ARDF RECEIVER VT3
BUILD MANUAL

IMPORTANT
See below for changes from previous versions that may have been published on media elsewhere.

1. TRANSFORMER L1
Winding ratio changed for increased gain
1.1 Revised to 10t:10t
1.2 C20 56pF, added to primary winding.

2. OSCILATOR
2.1 Change C9 and C10 values. Revised values reduce the oscillator amplitude variation when tuning across the band, and increases the amplitude at the high frequency end.

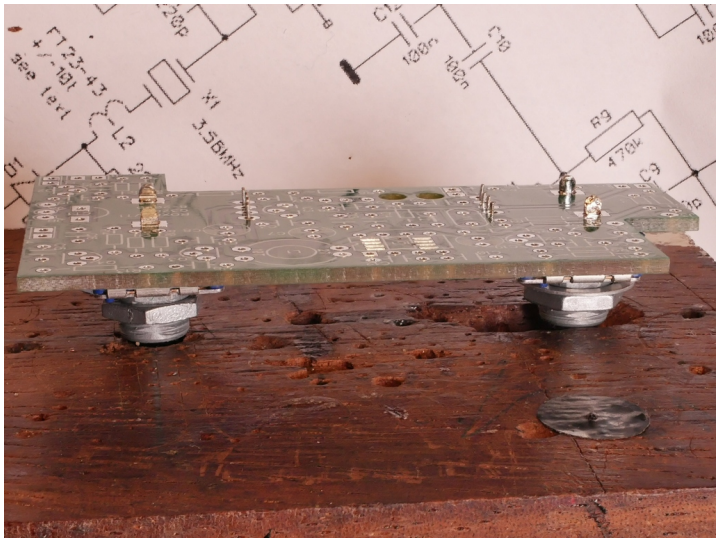
4 ANTENNA ROD WINDINGS.
4.1 Changed to 4t:24t:2t (non critical)

The component numbering has been revised (compared to VT1)

The adjustment of the upper tuning range is set by a preset trimmer resistor (see text)

The position of the frequency control pot, the LED and phone socket has been revised. (please refer to revised hole position diagram).

BUILDING TIP
Find a block of wood, similar to the size of the enclosure, and drill two holes, 6mm diameter, at least 10mm deep, spaced 44mm apart. The PCB, with the pots fitted, allows the shafts placed in the holes. Helps when testing and assembling the board.



1 Introduction

ROX80 is a small simple 80m direct conversion receiver designed be used in the classic (international) type of ARDF. These are pedestrian ARDF events where the distance from a 1-3watt transmitter not likely to be greater the 3 km. However the receiver is sensitive enough to monitor more distant transmissions where propagation conditions are favourable.

The VXO uses a 3.58MHz resonator which is pulled to give a tuning range of 3.51MHz to 3.6MHz. This provides a very high degree of frequency stability.

Specifications

Power suppy: 9v from a PP3 battery
Target frequency coverage: 3.51 to 3.60 Mhz
Static current: 16mA
Sensitivity:* better than 1uV (-107 dBm), typically -118.5 dBm for a 3dB Signal to Noise ratio.
Sense - front to back ratio:* up to 17db with short or internal antenna only.

* measurements thanks to Tim Raven G4ARI

POPULATING THE PCB notes

NB: All holes are through plated. Avoid misplacing components or filling solder holes accidentally. They are not always easy to de-solder.

RESISTORS
Lead-outs bent for 10mm (0.4") hole spacing.

X1& L2. Do not initially solder (see notes on resonator choice and the tuning range)

CAPACITORS
All 5mm (0.2") lead-out spacing.
Electrolytic capacitors - negative lead shown shaded on PCB
C18 100uF should be bipolar/ non-polarized type.

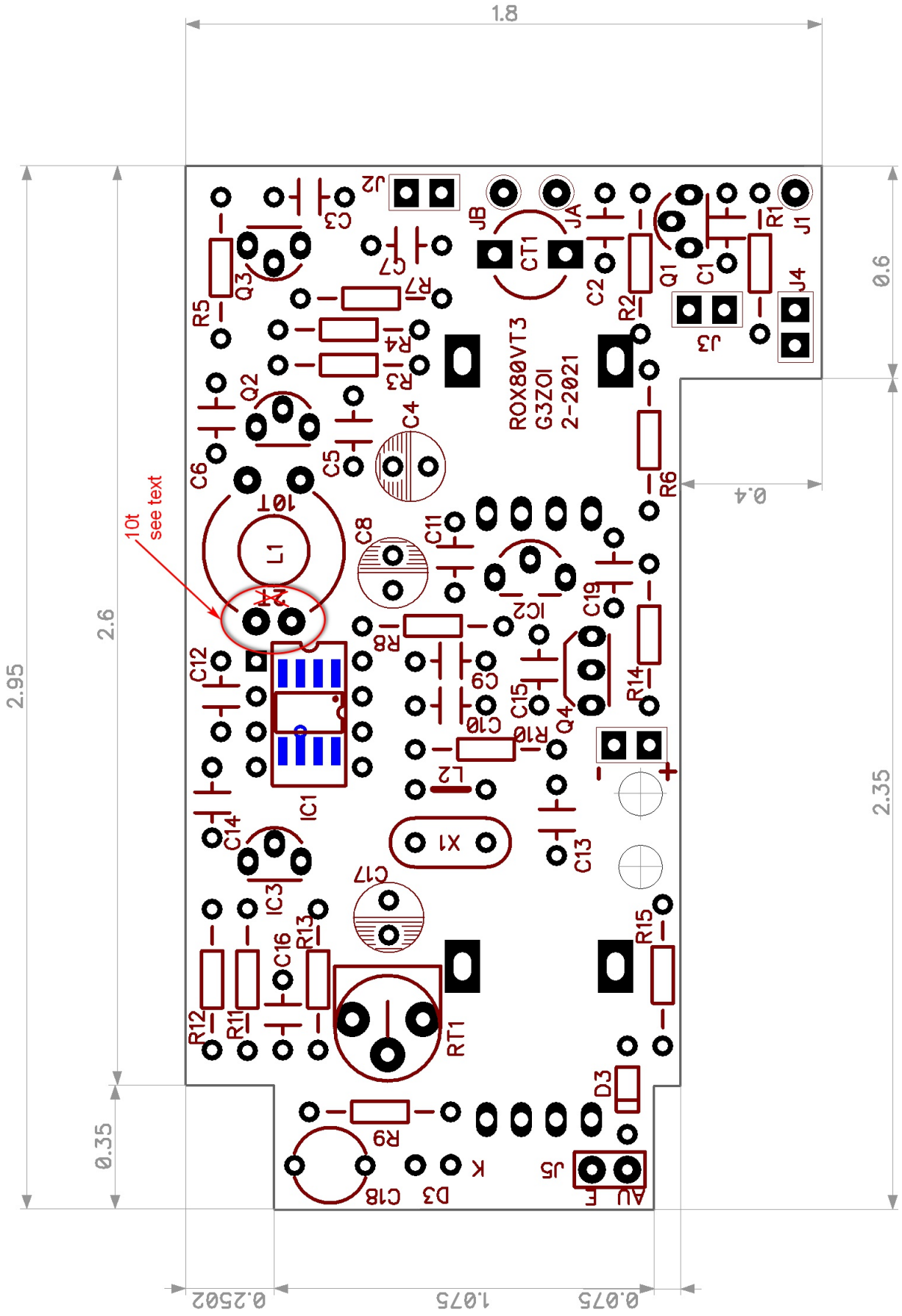
IC2 is a standard 5v regulator. An LDO type can be substituted, to improve battery life, but it will increase the noise floor level.

