In This Issue

288GHz First Contact

Finningley Microwave Round Table

Subscription Information

The following subscription rates apply.

UK £6.00   US $12.00   Europe €10.00

This basic sum is for **UKuG membership** For this you receive Scatterpoint for **FREE** by electronic means (now internet only) via

https://groups.io/g/Scatterpoint and/or Dropbox Also, **free access to the Chip Bank**

Please make sure that you pay the stated amounts when you renew your subs next time. If the amount is not correct your subs will be allocated on a pro-rata basis and you could miss out on a newsletter or two!

You will have to make a quick check with the membership secretary if you have forgotten the renewal date Please try to renew in good time so that continuity of newsletter issues is maintained. Put a **renewal date reminder** somewhere prominent in your shack.

Please also note the payment methods and be meticulous with PayPal and cheque details.

PLEASE QUOTE YOUR CALLSIGN!

Payment can be made by: PayPal to

ukug@microwavers.org

or a cheque (drawn on a UK bank) payable to 'UK Microwave Group' and sent to the membership secretary (or, as a last resort, by cash sent to the Treasurer!)

Articles for Scatterpoint

News, views and articles for this newsletter are always welcome.

Please send them to
editor@microwavers.org

The CLOSING date is
the FIRST day of the month

if you want your material to be published in the next issue.

Please submit your articles in any of the following formats:

Text: txt, rtf, rtfd, doc, docx, odt, Pages

Spreadsheets: Excel, OpenOffice, Numbers

Images: tiff, png, jpg
Schematics: sch (Eagle preferred)

I can extract text and pictures from pdf files but tables can be a bit of a problem so please send these as separate files in one of the above formats.

Thank you for you co-operation.
Roger G8CUB

Reproducing articles from Scatterpoint

If you plan to reproduce an article exactly as in Scatterpoint then please contact the Editor – otherwise you need to seek permission from the original source/author.

You may not reproduce articles for profit or other commercial purpose. You

may not publish Scatterpoint on a website or other document server.

UKµG Project support

The UK Microwave Group is pleased to encourage and support microwave projects such as Beacons, Synthesiser development, etc. Collectively UKuG has a considerable pool of knowledge and experience available, and now we can financially support worthy projects to a modest degree.

Note that this is essentially a small scale grant scheme, based on 'cash-on-results'. We are unable to provide ongoing financial support for running costs – it is important that such issues are understood at the early stages along with site clearances/licensing, etc.

The application form has a number of guidance tips on it – or just ask us if in doubt! In summary:-

- Please apply in advance of your project
- We effectively reimburse costs - cash on results (eg Beacon on air)
- We regret we are unable to support running costs

Application forms below should be submitted to the UKuG Secretary, after which they are reviewed/ agreed by the committee

www.microwavers.org/proj-support.htm

UKµG Technical support

One of the great things about our hobby is the idea that we give our time freely to help and encourage others, and within the UKuG there are a number of people who are prepared to (within sensible limits!) share their knowledge and, what is more important, test equipment. Our friends in America refer to such amateurs as "Elmers" but that term tends to remind me too much of that rather bumbling nemesis of Bugs Bunny, Elmer Fudd, so let's call them Tech Support volunteers.

While this is described as a "service to members" it is not a "right of membership!"

Please understand that you, as a user of this service, must expect to fit in with the timetable and lives of the volunteers. Without a doubt, the best way to make people withdraw the service is to hassle them and complain if they cannot fit in with YOUR timetable!

Please remember that a service like our support people can provide would cost lots of money per hour professionally and it's costing you nothing and will probably include tea and biscuits!

If anyone would like to step forward and volunteer, especially in the regions where we have no representative, please email john@g4bao.com

The current list is available at

www.microwavers.org/tech-support.htm

UKµG Chip Bank – A free service for members

By Mike Scott, G3LYP

Non-members can join the UKµG by following the non-members link on the same page and members will be able to email Mike with requests for components. All will be subject to availability, and a listing of components on the site will not be a guarantee of availability of that component.

The service is run as a free benefit to all members of the UK Microwave Group. The service may be withdrawn at the discretion of the committee if abused. Such as reselling of components.

There is an order form on the website with an address label which will make processing the orders slightly easier.

Minimum quantity of small components is 10.

These will be sent out in a small jiffy back using a second class large letter stamp. The group is currently covering this cost.

As many components are from unknown sources. It is suggested values are checked before they are used in construction. The UKµG can have no responsibility in this respect.

The catalogue is on the UKµG web site at
www. microwavers. org/chipbank. htm

UK Microwave Group Contact Information

Chairman: Neil Underwood
G4LDR
email: g4ldr@btinternet.com
located: Wiltshire IO91EC
Tel: 01980 862886

General Secretary: John Quarmby
G3XDY
email: secretary@microwavers.org
located: Suffolk JO02OB
Tel: 01473 717830

Membership Secretary: Bryan Harber
G8DKK
email: membership@microwavers.org
located: Hertfordshire IO91VX

Treasurer: Dr John Worsnop
G4BAO
email: treasurer@microwavers.org
located: Cambridgeshire JO02CG
Tel: 01223 862480

Scatterpoint Editor: Roger Ray
G8CUB
email: editor@microwavers.org
located: Essex JO01DP
Tel: 01277 214406

Beacon Coordinator: Denis Stanton
G0OLX
email: beacons@microwavers.org
located: Surrey

Scatterpoint Activity news: G4BAO as above   scatterpoint@microwavers.org
Contests & Awards Manager: G3XDY as above   g3xdy@btinternet.com

Assistants

Murray Niman	Webmaster	G6JYB	g6jyb@microwavers.org
Kent Britain	USA	WA5VJB/G8EMY	wa5vyb@flash.net
Mike & Ann Stevens	Trophies	G8CUL/G8NVI	trophies@microwavers.org
Noel Matthews	ATV	G8GTZ	noe@noelandsally.net
Robin Lucas	Beaconspot	G8APZ	admin@beaconspot.uk
Chris Whitmarsh	mmWaves	G0FDZ	chris@g0fdz.com
Mike Scott	Chip Bank	G3LYP	g3lyp@btinternet.com

UK Regional Reps

Martin Hall	Scotland	GM8IEM	martinhall@gorrel.co.uk
Gordon Curry	Northern Ireland	GI6ATZ	gi6atz@qsl.net
Peter Harston	Wales	GW4JQP	pharston@theiet.org

Loan Equipment

Don't forget, UKuG has loan kit in the form of portable transceivers available to members for use on the following bands: **Contact John G4BAO for more information**

5.7GHz   10GHz   24GHz   47GHz (coming soon)   76GHz

Chairman's Notes

The summer months are a busy period for microwave events and contests as well as the usual radio rallies up and down the country. When I was persuaded to take on the role of Chairman at the AGM in April I set myself the goal of trying to attend all of the microwave round tables in the UK during my tenure. I have always tried to support the ones in the South of England but had never ventured towards the north. This year, at the end of June I headed up to the Finningley event near Doncaster. On the Saturday the British Amateur Television Club (BATC) took centre stage with talks and demonstrations of digital ATV including contacts via the Q0-100 satellite. A number of UKuW group members attended this television day. The Sunday saw the microwave roundtable which again was well attended. It was good to meet with many of the membership and to meet some of you who I had not met before. Thanks must go to Kevin (G3AAF) and the members the Finningley Amateur Radio Society for organising the event.

The RAL roundtable in Oxfordshire was held a couple of weeks before the Finningley event. As always it was organised by Mike G8CUL and Ann G8NVI and the members of the Harwell Amateur Radio society who did a great job again, thank you. There were a number of interesting talks and several members selling useful surplus equipment and components (I always seem to miss out on the bargains at these events).

With so many events there will always be clashes; the date for the June mm-wave contest (24GHz and up to 241GHz) had to be moved as it had been scheduled to be on the same day as RAL. Finningley however did clash with the 5.7 and 10GHz contest so may have reduced the number of entries for that contest. The clubs and societies and the UKuW group try to prevent clashes but it is not always possible as the contest calendar is set before the start of the year and dates of the roundtables organised by local societies are often dictated by availability of suitable venues.

In the news in recent months (and I'm not thinking of the 'B' word), has been the threat to both the 2m band and 23cm band from commercial users. Whereas the threat to sharing the 2m band with non-critical aeronautical users has gone away, the issue of sharing the 23cm band with satellite navigation systems, especially Galileo remains. Following the European Union's insistence, the national radio regulators within the EU agreed at the European Conference of Postal and Telecommunications Administrations (CEPT) meeting in August that the issue be put to the upcoming World Radio Conference (WRC) 2019 being held in November as an agenda item for the WRC in 2023. If this is adopted by WRC19 then the IARU and national member societies around the world will need to build a case to defend our use of the 23cm band. We as amateurs really do need to demonstrate that we make use of 23cm (and the other bands) especially as some amateur microwave allocations in some European countries have been taken away at short notice in recent months. There was some good news from the CEPT meeting, it looks as if 47GHz band will remain as a primary amateur allocation.

Neil Underwood, G4LDR.

