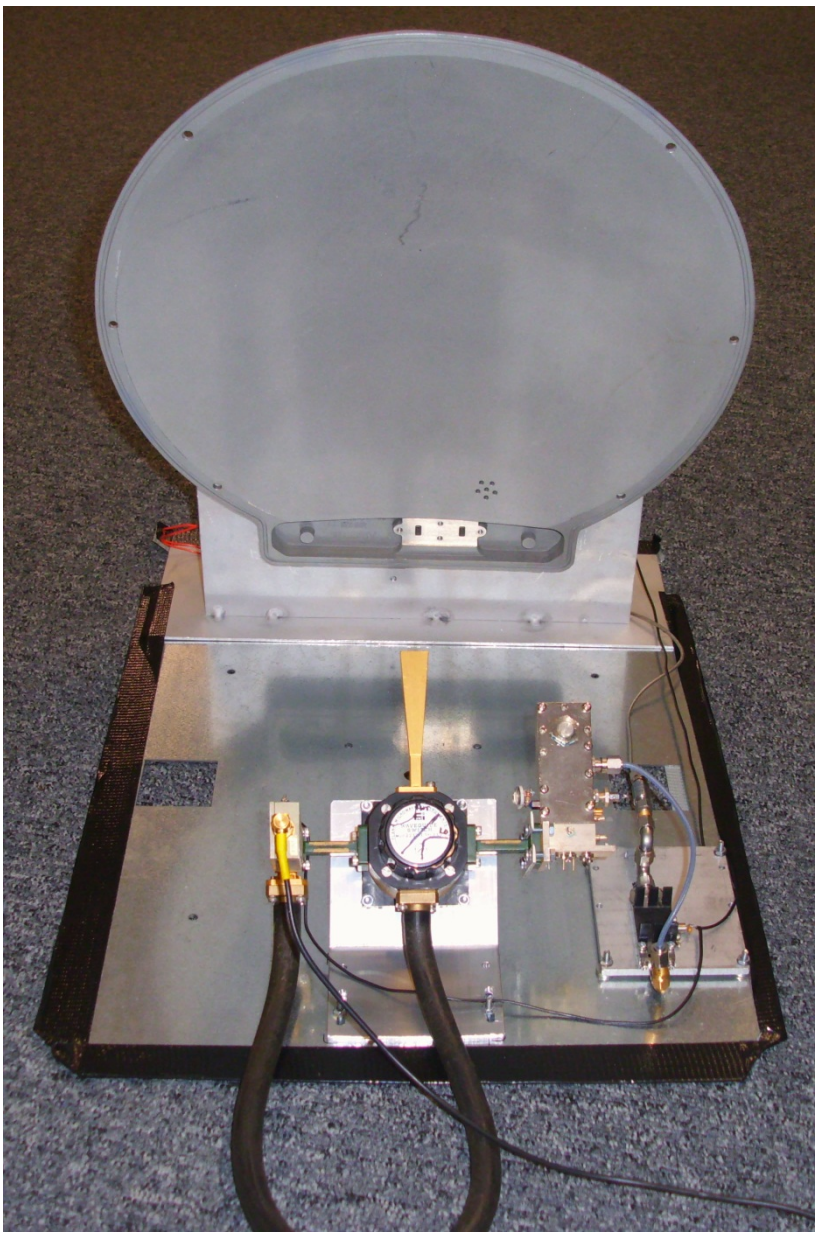
Simple 47GHz Transverter

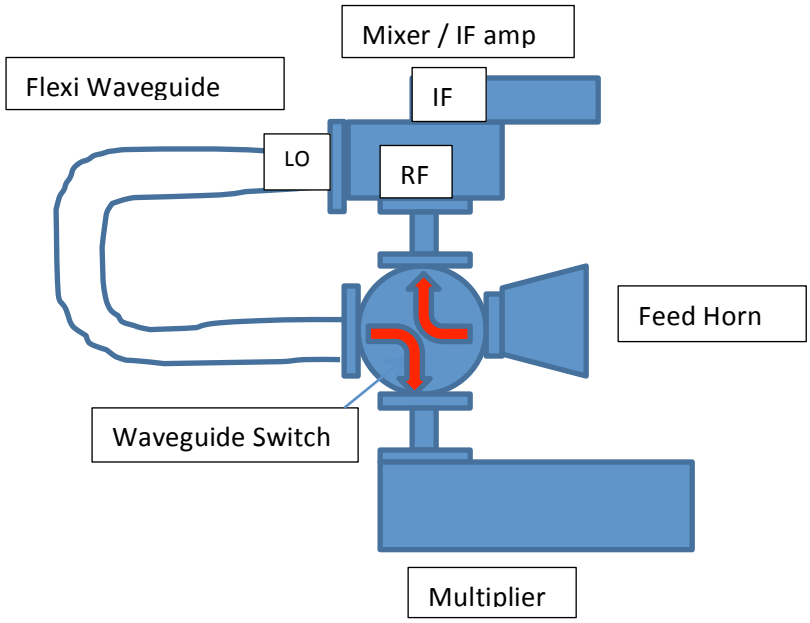
By Roger Ray G8CUB



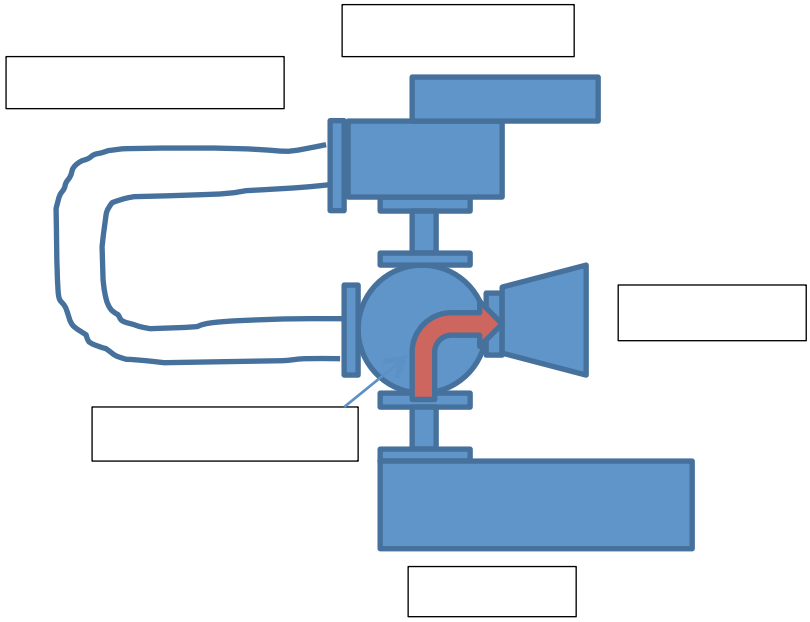
The idea of putting together a quick transverter for 47GHz came to me after 2012 RAL. Having come away with an offset dish (thanks Peter), and a WR-28 four port waveguide switch. It was decided to try and put something together in 4 hours, and have it ready for the '76th' August tests. Of course it took 6 – 7 hours to build, but was finished in time!

The other component that I needed had come from ebay - A Honeywell WR-28 mixer, with IF amplifier attached. I had previously removed the IF amp, and was using it as a X2 multiplier 38 / 76GHz. It worked pretty well in that role giving 1.2mW out for 80mW drive. Hopefully it would work well in its original role as a mixer, but at 47GHz.

From my original Pasolink transverter, I was retaining just the X4 multiplier. This was to be driven at 11.7 GHz from an Elcom synthesiser via an amplifier to achieve sufficient drive. The same synthesiser to be used as LO for the mixer, and TX output.



Waveguide Switch in Receive position.



Waveguide Switch in Transmit position.

The constraints of the 3.33MHz steps with the Elcom, meant using an odd IF of 434.66 – 436.66 MHz, as I wanted to keep the LO on the low side of the RF. Although that was not a problem using the FT817 as IF receiver. The biggest problem was getting a TX signal between 47,088 and 47,089MHz. The nearest synthesiser output was several MHz away. My solution was to use an offset synthesiser reference of 9.999 MHz for TX, while keeping 10MHz for RX. The synthesiser was programmed for 11.663333 for receive, and 11.773333 for transmit. The transmit frequency is then (11.773333 x 4) x 9.999/10 = 47.088624 GHz.

