PHANTOM X-1 ENGINE & INSTRUMENTATION MANUAL

(X-1 & X-1E are almost identical in construction, see the Addendum for other X-1E instructions)

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INTRODUCTION

This manual is a supplement to the main Phantom Assembly Manual. Engine Installation instructions and Instrumentation Installation instructions are guidelines. The owner may customize his or her aircraft to there liking. Additional sources of information for Rotax engine information is Leading Edge Airfoils (1-262-763-4087) or California Power Systems (1-800-247-9653). Both of these companies have manuals / catalogs with drawings describing engine parts, installation and the like. This manual has some of these items. Be sure to read the Rotax Installation Manual along with this manual.

ROTAX TORQUE SPECS (Rotax 447, 503)

Bolt Style	Usage	Bolt Size	Tool	Loctite	Torque (In-Lbs)
Hex Screw	Crankcase	8mm	13mm Socket	None	195
Hex Screw	Crankcase	6mm	10mm Socket	None	90
Allen Screw	Crankcase	8mm	6mm Allen	None	195
Allen Screw	Crankcase	6mm	5mm Allen	None	90
Hex Screw or Nut	Mount Base	10mm	17mm Socket	221	335
Stud	Mount Base	10mm	17mm Socket	242	105
Stud	Cylinder	8mm	13mm Socket	None	60
Hex Nut	Cylinder Head	8mm	13mm Socket	None	195
Allen Screw	Stator Plate	5mm	4mm Allen	222	55
Allen Screw	Fan Housing	6mm	5mm Allen	222	90
Hex Nut	Fan	16mm	22mm Socket	242	530
Hex Nut	Magneto Housing	22mm	30mm Socket	242	800
Allen Screw	Starting Pulley	8mm	6mm Allen	242	195
Allen Screw	Rewind Starter	6mm	5mm Allen	None	90
Hex Screw	Rewind Starter	6mm	10mm socket	None	90
Hex Screw	Cylinder Cowling	8mm	13mm Socket	None	120
Hex Screw	Intake Manifold	8mm	13mm Socket	242	175
Hex Screw	Intake Manifold	6mm	10mm Socket	222	90
Hex Plug	Spark Plug	14mm	13/16” Socket	None	240
Taptite Screw	Ignition Coil	6mm	8mm socket	222	55
Allen Screw	Exhaust	8mm	6mm Allen	242	210
DUCATI IGNITION					
Hex Screw	Ignition Plate	6mm	10mm socket	222	45
Hex Locknuts	Electronic Box	6mm	10mm socket	222	70

Follow these Torque Specs when doing the engine installation.

ENGINE INSTALLATION

Step 1 – Mount Plate Installation

Unpack engine and inventory the parts. Flip engine over and remove engine mounting studs using a set of channel locks or vise grips. There is no need to worry about stripping the threads on the studs, these will not be used again. Install motor mount plates using 10mm bolts, 1" spacers and appropriate washers provided with the X-1 Kit. Refer to the Rotax Torques Specs and Figures 1,2 and 3 for this installation. Loctite these bolts into position.