QRO 23cm Harmonic Filter and Reflectometer

John Quarmby G3XDY

Harmonic output from microwave SSPA's seems to be rather neglected in some designs I have seen. As more of the lower microwave bands are taken up with mobile telephony, we need to ensure our out of band spurious emissions are kept under control. This filter aims to do that job whilst being capable of handling powers >400W with low losses. By using stubs to suck out the harmonics the Q factor of the filter at 1296MHz can be kept quite low so the peak currents and voltages in the filter are minimised. The first version of this filter was built back in 2010 and used with my previous SSPA using 8 x MRF286 devices. The prototype was built in a brass box and adjusting it required a lot of screws to be removed and replaced. When building a Mk2 SSPA using a modern 50V LDMOS PA device I decided to design an easier to adjust version that would fit inside a standard tin box. With the advent of laser cut metal parts the filter line could be easily mass produced.

Circuit
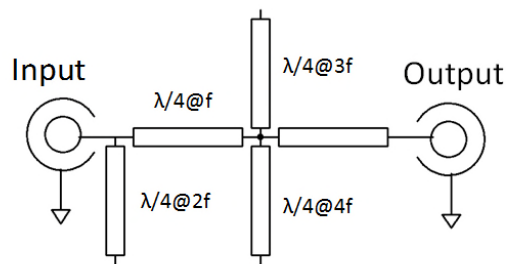
The filter section consists of a quarter wave stub resonant at 2592MHz, and two stubs resonant at 3876MHz and 5184MHz spaced along the line so as to cancel the reactance of the lower frequency stub at 1296MHz. Each stub shorts out any harmonic energy and reflects it back towards the source.

The filter was simulated using the free Sonnet Lite tool, with stub sizes and line widths/lengths adjusted to get a satisfactory result. The aim was to achieve 30dB suppression of the second third and fourth harmonics, to exceed 23dB return loss in band, and through losses well below 0.1dB. The end results of the simulation are shown in the figure below:

Simulation Result

S11 -25dB @1296MHz

30dB Notch @ 2.6GHz   Box Resonance

28dB Notch @ 3.9GHz

52dB Notch @ 5.2GHz
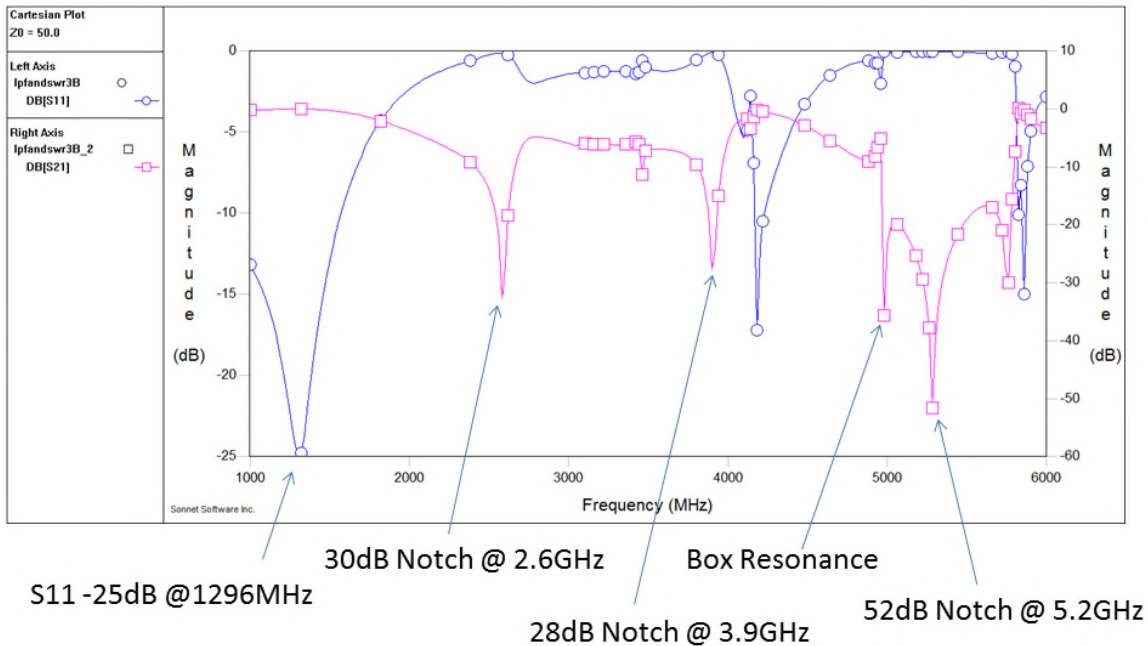
The final change made was to use a custom designed PCB groundplane with the reflectometer sense lines and detectors built into the board. This makes the filter easy to implement, just requiring the use of a bench drill and some filing, rather than any machining.

PCB Groundplane
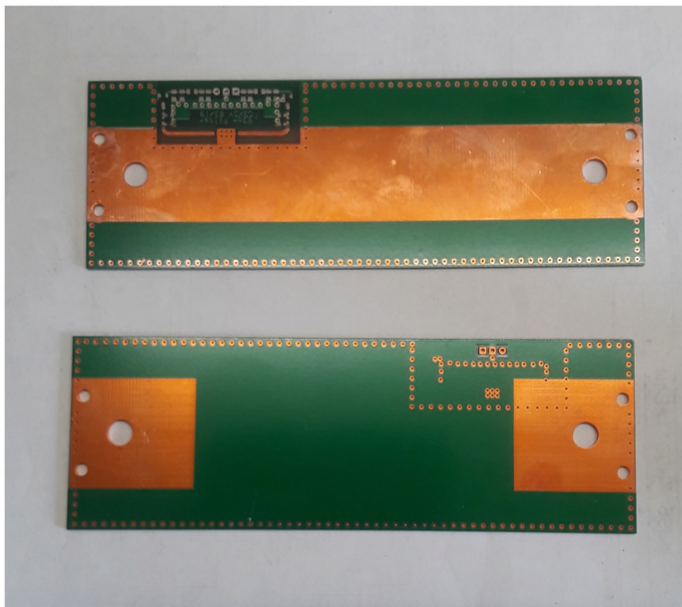
Laser Cut Filterline
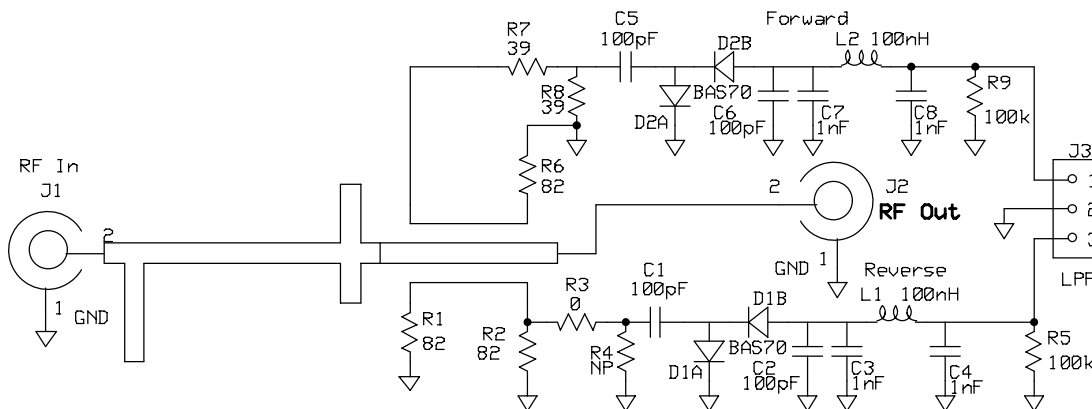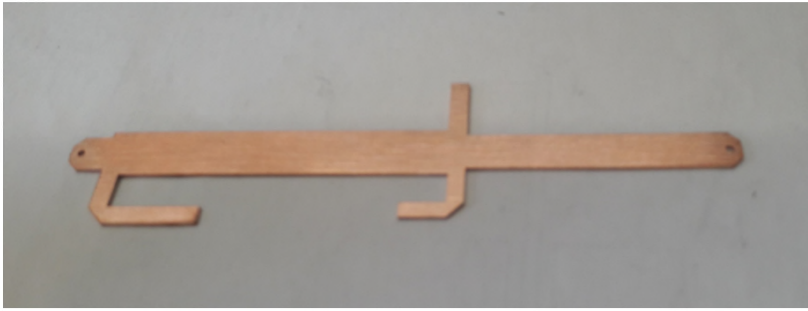
The circuit of the complete harmonic filter/reflectometer is shown above. The reflectometer uses separate coupled lines for forward and reflected waves. With the component values shown the prototype forward detector produces just less than -5V for 600W forward power, whilst the reverse detector produces -1V for 60W of reflected power. The circuit below can be used to invert the signals for application to devices needing a +ve going signal such as PICs or Arduino controllers. A microcontroller can be used to linearise the power scale using a look up table.
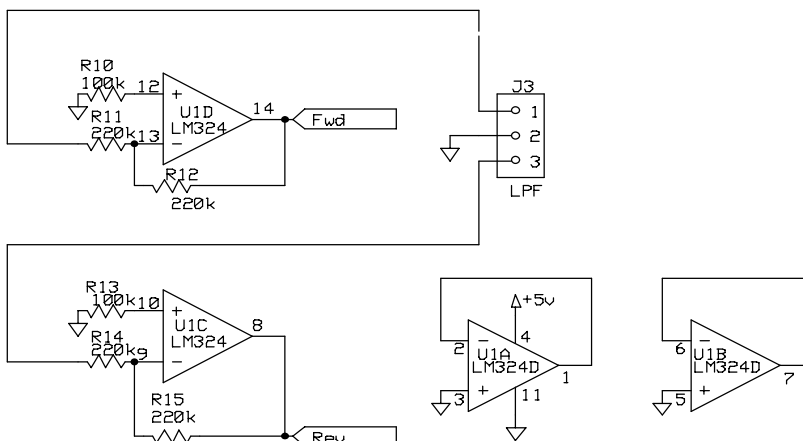
Kit Assembly

