Simple 130-150Mhz VHF FM Variable Signal Generator

Angus Anderson ZR6UM

E-Mail: falcon@falcon.co.za
www: www.lsgi.co.za/weather
fax: +27 (0)33 330-5195
tel: +27 (0)33 330-4880 (work)
Post: P.O. Box 628
Howick
KwaZulu/Natal
3290
South Africa

This document is in Adobe Portable Document forma (PDF), version 3. It may be viewed and printed on any compatiable workstation, including Windows 95/98/NT4, Apple Macintosh, Unix, Sun and others. The advantage of PDF format is that text and graphics are shown at the original quality and dimensions.

Circuit description

Figure 1 shows the circuit diagram of the VHF generator. It uses a NE602 balanced mixer/oscillator chip in unbalanced mode. By making pin 1 a resistive input and pin2 a capacitive input, the resulting phase difference unbalances the mixer so that all of the oscillator energy is transferred to the outputs at pin 4 & pin 5. We use pin 4 for output.

The oscillator section uses a home made coil of 3 turns of enamelled copper wire over a 6mm diameter former. Use a 6mm drill bit to form the coil. This is DC tuned by a 10k multiturn pot, through a 56K resistor. Zener diode ZD1 ensures that only 6.8v reaches IC1 and the tuning pot. The coil is adjusted to get it on frequency by squeezing it open or closed with a suitable implement. Once adjusted, seal it with beeswax to prevent movement. I used a 10 turn pot because it gives much better tuning resolution, but you can elect to use a standard linear 10K pot if you wish.

Also connected to the DC tuning voltage is a phase shift sine wave audio oscillator using a common 741 IC, which on my system oscillates at about 700Hz. Ideally, it should be set at 2400Hz, and changing the .068u caps for lower values will bring you higher in frequency. If you want to get fancy you can switch the audio feed and stuff a WXsat test signal (see my project: WXSAT test signal generator using your PC) into the audio input and have a portable NOAA or Meteor generator!

Stability is adequate for short term measurements. When measuring, try and keep the temperature stable, don't try and put the box outside in the sun, for instance. Use good quality components for the tuned circuits. Temperature changes are the single biggest upsetter of generator frequency stability. Another possibility is to line the inner box with styrofoam to limit temperature excursions. If you really want to get fancy, a small heating resistor and temperature control circuitry using something like an AD590 temperature transducer will stabilise temperature. I wish I had the time to experiment with all these things.... Fig 2 shows a suitable temperature control circuit from the Analog Devices Handbook.

As shown, the deviation control is far too fierce - I suggest that you try to experiment with the 560k resistor, increasing it will bring the deviation level down to something that is more smoothly controllable. If you have a friend with a PCR-1000 or one of the other Icom Models with a bandpass display, you can check the frequency deviation from the generator right on screen - you can then calibrate the deviation control.

