ARDF 80m Receiver Construction Manual

Version 2.0

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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 4-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.

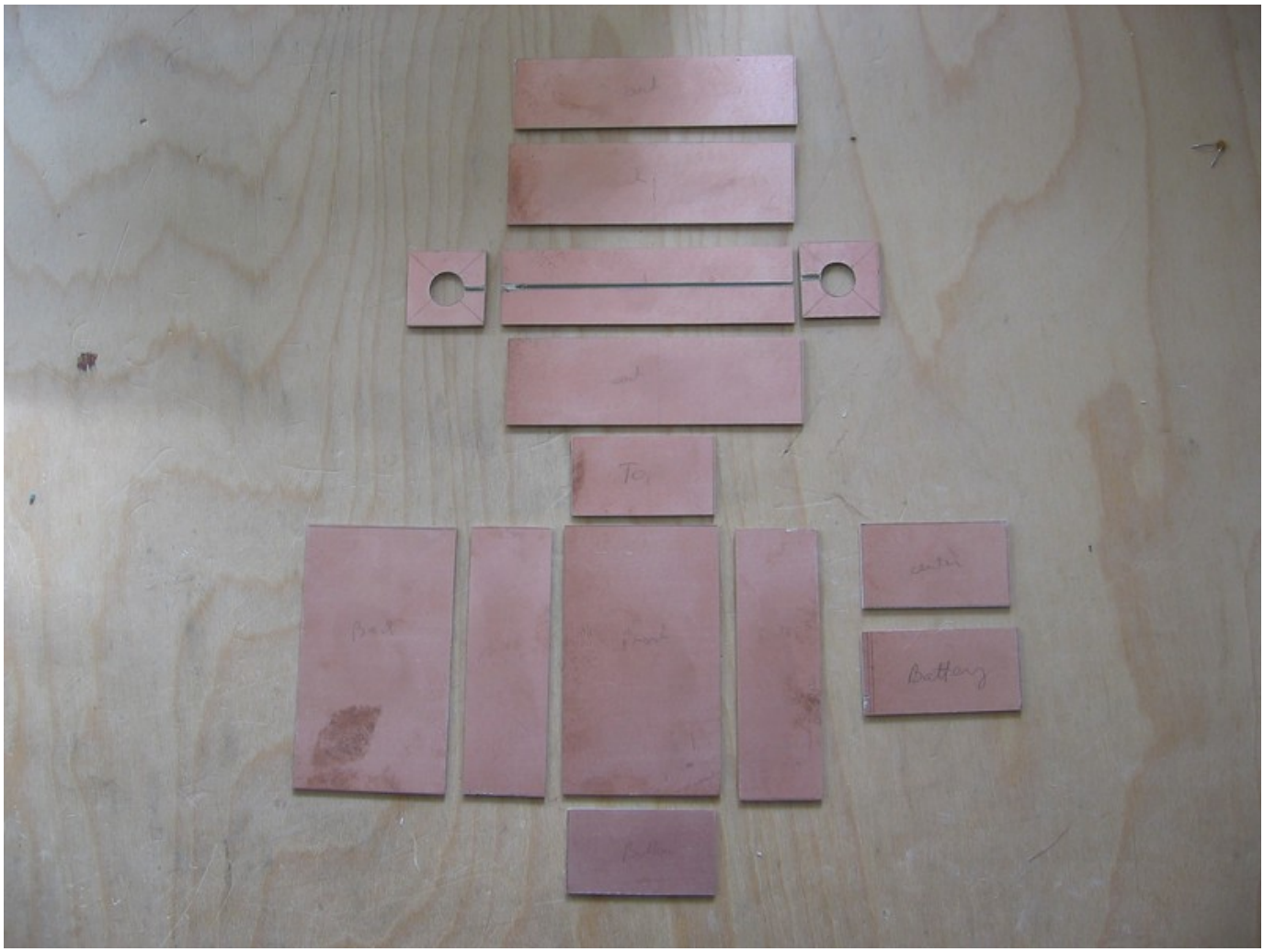


Figure 1. Receiver Box pieces

Preparing the PCB pieces

Cutting the pieces from blank PCB (12” X 12” piece), see the suggested cutting pattern—figure 2, and the “dimensions” section.

- Mark off a 27mm strip. Saw, allowing about .5 mm (or less, depending on accuracy of your saw cutting) clearance from the exact size.
- Trim the 27mm strip to exact size with file/sandpaper.
- Smooth the cut edge of the remaining stock so it's level along the entire length.
- Mark off a second 27mm strip..repeat cutting, trimming, smoothing

- Repeat for a 30mm strip, and for a 51mm strip. These two need not be the entire length of the board, although it may be simpler to make them the entire length

- Next cut the long strips into the pieces as shown on the cutting diagram, one piece at a time. Use a square to mark the cuts, and repeat--cut, finish both sides of the cut--steps as done for the strips. Cut the smaller pieces first so that the last cut in a strip can be done with a substantial piece to hold on to while sawing.

This procedure allows for getting all of the front-back spacing pieces (27 mm) exactly the same size. It may be useful to check the precision of the width with vernier callipers. At the end of this process, you will have a set of parts as shown in Figure 1 (except for the ferrite rod mounting holes and the shield gap, which are described below).

Drilling the mounting holes

There are two possible ways to proceed with assembling the pieces. Either the pieces may be assembled into a box and then the mounting holes can be drilled to fit the components into the available space, or the several mounting holes can be drilled first, following previously determined locations given in the dimensions section. The advantage of the first method is that various imperfections in the assembly can be compensated by slightly moving hole locations to accommodate the imperfections. The first method was obviously followed initially for the first assembly. The second method allows for drilling all the holes while the pieces are held down flat.

If the holes are drilled first, the critical alignment of the antenna cover bottom (piece #3) with the receiver box top can be accomplished if the two pieces are clamped tightly together, positioned as they will be when finally assembled (the receiver box top centred on the antenna cover bottom, non-copper sides together) and drilling the three 2.7 mm holes through both pieces at the same time.

If the holes are drilled after the receiver box assembly, the alignment can be accomplished as follows (refer to Figure 8):

- first drill one mounting hole in the antenna box bottom (6mm in from each edge),
- then align the antenna box bottom back edge with the receiver back edge, and centred lengthwise on the receiver box. Mark the hole location on the receiver box.
- Drill the mounting hole in the receiver box. Bolt the antenna box bottom to the receiver box.
- Mark the location of the second mounting hole and drill through both the antenna box and receiver box. Bolt the second mounting hole.
- Drill the wire-access hole though both antenna box bottom and receiver box.

The antenna box can now be assembled, following the same steps as for the receiver box

Figure 2. PCB cutting pattern

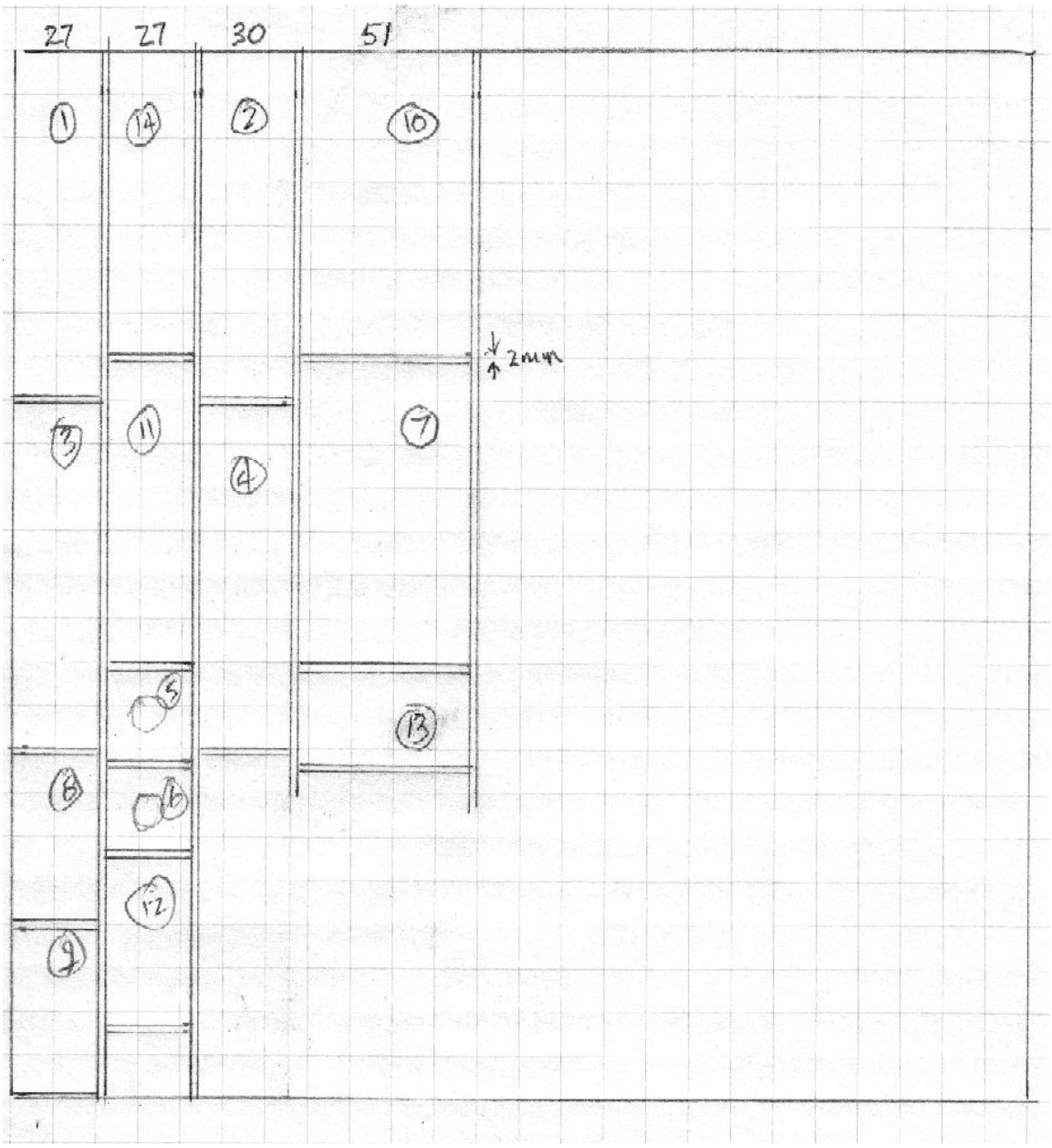


Figure 3. Preparing the antenna mounting box/shield

Cut a gap along the centre of the back (100mm X 27mm) of the antenna enclosure
NOTE: see appendix B if using shock-mounted antenna variation

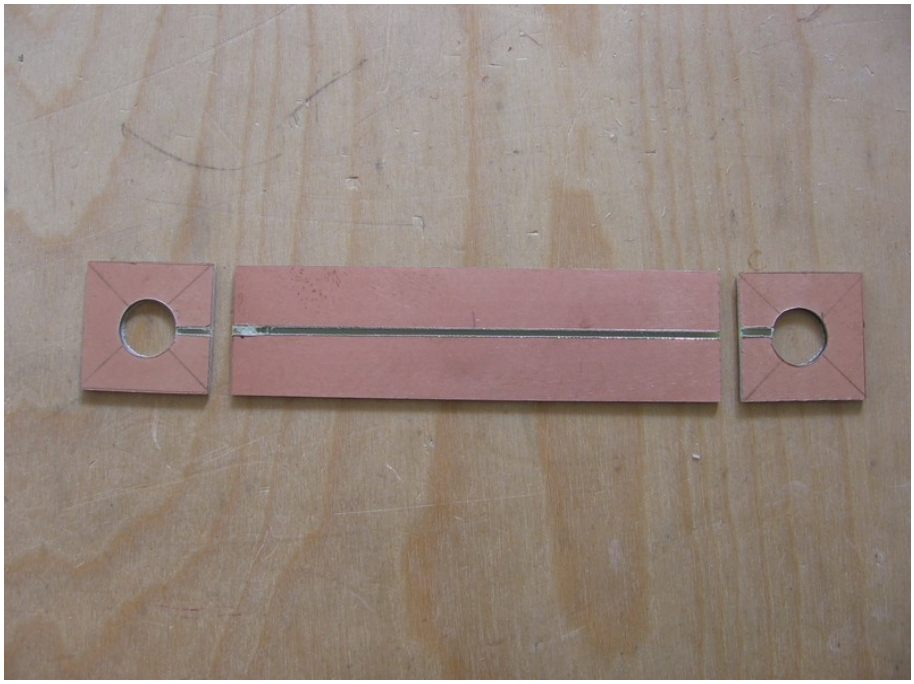


Figure 4. Prepare antenna mount box/shield—end pieces.

Drill the 1/2” (13 mm) antenna rod mounting holes in the left and right end pieces. (Drilling not required if using shock-mounted antenna.)

Cut the end gaps to align with the back gap as shown (fig 4).

