United Kingdom
Microwave Group

Scatterpoint – *Issue 6*

October 2001

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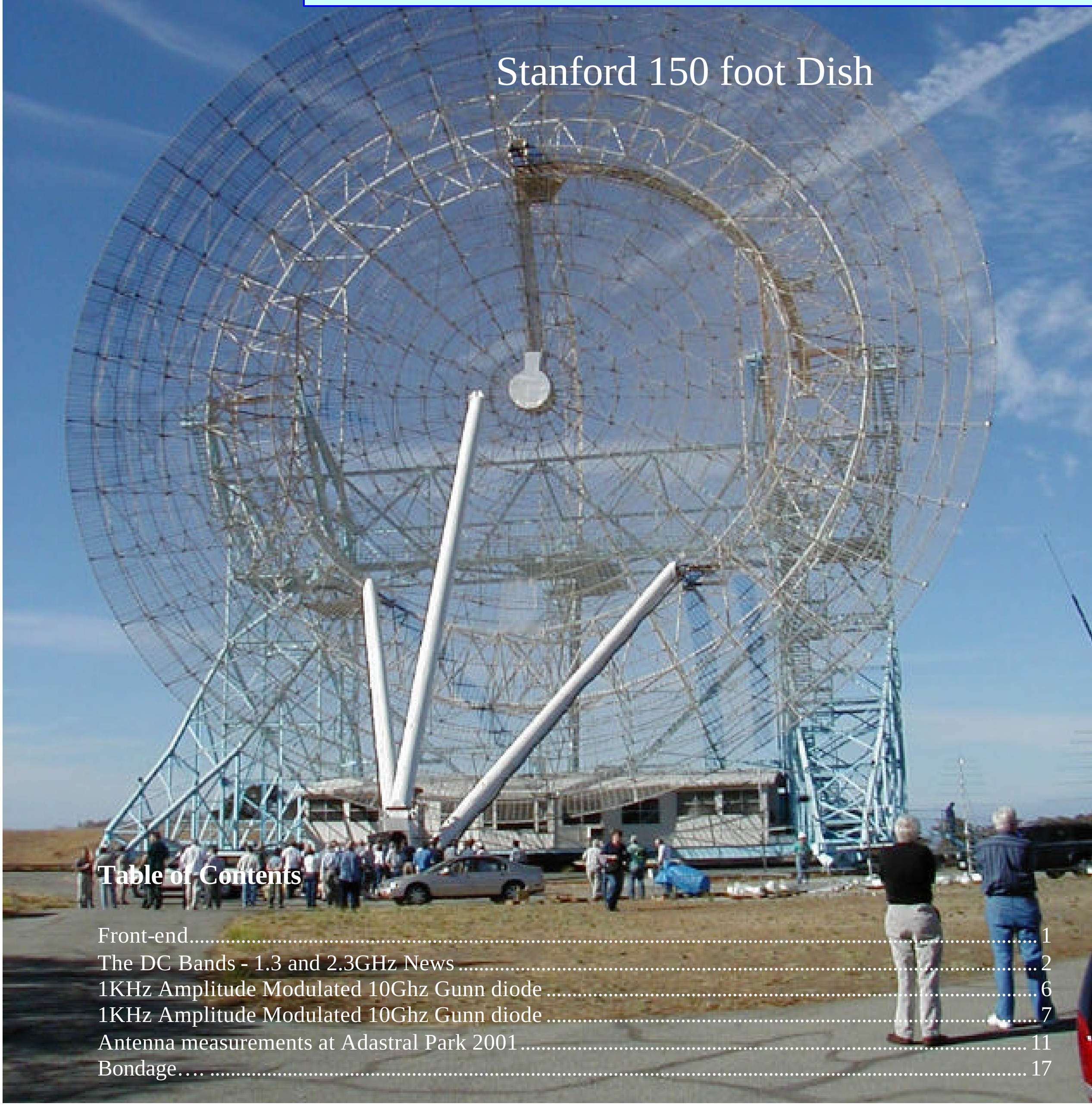

Stanford 150 foot Dish

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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 Sam Jewell, G4DDK Blenheim Cottage Kirton Road Falkenham Ipswich IP10 0QU jewell@btinternet.com	*Membership Secretary* Steve Davies G4KNZ 17 Haywood Haversham Park, Bracknell, RG12 7WG steve.davies@nokia.com	*Scatterpoint Editor* 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;

