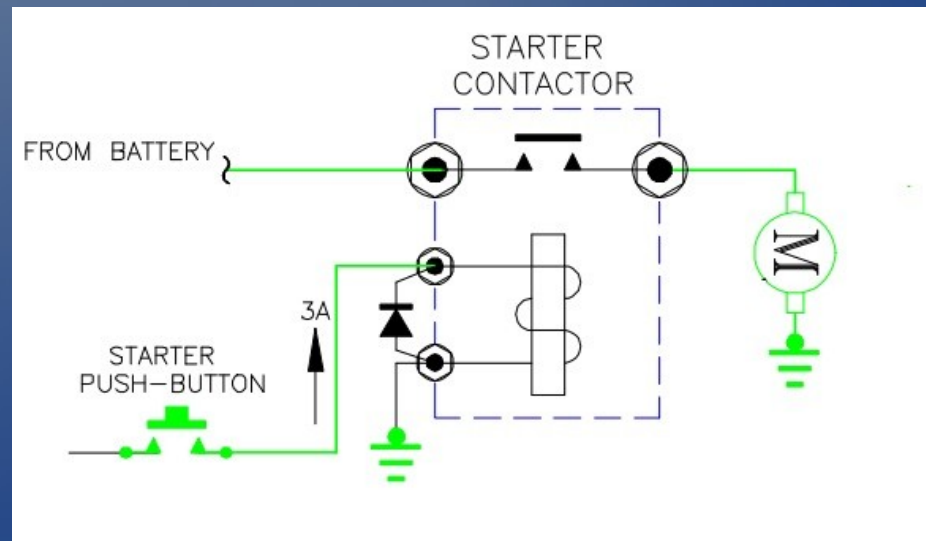


Westebello 2010

Wiring your Challenger

Presented by : Brent Thompson

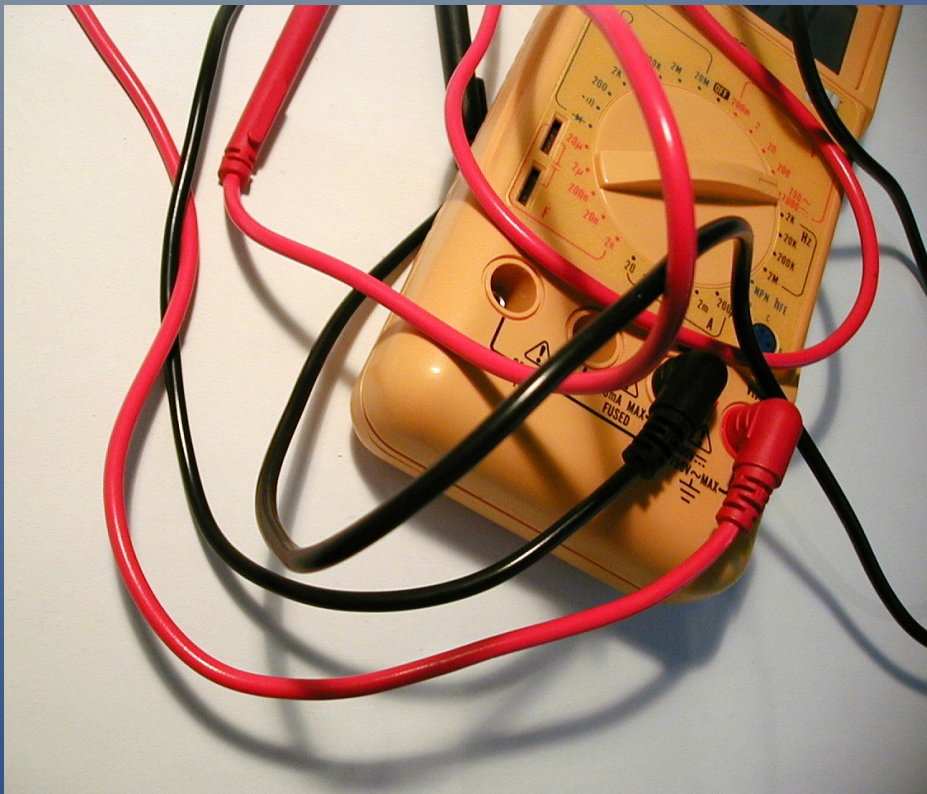
Version: 2010-07-07



Disclaimer / Warning / Intro

- This presentation should be used as a guide only. It is the builders final decision regarding any wiring, fusing or equipment that will be installed during their Challenger build.
- Refer to all installation instructions and safety warnings provided with your kit and all additional equipment or manuals provided.
- Beware of what you research or read on the internet. There are many experts with impressive credentials who mean well, but are way out of touch with common industry practice when it comes to wiring for both kit building and production aircraft.
- Try to build 'light'. Resist the temptation to add numerous devices and extra wiring which only add weight and result in loss of performance.
- The slides contained in this presentation are not final and this document may be changed, altered or updated in the future. If you pass this document on to someone else, please ensure all of the original content is included with the file.
- If you do find this presentation helpful, all I ask is that you make a small donation to your favourite charity.

Challenger LSS/Standard Kit components



- What parts will I use?
- What devices / parts do I still need to get?
- Can I do all of the wiring myself?
- Do I need any special tools?

Decisions to make



- All analog / digital or a combination of both
- Radio / Intercom w/PTT switch
- Will I need a Transponder?
- Other items to install? fuel flow and/or level sender

Battery – Wet Cell lead acid



Motomaster lead acid (terminal style not shown)

Must be mounted upright with a suitable tray

If overcharged, will boil and produce hydrogen gas and may spill acid

Low cost (replaced / recycled every 2 or 3 years) may last longer, but it will fail at some point

Will sulfate – shorten lifespan if left to discharge below 10vdc more than once. May be permanently damaged if allowed to fully discharge

High self discharge rate and high internal resistance (means lower cranking amps)

Battery RG / AGM / SVRLA



Recombinant Gas (AGM) 'absorptive glass mat' lead acid battery (terminal type) Also called a 'Sealed valve-regulated lead acid' or SVRLA – They are NOT to be confused with the older 'Gell Cell' technology

Suitable size for a Challenger 503/582 would be an Odyssey PC680 (shown) or similar

Can be mounted in any position with any style of bracket (will not spill)

Very good performance in cold weather

Very low self discharge rate (several months)

Very low internal resistance (good cranking ability)

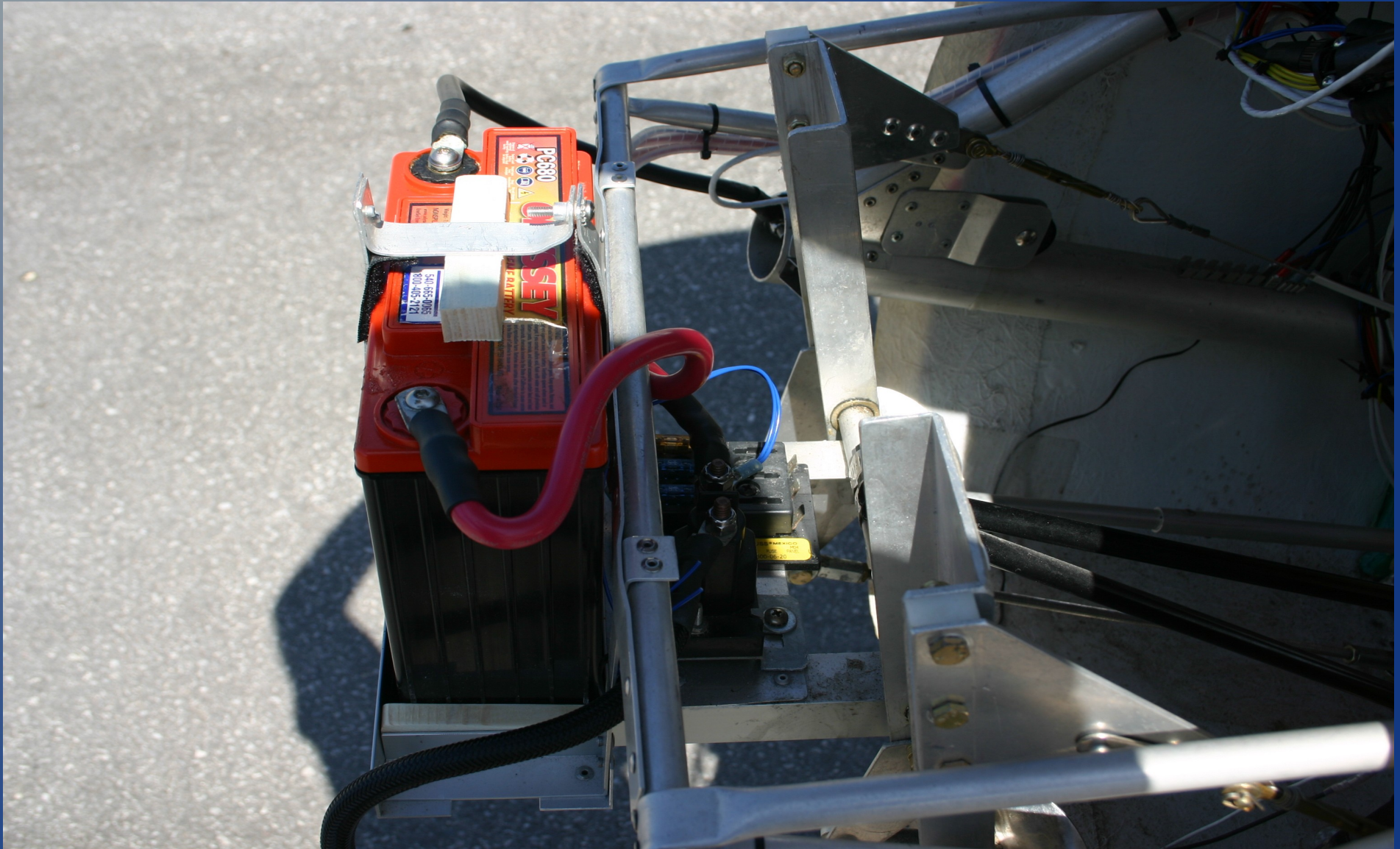
Higher cost \$120+ (should last 3 – 5 years)

Like any battery, do not allow to discharge below 10.5vdc, battery life will be shortened

Location of the Battery

- The Challenger, like many pusher configurations, usually requires the battery to be mounted at or near the front of the aircraft. This explains the requirement for a larger size of starter wire.
- The starter kit should have enough wire of suitable size. (GPL / QCU)
- Confirm your weight and balance requirements before deciding on the location of the battery. Common locations are in front of the rudder pedals, at the side on the longeron near the back of the instrument panel. Even under the front or rear seat (AGM battery only!) with a proper (safely) designed bracket! This still allows an inch or more clearance from the elevator control tube. Under the seat option is usually not required, unless the pilot is very heavy and has the 503 configuration.
- When the location is decided, also make a small bracket to mount the starter solenoid as close to the battery as possible. i.e. 6" or less is good.
- At this point, you can determine if the starter wire length supplied is long enough.

Example of battery mount in front



Battery mount under seat

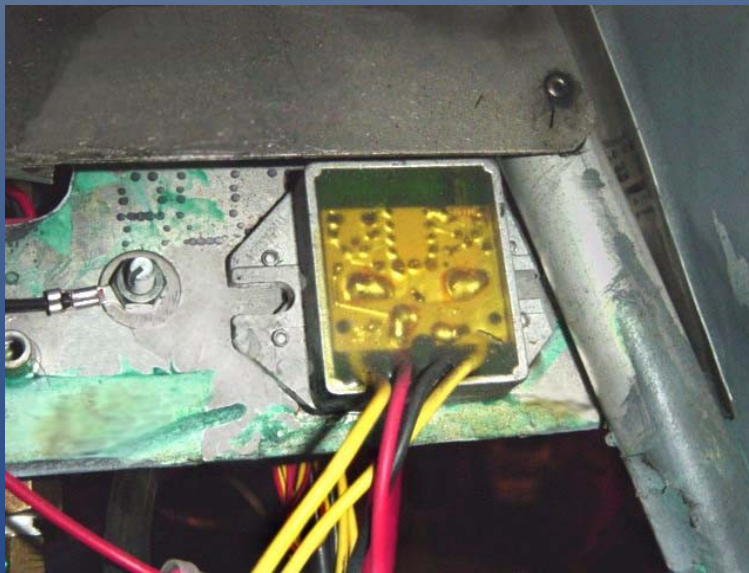


Battery Safety!!

- Avoid primary short circuits at all costs while wiring and mounting the battery. Final connection of the battery ground wire should be done last to help prevent this. Keep electrical tape over one or both terminals of the battery. Use protective rubber/plastic covers over the battery terminals after the wires are installed.

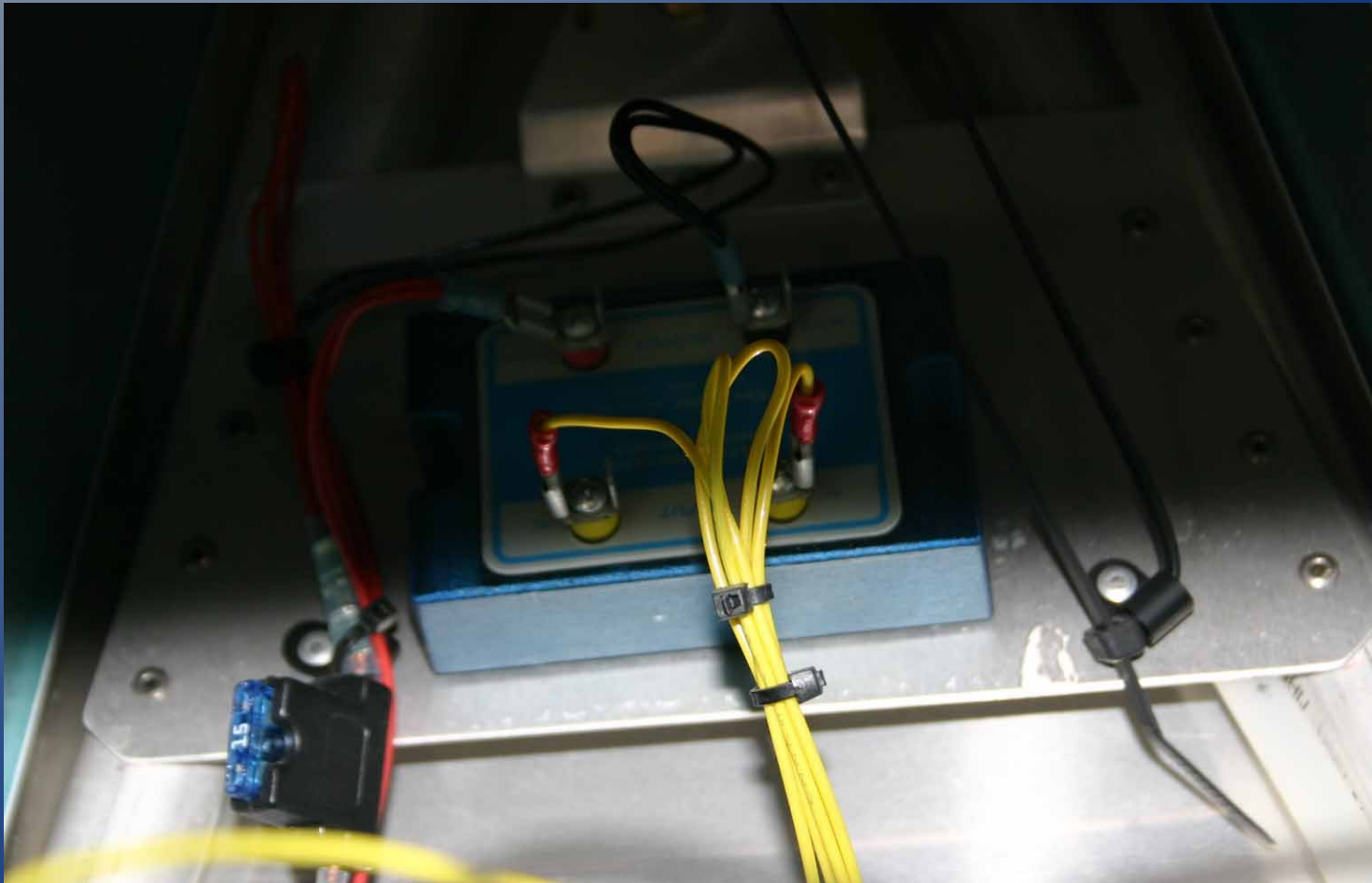
Regulator

- There are different styles of regulator for the Rotax 503/582. The older Challenger standard kit included the Rotax supplied 'load dump' type regulator. (866 080) This regulator required a battery and minimum load to maintain proper voltage. Great for a snowmobile, but not a Challenger.(below left)
- The latest kits are supplied with a Rotax '3 phase' style (264 870) . It costs more. \$100+ but does not require a minimum load. It should be used with a battery and sometimes a 'filter capacitor' if intercom noise or an EFIS is being used. The KeyWest(blue colour) regulator is preferred as it provides a more filtered output and easier connections.



