

# **ARDF 80m Receiver Construction Manual**

Version 3.01

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# Introduction

The receiver described in this document was developed by Les Tocko, VA7OM, with assistance from Joe Young, VE7BFK, to provide an inexpensive, simple receiver suitable for use by beginners in Amateur Radio Direction Finding (ARDF). While simple, the receiver performance is still quite adequate for use in formal ARDF competitions.

To achieve low cost, components were chosen that were either already on hand (free) or could be obtained at a discount. This choice also meant using a small printed circuit board with very small surface-mount parts so that several boards can be obtained on one minimum-cost board order.

The circuit board assembly is consequently not within many hobbyist's capability, and to make the project widely available, we can construct and test the printed circuits. With the boards available as a component, the receiver assembly can be accomplished with normal workshop hand tools.

The receiver circuit architecture is a direct-conversion type. The RF signal is received with a ferrite-rod antenna, passes through a switch attenuator, an RF amplifier stage, and then is down-converted in an SA602 mixer/oscillator. The base band signal is low-pass filtered with a 2-pole filter using a single op-amp, and finally amplified to headphone level in the LM386 audio amplifier. The oscillator uses a voltage-variable tuning capacitor to adjust the frequency over a narrow tuning range including the usual ARDF transmissions from 3550 to 3600 kHz. A second RF signal path for a second short whip antenna, is activated by switching power to a transistor amplifier stage. The output signal from this antenna is coupled into the ferrite-rod signal via a winding on the rod. When this second signal is present the received signal antenna pattern is changed to a cardioid shape (uni-directional) that can be used to determine which of the two equal direction possibilities from the ferrite-rod signal is toward the transmitter. Power for the receiver is provided with a 9V battery within the receiver case which is regulated with a low-dropout voltage regulator. The receiver thus operates normally until the battery voltage falls below about 5.5V. Typical operating current is about 10 mA.

## ***New with manual version 3.0***

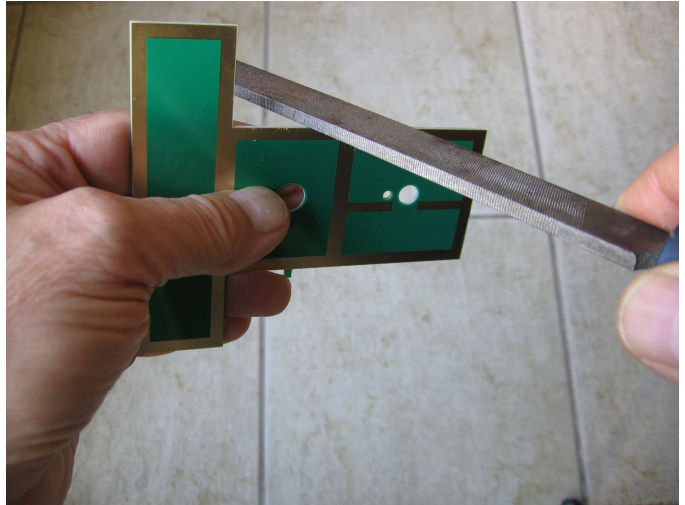
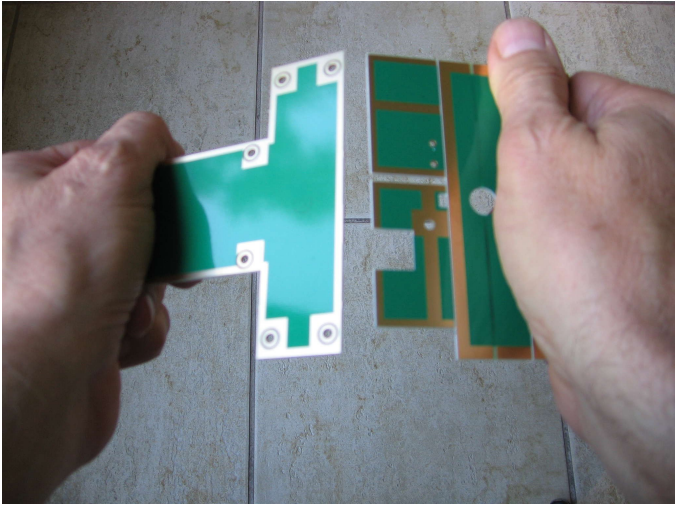
A lot of additional work to greatly simplify the receiver construction has been done by Dave Miller, VE7PKE, and Keith Witney, VE7KW,

The principal change concerns the method of constructing the receiver case. It is still made using single-sided printed circuit board material, but now the pieces are already formed using the PCB manufacturing process. Consequently, construction is greatly simplified, and manual materials on preparing the board pieces is eliminated. The photos showing the assembly process are all new, illustrating the new panels and steps to follow.

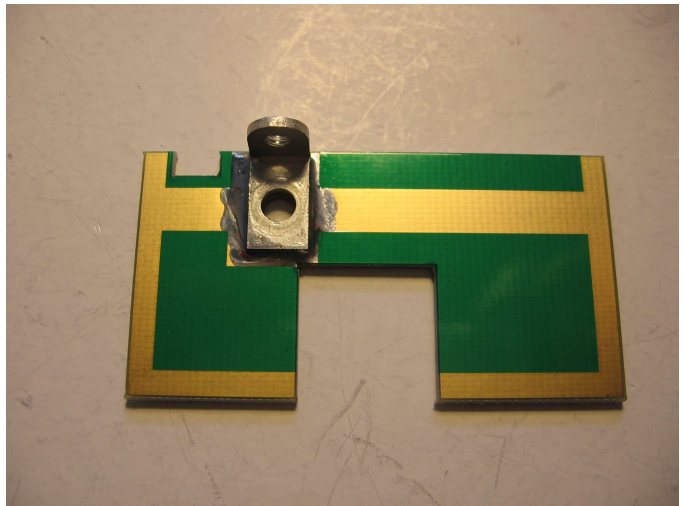
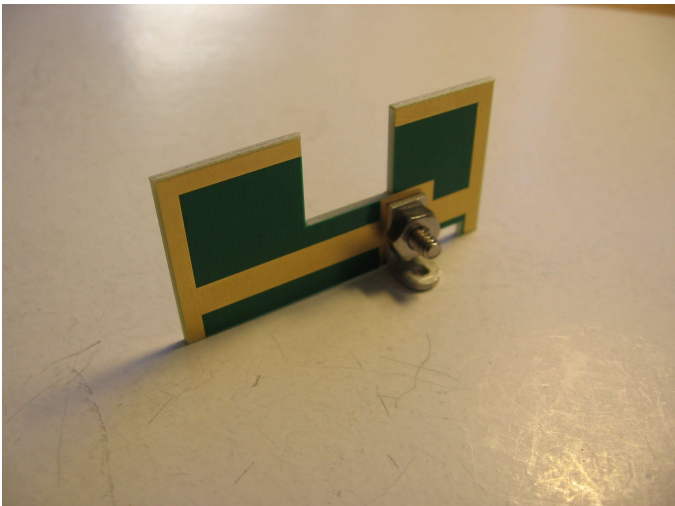
The receiver circuit is nearly unchanged save a few recent component availability issues and providing trim pots for frequency range adjustment.

A kit of parts is available which includes fully-assembled and tested boards for the main receiver, the attenuator, and the front-end, further simplifying assembly of the receiver.