Drill the sense antenna mounting hole in the centre of the back piece. 3/8” (9.5mm)

Assembling the receiver box

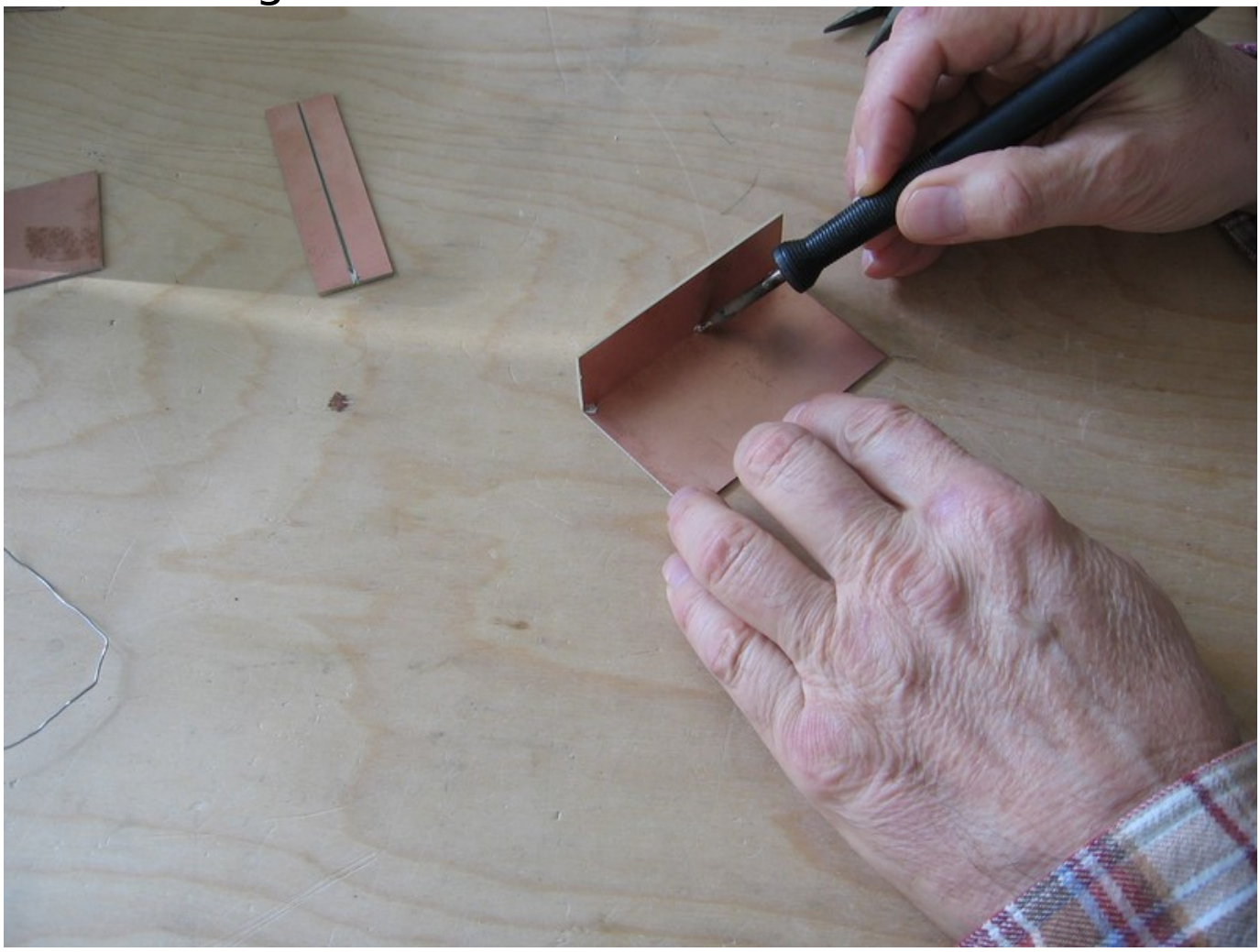


Figure 5. Tack soldering

1. Tack-solder (a small amount of solder, about the middle) a side piece to the front panel. It may be helpful to use a wooden block with accurate 90 degree sides to hold the side aligned with the front, and at 90 degrees.
2. Tack-solder the other side piece.
3. Insert the top piece, align with the sides and front so that there are accurate 90 degree angles between the sides, top, and front panels. Tack-solder between front and top and at the two back corners.
4. Insert the bottom piece as for the top.

This process should result in the sides, top, and bottom of the receiver chassis being accurately located and at right angles to the front. After checking the alignment and dimensions, solder the corners at the front panel. Avoid soldering right at the top back corners of the receiver compartment, or all of the back corners of the antenna box, as these locations will be used for soldering in the cover holding nuts.

Figure 6. Completed receiver box, viewing front

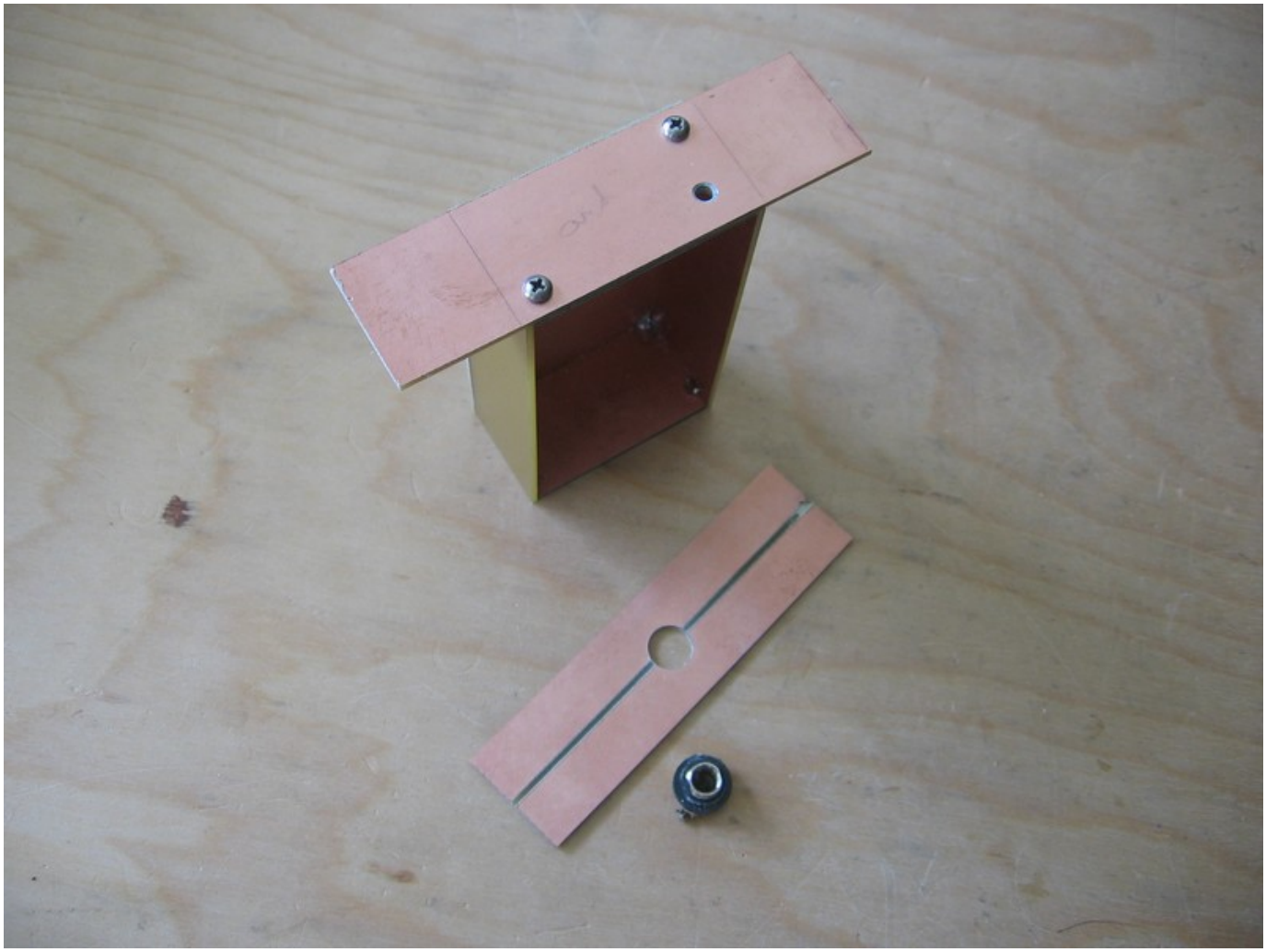


Figure 7. Mounting antenna box/shield to receiver chassis

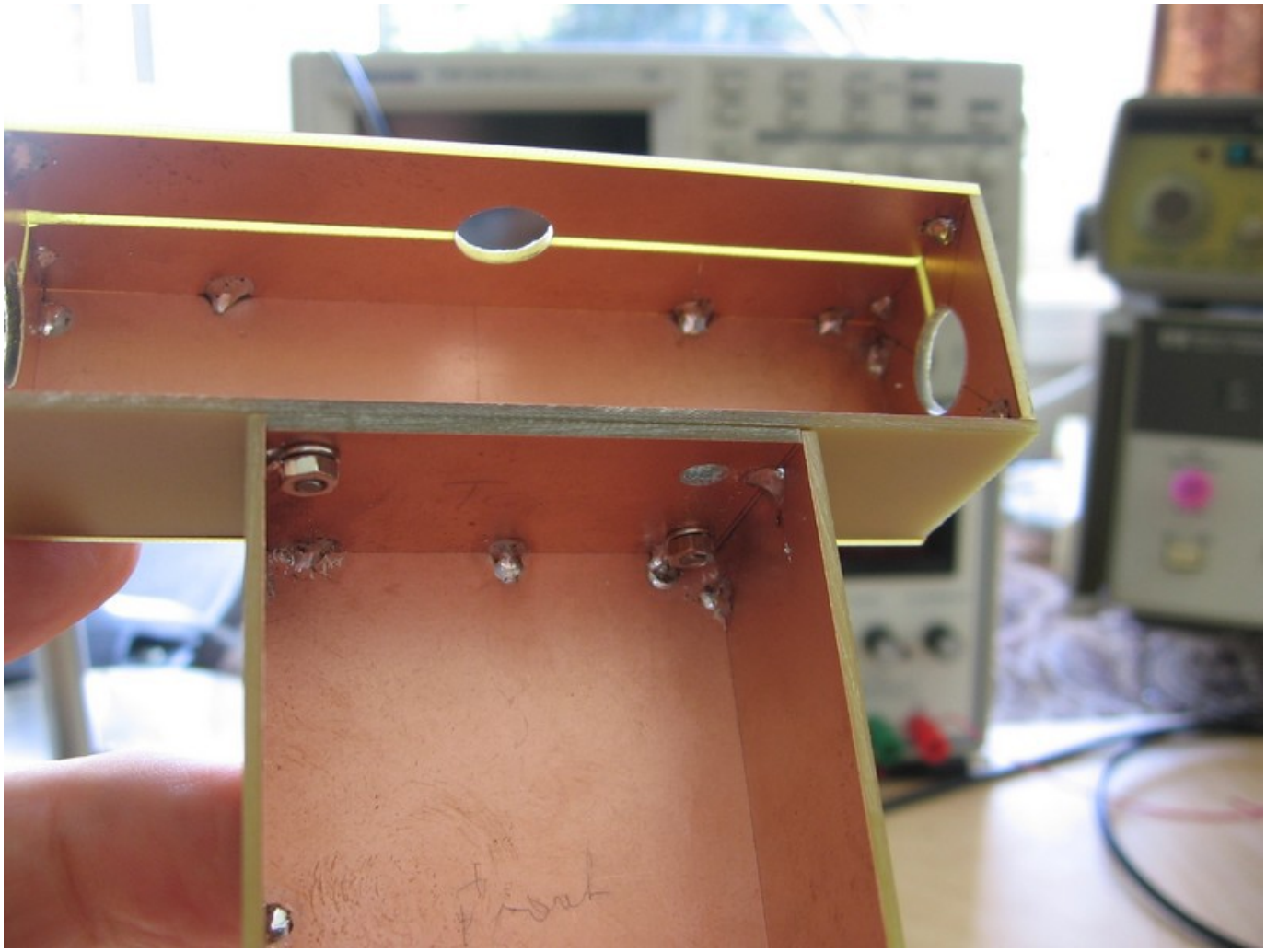


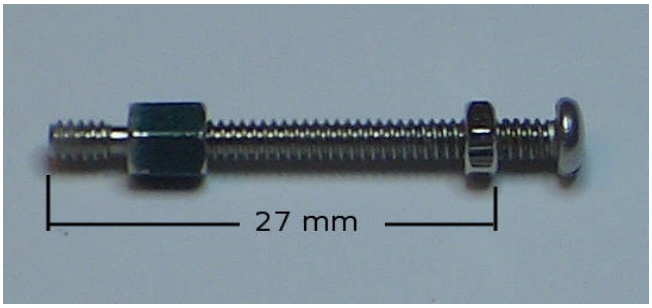
Figure 8. Antenna box mounted.