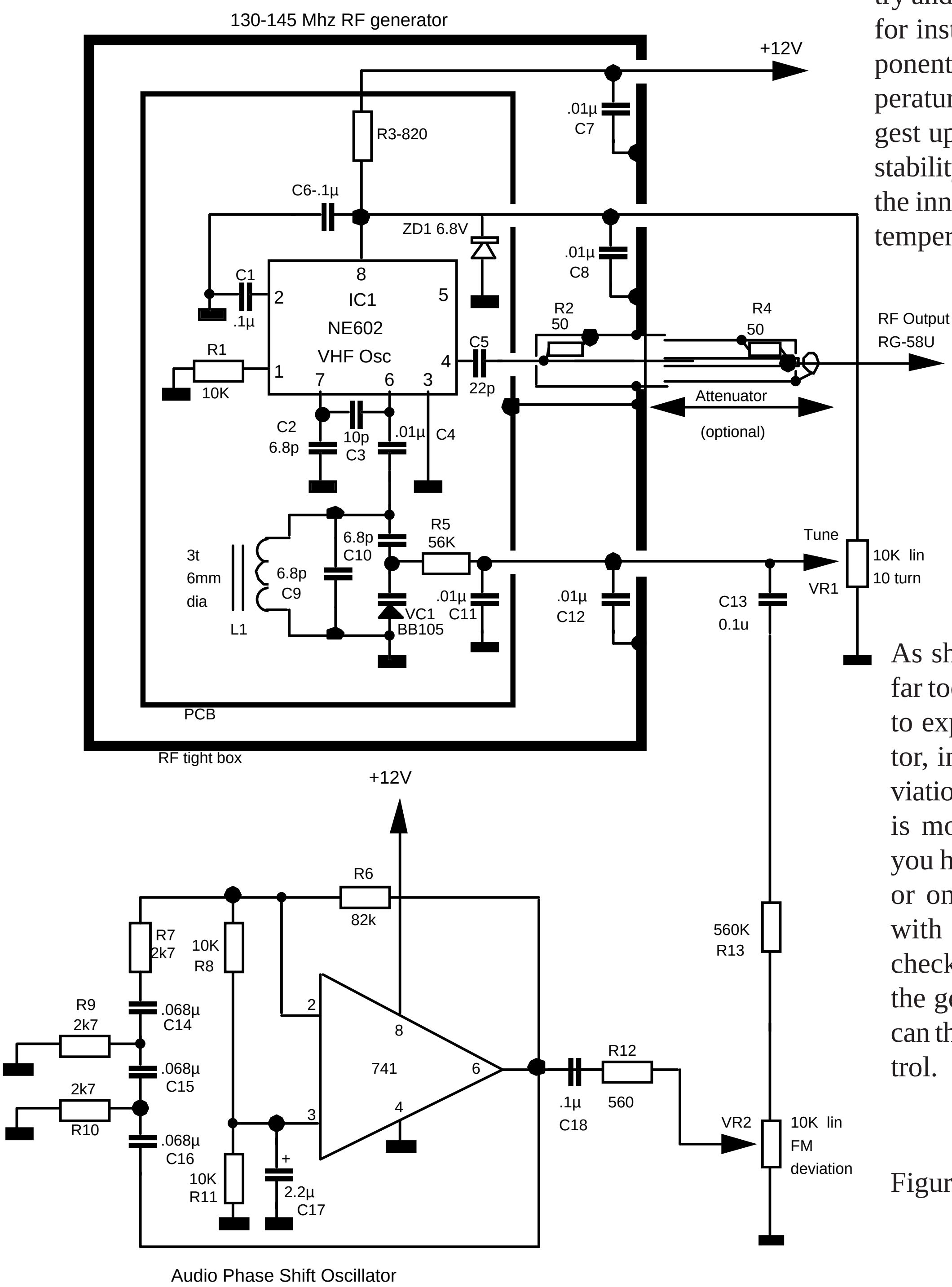


Figure 1

Temp controller circuit

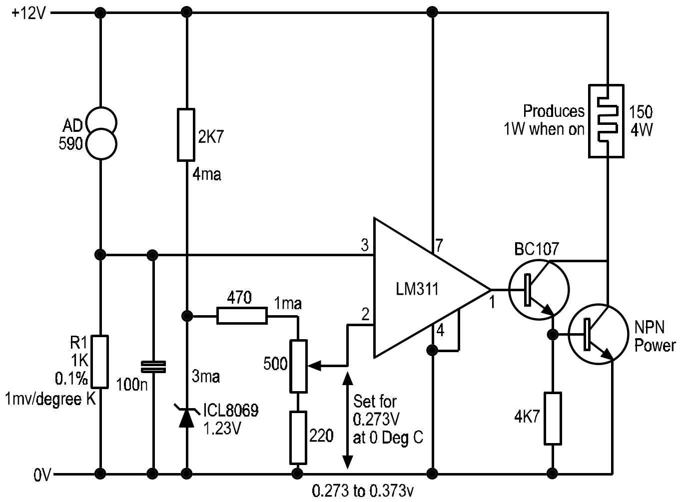


Figure 2

Figure 3 shows a 10.7Mhz RF generator that tunes 10.00 - 11.00 Mhz, and is quite stable as it is oscillating at HF, and not VHF. Here you would use a straight linear 10k pot to tune the frequency, not an expensive multiturn pot. It uses a Toko 10.7Mhz IF transformer as the tuned element, of which I have plenty in stock should you wish to source from me. The 10.7 generator can be built using the same techniques as the 137Mhz generator, and put into the same enclosure made of PCB scraps.

