United Kingdom
Microwave Group

Scatterpoint – *Issue 5*

June 2001

www.microwavers.org

WA5VJB Feed beautifully mounted by PA5DD

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About the UKuG

The United Kingdom Microwave Group was formed in Autumn 1999.

Membership subscriptions are currently UKP12.00 per year.

The committee comprises of the following:

Chairman	***Membership Secretary***	***Newsletter Editor***
Sam Jewell, G4DDK Blenheim Cottage Kirton Road Falkenham Ipswich IP10 0QU jewell@btinternet.com	Lehane Kellett G8KMH Woodpeckers Church Lane Arborfield Berkshire RG2 9JA lehane@mm-wave.demon.co.uk	Martyn Kinder G0CZD 12 Jessop Way Haslington Crewe Cheshire CW1 5FU martyn@g0czd.clara.net Tel: 01270 505930

There are also six ordinary committee members;

Neil Whiting	G4BRK
Steve Davis	G4KNZ
Peter Blakeborough	G3PYB
David Wrigley	G6GKX
Alan Wyatt	G8LSD
Mike Willis	G0MJW

Membership enquiries and applications should be sent to the membership secretary.

A membership form is available at on http://www.microwavers.org/ukugmemb.htm

The UKuG web site is at http://www.microwavers.org

Contributions for Scatterpoint, letters, For Sale and Wanted should be addressed to the newsletter editor.

If you like what you see here, please tell others, if you don’t like it, please tell me.
73, Martyn Kinder G0CZD

Front-end

It is now many months since I wrote the last Front-end for Scatterpoint. In that issue I looked forward to the first operation of the Amsat Oscar 40 (AO-40) transponders. At that time it was still uncertain if A0-40 would be able to provide us with any usable transponder operation following its December 'incident'. However, as many of you will now know, AO-40 is alive and well and providing some excellent signal using it's S band (2.4GHz) transmitters in conjunction with it's U (435MHz) and L (1269MHz) uplink receivers.

Using my Drake 2880 S band converter and my G3JVL 13cm quad loop yagi I was able to copy the 2401.323MHz MB beacon at about 10dB above noise in 2.4kHz bandwidth. Twelve stations were copied including several Americans, and a significant number of Europeans from OH down to I8. One of the best signals was from our own Charlie, G3WDG, who was using his 10 foot EME dish for receive and a small 1.5 metre dish to transmit on 1269MHz.

Spurred on by this result I connected my DJ9BV 13cm preamp in front of the Drake and found to my surprise that the beacon only improved to about 12dB over noise, most likely due to the enormous sidelobe response of the QLY being used so removed from its intended frequency band.

Recent tests by the AO-40 team to get the X band (10.450GHz) transmitter to work have been unsuccessful as has the C Band (5.668GHz) uplink receiver. If further tests to find and solve the problem prove unsuccessful, then we may find that we have only the S band downlink and maybe the K band (24GHz) to play with. However, these are both very much microwave bands and as such we microwave enthusiasts should be using AO-40 and learning about space propagation and working some really great DX.

I plan to be at the Amsat-UK Colloquium (27 to 29th July, 2001) again this year. I will have the usual test gear available from Friday to Sunday. If you have microwave or VHF/UHF satellite radio kit to be tested, I will be pleased to help. I hope to have the noise figure meter and will definitely have the sweep gear for antenna matching from HF to 18GHz. In addition I will bring the power measuring gear from 10MHz to 26.5GHz.

I will be providing this service jointly under the RSGB Microwave Committee and UK Microwave Group banner.

Details of the Colloquium are available at www.amsat-uk.org

73 de Sam Jewell, G4DDK
Chairman, UKuG

The DC Bands - 1.3 and 2.3GHz News

John Quarmby G3XDY

Auroral First on 1.3GHz

SM3AKW has reported what is thought to be the first two way auroral QSO on 1.3GHz. This took place on 11th April between SM3AKW and SM5QA during a strong auroral opening. Signals were only 33A despite the use of high power (500W) and 20dB antenna gain. Doppler shift was of the order of 5kHz. The only other instance I recollect of auroral propagation on 1.3GHz was during the "Mega Aurora" of March 1989, when G4FUF was reported heard by HA2RD, but only 1 way. Congratulations to both stations, who have been trying for an Au QSO for several years.

1.3GHz EME

Ken G8VR has reported success in hearing several stations on 1.3GHz EME recently using a simple antenna, just a single 23 element Tonna. He heard HB9Q, HB9BBD, LX1DB and OE9XXI and saw traces of signals from other stations on his FFTDSP display. The secret probably lies in the preamp from WD5AGO using the latest PHEMT device, mounted right at the feed with no relays in the way. Elevating the antenna reduces the ground noise which makes a big difference to the overall signal to noise ratio. Of course the stations Ken heard are in the big league, with dishes of 9m diameter or more and power to match, but it certainly shows what can be done with a simple set up.

I recently had a QSO with Howard G4CCH, who was using his EME dish for tropo working until he gets his other antennas back up. Howard built a 5.4m diameter dish over a period of three years to replace the smaller one he used previously. The new dish has been in use for over a year now with excellent results. In a recent DUBUS EME contest he worked 44 stations over a weekend, and also reported 23 SSB QSOs in a US contest early this year. Those of you with web access can find some nice pictures of the dish and audio files of recent contacts at http://www.g4cch.co.uk . Other stations in the UK known to be regularly active on 1.3GHz and/or 2.3GHz EME include G3LTF, G3LQR, G4DZU and GW3XYW – if there others of you on the moon out there then let me know!

March and May Contest reports

The first weekend in March is a 144/432MHz only event in the UK, but all bands elsewhere in Europe. The lack of portable activity in the UK due to Foot and Mouth made for slow going on 144/432, so it was interesting to see what could be achieved under flat conditions on the microwave bands. PA6NL were loud on all bands as usual, and there were several other very active PA stations around. A few DL stations were audible on 1.3GHz on the East coast, with DL3YEE (JO42) and DK0ES/P (JN48/712km) the best. Neil G4BRK (IO91DP) reported a QSO with DL5DAV at 623km, a 1 way with DL3YEE at 704km, and PI4TUE worked as best DXon 2.3GHz.

