12 Fuel System

The fuel system is shown for the Rotax 912. For other engines the fuel system will be similar. Consult your engine installation manual. For instance, the Rotax 582 system is the same, but without the fuel return line and its associated fittings. The Jabiru system also does not have a fuel return line, has only one carburettor, but the fuel lines must be fitted with fire-resistant oversleeve in the engine compartment.

12.1 Fuel Piping

Follow the fuel system schematic, 243.

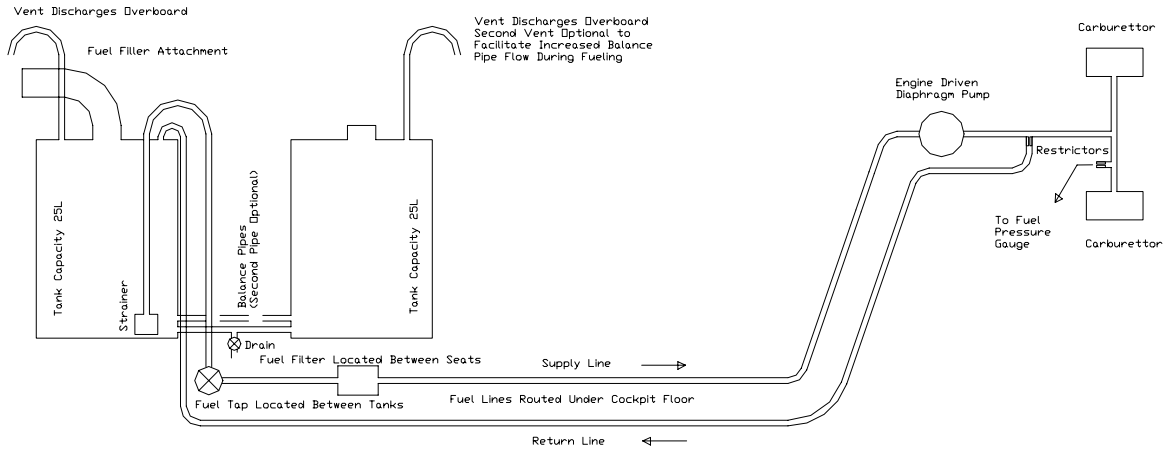


Figure 243; fuel system schematic, Rotax 912.

12.1.1 Engine compartment

a) Fit a T-piece in the pipe joining the two carburettors, Figure.

Remember to slip the appropriate pipe clips over the pipes.

The fuel pipe joining the two carburettors can be conveniently clipped to the intake manifold balance pipe.

Fit a second T-piece with a restrictor into this pipe if a fuel pressure gauge is to be fitted. The T-piece restrictor may be made by fitting a sawn-off self-tapping screw, which allows some flow past its sides.

Figure 245; fuel pipe routing in engine compartment.

b) The standard T-piece is connected to a short length of fuel tube running forwards approximately half way to the fuel pump outlet.

c) At this position a T-piece with a restrictor connects to allow the anti-vapour lock fuel return line to pass neatly behind the gearbox, Figure.

This restrictor should be a precision Rotax/Skydrive item.

d) The front of this T-piece then connects to the fuel pump outlet (the smaller diameter pipe).

e) The fuel supply pipe from the tank connects to the inlet of the fuel pump (the larger diameter pipe).

Note that although the fuel pump inlet and outlet tubes are of different diameters, the fuel tube will fit over both of them.

A useful tip: to fit ¼" bore flexible rubber pipe to 8mm metal tubes, such as those on the fuel tanks and elsewhere: tenderise (as per a steak) the end of the rubber pipe, or heat it by dipping into boiling water. This softens the end. If not already done, clean up the end of the metal tube with a file, and wash to remove any swarf. Then with a small drop of light oil (3-in-1) placed on the tube or the pipe, slip the rubber tube over the metal pipe. The pipe clips may also be a tight fit, but will go on with some worrying!

f) The fuel supply pipe and the fuel return pipe both pass behind the gearbox and back over middle of the engine and under the centre piece of the engine mount, to pass through the firewall beside the rear of the port upper engine mount along with the pipe from the additional restricted T-piece to the fuel pressure gauge (if fitted).

Ensure that the tubes cannot chafe against the firewall, using rubber grommets or sheaths of split fuel tube or oil hose.

12.1.2 Cockpit

a) The fuel supply and return pipes pass down the cockpit side of the firewall in front of the nose wheel steering bar, Figure, and then under the floor.

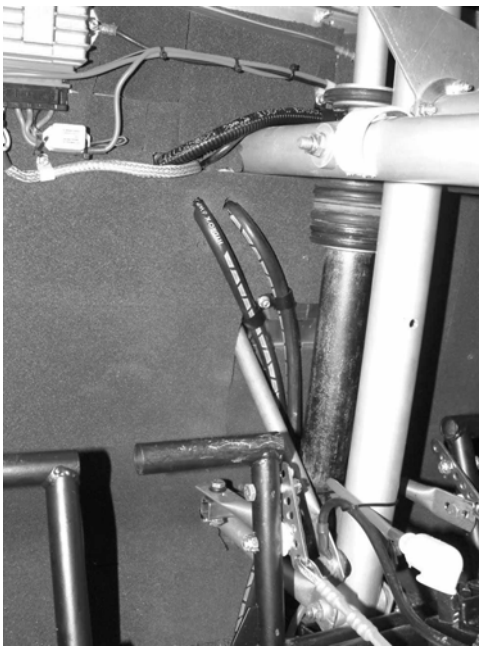


Figure 246; fuel tube routing.

b) The fuel pipe should be routed under the starboard side of the floor back to the fuel filter attached to the steel diagonal bracing piece under the starboard seat, Figure.

It is held in position by a pair of cable ties run through short lengths of fuel tube to act as spacers.

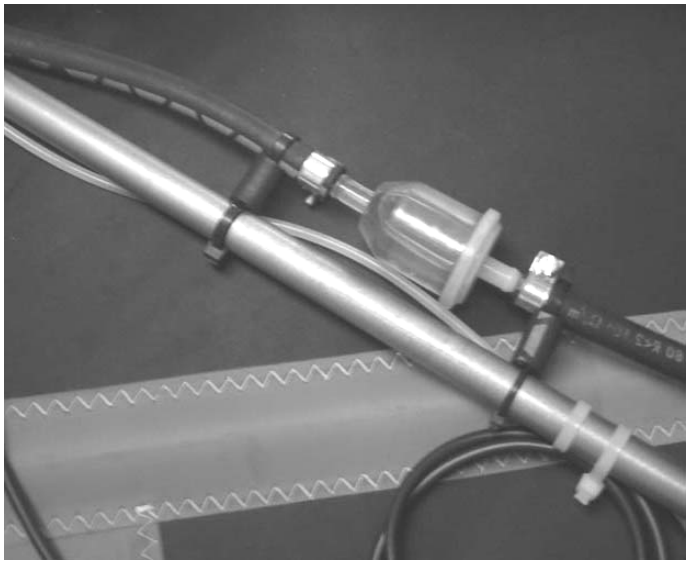


Figure 247; fuel filter under starboard seat.

12.2 Fuel Tanks

a) Fit the balance pipe fittings to both tanks, close to the bottom of the inside rear corners of the tanks.

Drill a 31/64" hole in each tank, high enough to allow the sealing washers to sit on the almost flat area on the bottom corner of the tank, Figure, and use the push-in fittings provided. Note the hole size must be correct, no metric equivalents!

Position them low – in the lower half of the flat corner area.

Figure 248; balance pipes.

b) Optionally, a second balance pipe may be fitted above the first, to speed bala

c) Drill three holes (only two for the Jabiru and 582, no fuel return is required) in the top of the starboard tank for the fuel supply, fuel return, and a breather, Figure.

The fittings should be a screw-fit into the holes.

Keep the holes close enough to the cap to allow a bent spanner to be used to secure the internal nuts.

The fuel supply is the long aluminium pipe fitted with a filter cut in half to form a strainer, and a plastic olive to seal the pipe into the tank. It should be gently bent if necessary to arrange it to take fuel from the inside rear corner of the tank.

The other two pipes should be fitted into the tank, but should not stick very far in.

Check that the ends of the metal pipes are clean, dress with a file if necessary.

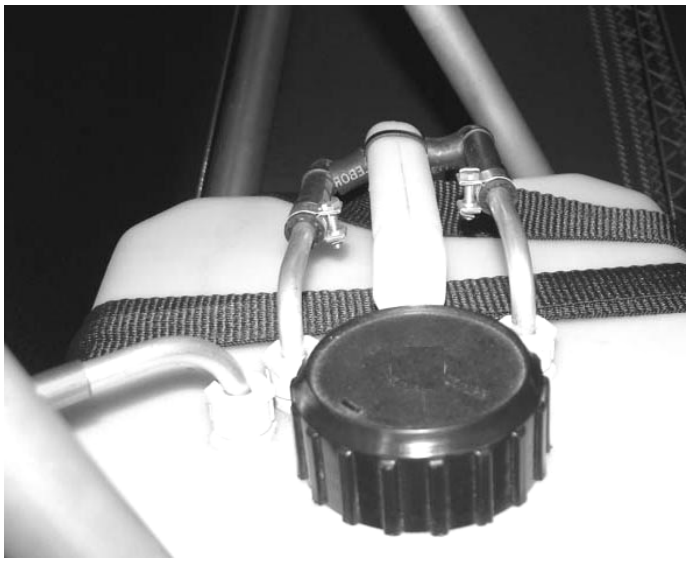


Figure 249; top of starboard fuel tank.

d) In a similar manner fit the breather tube to the top of the port tank.

e) When all the holes have been drilled and the pipes fitted into place, carefully rinse any swarf out of the tanks and pipes with water, and allow to dry with the tops removed.

f) It is worth trial fitting the tanks in place to determine the lengths of fuel pipe required, then remove them and fit as much of the piping as possible before actually fitting the tanks to the aircraft. Otherwise it is quite difficult to fit some of the pipes in situ.

12.2.1 Fuel tank load spreader bars

Ensure that these were fitted earlier, in the section on the forward fuselage.

Figure 250; fuel tank spreader bar.

12.2.2 Fuel tank securing straps

a) Push fit the tanks onto the cross bar in the rear fuselage, the one supporting the flap handle pivot, with the filler caps forwards.

Put pieces of tape or similar onto the fuselage covering where the rear lower edges of the tanks push against it, to reduce chafe.

You may find it easier to fit the pipework to the tank fittings with the fuel tanks sitting loosely in place, before strapping them down. See the next section for the details of the pipework.

b) Fit the tank securing straps, which are one-piece with a metal ring slipped over the strap. Start by looping the strap around the lower support on the outboard side of the tank, with the metal grip end as the stationary end.

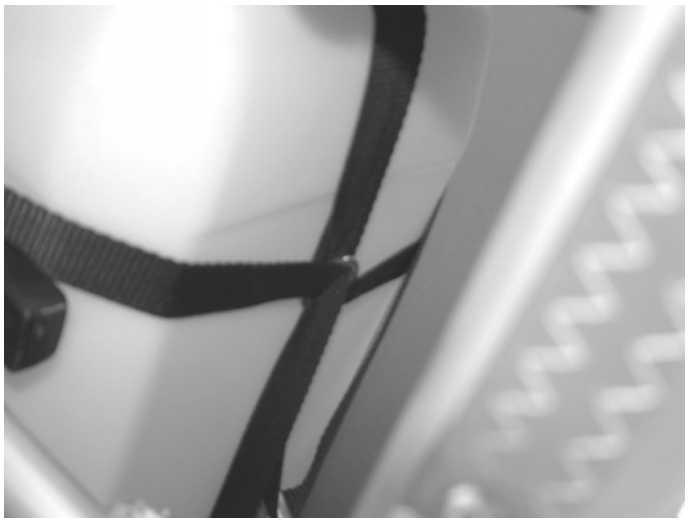


Figure 251; metal ring.

c) Take the strap up and over the tank leaving the ring half way up the outboard tank side.

d) Continue down the other side around the lower support and back up over the tank. Pass through the tank handle each time.

e) On the way back down pass through the ring and change direction to encircle the tank. On the way take a turn around tube ***tu27*****,** Figure.

f) Pass back through the ring and then change direction again downwards to engage in the metal grip end.

g) If the ring does not sit flat against the tank side, the straps should be re-routed through the ring from the other side. Look at it long enough, and you'll manage!

h) Pull everything tight, working the tension around the system until even.

i) Finally tie off any loose strap.