Q1 JFET J113. Alternative BF245a can be used but the lead-outs are a reversed, so the outline on the PCB will not match the profile.
The grid is located on the pad nearest the edge of the pcb.

J3 SENSE INPUT. Using header pins, may make it slightly easier to swap the sense wires, if the sense direction needs to be reversed?

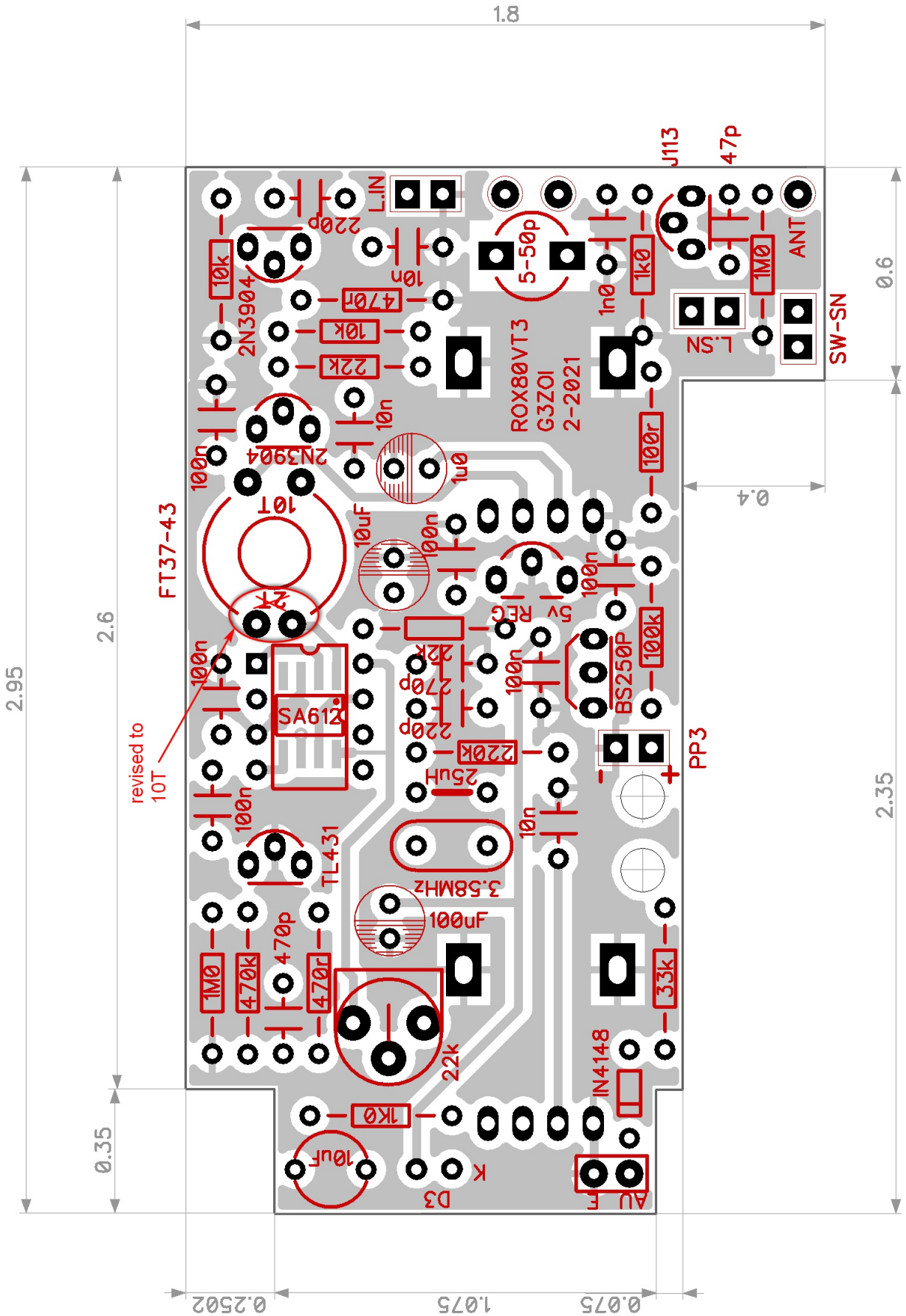
D3. One pad is close to a support foot of control pot RV1. Check for adequate clearance.

