



### UK Amateur Radio in 47GHz

23-Aug-2016

#### Overview

The 47GHz band is the only amateur allocation between the wide expanse of 24 to 76GHz. Its origins begin with it first being allocated in WRC-79, and was initially severely limited by equipment availability. Some brief highlights from UK records to hand:-

- **UK First use:** 16-Aug-1991 by G3HBW/P and G3HBR using wideband-FM, 50mW into the antenna and 13km distance
- **First International Contact:** 25-Jun-1999 UK-Fr, 34km Dover Castle – Cap Blanc Nez, Calais Peter G3PYB to Hans F/PA0EHG using ~12-15mW Tx into a small dish
- **Distance Record:** 21-Oct-2001 203km (GW0IVA/P on Snowdon N.Wales to GM7MRF&GM0HNW on Cambret Hill, Dumfries)
- **Current 47GHz distances in UK mmWave Contests** (from 2014-2016 logs) ~30 – 93km

47GHz equipment availability and technology have improved since 1979, growing its full potential for amateur usage. 47GHz usage for analogue and digital modes is well established and is serving as a springboard for increasing development and usage in the 76, 122, 134 and 241 GHz amateur bands. Indeed some amateurs are building dual band (eg 24/47 or 47/76GHz) equipment. The longer range on 47GHz enables it to be used cross-band or for talk-back for higher band contacts at 76GHz and above.

There is no mass market of amateur-specific equipment available for this band and operation largely relies on the innovative use and adaptation by amateurs of surplus or redundant commercial (and ex-military) sub-systems and components.



G0FDZ 47 GHz Portable Transceiver  
(Yaesu VHF Transceiver + mmWave transverter)

The 47GHz band, assisted by its Primary amateur status, is one where we have some of the best amateurs as it is used by those with high motivation, self-training etc (ie true amateur radio spirit). The excellent contact distances are attributable to high-frequency stability narrowband kit, high antenna gains and optimised weak signal setups; despite high transmit powers and low receiver noise figures remaining a challenge.

A broader benefit from the activity has been the trickle down of propagation knowledge and precision frequency sources (such as Elcom synthesisers) into the lower microwave bands, as well as pioneering amateur interest in frequencies above 275 GHz. Most recently RSGB has been collaborating with Amsat Groups to support ESA studies (see later) so activity (along with EME/moonbounce in other countries) is broadening from its terrestrial origins.

Nowadays even commercial interests are moving higher in frequency as evidenced by WRC AI 1.15 addressing 275-450 GHz.

Whilst the following is provided in good faith, the Society is concerned by WRC-19 AI-1.13 and certain frequency ranges under study in Resolution 238. The Society is very protective of the Primary allocation to the Amateur and Amateur Satellite services and its microwave enthusiasts, as we also recognise it has great growth potential. The primary allocation provides good motivation for longer more complex projects such as those involving the amateur satellite community, where long-term certainty is especially important.

Overleaf are some answers to the recent Ofcom questions as well as some broader information regarding current and expected usage, geography etc for the amateur and amateur satellite service.

## Ofcom Q+As

### *Current usage of the band – how used is the band by amateurs?*

#### **Current Equipment/Modes**

In the UK almost all active use to date is by relatively modest power narrowband systems (CW, SSB, FM modes etc). A review of recent entries in contest logs indicates transmitter powers are usually in the 0.1-100mW range - into the antenna.

The small (but not too small) wavelength has been ideal for modest portable antennas (dishes/horns) to offer excellent gain<sup>1</sup>. Equipment is typically some form of frequency translation system (so-called transverter) driven by a commercial VHF/UHF amateur transceiver and multiplied/mixed with a high stability low-phase noise local oscillator (often synthesised/locked). A typical user equipment antenna is very directional, whereas beacons often use omnidirectional antennas or sectoral horns.

#### **Spectrum/Bandwidth**

Current UK usage is generally for narrowband (<25kHz) operations and 24/7 propagation beacons centred on 47088MHz. This follows the IARU-Region-1 band plan which has this as the coordinated frequency across the CEPT/Region-1 area.

Wider bandwidth systems (notably Amateur TV and Data links) are generally not yet used in the band, though currently common upto 24 GHz. The directional and portable nature of 47 GHz is ideally suited to ongoing evolution, so we would expect some wideband systems to appear in due course.

#### **Usage/Timing**

Activity is sporadic and led by a few dozen well equipped amateur stations (many of whom have significant test equipment). In addition to adhoc development tests, and weekly activity days, effort is targeted at a series of annual contest events per year. For these occasions, stations will typically travel out to hilltop locations to maximise their potential coverage – achieving long distance contacts are the major attraction. These contacts rely not only on propagation conditions but also stable transmissions and very low noise receivers.

In addition there is long-term 24/7 usage by several propagation beacons which support the above, each of which involve a 'keeper' and additional closedown operators. (see Beacons item later)

**EME(moonbounce) and Satellites** – see overleaf for developments (including ESA support).

### *Where is the band used geographically in the UK?*

As touched on above there is a split usage pattern:-

- a) Development tests will typically be short range in small clusters around the locations of amateur home stations (typically suburban)
- b) Contest activity will see most amateurs travel out to hill top locations, often at some distance from their home station in order to seek out maximum line-of-sight paths
- c) Propagation Beacon locations are generally fairly rural on fixed high points

When the band was first allocated some of the leading amateur home stations were located in Yorkshire as well as South and Southeast England. Usage patterns have seen the South / Southeast / Southwest and Welsh/Scottish stations increase, and specific journeys to the Channel Islands, whilst to date little has occurred in N.Ireland.

