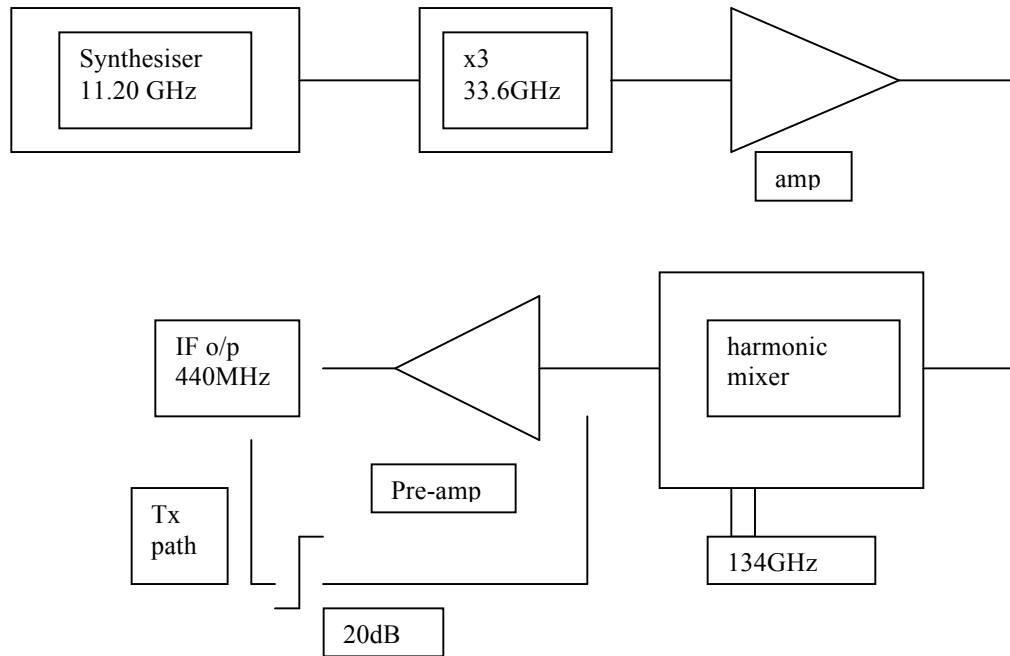


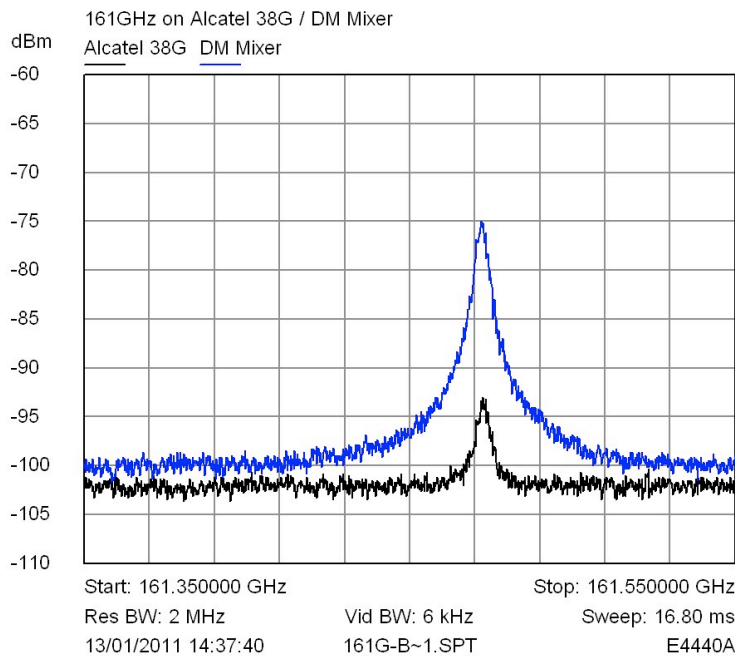
134GHz Transverter

Roger Ray G8CUB



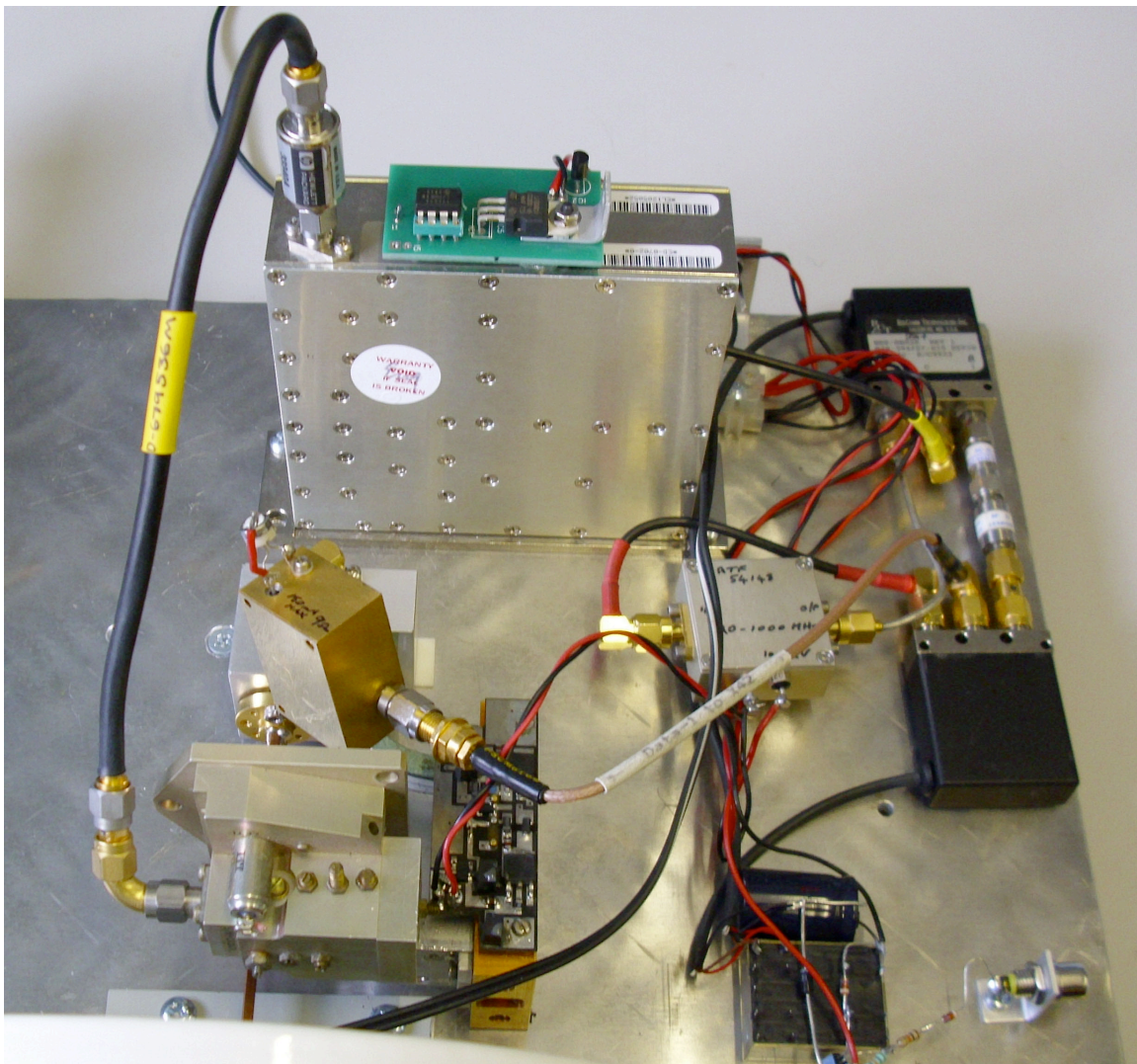
Simplified 134GHz transverter block diagram

The idea for a 134GHz system started about 18 months ago. Initially I intended to use an Impatt diode source. This proved to be very noisy, and hence requiring a large bandwidth.