COMPONENT LAYOUT.
As screen printed on the PCB

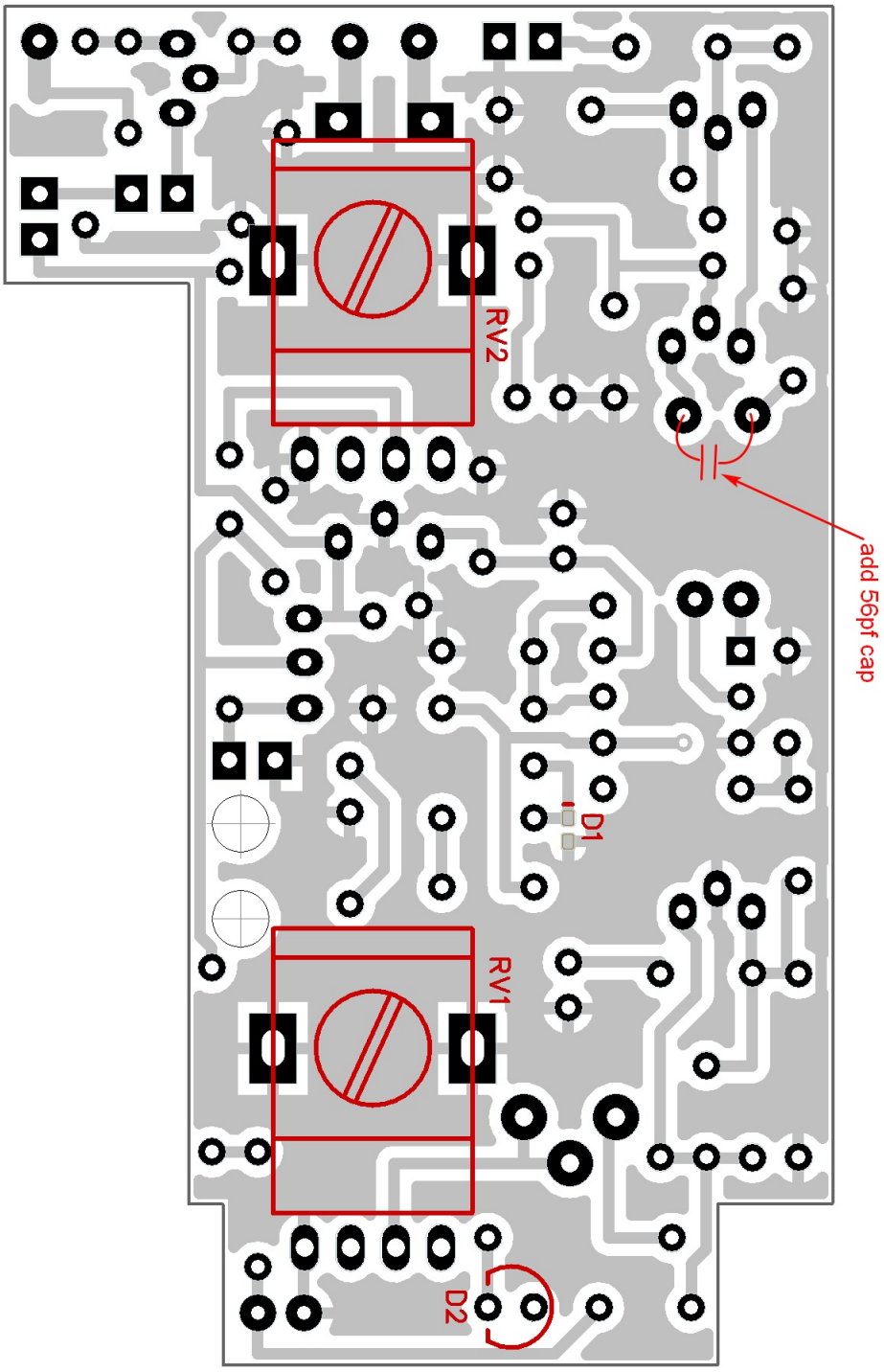


COMPONENT LAYOUT

Showing component values



BOTTOM SIDE LAYOUT
Showing component values



TUNING RANGE.

The target range is 3.51Mhz to 3.60MHz, which is the IARU defined ARDF band.
A 3.58MHz resonator can be readily pulled to a lower frequency, potentially even lower than 3.51 MHz.
Pulling to a higher frequency is much more limited. The VXO cannot be pulled very much higher than 3.60MHz before the oscillator amplitude rapidly reduces and eventually dies.
Pulling the frequency is achieved using the capacitance from a varicap diode in series with the resonator. If that alone is insufficient, series inductance can be added (L2).

IMPORTANT: RESONATOR CHOICE
Resonators vary considerable when used as a VXO.
Murata and other branded types are generally more consistant. Generic types can vary between good and unusable.
Resonators which pull low easily can be more prone to drifting. Check if the drift is acceptable, some might be ok after an initial 'warm-up'.
Generic resonators are also prone to frequency jumping when pulling near to 3.58MHz. This is easiest to detect by monitoring the oscillator output at pin7 of the SA612.
nb. In a sample of generic resonators obtained on eBay over 50% had this unwanted characteristic.

SERIAL INDUCTOR L2
If the core ferrite material on L2 is type 43 (toroid or bead) and the inductance required to pull down to 3.51MHz is more than 22uH (12t on a FT23-43) then the amplitude of the oscillator is reduced significantly and may compomise the operation of the SA612. Aim for at least 400mV pp measured at pin7.
If L2 is wound on type 61 ferrite, the oscillator amplitude is reduced far less but will produce a distored wave form, (due to the interaction with the varicap diode ?).

(nb. all the pre-wound radial inductors tested by the author appeared to use type 61 ferrite.)

To correct this, a resistor of between 100-470 ohms requires to be inserted between L2 and V1. Cut the track and insert a 0805 smd resistor. In most cases a 220ohm resistor will suffice.

