An Amateur Radio publication for the Microwave enthusiast

MICROWAVE NEWSLETTER

Published by the Radio Society of Great Britain and edited by G3PHO and G8AGN.
Lambda House, Cranborne Road, Potters Bar, Hertfordshire EN6 3JE

FROM THE EDITOR

2002 – JUNE

Apart from the sad news shown below, this issue contains some welcome input from new sources. Grant Hodgson, G8UBN, provides the excellent article on 2.3GHz amplifiers. Peter Weedon. G8ZKZ, follows up last month's article by K2RIW on directional couplers with some of his own work using stripline. Other contributors, who have already written for the Newsletter in the past also provide interesting reading … HB9DRD sent us a long email from which we have had to glean just a small part for this issue. There's more from Jonathan next month. Our thanks go to everyone who has contributed to this month's newsletter.

Comments on the May contest and contests in general continue to come in. We are forwarding them to the Contest Adjudicator for his consideration. Hopefully there will also be further constructive discussion and action at the next Microwave Committee meeting.

Tim Leighfield, G3KEU ~ Silent Key

Many of you will already know the sad news that our friend and fellow microwaver Tim, G3KEU, passed away in mid May. This issue contains several tributes to him. We will really miss him on the microwave bands. To his wife and family we extend our most sincere condolences.

Contents

- Tributes to G3KEU
- State-of-the Art 2.3GHz preamplifer
- Waveguide Slot antennas
- Direction Couplers – follow up
- Our Man in Switzerland
- Activity News
- Contest Results
- For Sale and wanted adverts
- News snippets from here and there

News, views and articles for this newsletter are always welcome. Please send them to G3PHO (preferably by email) to the address shown below. The closing date is the Friday at the end of the first full week of the month if you want your material to be published in the next issue.

G3PHO: Peter Day 0114 2816701

G3PHO: Email: g3pho@qsl.net
or p.day@virgin.net

G3PHO, Peter Day,
146 Springvale Road,
Sheffield, S6 3NU, UK

SUBSCRIPTION ENQUIRIES SHOULD BE SENT TO RSGB HEADQUARTERS AT THE ADDRESS SHOWN AT THE TOP OF THIS PAGE AND NOT TO THE EDITOR ..

PERSONNEL WANTED

Wood & Douglas Ltd, based near Basingstoke, began life in 1977 in the radio amateur market and now a staff of over 50 people design and manufacture professional products for the telemetry, broadcast and security markets.

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Contact Trish on jobs@woodanddouglas.co.uk or call 0118 981 1444

HP SWEEPER MANUAL AND SCALE WANTED

I'm looking for the manual (schematics would do) for the HP86250D 8-12.4GHz plug-in for the HP8620 sweeper and the tuning scale which goes with this, and that for the 86260A 12 - 18GHz plug-in. I'm also in the market for the 4 - 8GHz plug-in - with tuning scale.

Chris Bartram GW4DGU
Gladstone Hall, Llanpumsaint,
CARMARTHEN, Dyfed SA33 6BU
Phone/fax: +44 1267 253903. Mobile: +44 7968 193555

NEW ZEALAND NEWSLETTER

A very interesting newsletter, with good quality technical content and colour photos, is now available from New Zealand. Called **FUN** for short (full name **F**requencies VHF, **U**HF and SHF **N**ewsletter), it is published in electronic format (Acrobat PDF) at various times of the year. So far we have received four issues in the last 12 months. The editor is Kevin Murphy, ZL1UJG and you can get on his mailing list by emailing him at:
rfman@extra.co.nz

24GHz DROs wanted ...
Andre Jamet, F9HX is looking for **two** 24GHz DROs, with horns if possible. Please contact him at: A. Jamet, 3 rue Professeur Calmette, 69330, MEYZIEU, France or email him at: **agit@wanadoo.fr**

WANTED URGENTLY

Sivers Lab manual coaxial switch, in SMA, rocker type. Part no. 7560 … or ...
Two latching coaxial relays (good to at least 10GHz).

Please contact David Hall, M0VZT qthr or telephone 01952 222101

HELP WANTED

Julian G4ZOD has a Clark 40 Ft Ex- WD pump up mast (ex Anchor Supplies). He has managed to strip down the mast (which was jammed) and is now ready to rebuild it.
Has anyone got information on:
(a) the seal dimensions or part numbers and a source of supply?
(b) the method of demounting the existing seals and replacing them?
(c) the type of grease and amount used?
He has new 23cm and 13cm transverter systems waiting since last year to get on the air!

Please contact via email:
julian.greenberg@kcl.ac.uk

EEV TWT Type N1083
Does anyone have information on this tube including the connection colours please?
Email John, G8ACE at: hazell@cwcom.net

CRAWLEY MICROWAVE ROUND TABLE

PRELIMINARY NOTICE

September 15th, 2002
Details to follow

CONFUSING INFORMATION!

RadCom had me rather worried with its Surface Mount Capacitor polarity information shown on page 56, in the May 2002 issue. However, on double checking a number of professional PCBs etc, I concluded I have been doing it right. All along … phew!

Contrary to the RadCom info, the bar or line on the smd electrolytic is **+ve.**

http://www.marsport.demon.co.uk/smd/cap.htm agrees. Does everyone else?

73 John, G8ACE

INFORMATION WANTED …

I recently acquired a type 904A Noise Generator made by PRD Electronics Inc. It contains a coaxial thermionic diode, apparently similar to the one used in the noise factor meters which came on to the surplus market a few years ago. If any reader has any technical information (e.g. handbook or specification) about the PRD 904A instrument, I would like to negotiate for a copy please. Likewise, I shall be pleased to hear from readers who have experience of its use.

Lastly, is anyone out there still using an Icom IC 1271E? I'd like to correspond with IC 1271E users.

Best regards & 73, Pete Weedon, G8ZKZ [Peter_Weedon@compuserve.com]

TIME TO THROW OUT YOUR IC202 ?

Here's a 'nugget' I found on the web. For those who raise the IC-202 to the status of an idol, there is now something close to a replacement available as a kit. It is called the **Hohentwiel** and can be seen at **http://www.dl-qrp-ag.de/qrpshop/eshop/pi505238424.htm)** It's very similar to the IC-202 in that it uses a VXO, but it uses more modern components and probably provides better performance. It provides 5W output power and has very low power consumption, 50mA on RX, 600mA on TX and uses a +7dBm diode ring mixer.

Jonathan HB9DRD/G4KLX

FREE STUFF!