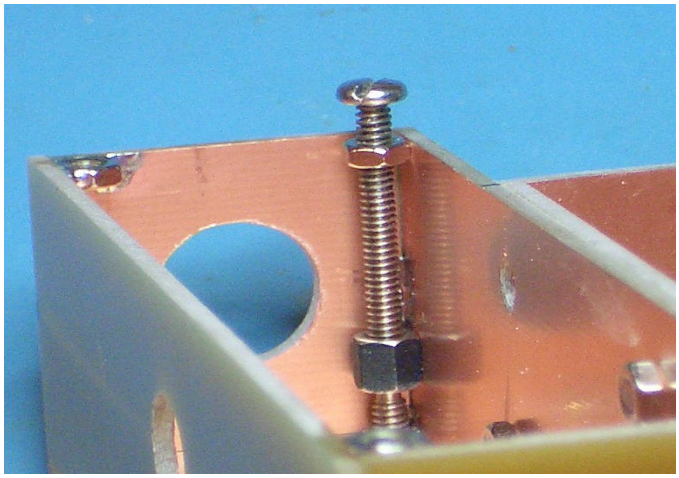
Cover mounting

When the chassis assembly is completed, the nuts for the cover holding screws can be soldered into the 4 corners of the antenna compartment, and 3 locations in the receiver compartment—top left and right corners, and at the junction of the battery box and bottom corner. The nuts to use must be solderable—brass or nickel-plated steel. Smaller sizes are preferable so they do not impede access to the inside. One suitable 4-40, 3/16”, nickel-plated nut is Mode Electronics Ltd. part number 54-526-100.

The nuts should be flush with the inside back edge of the box, and parallel to the plane of the cover so that tightening the cover screw does not put any strain on the solder joint holding the nut. A long screw (or a shorter one with an extension) that will reach to the front of the box with two nuts is a helpful jig to get the position just right.

Even using such a jig, and being careful to always align one flat of each nut consistently with the sides of the box, the location of the cover screw holes will be a 'custom' fit for each assembly, so marking the locations for the cover screw holes must be done after all of the nuts have been soldered in place.





Cover mounting nut jig

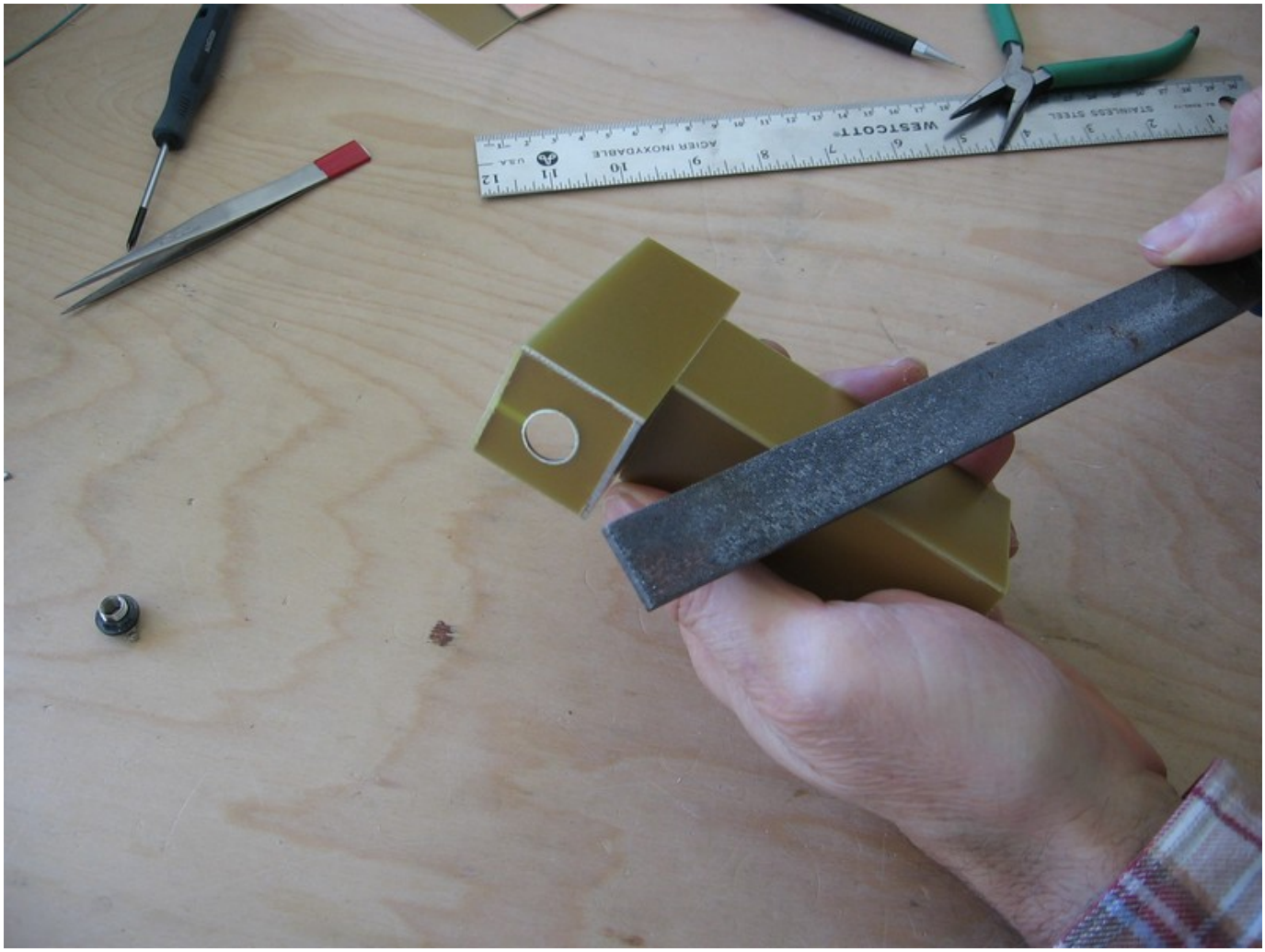


Figure 9. File corners of box

Control mounting, battery compartment and shield

The control mounting positions are constrained by trying to locate them as close to centre of the front panel as possible, attenuator and tuning controls are aligned vertically, and the sense switch located near where your index finger easily reaches it. To have the sense switch as low as possible, the attenuator switch is mounted as near to the shield as possible. The 'dimensions' drawings reflect these mounting considerations.

Prepare the battery partition by cutting a hole for the tuning potentiometer. This hole allows the potentiometer to be moved toward the centre by 1.5 mm. The exact location of the hole can be placed according to the preference for the placement of the tuning potentiometer, but the dimensions given in the 'dimensions' section locate the control in the centre (vertically) of the receiver board compartment.

NOTE: see additional instructions in appendix A if using slide-in battery connector.
The battery compartment width is 18mm to allow for some tolerance on the 17mm nominal battery thickness. Locate the battery compartment wall and tack the bottom end to the bottom wall. Square up the wall vertically and tack the top-front edge to the front panel. Check that the tuning control can be slipped into its mounting hole—the mounting hole and/or the battery shield hole might need to be enlarged or moved over slightly to permit the control to be inserted at an angle, and to ensure that the control does not extend into the battery compartment.

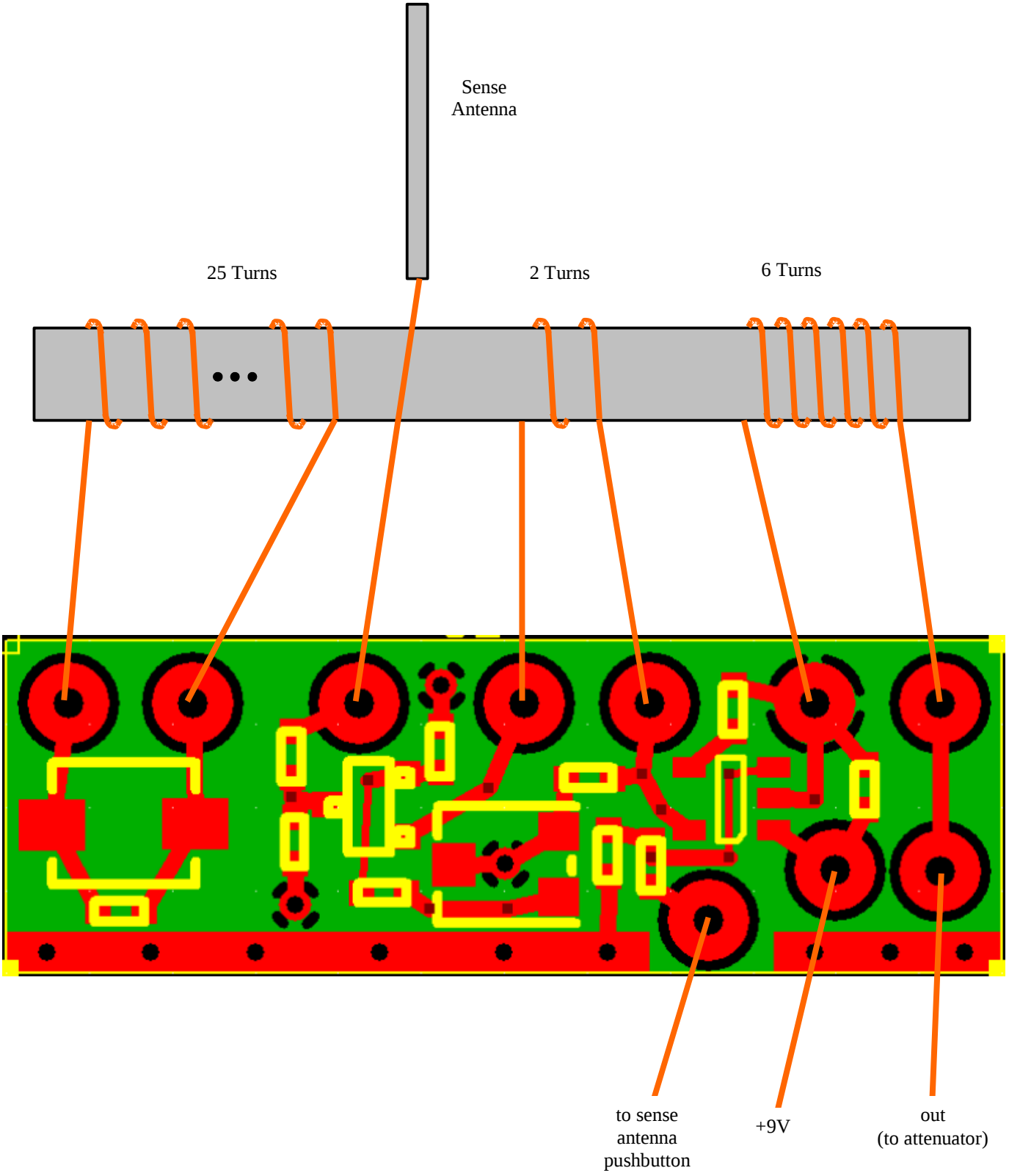
Tack the shield to the top edge of the battery wall close to middle of the 27mm battery wall edge. Square the shield horizontally and then tack each end to the sides—avoid soldering the shield end in the receiver compartment too close to the back because the receiver board will fit snugly in its compartment and a solder filet will prevent it going in.

Finishing

When all of the mounting holes are drilled (if drilling following assembly), box assembly is completed by rounding the sharp corners of all outside edges of the box to make it more comfortable to hold (see figure 9). Then all the panel surfaces are lightly sanded. Cover all the mounting holes with masking tape on the inside. Clean with isopropyl alcohol and spray paint. A paint that adheres well to the roughened epoxy surfaces is “Dupli-colour, perfect match” automotive enamel, available in small spray cans. Canadian Tire stores generally have a good assortment of colours.

Antenna windings

Ferrite antenna windings and connections



There are three windings on the ferrite rod, the resonant circuit, the sense signal coupling winding, and the signal output coupling winding. Use 24 or 26 AWG magnet wire for the windings.

Start by winding the 25-turn resonant circuit winding about 30-35 mm from one end. Leave about 3 cm free on each end of each winding. Hold the start of winding in place with a strip of electrical tape 3 or 4 mm wide by 80 mm long wrapped twice around the rod, and have a second piece ready to secure the end of the winding. Glue the winding in place with Q-dope or Gorilla Glue and allow to harden.

Repeat for the sense coupling winding and the output signal winding, taking care to wind each additional winding in the same direction as for the first.

Recent experiments have shown improved sensitivity if the output coupling winding is made with 6 turns instead of the 3 turns shown on the winding diagram (in earlier versions of the documentation).

Printed Circuit assembly

If necessary, cut the receiver circuit board and the antenna circuit board from the fabrication panel, and trim the receiver circuit board to size so that it fits easily into the receiver compartment of the box.

It is usually easiest to assemble the tiny SMD components in order of size, smallest (resistors, capacitors) first, then add the larger parts after, ending with the headphone jack on the back side. This general suggestion may be ignored if there is enough room around the larger components that the tiny ones can be held in place for soldering. Then, it may be more convenient to work on the board in circuit sections—power switch and audio stage, power supply and LP filter, preamp, mixer and oscillator.

It is important to be very careful soldering the inductors used as it is very easy to remove the solder pads on the inductor, rendering the part unsolderable and useless.

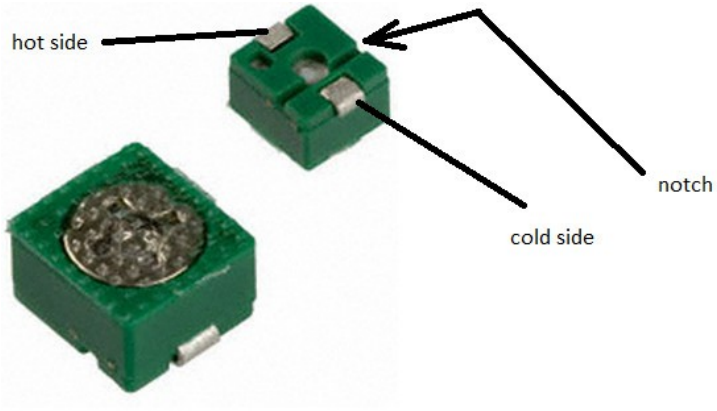
Do not populate C9 and C11 as they are for adjusting the oscillator tuning and often not needed. It is usually easier to modify resistor values (R16 and R17) than capacitance to bring the oscillator to correct tuning range.