Regulator

- Try to mount the regulator as close to the engine area as possible. A good location is the metal plate inside the engine firewall area. This keeps the noisy AC charging coil wires away from the instrument panel area.



Fuses or Breakers

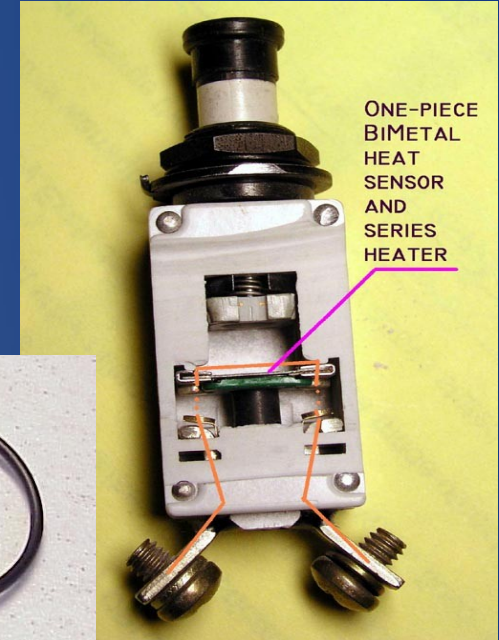
- Breakers are OK, but are expensive and take up already limited panel space.
- A standard 'blade' style fuse block (6 or 8 position) is more than adequate. It can be mounted under the instrument panel, but within reach while on the ground.



S804 SERIES
PLUG-IN FUSES



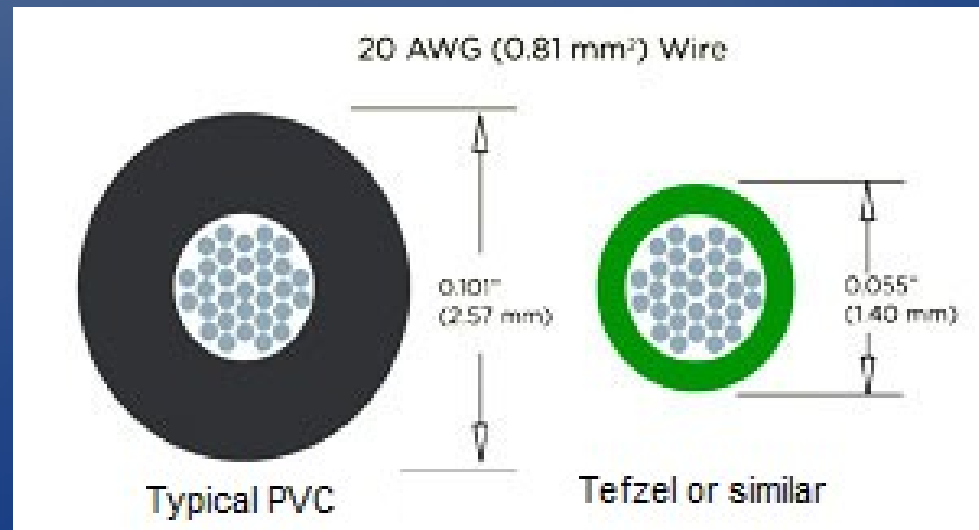
ONE-PIECE
BIMETAL
HEAT
SENSOR
AND
SERIES
HEATER



IFH-2 ATC STYLE
IN-LINE FUSE
HOLDER

PVC or Tefzel wire?

- You can easily make use of any wiring or harness supplied with your kit. The latest versions of the QCU(LSS) manual indicate 2 – 8 foot lengths of 4 conductor cable are supplied. You will often need to buy more wire, to either extend or add various accessories. You may also prefer using a shielded 4 conductor cable instead.
- Cheaper PVC insulated wire can vary in quality of insulation and number and size of copper strands, whereas Tefzel wire is manufactured to higher standards. You can use a smaller diameter(gauge) of Tefzel wire than the equivalent gauge of PVC wire due to Tefzels higher operating temperature. This also means 'lighter weight'
- Common suppliers are Stein Air (steinair.com) or Aircraft Spruce as they supply the tefzel wire among other common parts required. i.e. Switches, fuses, breakers or connectors. Check with your local Challenger dealer first as they may stock or can get various parts such as wire, fuses, regulators etc.



Wire stripping

- There are a multitude of wire strippers. Tefzel can be tough to cut with most which are designed for PVC style insulation. The best wire strippers can actually be a simple pair of blue handle pliers as shown. It just takes some practice to prevent cutting any strands of the wire.



Wire stripping

- This style of stripper works well with most wire. Using a utility knife works for cutting the shielded wire sheath or large starter wire covering.



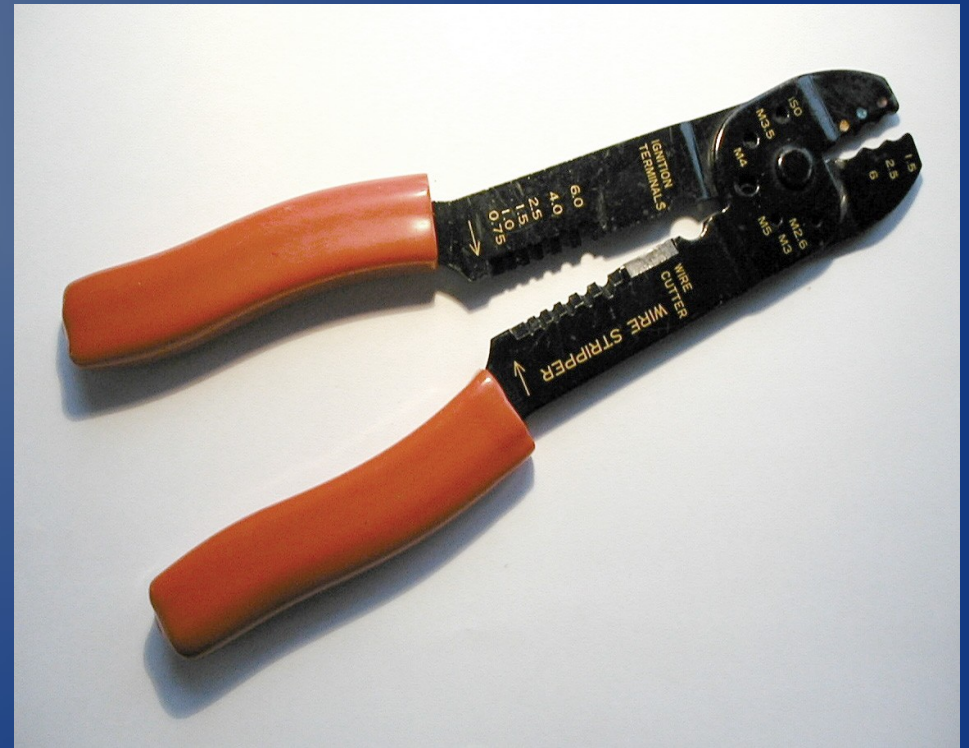
Wire / Connectors

- Some connectors may require soldering, such as D-Sub (radio, transponder harnesses) The harnesses can be purchased, but you can save well over a \$100.00 if you learn to make them yourself! (XCOM harness shown)



Wire / Connectors

- Invest in a ratchet style crimper (left) instead of the cheaper 'kit' style crimper (right). A good crimp can still be made with either, but the ratchet style is easier to use.



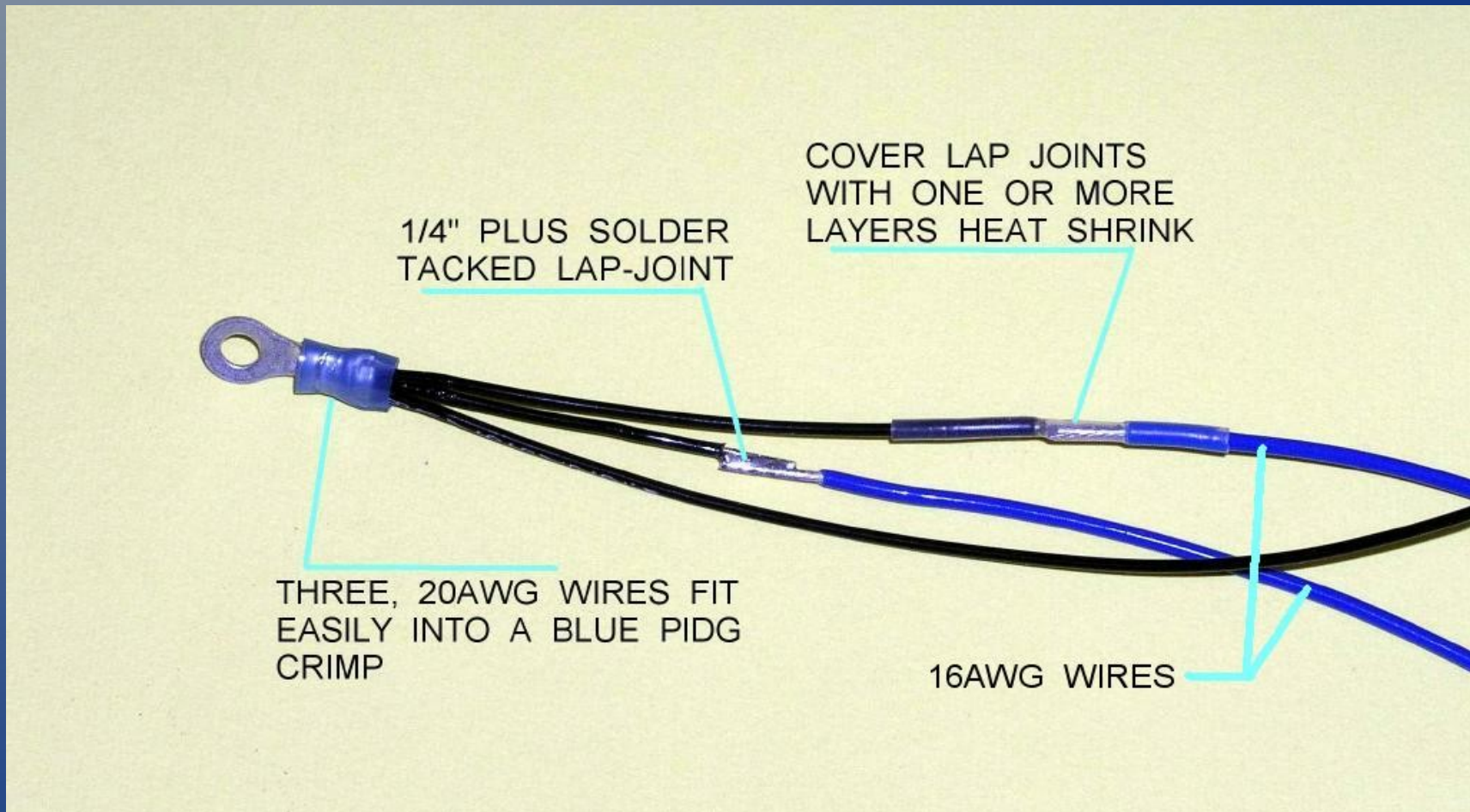
Wire / Connectors

- Spade 'push on' connectors are preferred over ring style terminals when available
- Use 'PIDG' (permanent insulated diamond grip) AMP brand crimp terminals (left) rather than the cheaper automotive / hardware store brand (right)



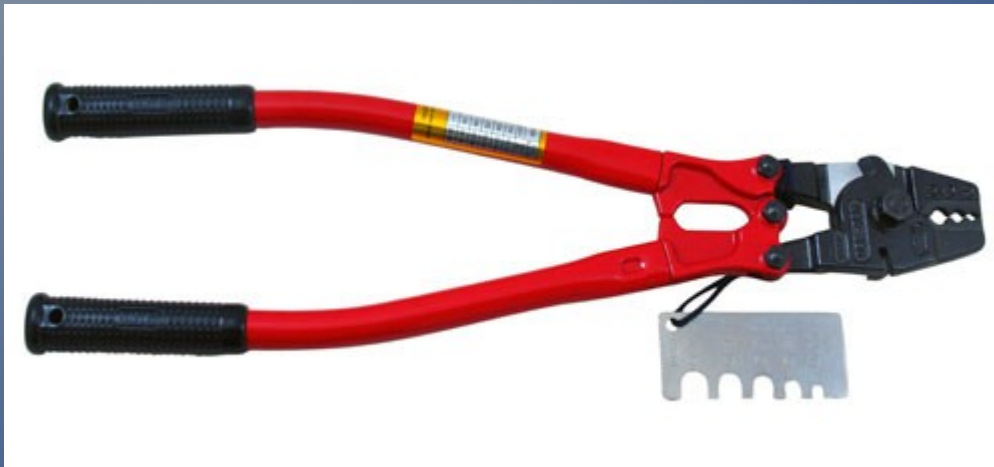
Wire / Connectors

Multiple conductors are OK in the same crimped connection, as long as all of the wires fit properly. Photo also shows a simple lap joint soldered w/ clear heat shrink



Wire / Connectors

- The large 4 or 6 gauge terminals for the starter circuit can be made using a less expensive style 'swage' tool. (solder is optional and not even required when the connector is properly crimped)



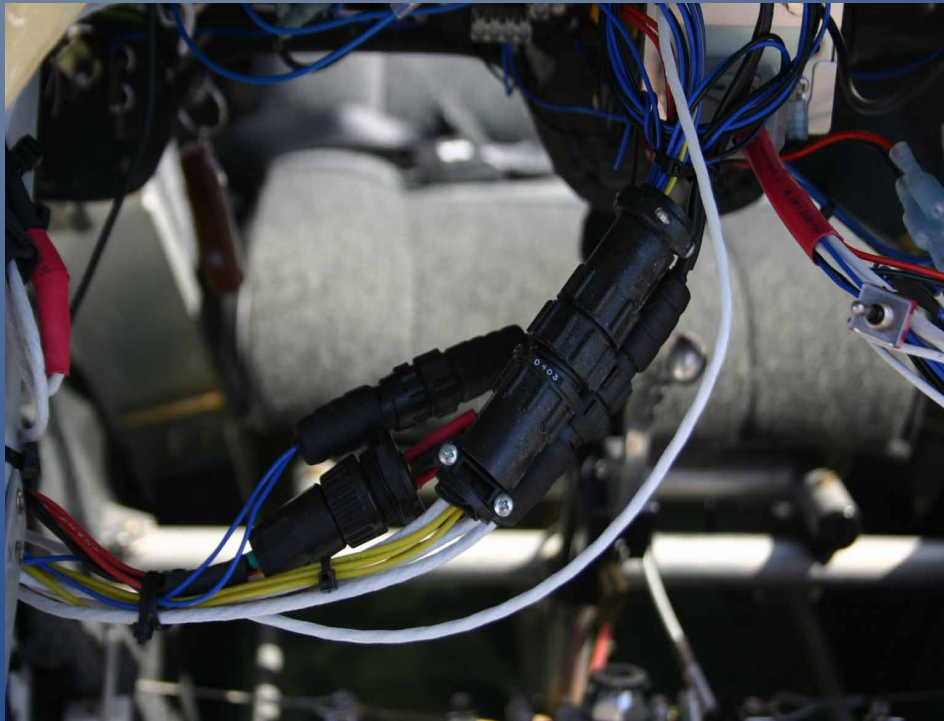
Wire / Connectors

- The solder method can be used on the open lug end instead of crimping. 'DO NOT SOLDER' the exposed wire portion near the insulation. This will create a solid stress area and will result in a 'break' failure from vibration.