Recently we have added some new articles and drawings to the San Bernardino Microwave Society web pages, in the San Diego Technical Papers section.

They include:

* Modifying a Qualcomm/Globalstar 1.6GHz 5-8 watt PA to 1.3GHz.
* Modifying TVRO 12GHz LNBs for 10GHz LNA use.
* Excel spreadsheets for NF/NT measurement by comparison of Earth vs. cold sky receiver noise output. These can be found at: **http://www.ham-radio.com/sbms/sd/swindex.htm**
* Updated Slot Antenna design program in BASIC (with warnings!)
* And items related to P-Com 23GHz conversion to 24GHz, such as K6VLM's 3072-432 U/D Converter schematic, parts list, and pcb layout of the newly produced boards. K6VLM's i.f. filter design for 3072 and 2208 MHz, WB6IGP modification of the Qualcomm DRO Synthesizer to 2640MHz.

These can be found at:
http://www.ham-radio.com/sbms/sd/

73 from Ed Munn, W6OYJ

TIM LEIGHFIELD, G3KEU 1930 –2002

Tim Leighfield, G3KEU died on the 14th of May, 2002, in a hospice near his home in Swindon. He had entered the hospice just a few days before. Many of you already know that Tim had been very ill with cancer over past months. He struggled on bravely but the past few weeks unfortunately saw a rapid deterioration.

Tim is yet another of my close microwave friends to go this way in recent years and, like the others, I shall miss him greatly. He was always there, out on the hills with Roy, G3FYX, during the cumulative contests, or on from home during the week, running his daily morning 10GHz sked with G3LRP just a few miles north of me and then on the 80m microwave net soon after. There is no doubt that much of the 10GHz activity in the southern part of the UK hinged around G3KEU for he was perhaps the most active UK operator on that band, having made over 840 contacts with G3LRP alone!

Tim was a most enthusiastic and helpful radio amateur as many of those who met him will testify. He was a great believer in home construction and if equipment could be made it would be made! The photograph above shows him many years ago, as a young man, busy testing some home constructed equipment. He made all of his microwave gear and also amassed an enviable array of test equipment.

Wonderful memories of Tim appear on the page opposite, in a letter from Tim's son Phil, to whom we gratefully acknowledge the fine photograph above. Further tributes can be found elsewhere in this issue of the Newsletter.

For those who wish to send their condolences to Tim's wife and family, the address is: Mrs E. Leighfield, 123 Avonmead, Greenmeadow Estate, Swindon, SN2 3PA.

73 and R.I.P Tim, from Peter G3PHO

I will certainly miss him - he was my mentor as I first got going on 3cm. Particular memories of him are:

- his assistance (with G3FYX) on my first 3cm /P foray with them which allowed me to fix my system and make some QSOs.
- The many technical discussions on 2m and 3cm - he kept well up to date with current technology and it was often interesting to get Tim's views, which were always made clear!
- the special sound of his 3cm rig on CW - I'm not sure what the effect was, but I could identify him by his keying tone before I heard any callsign!
- searching for rain cells by alternating 3cm transmission and reception between us and the optimising on the best peak.
- the friendly competition on who could get the best report from G3VKV (off Cleeve masts) or from G3LRP

Neil G4BRK

Very sad news indeed. Tim inspired and helped me to get started with many small radio related projects. Always a great source of knowledge and always willing to learn, he will be sadly missed.

Brian, M1CIY - Swindon

It's a very sad day.

Richard, G4ERP

Letter from Phil Leighfield:

Dad was born on 9th December, 1930, in Wroughton, just outside of Swindon, where he spent his entire childhood days. When he left school his Mum sent him to college to study building and plumbing, as there was "No real future in this electronics thing" (if only she had known!). When his mum died, Dad could really concentrate on his real love, electronics. He did his national service in the R.E.M.E. where he learnt a lot of his early electronic skills.

On leaving the army, he started at Currys, repairing pushbikes, which he hated. There he met Mum, and they were married in 1953. He then managed to get a job mending radios and moved on to Stones, taken over by Radio Relay, then Rentaset, then Radio Rentals and eventually Thorn, where he spent the majority of his working career as an Area Liason Engineer in Hampshire, the North East of England and back in Wiltshire, teaching people how to repair and fault find TVs and Video Recorders. The last few years of his career were as Technical Director of Cable and Satellite Communications in Swindon.

Amateur radio was his life. Every thing he did in his spare time was usually radio related in some way or another. From the age of 10 until I left home at 18, RC modelling took over, but he still found time for his regular radio skeds. If the weather was flyable, Dad and I were there, mainly gliders, but we also had a lot of fun with ic powered models, when we could find somewhere to fly them. He designed and built all of our RC equipment, starting from basic superhet and superregen receivers with rubber escapements, through analogue to digital, the basic principals which haven't really changed over the years.

Mum's bit:

'Tim's licence was first issued on 11th Feb 1955, he was so thrilled when it arrived. I can remember I had to rush down to the phone box to ring him at work. When he answered he said," Tell me quick, what's my call sign!" and so G3KEU went on the air. He built the majority of his equipment and over the years, as most hams will know, the hobby grew into great proportions, taking over one room of the house, loft, shed workshop. Even the greenhouse and garage had aerials etc in them, he loved it so much. Then the microwave bug bit! He was so keen to get a station on air, working hard with others to achieve this, giving and getting help when needed. All his knowledge he gladly shared with others, right up until the last few weeks of his life. He loved to be in his shack, talking to friends or working on some piece of equipment.

His other hobbies included cycling. Before I knew him he would ride his bike far and wide, thinking nothing of a day down to Brighton and back from Swindon. He loved the outdoor life. Once married, this reduced but still he would cycle to work and, over the years, would enjoy shorter journeys. He only really stopped just a few years ago when he started to get breathless due to his illness.

The model flying bug bit quite early on in our marriage. He would spend hours building both models and equipment, and getting great personal satisfaction from flying them on the hills around the country. Like his love of radio, he enjoyed his flying up until the middle of last year when he could no longer walk up the hills. His modelling included all of his family as on good day we all used to go up the hills with him and enjoy the great outdoors. Pip and Chris both continue with the modelling hobby and will do so for many years to come. Another joy was his love of the garden, growing mostly vegetables and flowers from seed in his greenhouse, so fresh veg and flowers were in abundance. His passion for radio and gardening always set out the house and land we were to live in most of our lives. We mainly lived on top of hills with large gardens, where we not only grew plants but aerials of all sorts, which were draped around the house and garden! I can remember he said many times since he retired, "There are just not enough hours in the day, I don't know how I found the time to go to work".