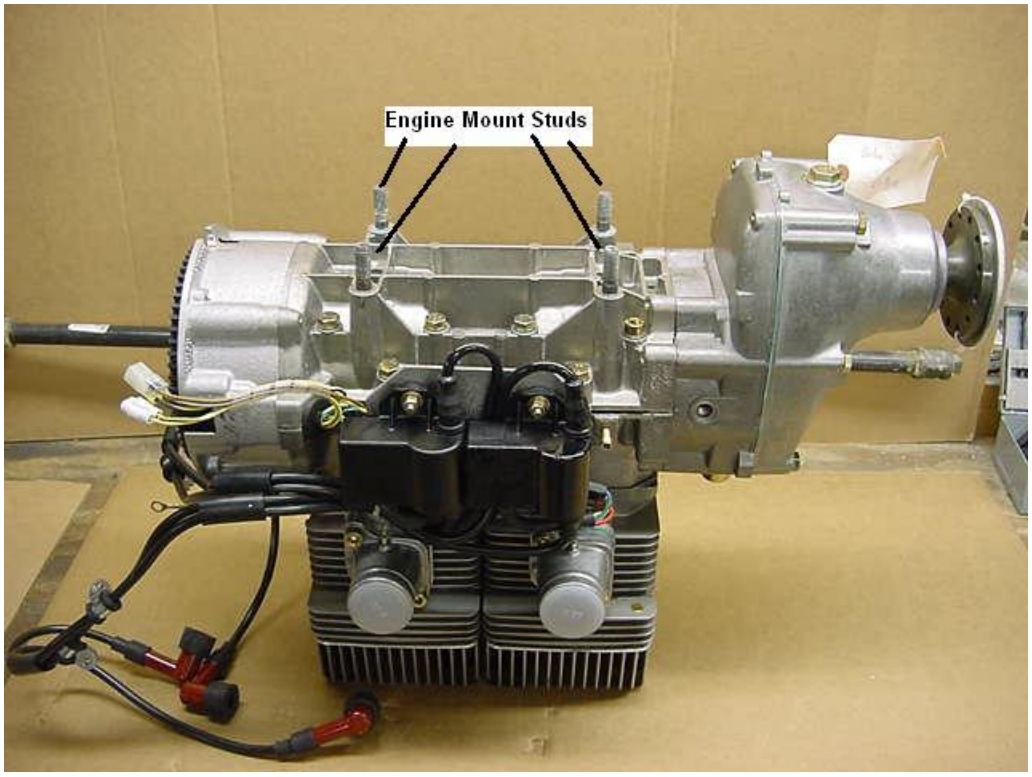


Figure 1 – Engine Mount Studs

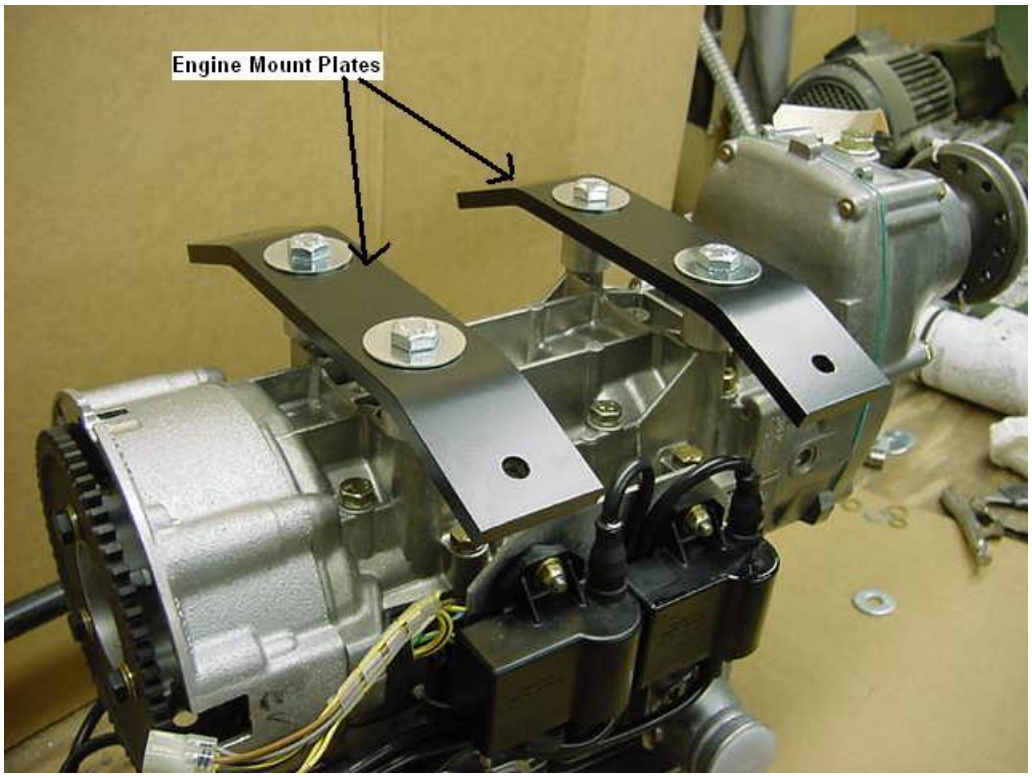


Figure 2 – Engine Mount Plates

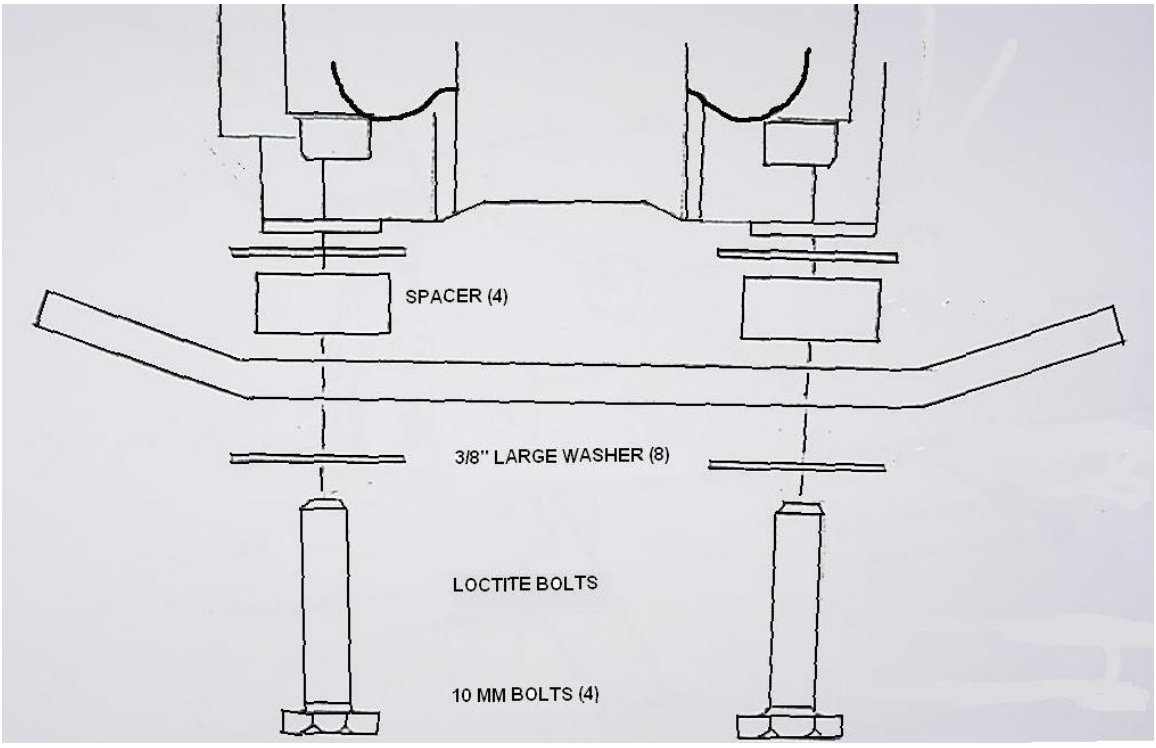


Figure 3 – Bolting of Motor to Motor Mount

STEP 2 – Mount Exhaust Manifold

Turn Engine right side up and mount the exhaust manifold according to the torque specs using the (4) 8mm Allen Bolts provided with the engine. Install supplied gasket between manifold and engine. Note the location of the Exhaust Gas Temperature Mounts (EGT). They should be facing down. Refer to Figure 4.

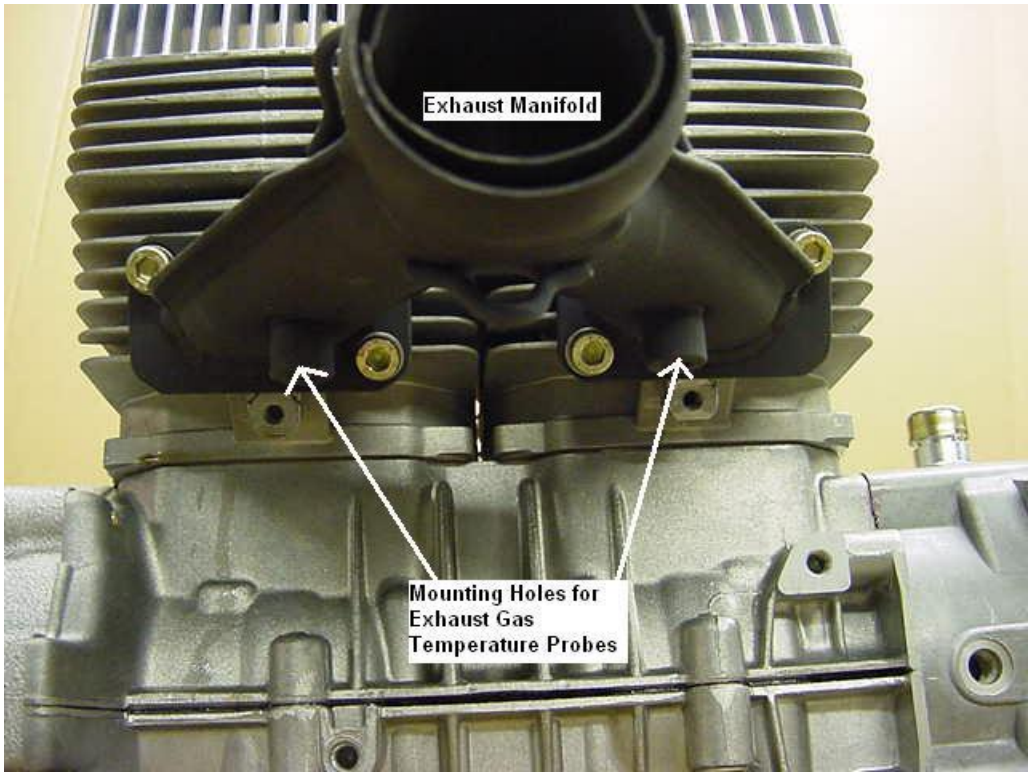


Figure 4 – Exhaust Manifold

STEP 3 – If purchased install the electric starter

Install starter using (4) 6mm Hex Screws and Lock Washers provided with the starter. Refer to Figure 5. Starter is mounted on the rear of the engine when using a B Type Gear Box.