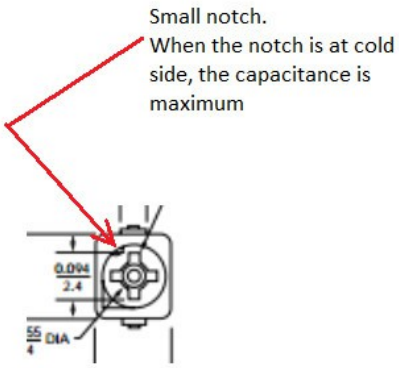
Take care when mounting the headphone jack—there are two small plastic 'feet' that may cause the jack to be not parallel to the PC board if the jack is pressed tightly into the PCB. The feet do align the jack properly if the lead preforms (little kinks in the leads) are allowed to settle properly in the PCB holes. So, either cut the plastic feet off, or just make sure the jack body is parallel to the board before soldering.

Assemble the components on the antenna board in a similar fashion. Take care when installing the 20K potentiometer—the wiper end of the control has exposed metal parts that connect to the wiper pad and are just above two traces on the circuit board, so that a slight clumsiness when soldering the wiper pad may short these exposed parts to the traces.

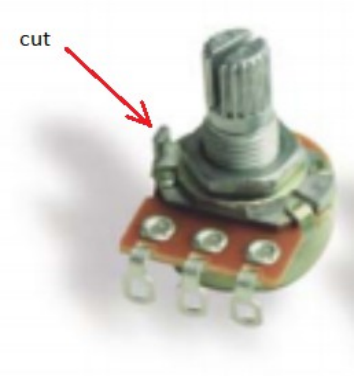
Final Assembly and adjustments

Notes about tuning capacitors CV1 and CV2 (It's been observed that the notch position is not always as shown. If possible, verify with capacitance measurement):





Tuning potentiometer has an anti-rotation tab that I usually cut off:



Prepare the rotary switch by removing 23 mm from the shaft.

Prepare the sense push button by bending the terminals at nearly right angle from axis of switch.

Mount the sense push button first, then the attenuator rotary switch

Prepare the tuning control by soldering three 6 or 7 cm lengths of coloured wire to the terminals, noting which colours correspond to the top, wiper and bottom of the control. Feed the three wires through the hole in the PCB, and solder the free ends to terminals 1, 2 and 3 respectively on the receiver board.

With the tuning control connected, the receiver board may be tested before further assembly if desired. Connect the battery and plug in headphones. When a signal generator is connected between the INPUT terminal and ground on the circuit board, the receiver should be able to hear a signal well below 1 uV. This sensitivity is realized when CV2 is adjusted with an input signal at 3.58 MHz. The preamp tuning may need to be adjusted by changing C15. The preamp tuning peak is quite broad.

The tuning range is set from 3.550 MHz to 3.600 MHz with a few kHz extra at each end. See the tuning range adjustment section below for a suggested procedure for determining R16 and R17.

If the initial tuning range is considerably higher (say above 3.600 MHz) it may be useful to add a small capacitor at C11. 10pF will move the range down by about 85 kHz, 5pF about 50 kHz.

The final adjustment of the tuning range should be left until the receiver is fully assembled into its case.

Feed the free ends of the antenna windings through the soldering holes on the antenna board and arrange the wires and board to fit in the antenna box as shown in figure 10—the antenna board is about in the centre between the box mounting screw and the wire feed through hole and into the box far enough that the tuning capacitor is clear of the cover. When the arrangement is satisfactory, clip the winding leads about 1mm above the board, then scrape the insulation from each lead for about 3 or 4 mm from the end. Replace the board on the windings and solder the winding ends in place.

Mount the sense antenna connector into the box. The insulating washer that goes into the mounting hole from the inside needs to have the two anti-rotation tabs removed. The star lock washer may not be able to be used since it adds enough thickness that the securing nut may not catch. The thickness of the PCB material is greater than the original case the hardware came from.

Next install the antenna rod assembly. Spot solder the board to the side of the antenna box. The board will hold the rod in place well enough to complete the overall receiver testing. Gluing the rod into the box with epoxy can be done after that checkout.

Next install the receiver board: Connect battery terminal(s), mount the tuning pot, place the board in position and spot solder a ground tab to the box. It may be helpful to solder a length of wire on each side of the receiver compartment near the top corners to hold the receiver board's input edge at the same height as the headphone jack holds the bottom edge.

Wire the board's interconnections:

- from the antenna board sense input to sense antenna connector,
- from the antenna board to the sense switch,
- top of sense switch to 9V output on receiver board,
- top of sense switch (9V) to 9V input on antenna board,
- bottom of sense switch to sense switch input on antenna board,
- antenna board signal output to top common terminal of attenuator switch,
- bottom common terminal of attenuator switch to receiver board INPUT,
- attenuator switch position 1 input section to position 1 output section.

The receiver can now be fully checked out and the tuning range setup performed before adding the rest of the attenuator resistors or more solidly soldering the boards in place.

Setting up receiver tuning range

1. Determine the tuning range with the schematic component values (omit C11, C9, R16 = 10K, R17 = 4.7K). Example1: 3550 3620

2. Adjust R17 so that bottom end is about 3540. Example1: R17 changed to 3.3K

Adjustment may be complete with step 2 (Example1)

3. If the top end is greater than approximately 3610, the tuning range span needs to be reduced. Set signal generator to 3610 and tune Rx to that frequency. Measure the voltage at wiper of RV2 - 2 on PCB. (Example2 3.05V) This voltage is the target value to be at the top of RV2 + R17, so R16 needs to be increased. The voltage divider made of R16 and RV2+R17 can be used to calculate a good estimate of the required resistance:

$$\frac{(25K + R17) \times 5V}{25K + R17 + R16} = 3610 \text{ voltage}$$

For example2: R17 = 3.3K, 3610 voltage = 3.05V

$$\frac{28.3 \times 5}{3.05} = 46.4; \quad R16 = 46.4 - 28.3 = 16.1K$$

Some receivers have been observed to drift UP with decrease in temperature. Consequently, the tuning range adjustment should ensure that the bottom end of the tuning range (pot at stop) is no higher than 3545.

Front end tuning and sense antenna gain setting

To adjust the resonant circuit and sense amplifier of the antenna, you need a temporary cover for the antenna box which has two holes over the tuning capacitor CV1, and the sense amplifier gain control RV1. A suitable cover could be made from the remainder of the 30 mm PCB strip, or a scrap of sheet metal.

CV1 could be adjusted using a signal generator coupled to the rod with a loop of wire in series with a 50 ohm resistor (to terminate the signal generator output) across the end of a length of coax from the signal generator. It can also be adjusted with a fox signal outdoors, and this outdoor arrangement may be best since the sense antenna gain needs to be adjusted in this way.

Peak CV1 at mid-band (3.780 MHz). If using a signal generator, you should be able to hear signals below 1 uV.

With the receiver facing AWAY from the fox, and at a distance that you can hear a deep null off the end of the antenna rod, push the sense amplifier switch and adjust the gain for a null in the received signal.

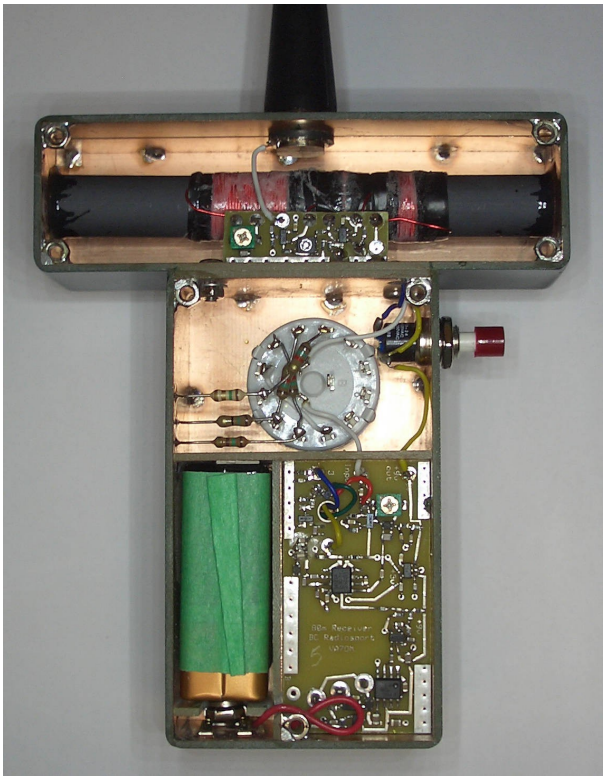


Figure 10 completed assembly, covers removed

The receiver example shown in figure 10 has been constructed with a slide-in battery connector where the spring contacts have been mounted on the inside of the bottom plate. The connector construction is shown in figure 10a.