12.2.3 Fuel tank connections

a) The fuel drain should be connected to the fuel balance pipe (the lowest if two are fitted). Fit the pipe with a T-piece to connect the fuel drain, which must discharge clear of the aircraft, Figure.

The fuel drain tap can be secured with a P-clip attached to the undercarriage leg with a small self-tapping screw.

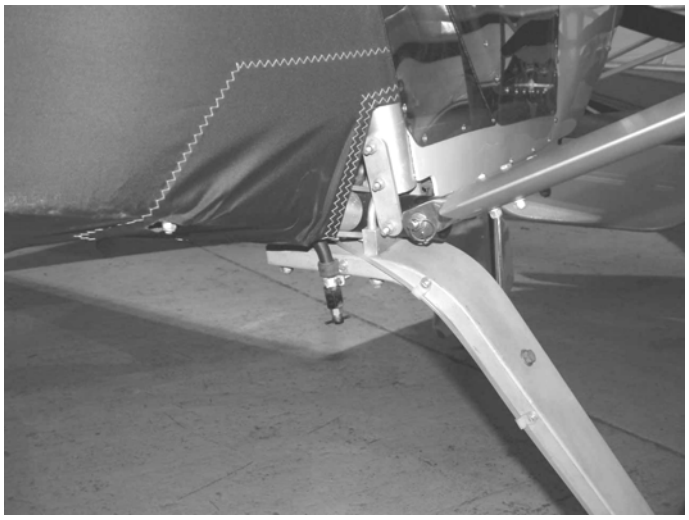


Figure 252; fuel drain.

b) The fuel supply pipe should be connected from the pickup dip tube in the starboard tank to the fuel tap.

c) The fuel tap should be mounted between the fuel tanks towards the starboard side, Figure.

The mount for the fuel tap is a small piece of aluminium angle, riveted onto the cross-tube below it.

Figure 253; fuel tap.

d) The tap should then be connected to the fuel filter under the starboard seat.

e) The fuel return pipe from the engine compartment should be attached to its fitting in the top of the starboard tank.

f) Both breather fittings should have individual lengths of tubing attached, routing directly upwards to curve over and into the tops of the rear cabin uprights ***tu6***, Figure.

This ensures a reasonable static pressure, and that the pipes discharge overboard.

Use a short length of bent aluminium tube at the top ends of the plastic tubes, otherwise the plastic tubes are likely to kink where they are bent over to fit into the top of the rear cabin uprights.

Figure 254; fuel tank breather.

g) Secure the pipes at the top of the tanks using pieces of fuel tube with cable-ties passed through them between the pipes and the tank handles, as seen in Figure.

12.2.4 Drainable sump verification procedure

The fuel system is designed to operate with the fittings as low a possible in the tank in order for the fuel drain to be effective at removing water and debris. It is also designed for the fuel supply dip tube to be above the level of the drain to provide a sump area so that accumulations of water / debris between draining does not get ingested into the supply to the engine.

a) Fill the tank with fuel up to the point where the linking / drain fittings are completely covered.

b) Remove fuel from the tank using the drain until no more fuel will come out.

c) Measure in a further 0.25L of fuel

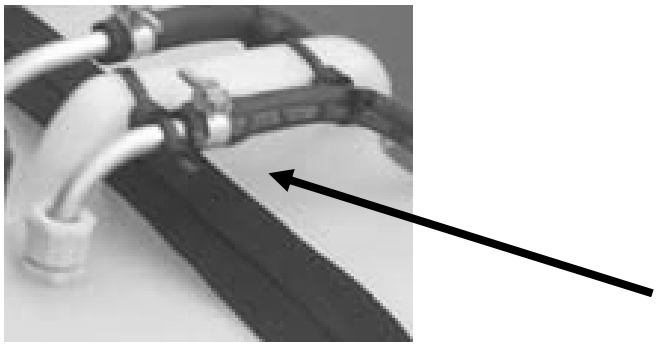
d) Size the supply dip tube by trimming the end so that it aligns with the level of fuel **(important the end of the dip tube must be cut at a 45 degree angle so as to prevent suction causing a seal with the strainer end cap).** Check that the dip tube end is in no case higher than the moulding line step viewed from the rear of the tank (otherwise the unusable fuel is greater than that allowed in Section S)

Inside of tank showing linking / drain fitting and delivery dip tube with strainer in position on end. Positioning can be clearly seen by looking directly in the top of the tank with cap removed

Dip tube end MUST be higher than this fitting.

Fig 255; dip tube position

e) Fix the delivery dip tube into position with the retaining gland screwed tight and secured against vertical movement (as illustrated using cable ties and spacers on to the handle on the top of the tank.



Top of tank showing delivery dip tube secured using cable ties and short lengths of tubing, to resist vertical movement.

Fig 256; fixing dip tube position

12.3 Choke

12.3.1 Rotax 912

The choke is fitted to the instrument panel, which is not fitted until the next chapter, so fit the other parts now and complete the choke fitting when the panel is installed.

a) The choke is a simple loop of cable covered with plastic tube, passed through the instrument panel on the port side, Figure.

   This position is chosen to allow the choke to be operated with the same hand holding the throttle lever.

   A pop-rivet with the centre pushed out makes a neat cable guide for the choke cables passing through the instrument panel. Secure the rivets with a small piece of tubing pushed over the rear of them, or with a touch of glue.

b) The cable outers are mounted on a plate riveted to the port side of the firewall, alongside the throttle cables, Figure.

   The choke cables are the pair towards the centreline of the aircraft, on the left of the picture.

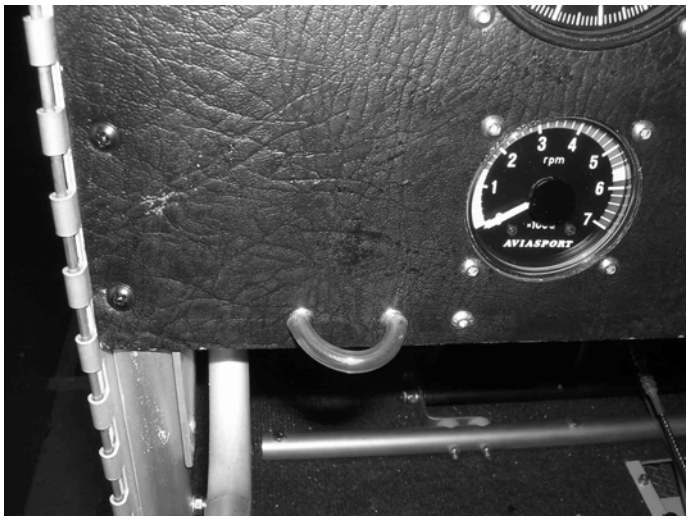


Figure 257; choke.

12.3.2 Rotax 582

Figure 258; Rotax 582 choke cable and lever arrangement.

a) The choke lever should be mounted to a spare hole on the pilot's side of the port central cabin tube.

b) The cable outers should be mounted to a plate attached to the bolt holding the central cabin tubes to the front vertical tube.

c) The cable inners, terminated with loops, should be attached together and to a single length of cable to attach to the lever.

12.3.3 Jabiru Choke and Carb Heat Controls

These are fitted to the instrument panel, which is not fitted until the next chapter, but the cable routing should be prepared now whilst access to the rear of the firewall is reasonably easy. Complete the fitting when the panel is in place, noting that the cables need to be fed in from the front of the panel.

a) The choke cable is provided with the Jabiru engine installation kit and should be fitted to the instrument panel close to a support.

If a panel with a drop-down central part is fitted then this is ideal for the choke and carb heat cables, Figure.

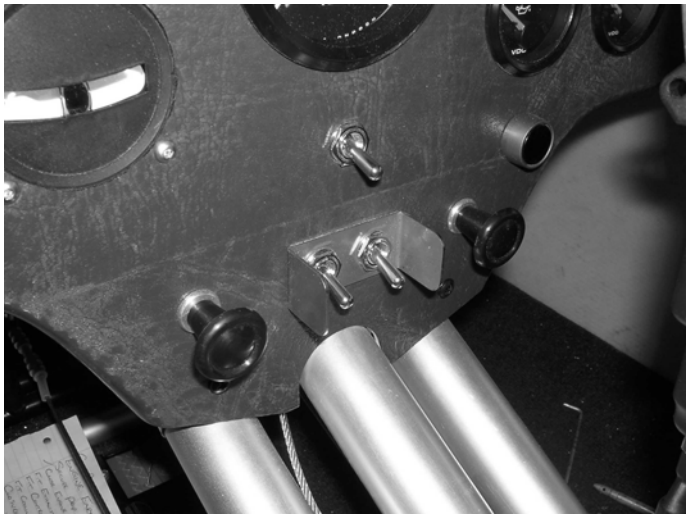


Figure 259; choke and carb heat knobs for Jabiru.

b) Pass the choke cable through the firewall and loop it around to connect to the choke (the aft-most connection on the carburettor).

c) The outer cable may be cut to fit if required.

d) The cable outer end fitting is attached by slipping it over the outer cable and carefully compressing it with the crimping tool provided in a vice.

Remove the cable from the aircraft again for this stage.

e) The cable inner end fitting should be fitted in situ by locating the small brass tube in the hole in the choke lever (the aft-most one with the small hole).

Slip the inner cable through the hole on the side away from the carburettor and solder the inner cable in place in the small tube.

Secure the other end of the small tube into the hole in the lever using the split pin provided.

Spacer washers may be used to take up any slack if necessary.

f) The carb heat cable should be looped around and passed through the firewall to connect directly to the carb heat actuation lever.

g) Drill the hole in the firewall to line up with the cable outer clamp on the airbox.

h) Clamp the cable outer in place.

i) Attach the cable inner to the actuating lever in the same manner as for the choke cable.

j) With the cables in this position the drop down part of the instrument panel must be braced to the central cabin tubes with a pair of bent aluminium brackets Jubilee-clipped to the central cabin tubes and screwed or bolted to the instrument panel.

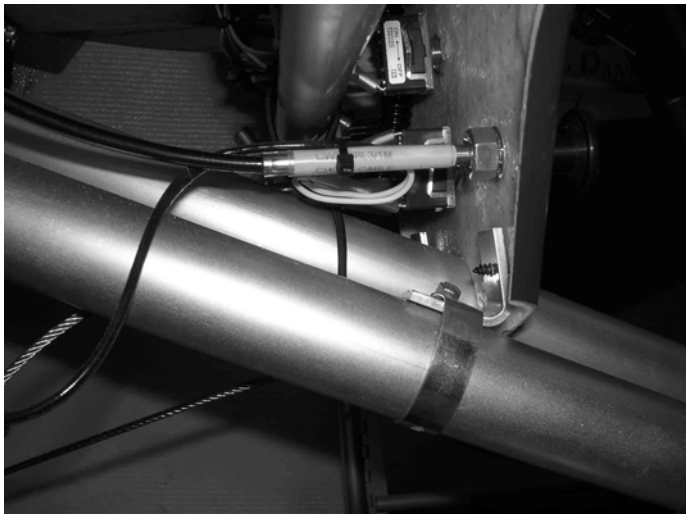


Figure 260; ‘Drop down centre’ Instrument panel centre mounts.