Start by marking out the box lid using the PCB as a guide for the holes needed for J1, J2 and J3, making sure the PCB is centralised on the lid as the clearances to the edges are tight. The central holes for J1 and J2 need to be 6.5mm in diameter. When the holes have been drilled and filed and any swarf and sharp edges removed, make a trial assembly with the N type sockets and PC forming a sandwich with the lid as the filling and the PCB inside on the flanged side of the lid. Check that the box sides can be fitted around the board and that the top cover can be fitted in place. Once any necessary adjustments have been made, solder the

box sides together and solder the top lid (not the one with the PCB attached) to the box sides, using a temperature controlled iron with a large bit. After the assembly has cooled, check that the box can be removed/refitted from the lid carrying the PCB. There may be some benefit in rigidity if additional screws are placed as shown in the photo, on either side of the line near the centre of the box, the holes for these can be drilled now.
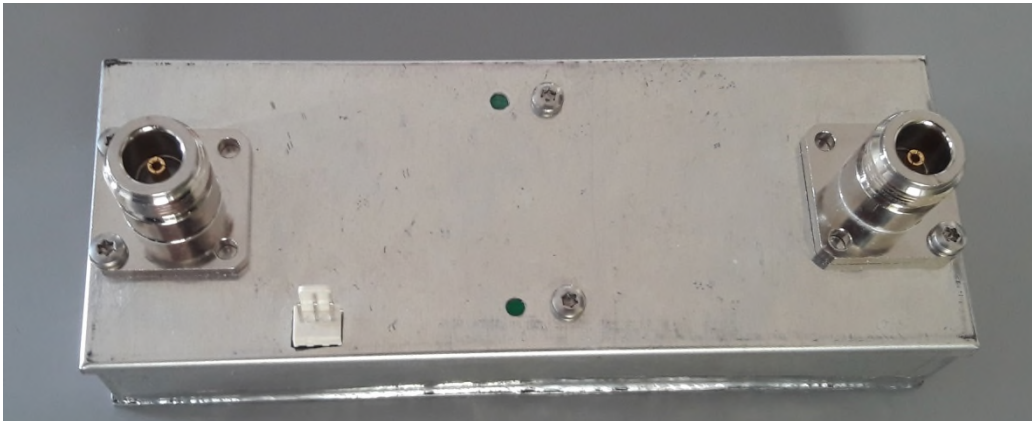
At this stage the SMD components can be added to the PCB. Clean the PCB with a PCB cleaner before starting, you may find it beneficial to tin the component pads before adding the parts. Solder in the R's and C's first, then the two inductors and finish with the dual Schottky diodes D1 and D2. The DC output connector J3 may be added now. If you need to reduce the sensitivity of the reflectometer then there are pads provided to allow construction of attenuators using 0603 resistors. Calculation of the resistors needed should be based on a terminating impedance of 80 ohms for the line. Note that the diodes don't look like a resistive termination, they exhibit mostly capacitive reactance, so simple voltage dividers can be used made from two resistors that add up to near 80 ohms.

Now measure the height of the centre pins of the N connectors above the PCB groundplane. Remove the connectors and carefully saw and file to leave 2.5mm protruding above the ground plane.

Enlarge the holes in the copper line to just fit over the N centre pins, increasing the drill diameter in stages and feeding the drill slowly to avoid damaging the line. File it if needed to get the alignment correct.

The line spacing required is 1.6mm above the groundplane to the underside of the line, easily jigged using odd scraps of FR4 PCB material. Clamp the line in place on the spacers then use a hot soldering iron to solder the line in place at each end. It should look like this:
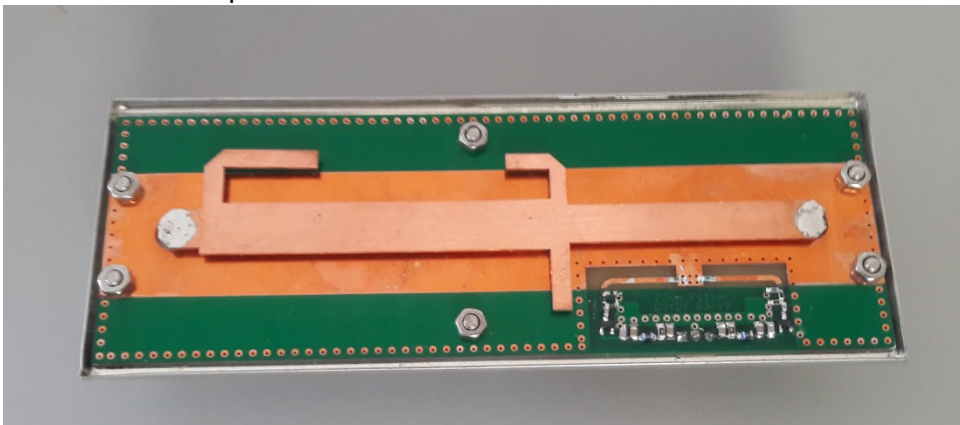
If you use small flange connectors with a thin centre pin, the holes in the line are the right diameter as supplied. You will need to drill additional holes through the flange into the box lid and PCB to accommodate fixing screws. Silver plated flanges of either size can be soldered to the box lid to ensure good grounding if you have a suitable soldering iron.

Tuning up

To tune up the filter you will need either a network analyser or a combination of spectrum analyser, signal generator, and a reflectometer bridge, The first stage is to check and adjust the in band return loss, using

the set up in the figure below. By bending the line up or down a little in between the filter stubs it should be possible to achieve more than 25dB return loss at 1296MHz.

Tuning Return Loss
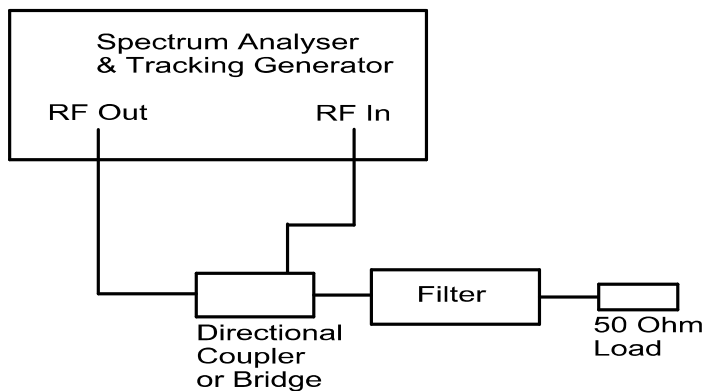
Having established the correct line impedance, then turn your attention to the stubs, starting with the longest one. This needs to be tuned to put a notch on 2592MHz. Using the set up below, start by looking over the range 2350MHz to 2850MHz to find the notch, then adjust the free end of the stub with pliers to tune it. Put the lid on the unit when measuring to ensure accuracy. The tuning is very sharp and may require some patience because the copper line is quite springy. Use a second pair of pliers and a piece of FR4 PCB as a spacer to hold the fixed end of the line firmly in place to make the process easier. Repeat this for the other two stubs, the shortest one should be tuned to 5184MHz and the intermediate one to 3876MHz. If you want to be sure you can then repeat the setting up process to get the best overall performance.

Tuning The Stubs
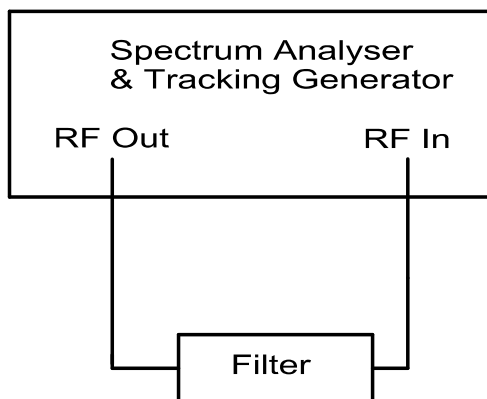
If you have a calibrated power measuring capability then you can check the reflectometer DC outputs using the intended transmitter and draw your own calibration chart. The prototype figures below give a guide to what you should see. Some typical performance graphs are included at the end.

Forward		Reverse	
Power	-DC Out	Power	-DC Out
0	0	0	0
10	0.06	7	0.042
20	0.16	10	0.092
30	0.29	15	0.181
40	0.42	20	0.273
50	0.56	25	0.364
75	0.91	30	0.46
100	1.2	40	0.644
150	1.84	50	0.815
200	2.3	60	0.97
250	2.72		
300	3.08		
350	3.45		
400	3.73		
450	4.05		
500	4.35		
550	4.64		
600	4.88		

Component List

Laser cut copper line		G3XDY
Groudplane/Reflectometer PCB		G3XDY
Tin Box 55.5x148x30 No1000107		G3NYK
N type connectors J1/J2	e.g.	G0KSC EBay

These must have a completely flat back.

