Last Months Meeting – Millimetric Microwaves

For September we welcomed back Chris Whitmarsh G0FDZ who had previous given us a talk on the Kent GB3VHF/UHF beacons.

Many of you will have glanced at the very highest frequencies shown your licence schedule and thought to yourself "Who on earth uses these frequencies?". The millimetre wave bands are where the wavelength falls below a centimetre and for amateurs these are:-

Frequency, GHz	Wavelength, mm (Approx)
24	12
47	6
76	4
122	2.5
134	2
241	1.2

It so happens that a small but dedicated group of microwave enthusiasts in the UK do use these and they regularly make QSO's, sometimes at surprisingly long distances and with very low power. Equipment for these bands is not to be found in your local emporium so it is one of the areas where some outstanding home construction occurs.

Some of the plus points include the challenge of new microwave territory, particularly above 100GHz, the self-training in of new techniques (even compared to lower microwave bands) and the fun and the sense of achievement of getting it going and operating. Even these bands are not the limit with a few countries having access to the sub-millimetre bands above 275GHz whose huge potential is under investigation for security scanners, super-Wi-Fi and various scientific uses. Some of the recurring issues to be faced are

a) where do get the kit from – which often is solved by multiplying and mixing, though that can result in QRP power levels due to the lack of amplifiers

b) Dealing with the path losses in the atmosphere (mainly the humidity) - so most of the distance records are from high points on cold low-humidity days. Mike Willis G0MJW has free software for this

In the case of the latter the total path loss is the sum of the free space path loss, oxygen losses, water vapour – and any additional losses due to mist or rain. Paths are essentially optical line of sight with very little refraction

Chris G0FDZ has been operational on these frequencies for many years and brought a extensive slide set that explained techniques used for equipment on each of the mmWave bands

At these frequencies coax is very lossy (if it works at all). Above 24GHz waveguide is quite common and is relatively low loss. Antennas are in principle quite simple and a mix of horns or dishes are used.

A key benefit of small wavelengths is that the antennas are compact abut still give remarkable high gain (often ~40dB and occasionally even higher) - the downside of which is you have align the equipment and point things very accurately so a common feature is that telescopic sights are a key accessory

Chris has operational equipment for all of the millimetre-wave bands and brought it along to show us, along with his presentation.

In the early year wideband-FM from Gunn Diodes was used and ranges of of a few kilometres were achieved (sometimes with talkback on 144 MHz). Nowadays this has all changed to narrowband operation courtesy of using surplus synthesisers that provide an initial source in the ~11-13GHz range and set up as part of a transverters from a VHF or UHF source radio. Several bands do have transverters commercially available from DB6NT Kuhne Electronics in Germany though they are pricey. Instead Chris and others often prefer to acquire the bare mixer circuit boards from DB6NTand

assemble their own. On the drive side Chris brought with him his FT817s - he has several so he can have one per transverter !

Chris gave an example of the conversion for the 24 GHz band:-

11.952 x2 (=23.904) +144 MHz = 24.048 GHz (the standard IARU freq) – whereupon the output waveguide acts as a natural high pass filter and removes the lower drive frequencies from the output spectrum. At 24 GHz other parts are readily available so he has a 2Watt PA and GaAs FET LNA.

The transverter approach remains the same for higher bands, but PAs and LNAs are scarcer. The 24GHz band is one of the lossy ones due to a water resonance, but even that has line of site QSO distances of 100+km and even further can be obtained by exploiting troposcatter or rainscatter.

For higher bands at 47GHz and beyond harmonic mixers are used and CW and SSB are the norm. However for transmitters, fundamental mixing is preferred as that gives the most power

As frequencies rise the size of the components, particularly the beam lead mixer diodes, becomes minute and some careful handling is required.

It was nice to see plenty of slides of people operating, and quite a proportion were in Essex including from Danbury Hill, Brentwood and Hanningfield Reservoir. Alas John Wood G4EAT who was a keen operator became a silent key in Feb-2015, but Roger G8CUB is now pushing ahead nearby.

The presentation and the kit on demo showed how all bands inc 122, 134 and even 241 GHz had been activated by Chris – though the latter with just microwatts at present.

Despite the milliwatt powers, the high antenna gains have given impressive UK QSO Distances including:-

- 24GHz: 408km
- 47GHz: 203km
- 76GHz: 129km
- 134 GHz: 35 km

That doesn't include moonbounce which is doable on 24 and 47GHz (with TWT amplifiers)

After the break the talk was wrapped up with lots of questions from the interested audience (some of whom are ex engineers or were intrigued by the construction work). Chairman Chris G0IPU helped draw the raffle and we concluded a really educational and eye-opening evening.

Murray G6JYB, Sep 2016