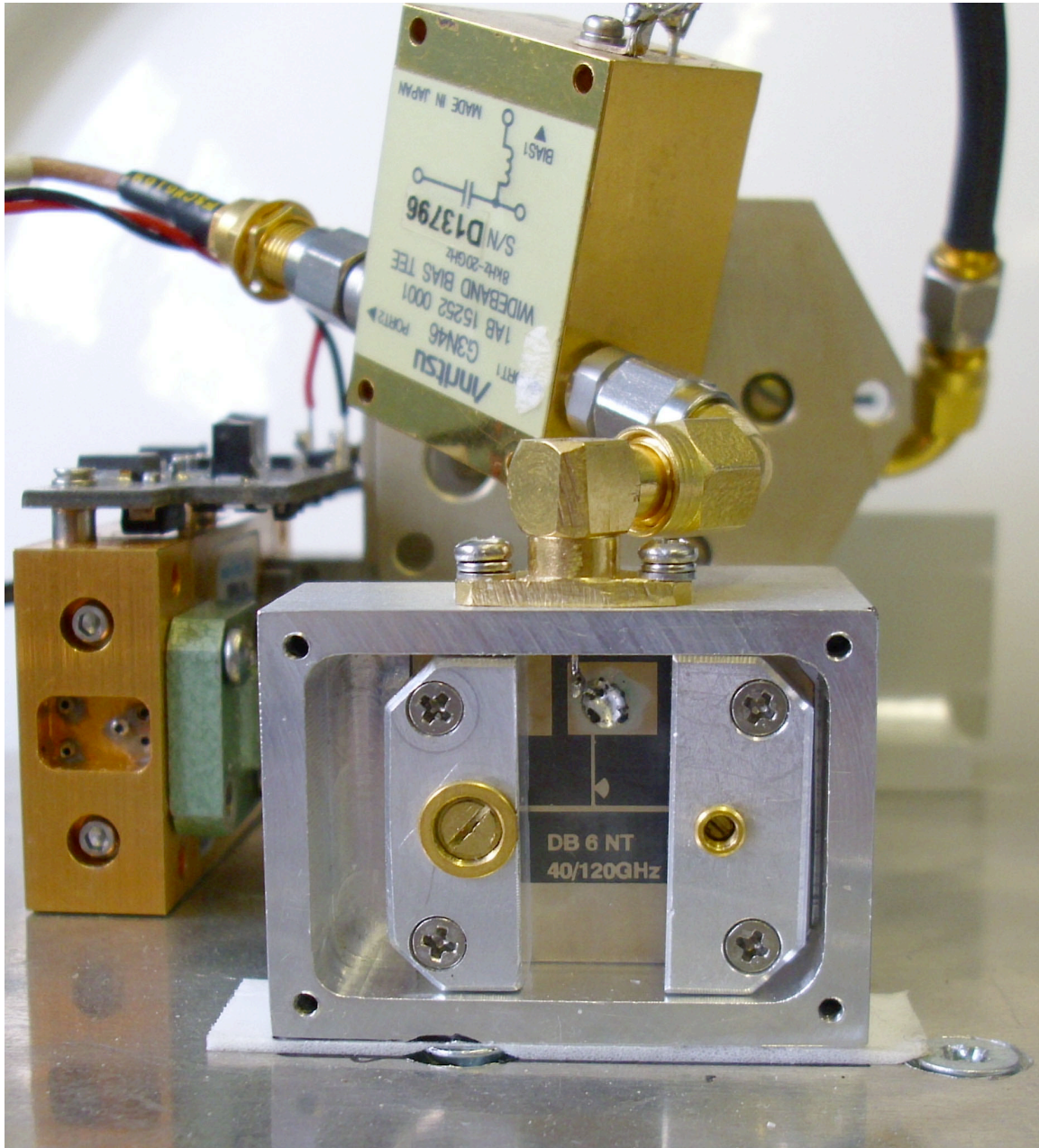
The plot shows the oscillator on 161GHz. The higher (blue) trace was measured with a commercial mixer (110-170GHz), the lower used a 'test module' from an Alcatel 38GHz 'white box'. This shows that even at 160GHz the test modules work as a low cost mixer! The signal bandwidth is much greater than the spectrum analyzer 2MHz bandwidth, so the true power is greater than the plot.