Summary
Use Murata resonators if possible. Purchase more than you require. If the resonator drifts too much, frequency hops or requires L2 > 25uH, try another resonator.
If you still cannot get the frequency range required, try a type 61 for L2 (eg. FT23-61 or radial inductor) with the resistor modification as described above.

TUNING RANGE SET-UP

After fully assembling the PCB, (without the antenna connected).
X1 and L2 can be inserted into place without soldering. The holes are through-plated, so temporary contact with the PCB track is possible, without soldering. This testing is easier done on the back of the PCB. Initially replace L2 with a link.

Apply voltage to the PCB and monitor the VXO output with a receiver.
Turn the tuning control fully anticlockwise.
The resonator with no series inductance (L2), should pull down to between 3.50MHz to 3.53MHz.
If the frequency is lower than 3.51MHz no inductance is required.

L2 (if required)
Wind 14 turns on to a FT23-43 toroid. Tin the ends. Place into the PCB holes (not soldering) or tack solder to a connected pad.
Re-check the lowest frequency. Progressively remove turns until the lowest frequency is just below 3.51MHz, re-trim the leads and solder to the PCB

RT1
Monitor just above 3.60 MHz. Turn the tuning control fully clockwise.Adjust RT1 until you can hear theVXO.

COMPONENT LIST

Please note: Stock codes are only listed as a **guide** to ordering.
Errors can occur with cryptic suppliers codes, so please check before ordering.

Supplier stock changes frequently, components can quickly go obsolete, so the list is valid only at the time it was prepared.

Component are often subject to a minimum order quantity, therefore, depending on the number of receiver units being constructed, alternatives with a higher unit price may represent better value.

** CONTROL POTENTIOMETERS ** (03/2021)

Before ordering these pots, confirm the panel fixing nuts are also included.
RS do NOT always include the nuts despite being marketed as a 'panel mount' device and the nuts shown in an image of the component.
The M9x0.75x2mm nuts are difficult to source separately.

Alternatives
1. Contact the author, who may have stock.
2. Digikey and Mouser.
Both sell the pot. under the brand 'TT electronics', with a series code of 'P110KH1'. If you cannot source the 50k linear version, 10k or 20k can be substituted but will they will draw a little more current.

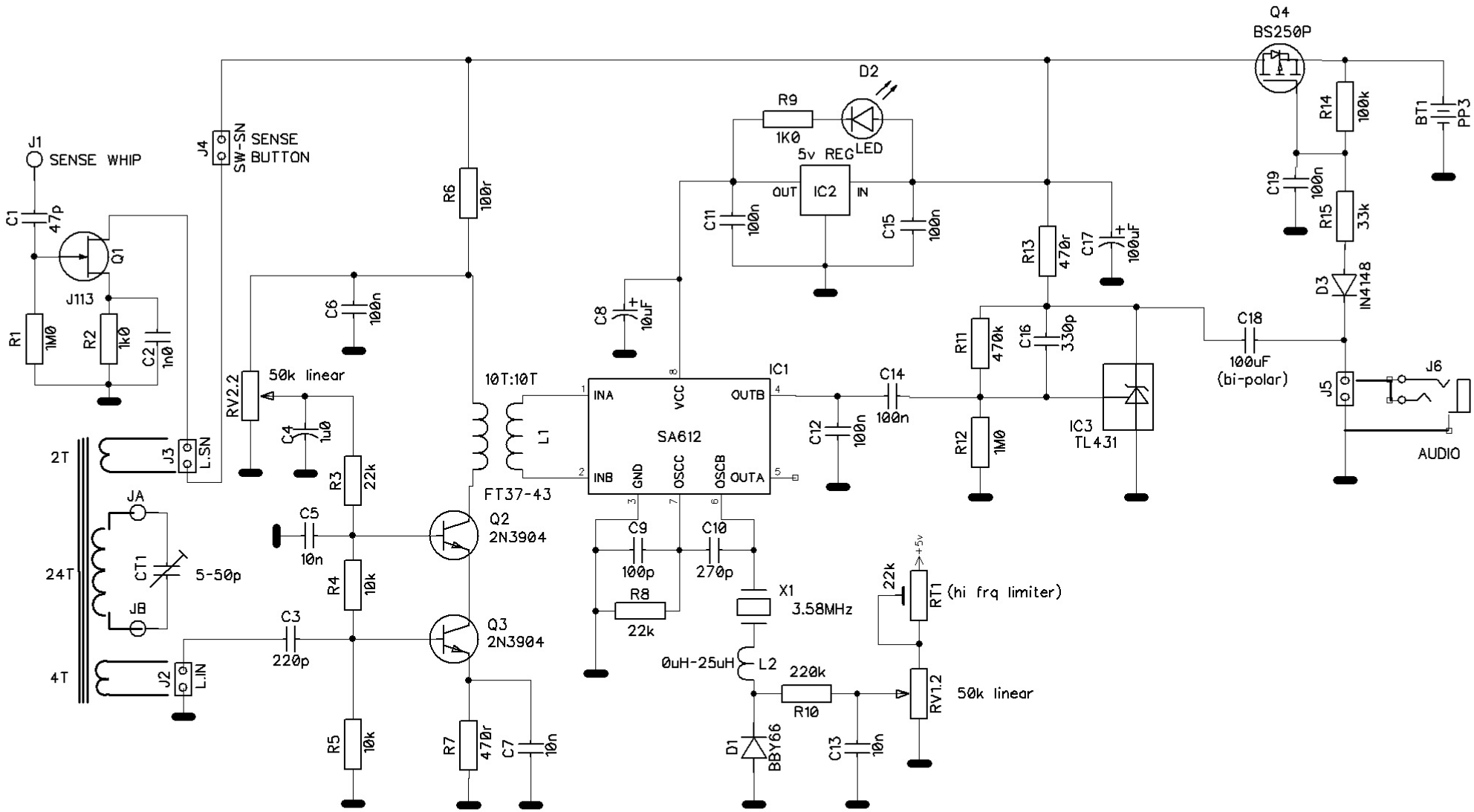
RefDes	Quantity	Value	Name	Pattern	Supplier
C1	1	47p	ceramic	5mm radial	RS:194-0462 /FN:2990774
C2	1	1n0	ceramic	5mm radial	RS:194-0495/FN:2860087
C3	1	220p	ceramic npo	5mm radial	RS:194-0479
C4	1	1uF/16v	electrolytic	2.5mm radial/5mm dia	RS:475-9009
C5 C7 C13	3	10n	ceramic	5mm radial	RS:194-0524
C6 C11 C12 C14 C15 C19	6	100n	ceramic	5mm radial	RS:194-0538
C8	1	10uF/16v	electrolytic	2.5mm radial/5mm dia	RS:440-6547
C9	1	100p	ceramic npo	5mm radial	RS:194-0470
C10	1	270p	ceramic npo	5mm radial	RS:194-0481
C16	1	330p	ceramic	5mm radial	RS:194-0483
C17	1	100uF/16v	electrolytic	2.5mm radial/5mm dia	RS:228-6650
C18	1	100uF/16v	**BIPOLAR** electrolytic	5mm radial/5mm dia	RS:727-0492
CT1	1	50pF	trimmer	5mm	RS:175-3548
D1	1	BBY66-02	D-VCAP_0402	SMT	RS:826-9399
D2	1	3mm LED	RED	lead thru	RS:228-5916
D3	1	1N4148	Diode	lead thru	RS:739-0290
L1	1	FT37-43	10t:10t		EBAY (1)
L2	1	FT23-43	Up to 14t, to pull down to 3.51Mhz (see text)		EBAY(2)
Q1	1	J113	JFET	TO92	RS:186-8891
Q2 Q3	2	2N3904	NPN	TO92	RS:739-0442
Q4	1	BS250P	PMOS	TO92	RS:215-6688
R1 R12	2	1M0	Resistor 0.25W		RS:136-058
R2 R9	2	1k0	Resistor 0.25W		RS:125-1150
R3 R8	2	22k	Resistor 0.25W		RS:135-954
R4 R5	2	10k	Resistor 0.25W		RS:125-1153
R6	1	100r	Resistor 0.25W		RS:135-774
R7 R13	2	470r	Resistor 0.25W		RS:135-831
R10	1	220k	Resistor 0.25W		RS:136-020
R11	1	470k	Resistor 0.25W		RS:707-7883
R14	1	100k	Resistor 0.25W		RS:135-982
R15	1	33k	Resistor 0.25W		RS:135-960
RT1	1	20K PRESET	Horizontal 5x2.5mm	BOURNES 3306P	RE:67-0614