## Assembling the Receiver Box

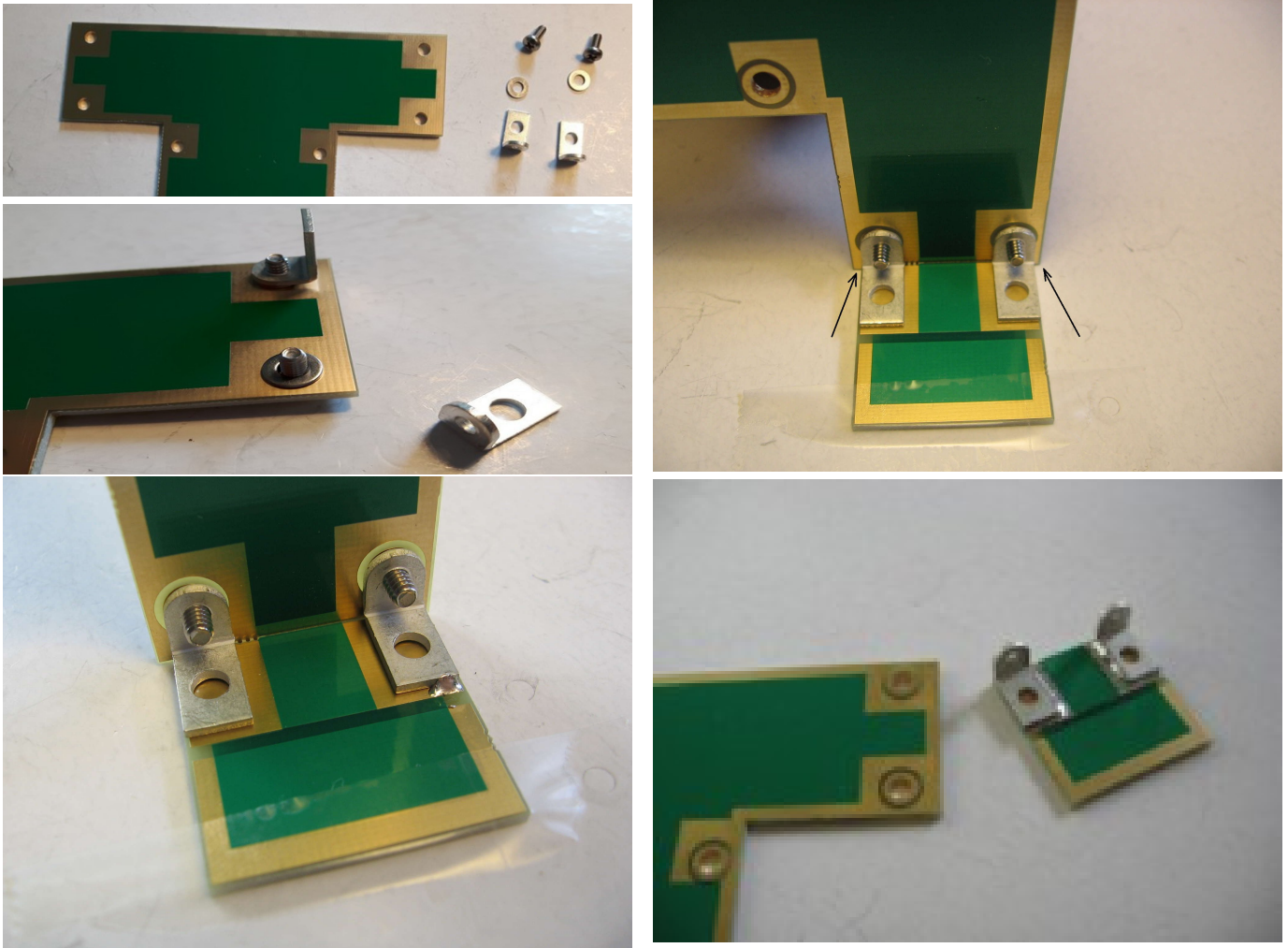


**Figure 1.** Break apart box panels, clean up edges where panels were joined.



**Figure 2.** Mount bottom cover bracket

Use a #6 screw and nut to hold the bracket to the battery compartment divider wall (piece with square cutout). Solder the bracket and remove the screw.



**Figure 3. Mount cover brackets**

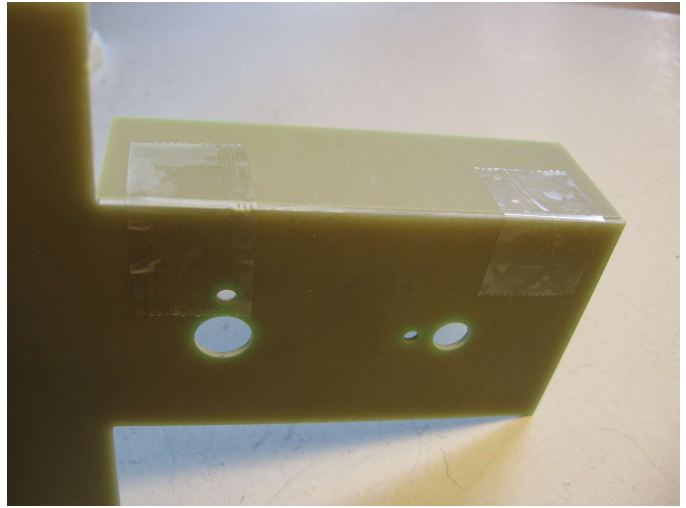
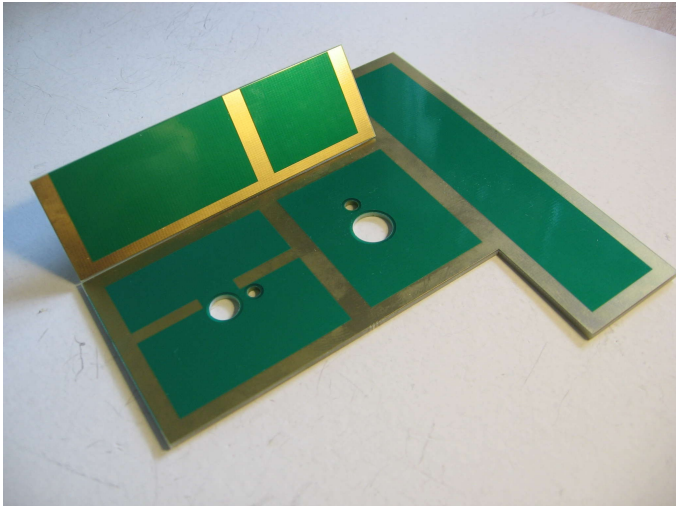
Mount two of the brackets to one end of the antenna box cover. Use a thin washer between each of the brackets and the cover so that the cover will be held down tightly later when the cover screws are holding the cover to the receiver box.

Tape down the small end piece so that it does not move when soldering.

Ensure that the cover is centred on the end piece indicated by arrows in the photo.

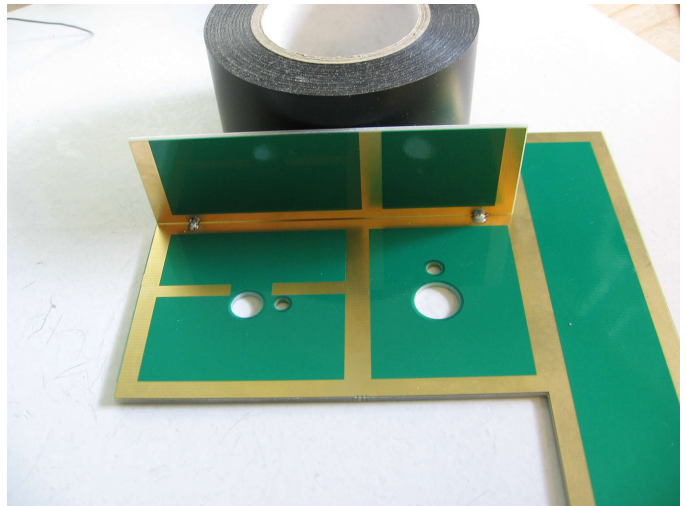
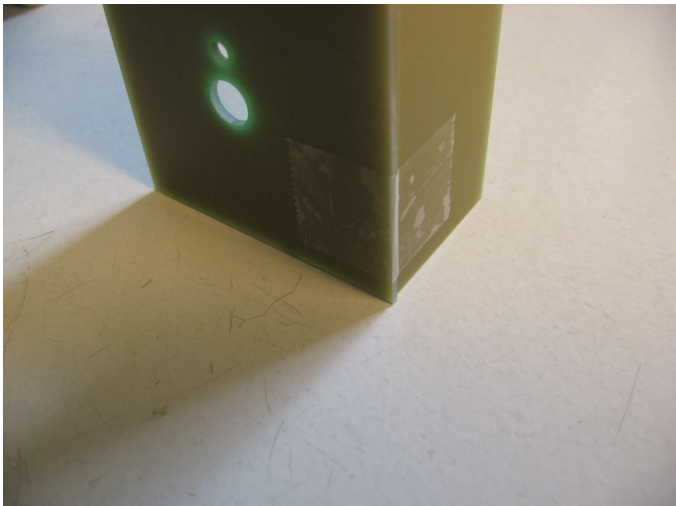
Tack solder the bracket corners, re-check that the end piece is aligned properly, then solder down the brackets.

Repeat the process for the two brackets on the other side of the cover. Remove the end pieces from the cover, they will be soldered into place in a later step.



**Figure 4. Mount side panel**

Position a side panel on top of the front panel and tape them together to hold while soldering.

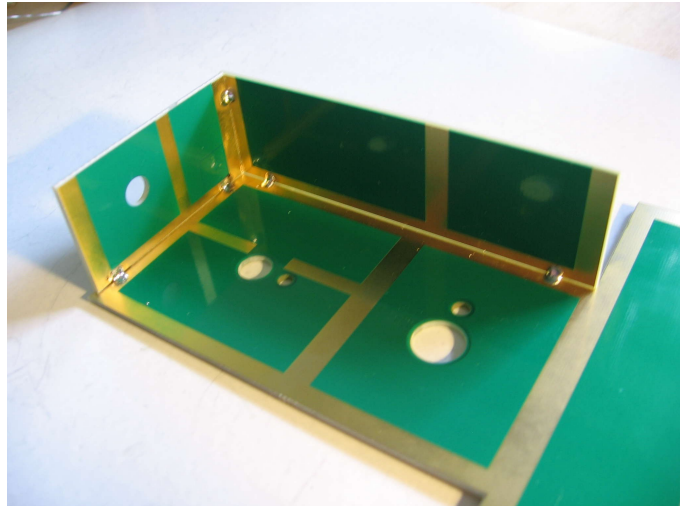
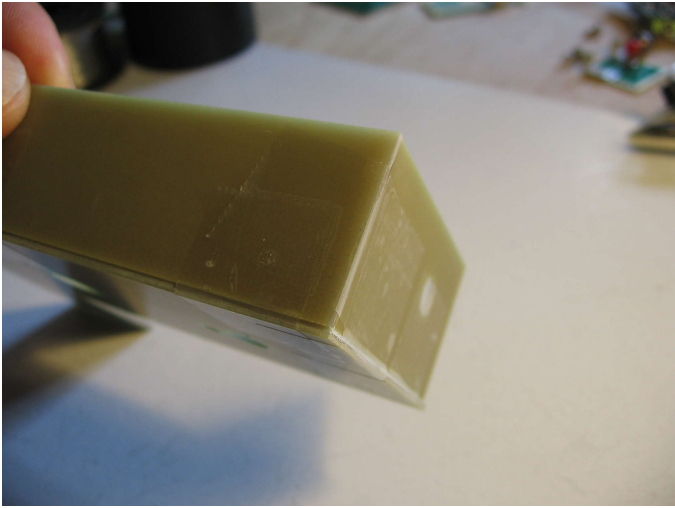


**Figure 5. Mount right side panel**

Note that “left” and “right” are with respect to viewing the receiver case toward the front with the receiver upright (left photo of Figure 5).