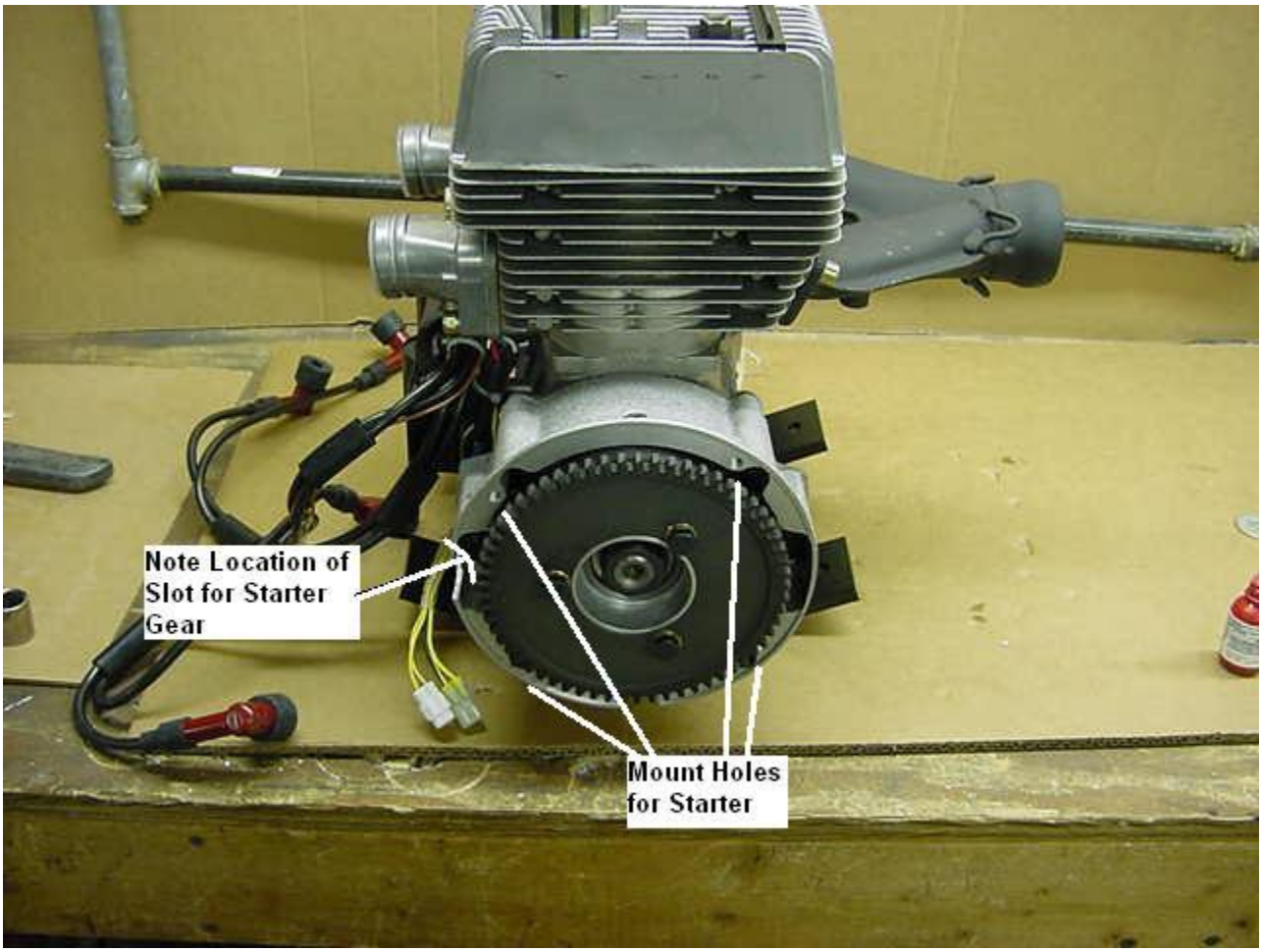


Figure 5 – Starter Mounting Location

STEP 4 – Carburetors

Install Rubber Carb Boots onto Intake Manifold using large hose clamps provided with the engine. These boots are directional. An arrow is usually marked on the boot showing the direction of airflow. Mount Carburetors onto boots and secure using hose clamps. Position hose clamps to they are easy to tighten when accessing the engine from the sides or bottom. Carbs should be facing upright as is shown in Figure 6. Test fit air filter provided in the X-1 Kit.

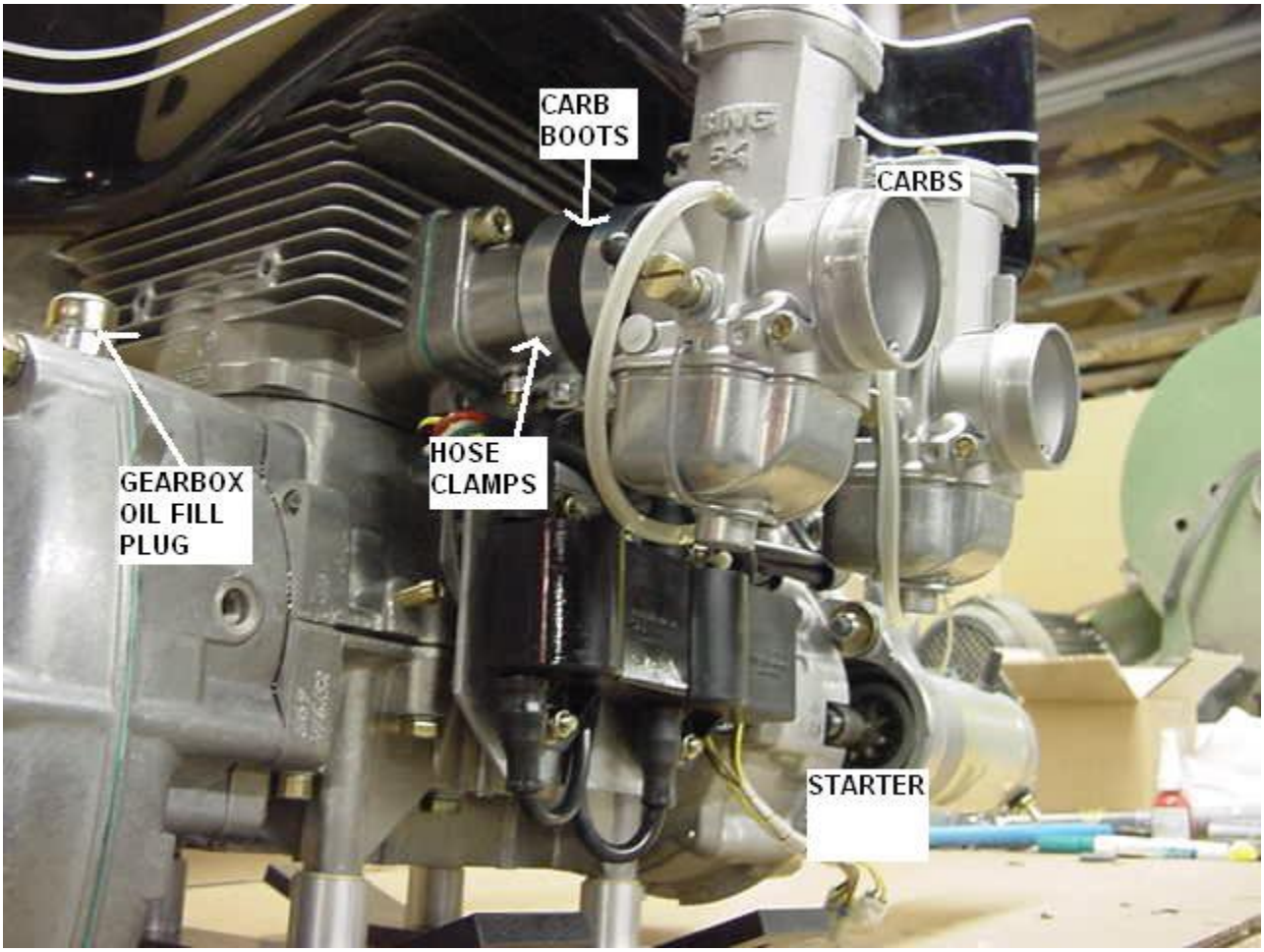


Figure 6 – Carb Installation

STEP 5 – Install Air scoop if provided

If you have a fan cooled engine skip this step. First move the 4 female studs on the cylinder heads to the outermost 4 corners of the engine. This may require movement of the female studs and nuts. Be sure to retorque the cylinder heads to the proper torque. The heads should be torqued in a Figure 8 pattern like lug nuts on a car rim. If you are using a stainless steel scoop simply bolt the scoop in place on the 4 female studs. If you are using the fiberglass scoop first cut out the holes for the female stud bolts and holes for spark plug wires. If you look carefully at the top of the fiberglass scoop you will see a faint pattern for these 4 bolt holes and spark plug holes. Cut out these holes with a Rotary tool. Test fit the scoop until you are satisfied. The spark plug wires should not rub against the scoop. Before completing installation of the scoop you must also install a vane inside the scoop inlet. Refer to the instructions below for a more detailed description. Prior to complete installation of the scoop install the spark plugs and Cylinder Head Temperature Sensors. One sensor should be on each cylinder. Route the sensor wires so they will exit the cylinder heads on the side opposite the carburetors. The wires should pass between the head and the edge of the Air Scoop. Torque Spark Plugs into place and finish installation of the scoop. Lastly attach the spark plug wires. The longer wires go to the front cylinder the shorter wires go to the rear cylinder.

Figure 7 – Installed Scoop

Figure 8 – Installed Scoop Vane

ROTAX 447/503 FIBERGLASS SCOOP ASSEMBLY PARTS

Quantity	Part Number
1	Air Scoop
2	Vane Bracket
1	Inlet Vane Plate
4	8mm Bolt
4	8mm Washer
4	Rubber Washers (same as fuel tank washers)
4	8-32 Bolt
8	8-32 Washer
4	8-32 Nut
8	Fender Washer

Final Installation and fitting is left to the customer. Each application is slightly different and it has been found that the final cutting of mounting holes and spark plug holes needs to be left to the customer and removes any issues of improper fit. This allows freedom to move the cowl around the engine to provide proper clearance around carburetors, throttle cables, etc. Suggested cutout holes have been marked on the cowling.