I found it very touching to know just how popular Dad was. It makes it even harder to accept that he's gone forever.'

Best regards, **Phil Leighfield, for and on behalf of G3KEU's family.**

I was sorry to hear about Tim. He will be missed by many. I often had a contact with him on a Monday evening and of course when he and Roy were out portable.

Neil, G4LDR

Tim will be greatly missed on the microwave bands. He kept on the air for our weekly skeds for as long as he could and was a fighter to the end.

His callsign has been a regular feature in my logbook for over 20 years. In fact, if we had not met on Cleeve Common in the early '80s, my enthusiasm for microwaves would possibly have faded without trace.

Everything was a challenge to Tim - why buy it if you can make it? - was his motto. We used to meet at most of the major rallies. Without fail, we would both leave with a boot full of microwave junk, much to his XYL Ena's dismay!

I have been on many cumulatives with Tim, from Hardy's Monument, Dorset to a marathon trip with Roy G3FYX to Haytor Rock on Dartmoor with Walbury, Cleeve and Hackpen being favourites.

We pass on our sympathy to his Wife and Family

Graham Jones G3VKV - Cheltenham

I had known Tim for only a relatively short period, but during that time I had found him such a helpful man, who boosted my interest, as a late beginner, into the wonderful world of microwave communications. His keenness and knowledge rubbed off on you and drove you to make that extra effort. He sent me information and sketches which fired the enthusiasm even more. I finally met him in person only last summer when he called on me at home, when on his way to west Cornwall. I found we had quite a lot of interests and views in common and was sorry when he had to go. We spoke on the telephone and on 80m quite a lot. I will miss those chats terribly.

We in the amateur radio world have lost a beacon which could always be relied on to keep the interest going in the southern sector of the country.

Ralph Bird, G4ALY.

I was sorry to hear the sad news of Tim, He was stationed at Weybourne camp on the Norfolk coast. This was a gunnery training camp using the Queen Bee remote control aircraft. The camp is now a Museum of military transport and radios and has a amateur radio station with the call GB2MC. Tim said the thing he remembered about Norfolk was how cold the North Sea was! I was able to sent him a booklet with photos of the camp taken in the war years. He will be sadly missed.

73 John G4BYV

I am very sad to hear of Tim's death. I, too, will miss contacting him on 10GHz. Over the years he has been very helpful and a couple of years ago at Martlesham he volunteered to take my gear under his wing when it needed completely re-aligning. He was a true amateur.

Jack Booker, G3JMB

I am deeply saddened to hear about TIM. When he worked at Thorn TV Depot, Stockton on Tees, I used to see him weekly (and Ena when calling to his house). It is a great loss to family and microwave friends.

John Thompson, G3NWU

I am sad and shocked to hear about Tim. I have not been active for the past few months and was unaware that Tim had been ill.

Tim has been the inspiration for much of my microwave activity in recent years, and I will miss his almost guaranteed activity on the 10GHz events. Due to our proximity, Tim and I have, in recent years, hunted the 10GHz band together when we both operated from home in the 10GHz cumulatives, and activity days.

This always gave me great pleasure to see how Tim was able to work at least as many, if not more stations than myself, even though he lived in a much less favourable location.

Tim's knowledge, experience and inexhaustible willingness to help further my understanding of microwaves (especially the 10GHz band) will be sorely missed though never forgotten.

Paul Longstaff (G6UAJ)

A state-of-the-art 2.3GHz Pre-amplifier

Grant Hodgson G8UBN QTHR

Eagle-eyed readers may have noticed the reference to an ATF-54143 in John G3XDY's notes on the pre-amplifier testing results at the November Adastral Park round table, published in the March 2002 Newsletter. Here are some more details of this pre-amp which has some rather interesting properties :-

The ATF-54143 is the first of a new breed of low noise GaAsFETs. Released by Agilent Semiconductors (formerly HP) in mid-2001, it is less than one year old and offers some remarkable properties. It was designed for the mobile phone base station market, where low noise and good strong signal handling ability have to be achieved at the same time. However, it can be used up to at least 6GHz (although the gain is starting to roll off at this point), and is ideally suited for amateur microwave use in the lower and middle bands.

Agilent call the device an Enhancement-mode Pseudomorphic High Electron Mobility Transistor, or E-PHEMT. HEMTs have been around for some time now, and will be familiar to anybody who has built a microwave low noise amplifier (LNA). 'Pseudomorphic' is a development of the basic HEMT, and refers to the way the Gallium Arsenide is doped during device manufacture; the channel of the FET being made from many thin layers, which form a lattice structure. It sounds very impressive but is only of relevance to the semiconductor physicists involved in the details of the design and fabrication of the device itself. (Incidentally, PHEMT is pronounced 'pee-hemt - not 'femt, but there doesn't seem to be a universally accepted way to pronounce E-PHEMT'!)

The really interesting bit is 'Enhancement'. Until now, all low noise and high power GaAsFETs for RF and Microwave use were of the 'depletion' type, which means that the device has to be biased into the operating region by ensuring that the gate is at a more negative potential than the source. The two most usual ways of achieving this are by grounding the gate at DC and using resistors in the source lead(s), or by grounding the source lead(s) and using a separate negative voltage generator.

Enhancement mode FETs require a positive voltage to be applied to the gate, which obviously makes things far easier in terms of circuit design and construction.

The second interesting feature of the ATF-54143 is it's strong signal handling performance. Traditionally, low noise GaAsFETs have had significantly worse performance in terms of being able to handle either in-band or out of band strong signals than bipolar transistors or MOSFETS. The parameter most often used to describe strong signal handling performance is the 3rd order intercept point IP_3, either referred to the input (IIP_3) or the output (OIP_3) [1],[2],[3].

Note that the difference between the IIP_3 and the OIP_3 is simply the gain or loss of the device, so that an amplifier (or transistor) with an IIP_3 of +10 dbm and 6dB gain will have an OIP_3 of +16dBm. The ATF-54143 has an OIP_3 of up to 37dB at 2.3GHz, with an associated gain of 16dB, giving an IIP_3 of +21dBm which is a very impressive figure indeed. The IP_3 is a function of the bias conditions, and this allows a trade-off to be made between IP_3, gain and noise figure.