Foot and Mouth restrictions also seemed to reduce UK support for the all band event the first weekend in May. Conditions were flat and so DX distances were fairly average, although G4BRK had some good QSOs into Holland, Germany and Belgium including PI4GN at 614km on 1.3GHz, with ON4CP the best on 2.3GHz. GD0EMG put on a good multiband effort from the Isle of Man and was worked by G4BRK on 2.3GHz for a new country, but conditions were not good enough to make a QSO from my QTH on that band. Activity in Europe seemed lower than expected.

Tropo – what a difference a year makes!

In the last issue of Scatterpoint I bemoaned the dreadful tropo conditions during 2000, with no real lifts to speak of during the traditional Autumn season. This year has already gone some way to make up for last year's disappointments, with at least three openings to Scandinavia so far. The first was in mid January and was best for stations along the East Coast of the UK. SM4DHN in JP60VA provided excellent QSOs on both 1.3 and 2.3GHz. As the conditions moved further East stations in PA and DL were able to work OH0 and Eastern SM stations at distances out to 1400km.

A month later mid February saw an opening which benefited more of Southern England, with good 1.3GHz QSOs into PA, DL and OZ and SM from stations in the west. G4BRK worked some exceptional DX on the morning of 15th February, with a QSO with SM1BSA in JO97 at 1441km on 1.3GHz CW, and almost completed with SM1FMT as well.

To round off this report there were several days of enhancement in May. Starting on 12/13 May the opening favoured the western part of OZ and up to LA. Signals were very loud between stations located near to the coast at each end, occasionally signals penetrated further inland, allowing G4BRK to work OZ1FF in JO45 for example. LA6LCA was active on all bands and the nearby beacon LA1UHH in JO59 was audible here on 2320.860MHz. GM4OGI and GM4LBV were active and made some good contacts. The band also briefly opened to the Paris area and into the Ruhr area of Germany, but conditions did not last long to these parts.

A further lift took place from the 22nd May over several days, with good inter-G conditions which then extended to PA, ON and northern DL, with OZ and SM workable around the 24/25th. G4BRK had contacts on 2.3GHz with DL3YEE (JO42) at 704km and DK6AS in JO52 at 857km, plus other DL and OZ on 1.3GHz.

Station Activity

Nick Shaxted GM4OGI is often looking for QSOs on 1.3GHz when conditions are good, with 30W to 4x35 element Yagis. He has had difficulty attracting attention of stations even when conditions are good, but he now has access to the DXcluster network and has made good use of it to advertise his presence and make some DX QSOs.

Geoff Pike GI0GDP (IO74CR) is one of the few GI's active on 1.3GHz, with 20 to 30W into a 55element Tonna. He can be contacted at Geoffrey.Pike@ukgateway.net for skeds.

Antenna Corner

I have not been convinced my very old 2.3GHz 44 element Loop Yagi has been working as well as it should do, particularly as the elements have become severely corroded over the years. I decided to see if my 60cm ex-satellite TV dish could be used on 2.3GHz as well as 10GHz. After looking at reference material, in particular W1GHZ's excellent online antenna book (see http://www.qsl.net/n1bwt/preface.htm) I decided that for my Amstrad offset fed dish with an f/D ratio of about 0.65, the dual dipole EIA style feed should give good results. I modified the balun arrangement to make it easier to construct, but otherwise it is a simple job to scale the dimensions from the 432MHz original, which is described in the ARRL UHF/Microwave Experimenters Manual on page 9-34. I used a skeleton reflector to reduce weight and windage.

See figure 1 for details of the reflector and figure 2 for the dual dipoles. I used 1.4mm diameter copper wire extracted from $6mm^2$ cooker cable for most of the construction, with 2mm dia wire from $2.5mm^2$ mains cable for the outer frame of the reflector. The feed elements are supported on a piece of unetched double sided 1.6mm thick epoxy glass PCB, using UT141/RG402 semirigid cable for the feed connection and balun. The 2.3GHz feed is mounted offset horizontally from the 10GHz feed which remains at the prime focus. This means that the antenna beam on 2.3GHz is offset from the dish direction by about 10-12 degrees.

This can either be accounted for by re-setting the antenna heading (OK with digital bearing readout), or some clever engineering with a satellite positioner to move the dish or feed arm relative to the mast. I went for the former approach, but it does mean that talk back on 1.3GHz is more difficult as the antennas need to be swung back and forth. The loss in gain due to the feed being off boresight is under 1 dB when the dish f/D is 0.6 or more and the offset is about 1 wavelength. Another advantage of the offset fed dish is that there is virtually no blockage by the feed assembly and no interaction between the feeds. A small prime focus dish would suffer from significant blocking by a low frequency feed, which could also result in lots of 10GHz RF getting into the 2.3GHz receiver front end if used on both bands.

The proof of the pudding is in the eating of course, so how did it fare on the air? Initial tests using GB3MHS as a local signal source were encouraging, with the dish showing a 3dB advantage over the Loop Yagi. Listening to the PI7GHG beacon, which is close to the noise level under flat conditions, was less conclusive, but still indicated a marginal improvement using the dish. Results in the May UHF Contest were at least as good as with the Loop Yagi, with comparable numbers of contacts and best DX. On balance I will put up with the need to move the antenna to beam on stations as I now have reduced weight and windage overall and it seems to offer slightly better performance.

A larger offset fed dish would easily outperform Yagi antennas, with an 80cm dish offering almost 3dB more gain than a 60cm version. Since 60cm satellite dishes are readily available either free (as a result of upgrades to digital) or new for a few pounds, a pretty respectable 2.3GHz antenna can be achieved at very low cost.

It should also be fairly strightforward to build a circularly polarised feed for use with AO40 – has anyone tried this?