R1	82 ohm 0603 SMD	G3XDY
R2	82 ohm 0603 SMD	G3XDY
R3	0 ohm link 0603 SMD	G3XDY
R4	Not required	
R5	100k ohm 0805 SMD	G3XDY
R6	82 ohm 0603 SMD	G3XDY
R7	39 ohm 0603 SMD	G3XDY
R8	39 ohm 0603 SMD	G3XDY
R9	100k ohm 0805 SMD	G3XDY
C1	100pF 50V 0603 SMD	G3XDY
C2	100pF 50V 0805 SMD	G3XDY
C3	1nF 50V 0805 SMD	G3XDY
C4	1nF 50V 0805 SMD	G3XDY
C5	100pF 50V 0603 SMD	G3XDY
C6	100pF 50V 0805 SMD	G3XDY
C7	1nF 50V 0805 SMD	G3XDY
C8	1nF 50V 0805 SMD	G3XDY
L1	100nH 0805 SMD	G3XDY
L2	100nH 0805 SMD	G3XDY
J3	3 pin 0.1" KK plug	G3XDY
D1A,B	BAS70-04	G3XDY
D2A,B	BAS70-04	G3XDY

Hardware: M3 stainless steel screws 8mm long and M3 stainless steel nuts

Kits consisting of the laser cut filter line, the groundplane PCB, and the SMD parts required can be obtained from the author for £25 plus £2 postage. Please contact me at g3xdy@btinternet.com to arrange payment. The groundplane PCB will now include holes for the small footprint version of the N type connector. The tin boxes are available from G3NYK, and suitable N connectors with a flat back can be found on eBay. Performance plots are shown below. Insertion loss is of the order of 0.05dB (difficult to measure at this level).

Agilent Technologies   Stimulus Response - Return Loss   20:22:58 Mar 10, 2019   **Rev 2.0**

Save

Avg: Exponential (4/4)

Calibrated (1.2 GHz - 1.4 GHz)   MKR1: 1.296 GHz
-24.1 dB, 1.13 SWR

Save Now

dB
-18.0

-19.0   Type
Screen
-20.0

-21.0

-22.0

-23.0

-24.0   1   Name

-25.0

-26.0   Location
USB

1.2 GHz   Center 1.3 GHz   1.4 GHz

	Best	Worst
Frequency	1.320784 GHz	1.2 GHz
Return Loss	-24.9 dB	-17.9 dB
SWR	1.12	1.29

Catalog

Screen Image capture in progress ************************   Int Ref ●

Agilent Technologies   Stimulus Response - Two Port Insertion Loss   15:43:52 Mar 10, 2019   **Rev 2.0**

Marker

Marker 3.901 GHz   Avg: Exponential (4/4)

Marker

Normalized   MKR3: 3.901 GHz
-27.3 dB   1   2   3   4

dB   Normal
4
-10.0

-20.0   Delta
3
-30.0   1   2

-40.0   Off

-50.0

-60.0   Marker Trace
1   2
-70.0

-80.0   Auto Init
On   Off
-90.0

1 GHz   Center 3.5 GHz   6 GHz   Marker All Off

Screen Image capture in progress ************************   Int Ref ●

If you need any help then please email me (g3xdy@btinternet.com).

Editors Comments

This edition of Scatterpoint is a combined July and August edition. The summer period is often relatively quiet, and with holidays being taken, traditionally a two month magazine is published. September issue will be published in early October. The first of the Technical articles promised, has been held over until the nest issue.

Roger G8CUB

PICS and Development tools

Mike Stevens
G8CUL/M0CUL/F4VRB

Early PICkit 2

More expensive ICD 3

Latest low-cost 'Snap' interface

I read with great interest Andy's article on using some of the newer PICS and the problems he was having with getting it all working – that is the assembler and finally programming the device he wanted to use. Now, Andy is a clever chap and while I admire him for doing everything in assembler, having myself been a professional embedded system design engineer since the 1970s I would not dream of going down the route that Andy does. Writing in assembler is not for the faint-hearted and can lead to a frustrating time trying to get it all working, especially for those with less experience. I write all my embedded 'firmware' in 'C' (with the occasional smattering of assembler) and I can honestly say that there is nothing that cannot be done in the 'C' programming language that has to be done in assembler.

Another issue that I know that I would come up against using Andy's technique is getting it all working. Only being able to edit the source file with a simple text editor, assembling it then programming the object module into the target device to see if it works doesn't give any method of testing the newly created programme – ie debugging it. Using the Microchip IPE (Integrated Programming Environment) gives no way

that I can see of being able to test the code in a controlled way. That is what the IDE (Integrated Development Environment) is for. This, with suitable interface hardware, allows the editing, compiling, downloading and **debugging** of the newly created programme. The debugging stage allows you to set breakpoints in your programme where the running programme will stop so that you can examine local and global variables and also single-step through the programme to see where it's going and where it goes wrong! A simple edit, recompile and download then allows another try. As I said, Andy is a clever chap and no doubt can write his assembler correctly so that is does what he wants first time. Sadly, I can't, so the use of a suitable debugger is important for the projects I produce.

I talked about suitable interface hardware. Andy has already talked about the PICkit 2 and PICkit 3. I also have both of these as well as an ICD 3. All of these will work as a programming and debug interface with the caveat that the PICkit 2 doesn't support as many devices as the other two. The ICD 3 is supposed to be a more upmarket device than the PICkit 3 but for the simple devices I normally use, I've not found this necessarily to be true. I tend to use the PICkit 3 most of the time. Sadly, these debugging interfaces have become somewhat expensive (with the ICD 3 now being about £160!). However, Microchip have recently brought out a new, lower-cost debugging interface called the "Snap In-Circuit Debugger". This is listed at about £12 but Microchip regularly have reduction coupons which give up to 50% off. (You still have to pay the postage though!) The downside of this latest product is that it only works with the latest version of their IDE, MPLAB-X.

I've not yet talked much about development tools. I normally use MPLAB (note, **not** MPLAB-X). I am very comfortable with MPLAB, the latest version being V8.92. This is a tool that integrates the editor, compiler driver and debug (and programming) into one package. Within the tool, you can select the PIC device and the debug/programming interface you want to use and it can cope with any of the PIC devices available from simple 6-pin SOT23 10F devices right up to 100 or more pin PIC32 devices. Note that I said 'compiler driver'. MPLAB itself does not include the actual compiler as that will depend on the PIC device you want to use. There are 3 compilers (I think!), XC8, XC16 and XC32, which are basically for 8-bit, 16-bit and 32-bit PIC devices. Whichever one you want to use can be downloaded and will automatically be 'hooked' into MPLAB. From then on the compile stage using your newly created source file is just one icon 'click' away. MPLAB can be setup to automatically programme the PIC with the compiler output ready for debugging if there were no compile errors. If (or in my case when!) there are compile errors, MPLAB will list them and a double click on the error will automatically highlight the source code line in error.

As I said, I normally use MPLAB as I am comfortable with it but it has come to the end of its development, although still available for download. MPLAB-X is the later product and which is still developing with regular updates. It is also the only one that interfaces to the new "Snap In-Circuit Debugger". I have used MPLAB-X in the past but I find it a bit more complex than MPLAB V8.92 – I want to concentrate on the programme that I am writing, not driving the development tools! However, I suspect this is more due to my age and what I am used to using rather than the tool itself. I want to be able to use the new 'Snap' tool so I must try again with MPLAB-X.

MPLAB, MPLAB-X and all the compilers (XC8, XC16 and XC32) are all available free to download. The only limitations that I have come across is with the compilers where optimisation is not available in the free versions. Optimisation is generally used to make the complier output (the object module) smaller and sometimes make it run a bit faster. Not being able to use the optimiser is not really an issue for the sort of things we want to do. There is always a 'bigger' PIC device to use which has more programme memory and with embedded systems, sometimes the optimiser does some things that are not a good idea when accessing hardware registers. Before retirement when I was using a lot of expensive professional tools for embedded system design, I rarely used any optimiser for this very reason.

So, in conclusion, downloading MPLAB-X, the relevant compiler and buying a "SNAP In-Circuit Debugger" gives you a complete development environment where you can write your code in 'C' or assembler, compile/assemble it into an object module, download it into your PIC target and debug via the user interface, all in one package. When you are happy that it is all working, you can then switch to 'programme' mode and programme the PIC target ready for it to run 'stand-alone'. All this for the cost of the "SNAP In-

Circuit Debugger"! At the moment, there is an offer from Microchip that gives a 50% reduction on the "SNAP In-Circuit Debugger". See –

https://www.microchipdirect.com/product/search/all/snap

When I eventually get around to using MPLAB-X again with the SNAP debugger, I will endeavour to write it up for Scatterpoint.

The photographs are pretty much self-explanatory. The connection to the PC is by USB for all the interface devices. The connection to the target (the PIC) is also the same for them all and is basically a 5-pin connector. The new SNAP uses an 8-pin connector with the 1st 5 pins the same as the PICkit 2 and 3 with the other 3 pins unused!