Having rejected the Impatt diode idea, I looked for a way of using an Elcom synthesizer to drive a harmonic mixer. The Elcom lowest frequency is 11.200GHz, with 3.333MHz steps. Doing the maths, showed that $11.206666\text{GHz} \times 12$ gave 134.480GHz. It would be also possible to produce a TX signal at 134.920GHz (11.243333×12), giving a 440MHz IF. With a 134.48GHz LO, it would be also possible to receive the existing sub-band of 134.928 – 134.930, and transmit using a modified FT817 (448-450MHz IF).
[Also a 135.360GHz LO (11.28×12) could be used to give an IF of 432 -430MHz]



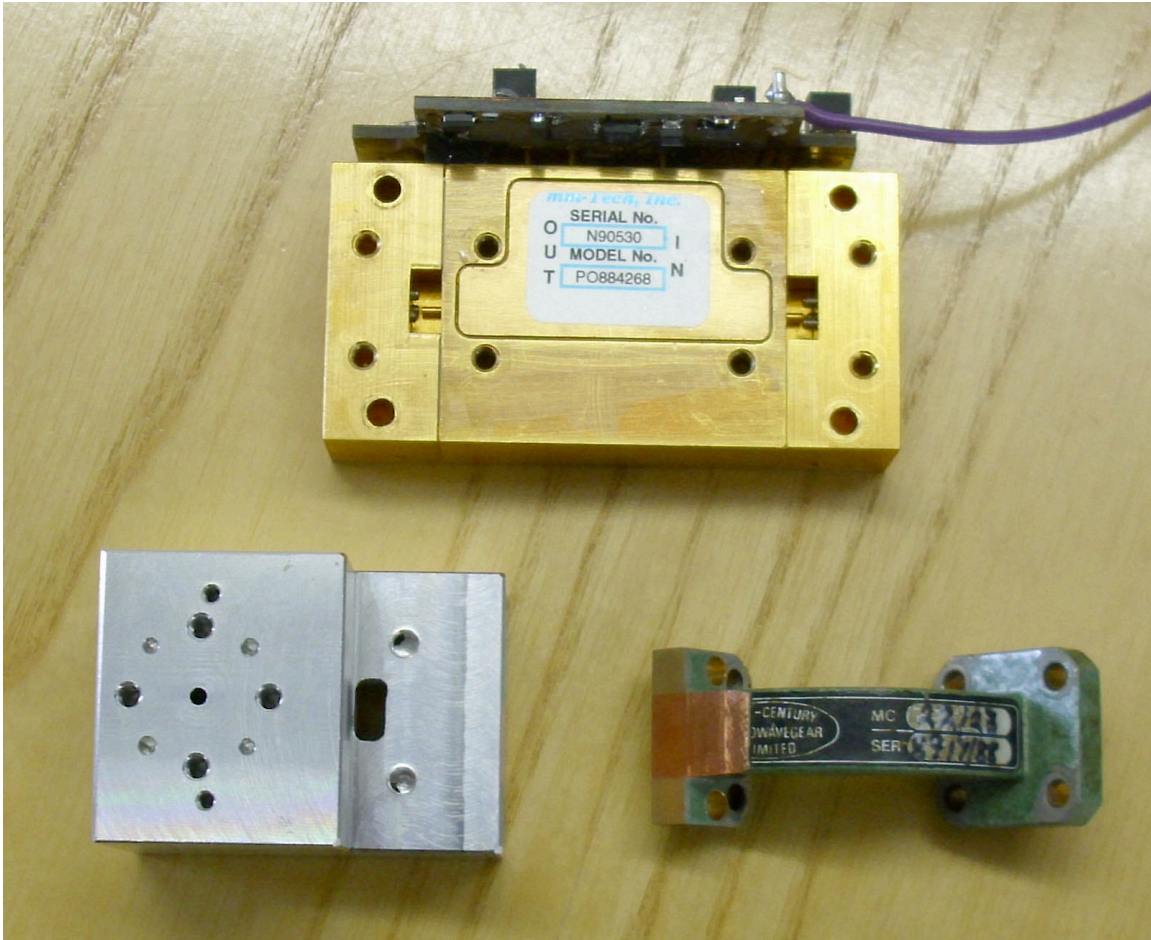
The synthesiser is at the top of the picture, with it's PIC loader board on top. Firmware is from Dave G4FRE, and is available on his website. In the foreground is a X3 tuned multiplier, which drives a mm-tech 23 -36GHz WR-28 amplifier. It was the appearance