Steve Davis	G4KNZ
David Wrigley	G6GKX
Alan Wyatt	G8LSD
Mike Willis	G0MJW
Kent Britain	WA5VJB
Mike Wade	G8OGO
Peter Day	G3PHO

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

Now that the winter evenings are drawing in it's time to look forward to sorting out the shack and do some serious equipment building. I have been gathering various kits for the last few years whilst in enforced QRT mode (QTH move), with a view to getting my home-based microwave station back on air with some new kit. So far, the only progress in this direction has been to build a T7F 70cm packet transceiver to re-enable my DX Cluster and Converse Mode access. At least I have a window on the microwave world again!

I also plan to build my DB6NT 3cm transverter kit over Christmas and with luck will be using it on 3cm EME from the spring. Yes, the dish is ready and I have obtained a reasonably high power TWTA. I have a substantial pallet mount already in position in a location where there is almost uninterrupted view from moonrise to moon set. I hope to have more to say about this in a future issue of Scatterpoint.

Unfortunately, the GCHQ Microwave Roundtable at GCHQ, Cheltenham, scheduled for October, had to be cancelled presumably due to the increased security requirements following the 11th September tragedy.

The November BT Adastral Park Microwave Roundtable was held on 10th and 11th November. This issue of Scatterpoint contains a write-up on the antenna measurements held at this event. There is also a good write up on the event at G3PHO's web site, The World Above 1000MHz.

Also at Adastral Park we held the UKuG AGM. In spite of the late hour it was well attended. Details of the AGM, including voting results, should appear on the group's web page at WWW.MICROWAVERS.ORG sometime soon.

Finally, we apologise for the late appearance of this issue of Scatterpoint. It is becoming increasingly difficult to obtain microwave articles for the magazine. I notice this seems to be the trend with several other European microwave magazines as well. Is no one building, operating, experimenting and writing up their results anymore? It almost goes without saying, we would be pleased to receive any articles of relevance to amateur microwaves from our membership, or even non-members. Without your contributions there can be no Scatterpoint.

73 de Sam Jewell, G4DDK
Chairman, UKuG

The DC Bands - 1.3 and 2.3GHz News

John Quarmby G3XDY

The Scottish 23cm Resource Centre

David Dodds GM4WLL has set up an excellent web site to encourage activity on 1296MHz in Scotland and the North of England. David seems to have stirred up activity up there in terrain which is pretty difficult for home station operation on the microwaves, and deserves congratulations for taking this on and getting people motivated to get on the band.

The web site can be found at http://www.qsl.net/gm4wll/23/23index.HTM and includes lists of stations active in GM, beacon lists, antenna information, and an active email reflector.

The 2C39A Killer?

A new generation of power MOSFETs looks like finally sounding the death knell for the venerable 2C39A. These Laterally Diffused Metal Oxide Semiconductor (LDMOS) devices have been developed for use up to 2.2GHz for UMTS base stations. Many contain narrowband matching networks, but others are quite broadband and offer excellent performance on 1.3 and 2.3GHz. Recently a number of French amateurs obtained a batch of MRF286 devices at a reasonable price (they do not appear to have been formally released to production yet despite having been announced for some time). These devices are capable of 80W output on 1.3GHz and 50W on 2.3GHz, with 9-10dB gain on 1.3GHz and 7-8dB on 2.3GHz. F1ANH has reported 330W output for 5W of drive from a 1.3GHz amplifier using one device to drive four in parallel, and 160W output for 8W of drive for the same configuration on 2.3GHz. These devices run from 28V supplies (the 23cm amplifier takes 30A!). Other manufacturers have LDMOS devices producing up to 120W on 2.2GHz from one push-pull device. The German firm Beko advertise amplifiers based on this technology. (see http://www.beko.cc) I think the days of the 2C39A are numbered, and I for one will not be sorry to give up chasing the anode tuning as the tubes warm up.

Ultra High Dynamic Range HEMT

Agilent Technologies (ex HP/Avantek) have an interesting HEMT in production. The ATF54143 is an enhancement mode device requiring a positive gate bias to turn it on, avoiding the need for separate –ve bias supplies using ICL7660 devices or source self biasing schemes which are difficult to bypass correctly to get the lowest noise figures.