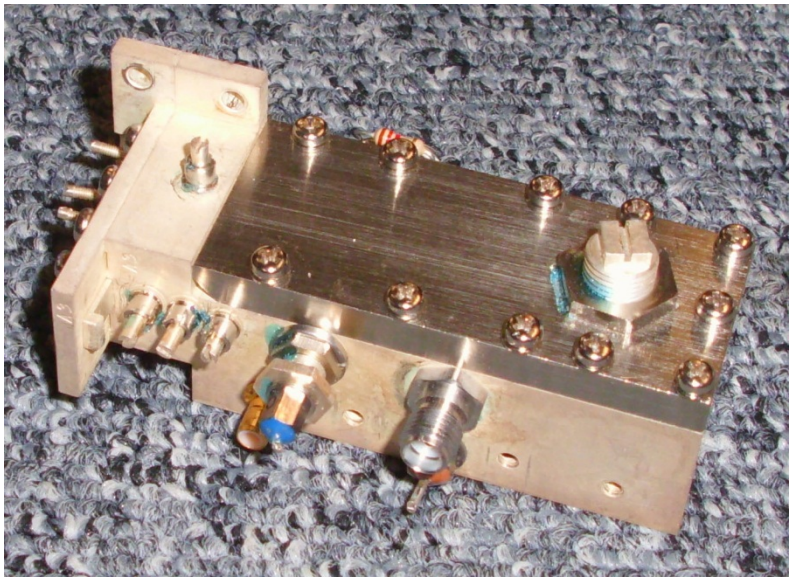
An old crystal oscillator with a heater was to hand, being part of a paging transmitter. The Ovenaire heater was for 85 deg.C I had a Quartz Lab crystal for 9.9921MHz 70 deg.C, but it was of the right order, and near enough in frequency to be pulled.

The oscillator had a varicap which might allow FM, if the FM would pass the pass through the synthesiser OK. A quick previous trial with a TCXO was unsuccessful, as the frequency shift was limited, and it refused to FM, probably due to internal decoupling.

The first stage of the build process was to program the PIC for the two frequencies, and modify the Elcom for external reference. The synthesiser that I had, came with reference in / out connections on the side, ideal I thought. However I could find no way of making it change to external reference input. I concluded that it must be a software command. In the end I just used one of the connections to give a wired reference input connection. Any attempt to keep the internal 10MHz reference running produced a signal like a Christmas tree, when external ref. was used. So in the end I reluctantly used an external 10MHz reference and the 9.999MHz offset ref. switched with a pcb coax relay. To drive the Pasolink multiplier I needed 100mW or so. To get this level I attenuated down the Elcom output and used an Avantek amplifier that would give the power.

Dave G4FRE has an article on his web page about modifying the Pasolink
http://www.g4fre.com/pasolink2.pdf

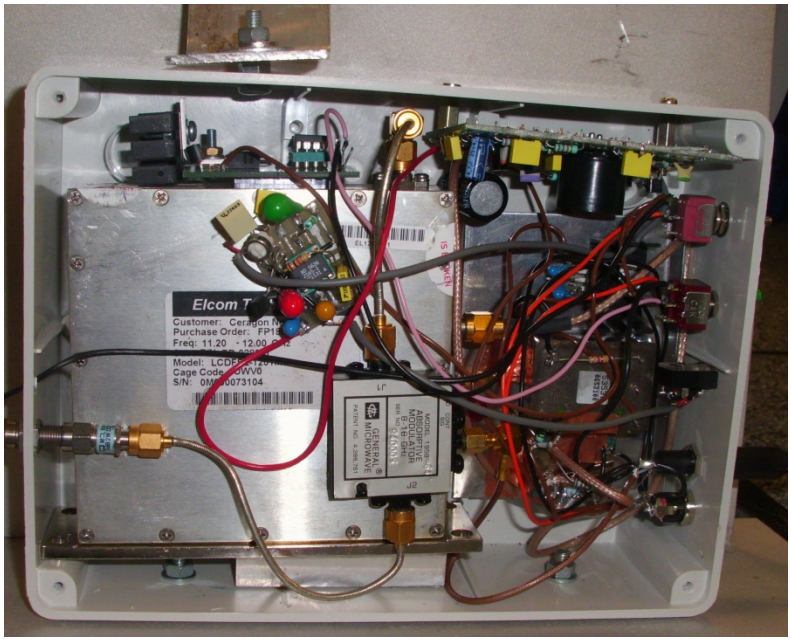
In this case I was just using the x4 multiplier, so alignment was straightforward compared to the multitude of small tuning screws on the whole system! To connect to the output I butted up a WR-28 waveguide flange, and made up a couple of metal strips to hold it in place. Modification is, remove the SMA monitor connector, and remove the spacer below it and screw it back in. Once this is soldered, and the original resonator removed, the SMA becomes the 11GHz input.