IC2	1	78L05	5v regulator	TO-92	RS:714-7768
IC3	1	TL431		TO-92	RS:661-9827
VR1 VR2	2	50k LIN	11MM Linear pot.	ALPS RK11 SNAP-IN	RS:263-3208
X1	1	3.579MHz	Ceramic Resonator	2 PIN	EBAY (approx price)
ABS BOX	1	Hammond 1591XXB	113X63X31 (smooth inside, no guide slots)		RE:30-6301(GREY)
TACTILE BUTTON	1	12mm			RE:78-0630
JACK SOCKET	1	3.5mm			RE:20-0133
PVC CABLE GROMMET	2	20mm			RE:65-0006
FERRITE ROD	1	100mm	(or longer)		RE:88-3098
15MM Speedfit PIPE	1	110mm cut off	(rod length+10mm)		DIY stores
PCB	1				G3ZOI
PP3 CLIP	1	rigid head with middle-lead outs			RE:18-0094
SUNDRIES	1	eg Wire 27swg for rod windings			
15.5MM KNOB	1	Tuning knob	screw fixing		RE:32-0290
20.3MM KNOB	1	Volume control	screw fixing		RE:32-0275
M3 or M4 25mm BOLT	1	Sense antenna	with tag and washer – cover with heat shrink		
10mm CLOSED GROMMET	2	Rod end caps			RE:04-0195

RS	RSWWW
RE	RAPID ELECTRONICS
EBAY(1)	Enigma-shop.com
EBAY(2)	spratreader (25603)
MO	Mouser