of these amplifiers on eBay for 20 Euros, that sparked of this version of the project. On the right are the TX/RX relays and UHF pre-amplifier (ATF54143).



The harmonic mixer is a DB6NT pcb No.47. The case used is a 122GHz housing from Philipp DL2AM.

The only difficult bit here, is that the case is designed to use a DML type 38GHz multiplier. To use a waveguide input, I modified a WR-28 bend by machining off part of the flange. This can be seen in the next photo, together with the mixer block, and mm-tech amplifier. After machining (or sawing/filing), it is then drilled to match the taped holes in the block.



The only part to mount on the pcb is the diode. Here there is a choice. Starting at under 7 Euros is an MAE1317, up to an HSCH-9161 at 45 Euros. The potentially difficult part is mounting the diode – they are VERY small. There are various schools of thought, as to the best mounting method. I used 2 part silver loaded epoxy, to attach the diode. A good microscope, is a must, preferably binocular. The adhesive is applied to the board, and the diode put in place using an alcohol wetted cocktail stick. The board is then cured at 100 deg.C for 2 hours. I then fitted the board into the block, which is held down by the two tuning element blocks. Articles in Dubus suggest that the board should be glued in place with silver epoxy. I have not done that, as I prefer the freedom of being able to change the board. The diode is self biased, using a 1k pot to ground. I used a bias-T to separate RF and DC. However a simple choke and capacitor would have sufficed.

The amplifier was hard into saturation with an input of -2dBm. After tuning the 3 screws in it's output waveguide, I obtained an output of +15dBm at 33.6GHz. With the pot set to mid-range the voltage across it was 1.33V. This is after adjusting the tuning elements for maximum voltage.

Do not do as I did the first time, by adjusting in the element over the diode and crushing it! I suggest setting the screw just over the diode and tuning out. This screw is finally set for best received signal, or maximum output.