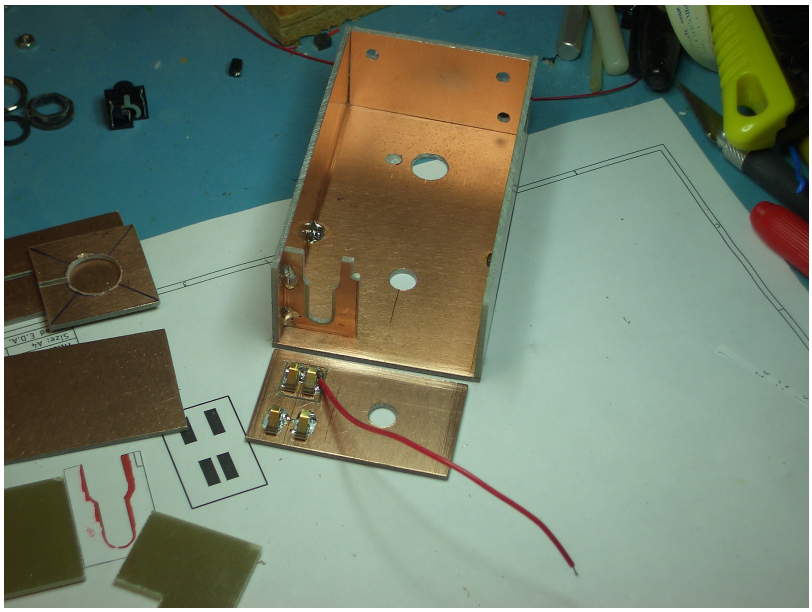


Figure 10a—slide-in battery connector

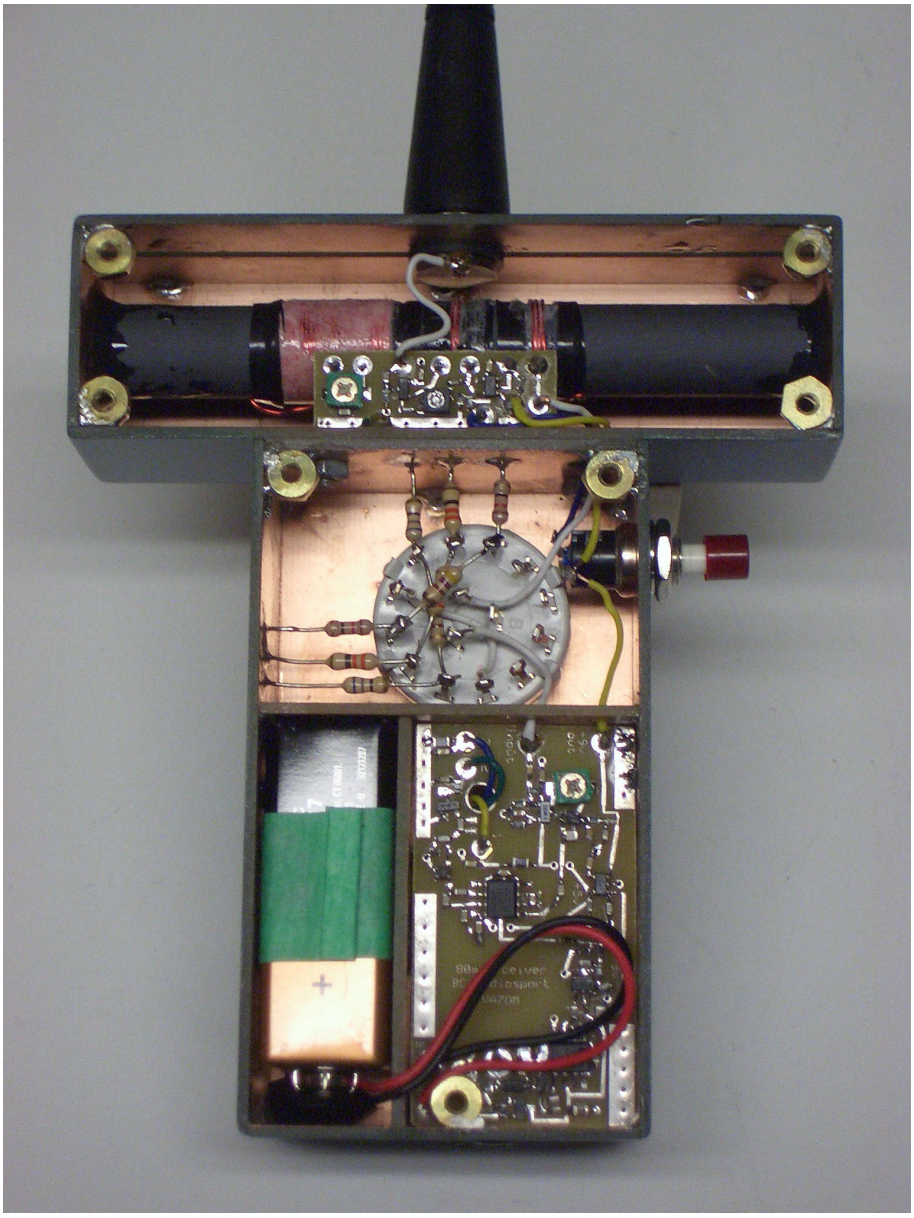


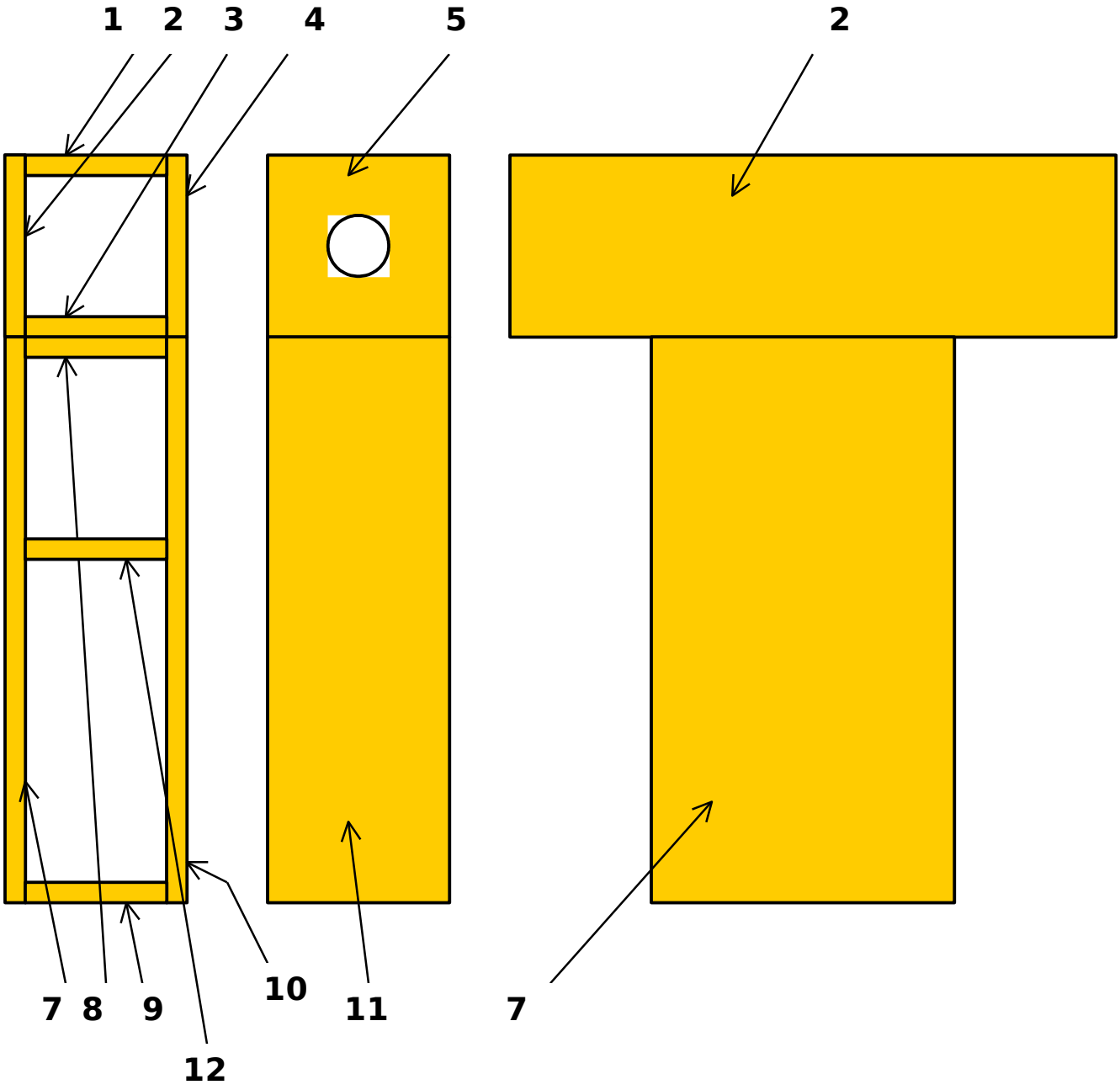
Figure 10b Completed receiver with battery snap connector

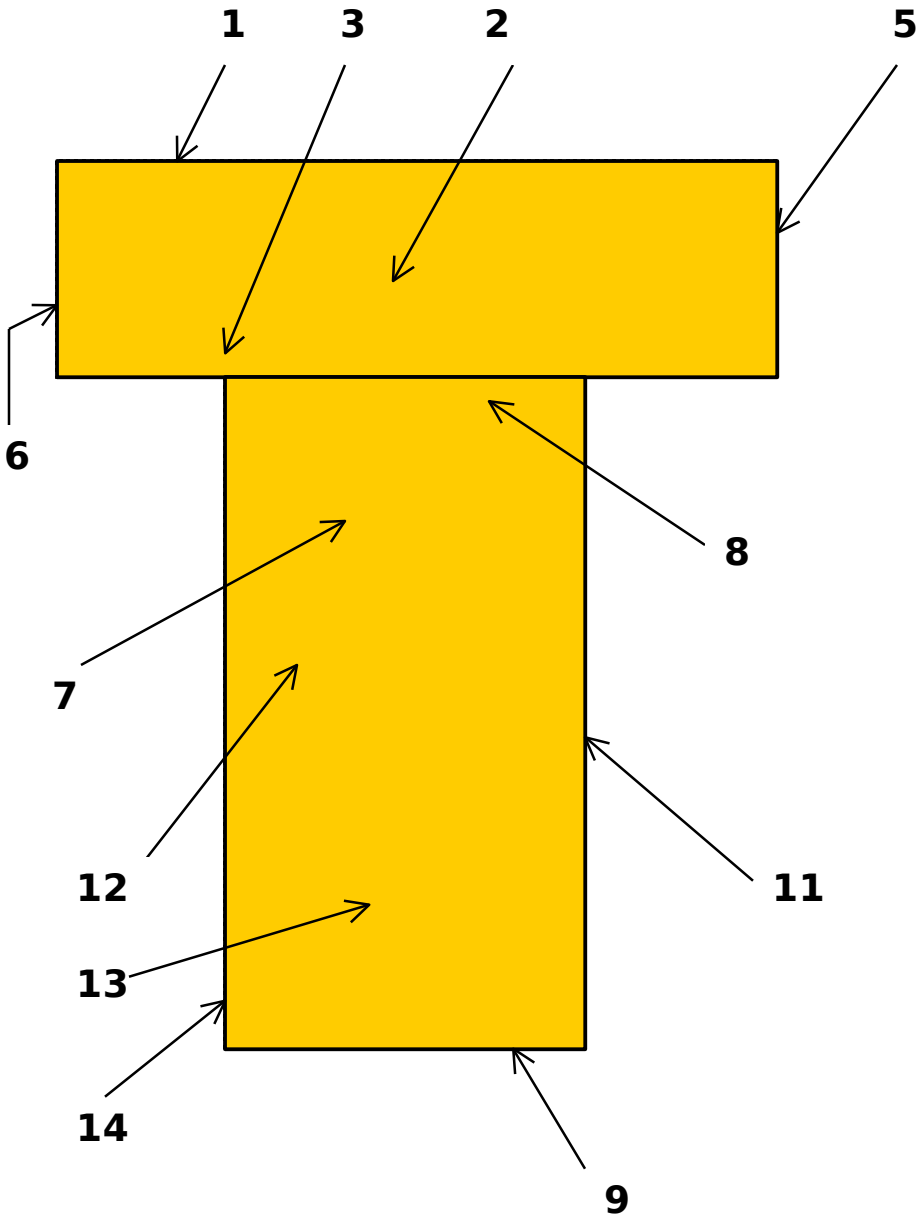
Figure 11 completed assembly, front panel

Figure 12 Receiver in operation

Dimensions

Not to scale




1
3
2
5
6
8
7
12
11
13
14
9

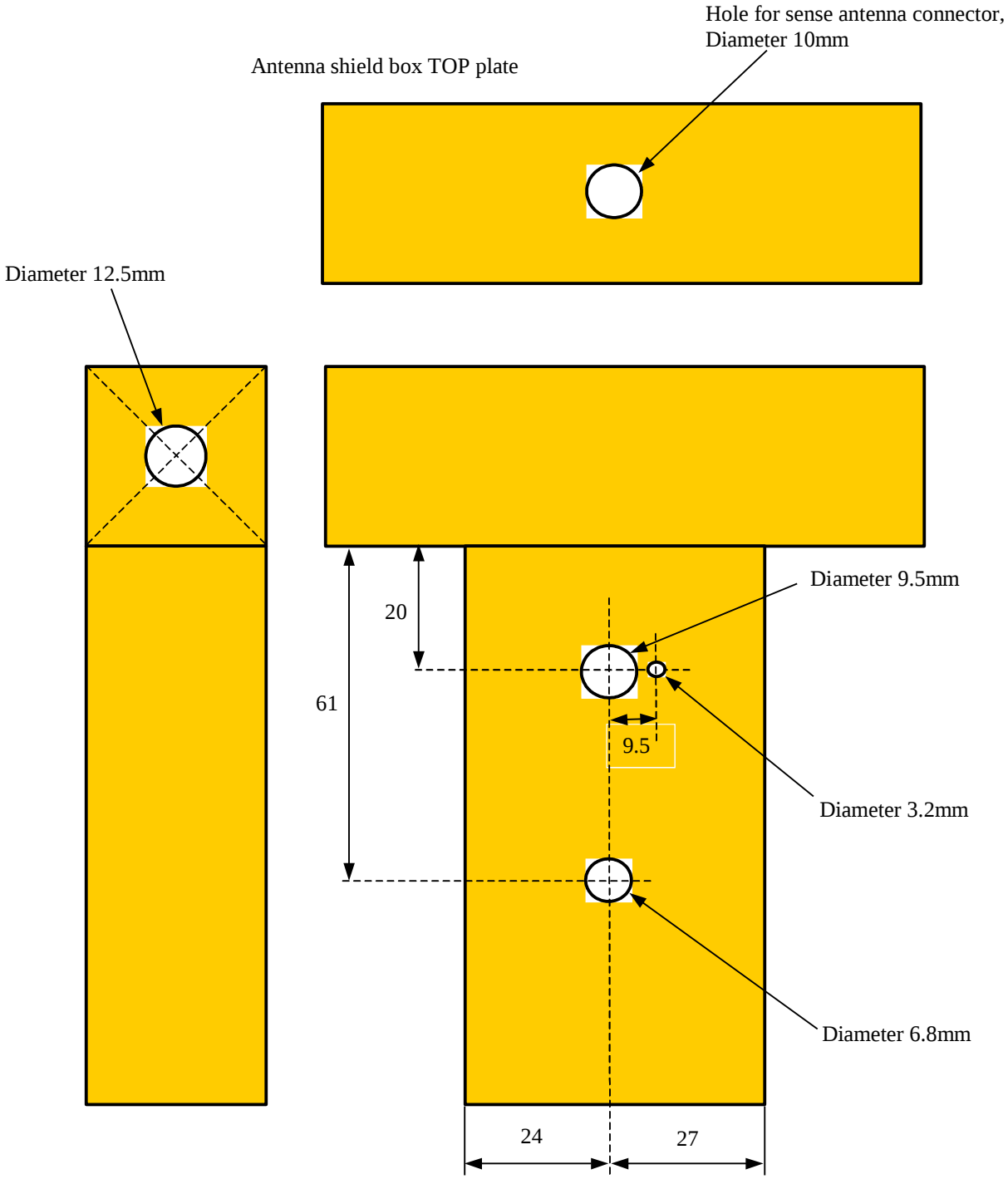
Dimensions are in millimetres

1 *****	Ferrite Antenna Cover – Top	27 x 100	Drill 10mm hole in the centre for sense antenna
2 *****	Ferrite Antenna Cover – Front	30 x 100	
3 *****	Ferrite Antenna Cover – Bottom	27 x 100	
4 *****	Ferrite Antenna Cover – Back30 x 100		
5 ******	Ferrite Antenna Cover – Right	27 x 27	Drill 0.5” hole for Ferrite Antenna
6 ******	Ferrite Antenna Cover – Left	27 x 27	Drill 0.5” hole for Ferrite Antenna
7	Front	51 x 88	
8	Top	27 x 48	
9	Bottom	27 x 48	
10	Back	51 x 88	
11	Side (Right)	27 x 88	
12	Shield	27 x 48	
13	Battery Holder	27 x 51	
14	Side (Left)	27 x 88	