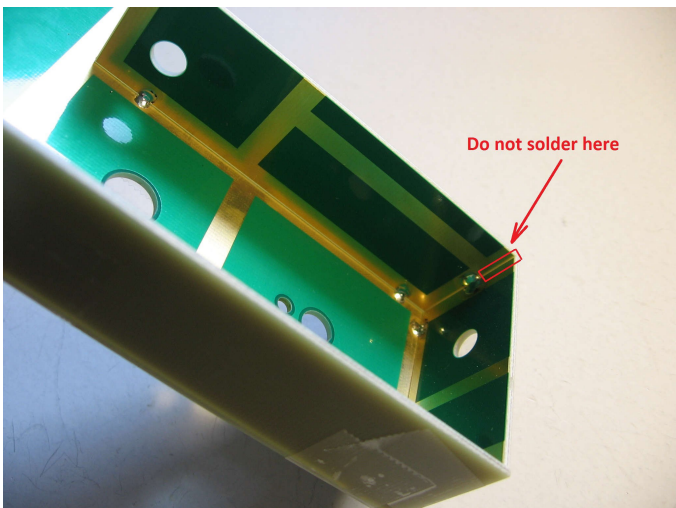
Be sure the side panel bottom edge aligns with the bottom edge of the front panel. Support the panel against a right angle for soldering. Since the boards tend to fold inward a little after the soldering has cooled, starting with the board tilted out slightly will help result in an accurate 90 degrees when cool.

Tack solder in two places away from the ends of the side panel



**Figure 6. Attach bottom end panel**

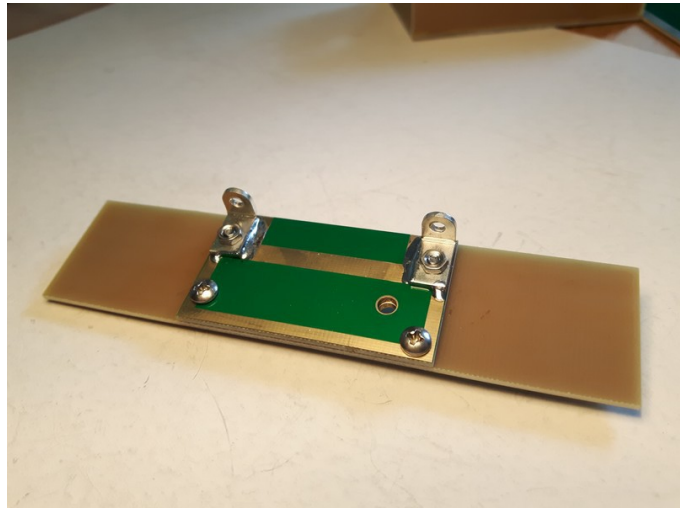
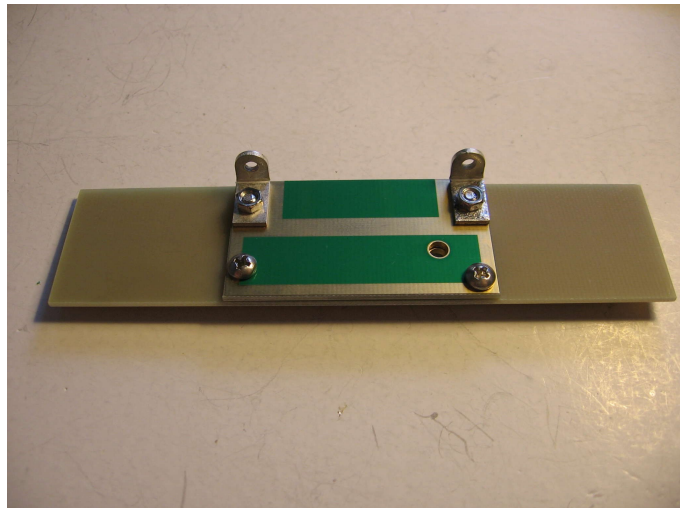
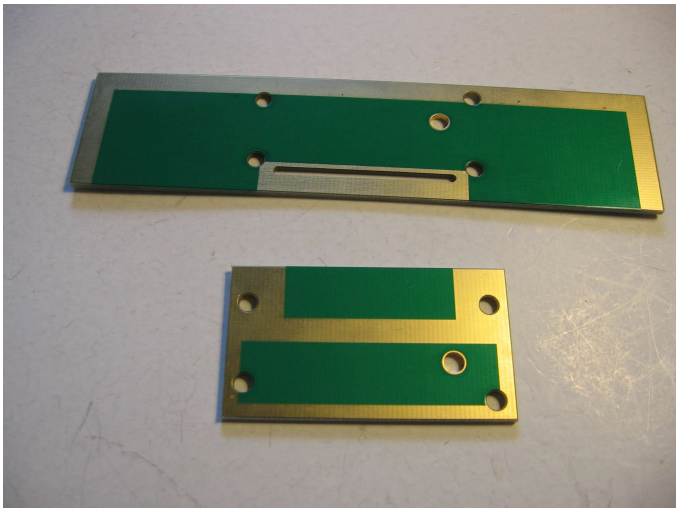
Tape the bottom end panel to the front and side, solder in 3 places as shown.



**Figure 7. Attach left side panel**

Similarly, tape the left side panel into position and solder in three places.

The back edge of the left panel should be left free of solder so that the receiver circuit board can be slid down into position later.

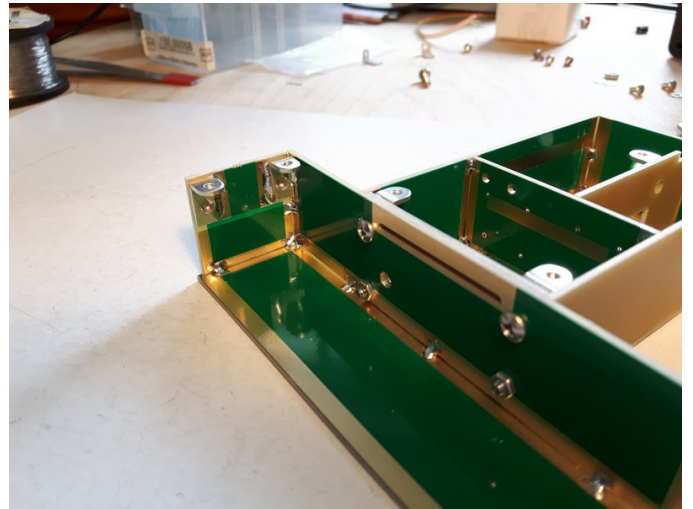
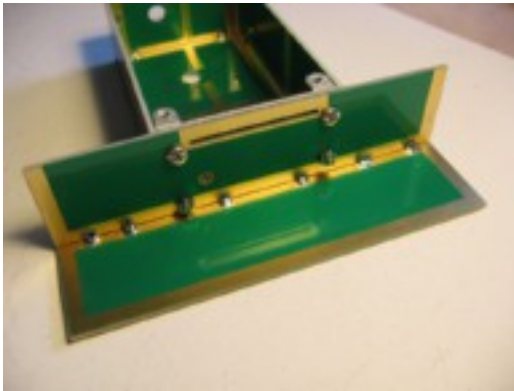
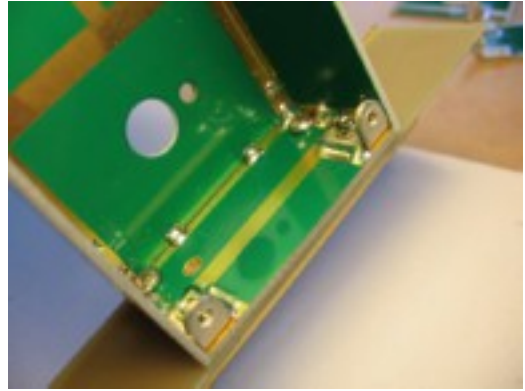
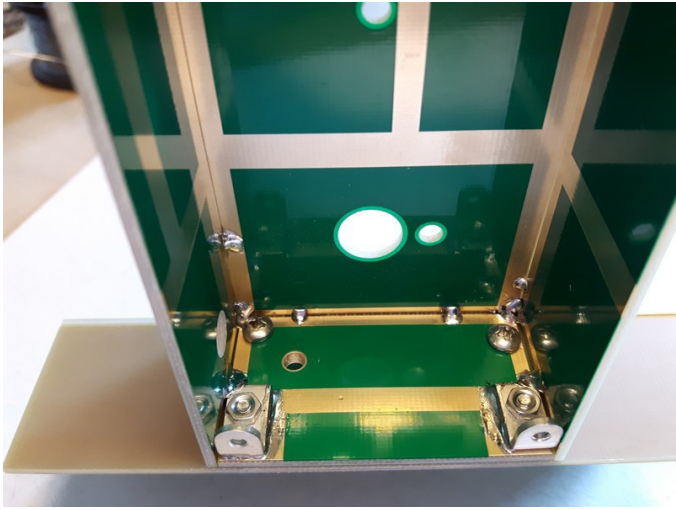


**Figure 8. Top panel and cover brackets**

Use four #4 screws and nuts to hold the top cover and two brackets to the antenna box bottom. Do not use the threaded bracket holes. Place temporarily between the two side panels to be sure all fits squarely. Adjust as needed, then tighten all the #4 screws to keep the antenna box panel and the brackets positioned as just adjusted. Remove the panel/bracket assembly, solder the brackets, leave the screws in place to hold the two panels together sturdily while further assembly is done.

