

Microwaves

Here's a part of amateur radio where experimentation and construction are still alive and well. It is an area that has not been dominated by the 'black-boxes' of the lower frequencies.



What are microwaves?

- Frequencies above 1000MHz (1GHz)
- Short wavelengths - less than 30cm
- "Pioneer" bands where the spirit of self training is alive and well!

Amateur microwaves are often regarded by the 'uninitiated' as an area where angels fear to tread! Many radio amateurs are put off by the apparent high level of technology required and the belief that distances achieved are governed by line-of-sight. Nothing could be further from the truth! There are many microwavers who had minimal technical expertise at the start but who acquired much along the way. Lots of microwavers have worked DX over hundreds if not thousands of kilometres. Today, most microwave equipment today is printed circuit board based. Waveguide (once nicknamed 'plumbing') is still used but only in short lengths to make feeds and feed horns for antennas.

The Microwave Bands

Many of these bands shown in the following list contain amateur beacons and repeaters which are useful for frequency calibration and as indicators of propagation conditions. A more detailed spectrum allocation can be found in the Bandplans Section of this Yearbook and on the RSGB Spectrum Forum website.

23cm	1240.0	-	1325.0MHz
13cm	2310.0	-	2450.0MHz
9cm	3400.0	-	3475.0MHz
6cm	5650.0	-	5680.0MHz
6cm	5755.0	-	5765.0MHz
6cm	5820.0	-	5850.0MHz
3cm	10.000	-	10.125GHz
3cm	10.225	-	10.500GHz
12mm	24.00	-	24.25GHz
6mm	47.00	-	47.2GHz
4mm	75.50	-	81.0GHz
and...	122.25-123,		134-141GHz
	241-250GHz		

Many bands are shared with other users and increasingly under threat from commercial interests!

- If we don't use them then we might lose them!

What can we do with microwaves?

The microwave bands can be used with a wide variety of transmit and receive modes. **Wideband** modes include amateur television and simple wideband FM telephony, whilst longer range **narrowband** modes include CW and SSB - the choice is yours! There are 50 active ATV repeaters on the 23, 13 and 3cm bands which have sufficient bandwidth for high quality amateur TV transmissions.



There are also many interesting microwave propagation modes. On most of bands **troposcatter** is important while **ducting** produces openings like those on VHF. On 5.7GHz and 10GHz, **rain-scatter** is a major propagation mode. On 24GHz absorption by water in the atmosphere becomes a problem but it has not deterred UK microwavers from having a go! The UK DX record on this band is almost 400km.

Microwave **EME** (moonbounce) is possible with quite small antennas. Even **aircraft reflection** is widely used!

Some operators started on microwaves through an interest in the AMSAT **satellites** which use microwave bands. Most microwave operation is via transverters from the VHF/UHF bands (23cm being an exception).

There has been a massive leap in the technology available for the microwave bands over the last twenty years, mainly from the mobile phone and satellite TV industry.

Amateur microwavers can be found all around the world especially in North America, Western Europe, Australasia and Japan. 10GHz EME contacts have been made between Europe (including the UK) and Australasia. USA and Canadian stations have worked into Russia on 47GHz EME! A few UK

amateurs have even heard Deep Space satellites such as Venus Express, while others have strong links with Radio Astronomy.

You can also

- Chat to folk ... just like HF!
- Experiment ... especially with high gain antennas
- Do propagation research.
- Make your own equipment
- Exchange information over microwave data links
- Enter contests
- Chase DX
- Make some really good friends

How did amateur microwaves come about?

As early as 1894 to 1896, Jagadish Chandra Bose experimented on 60GHz over a one mile distance using primitive semiconductors! He was the 'Father of Microwaves'.

In **1946** the first amateur microwave contacts were recorded in the USA when W1LZV/2 worked W2JN over two miles on 10GHz and W1NVL/2 worked W9SAD/2 on 21.9GHz (800 feet!). The World 10GHz record was set at 7.6 miles by W4HPJ/4 and W6IFE/3.

The first UK microwave contact was made in **1949** by G3BAK and G3LZ over 27 miles, a new world 10GHz record.

In the **1960-80s** the 10GHz world DX record was increased to 426km when W7JIP/7 worked W7LHL/7. The record stood until 1976.

It was all wideband FM on 10GHz with klystrons in the 1960s-70s and Gunn diodes in the 70s-80s. Then, in the late **1980s**, Mike Walters, **G3JVL** developed a low power (0.5mW) 10GHz **narrowband** CW/SSB waveguide transverter – a landmark development.

In the early **1990s**, Charlie Suckling, **G3WDG**, and Sam Jewell, **G4DDK**, developed modules based on PCBs. Available in kit form, they revolutionised UK 10GHz operating, and as distances rose wideband techniques declined.

In **1996**, G3WDG worked VK2ALU via 10GHz moon bounce (EME) and the world 10GHz terrestrial record was extended to 1912km by VK5NY and VK6KZ

From **1996** to the present, amateurs have gone higher in frequency with narrowband transmissions on 47, 75 and 142GHz. 10GHz DX work is now all on narrowband with several watts output power commonplace. In addition commercial kits and ready-made modules by DB6NT, DL2AM and Down

East Microwaves have come on the amateur market.

In 2000 we saw a new 10GHz DX record, 2000 kilometres between Italy and Israel and the first 24GHz and 47GHz EME contacts.

Aren't all microwave contacts line-of-sight?

Certainly not! It was so in the early days but not with today's higher power levels and narrowband CW/SSB equipment. The latter is capable of much greater distances over non line-of-sight paths, than the 1970s wideband equipment.