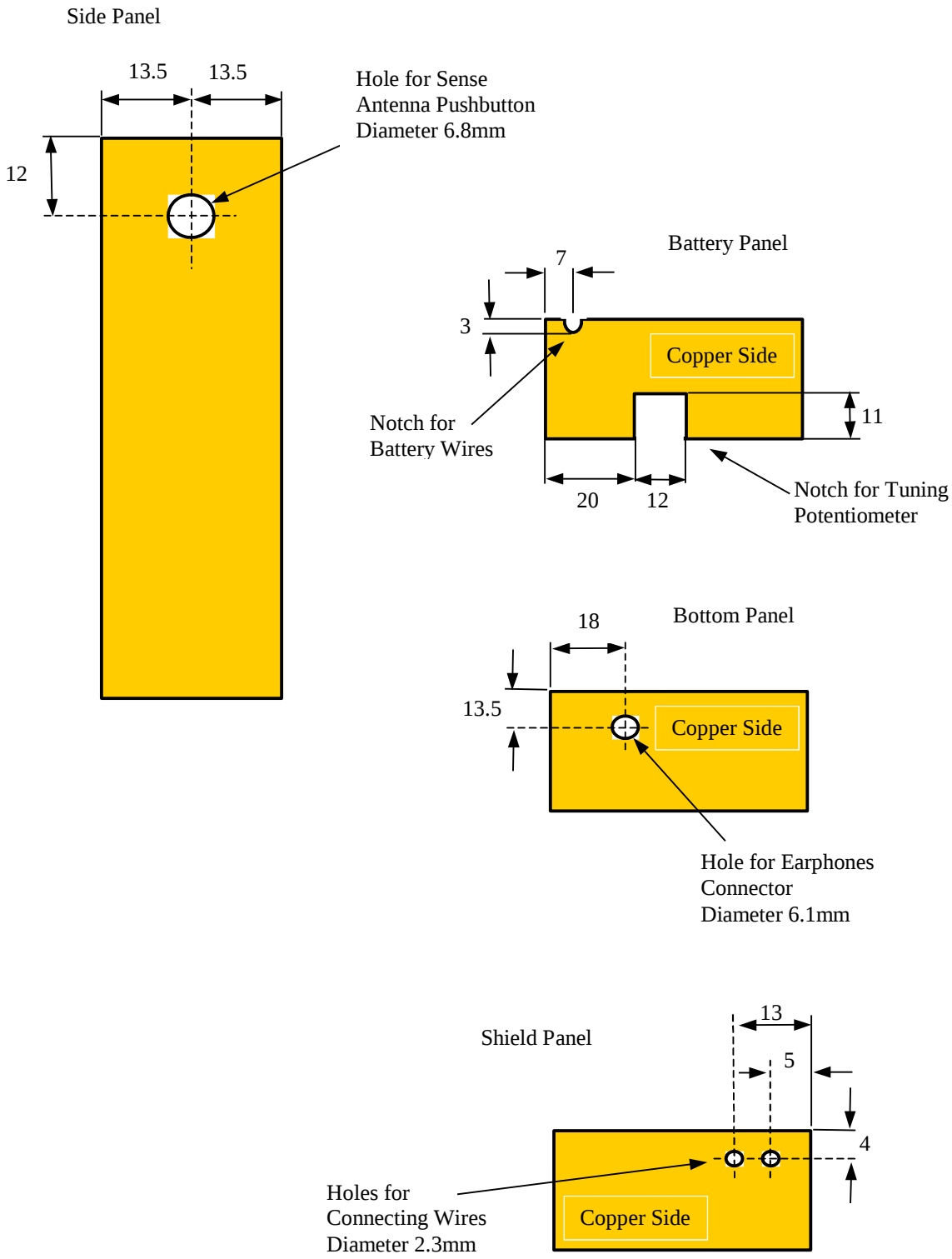
*** if using shock-mounted antenna, pieces 1, 2, 3, and 4 are each 111 mm long—see Appendix B**

**** Do not drill 0.5” holes if using shock-mount antenna.**

Not to scale

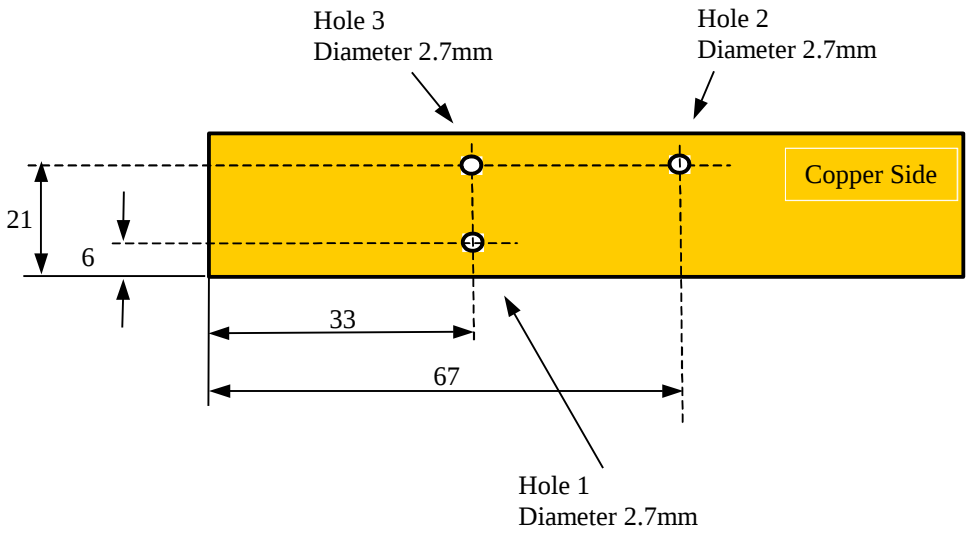

Hole for sense antenna connector,
Diameter 10mm
Antenna shield box TOP plate
Diameter 12.5mm
20
61
Diameter 9.5mm
9.5
Diameter 3.2mm
Diameter 6.8mm
24
27

Not to scale

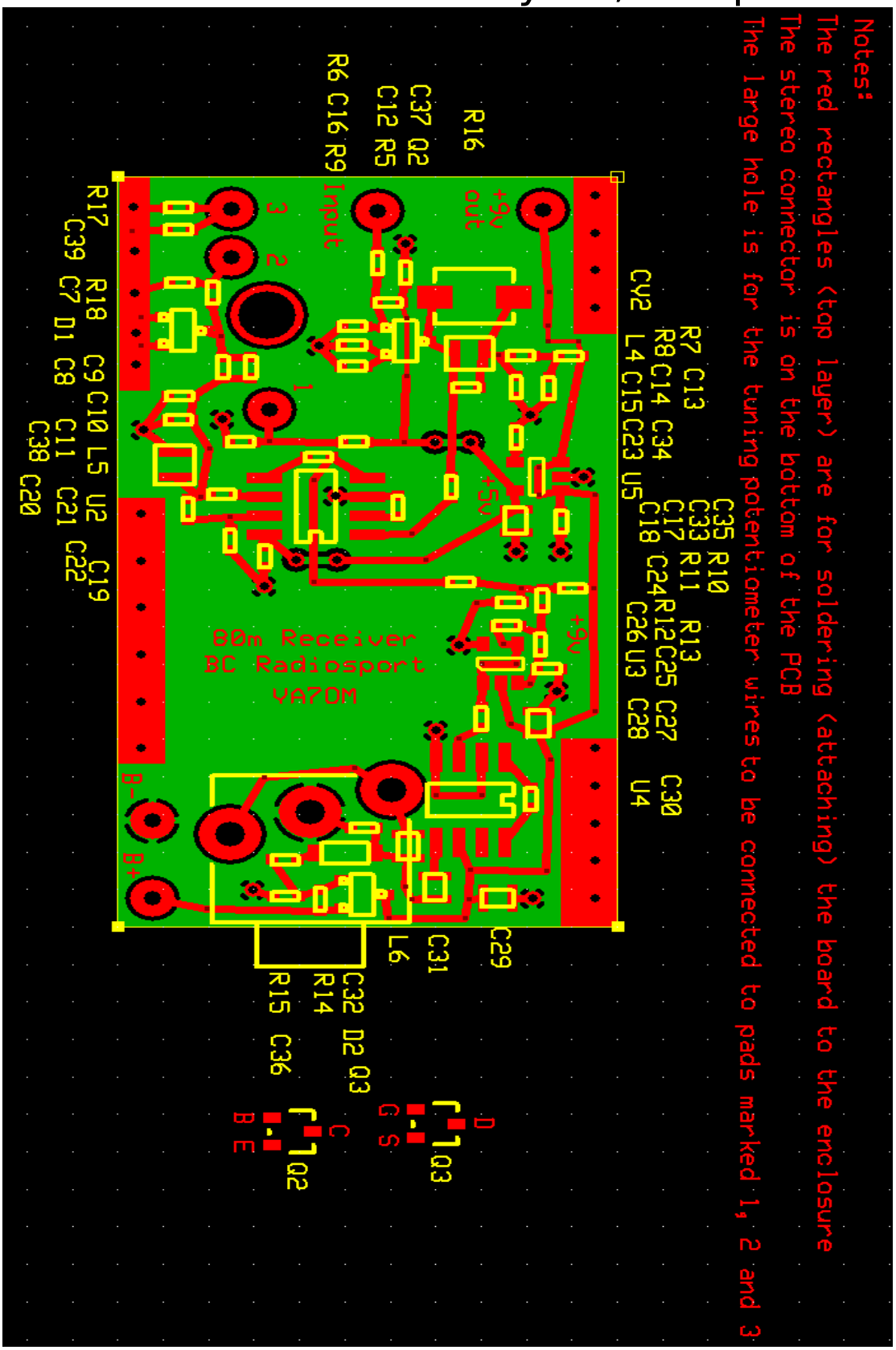

Side Panel
13.5
13.5
12
Hole for Sense
Antenna Pushbutton
Diameter 6.8mm
Battery Panel
7
3
Copper Side
11
Notch for
Battery Wires
20
12
Notch for Tuning
Potentiometer
Bottom Panel
18
13.5
Copper Side
Hole for Earphones
Connector
Diameter 6.1mm
Shield Panel
13
5
4
Holes for
Connecting Wires
Diameter 2.3mm
Copper Side