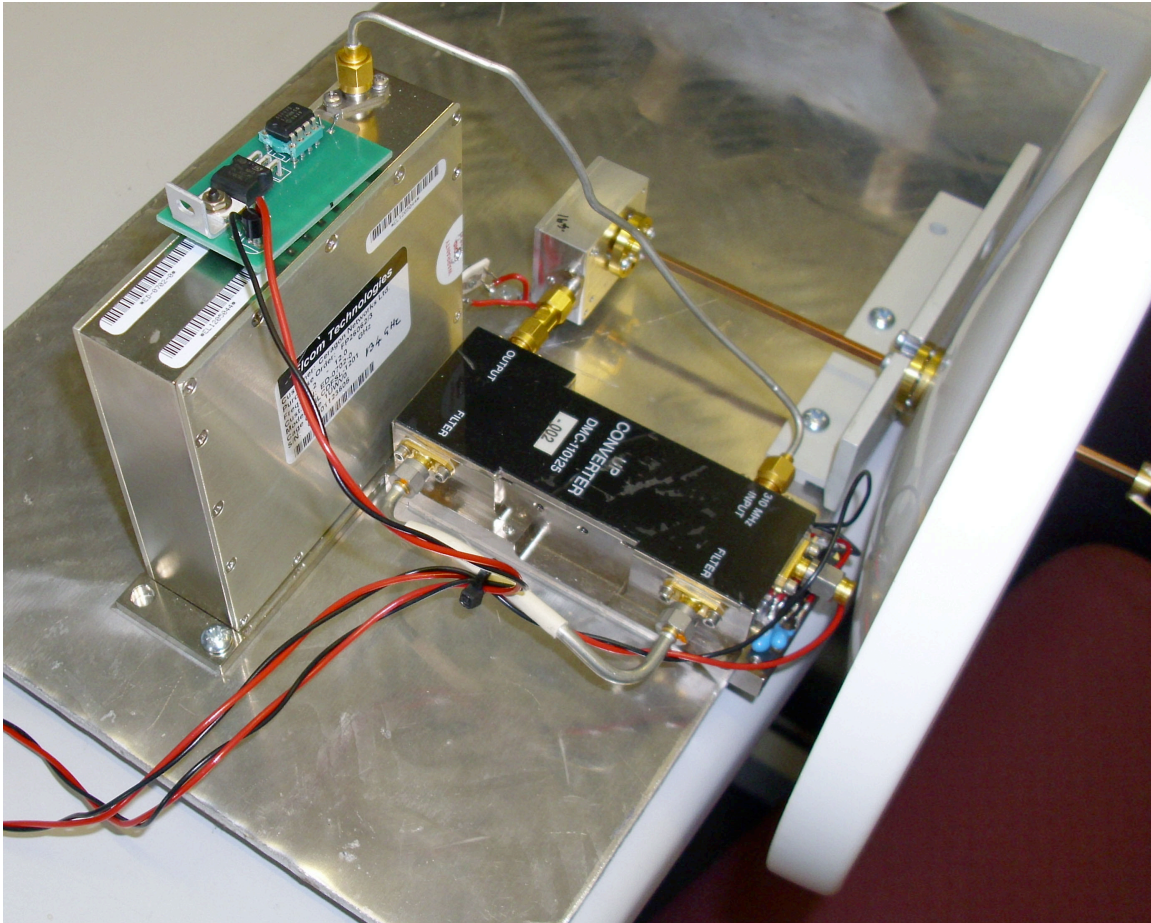
A pre-amplifier is necessary. I used an ATF-54143. A low cost pcb is available from RF Bay on eBay.

The selectivity of the mixer, is defined by the hole size in the block under the diode. This is used as a circular waveguide. The 122Ghz block came with a 1.85mm hole. This works fine at 134Ghz, but does not remove the unwanted signal at 101GHz. A possibility here would be to drill out the block and fit 1/16 id brass tube. I have now done this on a second unit, using 1/16" aluminum tube that was actually 1.65mm id. It works well and kills the 101GHz signal totally.

The second transverter I built by upgrading the 'test source' described below. Here I used the low cost MAE1317 diode. This unit had 6dB more Tx output than my first one, although the receive performance appeared lower.

My test source used another Elcom synthesiser driving a DML up-converter, used as a doubler amplifier. The mixer with RF on it's IF port, and is then connected to the amplifier section. The output was +19dBm at 22.4GHz. This then drove a 76GHz block using an MA46H146 diode. A small amount of RF at 134GHz is produced, and is selected by the WR-7 waveguide, connected to a Procom dish.

This worked surprisingly well, with the test signal being around 60dB above noise at 8 metres away.