Construction - Shielding box

Figures 4 & 5 show an view of how a number of pieces of single sided printed circuit board (PCB) are cut and shaped to make a box. The foil side of the PCB faces inward. The box is soldered together along the inside seams. Dimensions are up to you, but I allowed about 5mm clearance around the Generator etched PCB. The top of the box has springy brass soldered to the PCB, which mates & seals the box top when closed. Make the box tall enough so that closing the lid will not affect the coil tuning - about 50mm is right. Note that you should drill holes as per figure 7 before soldering the box together.

Figure 6 shows how the Generator PCB mounts into the box on insulated standoffs. Note that the one side of the box is omitted for clarity.

HF Signal source (10.7 Mhz)

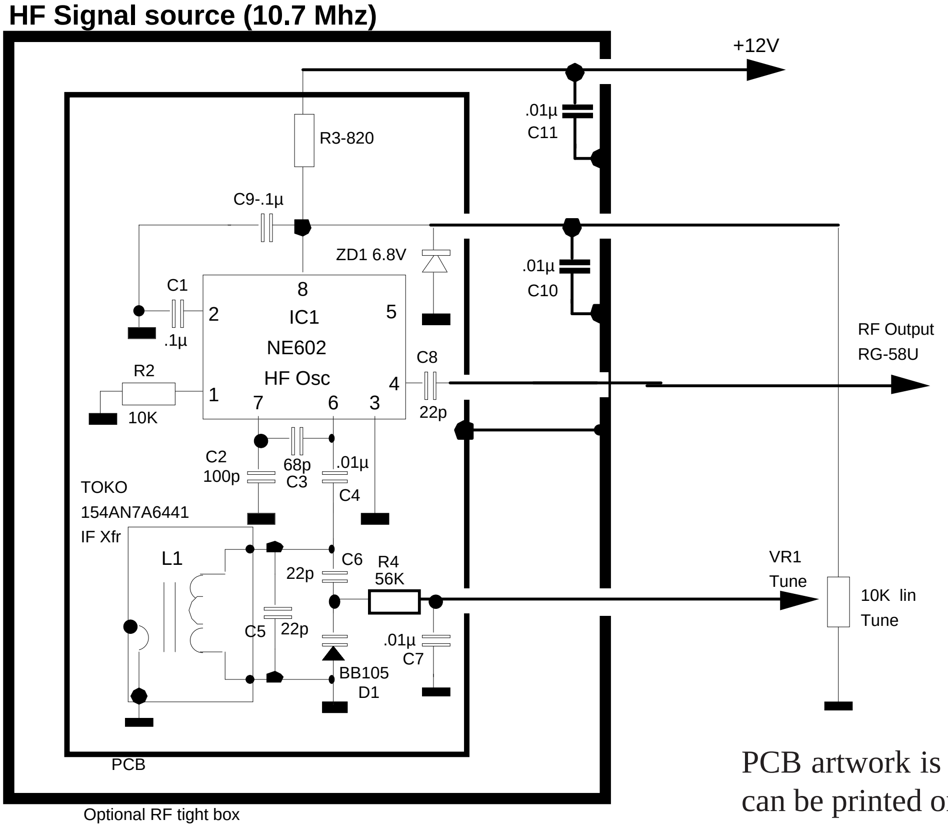


Figure 3

Figure 7 shows how the PCB unit is wired. The one wall of the PCB box is drilled with 4 holes, 3 which hold the feedthrough capacitors, and one which just passes the RG-58 cable. The only point at which the etched generator PCB is earthed to the PCB box is at the RF output of the generator. The RG-58 cable's braid is soldered to the PCB box wall at the entry point. The power lead and DC tuning leads are bypassed at the box wall with the .001uf feedthrough capacitors. Figure 7 should be self-explanatory.

This Figures 9 & 10 show the PC boards with their component overlays. Note that these are shown from the side components are mounted, so the tracks are seen as a sort of X-Ray view. Full size PCB artwork is provided on a separate page, so that it can be printed on any Windows compatable printer.