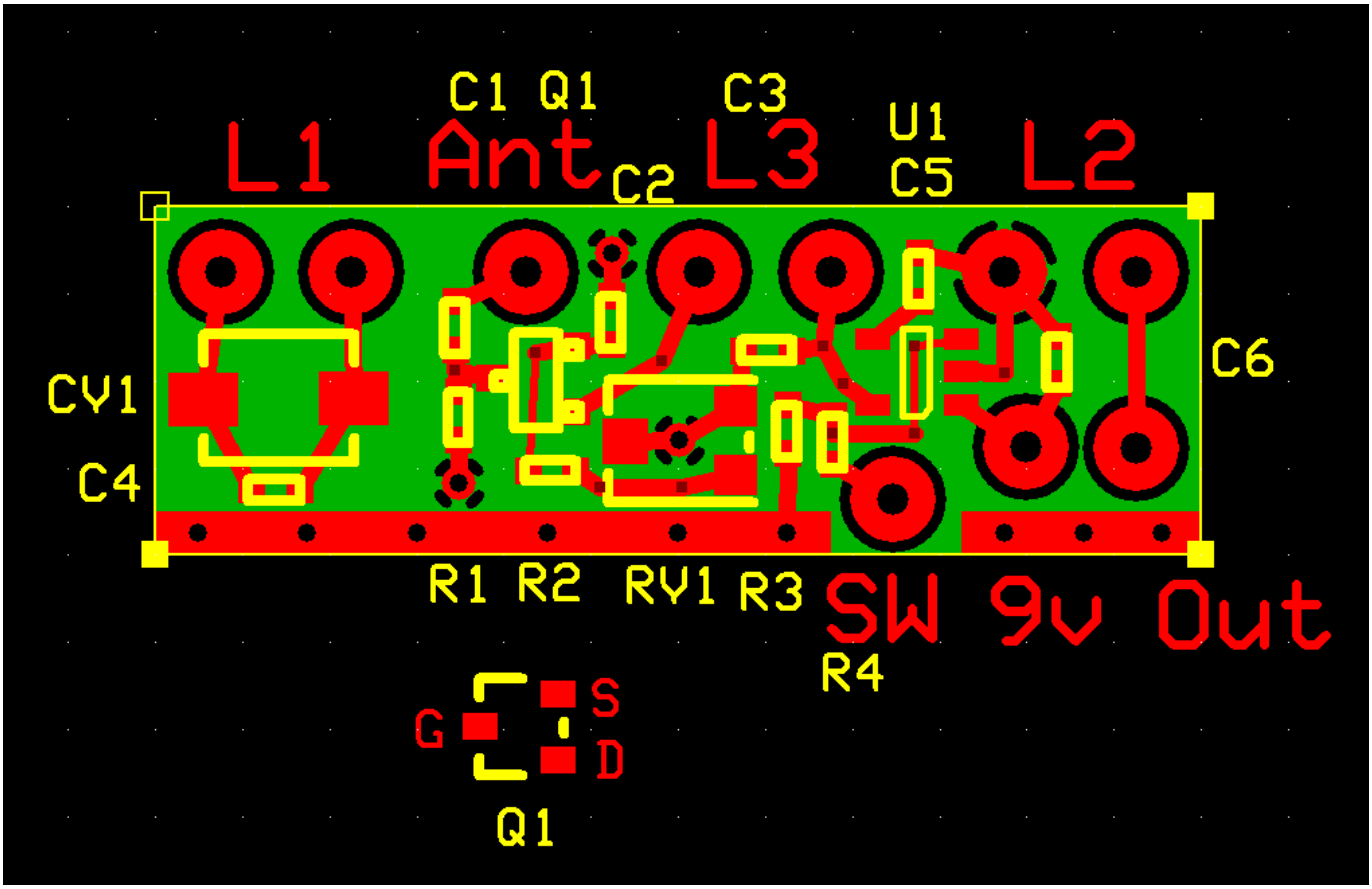
Not to scale

Ferrite Antenna Cover - Bottom

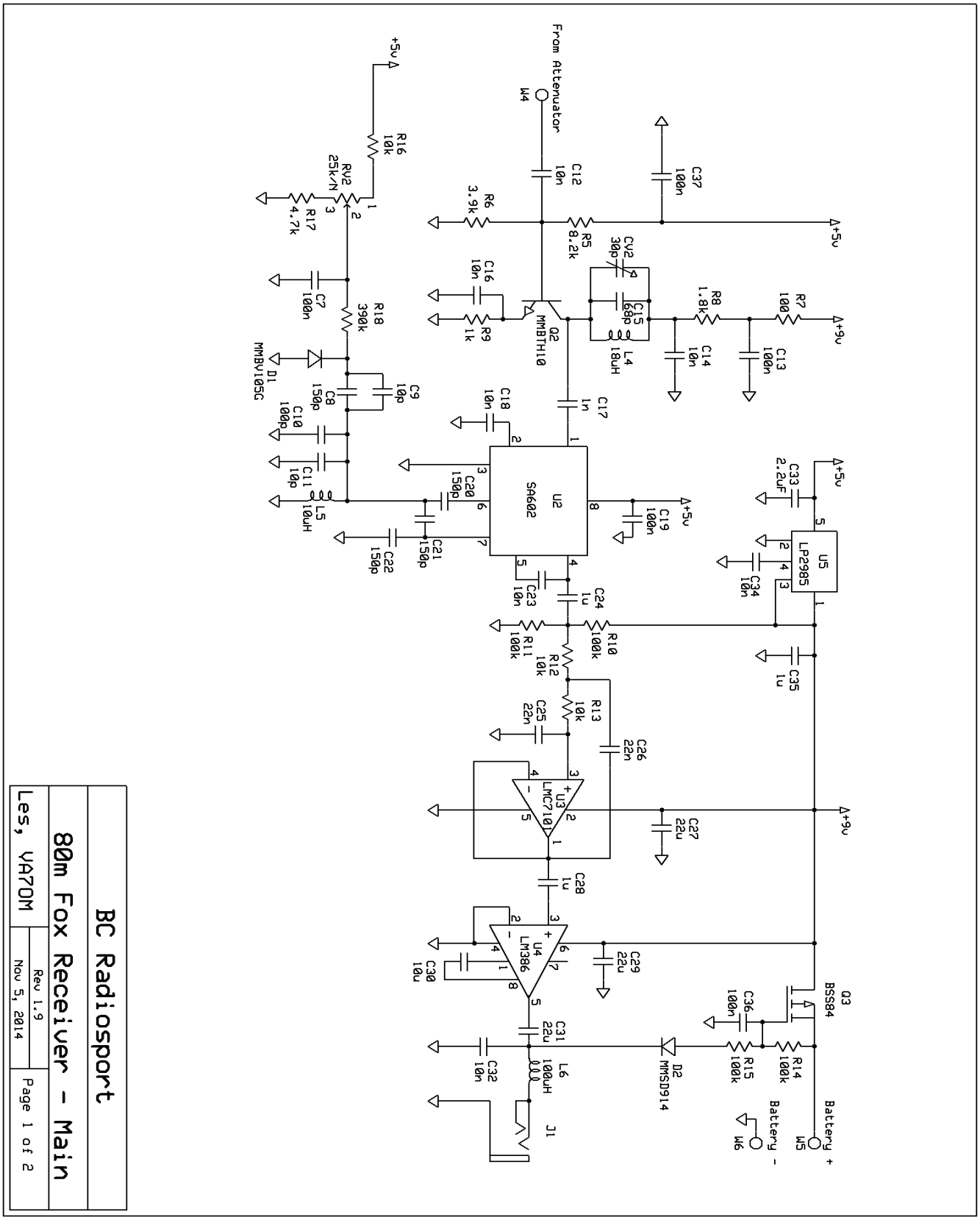


Printed Circuit boards layout, component locations




C1 Q1
C3
U1
C5
L1
Ant
C2
L3
L2
CV1
C6
C4
R1 R2 RV1 R3
SW 9v Out
R4
S
G
D
Q1

Schematic


BC Radiosport
80m Fox Receiver - Main
Les, VA7OM
Rev 1.9
Nov 5, 2014
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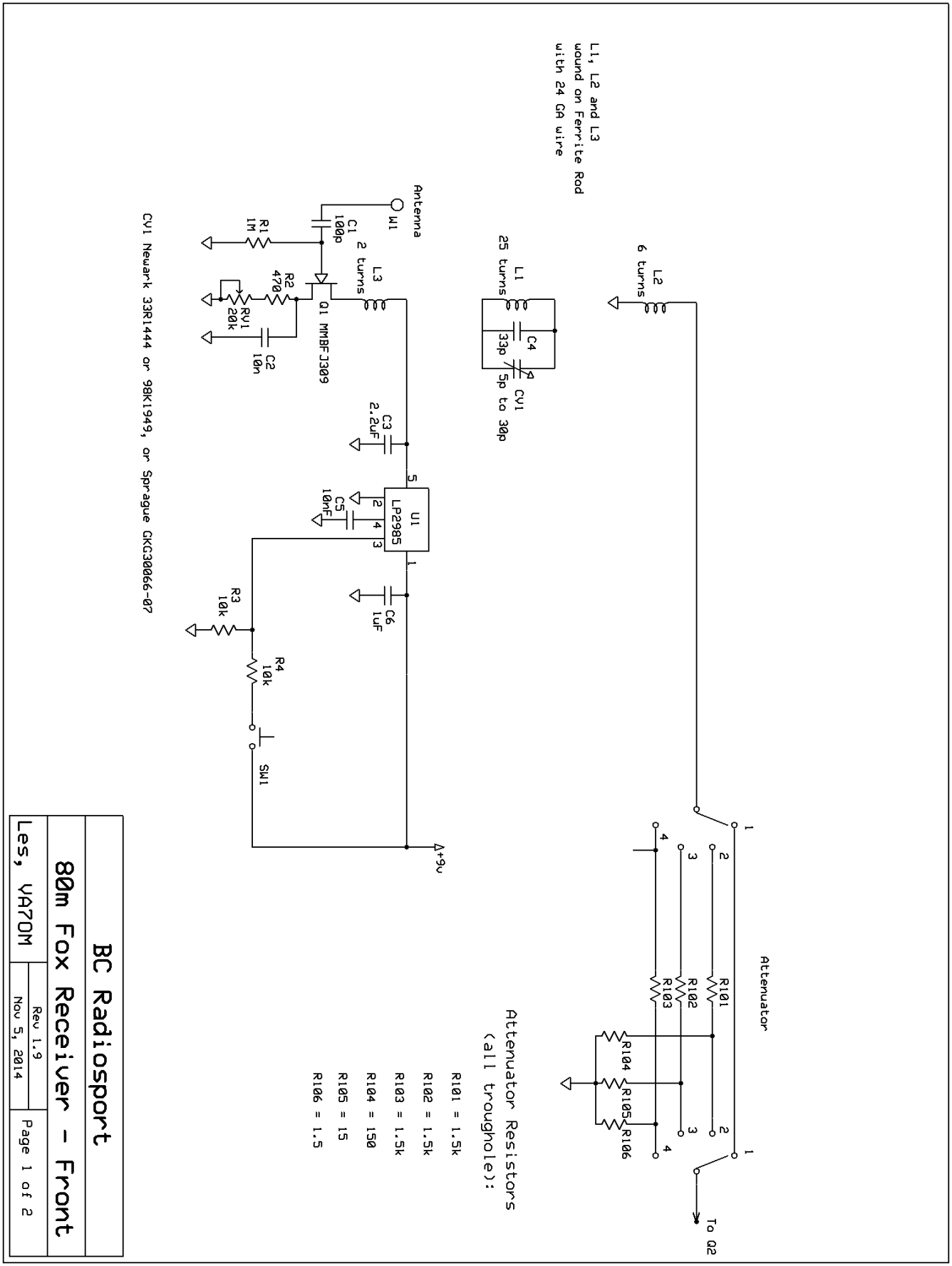
L1, L2 and L3
wound on Ferrite Rod
with 24 GA wire
L2
6 turns
L1
25 turns
C4
33p
CV1
5p to 30p
Antenna
W1
C1
100p
2 turns
L3
R1
1M
R2
470
RV1
20k
C2
10n
Q1 MMBFJ309
C3
2.2uF
U1
LP2985
C5
10nF
C6
1uF
R3
10k
R4
10k
SW1
+9v
Attenuator
R101
R102
R103
R104
R105
R106
To Q2
Attenuator Resistors
(all troughole):
R101 = 1.5k
R102 = 1.5k
R103 = 1.5k
R104 = 150
R105 = 15
R106 = 1.5
CV1 Newark 33R1444 or 98K1949, or Sprague GKG30066-07
BC Radiosport
80m Fox Receiver - Front
Les, VA7OM
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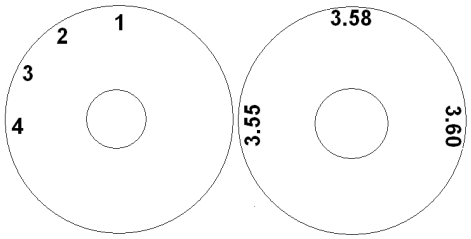
Bill of Materials

	Part Number	Description
U1	LP2985-50DBVR	LDO VOLT REG, 5V, 150mA, 5-SOT-23
U2	SA602D	MIXER/OSC DOUBLE-BALANCE, 8SOIC
U3	LMC7101	OP-AMP, SOT-23-5
U4	LM386MX-1	AUDIO PWR AMP, SOIC-8
U5	LP2985-50DBVR	LDO VOLT REG, 5V, 150mA, 5-SOT-23
D1	MMBV105G	VARICAP DIODE, SOT-23
D2	MMSD914	SMALL SIGNAL DIODE 100V 200mA SOD-123
Q1	MMFBJ309	N CHANNEL JFET, -25V, SOT-23
Q2	MMBTH10	VHF/UHF BIPOLAR TRANSISTOR, NPN, 25V
Q3	BSS84-7-F	MOSFET, P CH, -50V, 1.2OHM, -130mA, SOT-23-3
C1	100pF	0603, NPO
C2	10nF	0603
C3	2.2uF	0603, 10V, Ceramic
C4	33pF	0603, NPO
C5	10nF	0603
C6	1uF	CERAMIC, 16V, 0603
C7	100nF	0603
C8	150pF	0603, NPO
C9	10pF	0603, NPO
C10	100pF	0603, NPO
C11	10pF	0603, NPO
C12	10nF	0603
C13	100nF	0603, NPO
C14	10nF	0603
C15	68pF	0603, NPO
C16	10nF	0603
C17	1nF	0603
C18	10nF	0603
C19	100nF	0603, NPO
C20	150pF	0603, NPO
C21	150pF	0603, NPO
C22	150pF	0603, NPO
C23	10nF	0603
C24	1uF	CERAMIC, 16V, 0603
C25	22nF	0603
C26	22nF	0603
C27	22uF	CERAMIC, 10V, X5R, 0805
C28	1uF	0603, 16V, ceramic
C29	22uF	CERAMIC, 10V, X5R, 0805
C30	10uF	CERAMIC, 10V, X5R, 0603
C31	22uF	CERAMIC, 10V, X5R, 0805
C32	10nF	0603
C33	2.2uF	0603, 10V, Ceramic
C34	10nF	0603
C35	1uF	CERAMIC, 16V, 0603
C36	100nF	0603, NPO
C37	100nF	0603, NPO
CV1	5pF - 30pF	VARIABLE CAP, 5mm, SMD, GKG30066-07
CV2	5pF - 30pF	VARIABLE CAP, 5mm, SMD
R1	1M	0603
R2	470	0603
R3	10k	0603
R4	10k	0603