On the higher microwave bands, strong signal handling is not usually an issue but there are at least two cases where good strong signal handling could be used to good effect, particularly at 1.3GHz :-

1) The 1.3GHz band has a close proximity to the frequencies used by the huge Civil Aviation Authority radars in some parts of the country. Some 1.3GHz receivers are consequently overloaded.
2) Repeater builders have to go to great lengths to ensure that the repeater output does not de-sensitise the receiver. Traditionally repeaters have required a low loss, high Q cavity duplexer in order to separate the Tx and Rx signals. A receiver front end with a very high IP3 may not be as susceptible to self-desensitisation, allowing the possibility of a lower-specification receive filter.

The ATF-54143 could help in both of these situations.

The noise figure of the ATF-54143 depends on frequency, but at 1.3GHz the NFmin (minimum noise figure if the rest of the circuit was ideal) is only 0.4dB, and only 0.5dB at 2.3GHz. This is not quite as good as some other devices, such as the ATF-36077, but for the vast majority of cases this will not matter for two reasons :-

i) Noise figure differences of one or two tenths of a dB are only relevant in very special cases for space communications, such as satellite and EME - for terrestrial applications, it makes no real difference to the received signal/noise ratio due to the relatively high level of background noise (approx. 290K).

ii) Use of good RF circuit design techniques, high Q microwave passive components and low-loss PCB materials can reduce the circuit losses in a new LNA design such that the degradation in noise figure due to the these components (i.e. components external to the active device) are very small indeed, typically less than 0.2dB.

'So what's the catch?'

The ATF-54143 is not expensive, currently being only £6 each, which is considerably cheaper than (for example) the Mitsubishi MGF1402. One of the biggest problems is the size of the device - it is obviously in a surface mount package, as with all new devices (apart from those with no package at all - i.e. bare die!), and the package of the ATF-54143 is very small with the leads on a 0.65mm pitch, so some form of optical aid is required when soldering. There is also the usual problem with all HEMTs in that there is a reasonable amount of gain at high frequencies, and this gain increases as the frequency is reduced. This leads to the possibility of instability anywhere from several hundred MHz to over 10GHz, and careful circuit design is required to ensure that the resulting amplifier is stable.

Circuit Description

The positive gate bias can most easily be derived from a simple voltage divider consisting of two resistors. However, the drain current is highly dependent on gate voltage, and the relationship between the drain current and gate voltage (transconductance, Gm) varies from device to device, as do the individual I-V curves. The ATF-54143 data sheet [4] gives details of an active bias circuit, which ensures that the bias conditions (drain voltage and current) are consistent from device to device, and offers a degree of temperature stability. The design presented here is based on the Aglient design, with some subtle modifications.

Referring to the circuit diagram **(figure 1)**, R1 and R2 form a potential divider which keeps the base of TR1 at a constant voltage of approximately 2.7V. The emitter voltage of TR1 is simply the base voltage + 0.65V. This sets the drain voltage of TR2 at approximately 3.4V.

The drain current is set by the resistor R3 to be approximately 30mA. The gate current is almost zero, and can be ignored for the purposes of biasing. The gate voltage is therefore the same as the collector voltage of TR2, and is regulated by TR2 such that conditions for the drain voltage and current are always met. If the drain current of TR2 was to rise for any reason (such as a change in temperature), the voltage at the emitter of TR1 would drop causing the voltage at the collector to drop. This would reduce the gate voltage, causing the drain current to drop, thus maintaining bias stability.

However, the emitter-base voltage of a bipolar transistor decreases as the temperature increases. Therefore, D1 is included to compensate for this; if the temperature increases, the voltage drop across D1 will reduce, causing the base voltage of TR1 to increase, but the emitter-base voltage of TR1 will also decrease with increased temperature, and consequently the voltage at the emitter of TR1 will be almost constant over a wide range of temperatures. Measurements show that with this arrangement, the drain voltage of TR2 varies by only 100mV and the current varies by only 1.8mA over the temperature range -18°C to +60°C. The temperature performance of microwave circuits is often ignored, but masthead mounted pre-amps can be subject to extremes of temperatures, especially if mounted at the feedpoint of a dish which is pointed at the sun in order to make G/T

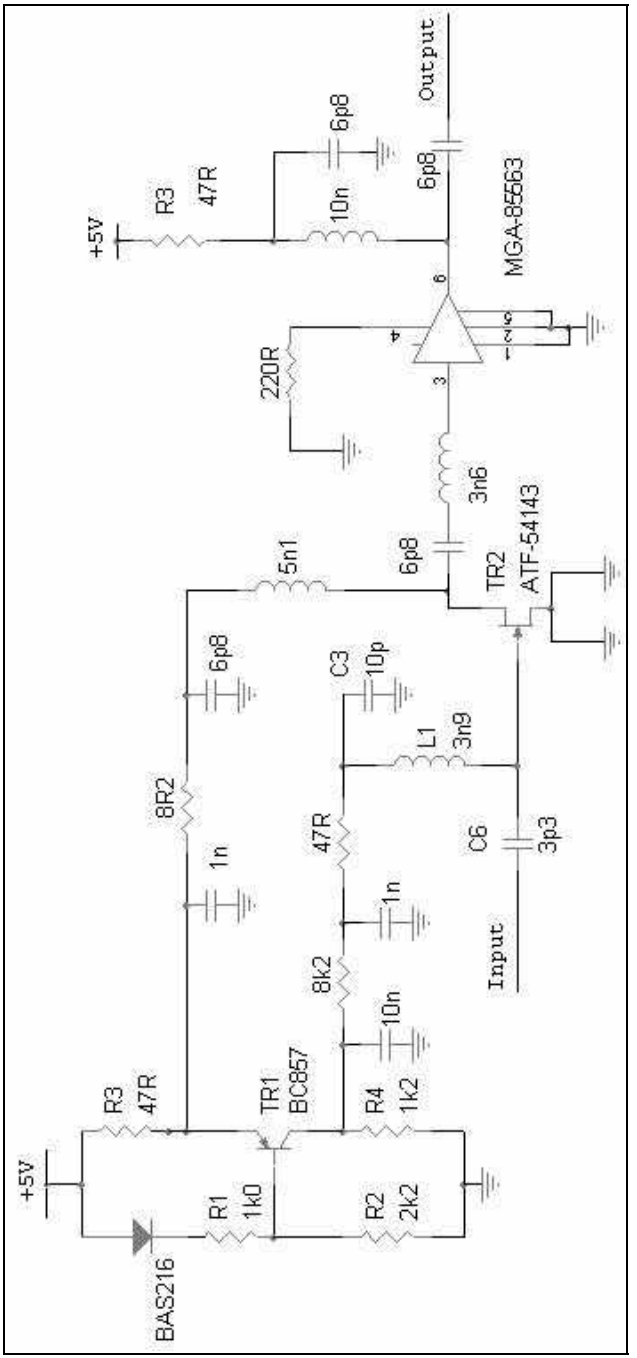

Figure 1: 2.3GHz converter: circuit diagram

measurements. The active bias circuit ensures that consistent bias conditions will be maintained over a wide range of temperatures. Note that this bias circuit could be adapted for use with a negative gate-biased FET to give a similar level of bias stability, but the author is not aware of any amateur designs that actually do this.