The generator PCB is made from double sided board. The holes on the non-etched side of the board are cleared with a drill, so that components can be inserted without shorting to the top foil. The top foil acts as a earthing

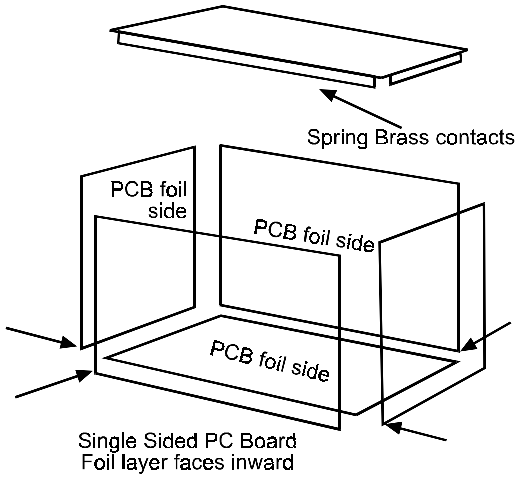


Figure 4

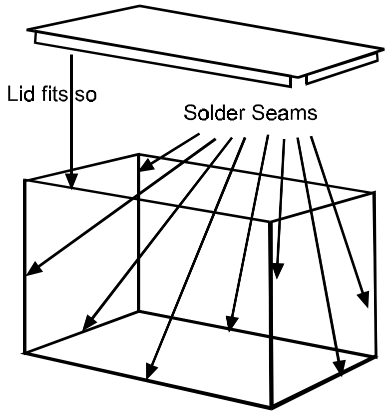


Figure 5

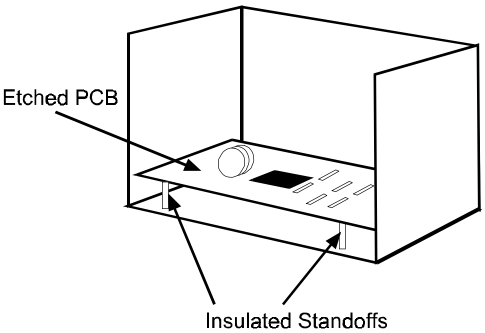


Figure 6

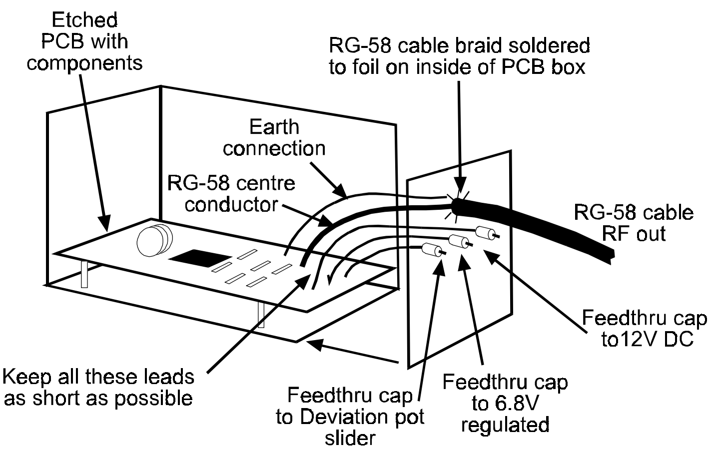


Figure 7

screen and aids stability. Because the PCB does not have any tracks etched on the top side, the PCB layout shows as single sided. However, make sure to stake through the top and bottom foils at the points shown in the overlay, so that the top is earthed.

PC Board construction is straightforward. To forestall problems, I like to measure all resistors and capacitors before installing. You should install a IC socket for the NE-602, but make sure that it a high quality socket! Make sure all diodes are the right way round before inserting. BEFORE installing the NE-602, make sure that the voltage on pin x is 6.8V, as this chip is NOT tolerant of voltages over 8V. Also measure that you get a variable DC reading at the junction of the 6.8pf capacitor and the Varicap diode when you adjust the frequency pot.

In the same way, the phase shift oscillator PCB goes together in a straightforward manner. Testing is simply to measure that 12 appears across pins 4 & 8 of the 741 IC. Otherwise, you should get a sine wave at the output (pin 6) of the 741. To test the audio oscillator, why not use the freeware ‘Winscope’ PC Oscilloscope written by Konstantin Zeldovich, (zeld@polly.phys.msu.su) to check the waveforms? This oscilloscope takes it’s 2 channel input from the L&R line inputs of your sound card, and is useful for audio waveform checking. You can also download Winscope from this web site.