POSSIBLE ALTERNATIVES

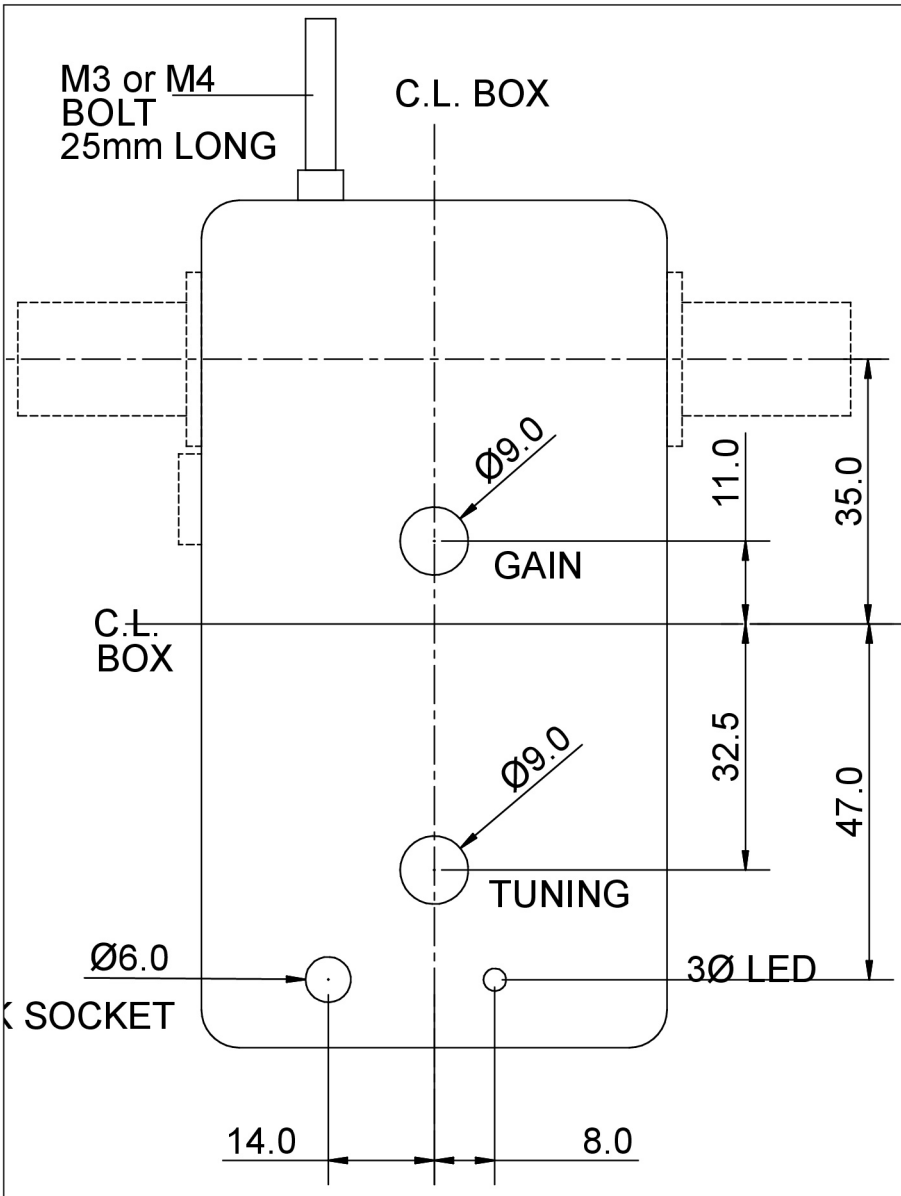
IC1 : DIL SA612AN	Spectrum.com



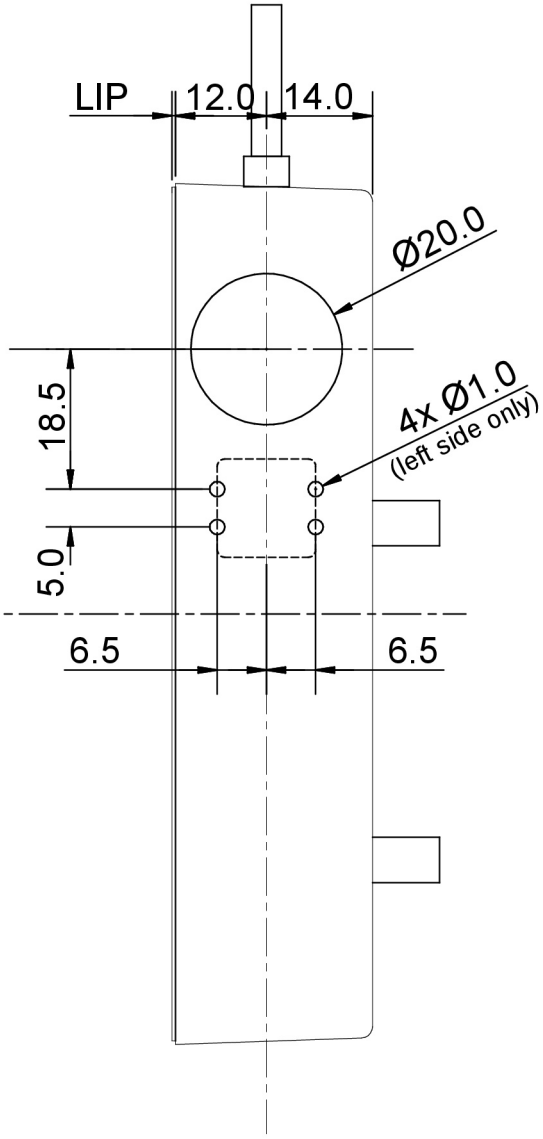
3.51-3.60 MHz

ROX80 VERSION VT3

BY G3ZOI
DESIGNED ON DIPTRACE

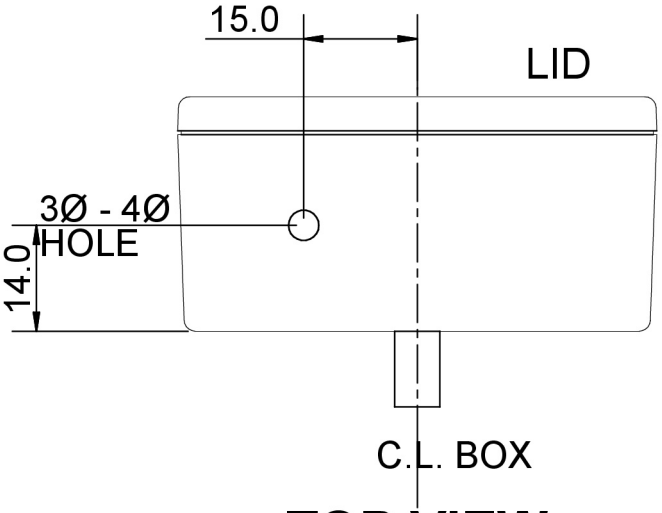


FRONT VIEW (BOTTOM OF BOX)



LEFT SIDE VIEW

(LID NOT SHOWN)



TOP VIEW (BOX END)

ENCLOSURE DRILLING

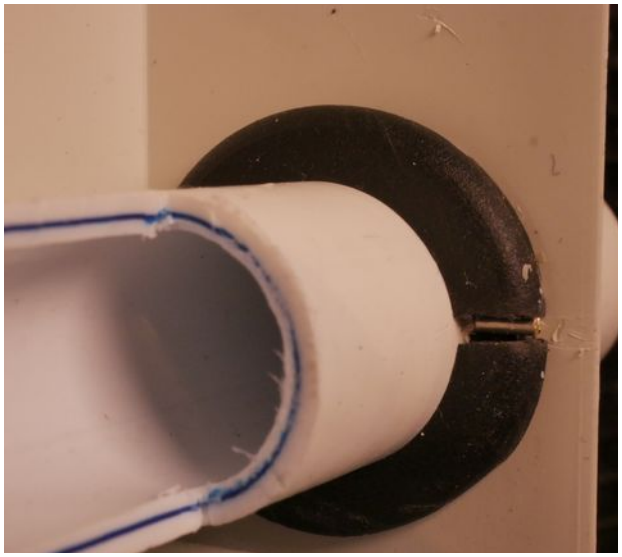
ROX-80-VT3

BOX PREPARATION.