1) Note: Four 13mm standoff nuts are (pre-installed by Rotax) are used to mount the air scoop. These standoffs take the place of typical cylinder nuts and MUST BE PROPERLY TORQUED TO PREVENT HEAD GASKET LEAKS! Refer to the Rotax 447 / 503 Operators Manual usually supplied with the engine for reference to the proper torque. Be certain to re-torque these after the initial fitting of the air scoop. Use a torque wrench when attaching the 8mm bolts that thread into the stand-off nuts too.

2) Check the fit of the engine cowling. Once proper placement is determined drill the mount holes. Pre drawn mount holes are shown on the scoop. Temporarily mount the scoop and determine the placement of the spark plug holes. Drill using a drill or rotary tool. Check the fit again.

3) After initial fitting is complete temporarily mount the air scoop. Next determine the placement of the splitter vane. Refer to drawing as needed. Mark the location of the vane brackets (4) and splitter vane (5). Remove the cowling and drill the mount holes for the vane brackets. Mount the vane brackets to the vane using the bolts (6) provided. Mount the vane to the air scoop using the bolts (6) provided.

4) Mount the air scoop onto the engine. Use a large fender washer (9) between the scoop and the standoffs. Use the 8mm bolts (3) and small washers (10) to clamp the scoop to the standoffs. If necessary use the large fender washer on top of the scoop as well.

5) Run-up the engine and check the Cylinder Head Temperatures. Temperatures can be adjusted by bending the splitter vane to the left or right to direct more airflow to one or the other cylinder.

Note: Enclosed drawing is for a two piece scoop. Many portions of the drawing are not needed for this one piece design.

Note: Recheck the torque of the standoffs and bolts after and hour of operation.

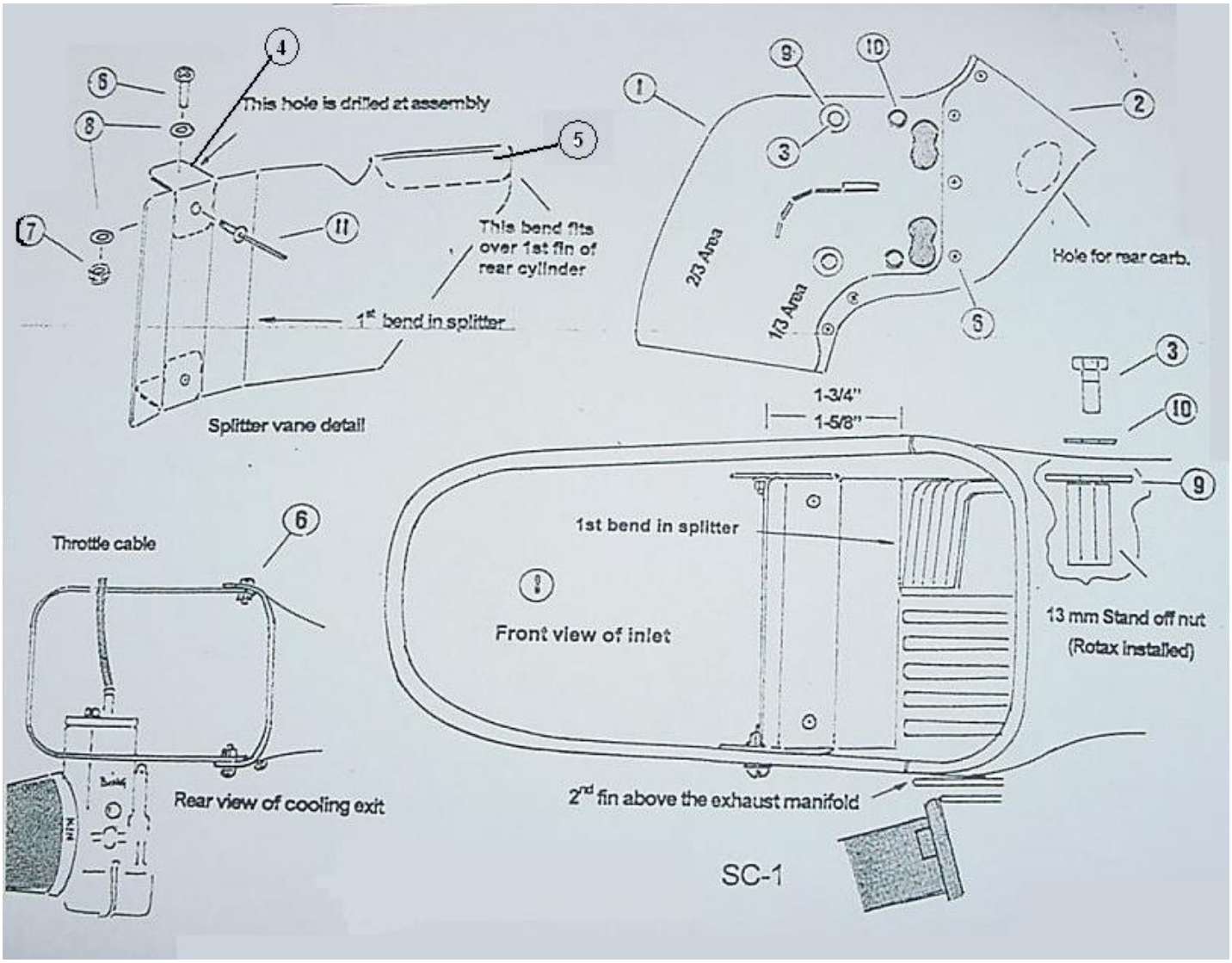


Figure 9 – Air scoop Diagram

STEP 6 – Mount the Engine on the plane

Refer to Figure 49 in the Main Manual for this installation.

STEP 7 – Mount the Fuel Pump

Refer to Figure 50 in the main manual for this installation. Do not forget to grind away a portion of the bolt heads to fit the fuel pump on the engine mount. The fuel pump should be mounted on the side opposite the Carburetors.

STEP 8 – Fill the Gearbox with Oil

Valvoline Synthetic Blend 80W-90 Gear Oil works well in the gear box. This can be found at a local auto parts store. Fill the gearbox from the plug on the top of the gearbox. Remove the "LOWER" plug on the side of the gearbox. The gearbox should be filled until oil runs out of the "LOWER" Hole. Once this occurs stop filling and let excess oil run out of the lower plug. Do not fill the box to the upper plug. If you do it is possible to blow the seals on the gearbox. Once this is complete re-install both plugs and safety wire them in place. Refer to Figures 10 and 11.