12.4 Throttle Cables

12.4.1 Rotax 912

a) The throttle cable outers terminate at the firewall on a plate riveted to the port side of the firewall, Figure.

The throttle cables are the pair on the right, towards the outside of the aircraft.

Position the plate as close to the edge of the firewall as possible. Ensure that the firewall is securely attached to the cowling at the plate position, otherwise unreliable idle settings and sloppy throttle control will result.

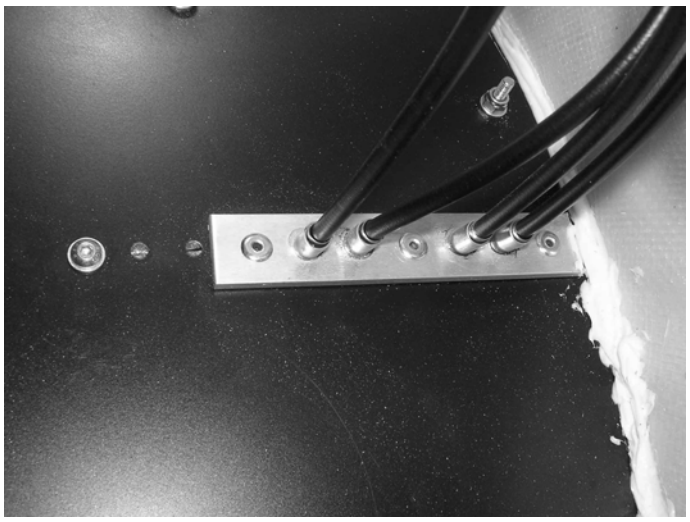


Figure 261; throttle and choke cables at firewall.

b) The cables pass through the firewall to mount onto the lever with swaged loops and plastic washers, one cable to each side of the bolt.

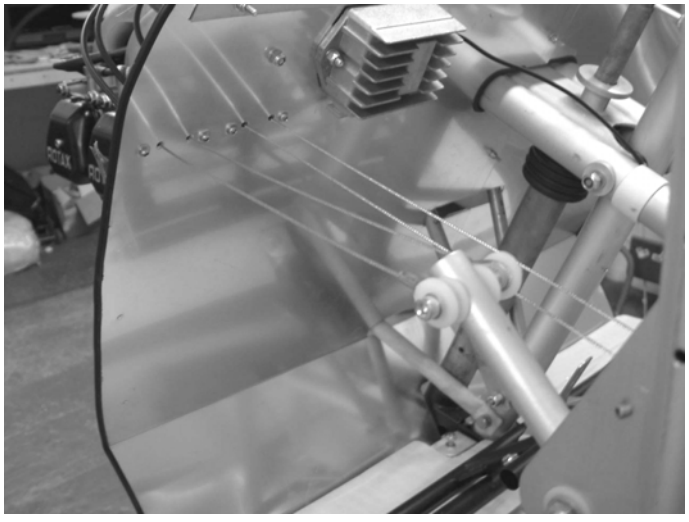


Figure 262; throttle and choke cables aft of firewall.

c) On the engine side the cables should be looped around as necessary to achieve nice smooth cable runs, with no sharp bends. They should then attach to the throttle on each carburettor.

d) Take care to ensure that the cables are secured clear of the throttle arms, as it is easy to prevent them from moving to their fully open position if a cable gets caught around them.

Cable-tie them to convenient fixings.

12.4.2 Rotax 582

a) Mount the cable outer terminations onto the port throttle lever.

b) Mount the inner cables onto the bolt and spacer tube with a large washer at the end, and fit this to the hole in the throttle mounting plate.

c) Pass the cable inners through the outers and connect them to the carburettors.

d) Check the angular movement of the cable outer mount on the lever as the throttle is operated. Determine the central position of this movement and tighten the bolt to secure the outer cable mount in this position.

This will minimise the bending action on the cables.

12.4.3 Jabiru

a) Connect the loop in the throttle inner cable to the lever on the carburettor using a 6mm bolt fitted with a short 8mm length of aluminium sleeve in the hole in the lever. The bolt passes from the carb side of the lever, through the spacer and then through the white plastic cable piece, to be secured by the nut. Ensure that the spacer tube is long enough so that the whole assembly can rotate in the hole in the lever, rather than being solidly fixed in the hole.

b) On the engine side the cables should be looped around as necessary to achieve nice smooth cable runs, with no sharp bends.

c) Fit the single firewall plate to line up with the inboard side of the throttle lever and slightly below the level of the lever at idle.

d) Connect the inner cable to the lever using a solderless nipple and the aluminium U-bracket with 5mm pivot bolt as per Figure.

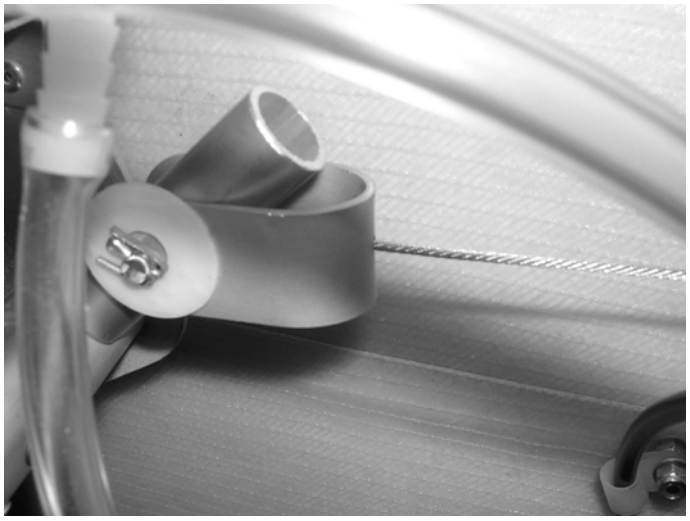


Figure 263; Jabiru throttle lever connection.

13 Instruments

13.1 Standard Instrument Panel

(Proceed to Section 19 if you have the Mk2 Curved top instrument panel)

a) Notch the lip on the instrument panel so that it will clear the cabin uprights ***tu34***.

The instrument panel is the grey fibreglass part with a 90 degree lip along one edge.

The panel is installed with the lip on the bottom.

b) Hold the panel in place and slide up and down until the throttle levers can come to within 5° of vertical before they contact the bottom edge of the panel.

This is intended to allow the golf balls to contact the curved edge of the dash board as the full-throttle stop, rather than the throttle lever crushing the bottom of the instrument panel.

c) Mark the top of the panel level with the cowling top edge, and trim to this level.

The slope of the cowling should ensure that even with the extra thickness of the dash board on top of the panel, it will be level with the cowling in front of the cabin uprights.

This is the standard position for the panel, however it may be made deeper by either moving the throttles downwards (discussed earlier in the section on fitting the throttles) or by allowing the top of the panel to go higher than the line of the cowling. In the latter case the back of the panel can be hidden by some black plastic if desired. The dash board top can still be fitted, or left off entirely.

Do not be tempted to keep the panel deeper by cutting slots in it for the throttle levers: the panel will be seriously weakened, and long-legged pilots' knees will bash the panel.

Figure 264; example of instrument layout, Rotax 912.

d) Cut a piece of light gauge aluminium angle to fit between the cabin uprights ***tu34*** level with the top of the panel.

e) Secure the panel and angle in place using two self tapping screws on each side, one at the top (securing the angle as well) and one at the bottom, with the top of the panel level with the top of the fibreglass cowlings.

The angle can be riveted to the panel to provide additional support if desired.

f) Make sure the instrument panel does not interfere with the operation of the hand throttles.

g) Trim the panel ends flush with the outer edges of the cabin upright tubes.

h) Mount the instruments, magneto switches etc. in the panel as desired.

However, note the position of the throttles and their torque-tube and do not mount instruments so that they interfere with them.

BMAA TILs 7 and 27 may be useful reading regarding the fitting of instruments.

A useful approach to cutting neat holes is to mark out the hole, drill a large number of holes inside this line close together, cut between them with a junior hacksaw, then finish the hole to the line with an abrasive flap-wheel in a power-drill.

13.2 Pitot-Static System

a) The Pitot probe should be mounted at the port forward lift strut to wing attachment using a P-clip, Figure.

Replace the standard bolt with a longer bolt.

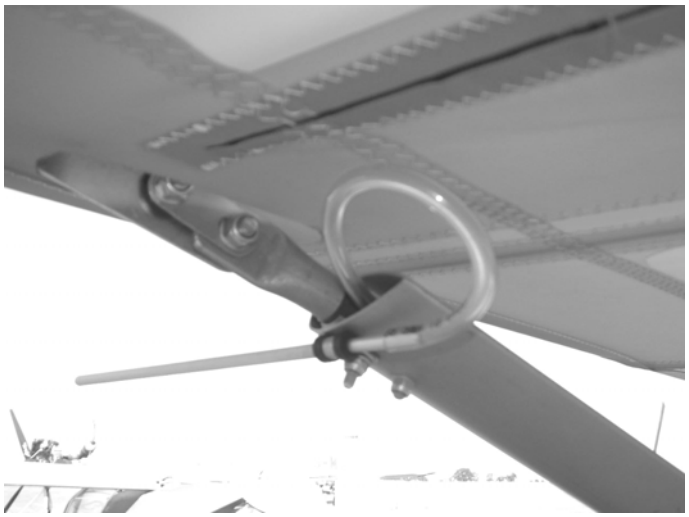


Figure 265; Pitot probe location.

b) The connecting tube should be routed down the inside of the lift strut, to a push fit joiner tube at the fuselage to lift strut bolt.

c) The fuselage piece of tube should enter the cockpit and pass under the floor and up behind the instrument panel to the ASI.

d) The static system consists of a pair of static ports, one on each side of the fuselage, positioned as shown in Figure.

These ports can be elegantly and simply made with a large pop rivet with the centre pushed out, passed through a hole in the fuselage and secured by the fitment of the tube on the inside.

They are located approximately 20cm forwards of the rear edge of the cowling, and 5cm above the join between the top and bottom halves of the cowling.

e) The two ports join at a T-piece, and must then connect to the ASI.

It may also be optionally connected to the altimeter and the VSI.

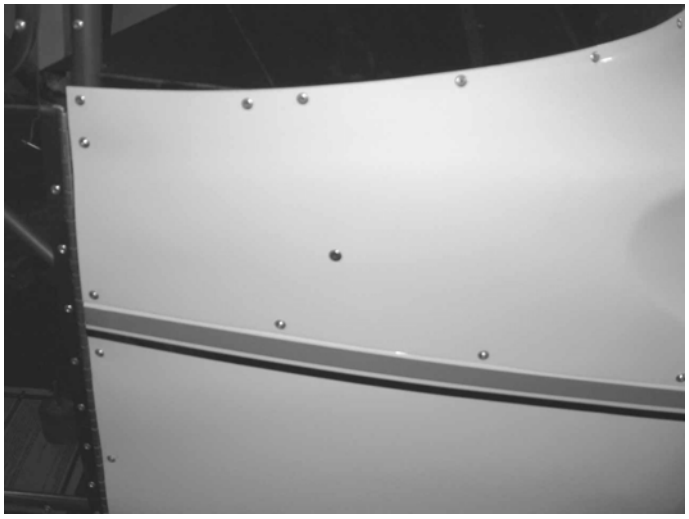


Figure 266; static port location.

13.3 Radio Aerial

A suggested position for fitting a radio aerial is shown in Figure. The aerial is mounted on a plate, which is in turn mounted on the rearmost bolt securing the port upper rear fuselage tube.