PICkit 3 in use debugging a PIC32 C/W GPS and 128 x 128 display

First >275GHz UK Contact

First UK contact under NOV >275GHz.

On 2nd August Roger G8CUB/P worked Chris G0FDZ/P on 288GHz over a distance of 175metres.
Location was Higham Kent JO01FK60 Reports 559 / 599
A one way contact was also made over a distance of 1.246km using 2m talkback 589 / 59.
288GHz Range extension

On 29th August a QSO was made over a distance of 650 metres at Brentwood. This was by gradually increasing the distance along a track, until we ran out of road!
Reports were 539 / 599. This time a 150mm quasi-optical horn was used on one receiver

288GHz Equipment
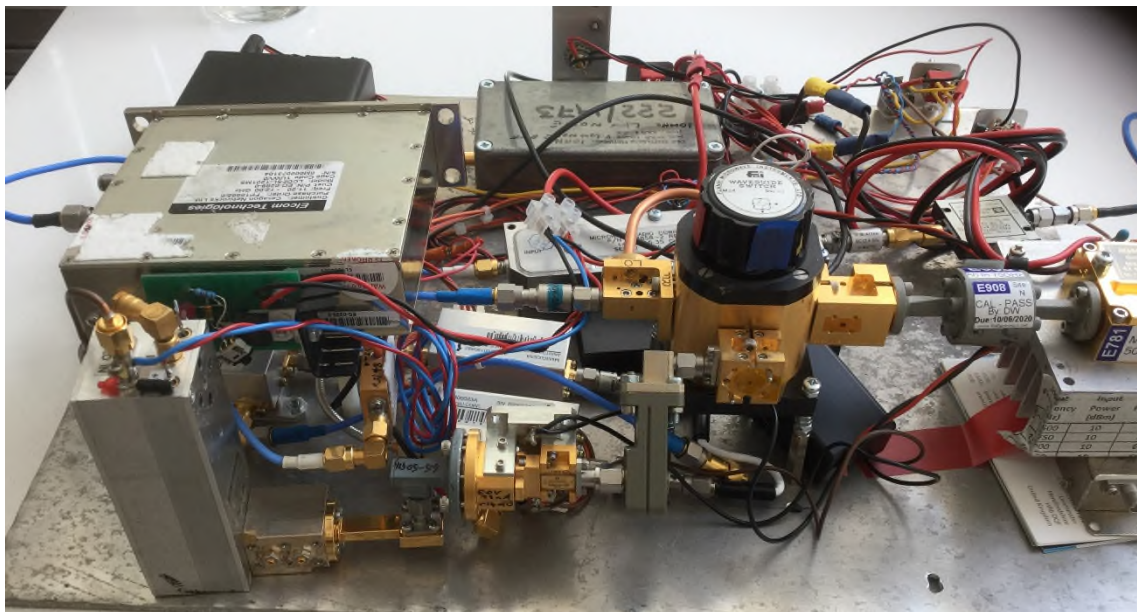
288GHz Receiver 1.

The Teratech sub-harmonic mixer is in mounted in front of a wr-10 waveguide switch (used on 122GHz). On the right of the wg switch is the 60/120Ghz doubler. This is as used on the system at 241GHz.

To the left a pair of wr-28/wr-28 transitions act as a bit of a filter, a transition 2.92mm to 2.4mm, a physical level shift and a dc block.

Next is a 47GHz LNA, a wg-22 to 2.4mm, 2.4mm to small flange wr-19 (Procom), into 47GHz filter. This is bolted onto a DB6NT 47GHz / 144MHz transverter (out of picture). For 288 a ZL14G synth @3.764210GHz is multiplied to 60.228GHz (x4,x4). It is then doubled to 120.456 @ 10mW which is the LO for the sub-harmonic mixer. The IF at 47.088GHz, goes via the LNA, and filter to an old DB6NT transverter to 144MHz (borrowed from coming loan system). Final IF is 143.900MHz.

The most important bit, ultra-low phase noise reference oscillators. Phase noise from 10MHz to 288GHz is increased by a massive 89dB, without considering any additional noise that the multipliers might introduce. This receiver used a Wenzel 10MHz reference. Antenna is a 30cm Alpha Cassegrain fed dish, with 120G feed horn.

The mixer is specified up to 230GHz, with up to 10GHz IF. Sufficient LO power was only available close to 120GHz, this dictated the 47GHz IF. So it was trial and error. Fortunately it worked exceedingly well, and eclipses the x7 harmonic mixer used in the other receiver by around 45dB!
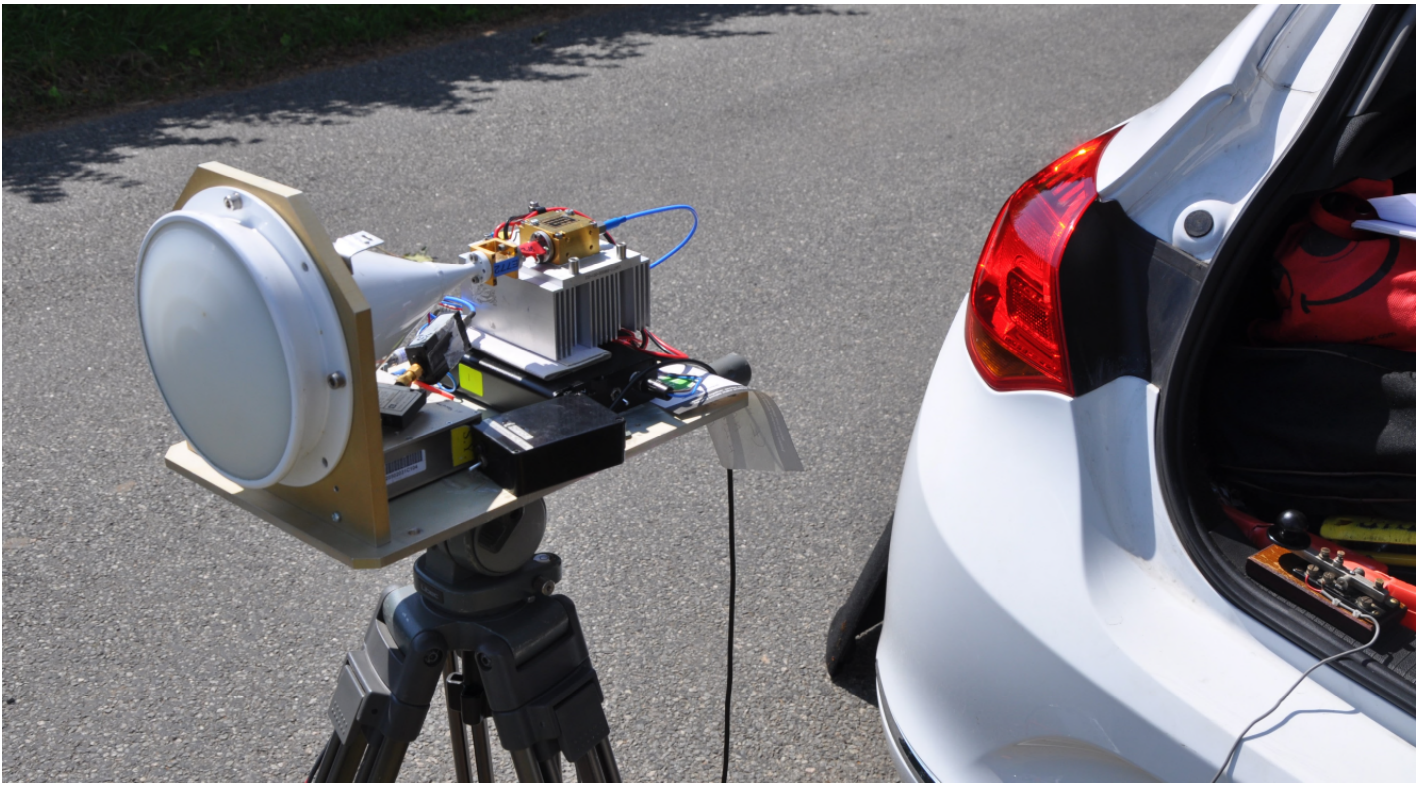
TX 1

ZL14G synthesiser on 8GHz, with 10MHz reference. The output is second harmonic filtered at 16GHz. Then a x6 active multiplier to 96GHz at 20mW. Followed by a Teratech x3 multiplier to 288GHz circa 350uW.
An 80GHz Flann horn is used as the antenna.

Receiver 2

This used another ZL14G synthesiser, with 100MHz reference. Output is on 13.6937GHz, which goes through a band pass filter (important). {Second contact used an ERA-1 synthesiser}.

This drives a CTR960459 multiplier to 41.0811GHz with 50mW output (yes these multipliers work here).

This is the LO for a x7 harmonic mixer. PCB is the x6 240GHz from DB6NT. Block is from DL2AM. Fortunately it is the same multiplier / PCB / block as used on 241GHz (x7 instead of x6).

Antenna is a 30cm Cassegrain fed dish originally used on 76GHz. Second contact used a 150mm quasi-optical horn.