R5	8.2k	0603
R6	3.9k	0603
R7	100	0603
R8	1.8k	0603
R9	1k	0603
R10	100k	0603
R11	100k	0603
R12	10k	0603
R13	10k	0603
R14	100k	0603
R15	100k	0603
R16	10k	0603
R17	4.7k	0603
R18	390k	0603
R101	1.5k	throughole
R102	1.5k	throughole
R103	1.5k	throughole
R104	150	throughole
R105	15	throughole
R106	1.5	throughole
FA	R61-050-400	FERRITE ANTENNA
L1		25 TURNS ON FERRITE ROD, 24 GA
L2		3 TURNS ON FERRITE ROD, 24 GA
L3		2 TURNS ON FERRITE ROD, 24 GA
L4	18uH	INDUCTOR, 18UH, 150mA, 5%, 18MHz ,SMD
L5	10uH	INDUCTOR, 10UH, 215mA, 5%, 27MHZ, SMD
L6	100uH	INDUCTOR, 100UH, 80mA, 5%, 9MHZ, SMD
RV1	20k	POT 3mm CARBON TRIM SMD, EVN-5ESX50B24
RV2	25k	POT ROTARY, 25KOHM, LIN, 16MM, 20%, 200mW
SW1	SWITCH	PUSHBUTTON, SPST, 3A, 250V, OFF-(ON)
SW2	SWITCH	ROTARY SWITCH, 4, 30°, 150MA, 250V
K1	KNOB, SENSITIVITY, PKES70B1/4	FLUTED KNOB WITH LINE INDICATOR, 6.35MM
K2	KNOB, VFO, PKES70B1/4	FLUTED KNOB WITH LINE INDICATOR, 6.35MM
PCB		MAIN PCB AND SMALL PCB IN ANTENNA DEPT
BARE PCB	BARE PCB FO ENCLOSURE	12X12WEC1 BARE PCB NO HOLES - PLANE SINGLE SIDED
Bat Strap	BATTERY STRAP	BATTERY STRAP, 9V, WIRE LEAD
EARBUDS		3.5mm EARPHONE EARBUDS
J1	EARPHONE SOCKET	SOCKET, 3.5MM JACK, PCB, STEREO
Sense Antenna		
Sense Antenna Connector		

Dial labels

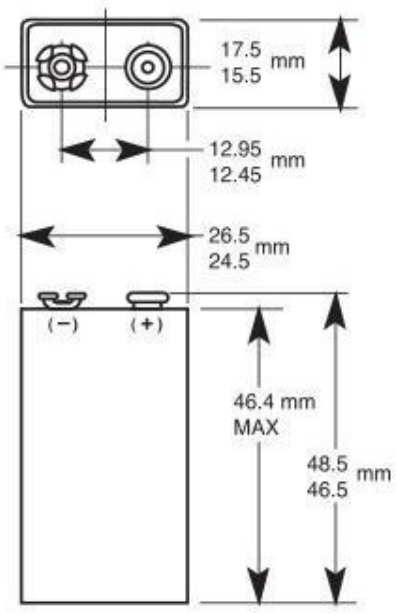


Appendix A – Slide-in battery connector

To avoid using the snap connectors for 9V battery, contact can be made via spring fingers soldered to the bottom wall of the receiver case, as shown in photo figure 10a, and using the layout pattern in figure A3 below. The positive connection fingers are isolated from the rest of the bottom wall by cutting the copper foil to form an island around the spring contacts. A 5 or 6 cm length of wire makes the positive connection to the receiver PCB.

An additional piece of PCB is used to form a 'polarity plate' which has a stepped slot that allows the battery to be inserted only one way. The slot is constructed by drilling two holes that allow the terminals of the battery to compress the spring contacts, then cutting out the back sides of the holes. Finally, the slot edges should have a millimetre or so of the foil removed to eliminate any chance of shorting the battery terminals.

The dimensions for the slot shown below acknowledge (some) of the variation permitted by the IEC dimension specification for the MN1604 9V battery shown in figure A1. Since there are substantial tolerances to the dimensions, some fine adjustment with filing may be needed for the particular battery you prefer.



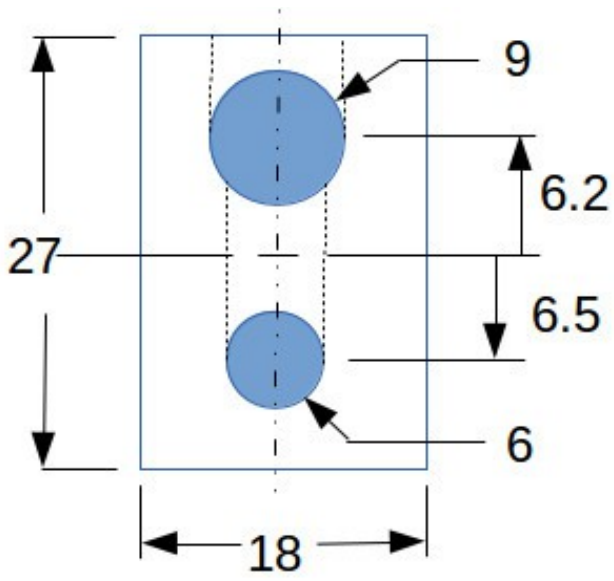


Figure A1 – IEC 9V battery size ***Figure A2 – polarity slot dimensions***

The polarity slot is soldered into the receiver case before soldering in either the bottom wall, battery side wall, or shield wall. It is located so that there is a 4mm space between the bottom face of the plate and the inside of the bottom wall. That is, at 5.5 mm from the bottom edge of the front and side panels.

As seen in Figure 10a, it's suggested to first tack solder the polarity plate to the side, then adjust the alignment to ensure it is square with the bottom edge of the front panel, tack to the front. Then, the battery side wall can be tacked to the front while held tight against the polarity slot which ensures that the wall is exactly 18 mm from the side. Align the battery side wall so it's square with the front panel bottom edge (or parallel with the side, 18mm all along) and tack solder it to the front. Then install the shield plate by first tacking it to the battery side wall, then square it up with the sides and tack it to the front and sides. Keep the solder filets in the receiver board compartment near the middle of the walls so that the receiver board is not prevented from sliding in. Finally, the box bottom plate can be soldered in place.

A suggested method for locating the spring contacts is to print out Figure A3, place it carefully aligned on the bottom panel next to the copper foil on the battery box side, then use a pin or similar sharp point to mark the corners of each pad. It might be necessary to adjust the print scaling to get the size exactly 18 mm by 27 mm. If the size slightly wrong, aligning the centre line between the pads with a centre line on the bottom (9 mm from edge of battery side) is generally a better method to locate the contacts so that they touch the edges of the battery contacts.

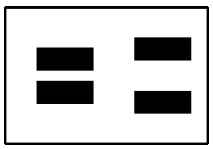


Figure A3 – connector pads, actual size

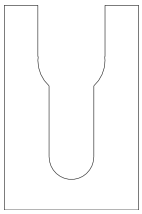


Figure A4 – slot, actual size

Appendix B – Shock Mounting for ferrite antenna

An alternate method of mounting the ferrite rod antenna has been devised where the rod is supported on each end with a silicone rubber casting. The casting material is one of several two-part silicone rubbers used for mold-making. The particular material used here is “Dragon Skin 10 Slow” made by Smooth-on. Information about this material (and several others) is available at www.smooth-on.com.

In this case, the material properties of the silicone rubber itself are used, rather than using the rubber to make a mold of some object. To fabricate the shock mount, a mold is made with 1/8” acrylic sheet as shown below. A short piece of 1/2” dowelling is suspended in the liquid rubber to form the blind mounting hole for the rod, leaving about 4 mm of rubber to isolate the rod ends from the box. The mold also has two small squares of acrylic glued inside to form clearance cutouts for the antenna box cover nuts. The dowel piece shown is wood, but 1/2” acrylic rod would be much easier to unmold.

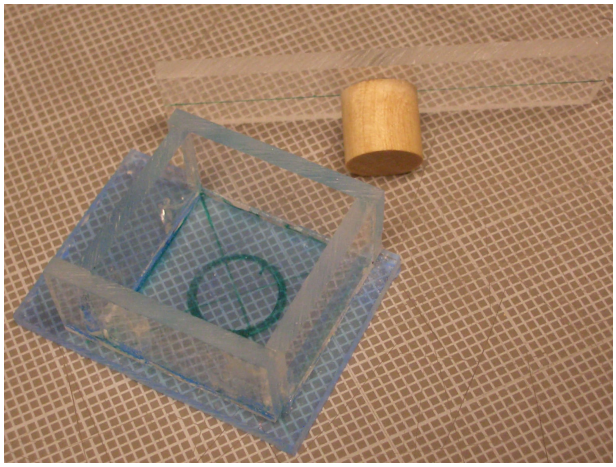


Figure B1 – shock-mount mold

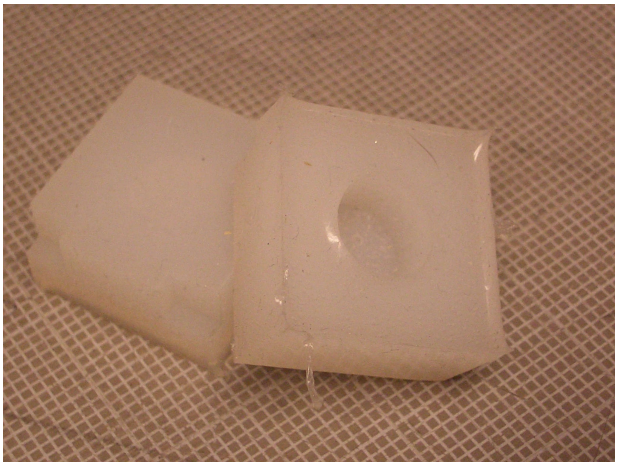


Figure B2 – silicone rubber casting

Modifications required to the PCB box pieces

With the antenna rod mounted entirely inside the antenna box, the box length must be adjusted: each of pieces 1, 2, 3, and 4 are made 111 mm long (instead of 100 mm). This extra length is made up of two PCB thicknesses (3 mm), plus the two 4 mm rubber end isolations (8 mm).

The two 27 X 27 mm end pieces do not have holes drilled, but the magnetic break in the conductive foil is extended across the whole width. See figure B3.

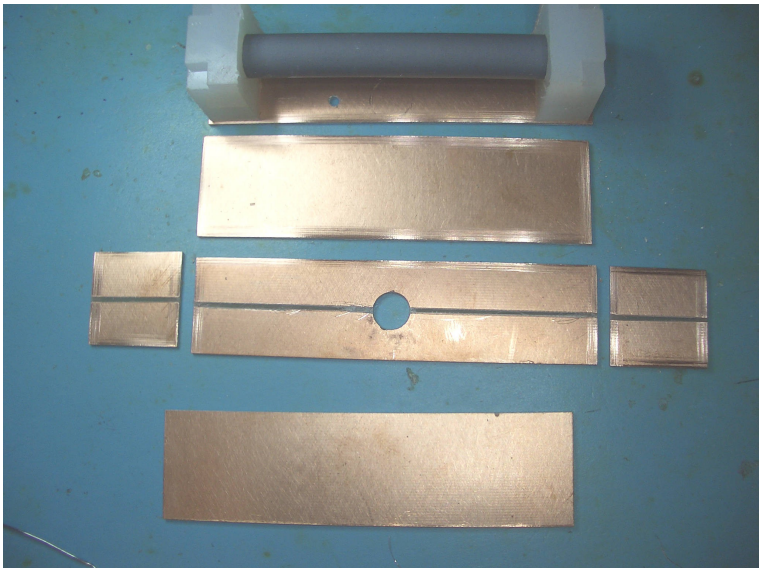


Figure B3 – Antenna box pieces preparation

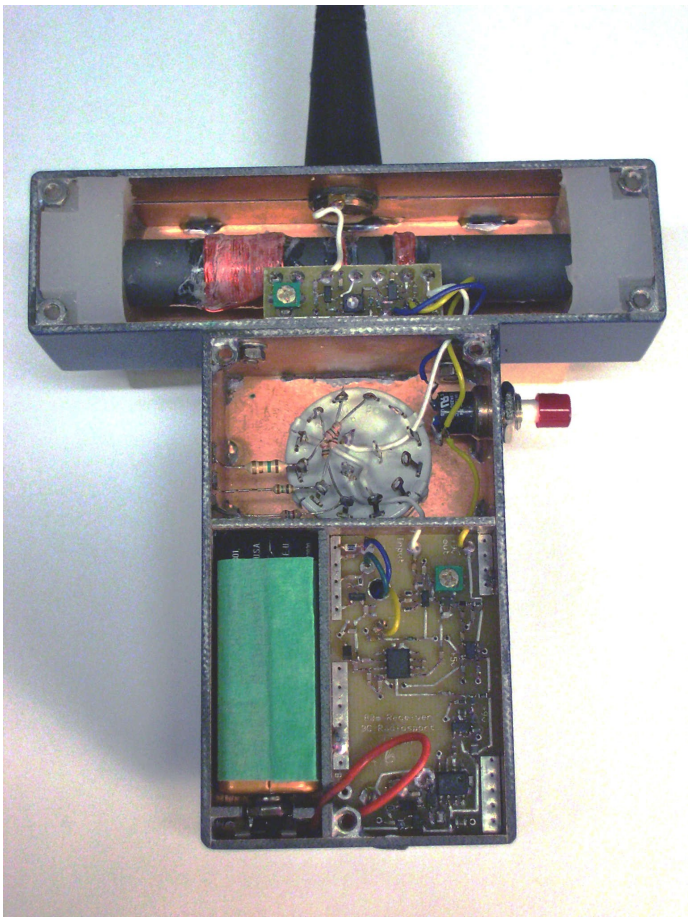


Figure B4 – completed assembly with shock-mounted antenna