If removing this bolt ensure that you push it out with another bolt so as not to lose the internal spacer tube – it's rather tricky to get it back again!

Figure 267; suggested aerial mounting.

14 Electrical System

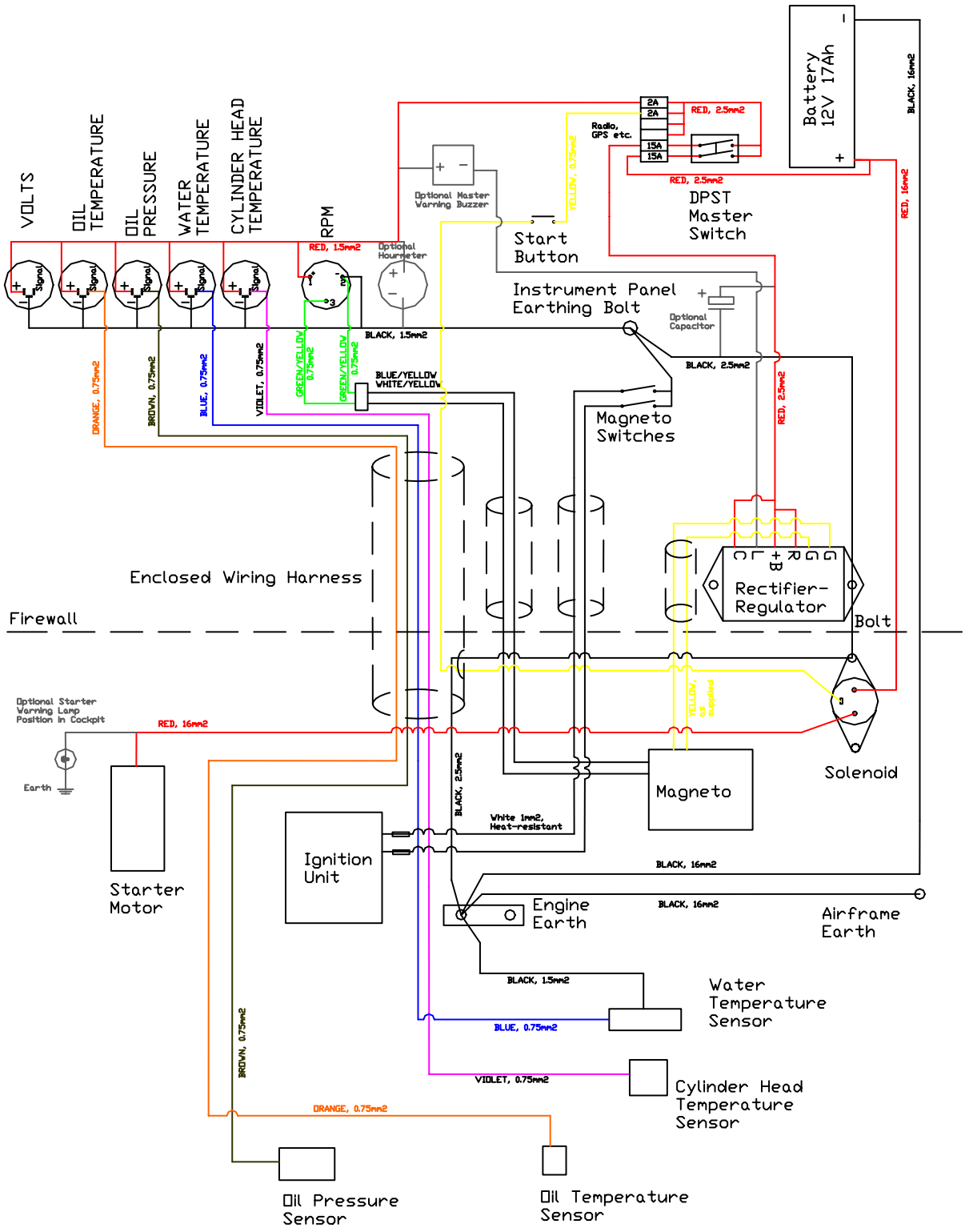


Figure 268; overall wiring schematic, Rotax 912 and standard instruments.

(ensure all colours are visible when printed out)

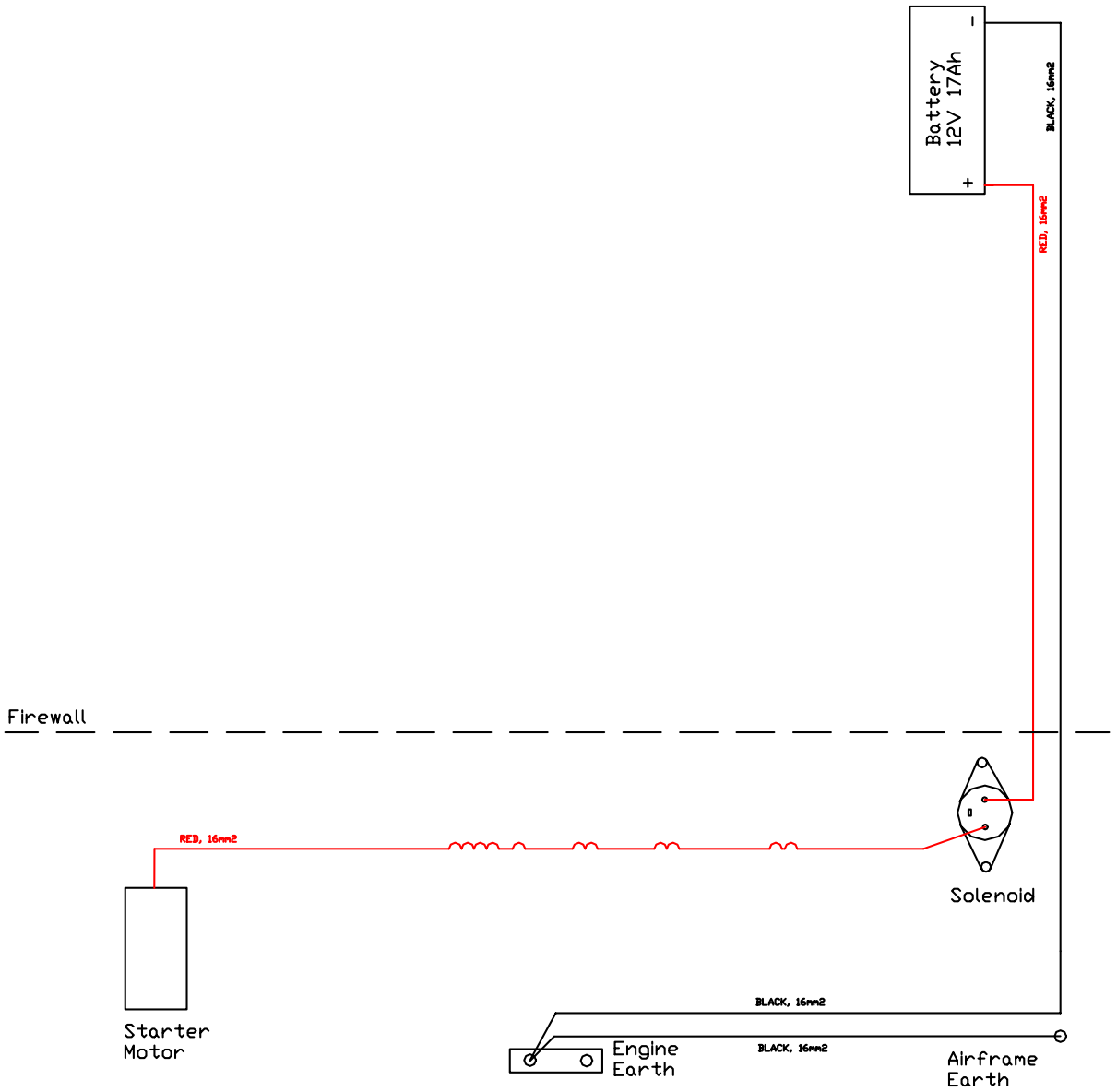


Figure 269; heavy duty power wiring schematic, Rotax 912.

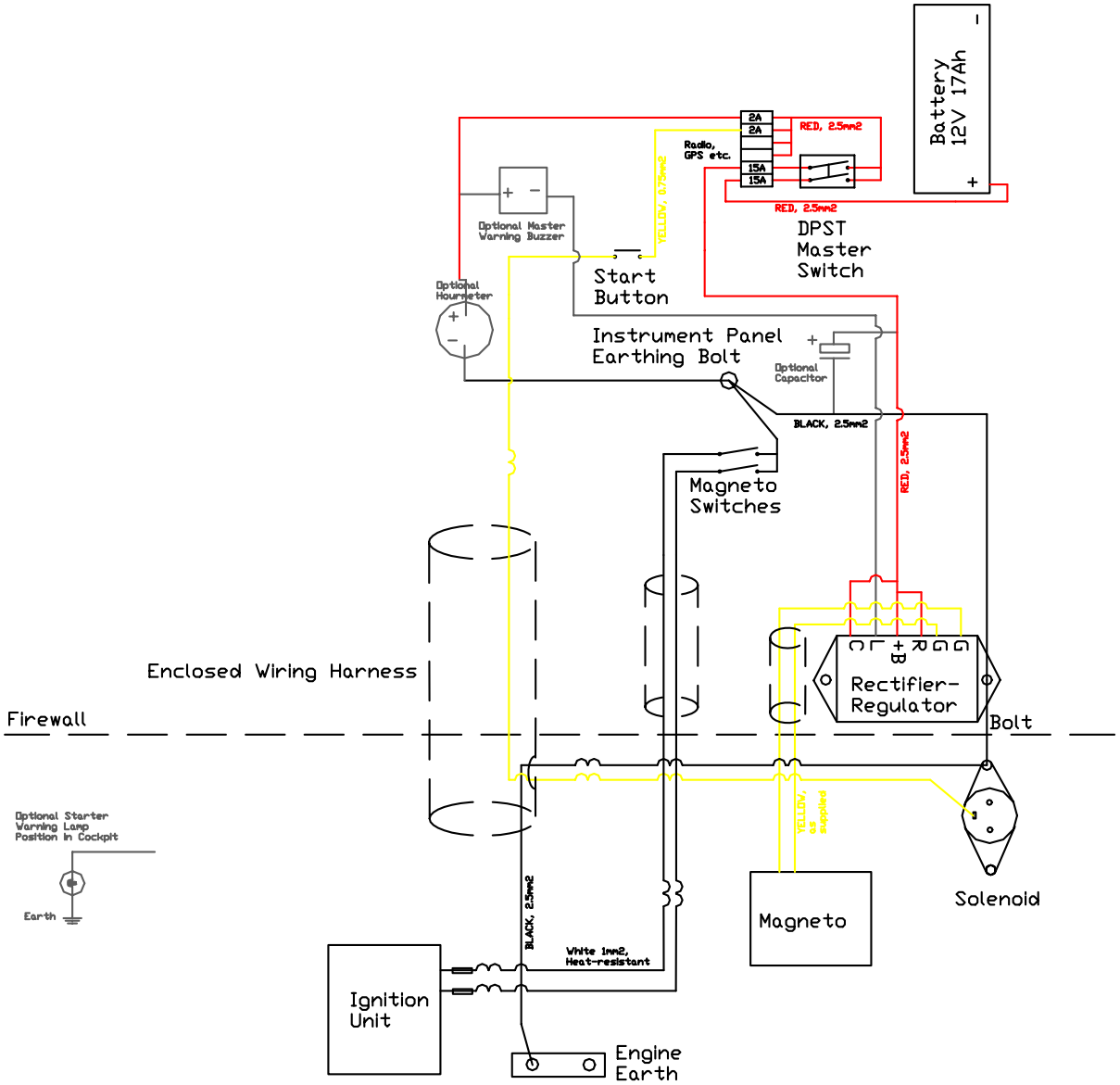


Figure 270; low current wiring schematic, Rotax 912.