TX 2

ZL14G synthesiser on 10.666666GHz, with 100MHz reference. The output goes into a Broadern x3 multiplier and amplifier. Output is 200mW at 32GHz, which is below the ideal 300mW (as the Broadern multiplier is outside its optimum frequency range). This drives a Teratech x9 passive multiplier to 288GHz circa 50uW.

An 80GHz Flann horn is again used as the antenna.
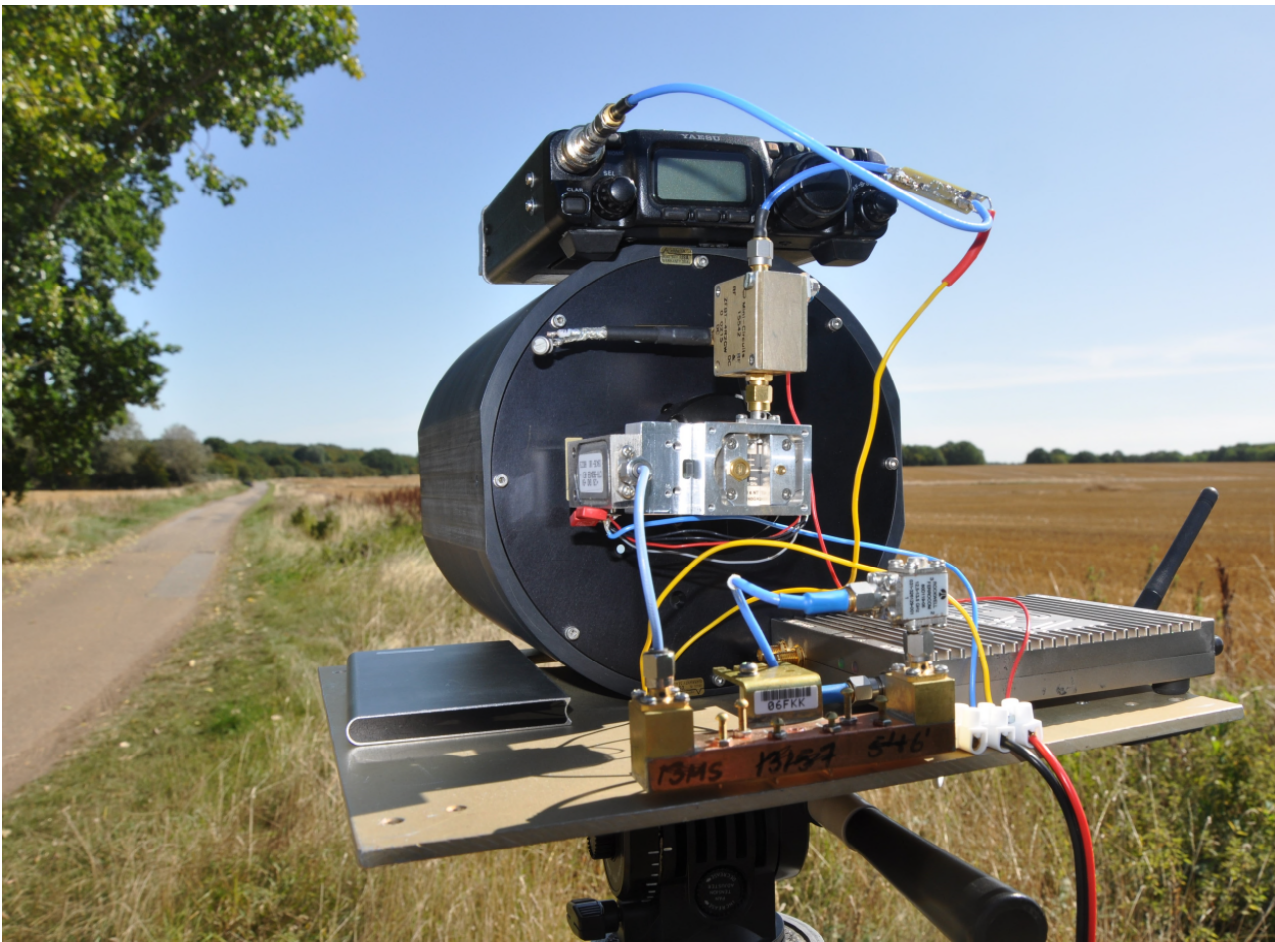
Receiver 3
As receiver 2, but with quasi-optical antenna. This is being used for the 650 metre QSO.

******************STOP PRESS************************STOP PRESS***************
On Thursday 12th September Roger G8CUB/P worked Chris G0FDZ/P on **288GHz** over a distance of **1.246km**.
Location was Higham Kent JO01FK60UC to JO01FK62JR. Reports 319 / 599

Activity News: July & August 2019

By John G4BAO

Please send your activity news to: scatterpoint@microwavers.org

Introduction

A report from the activity news editor John G4BAO.

From G4SDG near Bedford

Thought I'd let you know that having had some contacts via QO-100 (it feels a bit "been there, seen it, done it" which I suspect might be the case with many people) I thought I'd try a bit of 10GHz terrestrial. I've only got a 45cm off-set antenna at about 8m above ground and the LNB's not GPS locked but I can hear/see GB3CAM all the time and the Leicester beacon some of the time. During the contest a week or so ago I heard a couple of stations on SSB (G4ODA and G4KUX) and more on CW although I'm ashamed to say that my skills at that have been lost so I couldn't read them. I now know that even in this age of FT8, JT65 etc. I should try to relearn CW! Tonight I had the same problem with my lack of CW ability proving my downfall, and the rain scatter made most of the speech signals unintelligible too but I did copy G4DBN very well. Some very strong signals about anyway.

What did seem strange was to hear GB3CAM apparently also on ~10368.248 near many of the non-beacon stations with carrier at 12dB C/N. It was also audible very strongly at its normal frequency (carrier at -62 with noise floor at -96). I'm not sure if this is manifesting itself in my system or is there in reality. Tonight I was using a bog standard 9750MHz LO LNB (can't remember which type) fed into a Lime-Mini.

It's good that QO-100 is driving people's interest but it's time to put my SG-Labs transverter back to terrestrial use which is what I bought it for. Perhaps also to think about how to generate some 10GHz signals!

Great tropo last week (22 to 26, missed most until 26th Sun morn due to qrl). 172 stations worked across the bands, most last day 26th Sunday morning.

From Dave G7RAU

Great tropo for the week of 22 to 26 August. 172 stations worked across the bands, most last day 26th Sunday morning.

On 23cm with a 35el Tonna at 18magl 8w (65m cable run, no preamp) on 23cm I worked IL18,IL28,IN83,IN86,IN87,IN88,IN96,IN97,JN03,JN05,JN07,JN09.JN13

EA8 was a new DXCC on 23 for me and a bonus for 2 squares and a massive signal, it surprised me. I was asked to try 3cm but no kit here, I am pretty sure it would have been open as signals were stronger on 23cm than on 2m / 70cm

Sadly, 23cm is now off air here, as I accidentally fed the 2m into the ts2k input and fried it, I was rushing to have 30 mins of DX. Hopefully it is repairable.

I'm looking for a 1.3GHz PA and preamp, many could not hear me in the F contest on 23 one day I will have the money to buy one instead of blowing rigs and paying to repair them!

From John G4BAO

Not too active last few months but a few highlights

1.3GHz Terrestrial
20/08/2019 EI2FG   IO61AX   51   55   SSB 558km (new square)
24/08/2019 SM6VTZ JO58UJ   589   559   CW 994km
20/08/2019 DL2IAS   JN49EJ   559   539   CW 656km

10GHz Terrestrial
11/08/2019 G4UVZ   IO8ØKX 55   44   SSB rainscatter 271km
11/08/2019 G3UVR   IO83KH 59   59   FM   rainscatter 252km
25/08/2019 MØEYT   IO8ØWP 569   559 CW 242km

5.7GHz EME
Two new Initials/ DXCCs
25/08/2019 OH2DG   KP3ØCK -15   -18   JT4F 1823km
25/08/2019 UR5LX   KO7ØWK -17   -20   QRA64 2459km

August report from Nick G4OGI JO01MG Nr Canterbury

I recently acquired a reasonable Clark pump-up mast. After some maintenance I managed to get it to raise and lower as expected. As soon as I put a headload on it (my 60cm) dish pressure built and released quickly and the mast failed to move.
I continued with the 3cm build with the mast retracted and recognised things appeared to be working after pointing the dish in the direction of both GB3MHX and GB3PKT and noticing increases in noise from the Holly trees in the neighbour's garden. Pointing over to GB3CAM resulted in slightly less noise rise from the 60ft Plum tree.

On Friday the only option was to lock the mast and point the excellent Kathrein 60cm dish in my best take-off direction which just happens to be between two tall tress but out over the North Sea. Serendipity strikes again as that direction happened to be the exact bearing for DB0GHZ. This beacon came through via aircraft scatter from aircraft flying the Asia route from this part of Europe. High Doppler returns also arrived from PE9GHZ from aircraft flying the North American route from the European mainland. As the heat of the day dissipated DB0GHZ and PI7ALK popped out of the noise to be present throughout Saturday

Sunday morning (25th August 2019) between 03:00 and 04:00 utc provided the best propagation (just before dawn at the target location as always with microwave…).
Beacons heard:
DB0GHZ (564km)
PE9GHZ
GB3MHX
PI7ALK
OZ7IGY (861km)
GB3PKT
OZ1UHF (912km)

Of note, both the UK beacons appeared to arrive via a skewed as with the dish in its current location absolutely no direct path is possible, and the signals were affected by slow qsb. By about 08:30utc 25th August this morning an onshore breeze was noted, and propagation was back at normal levels and the band noise level dropped 2dB.