Phase 3D/ AO40

The AO40 satellite has been operational recently in transponder mode with the downlink on 2.4GHz being received well on relatively simple antennas (eg a medium size yagi or helical or a small dish). It looks promising for providing reliable DX communications with relatively simple antennas and equipment. Ken, G8VR has reported good results using a 16 turn helical antenna to receive the 2.4GHz downlink, for example. I look forward to hearing more results from satellite operators as the satellite is fully commissioned. As this is being written the transponders are off as the squint angle is unfavourable and other commissioning work is under way.

Forthcoming contests

There are UK All Band Microwave contests on Sunday 24th June and 12th August from 0900-2100gmt.

Unfortunately VHF NFD in the UK has been cancelled due to Foot and Mouth,but there will still be European activity on the first weekend in July on all bands.

The Scandinavian activity contests continue, with 1.3GHz and up on the 3rd Tuesday of the month, from 1700-2100UTC. It has been suggested that to maximise the chance of a contact stations from the UK will be particularly looking to Scandinavia at 2000utc and it is hoped they will beam to the UK then.

August sees another round of microwave events in Europe on the first weekend. The German contest has separate time slots for different bands, with 1.3GHz from 0500-0930 on 4th August, followed by 2.3GHz to 5.7GHz from 0930-1200gmt. The French event is 1400-1400 on all bands.

On 19th August the French have their 1.3GHz and up F8TD Trophy contest from 0400-1100gmt.

Sign off

Thanks to those that provided reports either direct or via various internet reflectors for the column.
I end with the usual plea for input - If you have any news and views for this column, please let me know. I can be contacted as below. I am keen to hear more about areas such as ATV, packet links and FM voice repeaters, as I am sure there is a lot going on that others could benefit from.

73

John, G3XDY

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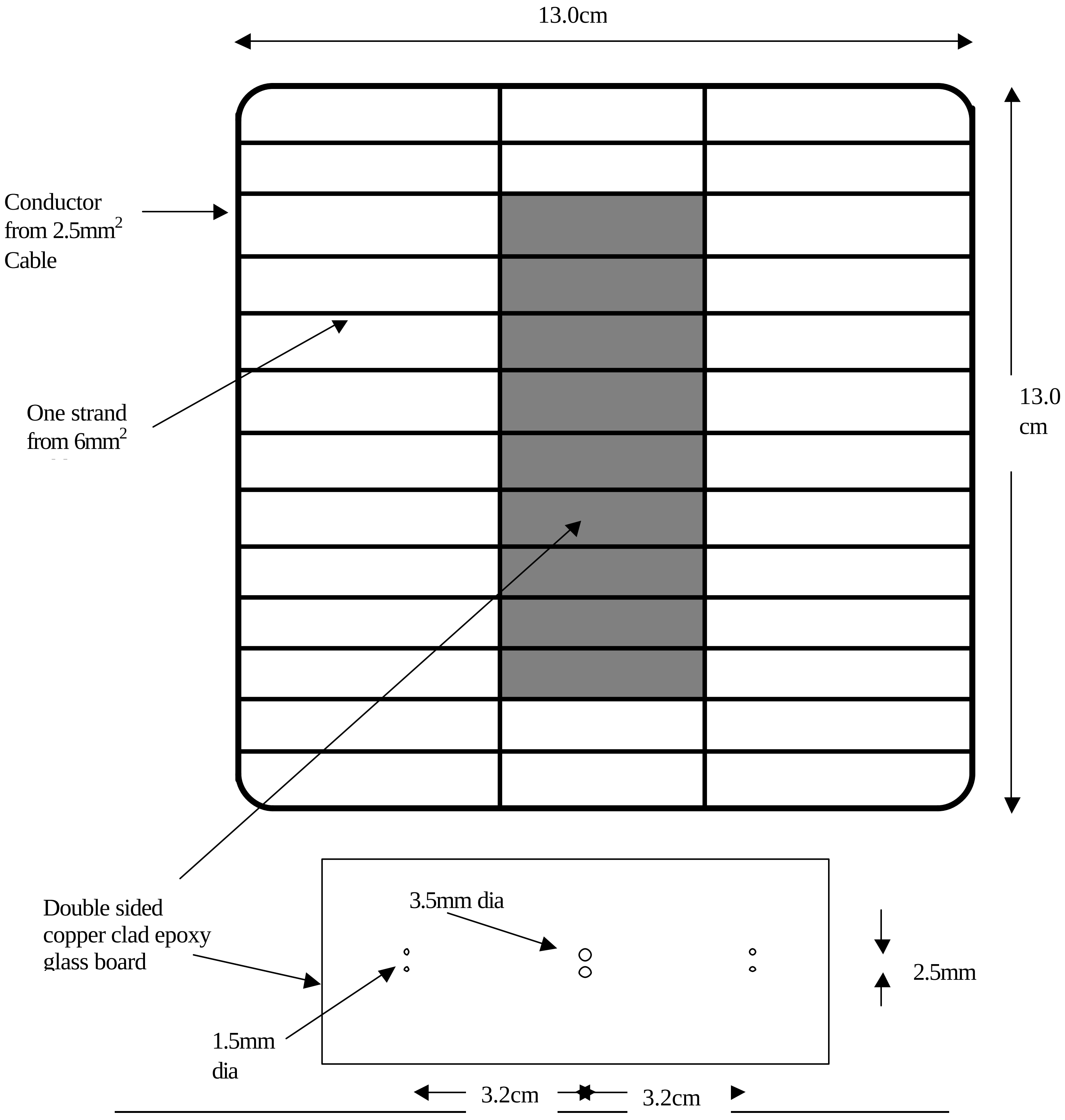
Post: John Quarmby, 12 Chestnut Close, Rushmere St. Andrew, Ipswich, IP5 1ED
Phone: 01473 717830 (between 18.30-21.00 preferred)