The inner box is mounted in turn in a suitable steel enclosure. I mounted the PCB box with double sided tape, so that it could be removed if needed. The coax goes to a BNC female connector on the front of the steel box. The Phase shift audio generator PCB and the battery mount inside the steel box. I used a 12V battery pack that takes 8 ordinary pencells, and mounted this with double sided tape as well. The Audio PCB can be mounted so that it is earthed to the steel outer cabinet should you so wish. The DC tuning control and the FM deviation control mount on the front of the steel box. Seal the steel box with a number of self-tapping screws to minimise leakage. Figure 8 illustrates the point.

The circuit diagram shows an optional attenuator, but I dispensed with this, as I couldn’t get enough signal attenuation. This is why I resorted to the “Far Field” method. R2 is optional, R4 is not used.

Getting it working

The generator tunes about 130-150Mhz when adjusted. To find out where the signal is, I usually resort to my trusty scanner, which scans up until a suitable very strong signal is found. You can identify this by switching the generator on and off. Once you have got this signal, follow it down on the scannerto the lowest frequency the generator will tune. If the frequency is too low, open up the coil slightly. If it is too high, squeeze the coil together slightly until the lowest frequency is about 130Mhz. Check that it will now tune the WXSAT band. If you are way off, you might have to change the tuned circuit L or C values to pull it in.

For those of you who just must have a front panel indication of frequency, a small 50ua meter connected to the tuning pot slider and suitably calibrated would work fine.

Use

Connect a small portable radio telescopic whip to a BNC male plug. Connect this to the BNC socket on the front of the generator. Calibrate the unit for frequency as described above. Once calibrated, you should be able to remove the whip from the generator in the shack, and the signal should disappear completely on the receiver. If you still get a signal, check your shielding, as you are getting unwanted leakage from somewhere. It's important to follow the earthing instructions faithfully as given above.

What I have dubbed the 'Far Field' technique is simply a technique whereby you introduce suitable attenuation to your RF signal by placing the generator some distance away from your receiver/antenna combination. Attenuation is further controlled by extending or collapsing the whip, and by rotating the whip so that it lies close to the ground, for instance. Although not the most convenient way of introducing attenuation, it's cheap, and has allowed me to align a number of receivers perfectly.

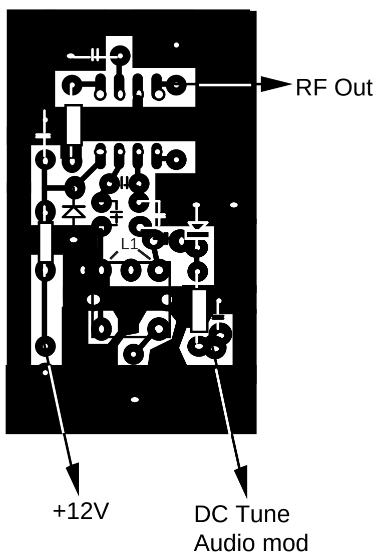
You start with the system configured as it would be for receiving satellites; that is, with the antenna connected. You will also have set the receiver to receive 137.5 Mhz, which is in the middle of the Wxsat band. Tune the generator to 137.5Mhz, and after a warming up period of about 10 minutes, place the generator close enough to the receiving system to get a useable signal, but not so close as to let the signal rise above S1 or S2 on the signal strength meter (if you have one) or at the point where the system is just below full quieting if you don't have a meter. The trick is always to keep the RF level fed to the receiver low enough so as not to enter FM limiting. This is because you are trying to align using variations in amplitude, and allowing the system to limit will kill or disrupt amplitude variations.

If you have a dual conversion receiver design, with ceramic filters for the IF's, then there is no separate IF peaking required, as the the IF's are fixed at the correct passbands. However, if your receiver has adjustable IF's than it might be worth building the 10.7Mhz generator (Email me)., so that you can peak the IF passbands first. One of your filters is sure to be a fixed unit that dictates the overall 50Khz bandwidth of the receiver

Align your various coils for peak, starting from the audio end of the receiver. (I can't go into specific techniques of alignment here, as all receivers are different). As the sensitivity rises, back off on the RF input. Do this by either collapsing the telescopic whip, or moving the generator farther away. Keep on backing off the input and moving farther away until no more increase in sensitivity can be obtained. This is where you get your exercise using the "Far Field" alignment technique.... I ended up with the generator at about 60 meters from the antenna. When peaked, you should be in a position to receive satellites, and a final check using a passing satellite should prove all is well.