For the best accuracy, measure from the centre of the box.
Snip off the four stand-offs from inside the box and the lid.
The drilling of holes is straight forward except as follows :

The positioning of the large 20mm holes is CRITICAL, check before you drill !
The two opposite holes must also be accurately aligned.
Mark out the 20mm hole circles, not just the hole centre.

The recommended method for drilling the 20mm holes is to use a stepped drill bit.
Check the drill hole in stages against the marked hole outline
for example: if the hole is drifts off-centre it might be necessary to stop the drilling at 16 or 18mm diameter and complete using a file or reamer.
If you over size the holes the grommet and antenna tube may be a sloppy fit.



The photo left shows a permanent method of preventing the tube from moving or rotating in the grommet, if additional fixity is desired.
Snip or cut out a small section of the grommet and insert a veropin or similar through a pre-drilled hole in the plastic tube (0.8mm dia)
If the veropin is inserted from inside the tube it can be self supporting, otherwise you may need a small dab of glue to secure in place.

Photo left.
Copper slug tape used for screening and fixed before the antenna tube is assembled.
(see also sense antenna assembly)

ANTENNA ROD AND HOUSING.

A video on the building the antenna can be found on YouTube
However, please note that since that video was published, the recommended winding turns have changed to :-
main winding: 26 turns, input link: 5 turns and sense link: 2 turns.

https://youtu.be/okiGt-biyyQ

ROD HOUSING.
Cut from a length of SpeedFit 15mm plastic tubing.
Cut 10mm longer than the ferrite rod, to allow for caps at each end.

Cut a slot in the middle of the tube , 25mm wide, for half the rod circumference.

FERRITE ROD
Prepare the rod by removing all sharp edges, ends and length wise.

COIL SLEEVE. (supports the 3 coil windings)
The sleeve is made by wrapping it around the ferrite rod over Selotape which provides extra clearance for the sleeve, after the Selotape is removed.
Wrap a length of 25mm wide x 150mm long Selotape round the end of the rod ,which should give about 4 layers of thickness.

The sleeve is formed from a single layer of brown wrapping paper, 25mm wide x 50mm long wrapped round the Selotape former, shiny side inside.
The length includes for a 15mm overlap. The overlap can be fixed with 12mm wide double sided tape or glued.

END CAPS
Made from a 10mm CLOSED GROMMET.
Snip the inside flange as shown in photo.

ANTENNA WINDING

Use 0.4mm wire (27-28swg). Cut lengths are shown in brackets below, and are generous.

Wind the coils, with the coil sleeve positioned over the Selotape wrap on the rod.

Wind the coils, right to left.

Sense winding 2turns (175mm)
Main Winding 24turns (1m)
Input winding 4turns (300mm)

The winding should start 50mm from the end of the wire and the coil wound over the end portion (see photo right) .

After winding the required number of turns, the two ends of the wire can be lightly twisted together, which will prevent the whole coil from unravelling.
(see photo right, main winding shown)

Wind the main, sense and input coils in the same manner, ensuring that they are all wound in the same direction.

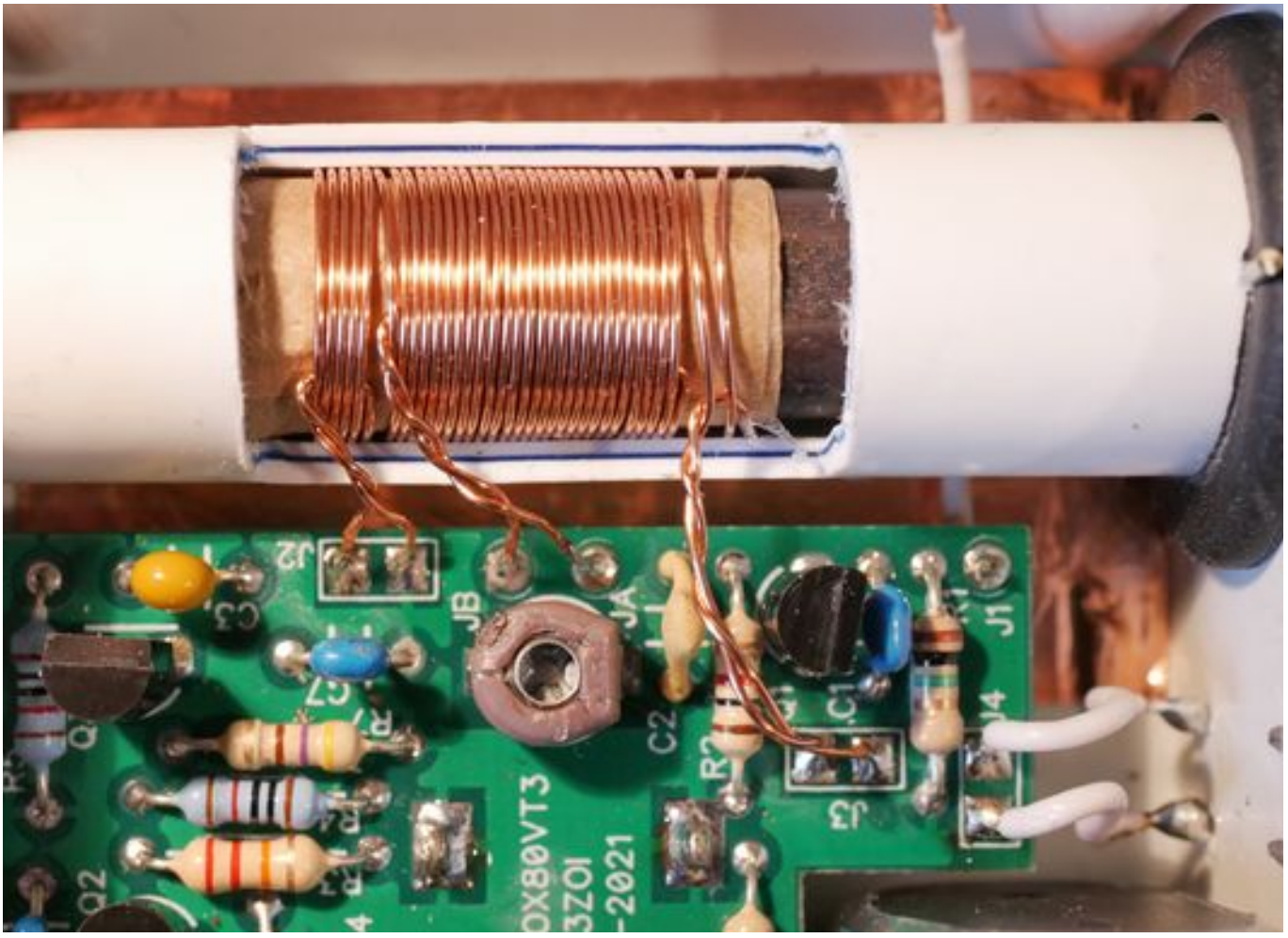
The twisted leadouts cut be cut to the following lengths