September update from G4OGI

I have spent rather a long time breaking down and rebuilding the system here after the end of the recent opening. I was amazed at the result using a fixed direction, so I pressed ahead and installed my lovely SPID RAS/HR. This along with the 75cm Kathrein dish with my homebrew 10w system is now in place on the mast

Whilst I have a problem with elevation control azimuth appears to be fine. For now, I have set a compromise dish elevation angle for terrestrial work

From monitoring 3cm so far this weekend I noted aircraft scatter from DB0GHZ (frequent and strong), GB3CSB and GB3LEX. GB3PKT is around about -16dBjt (60km away) not sure if that is good or bad. GB3MHZ is just visible…very, very weak which surprises me. Once cloud/rain appears though it gets up to 0dBPI4

Haven't heard GB3CAM or GB3SEE but that could be down to tree attenuation which is a big problem here. PI7ALKand PI7RTD appear on aircraft scatter too 40 – 60 degrees here is best direction (low noise level in the main .. 2dB lower that inland)

Provided I survive the autumnal storms I am looking forward to work a couple of people on the band.

From Neil, G4LDR

For the Apollo 11 weekend I managed to get my 6cm system ready just in time, although on RX at least it was underperforming (Sun noise about 5dB less than predicted); so much work still to do. I did manage to hear VK6EME and GB6GHY on the 20th July and just after the public event at Goonhilly concluded, Brian G4NNS (who operated GB6GHY) telephoned me at 00:45 and asked if I would like to TX, Brian was able to copy my CW okay. The day before the Apollo 11 event I was able to do some tests with GB6GHY over a 300km path on my terrestrial 6cm system. This enabled the team at Goonhilly to make sure their complete system including the VHF link to the main stage (for the public demonstration the next day) was working correctly, the 32m dish at Goonhilly was set to near zero elevation for this terrestrial test.

For the 9cm EME activity day on the 28th July I worked on CW, OK1KIR, G3LTF, VE6TA and OH2DG; I'm not set up for digital modes yet so apologies to the stations who wanted to try a digital QSO. Equipment is a 3m dish with RA3AQ feed (loaned to me by G3LTF), 70W on TX and 0.8dB NF TX. Again, the system is underperforming, I'm getting 4 to 5dB less sun noise than predicted. I am in the process of carrying out some measurements on the system that Peter, G3LTF suggested, he will look at the results and hopefully be able to tell me what is wrong and what I need to do to improve system performance.

On 3cm terrestrial I was able to hear the new EA1URG beacon in IN73DL on 10368.978MHz on the morning of the 26th August. It was 'only' 419 over the 900km path but would probably have been a lot stronger with me if I had not been beaming through a line of tall trees adjacent to my QTH.

From David G4RQI

I recently put a 23cm 18 ele yagi up on the chimney of the house and with 80w I have made the following QSO's.

Date	Time	Call	Freq	Mode	RST sent	RST rcvd	Locator/Notes
11/08/2019 2x44ele 603km	09:14	F6DKW	1296.2	SSB	54	57	JN18cs Maurice nr Paris 200w
11/08/2019 510km	09:21	F5IGK	1296.21	SSB	52	54	JN09nj Alain
11/08/2019	09:36	F8DLS	1296.21	SSB	51	51	JN19se 606km
24/08/2019 Tonna 377km	06:49	F4HRD	1296.217	SSB	52	51	JO00xx Jeff Calais 9W 55ele
24/08/2019 430m asl 350w 2m dish 652km	08:06	DK1VC	1296.22	SSB	55	55	JO31rg Horst 20km S Dortmund
24/08/2019 526km	08:16	PA0O	1296.2	CW	55	55	JO33hg Jaap 50w
24/08/2019	08:24	F6DBI	1296.23	CW	529	549	IN88ij 609km
01/09/2019	09:48	G4ALY	1296.21	CW	529	529	IO70VL 413km
01/09/2019 10w 28ele ! 242km	13:14	GM4FVM	1296.14	JT9F	5	-2	IO85wu Jim Ayton Berwickshire
07/09/2019 Tropo 272km	12:25	GW4MBS	1296.14	CW	529	559	IO71xw Clive Aircraft scatter no

07/09/2019   12:50   G8FJG   1296.141   JT9F   -3   -5   JO01cm Ron Rainham   10w 8ele
!   266km

I persuaded GM4FVM and G8FJG to try JT9F. Both stations were running 10w and each QSO was completed within a few minutes on a very flat band with G8FJG using a homebrew 8 ele LFA.

A new 10 GHz beacon commissioned in Northern Spain
For information
EA1URG/B (Provisional c/s at Gijon Club house) 10368.978 Locator IN73EN (Gijon) 1W and 20dB

Constructed by Jean-Paul F5AYE, It has already been heard in the Ralph, Neil and others.
It is in a good location so when conditions allow you should hear it.
 Thanks to Ralph G4ALY for the information.

…..and finally

The deadline for activity reports to be included in the next issue is Tuesday 1st October 2019. John G4BAO coordinates activity reports. Reports should be sent to **scatterpoint@microwavers.org**

Contests

24GHz/47GHz/76GHz Contest June 2019

Roving was used to good effect for this event. Conditions were noted as "nothing special".

Congratulations go to Barry G4SJH/P as winner, with the Telford group G3ZME/P as runner up on 24GHz, with Roger G8CUB/P leading John G8ACE/P on 47GHz and Neil G4LDR/P just pipping Roger G8CUB/P for the lead on 76GHz.

The 24GHz Trophy goes to Barry G4SJH/P, and the 47GHz Trophy to Roger G8CUB/P.

John G3XDY

UKuG Contest Manager

24GHz Contest June 2019

Pos	Callsign	Locator	QSOs	Score	ODX Call	ODX kms
1	G4SJH/P	IO91GI44	7	299	G3ZME/P	147
2	G3ZME/P	IO82QL83	3	297	G4SJH/P	147
3	G4LDR/P	IO81XG25	8	235	G8GTZ/P	66
4	G1EHF/P	IO91IK39	4	115	G4LDR/P	39
5	G8CUB/P	IO91FH20	2	58	G8ACE/P	36
6	G8ACE/P	IO91JB00	2	53	G8CUB/P	36

47GHz Contest June2019

Pos	Callsign	Locator	QSOs	Score	ODX Call	ODX kms
1	G8CUB/P	IO91FH20	2	58	G8ACE/P	36
2	G8ACE/P	IO91JB00	2	53	G8CUB/P	36
3	G4LDR/P	IO91GC68	2	39	G8CUB/P	22

76GHz Contest June 2019

Pos	Callsign	Locator	QSOs	Score	ODX Call	ODX kms
1	G4LDR/P	IO91EE26	2	59	G8GTZ/P	37
2	G8CUB/P	IO91FH20	2	58	G8ACE/P	36
3	G8ACE/P	IO91JB00	1	36	G8CUB/P	36

24/47/76GHz Championship Tables 2019

Positions after two events, the best three count to the total

24GHz

Pos	Callsign	19/05/2019	23/06/2019	TOTAL
1	G3ZME/P	888	993	1881
2	G4LDR/P	1000	786	1786
3	G4SJH/P	0	1000	1000
4	G8CUB/P	650	194	844
5	GW3TKH/P	555	0	555
6	GW4HQX/P	555	0	555
7	G1EHF/P	161	385	546
8	G8ACE/P	0	177	177

47GHz

Pos	Callsign	19/05/2019	23/06/2019	TOTAL
1	G8CUB/P	1000	1000	2000
2	G4LDR/P	555	672	1227
3	G8ACE/P	0	914	914
4	GW3TKH/P	849	0	849
5	GW4HQX/P	431	0	431

76GHz

Pos	Callsign	19/05/2019	23/06/2019	TOTAL
1	G8CUB/P	1000	983	1983
2	G4LDR/P	138	1000	1138
3	G8ACE/P	0	610	610
4=	GW3TKH/P	431	0	431
4=	GW4HQX/P	431	0	431

June 122GHz – 248GHz Contest 2019

As is often the case in summer, high humidity prevailed for this event. Roger G8CUB/P went roving around John G8ACE's QTH, and so they ended up honours even, apart from on 248GHz where a logging error resulted in Roger taking the honours.

8 digit locators are now being used at 24GHz and above and provide more accurate scoring.