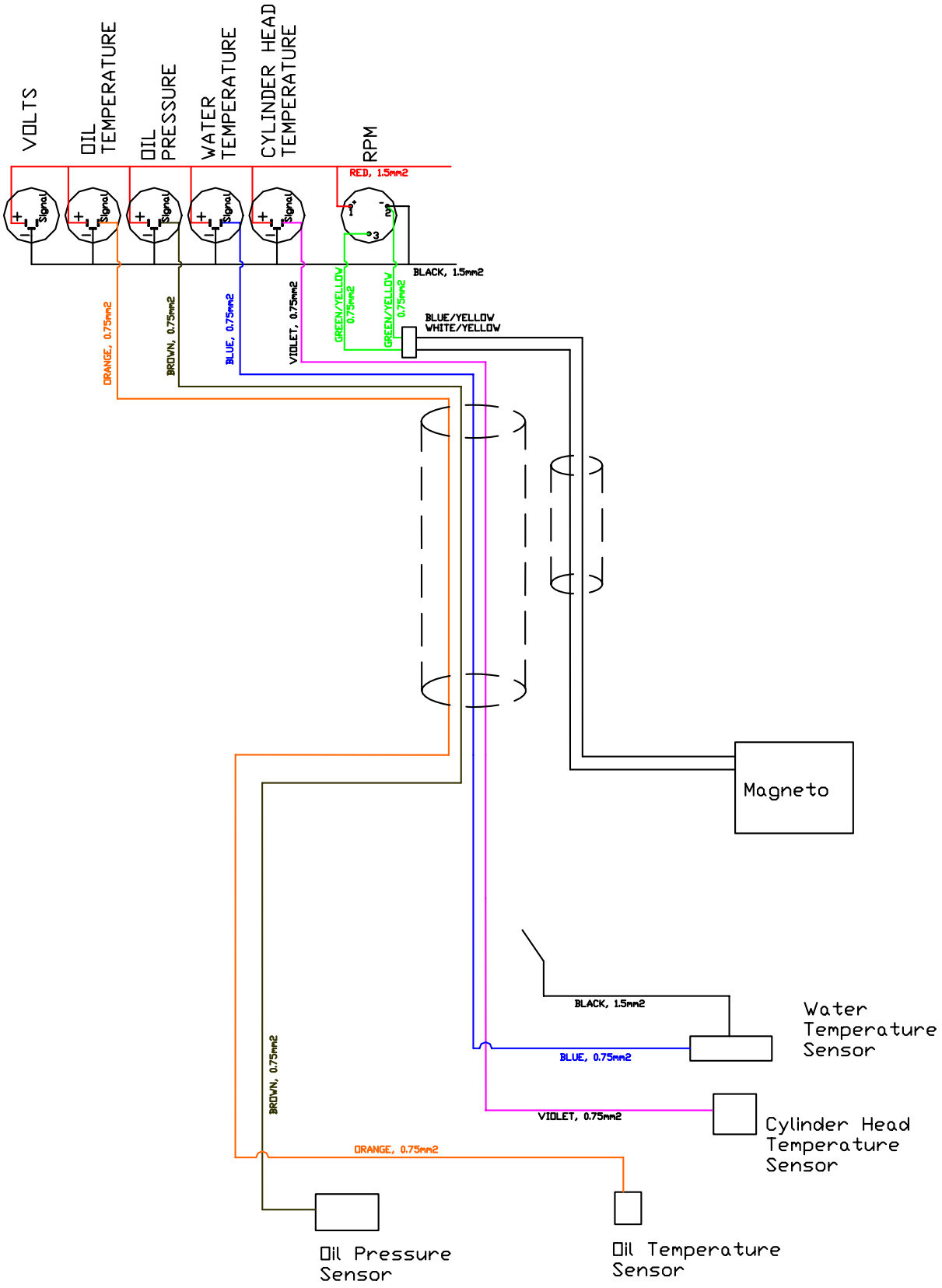


Figure 271; instrument wiring schematic, Rotax 912.

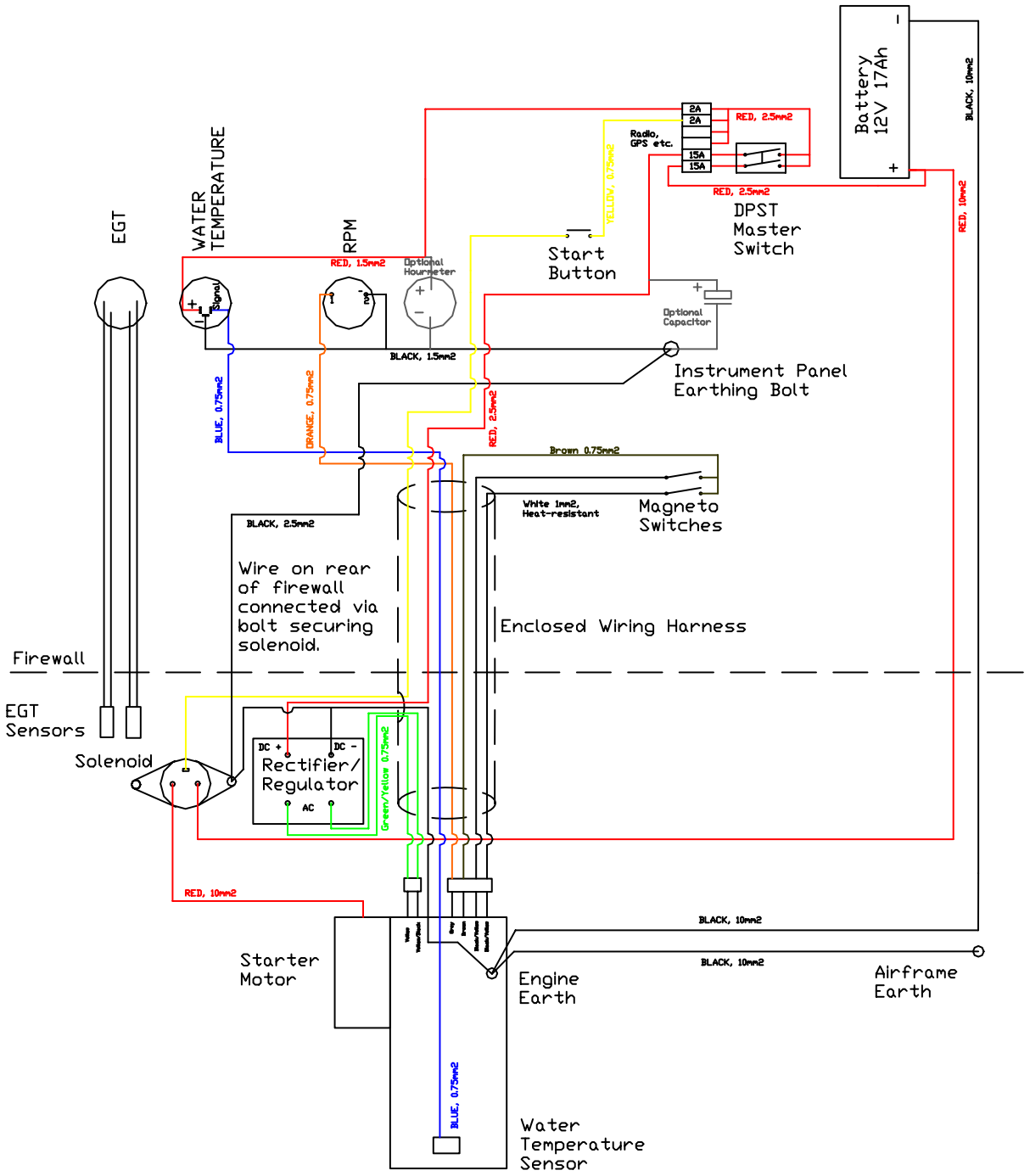


Figure 272; overall wiring schematic, Rotax 582 and standard instruments.

(ensure all colours are visible when printed out)

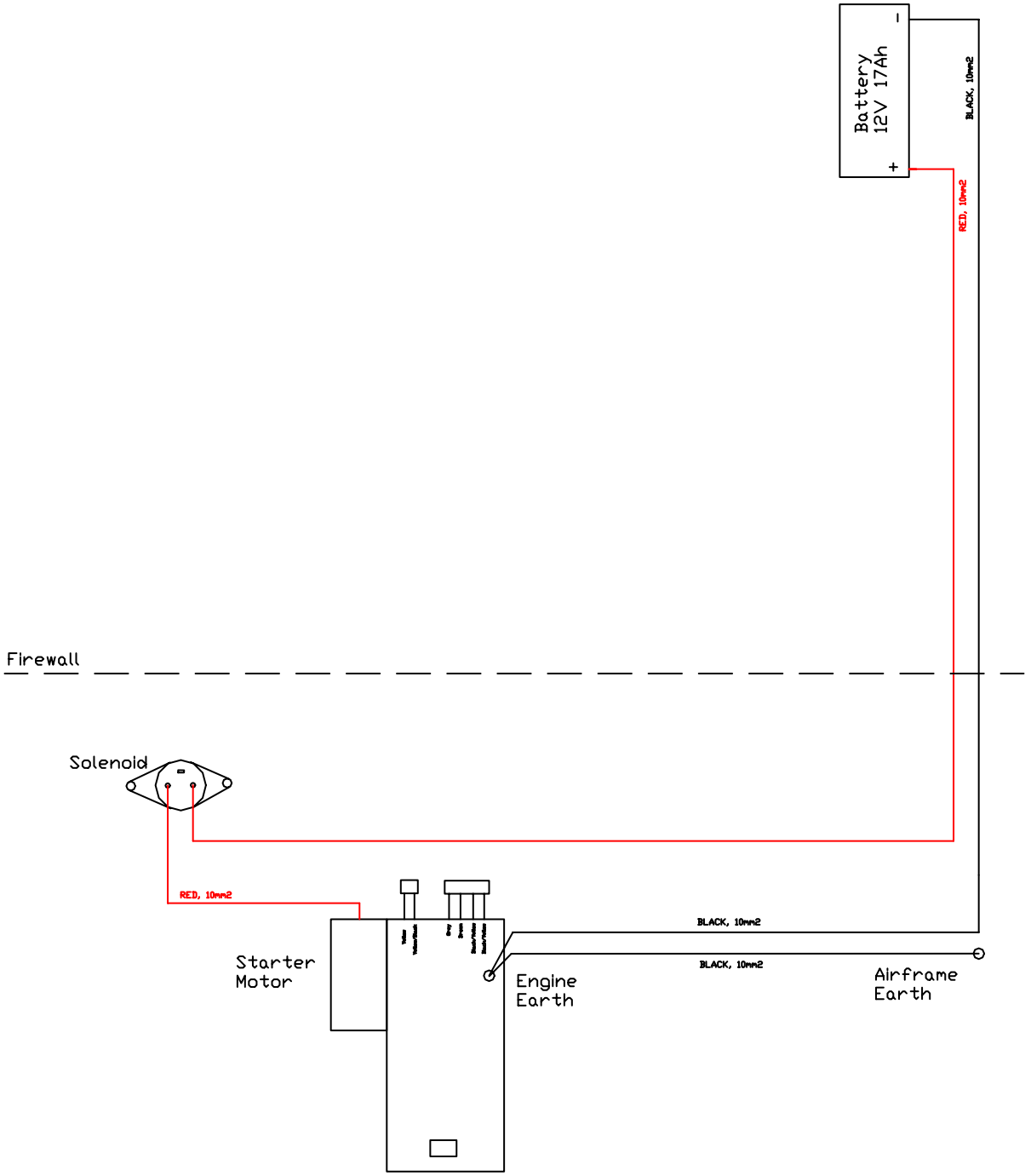


Figure 273; heavy duty power wiring schematic, Rotax 582.