....continued on next page....



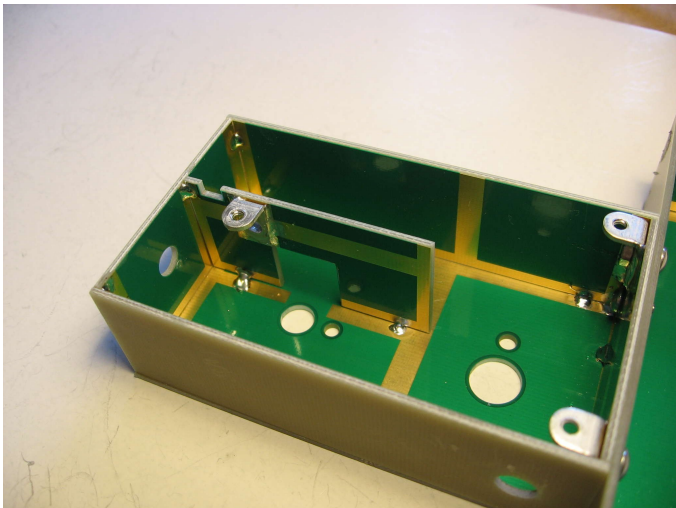
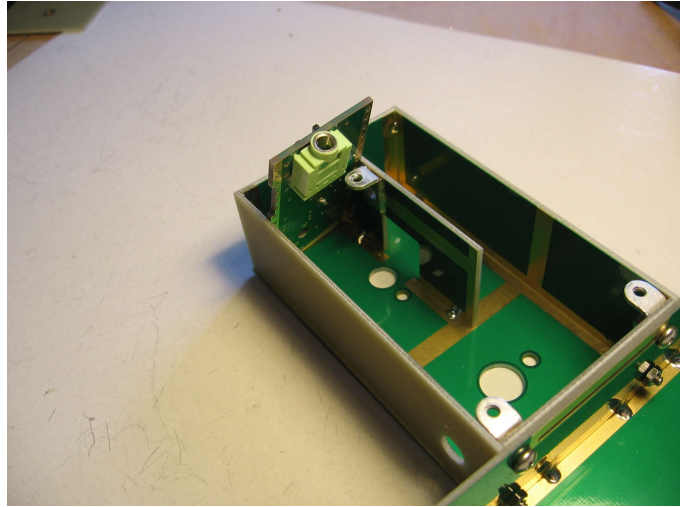
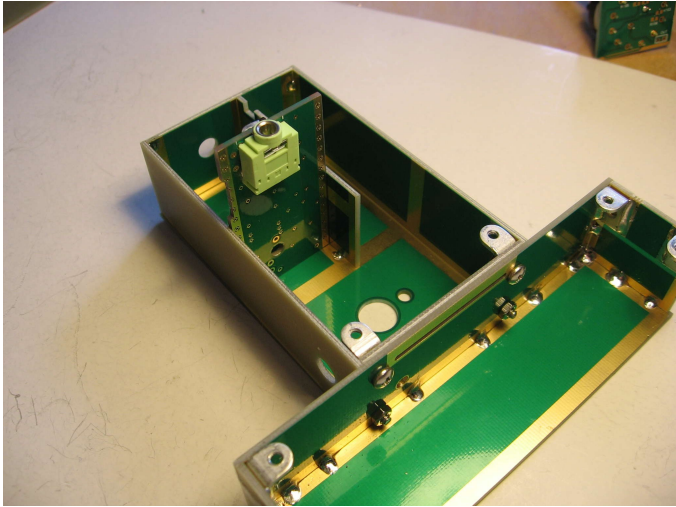


***Figure 9. Receiver box top panel and antenna compartment***

Then, return the top panel to the box and solder it to the sides and front (top two pictures).

Solder the antenna box bottom to the front panel (inside of antenna compartment, lower left).

Finally, add in the previously prepared antenna box end panels.

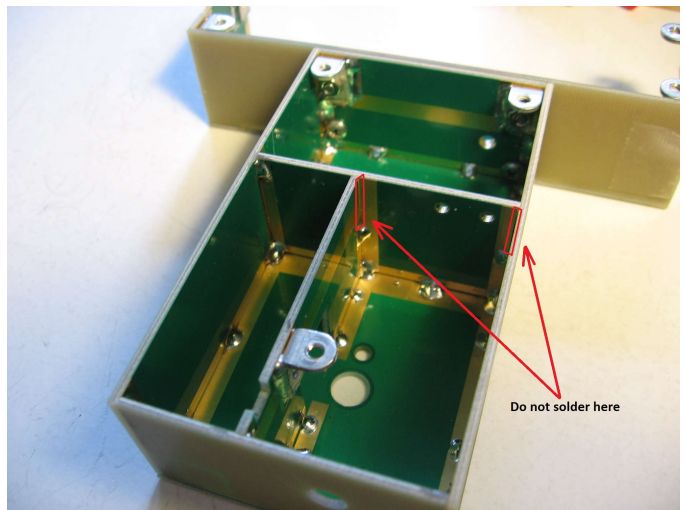
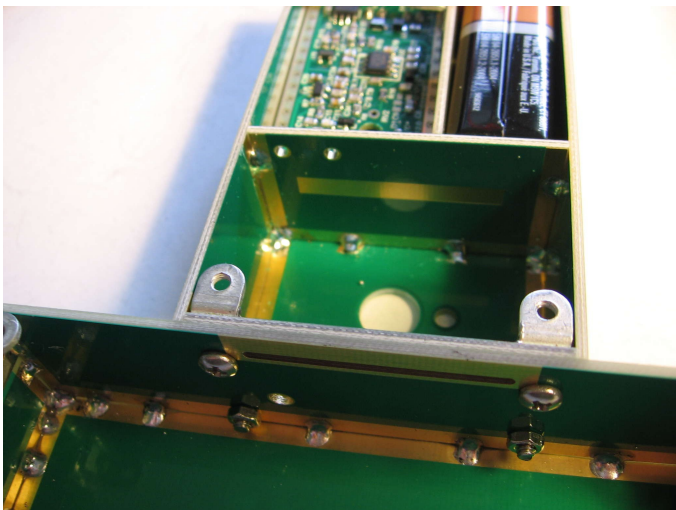
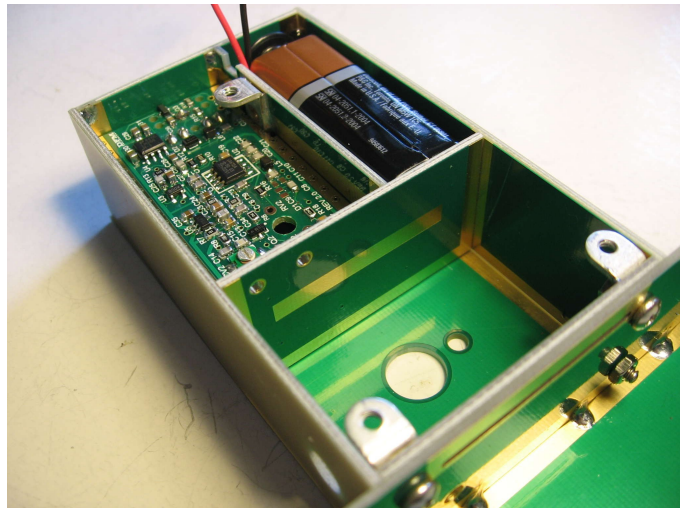
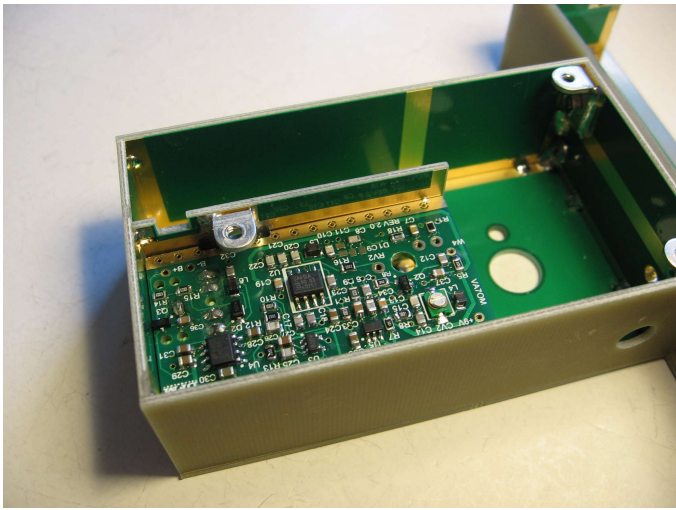


**Figure 10. Install battery compartment divider**

Using the receiver board as spacer, hold battery compartment divider in position and tack one point near the top.