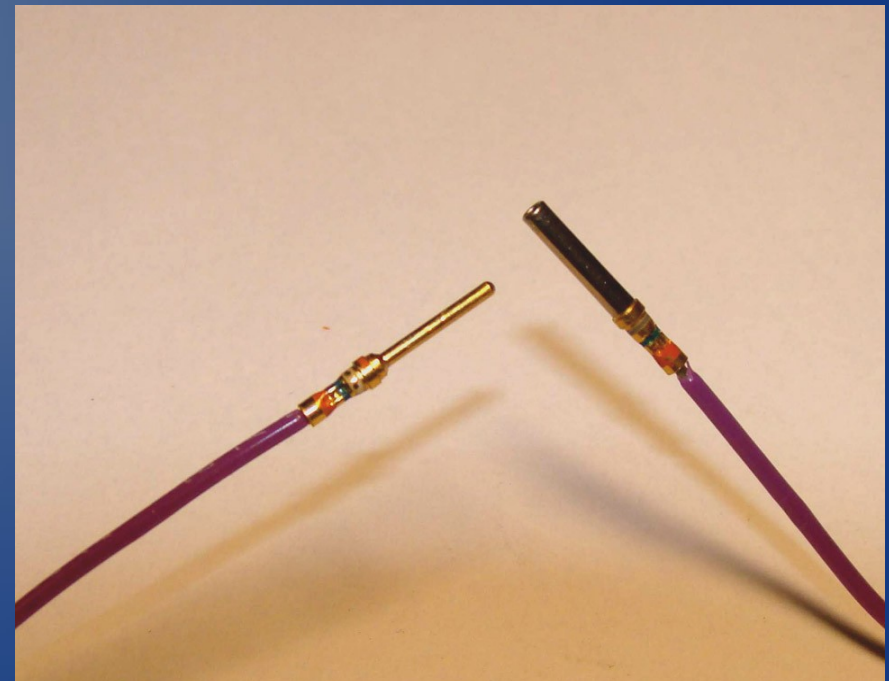
Wire / Connectors

- There are many styles of multiple conductor plugs/sockets that can be used for easy disconnection of wires. ex) wing root area for wing strobe/light wiring or wiring behind the instrument panel.



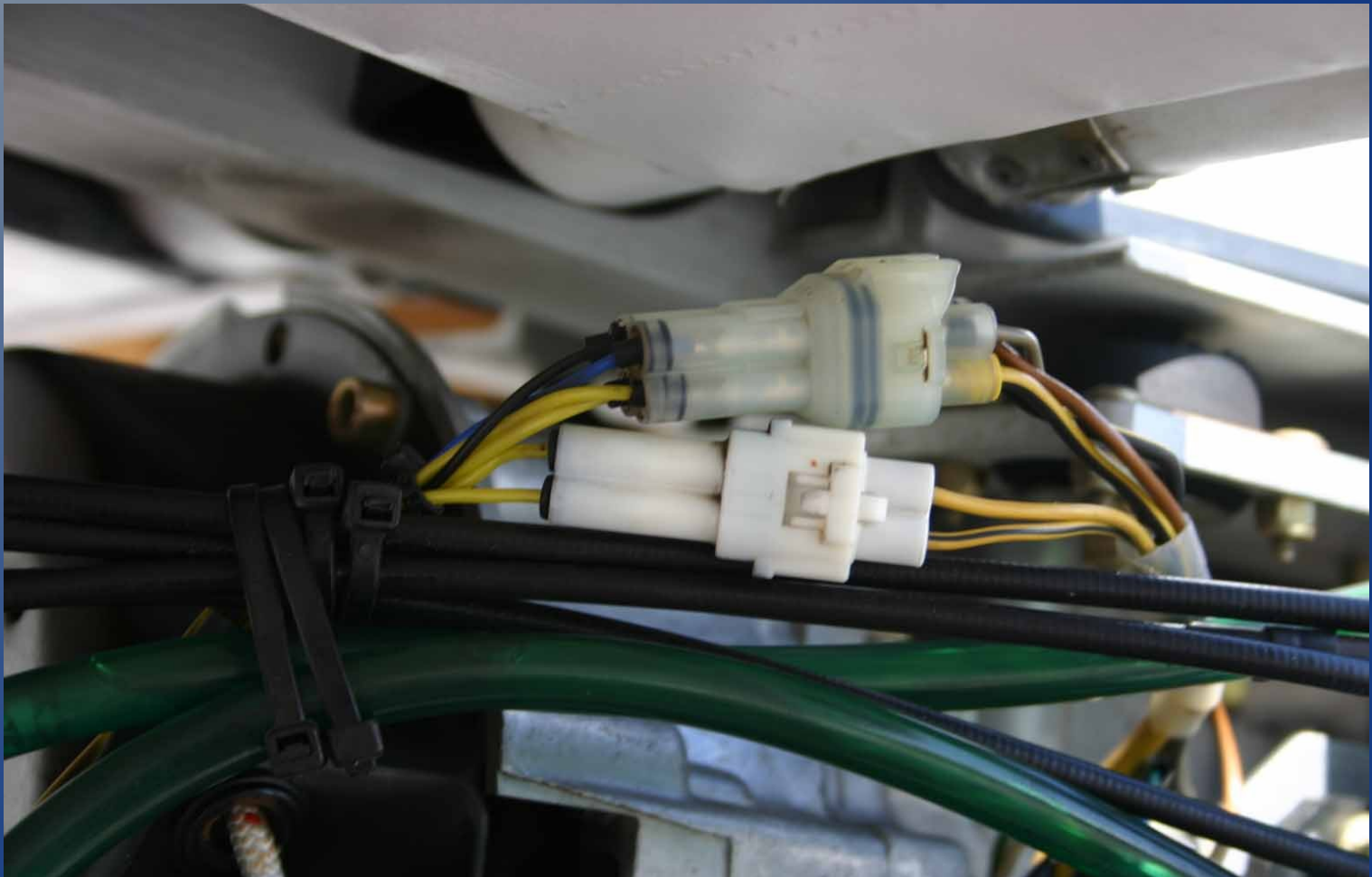
Wire / Connectors

There are multiple ways to join wires. In addition to solder and heat shrink. There is the common 'DSUB' socket and pin using an 'open barrel' style crimper. Useful for the EGT or CHT wire to harness connections. This style of crimper is also used for making the Rotax supplied connector crimps.



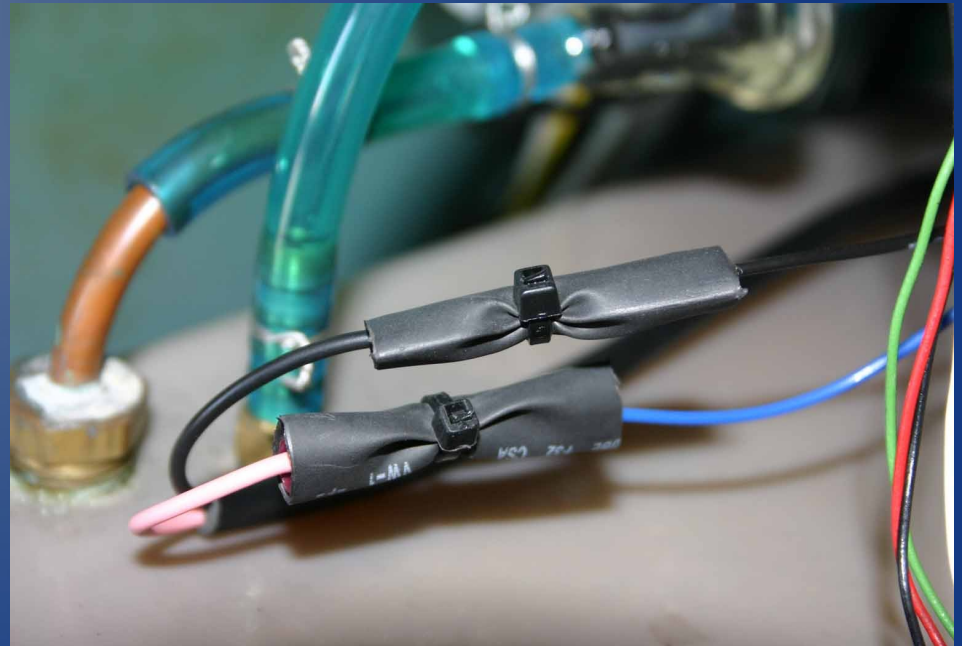
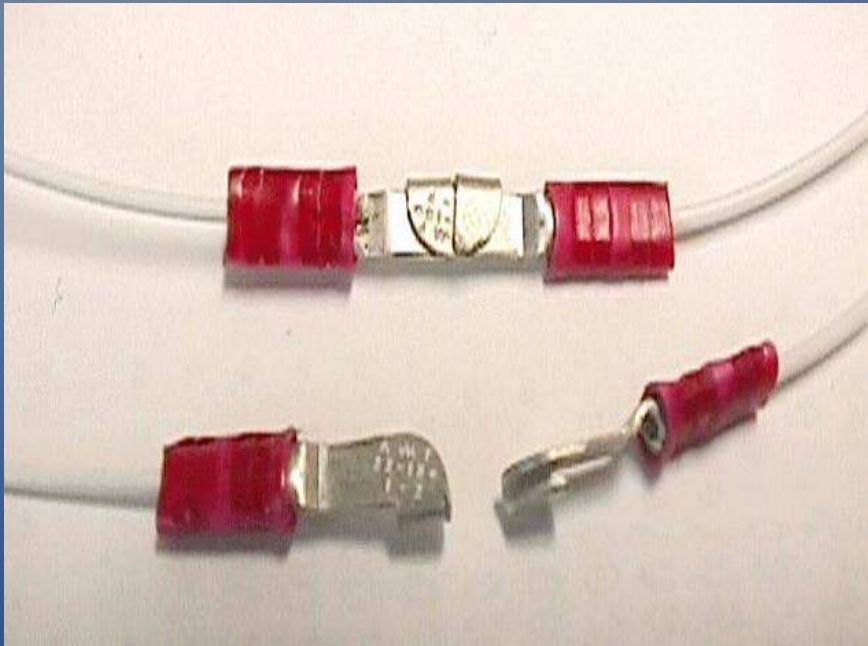
Wire / Connectors

- Try to use the Rotax supplied sockets to make the engine connection. Any other style of connector here may be cut off by any future Rotax engine repair facility. A very small flat screwdriver can be used to remove the pins when required. Observe the proper pin locations!



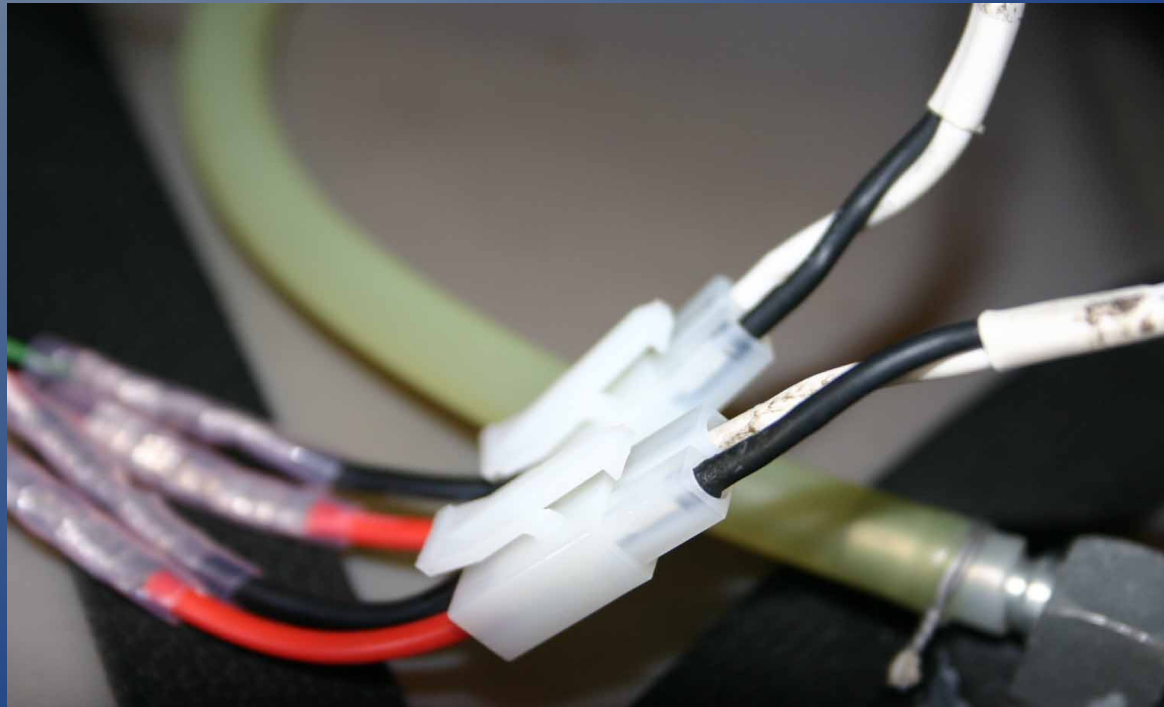
Wire / Connectors

- The 'knife' PIDG style connectors are an even easier way to join two wires. Use a piece of heat shrink as shown, but do not shrink it. Just place a wire tie in the middle as shown. Example shown is the fuel level sender to harness connection



Wire / Connectors

- The EGT(K) or CHT(J or K) thermocouple leads connect to the wire harness above the fuel tank area as shown below. The Westberg style probes have a silver pin attached which is easily plugged into a standard dual Molex connector allowing easy disconnection without damaging the probe wiring. Other styles of probes such as MGL, have only bare wires and could use the DSUB pins or 'knife' style connector.



Wire / Connectors

Of course, the simple 'butt' PIDG style connector works great for a fast and easy connection of two or more wires.