This device is capable of well over 100mW of output power, has an output third order intercept point greater than +36dBm, and can also achieve well under 0.5dB noise figures under the same bias and matching conditions. OZ2OE has built simple preamps for 432MHz and 1296MHz using this device with 0.26dB NF/23.2dB gain on 432MHz, and 0.39dB NF/18.4dB gain on 1296MHz. See http://hjem.get2net.dk/ole_nykjaer/oz2oe/atf54143/54143.html for details. Farnell stock some Agilent products but this device has not yet appeared on their list, if I can find a UK source I will include details in the next issue. Beware that this device could oscillate due to its high intrinsic gain at frequencies below 3GHz, and with that much output power available it could terminally damage later stages in the receiver chain! It looks like setting new standards as an ultra high dynamic range preamp for the bands between 430MHz and 3.4GHz.

Contest reports

Whilst the UK has its field day contest on HF during the first weekend in June, other parts of Europe have a microwave event on that date, with stations active in France, Germany, and Belgium. Conditions were fairly average, with the best DX from Ipswich being DL0PVD in JN49EJ out of 7 QSOs on 1.3GHz.

The UK Multiband microwave contest on 24th June was blessed with above average conditions, particularly at the start, with German stations workable using North Sea ducting on all bands. Although conditions dropped away after the morning lift, overall levels of activity were encouraging.

Sadly VHF NFD fell victim to Foot and Mouth disease this year, so the bands were very quiet in the UK on the first weekend in July. Not many continentals beamed to the UK as a result, so results were unspectacular for those that got on from home stations. Highlights from here included DL3YEE and DF9QX in JO42 on 2320MHz at just over 500km, and LX/OK1ORA/P and DL0GTH (JO50) on 1296MHz.

The Scandinavian Activity Contest on the 17th July had some enhancement of conditions, sufficient to hear SK7MW (JO65) at over 800km, but not enough to make a two way QSO.

David GM4WLL reported contacts with G4BRK, G0EHV and G1LPS during the all band microwave contest on 12th August, operating from Lauder Common IO85NR.

Finally there was the 1.3/2.3GHz contest on 9th September, blessed with mediocre conditions which made it hard going. It was good to see GM4WLL/P stirring up activity in GM, and working down as far as G4BRK at over 450km. Numbers of QSOs seemed down on previous years, and activity seemed to dry up an hour before the end of the event.

Tropo – the North Sea effect

Most of the tropo openings reported in the last Scatterpoint were due to surface ducting over the North Sea, with little or no elevated ducting to the central areas of Europe which give stations further inland a better chance of working the DX. The last 3 months have continued that trend, with just a couple of short elevated ducting events to report. Most high pressure systems have tracked over the UK and into the North Sea rather than moving southeast through Europe. This has given several periods where signals across the North Sea have been strong, with one notable occasion in the early morning of 29th July providing exceptionally strong ducting to Germany. DJ6JJ in JO31 was some 75dB above noise near the East coast on 1296MHz, but the enhancement dropped away rapidly further inland in the UK.

As far as elevated ducting is concerned, the evening of 4th July produced an unexpected opening to the Island of Gotland, in the form of SM1SBI, who was much stronger on 1296MHz than on 432MHz for a few minutes before fading down into the noise. No beacons from Scandinavia were audible, despite this path running almost directly overhead OZ and SM7 beacons, which points to it being an elevated duct. Another elevated ducting opening took place to Berlin on 1st August, with DG0RG and DL7VTX worked, and a pre-breakfast session on the following morning resulted in OK2BFH being moved up from 432MHz for a good CW QSO to JN99FN.

Station Activity

Andrew G6SPS operated from Walton on the Naze for the July 24th Scandinavian Activity Contest, and using 15W to a 35element 1m above the car roof he worked 6 stations including 4 OZs in JO45.

The advent of the GM4WLL web site has elicited a lot of information about stations QRV in Scotland, a few emails from David's site are reported below.

GW8IZR reports that he expects to be active from Anglesey (IO73) by the end of September with 2-300W and a 2m dish.