While lightweight hill-topping and backpacking up Scottish mountains is still a fun exercise, there is no real need to do so except on the higher bands, above 24GHz. Portable these days usually means from a vehicle. Home station operation, unusual on 10GHz before 1985, is now commonplace. The simple wideband FM gear dropped out of favour for some years but is now seeing a resurgence, particularly among S.O.T.A members, as more beginners take this easy and cheap route into microwaves.

Narrowband techniques have led amateurs to develop new skills in soldering surface mount components onto microwave quality printed circuit board. Activity has increased and new distance records set.

How far can you get ?

UK Microwave Terrestrial Records

Band, GHz	Distance, km
1.3	2617
2.3	1083
3.4	980
5.7	1244
10	1275
24	391
47	203
76	79.6
134	17.7
145	1.29
Light (red)	76

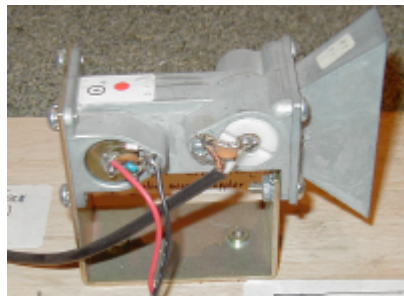
Ways into microwaves

- Buy commercial equipment
- Build your own gear
- Modify surplus
- Borrow equipment

The 1.3GHz (23cm) band is the easiest one on which to make a start. There's a lot of ready-made gear, including antennas for this band, and eBay is a great for microwave surplus.

What about "simple" 10GHz wideband gear?

- It's easy to make but you need to know how to solder!



Above: The Solfan Gunn module
Below: A more modern Satellite LNB



- Simple transmitters use Gunn diodes or Satellite TV DROs.
- Some components can be found at Maplin stores or J.Birkett in Lincoln.
- It all runs off a small 12 volt battery
- Low power output (5 to 10mW)
- If you can't find a Gunn module it's possible to use Sat-TV LNBs instead. They make excellent receivers!
- **Full details at www.g3pho.org.uk**

All levels of licence holders from Intermediate upwards can operate on 10GHz. You might not work very far so you need to work in pairs with a pal. It's an excellent, fun and cheap way to "wet your feet" in microwaves. Don't forget you will also something for **talkback liaison**, be it a phone or 2m ssb.

Microwave Antennas

On 1296MHz and 2.3GHz, yagi or dish antennas are the norm. High gain dishes and horns are the most

commonly used antennas at 3.4GHz and up as their size becomes more convenient.

Microwave antennas give much higher gains than HF ones! 10mW of 10GHz into a 60cm dish is almost 40W ERP (about the same as 10 watts into a 14MHz triband beam!). A 60cm, ex-Satellite TV dish on 10GHz can have a gain of 35dB and thus have a potential range greater than 144MHz, despite lower transmit power. Of course you have to point the dish more accurately than your 2m yagi. Microwave meetings in the UK often have a useful antenna test range available to help setting up.

Do you enjoy home construction?

If so, then microwaves are for you, since almost all microwave gear for bands above 1296MHz needs to be home assembled.

Today kits are widely available, especially from DB6NT in Germany and G3WDG in the UK. DB6NT also markets ready made modules for most microwave bands. New skills can be acquired, such as soldering very small components to pcb boards and aligning homemade modules.



Michael Kuhne, DB6NT rules! His kits are built the world over - or buy ready made.

Whatever the mode,

- You have to point the dish accurately, usually to within 1 degree
- You need accurate bearing information to the other station
- You need to know the other station's frequency
- Clear takeoffs make for better signals
- Antenna supports must be firm to withstand strong winds



A 10GHz narrowband system based around a DB6NT basic transverter kit, a GBACE designed ovened crystal oscillator kit and a DB6NT ready made 5W PA

Test gear for microwaves?

Simple 10GHz Gunn diode gear can be set up with very basic test gear such as a multimeter and a wavemeter (sometimes found at rallies). You could, instead, use a local beacon, if available, for alignment purposes or contact your local amateur microwave “elmer”. A list of elmers can be found at the UK Microwave Group’s website:

www.microwavers.org

Narrowband (ssb/cw) gear needs more sophisticated test gear. However you can usually access such equipment at amateur microwave meetings, called ‘roundtables’, held around the country each year. Your local university or college may also have a friendly member of staff who may help. Don’t be afraid to ask local amateurs for help.

Microwave Round Tables



Each year in the UK, there are gatherings, “Round Table Meetings,” at which over 100 microwavers, sometimes from as far a field as the USA and Australia, meet to hear lectures, check their equipment on sophisticated test gear, enjoy bargains at fleamarkets, meet for evening dinner and generally have a great time.

There are three main UK meetings each year ...

- **Martlesham** (Suffolk) – November
- **Rutherford Appleton Laboratories** (near Oxford) – April
- **Crawley Amateur Radio Club** (South of London) – September

How can I get into microwaves?

- Check out Peter Day G3PHO’s “World Above 1000MHz” website at www.g3pho.org.uk
- Make the simple beginner’s 10GHz wideband FM transceiver described on the website ... work with a friend
- Subscribe to the UK Microwave Group and receive its newsletter Scatterpoint.
- Visit www.microwavers.org the website of the UK Microwave Group
- Search the Internet for hundreds of great amateur microwave websites.
- Buy or borrow basic microwave books – simple ones do exist !

The UK Microwave Group

- Supports and represents all UK microwavers at RSGB level.
- More detailed information about the Group can be found in the Affiliated Societies section of this Yearbook.

That’s it for now

The rest is up to you. Get out there and have a go at microwaves. You’ll not regret it. It will liven up your amateur radio and give you a real sense of achievement.

You’ll no longer be a “black box operator”!