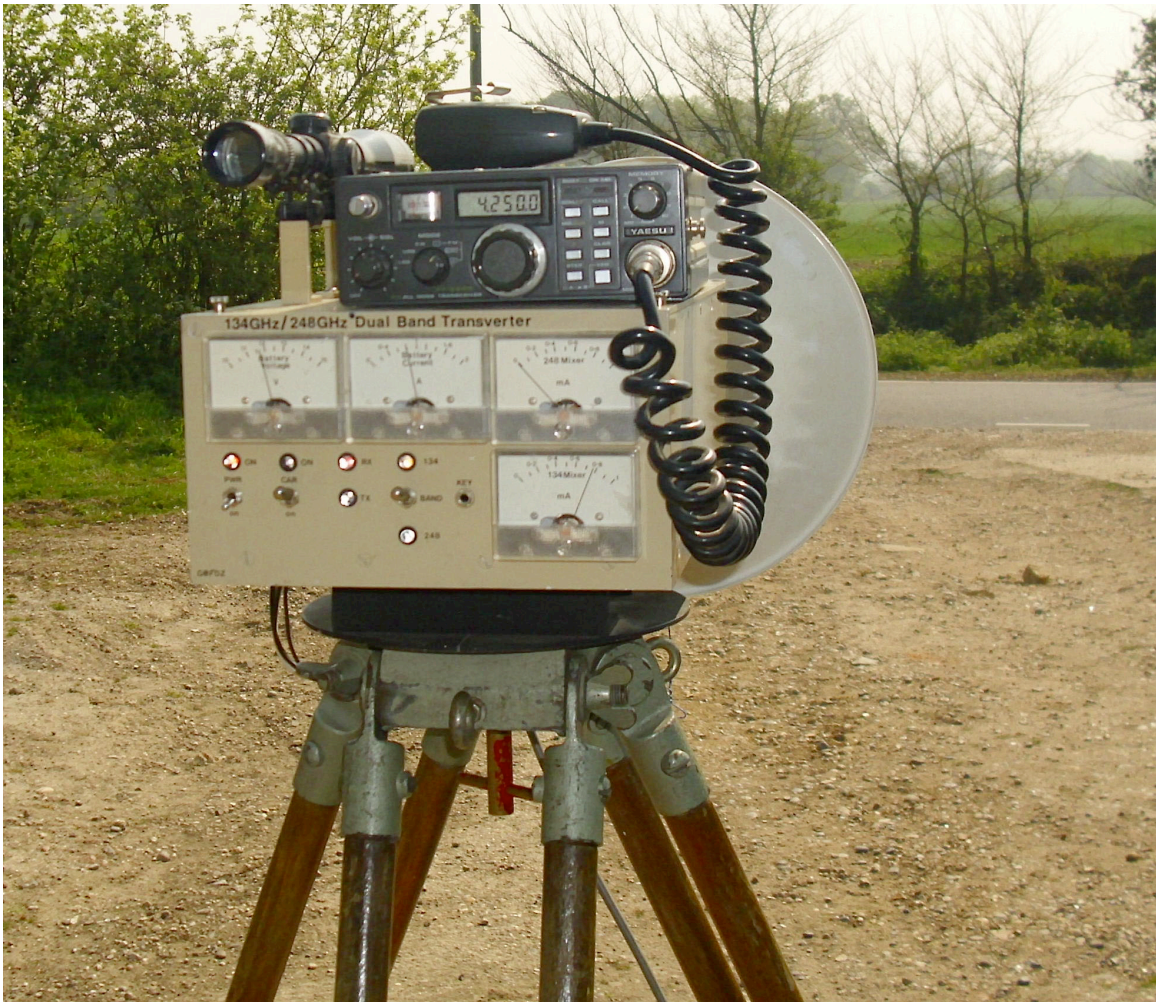
It is intended to later convert this test source to another 134GHz transverter- now done!

The first on-air tests were with Chris G0FDZ. After an initial false start, where it was found that Chris's transverter had a 1.4mm circular waveguide hole, that was cutting off at 134GHz! It was drilled out to 1.6mm, and we were away. Well, we could copy each other at a couple of meters.