Then, move the receiver board toward the bottom and tack solder a second point near the tuning potentiometer cutout.

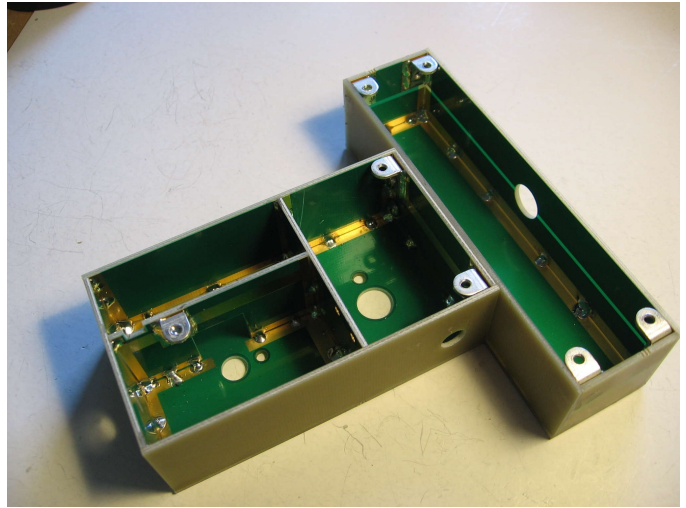
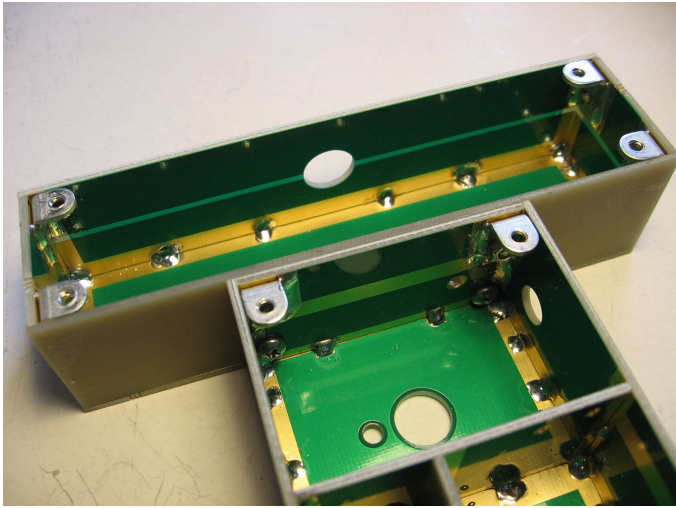
Finally, solder a third point on the bottom panel. It might be useful to keep the receiver board in the centre of the space to ensure right-angle alignment of the divider.



### **Figure 11. Installing shield panel**

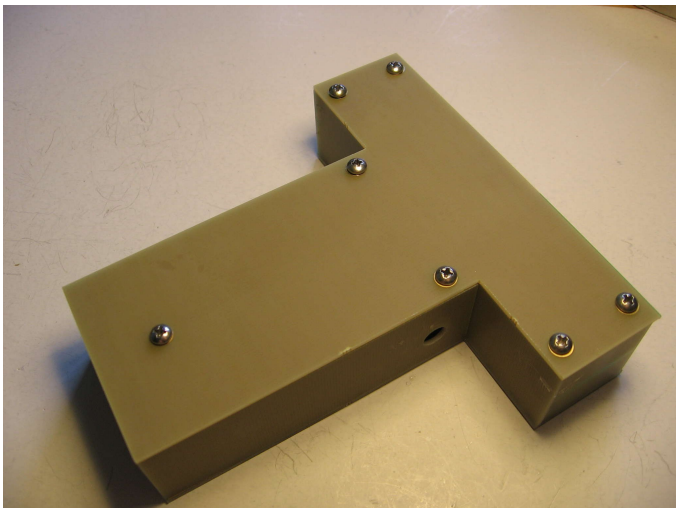
Put the receiver board into position in its compartment, tack solder one point if necessary to hold it in place. Position the shield panel across the top end of the receiver board and battery compartment divider. Check that the battery with its snap connector will fit in the battery compartment.

Tack solder the shield panel on the top side. Then, remove the receiver board and battery and solder on the bottom side of the shield. Note the regions to avoid soldering—so that the receiver board will later be able to slide into place.



**Figure 12. Install top panel**

Soldering the top panel of the antenna compartment completes assembly of the receiver box.

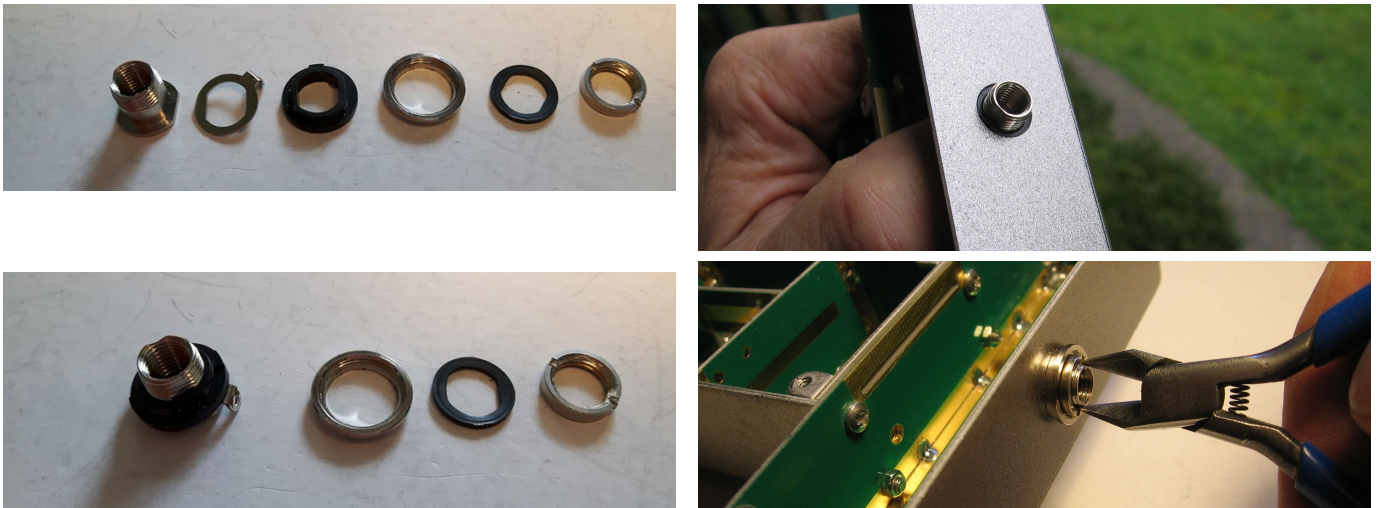


**Figure 13. Check cover fit**

Check that the cover fits properly. If necessary, use a large piece of sandpaper on a flat surface to level all the surfaces the cover contacts.

At this stage, the box finishing should be done. All the outside sharp edges filed to be rounded and smooth, the panels lightly sanded to ensure a good surface for painting, then cleaned (say with isopropanol), apply masking tape on the inside to cover all the holes. Then spray paint the box and cover with an automotive enamel—for example, “Dupli-colour, perfect match” available at Canadian Tire in small spray cans.