Pasolink multiplier from 50GHz unit.

Tuning is by the 4 large screws, and the 3 small ones. However most significant is the slider, under the over-hanging top. This can easily be missed. The screw above it locks it in place. The bias pot is set for maximum output, I measured 5.6V across the it.

I have always struggled to get the claimed output from these multipliers. In this case by upping the drive to +22dBm, I achieved an output of +6dBm (4mW). There is a good rejection of the 23 & 35GHz harmonics, but it may be best not to look too closely at the 58GHz component.



To allow for CW keying, I used an inline ‘modulator’ which switches the synth. output. FM was very last minute. I wanted some audio amplification and limiting. The only thing I found was a compressor chip, that I had never got around to using. This was stuck on the synth. and bias provided for an electret microphone.

The synthesiser and references were crammed into a plastic box – not pretty but it works. The dish, in-line amplifier and waveguide switch were mounted on a base plate as can be seen in the pictures.

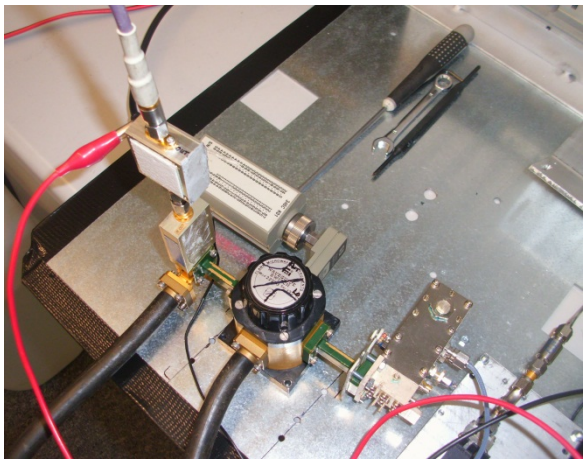
The feed horn was hack sawed through to give the right spacing to the dish. It is likely this under illuminates the dish, but time was running out.

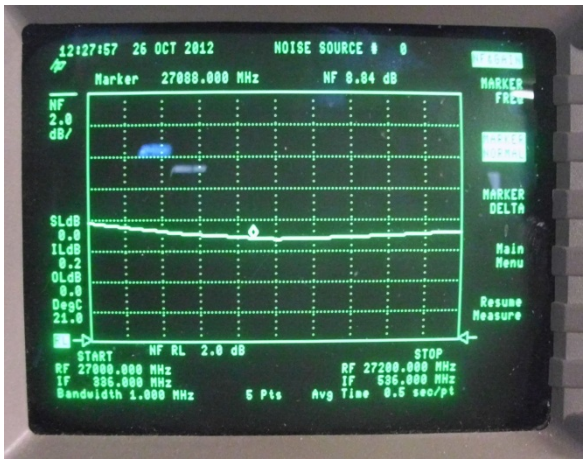
I had previously only had one QSO on the band, with Harold G3UYM/P using a Pasolink system, at the great distance of 100 metres.

The first contact with the transverter was at Bignor Hill, both Peter G3PYB and Ian G8KQW were 59+ at 53km on the Isle of White, with similar reports in the other direction using FM. It was great to know all was working. Dish alignment was not that critical, which probably meant that the feed position was not optimised. Also Ian's comment on the CW when in beacon mode, suggested frequency pulling when in CW mode. Not surprising in that the oscillator had a basic zener 10V regulator, and the keying was causing a significant shift in amplifier current.

58 / 59 FM reports at Ditchling Beacon @ 83km showed the transverter to be working well.

Later noise figure measurement, showed that the WR-28 flexi-waveguide was poor or damaged. When replaced a noise figure of 8.8dB was measured at the input to the waveguide switch, showing the mixer to be working pretty well at 47GHz.





Noise figure measurement with a HP346C K01 source. For 47GHz read 27GHz as the 8593E analyser allows a max. frequency offset of 30GHz!