The bias conditions of V_{DS}=3.4V and I_D=30mA were chosen to give a low noise figure and reasonably high gain at 2.3GHz, the objective being to reduce the noise figure of the system as a whole. The bias conditions are set only by R1, R2 and R3.

Source Degeneration

Traditionally, HEMTs and PHEMTs have required the absolute minimum inductance from the source lead(s) to RF ground for best performance. This is why FETs usually have two source leads; the inductance to ground is reduced which increases the gain. The ATF-54143 has been designed to allow some source inductance to be used in order to raise the input impedance to be closer to 50 ohms. The input impedance is of little importance in the majority of amateur radio applications, the exception once again being in repeaters where the performance of the duplexer is a function of the load presented to the ports. For the majority of amateur applications, the input SWR of a low noise amplifier is of secondary importance to the noise figure and gain.

However, the PCB (see below) has been designed to allow some source degeneration if required. This is achieved by etching two parallel tracks for each of the source leads. One track connects to the device source lead, the other is connected to ground with a row of vias. A small (0402 size) zero ohm link is used to connect the source lead to ground; the position of the link setting the source inductance. For 2.3GHz (and above) the inductance is set to minimum, although the resulting impedance is not zero – the size of the zero ohm link acting like a short transmission line with a non-zero inductance. This causes a reduction in gain of approximately 2dB, although the noise figure is unaffected. More details of source degeneration can be found in reference [5].

Input match

As with all discrete low noise amplifiers, the optimum noise figure does not occur when the device is matched to 50 ohms. This causes all manner of confusion to some, but suffice to say that the best (lowest) noise figure is obtained when a certain mismatch occurs. The input impedance is transformed to this optimum impedance with C6 and L1; C3 ensures that the junction of L1 and R6 is at RF ground. In order to achieve the best noise figure possible, the losses associated with these input matching components must be kept to a minimum, which means that high Q components must be used.

Traditionally, inductors at these frequencies would either be printed on the PCB or formed from wire of the correct size. The Q of printed inductors is limited by the loss tangent of the PCB material, and it is difficult to change the inductance of a track once the PCB has been manufactured. The use of surface mount wound inductors allows for very high Qs, and also allows for a single PCB to be used at different frequencies. The cost of wound inductors have recently been reduced to partly due to intense competition between the manufacturers, which is good news for the microwave constructor. There are no variable capacitors or inductors that need to be adjusted for best performance – this is a true 'no-tune' design.

Recent advances in ceramics technology (developed for the mobile phone industry) have led to the development of surface mounted inductors in a range of different values and sizes, some of which have a very high Q at low, and even middle, microwave frequencies. Once again, the bad news is the size of these parts – the highest Q inductors are in the 0603 or 0402 size. Whilst these are 'industry standard' sizes, they do pose some problems for the amateur at home – 0603 components measure approximately 1.6 x 0.8mm; 0402 components are considerably smaller! Hand soldering is possible with the right equipment, but the techniques are very different to those required for more conventional, larger components.

The inductor chosen for the input match in this design is a Coilcraft 0603CS-030 which has an

inductance of 3.9nH +/-5%. The actual inductance varies with frequency, but the graph of L vs f is very flat and the actual inductance at 2.4GHz is very close to 3.9nH. The Q of this inductor at 2.4GHz is approximately 100, and this high Q value is a major factor in keeping the noise figure of the amplifier down.

Second Stage

Some applications will benefit from a second stage of amplification. This is achieved with an Agilent MGA-85563 low noise Monolithic Microwave Integrated Circuit (MMIC). The MMIC is fairly easy to use compared to a discrete FET, requiring only one inductor to match the input and an RF choke and some decoupling capacitors on the output. An external resistor sets the bias current, and that's it! The bias current of the second stage has been set to approximately 15mA. The second stage has a noise figure of approximately 1.6dB and a gain of 18dB. The IIP_3 of the MGA-85563 is approximately –7dBm, which is considerably worse than the OIP_3 of the ATF-54143. This means that the overall system IP_3 is limited by the second stage, not by the first stage, and the resultant IIP_3 is approximately –20dBm. However, as mentioned previously, the strong signal handling performance at 2.3GHz or 2.4GHz is not really an issue, and this level of performance will be found to be more than good enough.

'Universal' Printed Circuit Board

The PCB used for this project has been manufactured professionally with 0.4mm plated through holes and a tin-lead finish. This is obviously not the cheapest solution, but it is felt that this was only option given the small size of some of the components used. Professionally etched PCBs offer a high degree of repeatability which is essential for consistent performance, and completely eliminate any uncertainty due to etching errors or mistakes.

The PCB dielectric is a material called AR320, made by Arlon Inc. in the USA. This is a hybrid material of PTFE and fibreglass, offering some properties of both. The losses are much lower than with conventional FR4, but the cost of the material is much less than even the most common PTFE-only material, Rogers Duroid 5880. Also, the hybrid material is much stronger than Duroid. The dielectric constant is (perhaps not surprisingly) about half way between the two, at 3.2 (hence the name AR320) and the thickness is 0.8mm. The PCB uses surface mounted components exclusively. This allows the same PCB to be used for different bands; all that is required is for use at different frequencies is to change the value of the matching components, and possibly the bias resistors. It is hoped that the same PCB can be used for a number of different pre-amps from 432MHz or below to 3.4GHz and maybe even 5.7GHz.

It is fully appreciated that 0.8mm Arlon AR320 is an unusual choice of dielectric material. This material was chosen for it's suitability to do the job, and also because the author has stock of this material, it being used on other projects. It is certainly not as readily available as FR4 or Duroid, and so 'home-brewing' the PCB will not be easy, if it is possible at all. (There may be an alternative PCB material such as Rogers 4003, although this has not been tried).