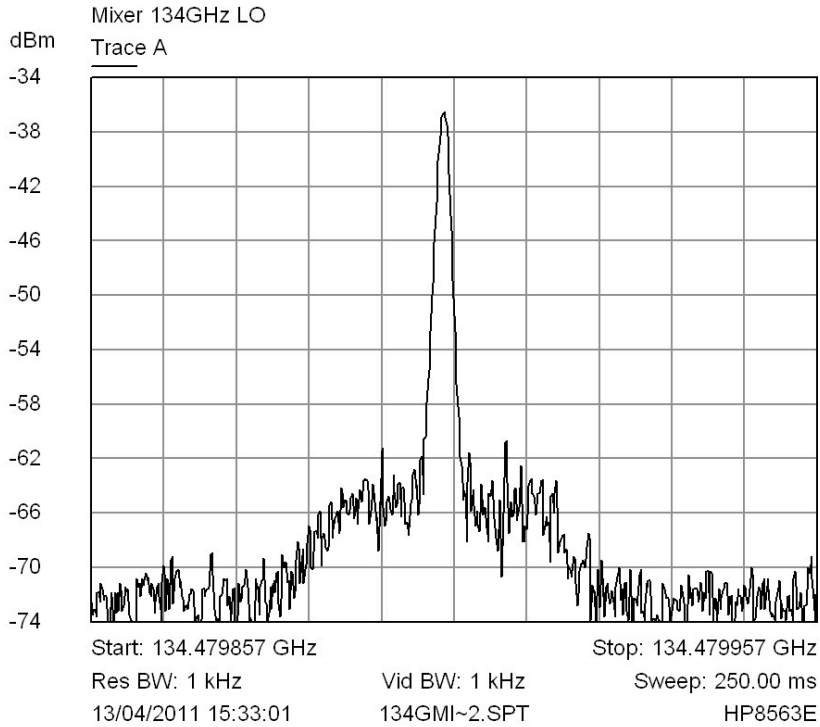
We struggled to find a clear test range, but eventually tried over a 500m distance. Alignment proved a challenge. The Procom 44dB dishes are very sharp, with a stated beamwidth of 0.8 degrees. Reports were exchanged on SSB to complete a QSO.



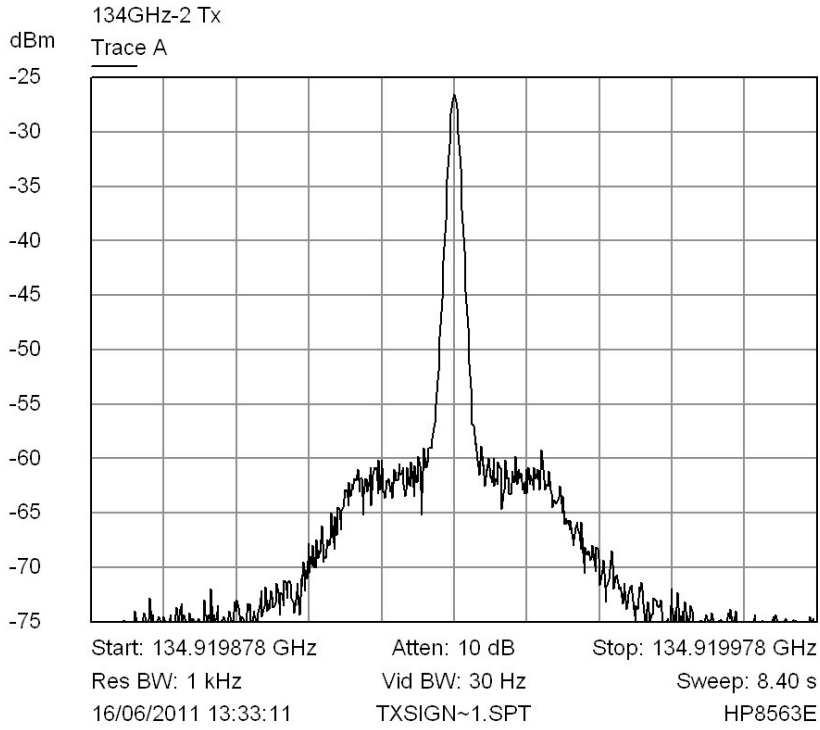
The transverter in action – yes I forgot about having to plug the microphone into the FT817!



The very well constructed G0FDZ transverter, at the 'farm' end of the link. Chris uses a 144MHz IF.



The spectrum plot of the LO signal at 134.480GHz. This using the internal 10MHz reference in the synthesiser. I am staggered how clean and stable the signal is! However since that first QSO, I found that the signal was not as clean when on battery. I was using a series diode in the supply. When the supply dropped below 11.4V the LO moved frequency and spurs were produced. Something I have never noticed at fundamental! It is fine on 12.0V.



This is the Tx output spectrum of the second transverter. The true output power is greater than that shown as the mixer is calibrated with a 13GHz LO, and the spectrum analyser LO output is being used to drive it (around 4GHz). This is using the MAE1317 diode and an IF input of +11dBm. LO drive at 33.6GHz is just under +17dBm.