MS25181 NYLON BUTT SPLICE SELF INSULATED

EXCERPT FROM [HTTP://AIRCRAFTSPRUCE.COM](http://aircraftspruce.com)



Red Nylon Splice
P/N 320559



Yellow Nylon Splice
P/N 320570

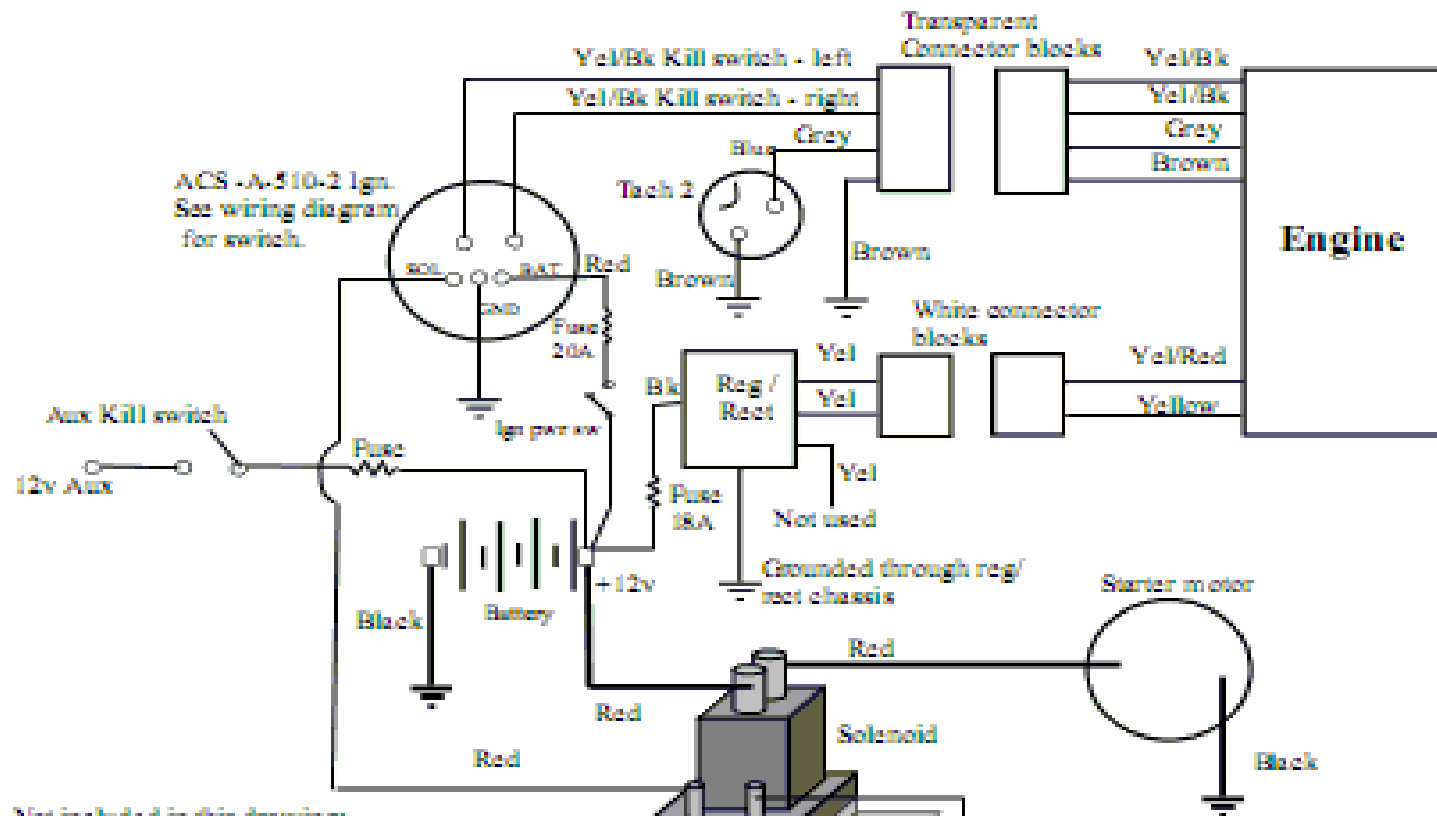


Blue Nylon Splice
P/N 320562

Description	Wire Range	Part No.	Price	Buy
Window Type Butt Splice Red	22-18	320559	\$0.61	ORDER
Window Type Butt Splice Blue	16-14	320562	\$0.59	ORDER
Window Type Butt Splice Yellow	12-10	320570	\$1.28	ORDER

(LSS) wiring diagram

Suggested wiring diagram for Rotax 447/503 Dual CDI, Dual carbs.



Not included in this drawing:

1. Oil/EGT circuits. Follow instructions supplied with gauges.
2. Fuel Gauge circuit. Follow instructions supplied with this system.

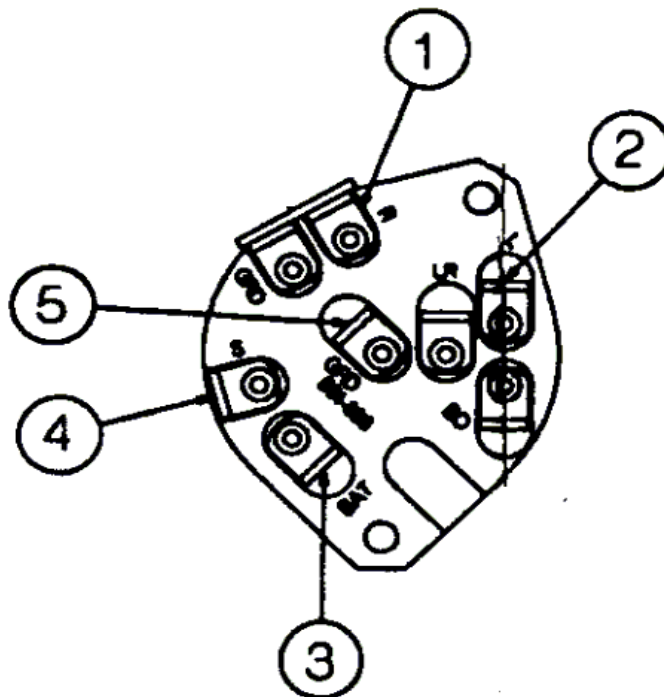
- 1 Small post to switch
- 1 Small post to ground
- 1 Large post to battery (+)
- 1 Large post to Starter Motor

NOTE: Cut the small wire loop on the back side of the TACH2 for engines with Dual CDI.

ACS Starter Switch

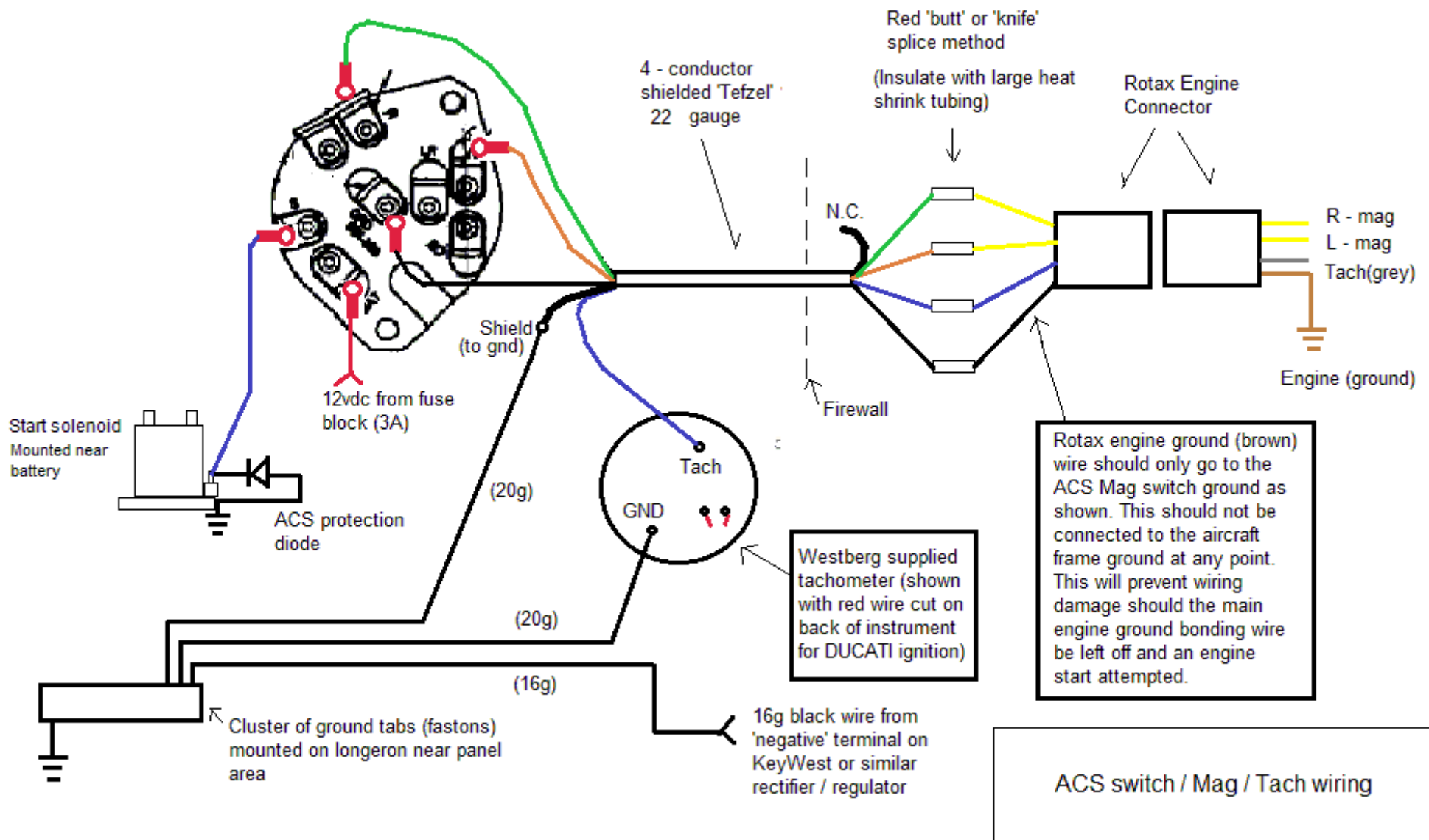
ACS 510-2 Switch

Rotax 503 or 582 using
shielded ignition wiring



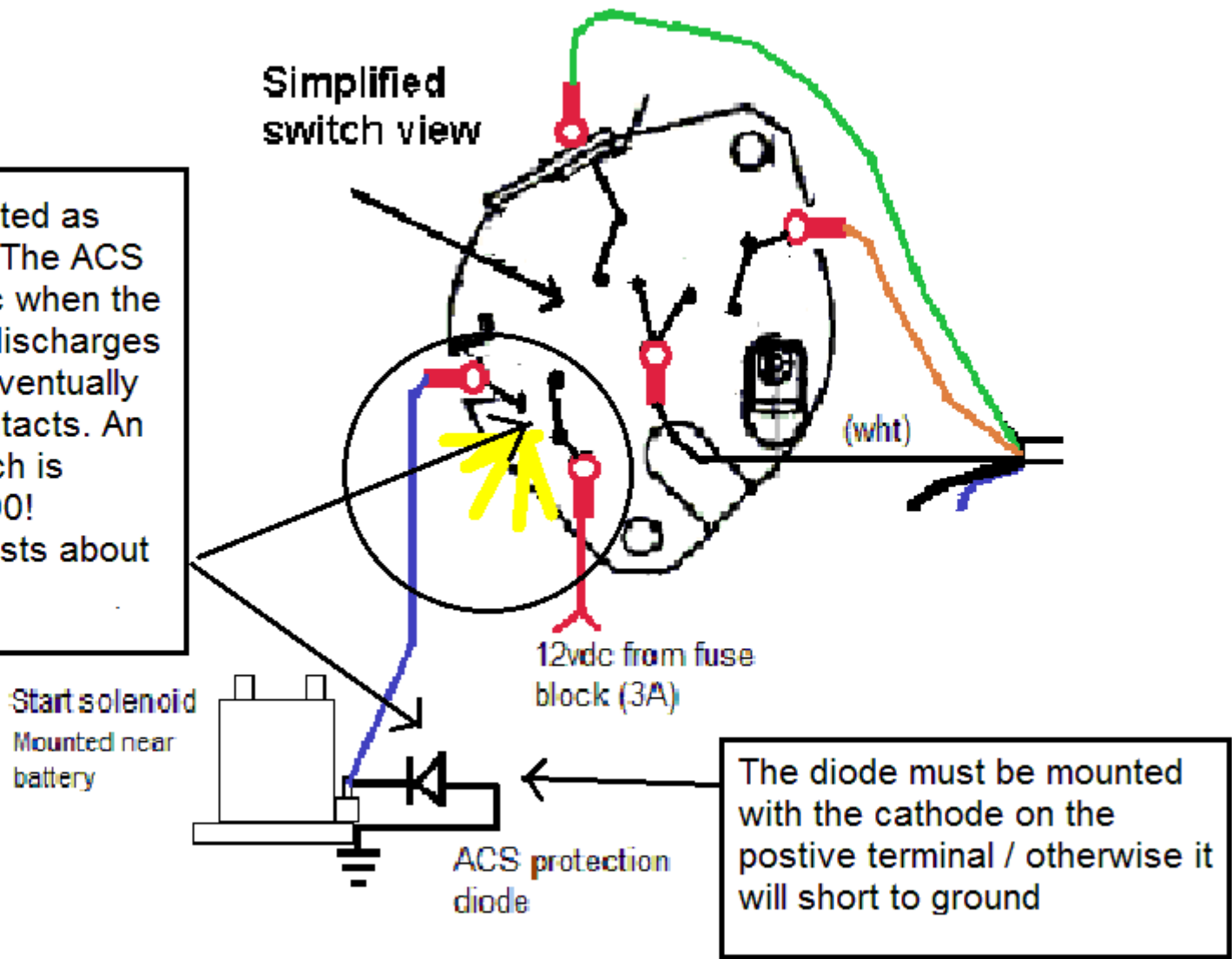
1. Connect RIGHT(MAG) Ignition wire to terminal 1 (R)
2. Connect LEFT(PTO) Ignition wire to terminal 2 (L)
3. Connect 12VDC POSITIVE supply to terminal 3 (BAT)
4. Connect Starter Solenoid POSITIVE lead to terminal 4(S)
5. Connect the engine (BROWN) separate ground wire to this terminal. Do not ground any other device or instrument to this wire