However, this LNA is presented to show the levels of performance that can be achieved with a state-of-the-art design, not necessarily something that can be etched in the kitchen sink. If any constructors wish to have a go at etching their own PCBs then please get in touch with the author who will supply artworks. It may be possible to modify the PCB artworks for different dielectric materials, but this has not been tried and there are many pitfalls for the unwary.

Performance

The noise figure of the ATF-54134 increases with frequency, and much work has been done to reduce the noise figure at 2.4GHz to an absolute minimum, for use with the AO40 S-band downlink at 2401MHz. The resultant noise figure of the two stage amplifier is 0.6dB (Te=48K) and the gain is approximately 28dB. The ATF-54143 can be used as a single stage amplifier, in which case the noise figure is slightly less, and the gain is 13dB. The output of the first stage (and the input of the second

stage) is matched to 50 ohms, making it easy to use the first stage on it's own if required. The simulated IIP_3 of the two stage amplifier is -20Bm. This is yet to be measured.

Further Developments

A 1.3GHz version of the pre-amp is currently being developed. The noise figure is expected to be approximately 0.4dB, although the biasing will be changed in order to improve the IP_3 performance which may lead to a slight increase in noise figure. The second stage will be re-designed in order to improve the IP_3. There are other reasons why a high IP_3 is of advantage at 1.3GHz; full details will appear in a future edition of the newsletter.

Conclusion

The above design demonstrates that the amateur microwave community can benefit from the massive amount of research and development that is being carried out by the major component manufacturers. New devices are being introduced literally on a daily basis, and some of these devices can be put to good use by radio amateurs.

Other designs for amateur radio use of the ATF-54143 have been published [6], but the author is not aware of any other designs for the 2.3GHz band using this device.

The author does not claim any originality for this design; all the individual ideas and circuit blocks are used elsewhere in commercial receiver designs. However, these ideas are now put together and demonstrated in a practical way for the amateur microwave experimenter.

Apart from the very small size, the ATF-54143 has no real drawbacks. Now we have a device with very low noise figure, positive gate bias, superb strong signal handling and easy availability. Active bias circuitry ensures that bias adjustment potentiometers are not required, and the use of high Q lumped components gives a low noise figure and no need for tuning. So not only can we have our cake, we can eat it and have second portions as well!

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PCBs or complete built & tested amplifiers are available from the author via GH Engineering;

email :-grant@ghengineering.co.uk

FROM OUR MAN IN SWITZERLAND ... Jonathan Naylor [jonathan.naylor@ggaweb.ch]

Hans, DD7MH manufactures dish feeds suitable for offset feed dishes, including the hardware to fit into the standard 40mm LNC holder. He has a website at **http://www.qsl.net/dd7mh**. The site is in German but is pretty understandable. He does single band, dual-band, tri-band, quad-band, and whatever five-band feeds are called!

One of my new projects here is a 'poor man's spectrum analyser'. This is not in the same vein as a real one but for use as a kind of activity/band monitor. I bought the IC-PCR1000 computer controlled receiver and have been experimenting with it using it as a tunable IF on my transverters or standalone on 2, 70 and 23. I am going to use it on AO-40 to receive the telemetry while I am operating another radio for the actual QSOs. I've built a resistive 6dB splitter and, after doing some tests, it should be possible. The radio even has an internal switch so that the audio output level is suitable for feeding a PC sound card directly. It would also be possible to use it to monitor the satellite pass band and to see who are the loud stations (probably including me!). It will be worth calibrating the signal strength reading in dB at different frequencies so that the spectrum display is meaningful.

I ran it during the May contest on 2m (the contest included 2m in Europe) and could immediately see where the loud signals were on the band, it was quite fun really. The receiver goes up to 1500 MHz, but its sensitivity is pretty hopeless up at 23 cms, even with a masthead pre-amplifier, more gain is required.I think the possibilties for such a radio are endless, I just need to write some software that matches what I want it to do. Most of the control software available for it assumes that you are using it as a standard general coverage receiver.

waveguide slot antenna update

The **W1GHZ Microwave Antenna Book** - Online at **http://www.w1ghz.org**, includes a spreadsheet calculator for waveguide slot antennas to go with the chapter describing them.

Recently, WA6EXV and N6CA have reported problems with slot antennas designed using the spreadsheet with waveguides that are relatively small for the frequency, i.e., close to cutoff (WR-284 at 2304, WR-137 at 5.8 GHz).

While the text recommends using waveguide sizes such that operation is near the centre of the waveguide operating range (eg WR-90 at 10 GHz or WR-159 at 5760) other sizes are often attractive, usually due to availability.

The spreadsheet will do the calculations for any waveguide above cutoff, since I had no data on the accurate range for the calculations. Thanks to Chuck and Chip, we now have some indication; they are continuing to experiment, so we hope to have some additional data.

If anyone else has built and measured slots in other sizes of waveguide or significantly different frequencies, real data would be appreciated.

For now, I suggest that designs be limited to the normal operating range for each waveguide size (see **http://www.wa1mba.org/wavegd.htm**). The spreadsheet has been updated to include checks and warnings which appear for frequencies outside the recommended range. A short update has been added to the chapter describing what we know today; it will be further updated as we learn more.

Ed, W6OYN, has made similar changes to his BASIC program for slot antenna design. So, if you are building waveguide slot antennas, please download the latest version of the spreadsheet or program.

73 from Paul, W1GHZ

Directional Couplers and Noise Meters .. a follow up

I was interested to read K2RIW's piece on directional couplers in the May Newsletter. Some years ago, I produced some printed circuit artwork for a stripline directional coupler with two side arms and intended to operate at 146MHz. It was designed (to use the term loosely) to be made in 1/8" + 1/8" Polyguide, one length with the etched pattern on sandwiched face-to-face with a second length with no copper. It had N-type launchers each end of the main through line and SMAs each end of the side arms. It was a 'PJ' as I was employed as a Systems Engineer and had no official access to hardware. Still, the man in the printed circuit department etched it for me (as a test piece to check the temperature of his vat) and a colleague in the hardware lab put the completed coupler on a network analyser for a check one lunchtime. I had drawn the artwork, from theory and the published technical data for Polyguide, with no practical microwave experience so I probably missed all sorts of corrections that a more experienced designer would have incorporated. Nevertheless, the unit had quite good directionality and showed its first peak very close to 145MHz.

Furthermore, as Dick indicates in his article, the response showed a series of zeros at multiples of half-wave and further peaks at multiples of quarter-wave, in particular at 435MHz and 1305MHz. The network analyser scale was logarithmic so I didn't recognise that the responses were half-sinusoids. A line joining the peaks sloped gently downwards with increasing frequency.