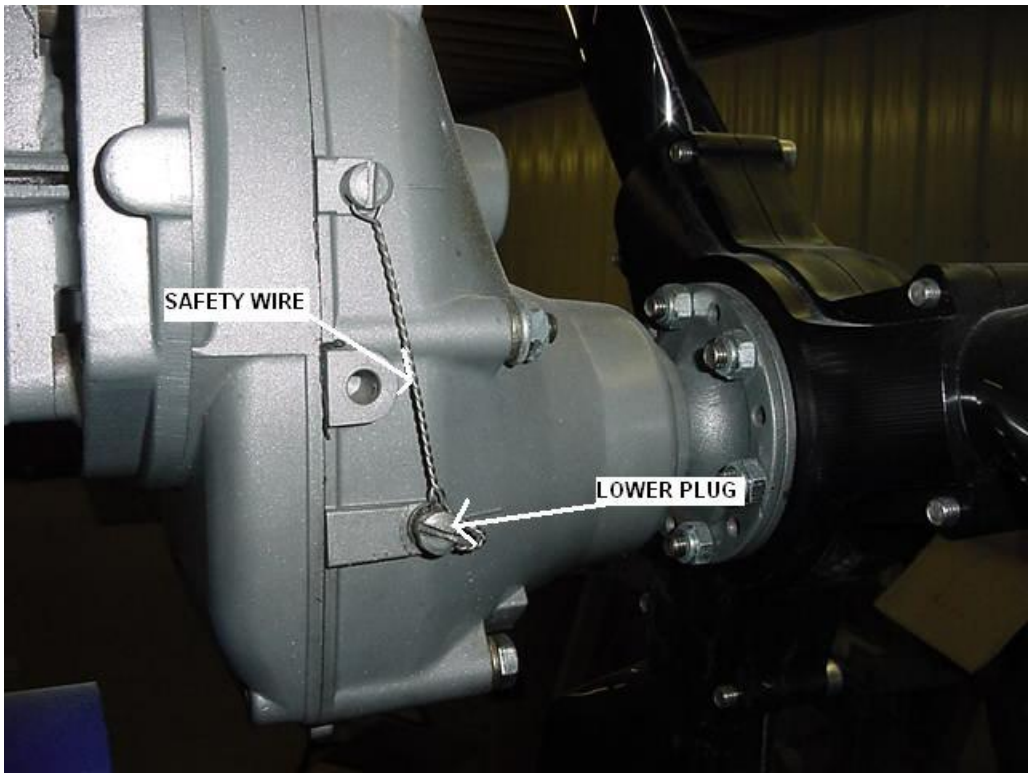


Figure 10 – Gear Box with Lower Plug

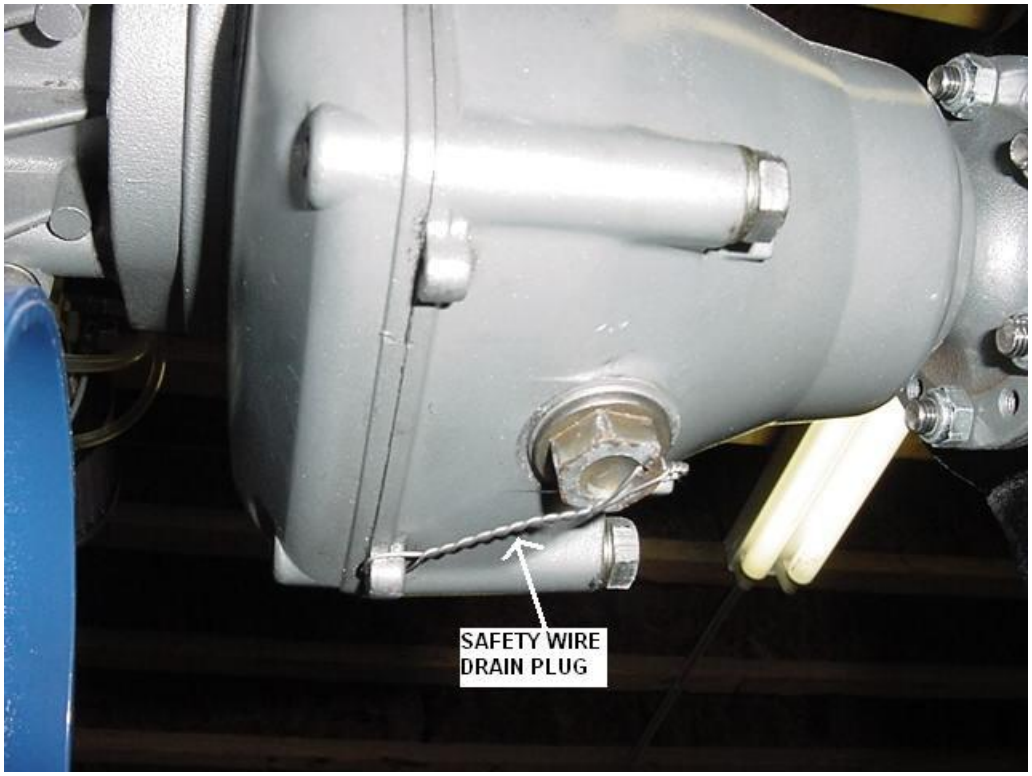


Figure 11 – Safety Wire Drain Plug

STEP 9 – Exhaust Mount

The next step is to mount the exhaust. You will first need to weld hooks to the exhaust. These are provided for you from Rotax. Springs will attach to these hooks to hold the exhaust in place. Six Springs and twelve hooks are included with the exhaust. 3 springs should be used on each joint. Figure 12 illustrates the pattern for the springs. Once in place safety wire the springs to the hooks. Mount the elbow to the exhaust Manifold initially and mount the muffler to the elbow after the following step. The exhaust mount is pre-assembled in a small box included with the X-1 Kit. Take note of the assembly and location of nuts and bolts. The first step is to mount the lower square tube to the front kingpost mount. Put the front kingpost and saddles inside the square tube as is illustrated in Figure 13 and bolt in place. Next wrap the stainless steel sleeve around the exhaust and bolt the sleeve to the upper U-bracket. Attach the side brackets and cross plate to the square tube. Bolt the Muffler to the cross plate. Attach the Muffler to the elbow with the springs and safety wire in place.

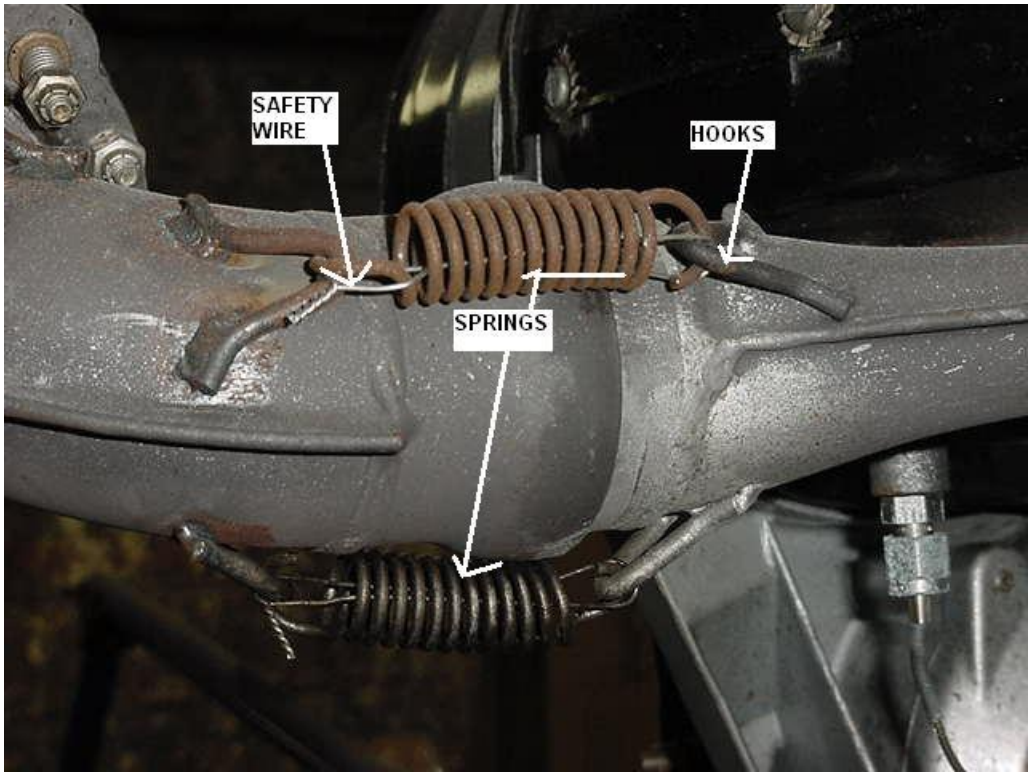


Figure 12 – Exhaust Installation (Front of Elbow and Manifold)