Figure 1   2.3GHz feed - Reflector Screen



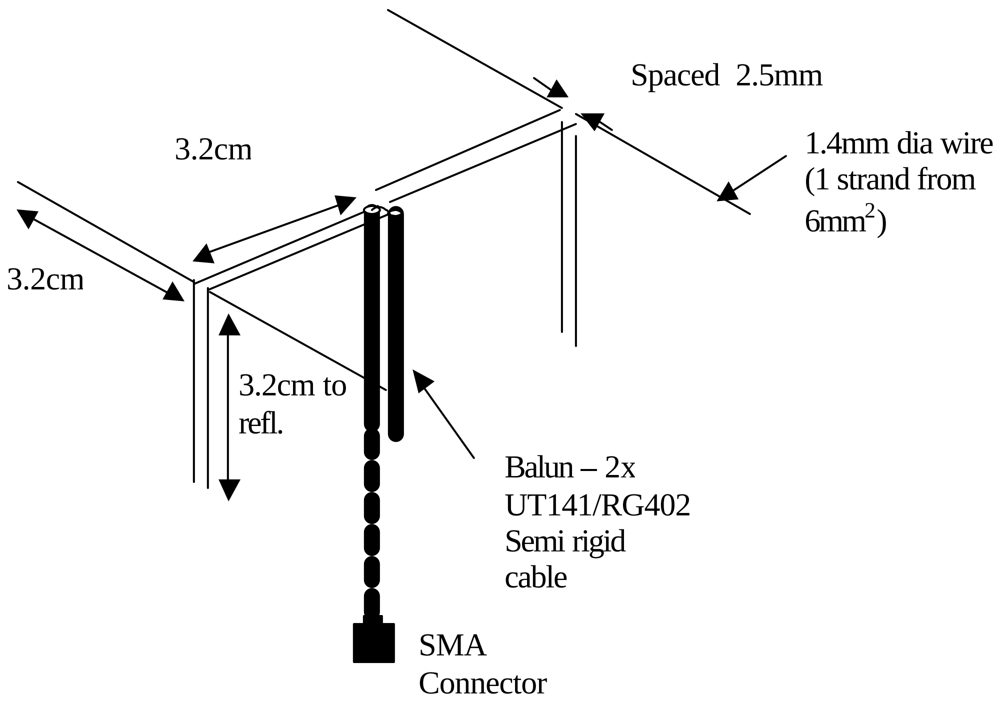


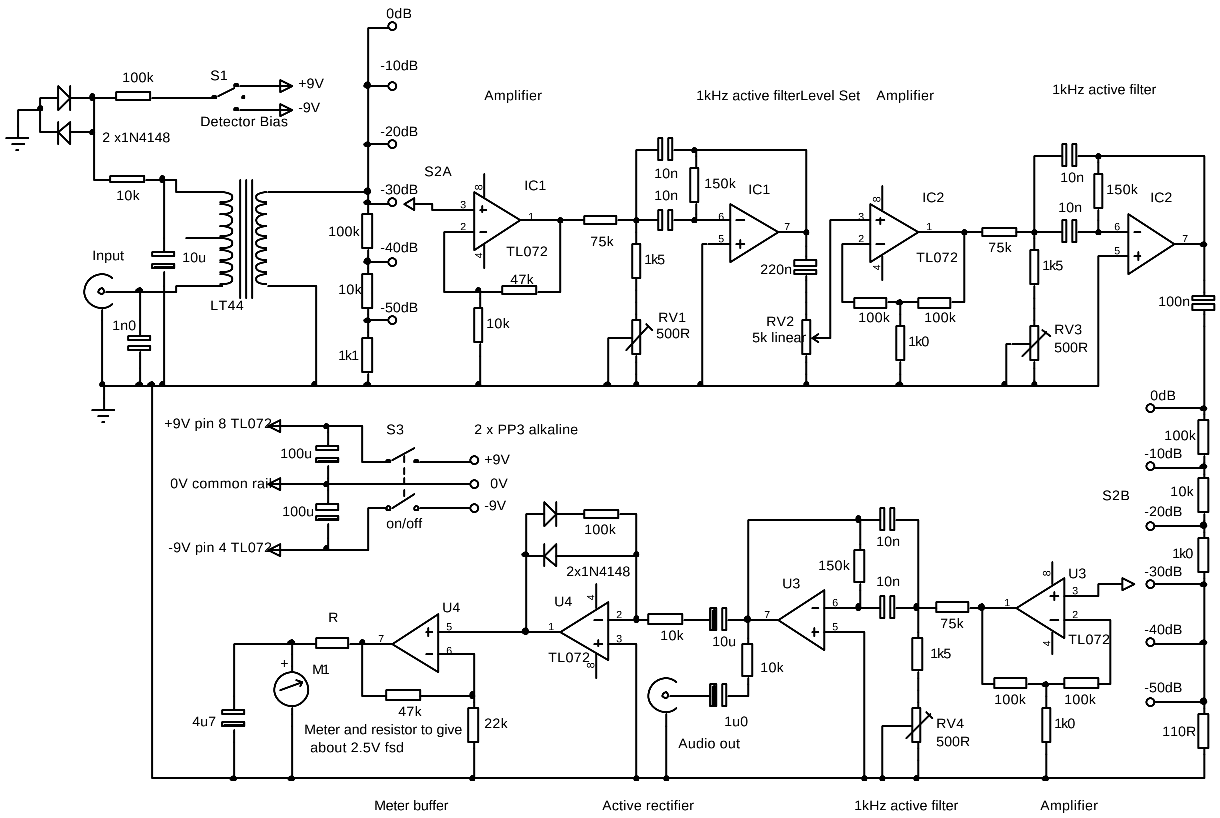
Figure 2 – Dual Dipole Feed

Tuned Audio Level Meter for RF Measurements (Part 2)

Roger Blackwell G4PMK

email:g4pmk@marsport.demon.co.uk

With many apologies to Roger, I omitted the Circuit Diagram in Issue 4. I have also included a reprint of the PCB layout (full size). Sadly the act of importing, reducing and reproduction left the original art work in rather a poor state.