GM6BIG runs a personal beacon on 1298.004MHz from near Shotts in IO85BU, running 110mW to an Alford slot antenna. This is colocated with the 3.4GHz beacon run by GM4ISM, which has been reported heard by several PA stations during tropo openings this summer, so it should be audible under good conditions.

For some real DX look for GM0PWS, located on the Isle of Lewis in IO68UG with 18W to a 19element Yagi. He has a good take off to the South and SouthEast, and is hoping to put up a pair of larger antennas in due course. He has worked GM3JIJ so far. Given the right tropo opening this would be juicy DX for stations in mainland Scotland, let alone the rest of the UK!

GM0BRJ is QRV from Kilsyth with 10W and a log periodic due to be upgraded imminently to a 67 element Wimo, and close by is GM3WYL with 10W to a 35 element.

Antenna Corner – 2.3GHz EIA feed postscript

One dimension got missed from the diagram of the 2.3GHz feed in the last issue. The holes for the UT141/RG402 semi-rigid cable should be on a centre to centre spacing of 5mm.

A more significant issue made itself felt during the July contest, which took place during heavy rain. This highlighted a problem caused by water bridging the open wire feed to the dipoles. Microwave ovens might be quite good at boiling away water at 2.4GHz, but the water forms an almost perfect short circuit across the feed, reflecting almost all the incident power, and attempts to shift it by applying 30W for 2-3 minutes made no impact. I solved this by making a “hat” from 2mm polycarbonate sheet recovered from redundant secondary double glazing as shown in figure 1, which works so long as the feed is mounted above the dish looking downwards into it.

I asked a question last time about circular polarisation feeds for 2.4GHz satellite operation and almost immediately found G1LVB’s site describing a helical feed for the Amstrad 60cm dish (see http://www.g6lvb.com/60cm.htm). More recently Sam G4DDK undertook some antenna tests at the AMSAT colloquium this summer which indicated good gain but relatively poor circularity from examples of this type of feed, with the the G3RUH patch fed prime focus dish offering a much better performance. It looks like a patch feed optimised for the F/D ratio of the offset fed dish would offer excellent performance.

Charlie G3WDG is also developing a dual band helical dish feed for 1.3/2.4GHz to allow one dish to be used for both up and downlinks. He has also developed notch filters to improve the isolation between the feeds to permit simultaneous transmission and reception. A 60cm dish is probably too small to be useful for the 1.3GHz uplink, around 1m is a more realistic size. More details are at http://www.g3wdg.free-online.co.uk/dual.htm .

Phase 3D/ AO40

The AO40 satellite continues its lengthy commissioning, with most operation using the 2.4GHz downlink as the primary channel. A higher gain 2.4GHz antenna and transmitter combination on the satellite gave very good signals for a short period in August, but that transmitter now appears to have failed so operation continues on the lower ERP 2.4GHz system. Recently the 24GHz transmitter has been successfully brought into service and has been heard by Charlie and Petra G3WDG/G4KGC.

Forthcoming contests

By the time you see this the October IARU and Trophy contest will have passed, I look forward to some reports for inclusion in the next column.

The 1.3GHz and 2.3GHz Cumulatives kick off on the 11th October, with the subsequent events on 26th October, 5th and 20th November, and 5th December. Times are 2000-2230 local time.

The Scandinavian activity contests continue, with 1.3GHz and up on the 3rd Tuesday of the month, from 1700-2100UTC. The event on 20th November coincides with a session of the UK 1.3/2.3GHz Cumulatives so let's hope conditions oblige on that occasion.

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.