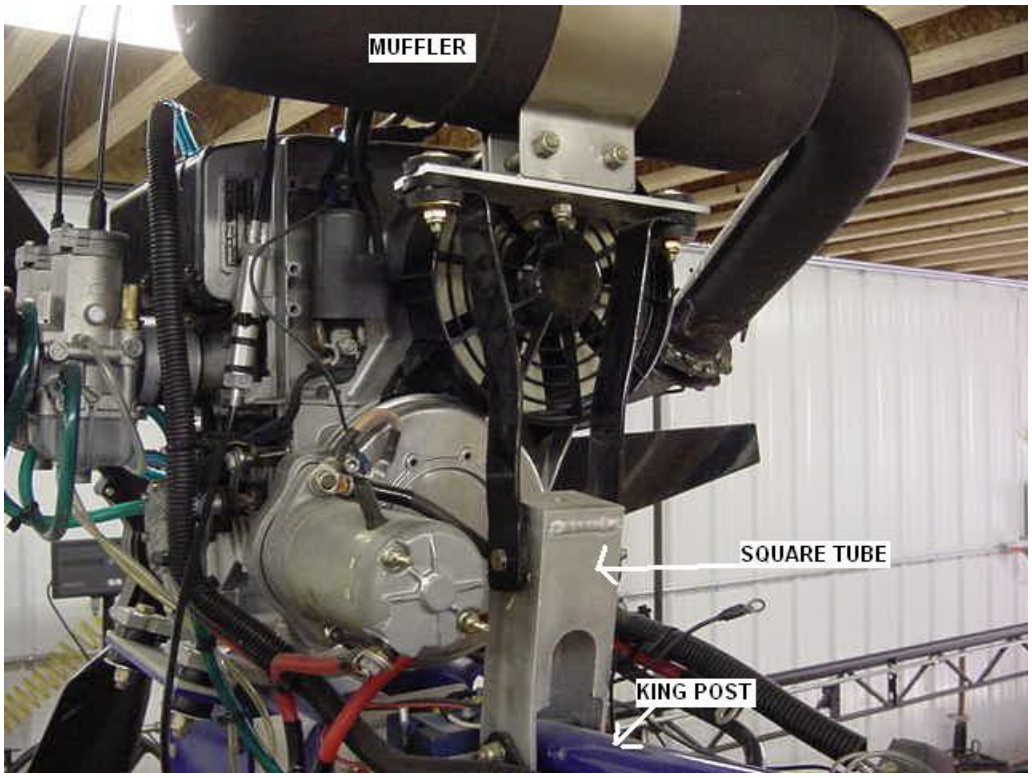


Figure 13 – Exhaust Mount

STEP 10 – Exhaust Gas Probes

Mount the two exhaust gas probes to the exhaust manifold. The probes should slide into the exhaust as far as possible. Refer to Figure 14. All probes are included with the instrumentation.

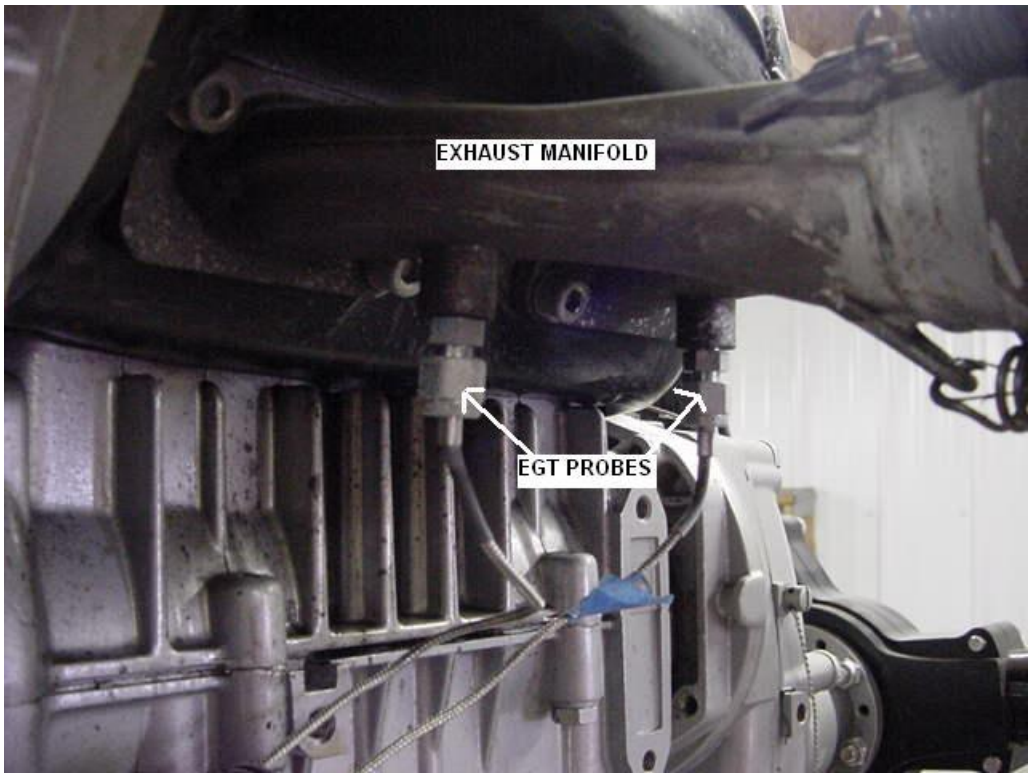


Figure 14 – EGT Probes

STEP 11 – Propeller

Mount Propeller According to manufacturer's instructions.

STEP 12 – Solenoid and Voltage Regulator

If you have the electric start option mount the Key West Voltage Regulator and Starter Solenoid to the U-Mount plate provided with the kit. The battery and battery box also mount to this opposite the starter solenoid. Mount plate to the keel tube using bolts. You will need to drill (4) holes in the "SIDE" of the keel tube to mount the plate. Refer to Figure 15.

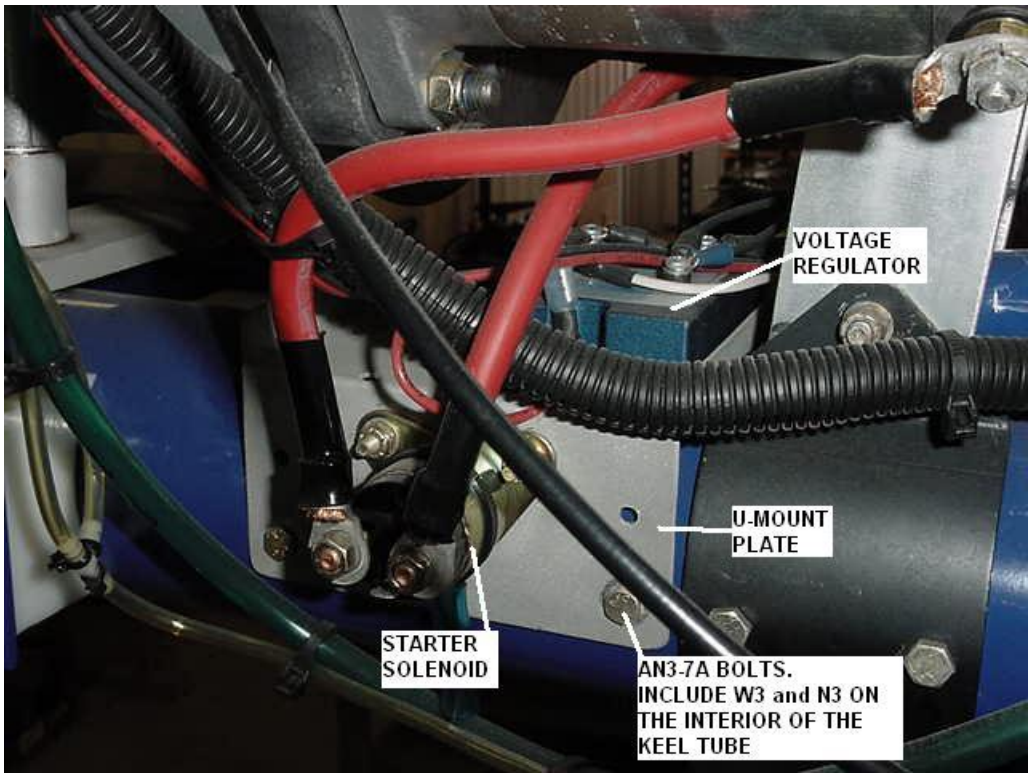


Figure 15 – Starter Solenoid & Voltage Regulator

STEP 13 – Primer and Fuel Line

Mount the Plunger Primer on the front down tubes or cage rail as is specified in the main manual. The location is left up to your preference. Run the ¼" blue fuel line from the lower fuel tank outlet to the included fuel filter. After the filter connect the line to the squeeze bulb primer. The squeeze bulb primer is directional. After the primer run the line to the intake side of the fuel pump. Near the front king post bracket cut the fuel line and insert a 'T' for the plunger primer. Run the thin 1/8" primer line from the 'T" to the intake side of the primer. Route another 1/8" line from the outlet of the primer to the Carburetors. The nipples on the Carbs for the primer line are between the Carb and the engine intake. There is only one place for these to go. For a dual carb setup the line will need to be split by a 'T' to run to each carb.