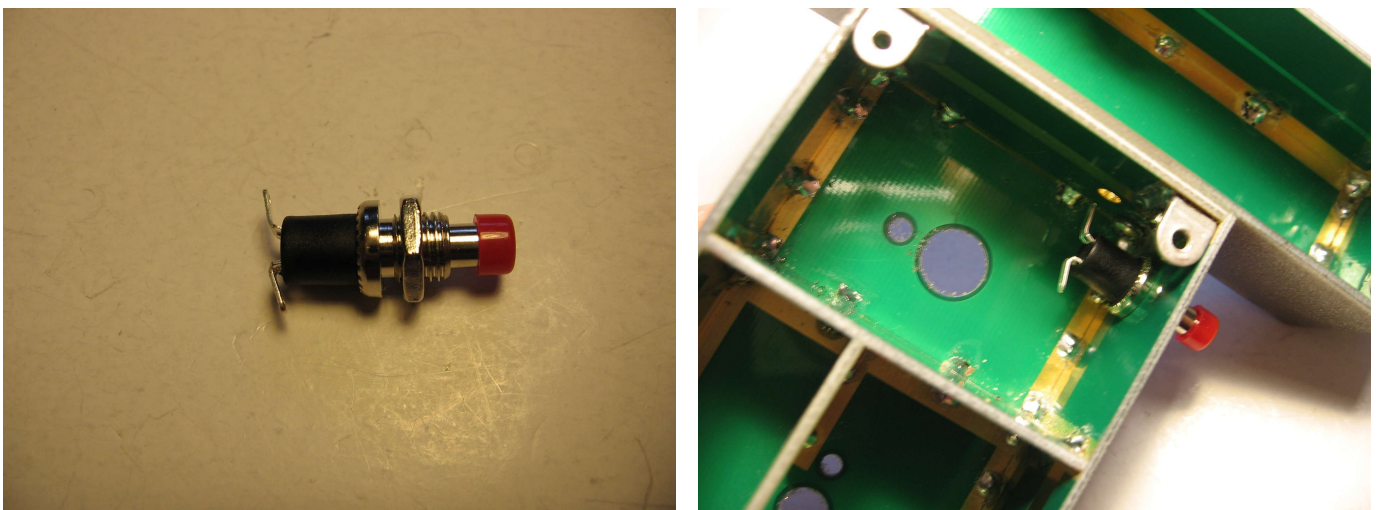
## Final Assembly



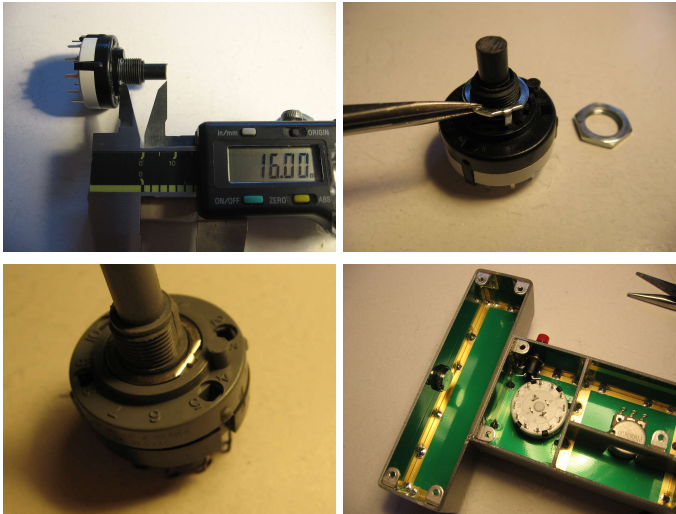
**Figure 14. Sense antenna jack**

The sense antenna jack is the type that is insulated from its mounting panel while carrying the antenna signal through the panel to the inside. Thus there are several pieces needed to accomplish this insulated mounting, shown in assembly order. Inside, the body is fitted with a solder terminal and then the large insulating washer. This group goes through the mounting hole. Outside is the clamp ring, the thin insulating washer and finally the fastening nut.

The thickness of the receiver case does not leave enough room to use the lock washer between the solder terminal and the connector body. While probably unnecessary, additional length of the connector body can be recovered if the two indexing tabs on the large insulating washer are cut or filed off.

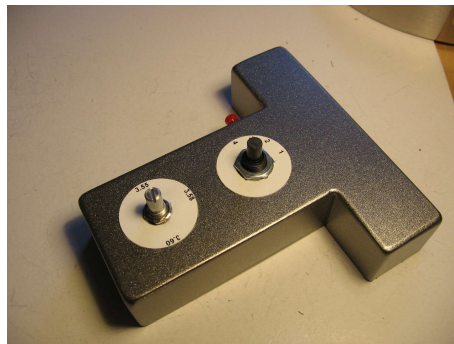
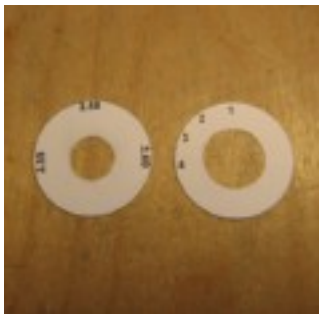


**Figure 15. Mount sense antenna switch**



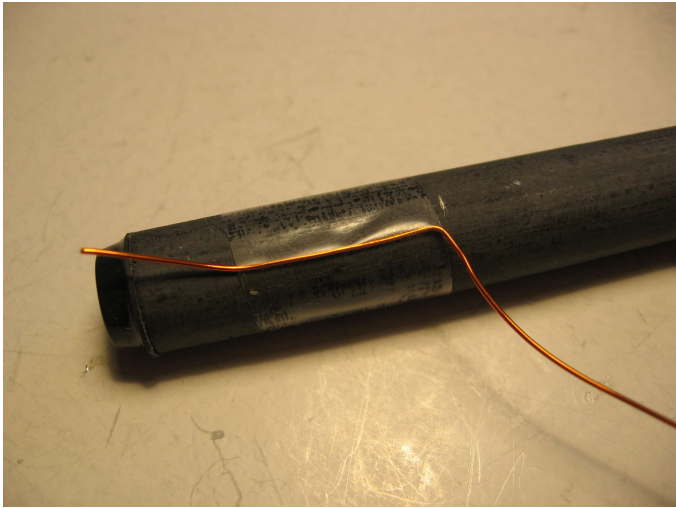
**Figure 16. Mount attenuator switch**

Prepare the switch by cutting the shaft to 16 mm length. Check that the switch shaft is turned to maximum CCW position. Move the indexing ring to position 4. Install switch in box, be careful to not over-tighten the mounting nut on the plastic switch housing threads.



**Figure 17. Finish front panel**

Cut out the scales and glue them in place using Gorilla glue, which works well. Add the knobs.



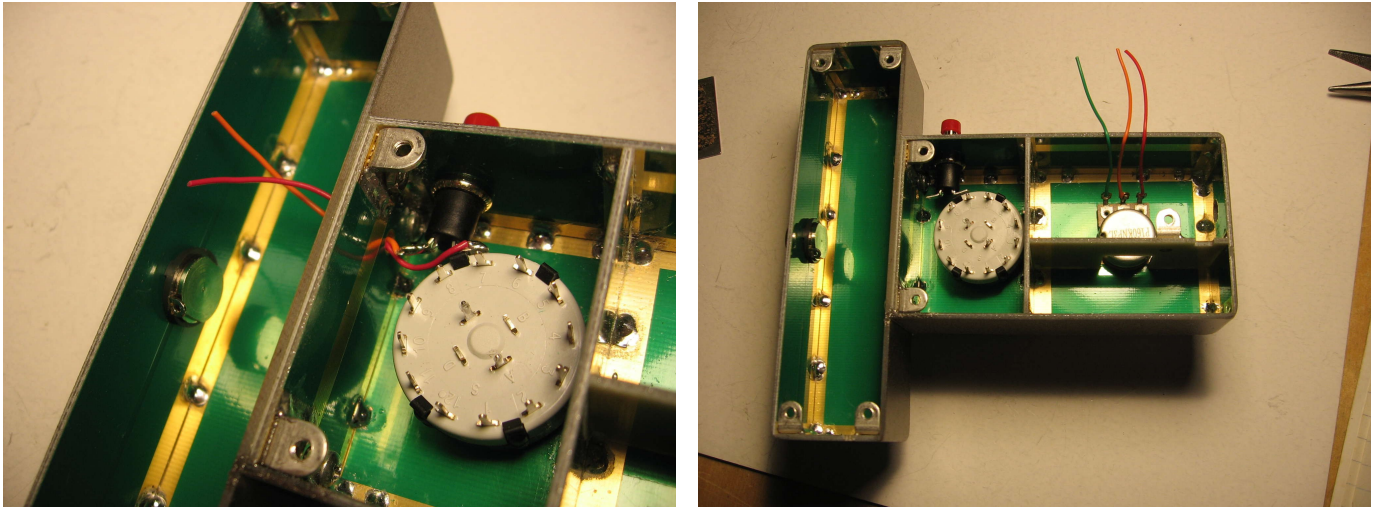
**Figure 18 Winding antenna coils**

Attach rubber bumpers to ends of ferrite rod.

Get 43 inches of #24 magnet wire. Start the winding about 30mm from left end. Tape down the start end of the wire. Wind 25 turns of the wire, note the **direction of winding**. Tape down the second end and then glue the whole winding. The glue dries clear.

When the glue on the first winding is dry, using about 5" of the same wire, wind the second winding. Start about 50 mm from left end, wind 2 turns in the **same direction** as the first winding. Glue the winding, wait until it's dry.

Wind the 3<sup>rd</sup> winding with about 11" of the same wire, start about 60 mm from the left end, wind 6 turns in the **same direction**. Glue and let dry.



**Figure 19. Control wiring**

Connect 50 mm lengths of hookup wire to the sense switch and tuning potentiometer as shown.