A quarter-wave at 145MHz turns out to be quite a manageable length when implemented in Polyguide but I guess most readers of the newsletter would be interested in a design 'starting' further up the spectrum. I would encourage other readers, if they have a source of the Polyguide material, to have a go at such a directional coupler. Three house moves in nine years have left me unable to put my hand immediately on my artwork but if anyone is very keen to try it out I'll have a search for it. Take note, though, my design won't work directly for other materials such as Duroid.

73, Peter Weedon, G8ZKZ

ACTIVITY NEWS FROM THE WORLD ABOVE 1000MHz

When newsletter space is tight, as this month, we have to hold over the Operating ladders once again! However, you can find up-to-date versions on the Internet at **www.qsl.net/g3pho**. Many thanks to all who have sent in updated scores for the 2002 Microwave League Table and for the All Time Squares/DX Ladder. Please excuse the greatly edited versions of your emails in the news below.

MAY 10GHz CUMULATIVE REPORTS

From: John, G8ACE [hazell@dsl.pipex.com]
The contest was quite a wet disappointment. Located in IO70, just SE of Tintagel, the 2m conditions meant 50w to an 8 ele yagi were totally inadequate to cause most others to look west! Many thanks to the seven stations who did make contact but this was well down on last time I used this site. I could hear three QSOs on 10GHz at one point but calling on the band produced no replies and these stations were not evident on 144.175MHz at any time. My best two-way was with G3PHO/P at 247km, using my 250mw and 58cm dish. Resorting to an SMS message produced the last contact before going QRT just after 16.00 as the sun appeared!

From: John M0JTT/P (Butser, IO90MX) [john@jmkl.freeserve.co.uk]
I worked 12 stations and the best DX to date is F6DKW at 335 KM. The gear used was a DB6NT Tx/Rx with about 200mW out put and the dish was a Sky mini dish with original feed (the eliptical type) all this was tripod mounted and carried to the top of Butser on a golfing trolly.

From: Ralph, G4ALY [Ralph.Bird@btinternet.com]
On the 25th May I worked only 5 stations from **Kit Hill, IO70UM,** before disaster struck in the form of a line squall which took my un-guyed tripod over and crippled the 70cm dish. I won't allow that to happen again!. Best DX for that day was G3PHO/P and G3PYB/P, both on the I.O.Wight. I have re-vamped my portable station with a new dish which will be mounted on the mast below the 2m beam. and the transverter mast mountedjust below, fed with flexible/twistable wave guide. I've extended the control and IF cabling to enable it to be operated from the car. I just require to set up the dish and horn to enable use of the home station now and then will finally be QRV from home as well.

The two Peters, G3PHO/P and G3PYB/P joined forces to activate **Ventnor Down (IO90JO)** on the Isle of Wight for the May 10GHz cumulative. The prohibitive ferry charges (the highest in Western Europe) did not deter them! Weather conditions were good during the morning but turned really foul in the afternoon, with strong winds and torrential rain, the latter producing good rainscatter conditions. This enabled G3PHO/P to work G3LTF who had his gear set up inside his garage, looking north east(!). G3PHO/P worked 26 stations of the estimated 32 active, the best being with G0HNW/P (IO93CH) at over 300km. Three French stations in JN18/19 were also contacted. G3PYB/P had his 24 and 47GHz gear with him but no contacts were made. The new GB3SC# beacons at Bell Hill were very useful direction markers, though their signals were disappointingly weak and not on their "official" frequencies.

June Millimetre Bands Contest

This was a poorly supported contest with only G3UKV/P, G7MRF/P, G3UYM/P, G4BRK, G4LDR, G3PHO/P and G8ACE known to be QRV. The weather was extremely bad, heavy rain and windy. Only one contact was made during the day, a 24GHz ssb QSO between G3UKV/P (Brown Clee, IO82QL) to G7MRF/P (Merryton Low, IO93AD). 47GHz failed over this usually reliable LOS path.

Other activity News

John, G3XDY (JO02) sends his usual excellent list: The past month saw mix of tropo ducting and rainscatter. On the 13th May I made 10GHz rain scatter contacts on with 3 Gs plus DJ6JJ. Some tropo on the 16th gave DL1SUN (JO53) on 1.3GHz, and G4FEV (Rushden) worked on 2.3GHz for the first time. The **1.3GHz Activity Contest** on the 21st included a QSO with OZ1FF on CW, with little enhancement apparent. **The 10GHz Cumulative** was enlivened by good rainscatter (and strong winds!). I made 12 QSOs including F6DKW, GW8AWM/P and PA3AOH as best dx.

The first weekend in June provided lots of activity from the French VHF/UHF contest in France, the all-band Belgian Field Day , and a German microwave contest. Above average tropo conditions early Sunday morning resulted in QSOs with DL3YEE (JO42) on 23/13/9 and 3cm at 500km. Other highlights on 13cm were 3 new squares (F5KAR/P JN09, OZ1FF JO45, and DG5FEB/P JO40), and DL0GTH (JO50) at 683km. On 23cm DK0NA (DB6NT at the mike) was best DX at 749km.

Finally, he was on for some more rainscatter on 10GHz on the 4th June, with F1PYR/P and DG1KJG the best of 5 QSOs.

Activity reports continue on the back page

All-band Microwave Contest - 06/May/2002
Adjudicated scores

Individual Band Tables

1.3GHz	Best DX	Located	Distance	QSOs	Score
G3OHM/P (SBRS)	F6DKW	JN18CS	449km	14	2036
G3ZME/P	G4CQR/P	JO00CR	274km	14	1949
G3PHO/P	G1JRU	IO90HU	255km	12	1732
G3YKI	DL5DAW/P	JO31RF	651km	8	1455
G4LDR	G3PHO/P	IO93AD	228km	2	261

2.3GHz	Best DX	Located	Distance	QSOs	Score
G3OHM/P (SBRS)	G6DER	IO93GN	167km	2	253
G3ZME/P	G4LRT	IO92LS	106km	1	106

3.4GHz	Best DX	Located	Distance	QSOs	Score
G8IFT/P (SBRS)	G6DER	IO93GN	167km	3	343
G3YKI	G8IFT/P	IO92GB	30km	1	30

5.7GHz	Best DX	Located	Distance	QSOs	Score
G3PHO/P	G4LDR	IO91EC	227km	5	636
G4LDR	G3PHO/P	IO93AD	228km	3	346
G8IFT/P (SBRS)	G3PHO/P	IO93AD	125km	3	238
G3ZME/P	G3PHO/P	IO93AD	87km	1	87
G3YKI	G8IFT/P	IO92GB	30km	1	30