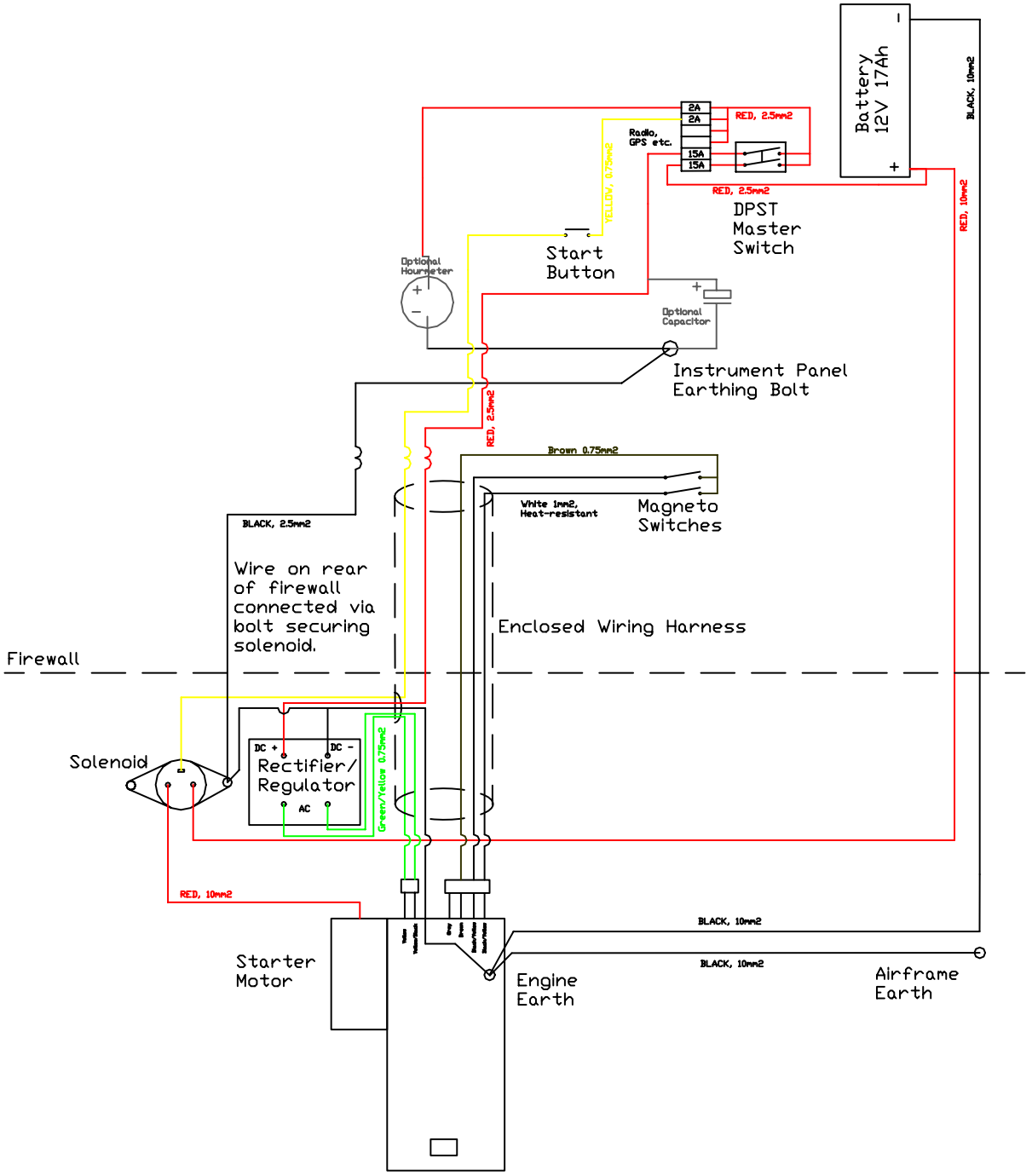


Figure 274; low current wiring schematic, Rotax 582.

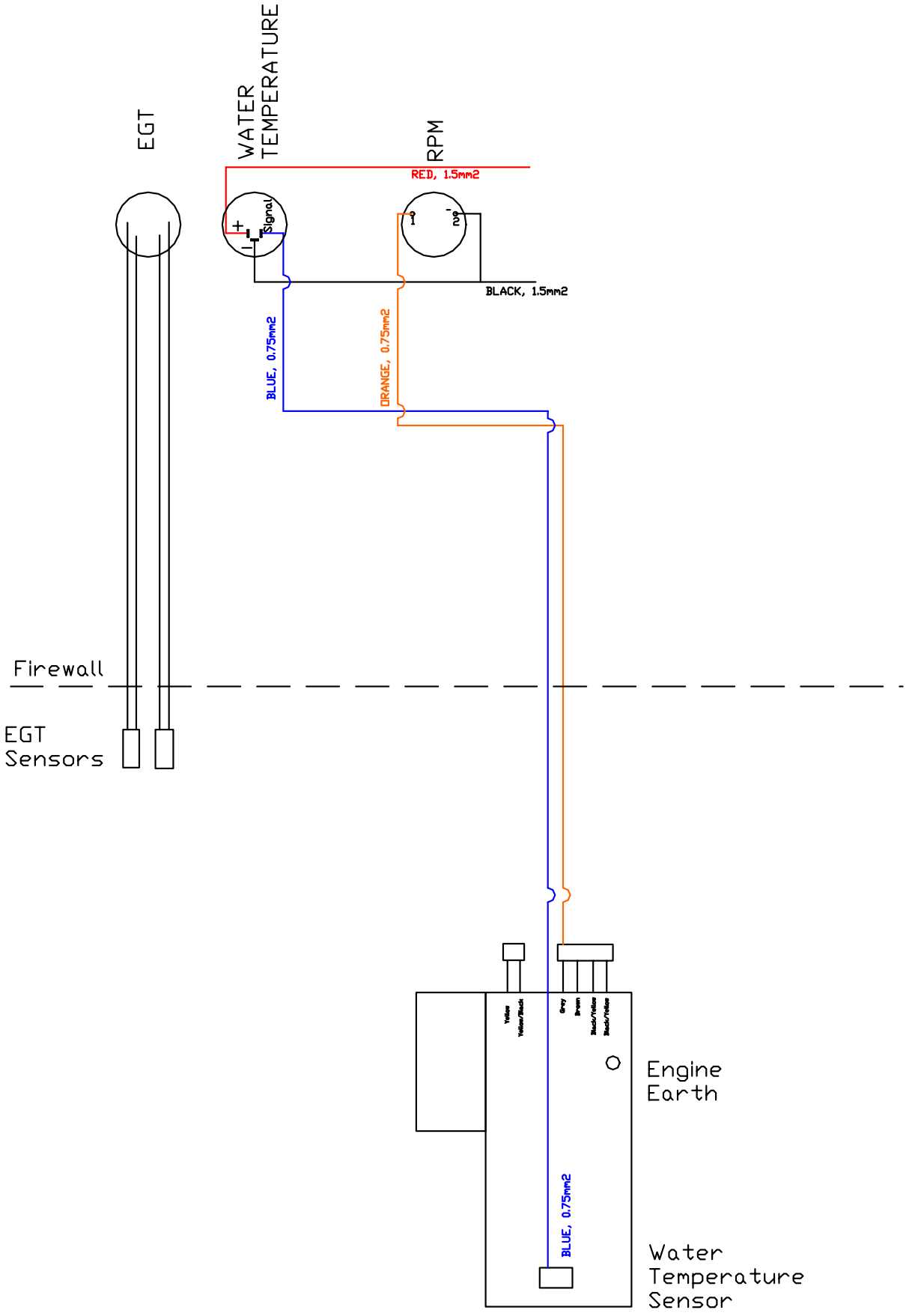


Figure 275; instrument wiring schematic, Rotax 582.

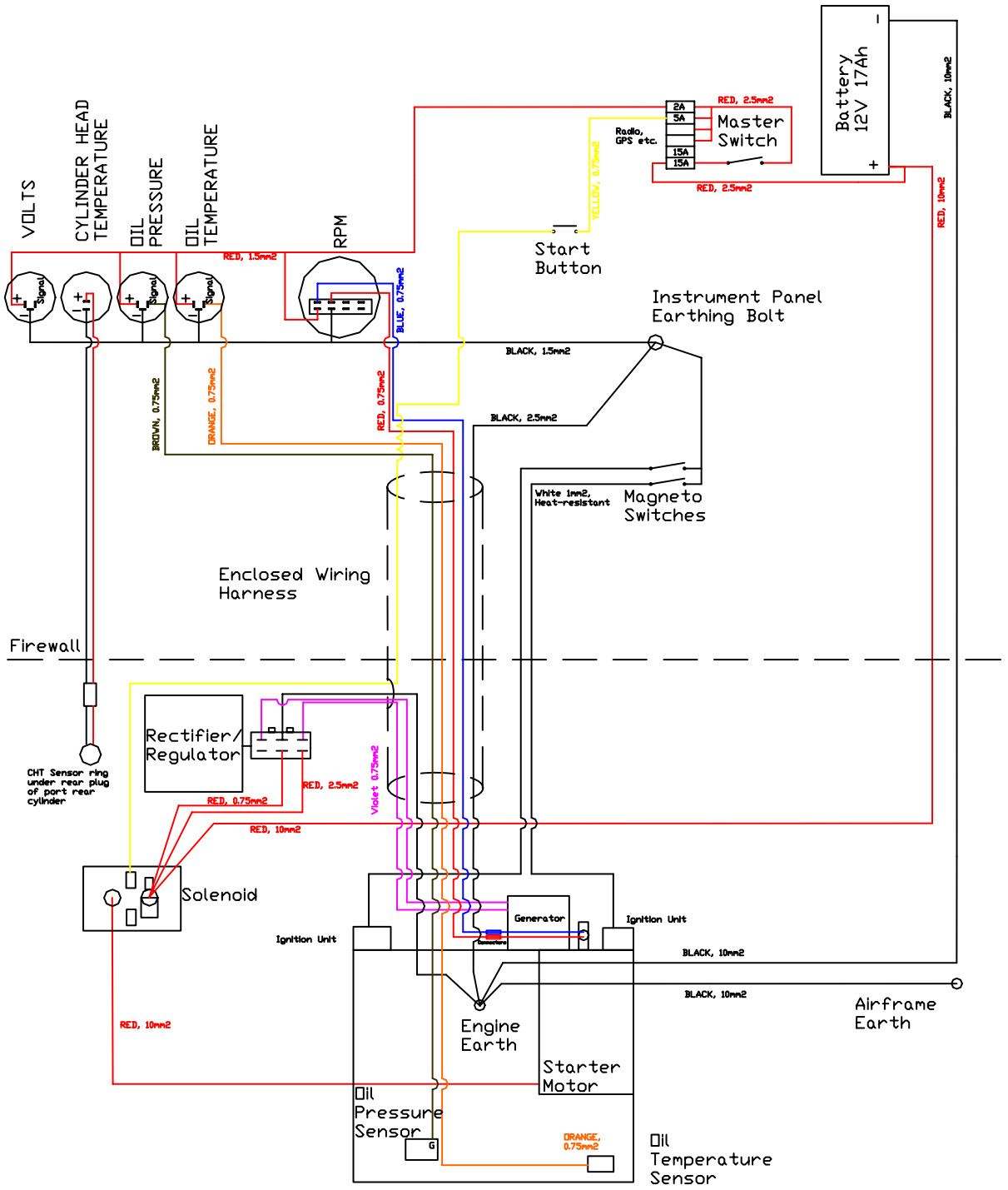


Figure 276; overall wiring schematic, Jabiru 2200 and standard instruments.