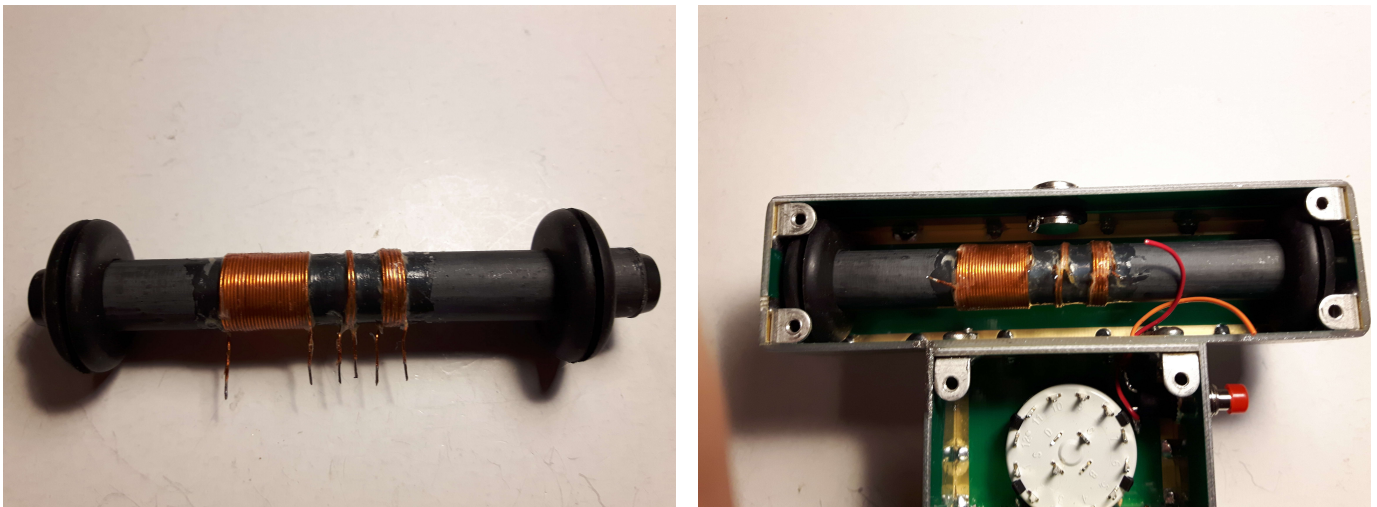
Recommended colours:

Red = +9V

Green = ground (low side of tune voltage).

Orange = switched 9V and voltage between 9V and ground

Yellow = signal

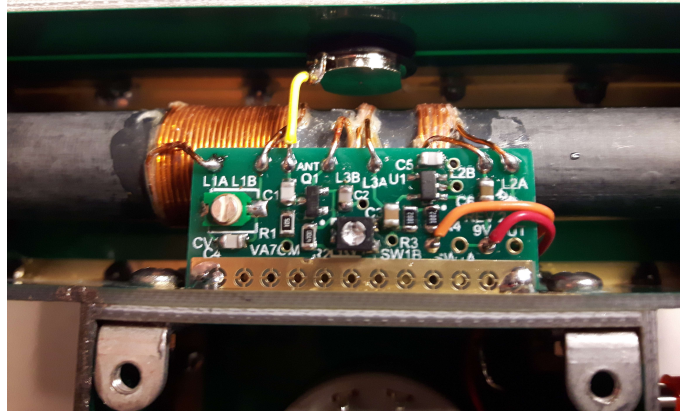
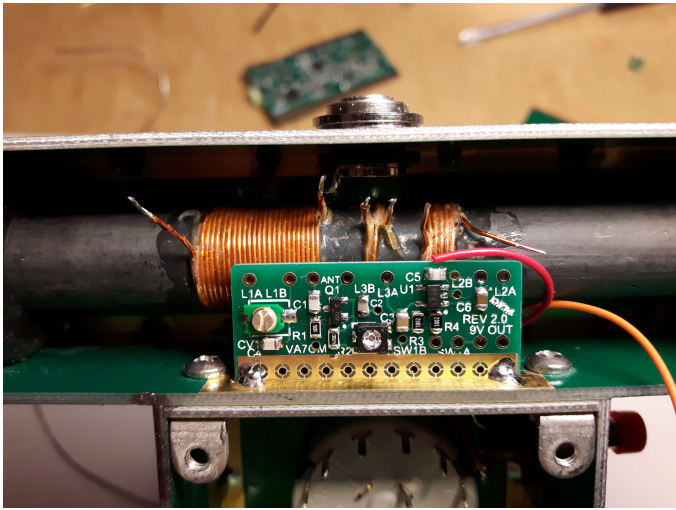


**Figure 20. Install ferrite-rod antenna**

Cut all the antenna wires to 10 mm and clean the ends for soldering.

Install the shock mount grommets, slide the antenna into the compartment and move the grommets toward the ends.

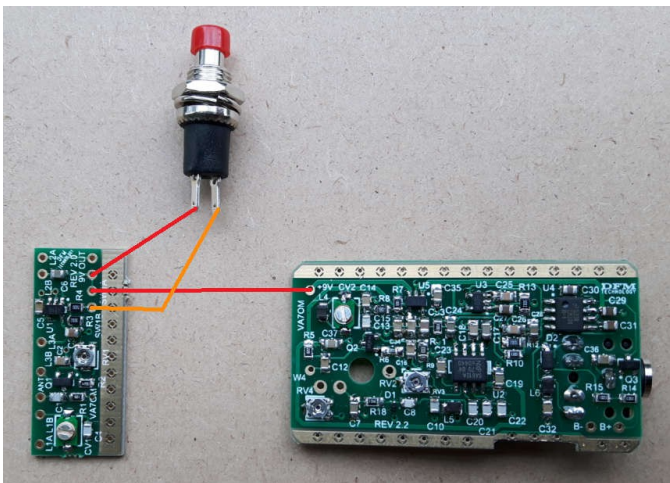




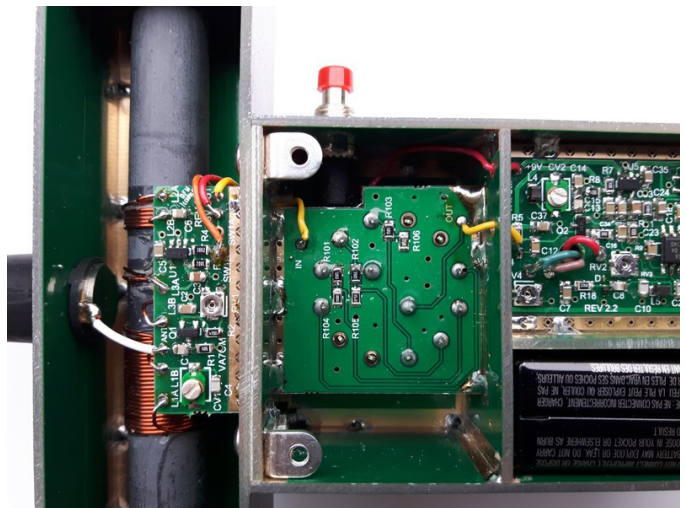
**Figure 21. Install front-end electronics board**

Fit the electronics board into the slot and solder it in a couple of spots.

Connect the antenna wires, the sense antenna (white wire), switch wires, and the power wires to the front-end electronics board. Fig 21a details the switch and power wiring.

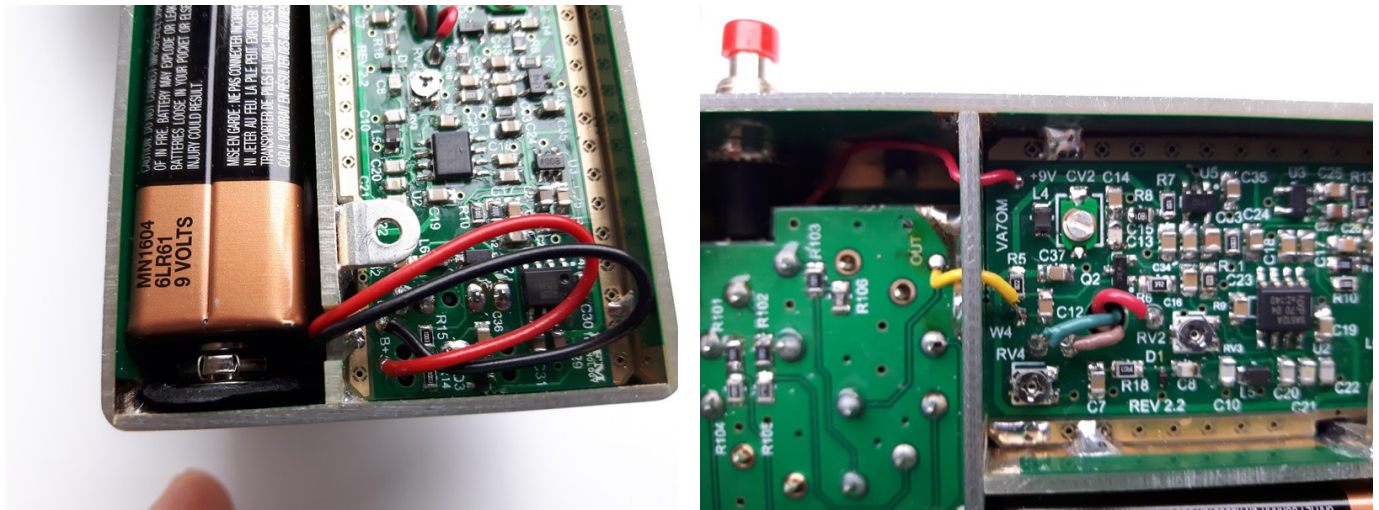


**Figure 21a Front power and switch**



**Figure 22. Install attenuator board**

Place the attenuator board on the terminals of the switch and solder the terminals to the board. Connect a (yellow) wire from the antenna output pad on the front-end board to the input of the attenuator board.