10GHz	Best DX	Located	Distance	QSOs	Score
G3PHO/P	G4ALY/P	IO70UM	332km	18	2767
G4LDR	F1GHB/P	IN88IN	307km	14	1682
G8IFT/P (SBRS)	PA6NL	JO21BX	382km	10	1598
G3ZME/P	G8LSD/P	JO01BB	243km	11	1360
G3YKI	G3PHO/P	IO93AD	111km	3	220

24GHz	Best DX	Located	Distance	QSOs	Score
G3PHO/P	G8IFT/P	IO92GB	121km	3	271
G3ZME/P	G8ACE/P	IO91GI	147km	2	232
G8IFT/P (SBRS)	G3PHO/P	IO93AD	125km	2	164
G4LDR	G8ACE/P	IO91GI	30km	1	30

Overall results table

	1.3	2.3	3.4	5.7	10	24	Total
SBRS	1000	1000	1000	374	578	605	4557
G3PHO/P	851	0	0	1000	1000	1000	3851
G3ZME/P	957	419	0	137	492	856	2861
G4LDR	128	0	0	544	608	111	1391
G3YKI	715	0	87	47	80	0	929

Activity was generally low as a result of the clash of three microwave contests over the weekend. Also there were few of the portable contest groups out for the weekend and propagation was not particularly good.

The overall winner was the **South Birmingham RS**, operating as G8IFT/P and G3OHM/P, by virtue of being operational on all bands from 1.3 to 24GHz, and band leaders on 3 of the 6 bands. An impressive array of equipment was taken out for all bands. Peter,**G3PHO**, as a single operator, was not that far behind, being band leader on 3 of the 4 bands he entered. One more band, and I suspect the result would have been quite close. This contest had been intentionally scheduled for the first weekend in May to take advantage of the widespread European (432MHz & up) activity on this date, as per the October 2001 event . Unfortunately, at the time this "All-band" event was agreed, we had not expected the 10GHz Trophy (set by VHFCC) to be on the same weeked. Not surprisingly, this clash diluted activity, and meant some people had to decide which of the events to support. Clearly we need some changes and better communication to avoid such a clash happening again; thanks for the comments from several entrants on this!

Steve Davies G4KNZ, adjudicator.

24/47GHz Microwave Contest - 21/Apr/2002
Adjudicated scores

Individual Band Tables

24GHz	Best DX	Located	Distance	QSOs	Score
G3PHO/P	G8ACE/P	IO91GI	139km	11	1160
G3UYM/P	G0HNW/P	IO83RO	182km	9	801
G8IFT/P	G8ACE/P	IO91GI	149km	7	785
G3UKV/P	G3UYM/P	IO92CA	124km	6	461
G4BRK	G8IFT/P	IO82QL	112km	7	415
G4LDR/P	G8IFT/P	IO82QL	149km	6	307
G8BKE/P	G3PHO/P	IO92QL	139km	5	292
G3LRP	G0HNW/P	IO83RO	76km	2	140

47GHz	Best DX	Located	Distance	QSOs	Score
G8IFT/P	G0HNW/P	IO83RO	125km	2	212
G8BKE/P	G3PYB/P	IO91JA	38km	1	38

There was very good activity for this event, and there would have been even more had the weather forecast not been so wrongly pessimistic (which put of one or two operators, including the adjudicator, from venturing out). A total of 12 stations appeared in the logs, with another 4, G3PYB/P, G7MRF/P, G8ACE/P and G1JRU also active, making a totaL of 16 (half the UK 24GHz nb population!).

Congratulations to Peter G3PHO/P, who won the 24GHz event with a clear margin; Peter commented that this was his best ever score in a 24GHz contest. G3PHO was running 0.5W on transmit to a 35cm offset-fed dish, and with a receiver NF of approximately 2.2dB.

Second and third places were close, with just a few points separating G3UYM/P and G8IFT/P - in years gone by, these would have been winning entries.

There were a number of quite long paths worked on 24GHz, the best being 182km between G3UYM/P and G0HNW/P, from Broadway to Winter Hill.

On 47GHz, Ian G8IFT/P and the South Birmingham Radio Society lead, working 2 stations, including a path of 125km from Brown Clee to WinterHill. The group was running 0.1mW to a 0.6m dish mounted some 5m above ground level - to clear local obstructions in the direction of Winter Hill - the only snag is that the wind causes some QSB as the dish blows.

No activity was logged on 76GHz this time. **Steve G4KNZ, adjudicator.**

John, G3NWU (Hartlepool) writes in to say he is still active on 1GHz but from home instead of portable. The later activity has been severely curtailed due to joint problems. Please note his new email address: **g3nwu@yahoo.co.uk**

From: Andrew, G6SPS[Andrew.Hutley@o2.com]: M1CRO/P operated from the usual location of JO01PU for the main 24Hr event and for the first time in a number of years managed to air all bands up to 24GHz. This was due in part to the timely completion of my 3.4GHz system (1 week to spare) and the visit of a member of the group not always available for these events. I can't quote actual QSO figures as our trusty scribe has not forwarded them on yet (he has submitted the logs to RSGB) but the two highlights of the weekend were my first ever QSO on 9cm being to DK2MN – having only ever heard white noise in the RX and seen the power meter moving on TX up until that point (!) and a **QSO with PA6C on 24GHz @ 375km**. The only other station worked on 24GHz was G8P although attempts were made with G4EAT, PA6NL & PI4ZLD following 599 reports on 3cm. Overall a good number of QSOs and distances were made on all bands with best DX on both 70cm & 23cm being made early on Sunday morning to OK & OL Finally, a word of apology for those stations who have sent us QSLs and are awaiting replies. Due to a mix up over QSL envelopes, we have not received any cards for sometime and indeed may have lost a few cards in the process. We are sorting the issue out asap.

From: Roger, G3MEH [g3meh@supanet.com] .. An idea to encourage newcomers to microwaves: May I suggest an opportunity for promoting their side of the hobby which I think microwavers are missing out on. The VHFCC have a 'claimed scores' facility on their web site (linked from the main RSGB site). If microwavers posted their claimed scores there for microwave contests organised by the VHFCC, such as the 10GHz Trophy and the 432MHz to 248GHz contests, we VHFers would have our attention drawn to the extent of activity on the microwave bands and our interest sharpened up.

THAT'S IT UNTIL NEXT MONTH ….