Run the ¼" fuel line from each of the fuel pump outlets to the intakes on the carbs. There is only one ¼" barb on the carb where this fuel line goes.

Run ½" OD ¼" ID Pulse Line from the underside of the Fuel Pump to the Pulse Line outlet on the engine. This is located near the front left side of the engine. The pulse line powers the fuel pump.

Refer to the following figures for added assistance. Safety wire all fuel line joints around the fuel line barbs.

Figure 16 – Plunge Primer

Figure 17 – Squeeze Bulb Primer

STEP 14 – Throttle Cable

Refer to Figure 53 in the main manual for the throttle handle assembly. The usual route for the throttle cable is inside the front down tube. If you have a dual carb setup a cable splitter is included with the kit. The splitter needs to be mounted securely to the engine either on the back of the air scoop or on the back of the engine near the pull starter or electric starter. A strap clamp can be used in conjunction with an existing bolt on the engine to hold the splitter in place. Refer to the Rotax Manuals for additional help in running the throttle cable.

To attach the cable to the carburetor first unbolt the top of the carb. This is done by loosening the two screws on the top of the carb. When reinstalling notice that the top is directional. Run the throttle cable through the top of the carb through the spring and through the white sleeve and needle ring inside the carb. Take note of the location of the spring, white sleeve, needle and slide before completely disassembling. Run the cable through the slot at the bottom of the slide. One side of the slot allows the cable through and the other holds it in place. Once this is accomplished reinsert the needle, slide, white sleeve and spring back into the carb. Bolt the top back on and continue with the next carb. Dual carbs must be adjusted so that they open the same amount at the same time. Full throttle is when the slide is at the top of the carb. Single carb

setups are easy to adjust, dual carbs are much more difficult and will take some time. There are two main adjustments for throttle cable length. The first is the barrel screw on the throttle handle mount. This can be slid in and out to adjust the length. The second adjustment is the brass screw on top of the carb. This can be adjusted in and out to move the slide up and down. If you are running into issues where the carbs are not closing completely then disassemble the splitter and make sure the cables are not hung up on the inside. For more information refer to the Rotax manual or call the Phantom Factory. This is sometimes easier to explain over the phone.

STEP 15 – Securing everything

Last step is to clean everything up and zip tie it to the frame. Make sure that nothing will work itself loose when flying. Make sure that the fuel line will not get caught in the starter or touch a hot exhaust. Make sure there is no chance of spark next to the fuel lines. See the next section for Instrumentation.

INSTRUMENTATION INSTALLATION

Wiring diagrams are included with each instrument. A general diagram for an electric start and pull start engine are included here. The key is to make sure all crimp connectors are secure and have shrink tube around every connection. Make sure the wire is securely in place and protected. Usually the wiring is run from under the panel, through one side of the seat forward on the keel tube to the engine. Another possible location is up the front down tube. It is up to you. Once the panel is drilled install it on the plane with the windshield. Install the instruments after you install the panel. This will save a lot of frustration when installing the windshield bolts.

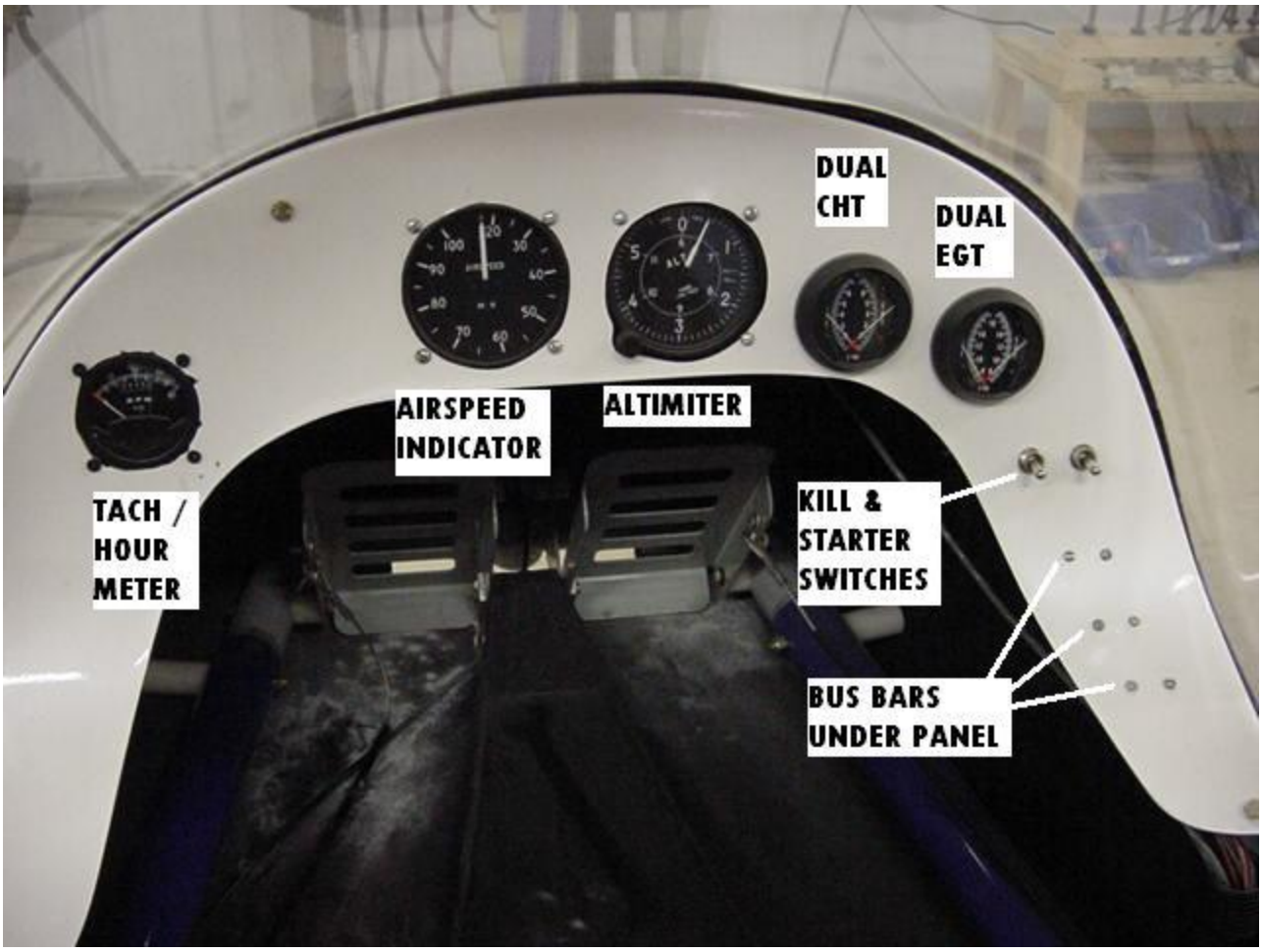


Figure 18 – Sample Instrument Panel

Airspeed Indicator

Requires 3 1/8” hole in the instrument panel. Route the 1/4” tubing up the seat and through the wing to the pitot tube. Only connect the total pressure port to the pitot tube. Leave the static port open.

Figure 19 – Wing Mount Pitot Tube (Left Wing outside the outer flying wire)

Altimeter

Requires 3 1/8” hole in instrument panel. Leave the port in the rear open and do not connect to any lines.

Dual Exhaust Gas Temperature Gauge

Requires 2” hole in the instrument panel and one gray 4 conductor wire running from the gauge to the 2 EGT probes. Crimp connectors and the 4 conductor wire are provided.

Dual Cylinder Head Temperature Gauge

Requires 2” hole in the instrument panel and one gray 4 conductor wire running from the gauge to the 2 CHT probes. Crimp connectors and the 4 conductor wire are provided.