PCB Layout Here

Using the Tuned Audio Level Meter

Roger Blackwell G4PMK

In the last issue of *Scatterpoint* [1], I described a tuned audio level meter. Here is some advice on using the meter, together with some information on accessories.

Accessories

To use the level meter, you need to provide an RF source, amplitude modulated at the 1 kHz frequency to which the level meter is tuned. If you have a signal generator or QRP Tx capable of amplitude modulation, that will do nicely; if not then it's a simple job to provide an external modulator for whatever RF source you use. Fig 1 shows a low-level (mW) modulator based on a PIN diode and a simple oscillator. By using appropriate construction techniques, SMD style components and sensible values for the RF chokes and bypass capacitors, this can be made to work up 2 GHz or so. Make the audio frequency adjustment easily accessible so it can be trimmed for best response with the level meter. The 2-pole centre-off switch allows selection of both modulated and unmodulated signals without disconnecting the modulator from the source.

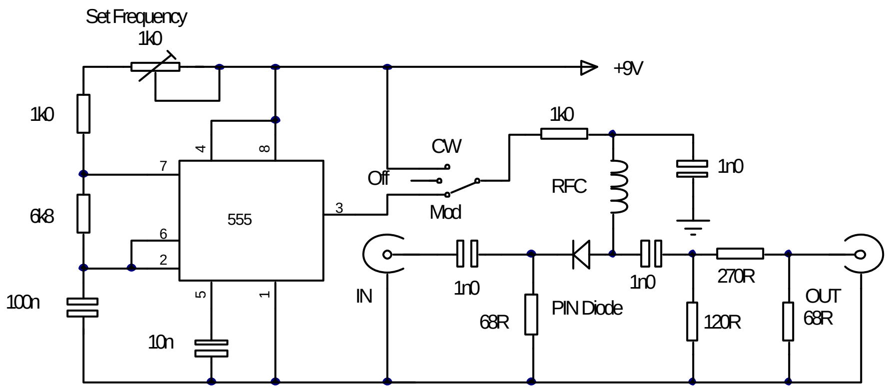


Fig 1: 1kHz amplitude modulation accessory

For higher frequencies, it may be possible to utilise a commercial semiconductor switch; I have used the Mini-Circuits ZFSW series to 5 GHz or so, and there are occasionally waveguide PIN modulators or switches available as surplus. Actually, I have a confession to make; I use a klystron source for 10GHz, modulated by feeding 25 V or so via a capacitor to the reflector. Sufficient AM is produced to render this source quite suitable for measurement applications. A Gunn oscillator could no doubt be modulated in a similar way.

The other item needed to complete your measurement outfit is a detector. One can often find suitable detectors on the surplus market - I'm thinking of those with an Ntype plug on one end and BNC socket on t he top, or one of those SMA m/f types, both look something like a coaxial attenuator. The diode type and polarity will determine what setting of the bias switch to use. Remember that this is a series diode, so the device you are connecting it to should provide a DC return for the bias current. Often a -3dB or larger attenuator between detector and source is a good choice and serves as well as a normalising impedance. If you cannot come across a surplus detector, then make your own in the body of a N-plug, with the diode connected between the centre pin and a feedthrough capacitor fitted on a disk of brass soldered on the top of the clamping nut. If you are lucky enough to find one at a reasonable price, a *slotted line* should have a detector fitted on the sliding carriage, and will enable you to make vswr measurements of components very easily.

Antenna Measurements

The interest shown in making antenna measurements using tuned audio level meters was what originally prompted these articles. I'll refer you to some references [2,3,4] for a full treatment, however here are some of the basics.
This incarnation of the level meter has a separate audio output, designed for use with an external battery-powered amplifier/speaker. This is useful, not only to hear what's Really Going On, but also to aid alignment of the antennas; if you are changing antennas for comparison purposes, it's particularly important that both are aligned for maximum forward gain rather than just visually.

Gain Measurement

For accurate gain measurement - or even accurate comparisons between different antennas - it is essential that the antenna under test is located entirely within a three-dimensional region of uniform field strength with a flat phase front. You will need a *source antenna* to create this RF field, and if you want to measure absolute gain you will also need a *reference antenna* of known gain. If you just want to compare two antennas, the reference antenna isn't required. The reference antenna could be one that's been measured elsewhere, or a standard gain horn, which can be home-made from published data.
For the purposes of this description, the source antenna is treated as the transmitter, and the antenna under test as the receiver. This is usually the most convenient setup, but the transmitter and receiver can be interchanged.
To create the uniform field mentioned earlier, the source must be in the *far-field* of the dish under test, and vice-versa. That means a distance greater than:

$$2D^2 / ?$$

between the two antennas, where D is the diameter of the dish, or the greatest dimension across the aperture for other antennas. If you are concerned with yagi antennas, you can calculate the equivalent aperture (a.k.a. capture area):

$$D_{EQ} = G\ ?^2/4p$$

where G is the gain over isotropic (in linear, not dB terms), ? is wavelength. D_{EQ} can then be substituted for D in the equation above.
For example, a 60 cm dish will have to be at least 24m away from the source at 10 GHz.
The ideal antenna range is floating in free space, and several ingenious range geometries have been devised to avoid the effects of ground reflection - if you can measure across a deep canyon or between two high buildings, then do it! However,

for most amateur measurements we have to use a level range and cope with the effects of ground reflections somehow. In most range geometries, both of your antennas need to be well clear of the ground and other reflecting objects. In general try and choose a level site for measurements - free of buildings, cars trees and metal objects. Ideally the surface between the two antennas should be flat, and smooth to a quarter wavelength or so - which is no doubt why measurements are often made in large empty car-parks. If possible, use vertical polarisation of the antennas as then the angle of incidence of the transmitted signal with the ground can be set to minimise reflections - this is known as the Brewster angle and is about 15° for soil surfaces. The spacing between the source and receiving antennas needs to be 7.5 times the source antenna height to achieve this Brewster angle. However, you also need to meet the far-field criterion mentioned earlier, and this may require impractical heights for the receiving antenna. In any case, it should be possible to check that you have a suitable set-up, by investigating the signal strength across the plane of the receiving antenna, using a dipole-on-a-stick probing antenna and the level meter. The signal strength should remain constant (within a dB or so) across the whole volume into which you are going to place your test antennas.