ACS Switch / Mag / Tach

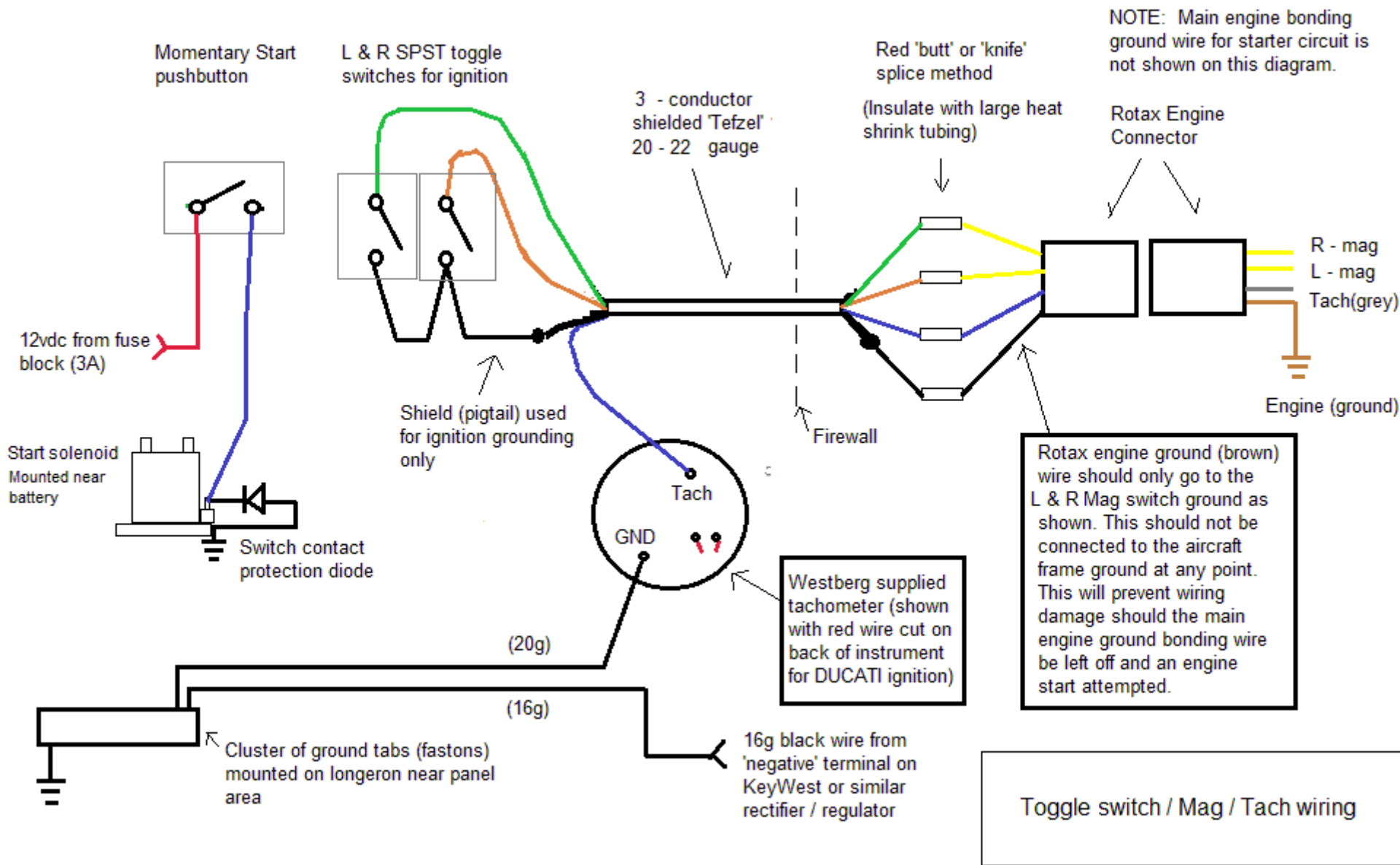


ACS Switch protection diode

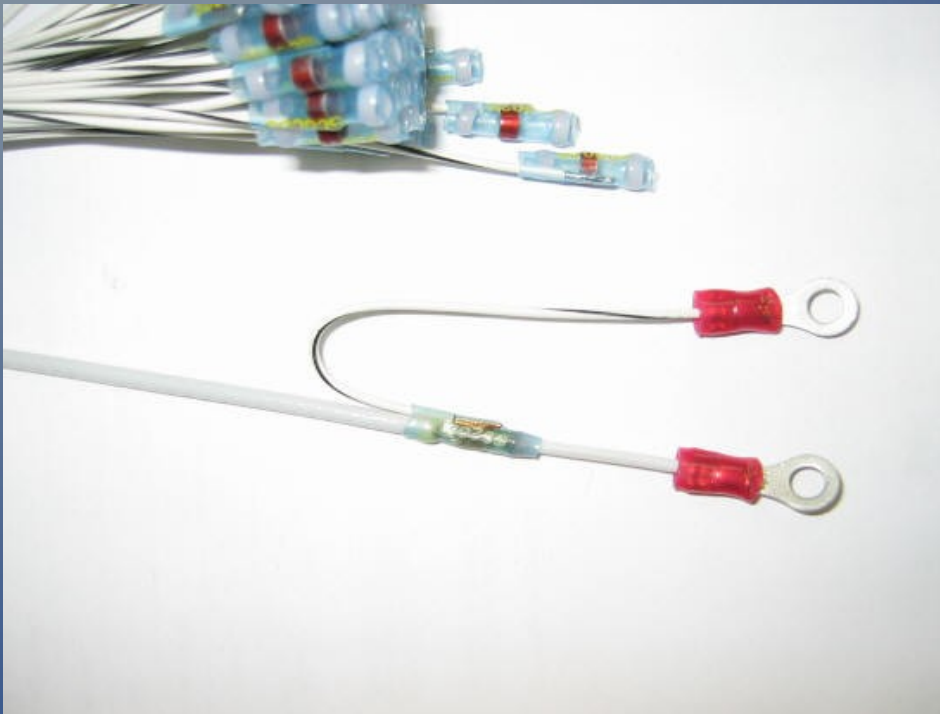
Without the diode mounted as shown on the solenoid. The ACS switch forms a large arc when the inductive solenoid coil discharges after a start. This can eventually wear out the switch contacts. An ACS 'start' feature switch is currently around \$125.00! The protection diode costs about 30 cents. ex) 1N4001-7



L&R Toggle Switch / Mag / Tach



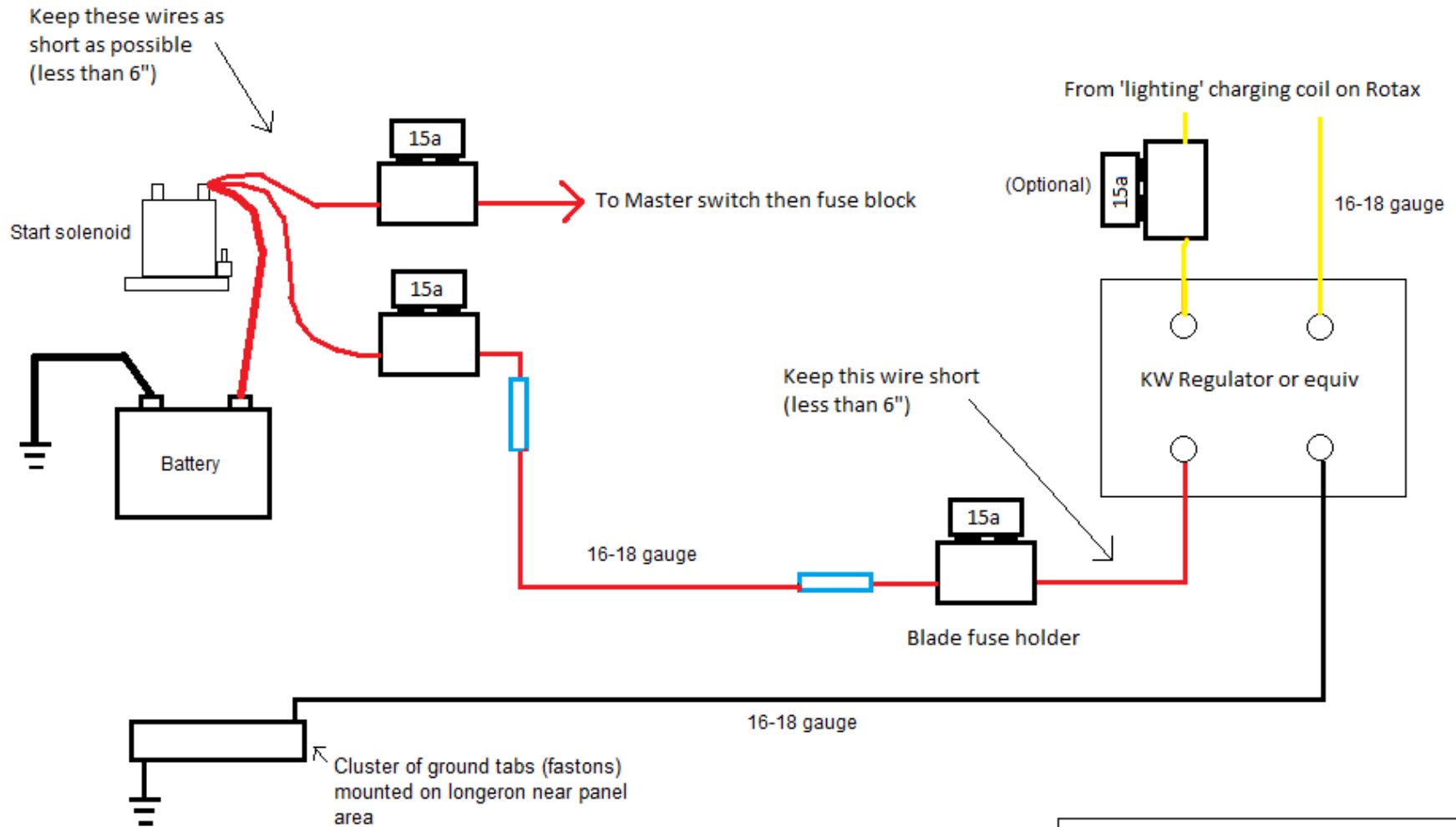
Shield to wire/terminal



Shield to wire/terminal

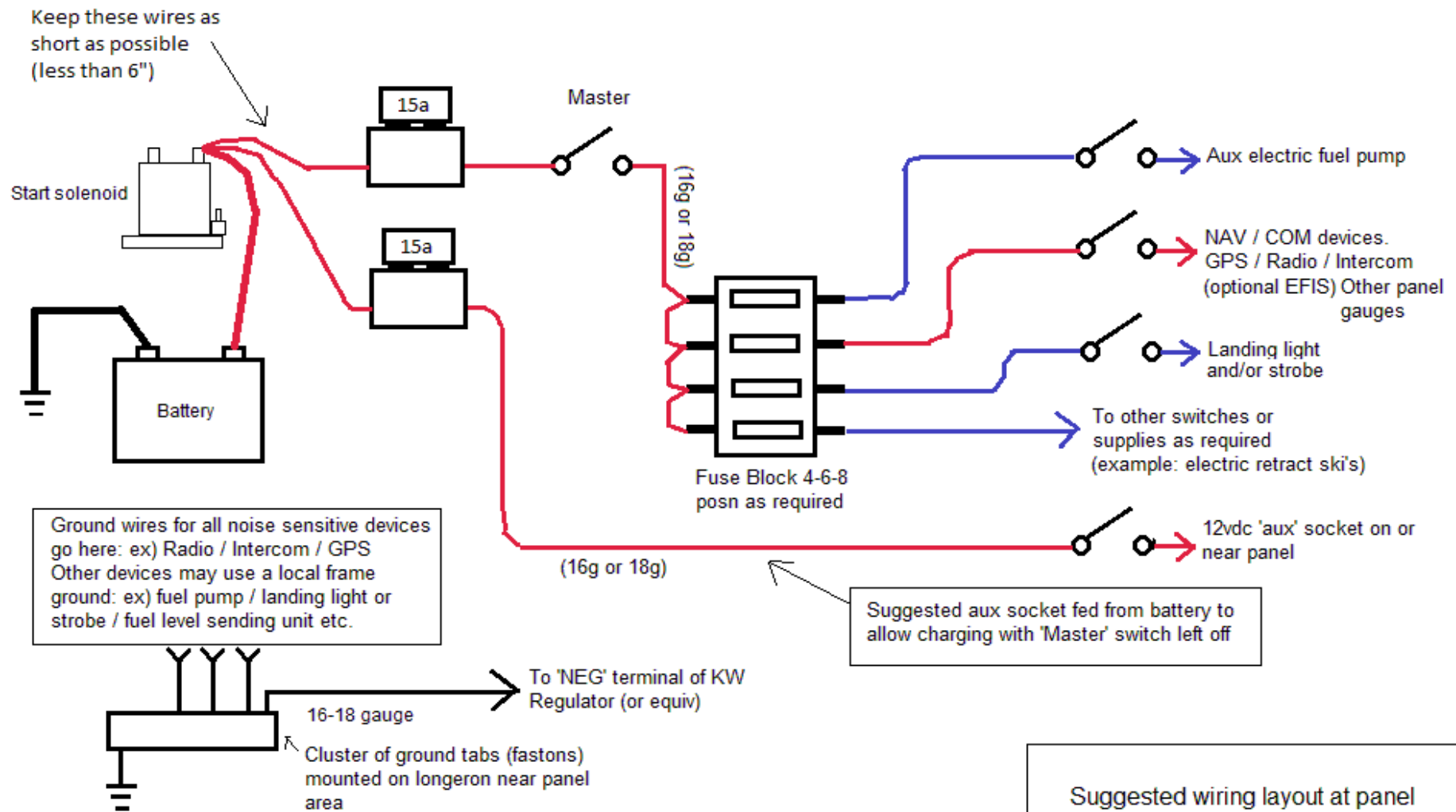


Battery / Regulator wiring

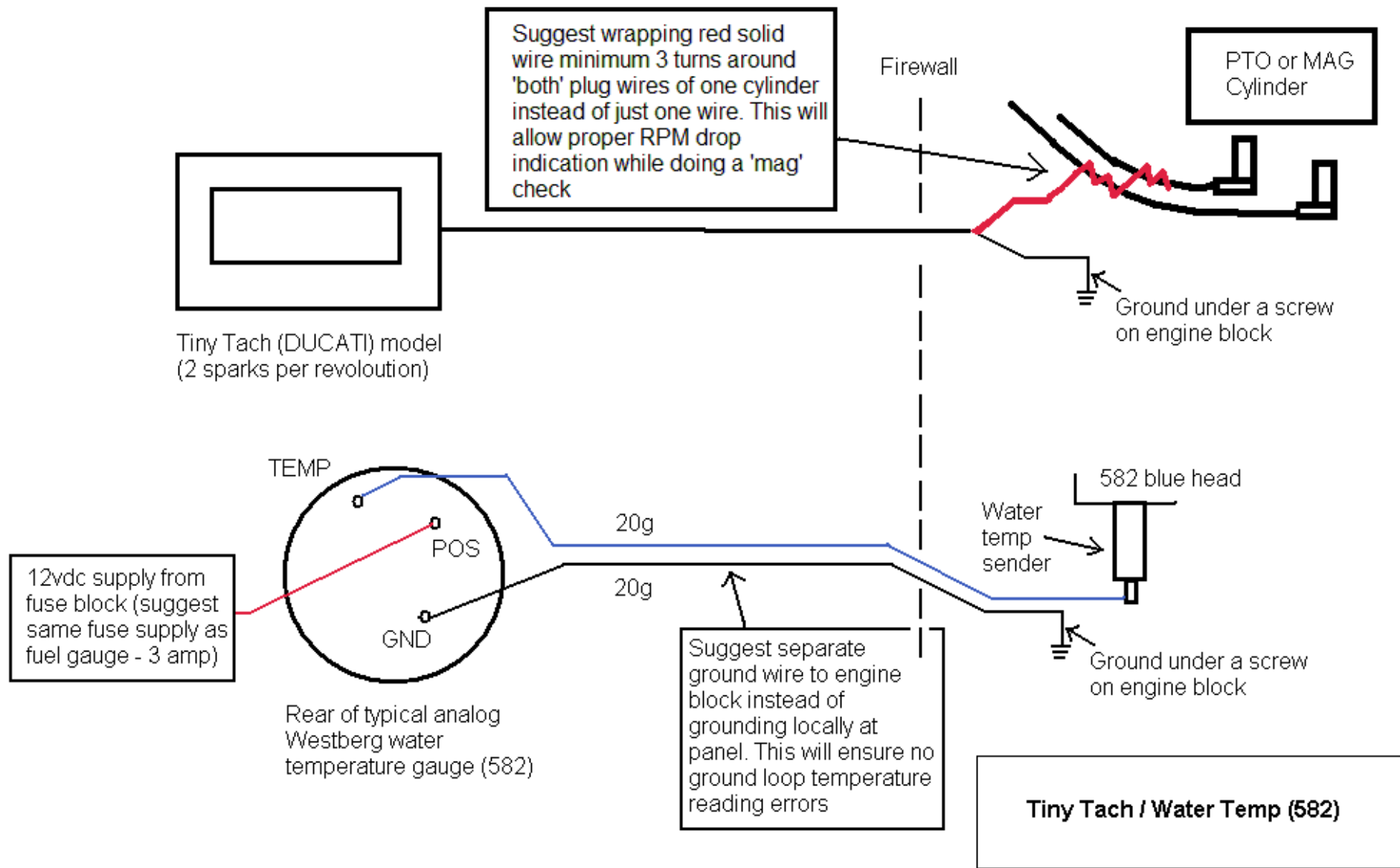


Battery / Regulator wiring

Wiring at Instrument Panel

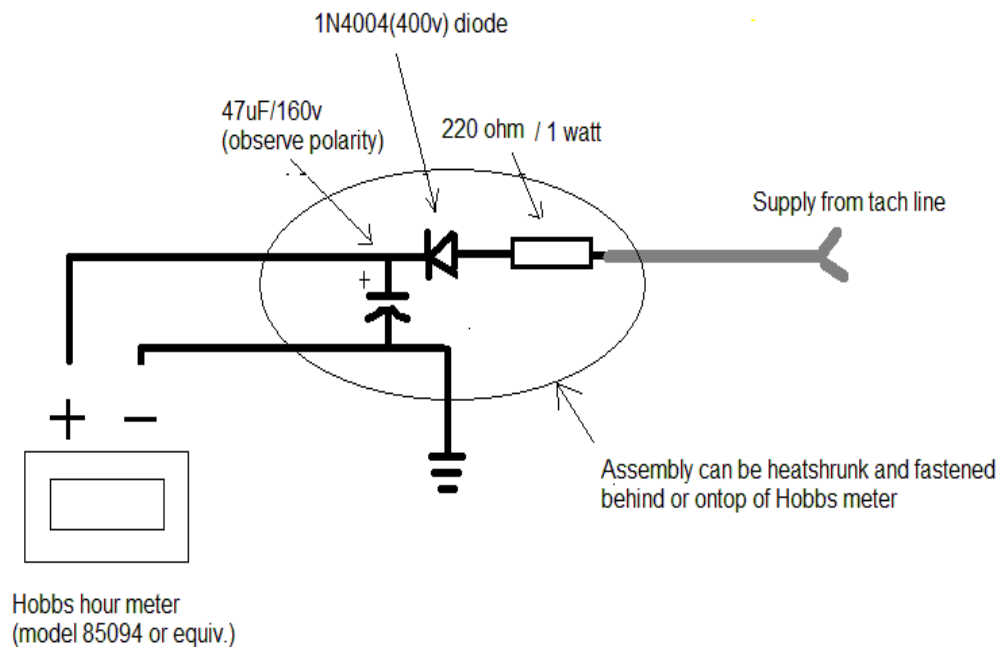


Tiny Tach / Water Temp (582)