**Figure 23. Install main board.**

If necessary, clean any paint from the hole for the audio jack hole so that the jack slides into the hole easily.

Pull the potentiometer wires through the hole in the main board. Tip the board to clear the bracket, insert the audio jack into the hole and push the board into place so that it is level, equidistant from the back all around. Solder it into place in a few spots.

Solder the battery snap leads to the B+ (red) and B- (black) terminals on the board. Solder the potentiometer wires to their pads on the main board as show.

Connect a yellow wire from the output of the attenuator board to the receiver input.

Connect the red power wire from the switch to the power-out pad on the main board (upper left in right-hand photo).

## Final adjustments

The main receiver board is supplied in the kit with all adjustments done. The frequency calibration of the receiver to the dial is set up. The only adjustments that should be required are on the front end board for the antenna tuning and the sense antenna sensitivity.

The tuning knob might need to be positioned to align tuning with the dial. Tune the receiver to a signal at 3.58 MHz, and loosen the knob setscrew and tighten with the knob pointing to 3.58 on the dial.

To make the front end adjustments, you will need a metallic cover which has two holes allowing access to the controls. The cover is necessary because the tuning is affected by the presence of the cover. This cover may be another piece of printed circuit board, a sheet metal plate, etc. One simple shield cover can be made from aluminium foil with double-sided tape holding it to a piece of card stock or packaging plastic cut to the shape of the receiver cover. A limited supply of boards as shown below is available to share with a group—say one per club.



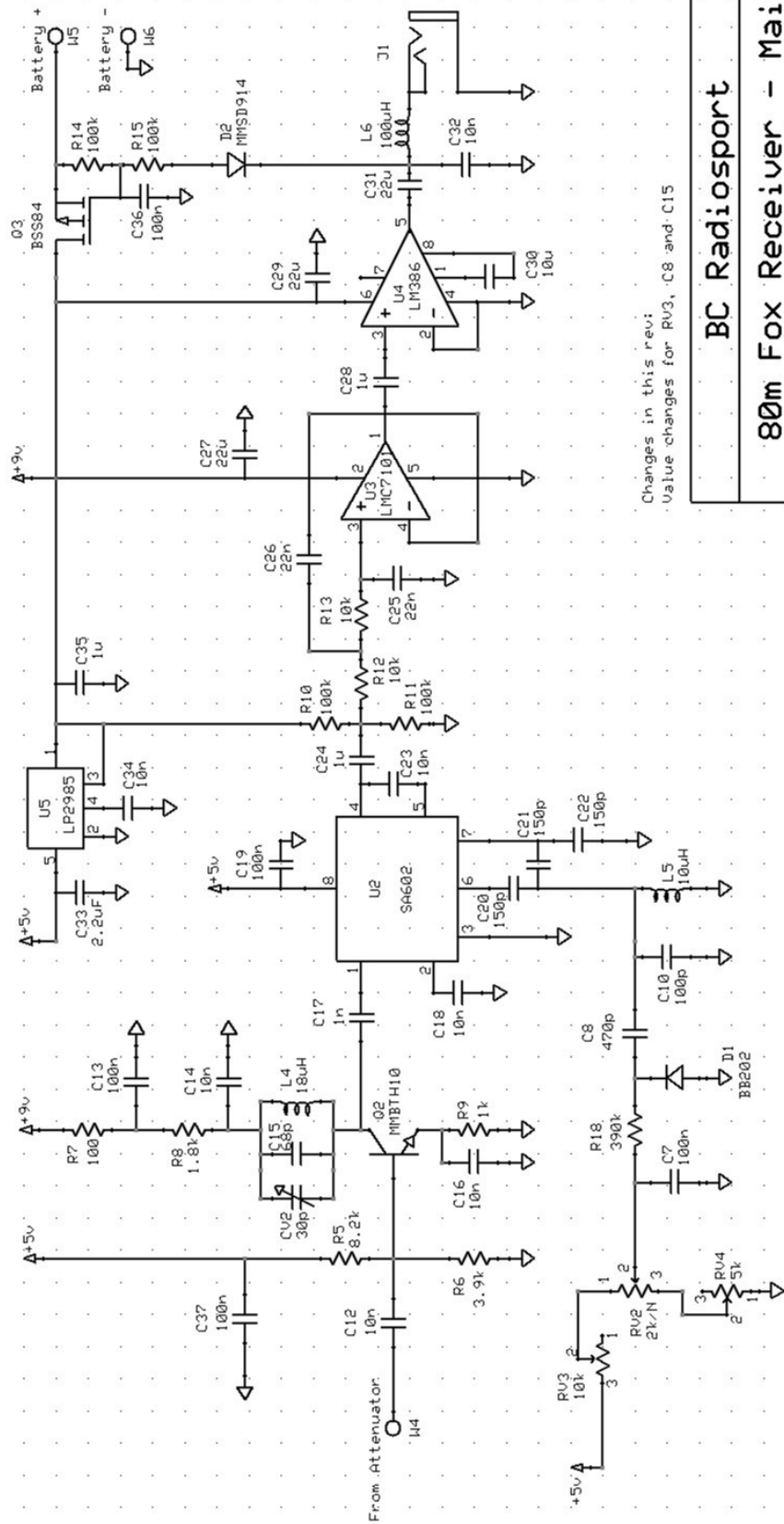
You can tune the antenna resonance either indoors with a signal from a signal generator, or outside with a low-power transmitter. The sense antenna sensitivity adjustment must be done outdoors, tuned to a signal from a low-power transmitter located about 100 meters away. The signal condition you want for tuning is a medium-strong signal. Hold the receiver facing the transmitter (the knobs are toward the transmitter, you are viewing the back where the tuning holes are). Attenuator in position 1. Trim the antenna capacitor for maximum signal. Press the sense antenna switch, and while holding it on, adjust the sense sensitivity control for a minimum signal loudness. Check that this setting gives a clear difference in the signal level between the receiver facing the transmitter and facing 180 degrees away from the transmitter.

### ***Description of the other controls***

There are only three trimmer adjustments on the main board: CV2 trims the resonance of the tuned preamplifier stage. It is adjusted for maximum gain while receiving a signal mid-band (3.58 MHz). RV3 and RV4 adjust the tuning range and frequency offset. RV4 is trimmed first with the dial set to 3.55 and a 3.55 MHz input signal is being received. Then the receiver dial and signal are moved to 3.6 MHz and RV3 adjusted to tune in the signal. The adjustments interact a bit, so the procedure is repeated.

With these two controls, the tuning range may be extended to cover 3.50 to 3.60, at the expense of making it more difficult to adjust the tuning knob to a desired signal since the increased range means a given knob rotation angle corresponds to about double the change in frequency. The current international ARDF event rules suggest 80m foxes be located in the range 3.52 to 3.60.

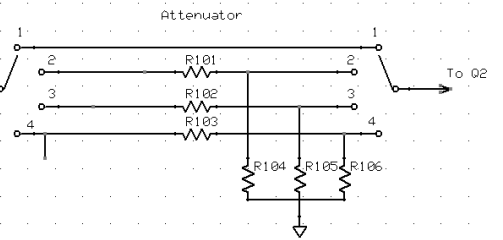
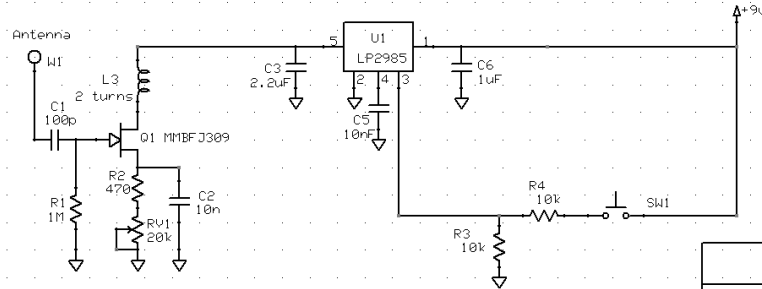
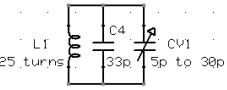
# Appendix 1 Schematics



Changes in this rev:  
 Value changes for RV3, C8 and C15

|                                |                         |
|--------------------------------|-------------------------|
| <b>BC Radiosport</b>           |                         |
| <b>80m Fox Receiver - Main</b> |                         |
| Les, YA70M                     | Rev 1.12<br>Mar 3, 2016 |
| Page 1 of 2                    |                         |

L1, L2 and L3  
wound on Ferrite Rod  
with 24 GA wire



**Attenuator Resistors**

- R101 = 1.5k
- R102 = 1.5k
- R103 = 1.5k
- R104 = 150
- R105 = 15
- R106 = 1.5

|                                 |                |             |
|---------------------------------|----------------|-------------|
| <b>BC Radiosport</b>            |                |             |
| <b>80m Fox Receiver - Front</b> |                |             |
| Les, VA7QM                      | Rev 1, 91      | Page 1 of 2 |
|                                 | March 12, 2016 |             |

## Appendix 2 Board layouts