Dish Focussing

This is pretty much the same as gain measurement, but obviously doesn't require a reference antenna. You'll still need a source and a transmitting antenna though. Having the detector/level meter attached to the dish to be adjusted will be more convenient. The level meter is also well suited to setting up circularly polarised feedhorns.

Gains and losses in components

Because of the dynamic range possible with the level meter, it is a very useful tool for measuring gains and losses - in cables, amplifiers or just about anything else. Of course, it doesn't matter if frequency conversion takes place, as long as there is an output at some frequency that can be fed to the detector. It's important to check that you are keeping within the linear characteristics of any active devices. Filters are a particular favourite application of mine - a band-pass filter response for example can be quickly plotted with a signal generator and the level meter. Very handy if you don't have access to a sweep generator or network analyser.

Using a Slotted Line for matching and impedance measurements

A slotted line is one of the most useful accessories for the level meter. These are sometimes available on the surplus market. You're more likely to come across a waveguide version, which consists of a length of guide with a slot along the top. Some kind of movable carriage runs along the top, with a probe whose end projects through the slot. A detector is connected to the probe. These lines are also made in coaxial airline form as well. You can use them for making SWR and impedance measurements, using just the level meter and a modulated source. Here's how:

Simple VSWR measurement

VSWR is defined as the ratio of maximum and minimum voltage on the line:

$$\mathbf{VSWR = Vmax / Vmin}$$

The square law detector used with the level meter means what is indicated on the meter is a power ratio, so:

VSWR = v (Vmax/Vmin)

First slide the carriage along for maximum indication, then use the Level Set control on the level meter to set FSD (100) on the meter. Now adjust the carriage for a minimum reading.

The VSWR is then:

v (100/reading)

If you have actually calibrated the meter in dB, then FSD will be 0dB, and the minimum reading is a 'loss' in dB , so:

VSWR = antilog$_{10}$ (Loss dB/20)

Impedance measurement

This is a bit more involved, so I'll go through it in steps.

A) Place a reference short (for waveguide, a metal plate) across the output side of the slotted line. Find the positions of TWO peaks, and hence the distance between them. That's the guide wavelength, **$?_g$**.

B) Connect the device to be tested in place of the short. Move the carriage to a maximum, and set the meter for FSD. Note position of the carriage.

C) Move carriage either towards the load or towards the generator (remember which!) for minimum. Note the position of the carriage again, and read the meter scale for VSWR as described earlier.

D) Now dig out the pad of Smith charts [5] and draw a VSWR circle on the chart.

E) Translate the distance between the two points already noted (max and min) into fractions of **$?_g$** using the length of **$?_g$** obtained above in step C. From the left hand side (R=0) of the chart, move the appropriate fraction of a wavelength around the circle - forward = towards load = clockwise; backwards = towards generator = anticlockwise. The point on circle is the impedance in normalised terms.

If you are fortunate enough to have a 50 ohm coaxial slotted line, then the impedance is normalised to 50 ohms. If you are using a waveguide slotted line, then the waveguide impedance is:

377 x (a/b) x($?_g$/$?_o$)

where **$?_o$** is the free space wavelength, and a and b are the internal dimensions of the waveguide.

I've used this technique very successfully with a WG16 slotted line to make and adjust WG to coaxial transitions for 10GHz.

So that's a few applications of the Tuned Audio Level Meter - of course there are others. Why not write up your application for *Scatterpoint*?

The circuit diagram and PCB layout is on my website, together with other info about the meter: http://www.marsport.demon.co.uk/projects.htm

[1] *Scatterpoint* Issue 4.

[2] Antenna Gain Measurents, Fred Brown W6HPH, QST Nov and Dec 1982.

[3] IEEE Standard Test Procedures for Antennas, ANSI/IEE 149-1979.

[4] UHF Antenna Ratiometry, Richard Knadle K2RIW, QST Feb 1976.

[5] *In Practice*, RadCom March 2001. A downloadable bitmap of the Smith chart is at http://www.ifwtech.com/g3sek/in-prac/smith.gif

HS400 – Electrical Frequency Control of the oscillator

David Wrigley G6GKX

The HS400 contains a very useful and high quality reference oscillator. We all need a frequency source that we can rely on to set up the local oscillator in our transverters and any frequency counters that we may have. This 5MHz reference oscillator is just the job to use as a reliable local source. It was the author's intention to control this oscillator by locking it to MSF or another reliable source and these modifications are intended to allow us to do that. The previous modification showed how easy it was to get out a buffered 5MHz output to a socket on the back panel. This modification allows us to electrically fine tune the crystal frequency and will ultimately allow us to set it to 5MHz manually (and later automatically) to within a few parts per 10^10.

Anyone who has seen the schematic diagram for the HS400 will have noticed that a provision for electrical frequency control is in place. How strange then that it doesn't work! The reason for this is that whist the external wiring is in place; Toyocom does not fit the internal components into the reference oscillator. To fix this problem we will need to get inside the reference oscillator can and make connections to the internal stabilized supply and then fit a Varicap diode and series resistor to the crystal circuit.

One Varicap? – well, I believe that using only one diode can theoretically produce some phase noise and that two diodes back-to-back minimise this effect. However, this 5MHz reference oscillator using only one diode has been used as a source for the Manchester 10GHz beacon and no significant phase noise has been heard in the receiver. I am reluctant to put in extra components unless I've experienced the need for it.