Hobbs DC hour meter

A suitable DC Hobbs hour meter would be the model 85000 or 85094 10-32 or 80 VDC about \$30.00. With a few simple parts, it can easily be fed from the Rotax (grey) tachometer wire. (preferred as the tach wire should already be behind the instrument panel)



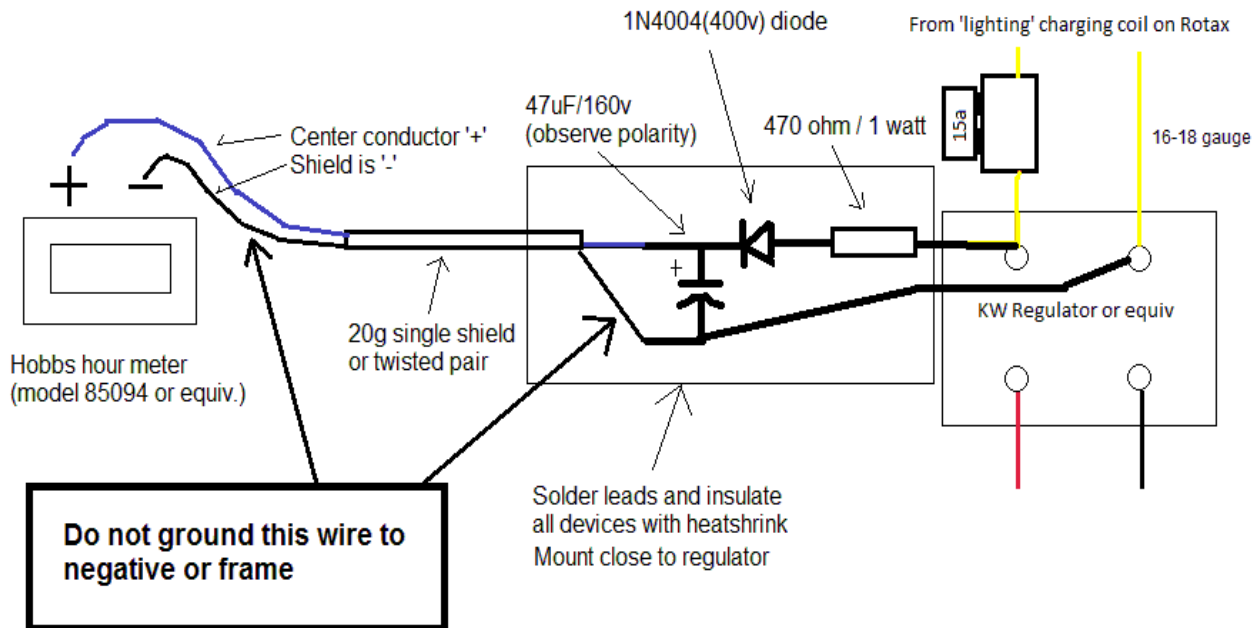
Hobbs hour meter supply
Tach line / record engine run time



AircraftSpruce.com
PN 15000

Hobbs DC hour meter

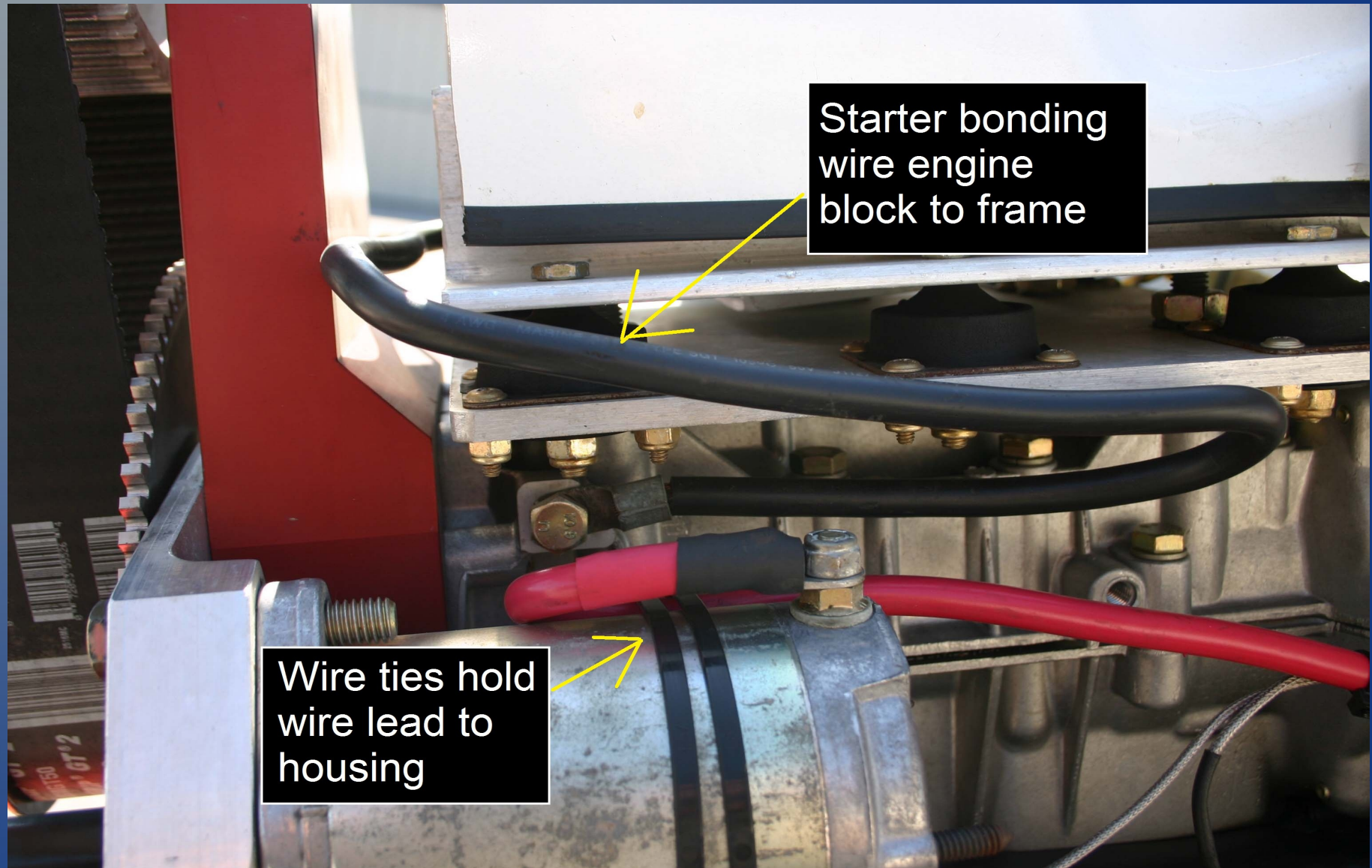
If a tach line is unavailable, you can use the lighting 'charging' coil as shown. Remember, we only want to record the engine run time with the meter. If the master switch was used, it would still record if the master is left on.



AircraftSpruce.com
PN 15000

Hobbs hour meter supply
Lighting coil / record engine run time

Starter ground & strain relief

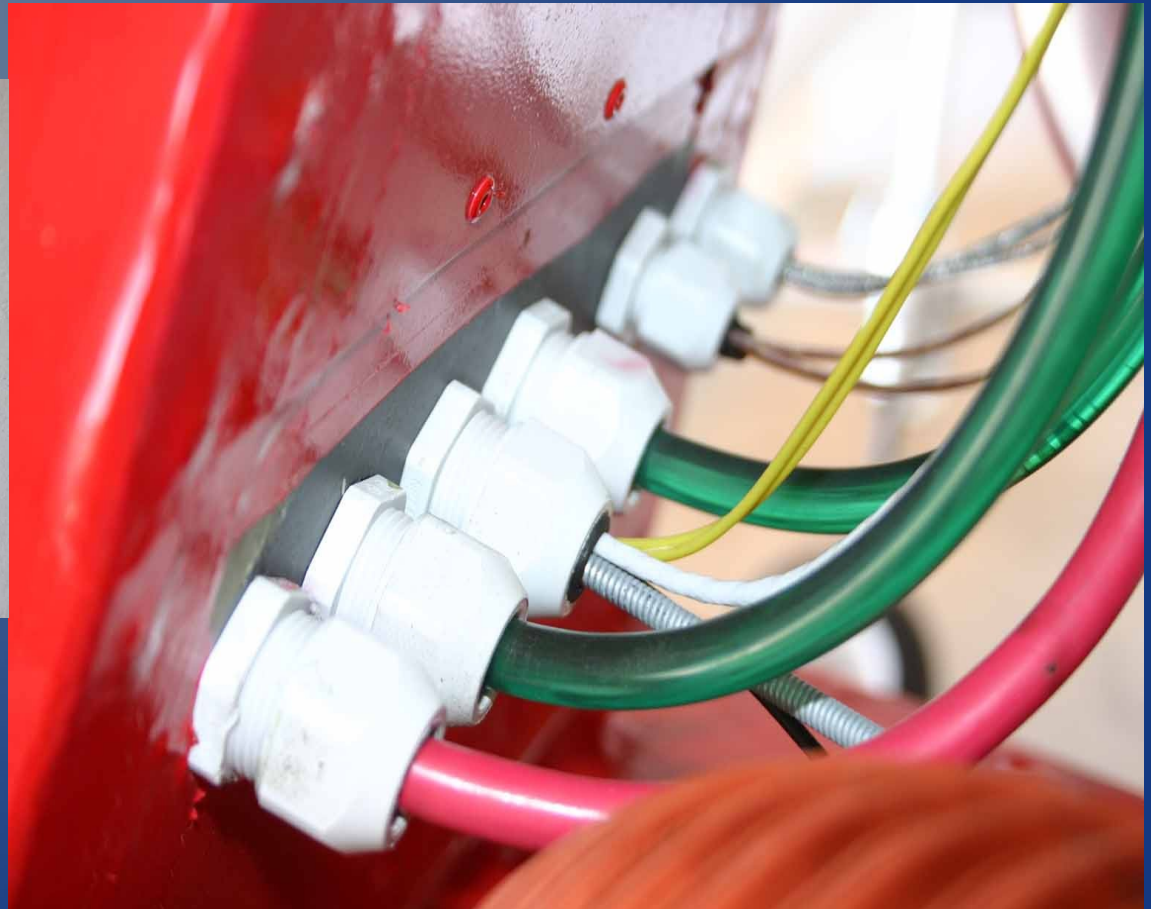


Starter bonding
wire engine
block to frame

Wire ties hold
wire lead to
housing

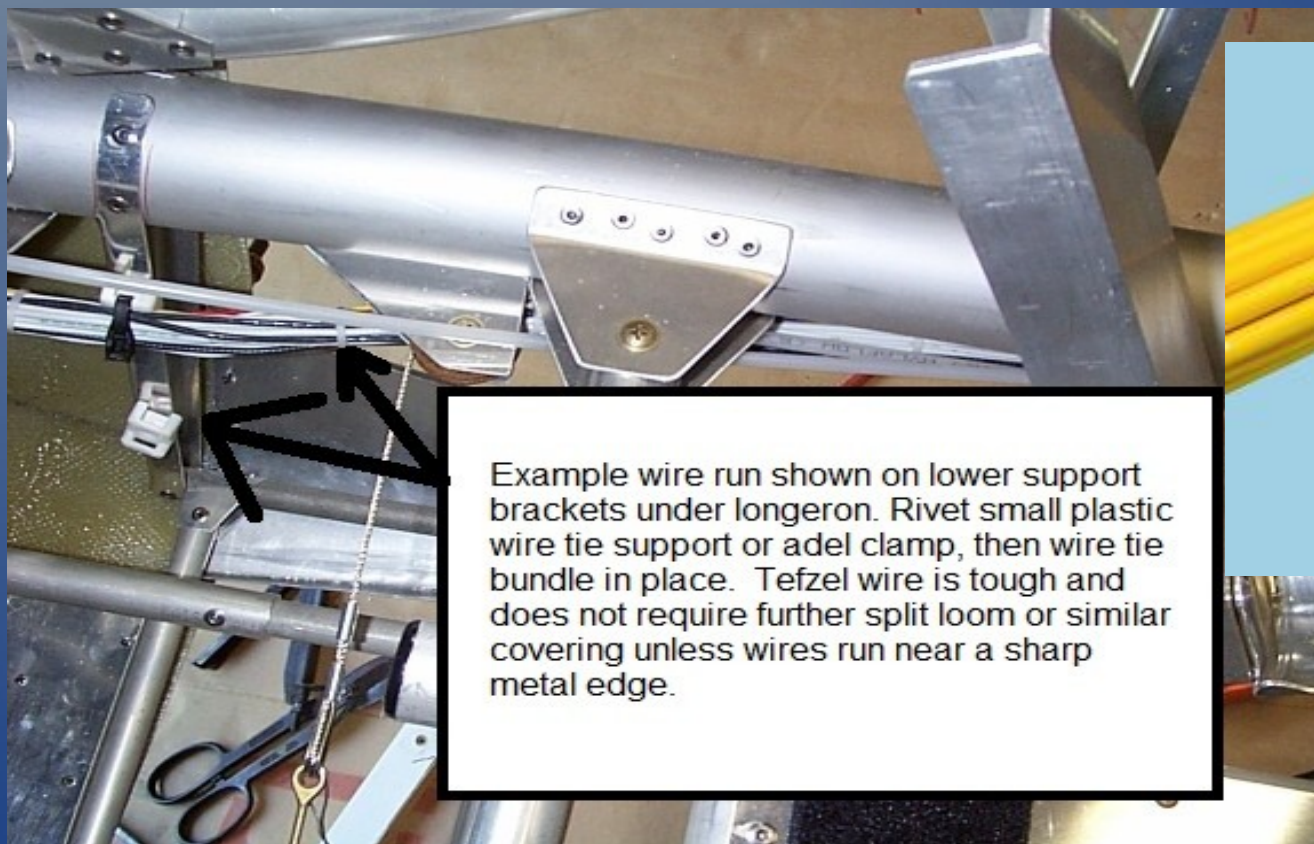
'Firewall' detail

- These plastic strain relief grommets work well with a rubber insert to protect the wire or fuel line. Use large size for starter wire or fuel line. Smaller size for wires. Or, you can use the less expensive rubber grommets (shown on left)