For contests, some of the locations and hill tops used include Scotland, Wales, Winter Hill in Lancashire, Ventnor Isle of Wight, Winchester area, Batcombe in Dorset, Danbury Essex etc. This pattern is also similar on 76 GHz. In principle some of the activity reports and contest logs could be accumulated and plotted, though that is significant work.

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<sup>1</sup> A 0.3m (1ft) dia dish has ~40dB of gain at 47GHz assisting link budgets, but requires accurate beam pointing

## Additional 47 GHz Information

### UK 47GHz Beacon Network

Propagation beacons play a key role for both equipment tests as well as propagation studies.

In addition to several personal beacons that we are aware of, Ofcom have licensed the following 24/7 GB3xxx unattended systems:-

- GB3CCX - Cheltenham
- GB3CSB - Central Scotland (Kilsyth – under construction)
- GB3FNM - Farnham
- GB3SCQ - Bell Hill (just licensed in July to replace the current G8BKE system there)



There are some noticeable gaps. Consequently there are current plans to build out the network further with the next most likely locations being the GB3MHZ cluster at the BT Martlesham tower in Suffolk and either Telford (GB3ZME) or Derbyshire in the N.West.

As there is also activity in South Wales, at some point a Cardiff or Swansea site might be in prospect, as they already have 10/24 GHz amateur beacons in collaboration with the universities there.

### Earth-Moon-Earth (moonbounce)

Despite the fact that the path loss is >290dB, internationally several amateur stations (USA, Russia, Australia) have been successful operating 47GHz moonbounce. This has been feasible because they have larger dishes and sufficient power, courtesy of surplus TWTs (~20-40 Watt Tx into a large dish) on 47 GHz – aligned to the 47088 MHz standard narrowband frequency.

Whilst reception of signals from these stations could in principle occur in the UK (we have insufficient data but a keen moonbounce community), so far UK EME (such as the photo) transmissions have been limited to the lower 24GHz allocation due to lack of surplus 47GHz TWT amplifiers. One other consideration is that the very narrow beam angles for 24/47GHz large dish EME makes antenna pointing/tracking accuracy a key consideration, so if UK47GHz occurs it would be expected to be at well-built home stations.



### Contest / Activity

At various times through the year activity days and contests are organised for the mmWave bands, principally by UK Microwave Group (UKuG), but also RSGB and IARU-Region-1.

The UKuG contest calendar has four main contest events per year for 24/47/76GHz (and one event that also includes the 122, 134 and 241GHz bands), run over 09:00-17:00 UTC on a given day.

The Society and UK Microwave Group recognises achievements in these higher bands through awards and trophies (such as the 47GHz trophy opposite) that provide recognition and an incentive to build and innovate.





Additionally, IARU Region-1 encourage mmWave activity by a 'multiplier' system based on

- 24 GHz 1x      47 GHz 2x
- 75/80 GHz 3x    122 GHz 4x
- 134 GHz 8x      245 GHz 10x

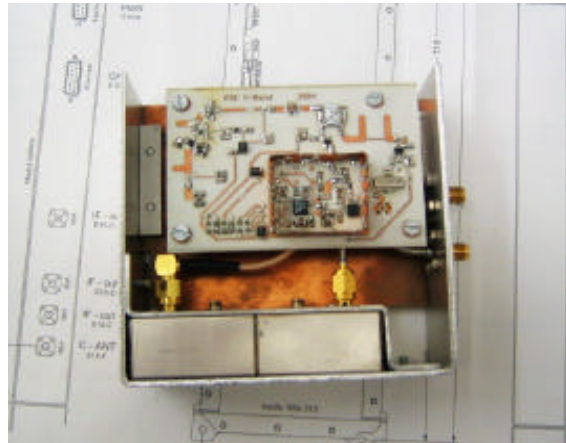
The score is the sum of the points scored on each of the bands, using the multiplication factors for the number of kilometres scored on each band. It is thus not unusual for amateurs to take out 24, 47 and 76 GHz equipment as the antennas and some of the equipment is common to each frequency.

UK amateurs have also recently put a lot of effort into the 134GHz band (even though the power output is lower), as the challenge, higher antenna gain and contest multipliers are quite attractive.

### Amateur Satellite Service

To our knowledge there are no 47GHz amateur satellite systems in service, but a number have been planned and RSGB and Amsat-UK has been supportive of these efforts. It is recognised that the high Doppler and narrow antenna beam angles make LEO CubeSats a fairly unsuitable platform, so most opportunities have been sought on somewhat larger attitude-stabilised platforms. Chronologically:-

**a) Germany - Amsat-DL:** Phase-3E is a HEO mission (~150kg at launch, spin-stabilised) with a 47088MHz beacon. This has been seeking a low-cost launch opportunity for the past few years.



**Phase-3E: The 5.8 GHz P3E transmitter is also the driver for the 47 GHz beacon**

**b) UK/Europe:** ESEO - ESA Student Earth Orbiter is the third mission within the ESA Education Satellite Programme. In the earlier phases a propagation beacon was one of the payload options and some preliminary work occurred, though that is less clear now as far as 47 GHz is concerned.

**c) Europe (with UK support).** A prime and current opportunity which amateurs have collaborated on is an ESA study and mission that would see 47GHz and 76GHz amateur beacons, accompanied by a distributed ground segment of amateur and professional groundstations for propagation and related measurements.

Original Tender:

<https://artes.esa.int/funding/cubesat-based-w-band-channel-measurements-artes-51-3b033>

Subsequently retendered in March-2016 as:-

ESA AO8565: "CUBESAT-BASED W-BAND CHANNEL MEASUREMENTS"

(which has IARU-R1 frequency coordinators, SMEs and Universities involved)

The test platform is expected to be a large stabilised CubeSat, launch 2019, mission 2yrs+