Schematic correction

Before we get deeply involved, it is a good idea to check the cable between the reference oscillator and the adjacent PCB. In the two units modified so far this cable did not agree with the circuit diagram. The circuit diagram should be:-

- ?? The Orange wire from SKT C/pin2 connected to SktA/pin 4 (not 2 as shown)
- ?? The Blue wire from SKT C/pin7 connected to SktA/pin 2 (not 4 as shown)

Getting to the oscillator PCB

You will need to remove the oscillator can from the HS400. The procedure is

1. Turn the top panel screws a quarter turn (opposite ways!) to release the top panel.
2. Locate the Reference oscillator can at the opposite end to the mains transformer.
3. Unplug the connector and slacken off the two clamp fixing screws to release the can.
4. The can will then slide out towards the front of the HS400 unit.

Move the can over to a clean area of bench and have a small tray handy to hold the collection of screws to be removed.

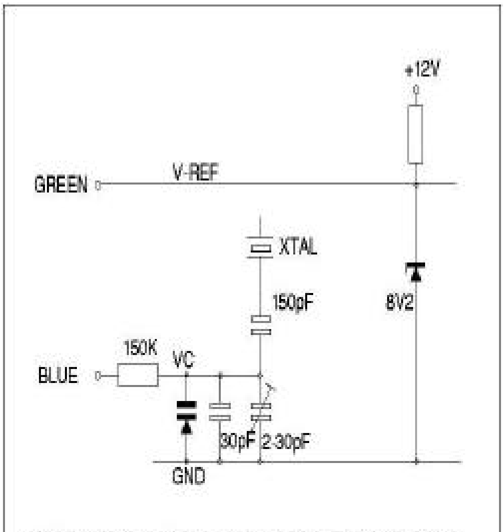
To strip the unit,

1. Unfasten the four small cross-point screws (with washers) on two sides of the can.
2. The base and assembly will then be able to be pulled out by means of the projecting screwed rods.
3. Unwrap the insulating fibre material and put this to one side.
4. The PCB in which we are interested is the small top one and can be worked on without any further dismantling at this stage.

The modification,

1. Fixing the Varicap diode and associated capacitor and resistor.

The Varicap diode used by the author was a small plastic (SOD323) 17pF (at 0V) type. The types likely to be suitable are the Farnell BB149A (316-2837) or alternatively (in SOT23) the Farnell, BBY31 (300-0310) or BBY39 (316-3076).



TOYOCOM 613 REF OSC - PARTIAL SCHEMATIC DIAGRAM

The Varicap diode is soldered across the points marked “GND” and “VC”. Also from “VC” is connected the (short) end of a wire ended 150K resistor. The other end of this resistor is connected to a wire and insulated with sleeving. The other end of this wire is soldered to the blue wire termination pad on the lower PCB. This wire provides an external connection for the frequency control voltage.

A wire is soldered between the point marked “V-REF” on the oscillator PCB and the green wire termination pad on the lower PCB. This connection provides an external connection to the internal +8.2V Zener stabilized supply.

The fixed capacitor (of about 20-30pF) in parallel with the trimmer may have to be reduced in value by a few pF to allow for the extra capacitance of the Varicap diode connected across it. However the trimmer has a range of 2-30pF and therefore depending on where it was initially set, the trimmer may be able to accommodate the addition of the Varicap – so try it – it worked with my unit. As crystals age they rise in frequency and therefore require more capacitance to bring them back down. In fact with crystals such as these - over twenty years old – it is not uncommon to find that the adjustment has insufficient range to bring them back on frequency – so a bit of extra capacitance may well be a help rather than a problem. If you do need to change the capacitor, ideally it should be a silver mica type as used originally, but a Low K ceramic dielectric type has been used without a problem.

Units with an inductor as a series element
You may find an inductor in place of the series capacitance – In the initial experiments this was left in but it was then discovered that the trimmer would not bring in the correct frequency when the Varicap was added and a tiny surface mount capacitor was added in series by breaking the track to the crystal. However in the final clean-up, the SMD capacitor and the inductor were both removed and replaced by a single 150pF ceramic capacitor.

2. Completing the wiring to the base socket

Access to the base connector is now required in order to connect the missing wire..

1. Remove the four screws which fix the lower PCB to the baseplate. You will see a green wire going to pin 5 of the connector in the baseplate.
2. Apply a soldering iron, and with tweezers or fine pliers, gently slide the wire off pin 5 and put it onto pin 2 (the pin next to that with the white wire).
3. Refit the lower PCB to the baseplate.

Reassemble the unit.
1. Wrap the insulating fibre round the heater, but keep the new wire links outside the fibre. This keeps the heating of the wires to a minimum and permits the use of PVC insulation for these wires.
2. Slide the assembly back into the can and refix the four screws and washers.

Conclusions and future direction

With the modification as it stands, the oscillator will have the facility of fine tuning by means of the external potentiometer and this facility can also be used to lock it to another source

In spite of the oscillator being temperature controlled, it is still very slightly affected by changes in external temperature – this causes a slight change in frequency over the day of two or three parts in 10^10. The specification of the HS400 is 5 parts in 10^10 per day (ageing rate) and this may have been true when the unit was new and had a high ageing rate. As readers will know, the ageing rate decreases with time. Now, after over twenty years of ageing, the effect of ageing is minimal and the ambient temperature change is now the main source of error. The ageing rate of the authors reference oscillator is so small that it is only detectable over a long period of time – it averages to about 2 parts per 10^10/month! This demonstrates the value of well used second hand parts – it's expensive and difficult to get this kind of stability off the shelf!

The author has used the unit as described above and locked it to the GPS time signal, by using a Motorola UT+ GPS receiver and the Brooks Shera GPS controller PCB. This works well and now that the US Department of Defense have taken the deliberate jitter off the system, averaging over a time constant keeps the crystal reference to about 1 part in 10^10. See the UKuG website for links to more info. There, you will also find the design for a tiny PCB to generate the required negative 5V 14mA supply from the regulated 12 Volt supply in the HS400 (see www.microwavers.org/sw).