Sense 25mm
Main 15mm
Input 10mm

Prepare the ends for soldering.

Slide the coil and sleeve assembly off the rod.
Discard the Selotape wrapping from the ferrite rod.

Drop the sleeve assembly into the pipe cut-out.
Thread the ferrite rod though the rod housing tube with the sleeve in-place.

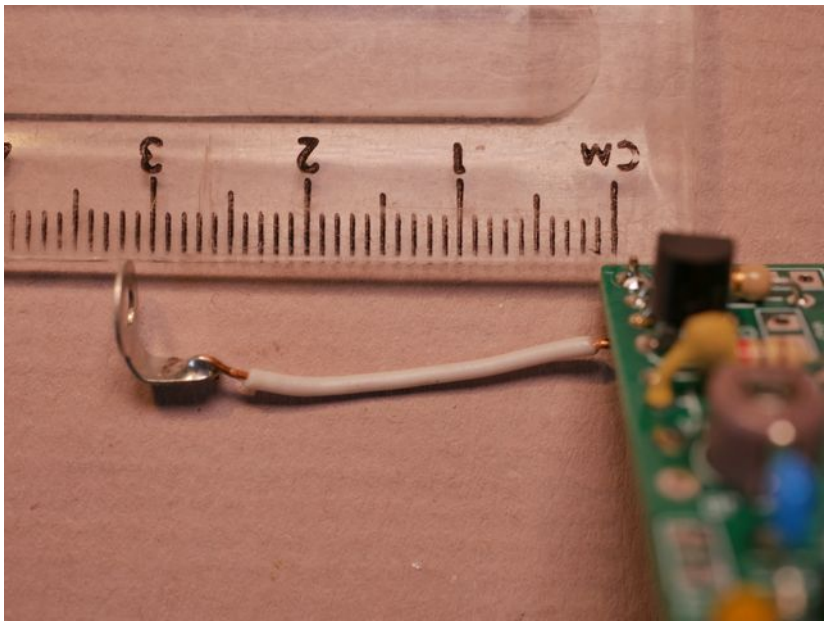


The above photo shows the lead-out wire connections to the PCB.
The sense lead-out wires may need to be transposed to deliver the preferred sense directions. The other lead-outs are bi-directional.

SENSE ANTENNA

The wire connecting the pcb to the sense antenna forms part of the antenna so ideally should be vertical, and best routed out-of-the-way, underneath the plastic tube.

The sense antenna can be simply made from a 25mm bolt, with the head and solder tag on the inside of the enclosure. However in this case, it will probably have to be located before the antenna tube is assembled.



The photo left shows an alternative using a small M3 stand-off spacer.

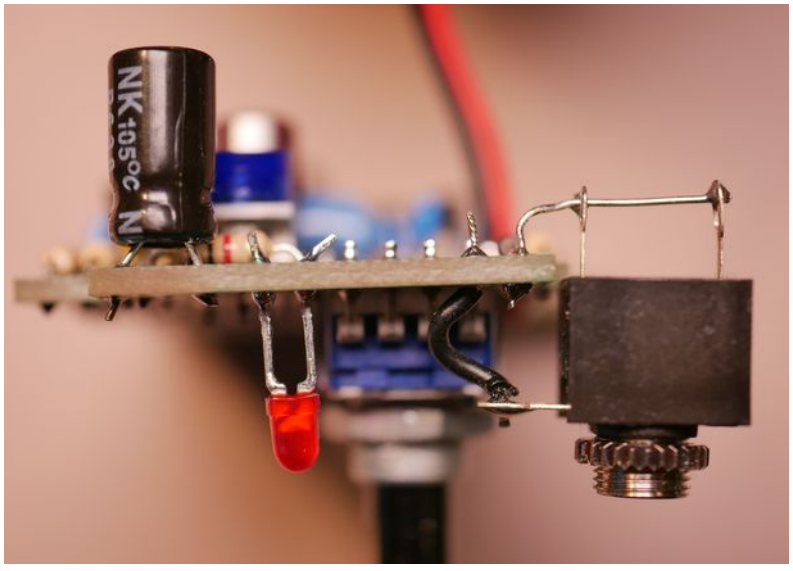


Photo right
LED and phone socket connection