73
John G3XDY
UKuG Contest Manager

122GHz Contest June 2019

Pos	Callsign	Locator	QSOs	Score	ODX Call	ODX kms
1	G8CUB/P	IO91IC76	2	10	G8ACE	7
2	G8ACE	IO91IB05	1	7	G8CUB/P	7

134GHz Contest June 2019

Pos	Callsign	Locator	QSOs	Score	ODX Call	ODX kms
1=	G8ACE	IO91IB05	1	7	G8CUB/P	7
1=	G8CUB/P	IO91IC76	1	7	G8ACE	7

248GHz Contest June 2019

Pos	Callsign	Locator	QSOs	Score	ODX Call	ODX kms
1=	G8ACE	IO91IB05	1	4	G8CUB/P	4
1=	G8CUB/P	IO91IB67	1	4	G8ACE	4

July 5.7GHz Contest 2019

This session was won by Dave G1EHF/P, the difference between his score and that of the runner up G3ZME/P was largely down to his DX contact with F8DLS at 430km – described by Dave as "difficult". Rainscatter aided some contacts but G3ZME/P noted problems with high levels of Wi-Fi QRM.
73
John G3XDY
UKuG Contest Manager

5.7GHz Contest July 2019

Pos	Callsign	Locator	QSOs	Score	ODX Call	ODX kms	Power
1	G1EHF/P	IO91GI	7	1155	F8DLS	430	5
2	G3ZME/P	IO82QL	6	757	G4ODA	172	15
3	M0GHZ	IO81VK	5	627	G4ODA	206	5
4	G8AIM	IO92FH	2	183	G1EHF/P	107	6
5	G3VKV	IO81XV	1	77	G3ZME/P	77	5

July 10GHz Contest 2019

Keith GW3TKH/P operated in "Rover" mode from three locations to take the lead in the restricted section from Barry G4SJH/P. In the Open section Nick G4KUX came in ahead of the Telford group, G3ZME/P, back at their normal Brown Clee site.
Rain Scatter helped make several longer distance contacts in this event, with the contact between F6DKW and G3ZME/P providing some good DX at 535km.
73
John G3XDY
UKuG Contest Manager

10GHz Contest July 2019

Open Section

Pos	Callsign	Locator	QSOs	Score	ODX Call	ODX kms
1	G4KUX	IO94BP	13	3491	G0API	432
2	G3ZME/P	IO82QL	21	2974	F6DKW	535
3	G4ZTR	JO01KW	13	2845	G4KUX	353
4	M0GHZ	IO81VK	12	2006	F6DKW	433
5	G3UVR	IO83KH	7	1225	G4ZTR	311
6	G3YJR	IO93FJ	6	784	G4ZTR	230
7	G3VKV	IO81XV	6	760	G4KUX	307
8	G8AIM	IO92FH	5	532	G4KUX	261

Restricted Section

Pos	Callsign	Locator	QSOs	Score	ODX Call	ODX kms
1	GW3TKH/P	IO81LS	17	2159	G4ZTR	270
2	G4SJH/P	IO91GI	13	1742	F6DKW	389
3	G3YKI	IO92BD	10	1221	G4KUX	279

5.7/10GHz Championship Tables

Positions after three events, the best three count towards the total

5.7GHz

Pos	Callsign	26/05/2019	30/06/2019	28/07/2019	TOTAL
1	G1EHF/P	937	932	1000	2869
2	G3ZME/P	737	964	655	2356
3	M0GHZ	652	892	543	2087
4	G4LDR	1000	0	0	1000
5	GW4HQX/P	0	1000	0	1000
6	G8AIM	0	0	158	158
8	G3VKV	0	78	67	145
8	G1DFL/P	0	39	0	39

10GHz Open

Pos	Callsign	26/05/2019	30/06/2019	28/07/2019	TOTAL
1	G3ZME/P	1000	547	852	2399
2	G4ZTR	815	358	815	1988
3	G4KUX	749	0	1000	1749
4	M0GHZ	349	728	575	1652
5	G3UVR	497	320	351	1168
6	GW3TKH/P	0	1000	0	1000
7	G8HAJ	742	178	0	920
8	G4LDR	466	0	0	466
9	G6TRM/P	0	459	0	459
10	G3YJR	156	0	225	381
11	G3VKV	0	87	218	305
12	G4RQI	284	0	0	284
13	G8AIM	0	127	152	279
14	G4BAO	0	209	0	209

10GHz Restricted

Pos	Callsign	26/05/2019	30/06/2019	28/07/2019	TOTAL
1	G4SJH/P	1000	1000	807	2807
2	GW3TKH/P	0	0	1000	1000
3	G3YKI	0	0	566	566

Finningley Microwave Roundtable

This year's Finningley Round Table was on Saturday & Sunday 29/30 June.

Jen's G4HIZ's Impressive Video system in use via Es'hail2

Barry G8AGN using Helliscriber via Es-hail2

Glasses with a 90 degree optical polarisation shift would be useful!

Neil G4LDR gave a talk on work done at Goonhilly and the upcoming anniversary

Tony G8DMU operating from the site during the 5.7/10GHz Contest

As always an excellent event. The weather again was good, which helped activities in the field.

Demonstrations by Jen G4HIZ of video transmission via Es'hail2, was impressive, as was the use of Helliscriber by Barry G8AGN.

Neil G4LDR gave a talk about the Microwave Group, and the plans for the 30m dish at Goonhilly during the Apollo Anniversary.

Bryan G8DKK presentation was entitled 'Measurement on a Budget'. It included low cost power measurement, Use of directional couplers and spectrum / network analysers. All of which was well received.

The project competition was won by David G0EID with a well-engineered 'Portsdown' ATV transmitter.

Crawley Microwave Round Table Program
Sunday 22nd September 2019

Welcome to the Crawley Roundtable hosted once again at the premises of the Crawley Amateur Radio Club. The morning session will feature the usual 'bring and buy' sale, so if you have surplus radio items then please bring them along.

Again this year following we will be holding a heat for the UK Microwave Group annual Project contest. Please do bring along your constructed equipment or project and enter. Entries do not necessarily need to have been finished during the last year. Please note that the contest will also accept software entries as well as hardware.

CARC award the G3GRO trophy to the winner of this round. The winner will also go on to be considered, together with entries from all the other round tables over a year both before and after this event for the G3VVB trophy.

We are also hoping that G3LYP will be attending with the UKuW Group chipbank. If you have a forthcoming project then why not contact Mike beforehand to place your orders, which are free for UKuW group members.

Below is the provisional timetable:

10:00: Venue opens

10:00: 'Bring and buy', general socialising

12:00   UKuW Group Project contest round/G3GRO trophy judging commences

12:15   Lunch (hot dogs and burger rolls etc. and tea/coffee available)

13:15   Welcome by Alun G4WGE/Denis G0OLX and results of the Project contest heat

13:30   A 24 GHz beacon source using IQ upconversion, Andy Talbot, G4JNT

Using the LimeSDR on the Microwave Bands, Dave Crump, G8GKQ

Break – Tea and coffee available

288 GHZ update, Chris Whitmarsh, G0FDZ

RFZero Signal Source, Denis Stanton, G0OLX

16:30   End of meeting

The venue is the Crawley Amateur Radio Club's hut and directions can be found at:

http://carc.org.uk/find-us/

UKuG MICROWAVE CONTEST CALENDAR 2019

Dates, 2019	Time UTC	Contest name	Certificates
15- Sep	0900 - 1700	3rd 24GHz Contest	
15- Sep	0900 - 1700	3rd 47GHz Contest	
15- Sep	0900 – 1700	3rd 76GHz Contest	
29 -Sep	0600 - 1800	5th 5.7GHz Contest	F, P,L
29 -Sep	0600 - 1800	5th 10GHz Contest	F, P,L
20 -Oct	0900 - 1700	4th 24GHz Contest	
20 -Oct	0900 - 1700	4th 47GHz Contest	
20 -Oct	0900 – 1700	4th 76GHz Contest	
17 -Nov	1000 - 1400	5th Low band 1.3/2.3/3.4GHz	F, P,L
Key:	F	Fixed / home station	
	P	Portable	
	L	Low-power (<10W on 1.3-3.4GHz, <1W on 5.7/10GHz)	

Events calendar

2019

Sept 6-8	64.UKW Tagung Weinheim	www.ukw-tagung.de/
Sept 22	Crawley Roundtable	http://carc.org.uk/2019/07/09/microwave-round-table/
Sept 27/28	National Hamfest	www.nationalhamfest.org.uk
Sept 29-Oct 4	European Microwave Week, Paris	www.eumweek.com/
October 3/5	Microwave Update, Dallas, Texas	www.microwaveupdate.org
October 3-5	RSGB Convention & Amsat-UK Colloquium	http://rsgb.org/convention/
Oct 28-Nov 22	ITU WRC-19, Sharm el-Sheikh	http://rsgb.org/wrc-19
Nov 2	Scottish Round Table	www.gmroundtable.org.uk/

2020

January 11	Heelweg	http://www.pamicrowaves.nl/
Apr 14	CJ-2020, Seigy	http://cj.r-e-f.org
June 26/28	Ham Radio Friedrichshafen	http://www.hamradio-friedrichshafen.de/
Aug 20-23	EME 2020 Prague	www.eme2020.cz
Sept 13-18	European Microwave Week, Utrecht	www.eumweek.com/
Oct 10-16	IARU-R1 General Conference, Novi Sad	www.iaru2020.org

80m UK Microwavers net

Tuesdays 08:30 local on 3626 kHz (+/- QRM)

73 Martyn Vincent G3UKV