(ensure all colours are visible when printed out)

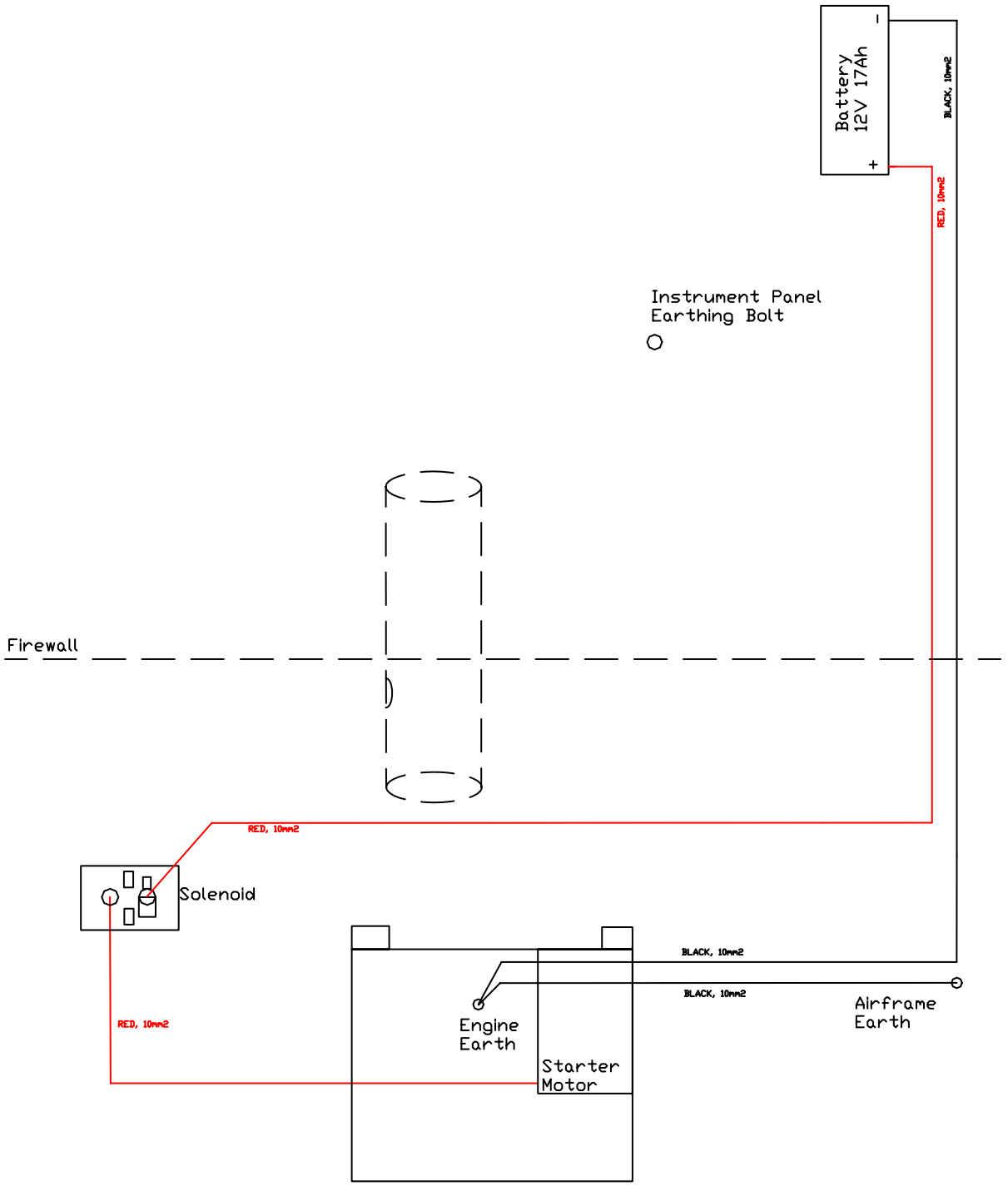


Figure 277; heavy duty power wiring schematic, Jabiru 2200.

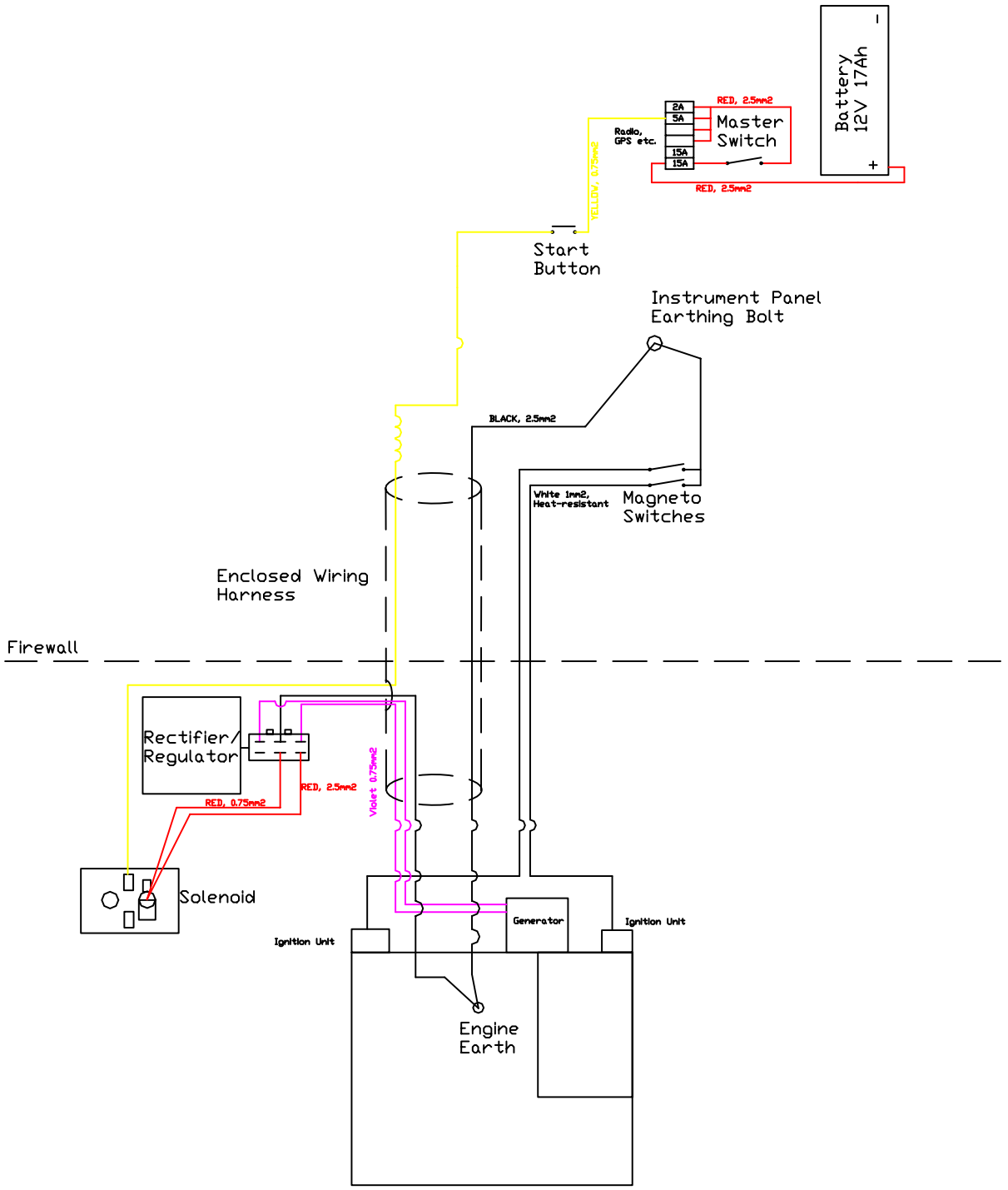


Figure 278; low current wiring schematic, Jabiru 2200.

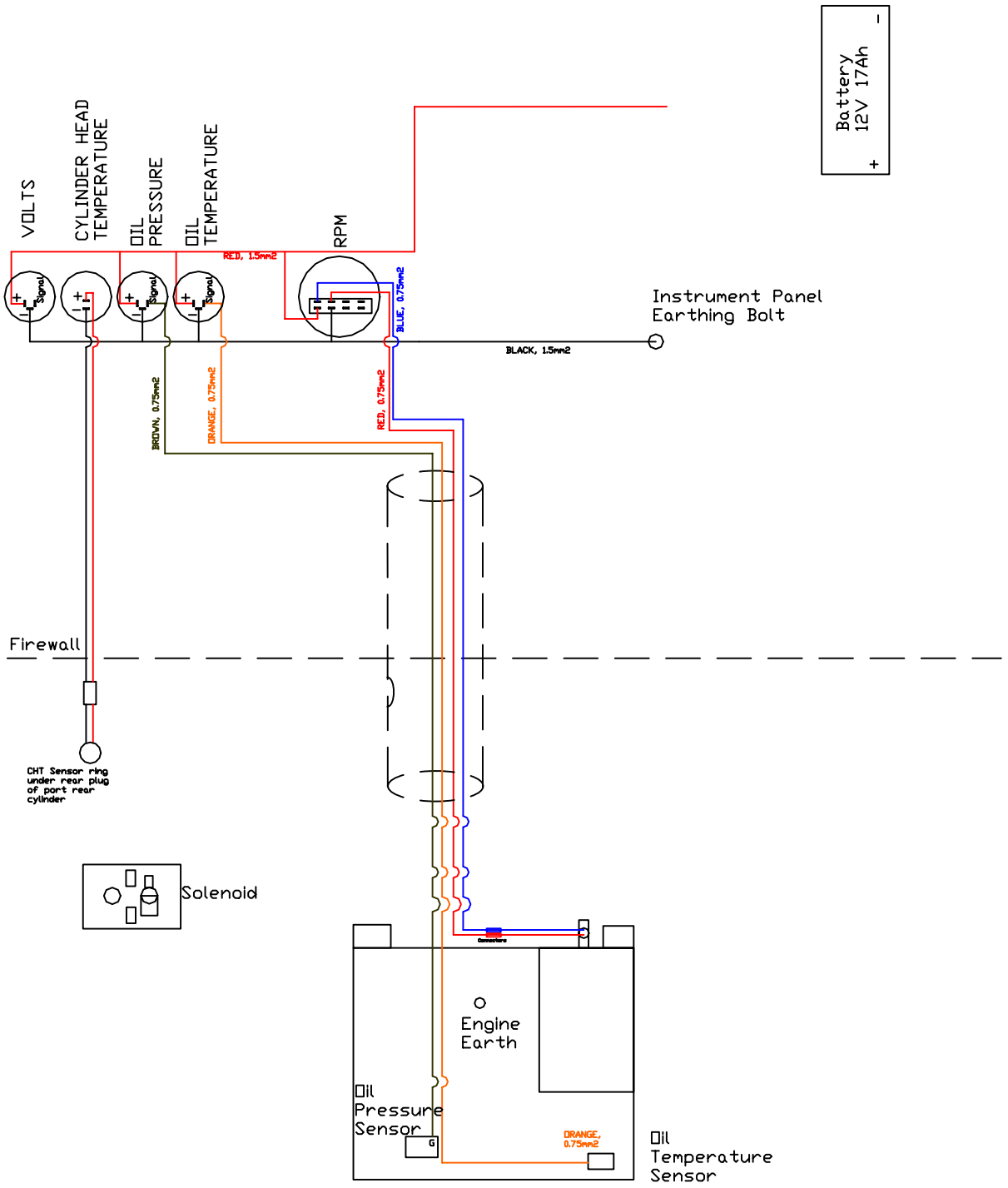


Figure 279; instrument wiring schematic, Jabiru 2200.