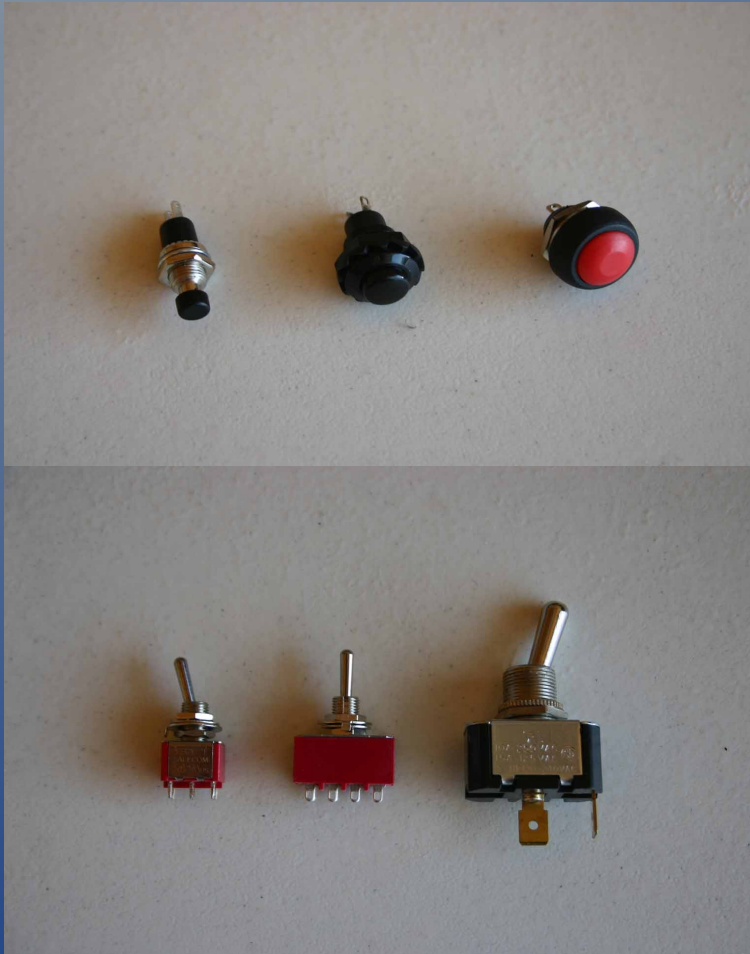
Wire bundle options

- There are many ways to route the required wire bundles from the panel area to the fuel tank or engine area. The bottom former tubes work well to hold wire bundles out of the way using nylon wire tie supports or metal ADEL clamps with wire ties. Try to keep noisy wires down one side of the fuselage(ignition/tach/tiny tach) and all other wires down the other side (starter/intercom/water temp/EGT/CHT wiring)
- Or space the wire bundles at least 4 inches away from each other



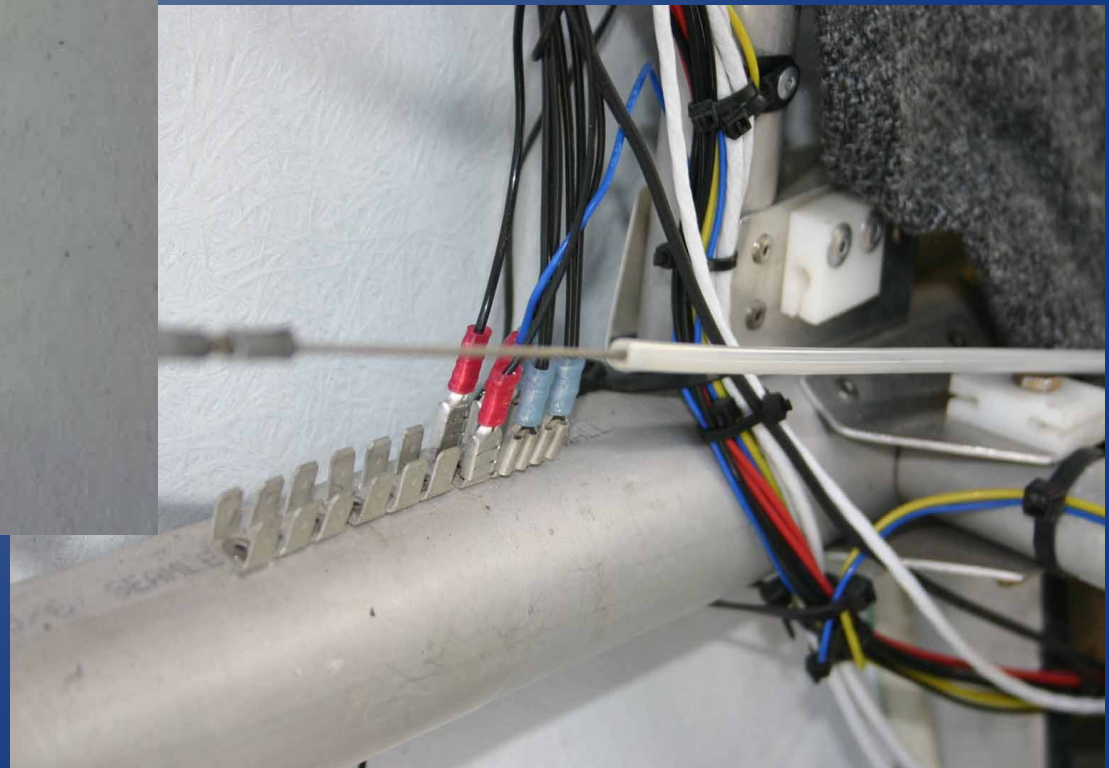
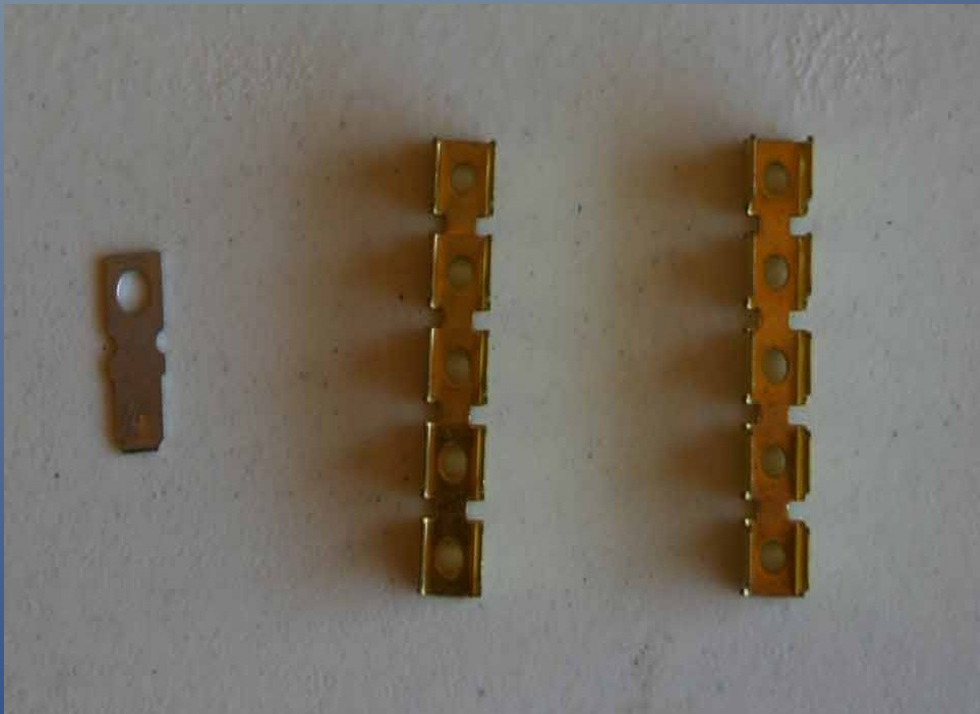
Switches

- Examples of common spade switches or smaller solder terminal switches. Also PTT momentary switches.



Ground tabs on longeron

- Example showing common spade ground tabs to allow common ground location for noise sensitive devices. (Intercom / Radio / GPS / EFIS etc) Main battery ground wire is located very close to this area. For easiest mounting, spread the end tabs apart and fasten them with 2 SS rivets.



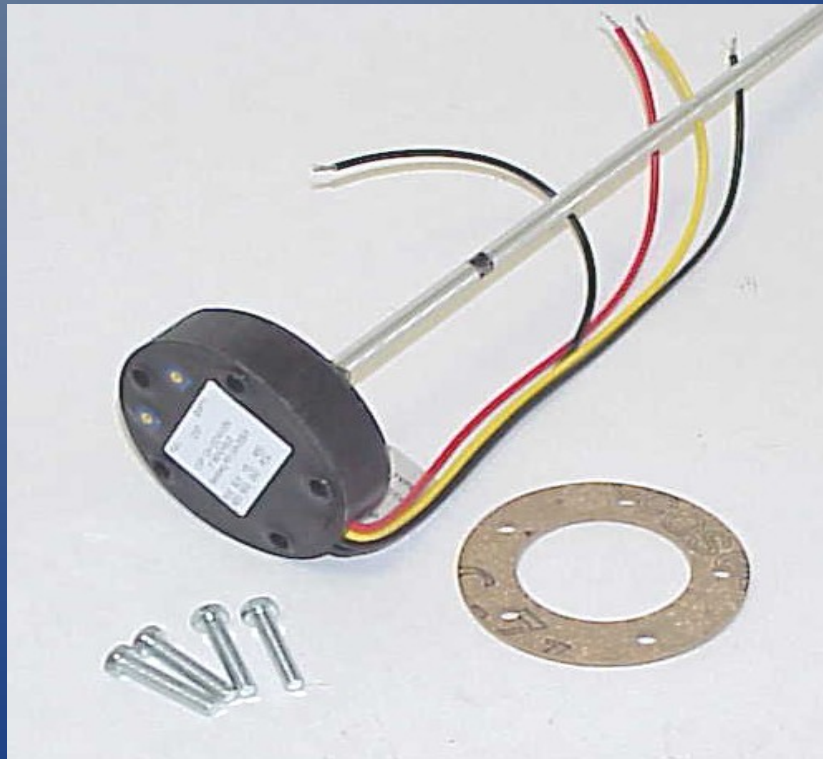
Hole size for switches

- This drill guide template works great for determining panel hole sizes required for various switches. The instrument panel design and layout are not covered by this presentation.



Fuel tank level sender / gauge

- The most common option today is the aluminium 16gal fuel tank option. The optional fuel level sender (if desired) is usually a 'capacitance' style as shown. The length can usually be adjusted shorter by cutting the tube. There are disadvantages with this style. Aside from finicky level adjustments and the requirement for supplying power to the sender, there is also a high failure rate after being in service for some time. The older style resistance 'float' type sender (not shown) often have accuracy issues as well and can often stick in one place.



Fuel tank level sender / gauge

- A common resistance style fuel gauge is the 240ohm style. This is a common automotive type gauge. A very reliable style sender that can be used with that gauge is made by WemaUSA.(\$50-\$60)
- Commonly used in the marine industry. The float cylinder contains magnets which are sensed internally by switches inside the stainless steel rod. You purchase a length that allows 1 to 2 inches from the bottom of the tank. It also has the standard 5 bolt pattern that most tanks use. This style provides the standard variable 240 ohm range. (Will also work with all EFIS/EMS systems, such as the Enigma)



Fuel flow sender and gauge

- MGL Avionics supply a fuel flow sender which interfaces with an individual electronic gauge, or will interface directly to any of their EFIS products. (Enigma)
- This option is more expensive (\$195US for just the sender) The fuel consumption can be calibrated very accurately. To the point that a fuel level gauge / sender is usually not required.



Thermocouples

- You will want to have a dual EGT gauge whether you have a 503 or 582. Not only to identify rich/lean conditions, but to assist in syncing of the Bing carbs.

- A single or dual CHT gauge is suggested for the 503 to indicate possible airflow cooling problems. It is optional with the 582, since the coolant temperature is more important

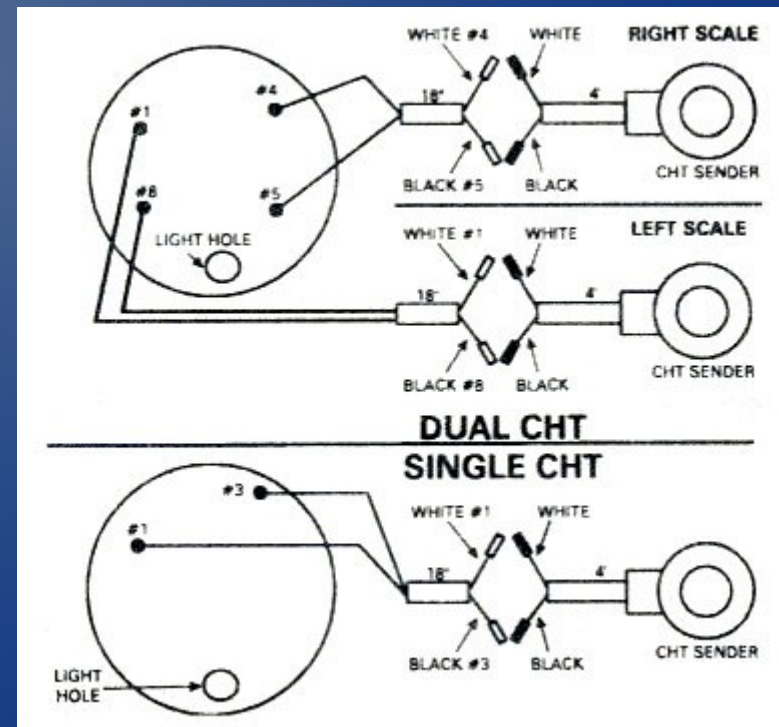
- MGL 'K' type probes are shown with the yellow/red wires. (Yellow is positive)

- Westberg gauges use a 'J' type probe for CHT shown with black/white wires (Black is positive) This means an MGL 'K' type CHT probe, cannot be used with the supplied Westberg (Westach) gauge.



CHT / EGT gauges

Westberg (Westach) gauge wiring is shown below. Do not purchase expensive thermocouple extension wire. Extend wire length with shielded or other tefzel 20g-22g twisted pair wire and make the connection with a knife connector or D-Sub pin splice. Make this splice connection in the fuel tank area. This connection becomes the 'cold junction' and will often be at roughly the same temperature as inside the cockpit. 15 degrees C is the calibrated cold junction temperature. Keep these wires away from the noisy ones such as the ignition, charging or tach wires



Intercom / Radio

- Should you decide to install a panel mounted XCOM or MicroAir style radio / intercom, give consideration to headset jack location. Panel mounted would not be great for the rear seat passenger. Also, cord jacks mounted low can be tangled easily. Shown is a break out type box with jacks mounted for both seats. If using a Comtronics or similar intercom, it can also be mounted in this area.



Intercom / Radio

Miracle Antenna Intercom / Radio / Headset / Antenna package which works very well. About \$1300.00 depending on radio chosen. Includes everything you need.



MultiComm AV24 and AV6 - includes -

- * MultiComm multi-mode intercom unit
 - * Two stick-mount PTT Switches w/cables
 - * Radio interface included w/ standard GA-compatible plugs for all radios
 - * Fully filtered/regulated power supply
 - Includes radio power that is Icom A6/A24 ready! (11 volts supplied to radio)
 - * All cables prewired and ready-to-go - one single DC connection to aircraft 12v.
 - * Full three-year warranty, plus...
- * Two Lightspeed QFR Solo SSC Headsets -*
One of the highest passive noise-attenuation ratings in the industry, the best Gentex noise-cancelling mike available, flawless sound, all-day-comfort, and cell-phone ready.
(1 yr manufacturer warranty)
- * Icom A6 Comm or A24 Comm. VOR transceiver - Your choice of either of these great radios - Icom quality all the way (1 yr manufacturer warranty)*
- * Miracle Air Whip Antenna - Proven in thousands of installations to be the best performing, easiest-to-install antenna on the market*

Intercom / Radio

- Comtronics also make a nice headset / intercom system. Requires an optional special cable depending on which radio you use.