Conclusion

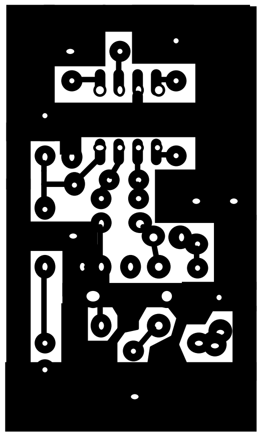
This is a very simple RF oscillator, but very versatile for all that. It is in constant use in my shack. By calibrating the whip antenna length and the distance from the house for the generator, I can reproduce a known Rf level, and thus do a quick check on my wxsat system's sensitivity. The criterai of low cost and ease of construction have been met. The next version will use a simple PLL circuit to provide accurate frequency calibration.



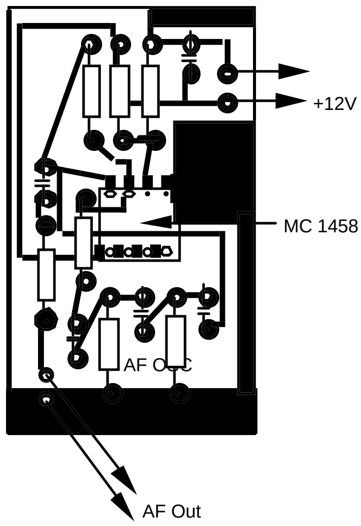
Generator PCB overlay

Parts List, VHF generator

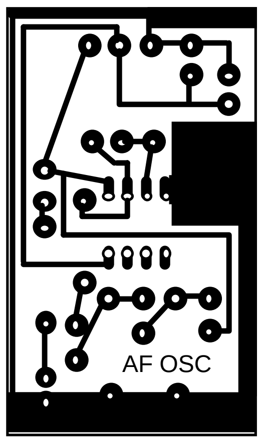
C1	.1uf (100n) ceramic
C2	6.8pf ceramic
C3	10p ceramic
C4	.01uf (10n) ceramic
C5	22pf ceramic
C7	.01uf (10n) ceramic
C8	.01uf (10n) ceramic
C9	6.8pf ceramic
C10	6.8pf ceramic
C11	.01uf (10n) ceramic
C12	.01uf (10n) ceramic
C13	.1uf (100n) ceramic
C14	.068u (68n) ceramic
C15	.068u (68n) ceramic
C16	.068u (68n) ceramic
C17	2.2uf 16V electrolytic
C18	.1uf (100n) ceramic
R1	10K ohm 1/4Watt
R2	50 ohm 1/4Watt (optional)
R3	820 ohm 1/4 watt
R4	50 ohm 1/4 watt (optional)
R5	56K ohm 1/4 watt
R6	82K ohm 1/4 watt
R7	2.7K ohm 1/4 Watt
R8	10K ohm 1/4 Watt
R9	2.7K ohm 1/4 Watt
R10	2.7K ohm 1/4 Watt
R11	10K ohm 1/4 Watt
R12	560 ohm 1/4 watt
R13	560K ohm 1/4 watt
VR1	10K linear pot optional 10 turn
VR2	10 Linear pot
ZD1	6.8V zener diode, 400mw
VC1	BB105 varicap diode
IC1	NE602 8 pin DIP plastic
IC2	741 8pin DIP plastic
2	8 pin DIL IC sockets, good quality
	Enamelled copper wire
1	Generator PCB
1	Audio Oscillator PCB
4	Insulated PCB standoffs
4	PCB standoffs
6	PCB offcuts, suitable soze for box
1	Metal cabinet
2	Suitable knobs
8	Suitable self tapping screws
1/2M	RG-58 coax cable
1	BNC female panel mount socket
1	BNC male plug
1	Portable radio telescopic whip



Generator PCB 1:1



Modulator PCB Overlay



Modulator PCB 1:1

1) Remember that components mount on the unetched side of the board
2) Clear around holes on unetched side of board to prevent shorts, except earth land holes. In other words, earth connections are staked through to solder on both sides of the PCB
3) Solder earthed connections on both sides of PCB
4) Generator PCB is made to mount 10.7 IF can. Mount the VHF coil as shown (L1).