14.1 Wiring General Points

A ready-made wiring loom is included with the engine installation package for the Rotax 912, Rotax 582, and the Jabiru 2200 with standard instruments. The instructions on wiring assume you have either bought this, or are wiring it yourself in the same manner.

If you do not have a basic understanding of electrical systems it may be advisable to buy an introductory text on electrics, especially if you are not using the ready-made loom, or are adding extra equipment. This will serve you well throughout your flying career, not just whilst wiring your Skyranger!

When making connections, crimping is generally the quickest and best method. Soldering may seem attractive, but introduces fatigue points and so is not generally recommended.

Crimp tools: you get what you pay for. This is a good moment to spend as much as you dare, your crimps will be better for it! Alternatively, you may be able to borrow or hire a decent tool.

Keep all wiring neat, and ensure that no bare metal connections are visible which may lead to short circuits. Heat shrink tubing is neater than insulation tape for this job! It is available from Maplins, electrical and car accessory shops etc..

Secure the wiring with cable-ties, P-clips or similar, ensuring that it remains clear of all moving and vibrating parts, and is protected from chafing against sharp edges.

Also ensure that the wiring cannot be accidentally damaged or disturbed by pilots' feet, baggage etc..

14.2 Low Current and Instrument Wiring

The low current wiring consists of that for the instruments, master switch and magnetos, plus other ancillaries such as a radio.

a) Read the instructions which come with the engine and the instruments.

   BMAA TILs 7 and 27 may be useful reading too.

b) The wiring loom should pass through the firewall alongside the central cabin tubes.

   On the 912 installation the port side is the clearest, close to the fuel lines. On the Jabiru installation the starboard side is the clearest.

   The yellow solenoid starter wire plus others sprouting from the main harness should be positioned in front of the firewall.

c) The wires from the 912 magneto should also pass through the firewall in this position, one set to the instrument panel for the tachometer, and one set to the regulator.

   See the engine instructions and wiring diagram for wire colours.

d) The ignition switch wires must also pass through the firewall, but keep them away from the others. Amongst other (safety) reasons, this should reduce electrical noise which may be audible in headsets and on the radio.

e) The fuse box can be riveted to the starboard central cabin tube behind the instrument panel, Figure.

The contacts can be conveniently connected together, where required, by drilling one hole through each of the protruding contacts in a line and soldering a length of solid wire into the holes.

Figure 280; fuse box.

f) The connections on the cabin side should be made according to the instrument instructions and the electrical system schematic.

g) A common earthing bolt can be fitted to the base of the instrument panel to provide a convenient earth point for the instruments and other connections, Figure.

h) All switches in aeroplanes should be UP for ON (in the sense of running, powered etc.).

Note "On" labelled on the switch is actually OFF as far as the engine is concerned, as the magnetos are grounded to prevent operation.

On the 912 the master switch is a double-pole single throw (DPST) type, to allow it to turn off the power from both the battery and the regulator, as the regulator draws current even when off. On the Jabiru a single-pole switch is used and the regulator is permanently connected to the battery, as it draws no current when off.

Figure 281; common earthing bolt fitted to panel.

i) The connections on the engine side should be made according to the engine installation manual and the electrical system schematics.

j) On the 912 the optional capacitor shown in the wiring diagram and the Rotax installation manual may be fitted if desired, although it is rather bulky.

This has two uses: if you experience interference with your radio through its power supply from the regulator, the capacitor will reduce this by smoothing the supply a little, although the battery already does most of this and a radio power interface does the same thing. The capacitor also provides a fail-safe against accidental disconnection of the battery whilst the engine is running, which would otherwise cause the regulator voltage to rise with possible damage to instruments, radio etc..

Disconnection would occur either by blowing of the fuse to the battery or if the wire to terminal C on the regulator were to become disconnected.

A suitable capacitor is available from Rotax/Skydrive. If only protection from disconnection were required, a smaller capacitor could be used at your own discretion.

k) Other optional items are shown on the wiring diagrams: they are an hour-meter, a master-switch warning buzzer, and a start-button warning light.

l) If a master warning buzzer is required on a Jabiru installation the wiring must be altered to disconnect the regulator from the battery in a similar manner to the 912 installation, using a double-pole switch. The buzzer may then be connected between the unused connection on the regulator and earth.

m) Additional systems such as GPS, radio etc. should be individually protected by fuses of the appropriate size.

14.3 Battery

a) All high current cables should be kept as short as possible.

b) The battery should be installed in its supporting box in the hole in the floor between the central cabin tubes, underneath the dash board.

c) Secure with the webbing strap.

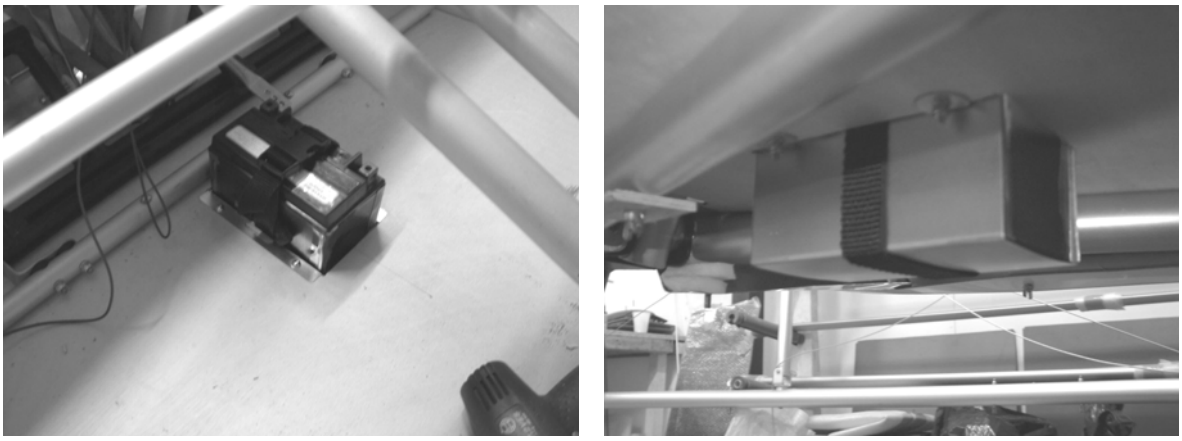


Figure 282; battery location.

d) Ensure that the engine block is well earthed to the airframe, Figure. Here an extra hole has been drilled in the engine mount. Alternatively, attach the earth to one of the existing bolts if enough thread length is available.

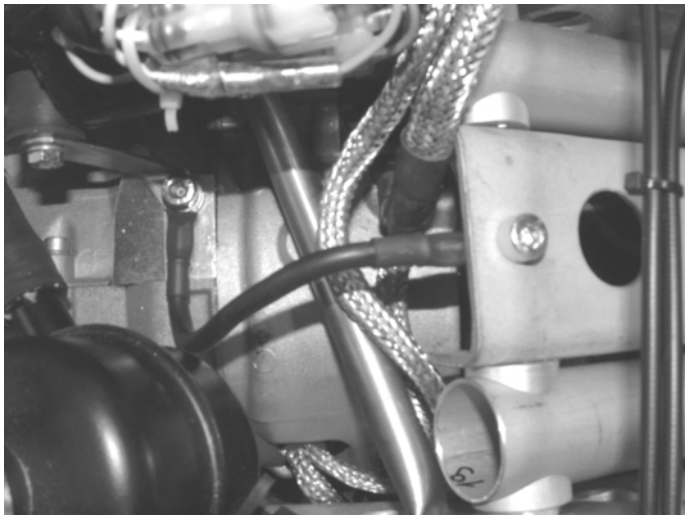


Figure 283; engine to airframe earth.

e) Attach the earth cable to the battery negative and to a bolt on the engine block.

Route the cable through the firewall in the vicinity of the other wires.

f) The regulator can be positioned on the front or rear side of the firewall, such as Figure and Figure.

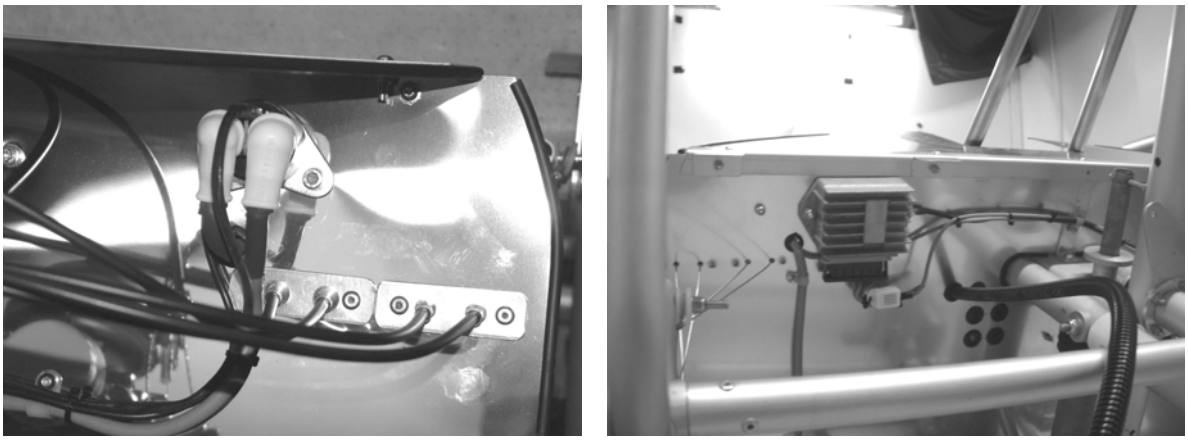


Figure 284; 912 solenoid and regulator on port side of firewall front and rear.

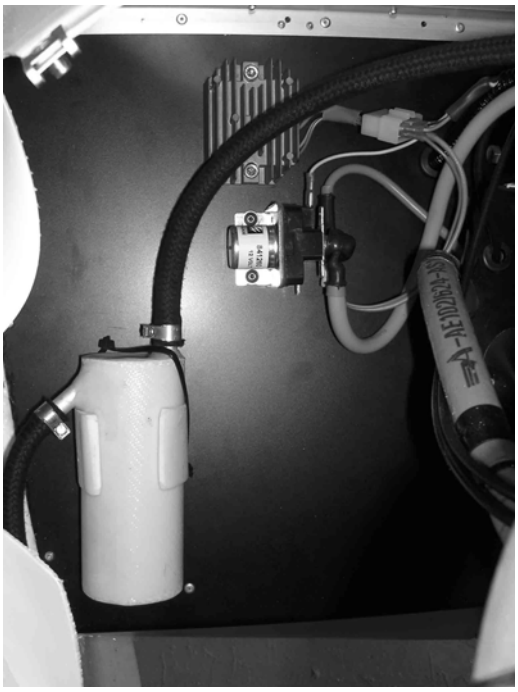


Figure 285; Jabiru regulator and solenoid, starboard front side of firewall.

g) Ensure that the regulator is properly earthed.

912: With the solenoid positioned in front of the firewall and the regulator behind it, this may be accomplished via a common securing bolt. This bolt should then be connected to a convenient earthing bolt on the instrument panel using the separate black wire provided with the standard wiring loom, thus providing a good earth for the instruments etc..

Jabiru: an earth connection is provided on the regulator connector as shown on the wiring diagram.

h) Ensure the battery terminal boots are firmly in place, and that the rudder stop cables are held away from the battery by their bungee restraint.

Failure to do this may result in a short circuit and fire!