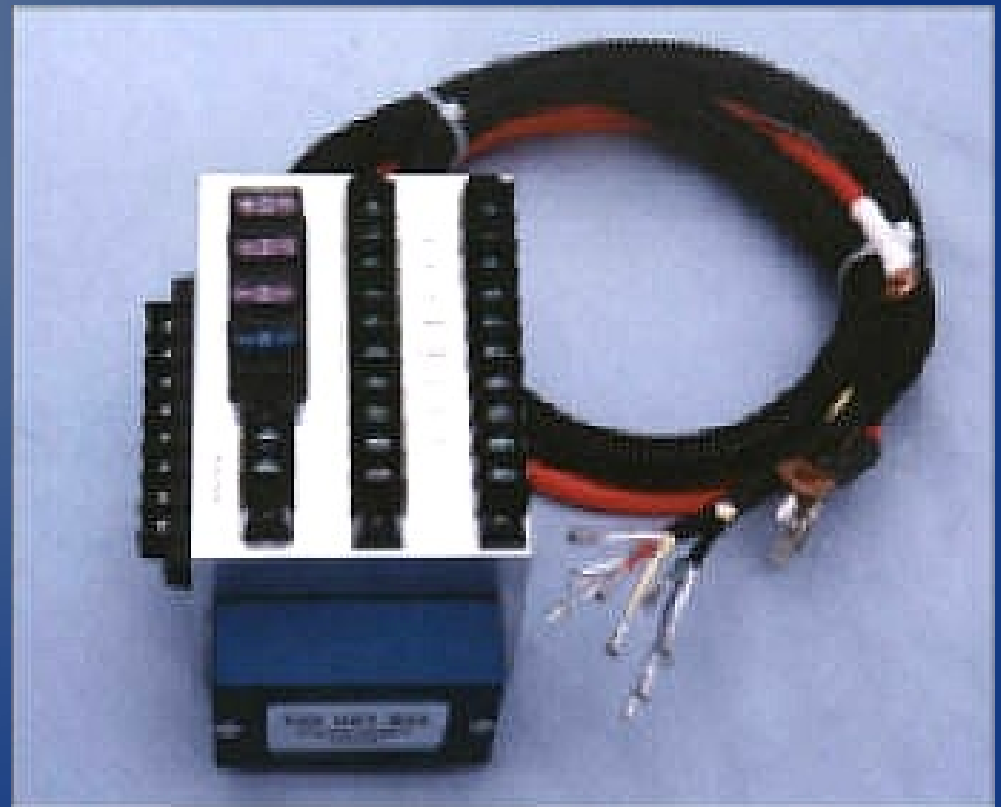


'Hot box' or similar devices

- There are many devices that claim to 'save time' or 'make things easier' Of course the perceived time saved is proportionate with the extra money spent. There are even suggestions that the costs are the same as if you had to buy the individual parts yourself. Lets look at the \$240.00+ hot box as a time saver and easier solution than 'doing it yourself'

- Your kit purchase should already have the regulator/rectifier. You also have the starter solenoid and large starter wire. After viewing this presentation, you should have the means to make all the wiring connections that are needed. You only need a fuse block and an optional Hobbs hour meter circuit if desired.

- There is no need for additional 'screw terminal barrier strips' anywhere in your Challenger.



'Hot box' continued

- Is there a saving on mounting anything? You have to mount the fuse block near the panel and the solenoid near the battery. 2 small aluminium plates w/rivets/rivnuts and screws (\$3.00-\$5.00?) The regulator is then mounted on an existing plate in the firewall area where it should be. NOT at the front of the plane as shown on this device.

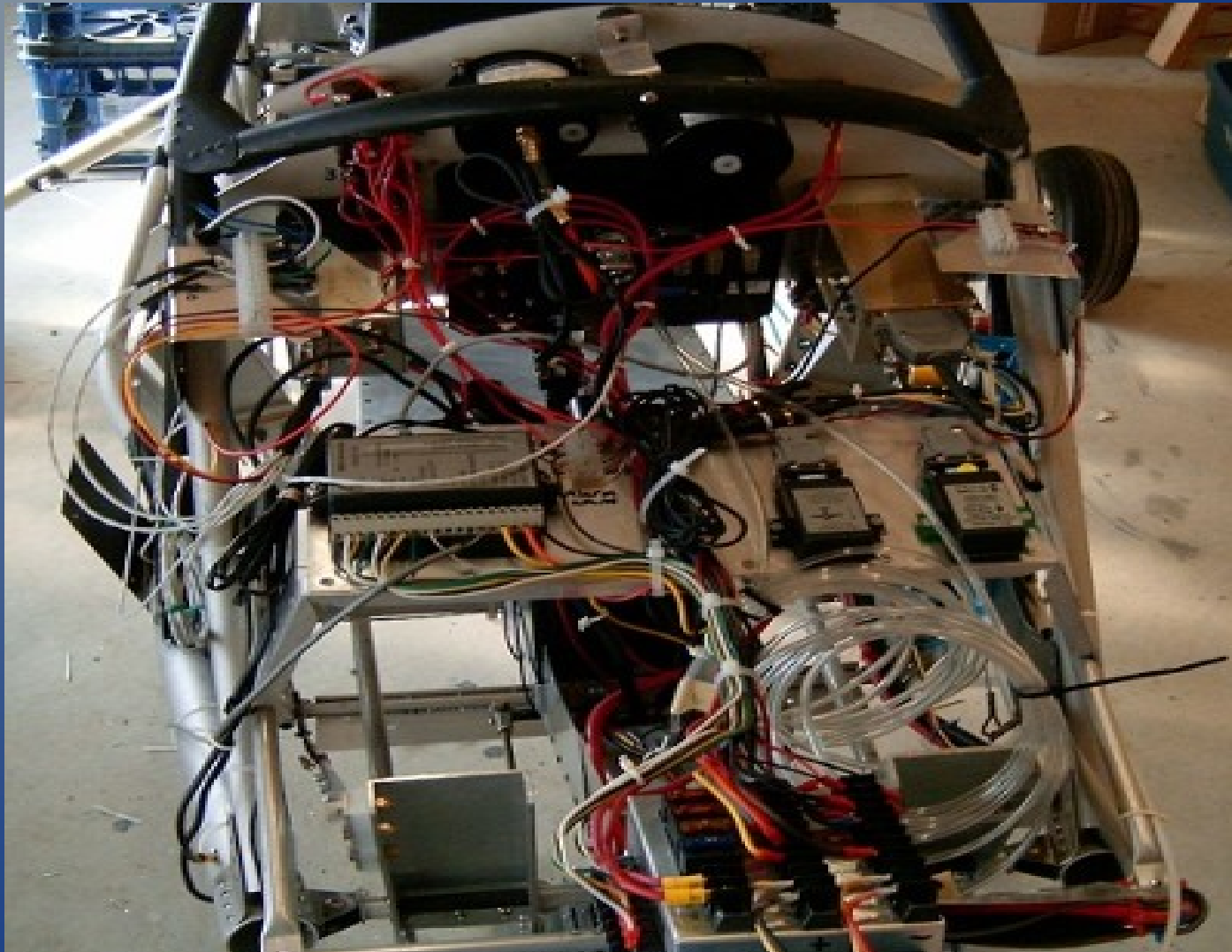
- Is there a saving on crimping connectors on wires? Numerous ring terminal connectors would have to be crimped onto the wires which attach to the terminal strips. No saving of time there. You still have to mount your panel switches and install the devices.

- The box features a Hobbs hour meter DC supply as a main selling feature. The additional parts for this type of feature cost about \$2.00



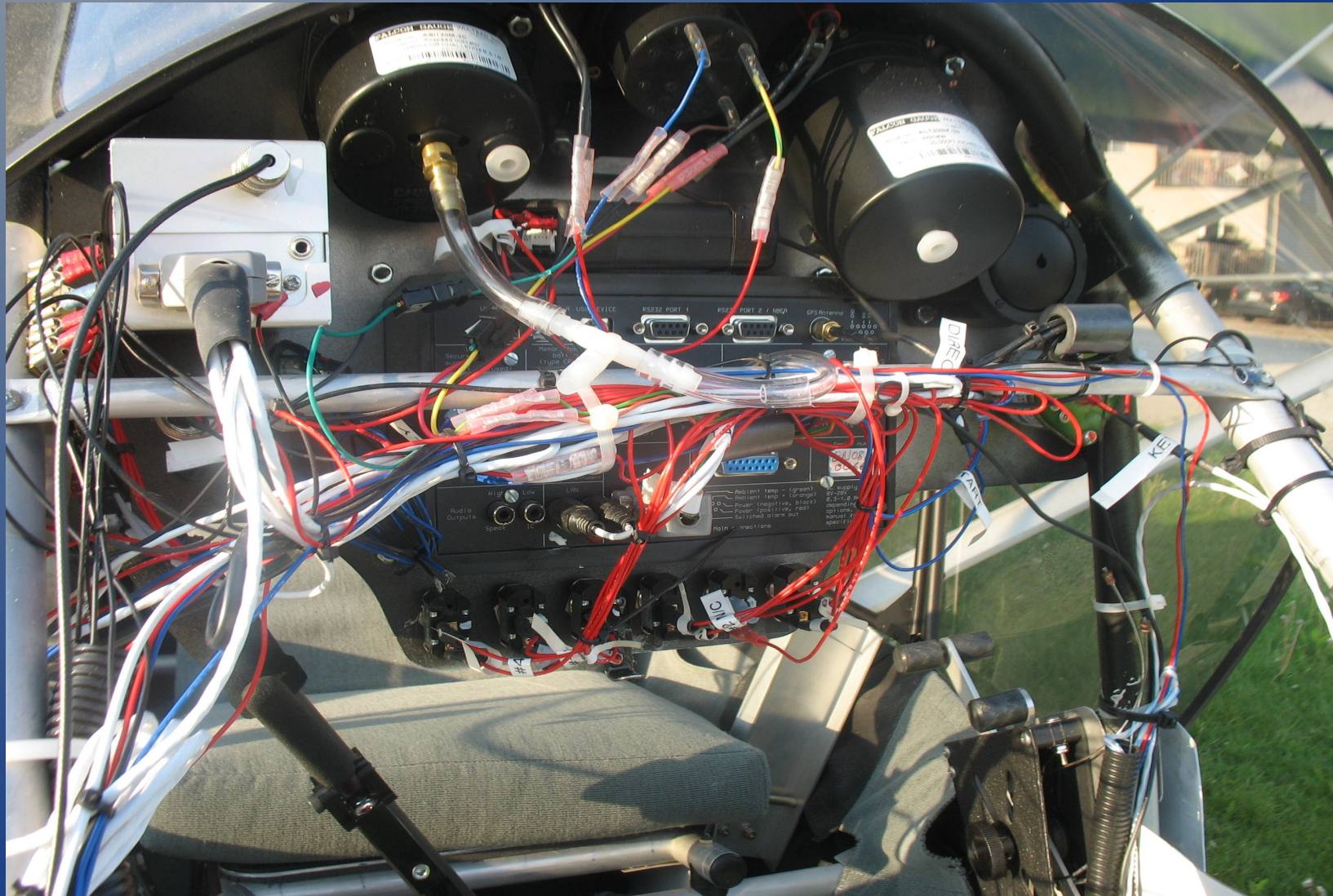
'Hot box' continued

- Perhaps this Challenger actually works after this build, but how much does it weigh? I have other issues with this build photo than just the hot box shown!



Back of Enigma

- Here is an Enigma EFIS install with no hot box and NO screw terminal barrier strips. The RDAC and sensor modules are mounted in other more suitable locations than behind the panel. Wires here could be tied a bit neater, but easy to fix.



Buy parts individually

- There is no need for wiring 'kits' or other such devices to wire even a fully loaded Challenger. Learn a few common wiring tasks and make a list of parts you will need. Instead of a Hotbox, you could purchase something else from Kuntzleman Electronics. Such as a low power LED landing light or a strobe light system. Visit: <http://www.kestrokes.com/>



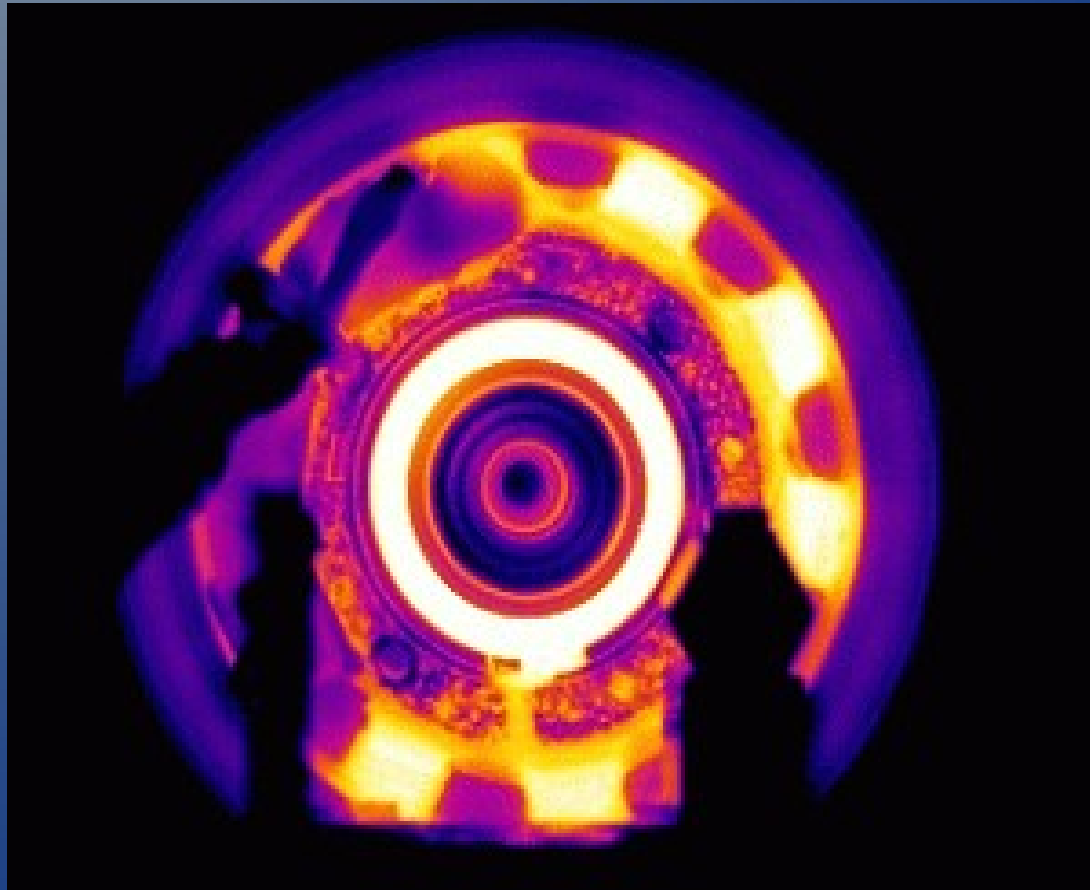
'Overdone?'

- There is no explanation for these example photos of other kit planes. Other than to say 'What NOT to do!!'



Easy on the options!

- Try to keep loads to a minimum. No multiple 50watt landing lights like I've seen on some Challengers. Here is a picture of a fully loaded Rotax 912 charging coil (similar construction to a 503/582 coil). This was done using an infrared camera by a group trying to determine why some coils seemed to be failing for no apparent reason.



References

National Ultralight: <http://challenger.ca/>

Challenger West: <http://challengerwest.ca/>

The AeroElectric Connection: <http://www.aeroelectric.com/>

Stein Air: <http://www.steinair.com/>

Rotax Charging/regulator: <http://www.challengers101.com/RotaxChargeSys.html>

Aircraft Spruce: <http://www.aircraftspruce.ca/>

Odyssey Canada: <http://www.odysseybattery.ca>

WemaUSA:

http://www.wemausa.com/tank_sensors/details_SSS_SSL_tank_sensors.htm

MGL Avionics: <http://www.mglavionics.com/>

XCOM Avionics: <http://www.xcomavionics.com/>

Comtronics: <http://www.comtronics-aero.com/>

Miracle Antenna: <http://www.miracleantenna.com/>

References

Digikey Canada: <http://digikey.ca/>

Fuse Blocks: <http://myworld.ebay.com/ebaymotors/notop442/>

Kuntzleman Electronics: <http://www.kestrob.com/>

All Electronics: <http://allelectronics.com/>

ICOM: http://www.icomcanada.com/products/avionics/avionics_ic-a6_a24.html

I welcome all feedback and suggestions or corrections regarding the topics covered in this presentation. I may be reached at: challengerflyer@gmail.com

For further information on the Challenger, you may contact National Ultralight or ChallengerWest depending on your location.