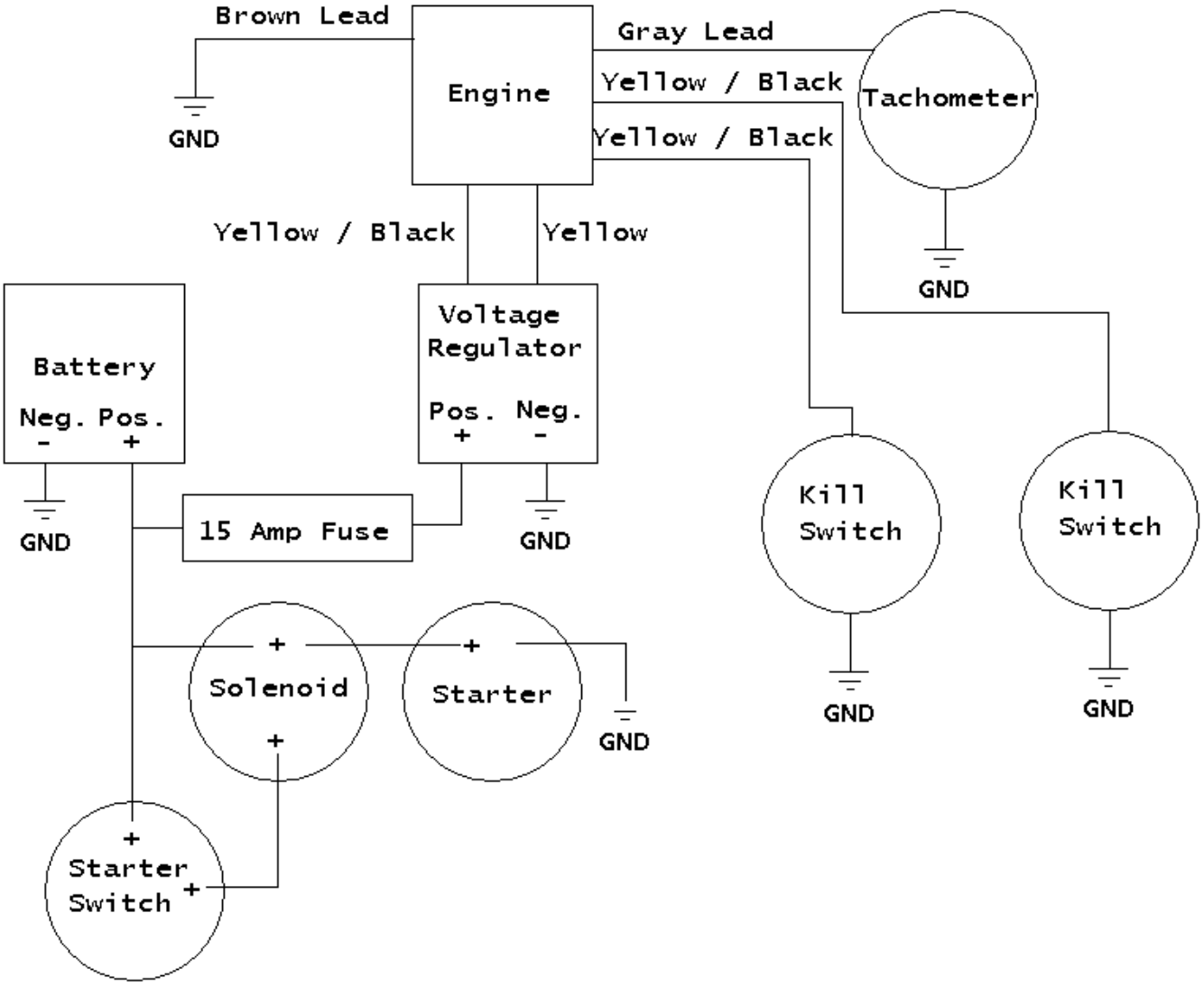
Tachometer / Hour Meter

Requires 2” hole in the instrument panel and two wires, one running to ground and the other running to the gray lead off the engine. Crimp connectors and the wire are provided.

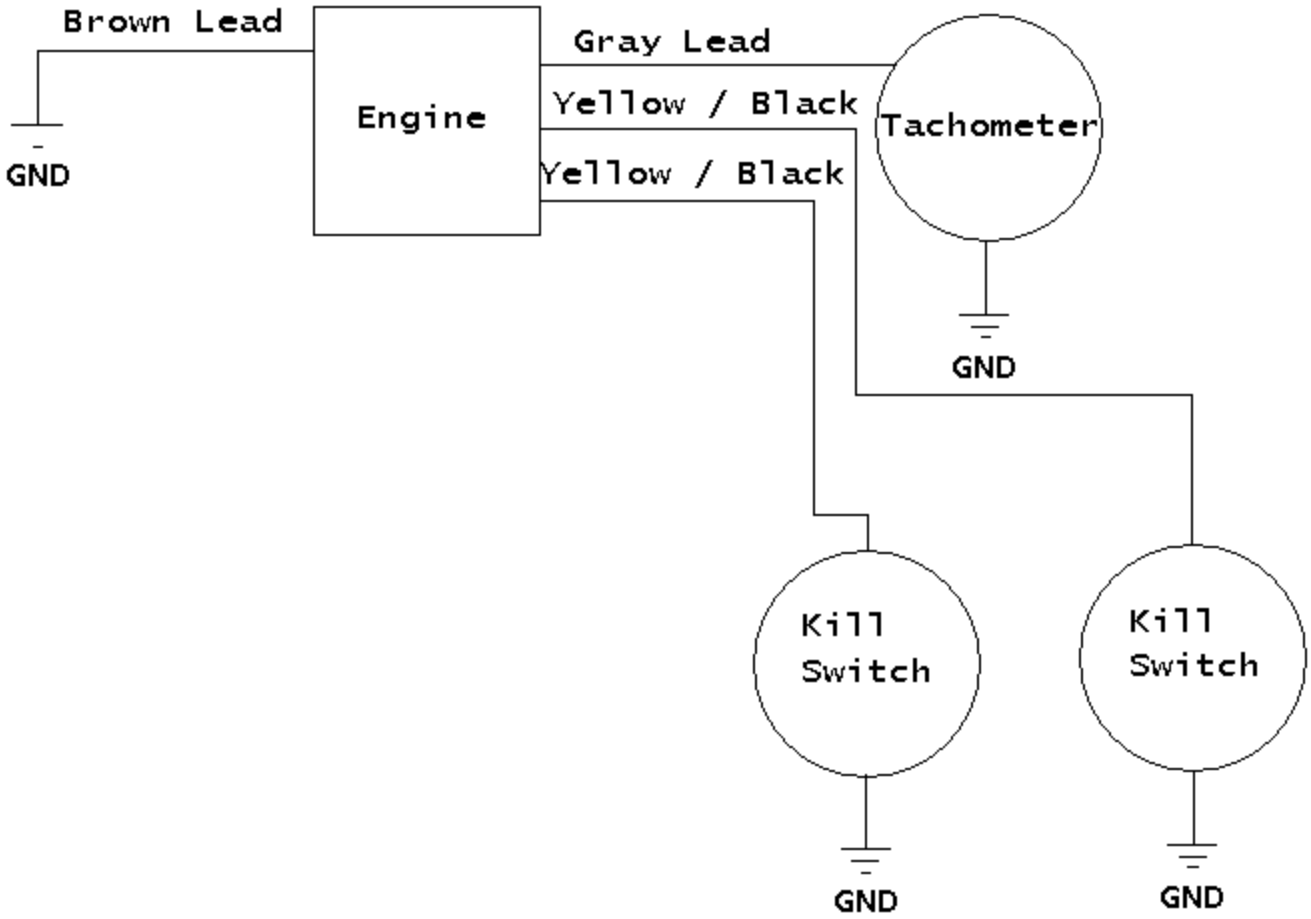
Single Pull Single Throw Switches

Use to kill to ground the ignition and stop the engine from firing. A momentary switch is also used for the starter.

BASIC WIRING DIAGRAM FOR ENGINE WITH STARTER



BASIC WIRING DIAGRAM FOR ENGINE WITHOUT STARTER



More wiring diagrams are included with the instruments and the Rotax Installation Manual. Three Bus Bars have also been included with the instrumentation kit. Usually these are mounted on the bottom right side of the instrument panel. One is for the Positive Leads, One is for the Negative Leads and the other is for general connections between the Tach, Starter and Kill Switches. These bus bars make it easy to install a radio or other instruments later on. It also aids in the installation of the panel. Utilizing these will allow the instrument panel wiring and engine wiring to be connected after the panel is completely installed. If you have any questions please call the Phantom Factory.