Work is currently proceeding on minimizing the small temperature effect and increasing the averaging period to try to obtain a further improved accuracy of 1 part in 10^11 or better. This of course is totally unnecessary for amateur requirements but it is another interesting challenge! It would probably be about the limit of what can be achieved with a crystal oscillator using a temperature controlled oscillator within a temperature controlled enclosure – in order to obtain an accuracy of about 0.1Hz at 10Ghz.

Uses of the reference oscillator

The reference oscillator is a useful basis of frequency measurement but there are more direct uses of it. For example, why set up your LO using a frequency counter referenced to the reference oscillator if you can use the reference oscillator directly to drive the LO. If a Droitwich receiver were locked to the reference oscillator a stability of about 1 part in 10^9 or better could be achieved (within 10Hz at 10GHz) – this would be useful for the roving microwave enthusiast. If this system is taken up then it implies a shift in our approach to LO design, with a trend to using a 5 or 10MHz based PLL as the basis for frequency generation rather than using specific crystals in the 100MHz region. This is along the lines of the article by Andy Talbot (G4JNT) – General Purpose Synthesizer- Microwave Newsletter - June 1998. The main point of which is that the accuracy is provided by the reference oscillator once only for all bands and also that there is significant flexibility in setting the frequency. With the newer PLL's direct generation of up to 3GHz can be achieved without the use of multiplier chains and one of these could be used as a direct replacement for the DDK004 2.6GHz multiplier chain. With the PLL, it is possible to program the LO for operation over a much wider range of each of our microwave bands than the 2MHz we currently use.

Dayton Report

Mike Willis G0MJW

The Dayton Hamvention was held as usual at the Hara arena, Dayton Ohio on 17th to 20th May. Those with a nearby calendar might note the 17th is a Thursday. In fact the event does not officially start until the Friday, but much of the inter-trader swapping and bargain detection is carried out by those on site during the set up on Thursday afternoon. Just like in UK rallies, with choice items appearing on dealer stands at higher prices.

It appeared that there were fewer people at the show this time. There was a notable lack of Brits. This was a pity as they would have been at home, with the torrential rain on the Friday that all but washed out the flea market. Having been around on the Thursday evening, I stayed inside on Friday and did some indoor shopping and my USA license exams. Saturday and Sunday were both good days, but many people do not stay on for Sunday. I think some people even packed up and left on Friday.

So, what was there new and interesting ? Dayton is not a microwave event, but the major USA microwave suppliers do attend and there is plenty to be had or simply admired on the flea market. Many dishes, microwave mixers, PLO bricks, packaged amplifiers, modamps, circulators, isolators, cables, waveguide etc were on sale for a few $ each. One stall was selling "White Boxes" for conversion to 3cms selling for $150, complete with a copy of G3PHOs instructions. One of our members, Kent Britain, was there with more PCB antennas including some single band designs for dish feeds and some interesting surplus waveguide switches. 28 GHz and 39 GHz LMDS equipment was again being sold on the Flea market offering interesting possibilities for conversion. Again this year, I was just in time in getting my 38GHz up and down converters on the flea market before a well known microwave dealer came along and bought the lot for resale on his stall for $20 extra, but at least that means we can get them in the UK via mail order !

As in previous years, there were walls of test equipment offered for sale. This year there was slightly less of it and it was more expensive. Much of the equipment on show was recent, of high quality and in good condition. If you are running a small company, you can set up a lab with excellent test gear for a very reasonable price, but a much higher price than most amateurs would be prepared to pay. People with small companies do go to Dayton for their test gear. It appears that there are fewer dealers, but those dealers have several pitches each. I only saw 20-30 HP141 spectrum analysers, less than last year and no 6ft piles of HP141 plug-ins this time. There were plenty of HP8660 microwave sweeper plug-ins from $50 upwards. It is a pity they are heavy. The major piles this year appeared to be Tektronix scope plug-ins. Used Bird wattmeter elements were all over, but cost much more in the USA than here, typical asking price for a meter was $250, and $40 for a slug.

Inside, all the major manufacturers were represented. As I have already noted, this is not a microwave show, it is aimed more generally, so there is plenty to see for the HF appliance operator. Down East Microwave regularly have a large stall and do good business. It was hard to get to the counter. This year they had several new higher power microwave PAs on show and were selling their extensive range of microwave transverters and pre-amps. Handy NiHM 1600mA/hr cells were $1.50, useful for portable equipment. The new FT817 was being sold for $669, about £475 and considerably less than in the UK even after taxes. This is looking like the successor to the FT290 and IC202 for driving transverters and may be instrumental in moving microwave IFs up to 70cms. The new Kenwood TS2000 and Icom IC-910H, both of which can cover 23cms, were also on show. Several companies had 2.4 GHz downconverters and antennas for Oscar 40. There was not a lot else of microwave interest inside.

One thing noticeable is that there is much more mobile operation in the USA than in the UK, especially on HF. An antenna on an SUV or car does not attract much attention and is usually safe from attack in the parking lots. As a result, there were many mobile antenna systems for sale. HF is popular, most VHF operation seems to be via repeaters. Typically, a "Ham" will have, by right, planning permission to install a tower capable of supporting a large HF beam, so there were plenty of those on display too.

To sum up, again a good show that far outstrips anything we have in Europe. The organisation was very good, parking was adequate and close, there was sufficient space between the isles inside and little to no objectionable BO.

Closedown

Many thanks to all the contributors this month. I think that this is the biggest issue that I have produced. This will the last Scatterpoint sent to anyone who has not renewed their subscriptions. Please check the renewal date on your address label. If you are an overseas member and would prefer to pay in US Dollars, the committee has advised me that they will now accept 20 US dollars in paper currency (***sent at your risk***) if you find it difficult to pay in UK Stirling. Please note that at present, we **cannot** accept membership payment or renewal in the form of cheques drawn on overseas banks, Mastercard, Visa etc. I am sure that this will be something that will be looked at if the UkuG continues to grow.

OK – have a nice summer – enjoy your radio and next issue due September. Contributions will be very gratefully accepted!

73,

Martyn G0CZD

Dayton colour photo repeated to make best use of colour copying!!