73

John, G3XDY

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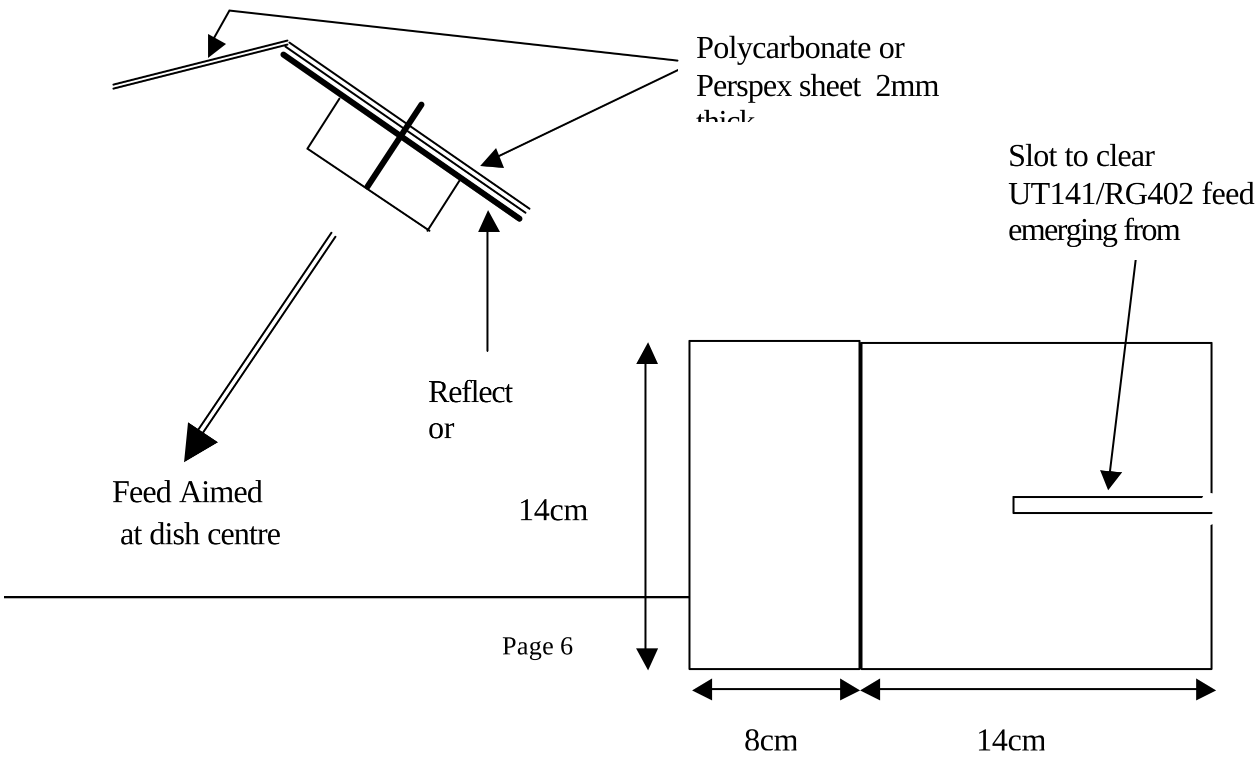
Phone: 01473 717830 (between 18.30-21.00 preferred)

Figure 1 Side View of 2.3GHz Dual Dipole feed showing "Hat"

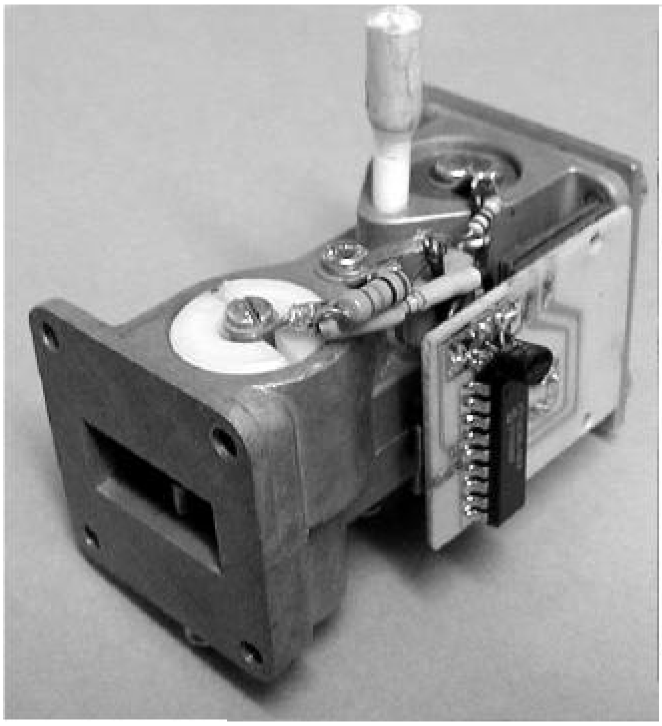


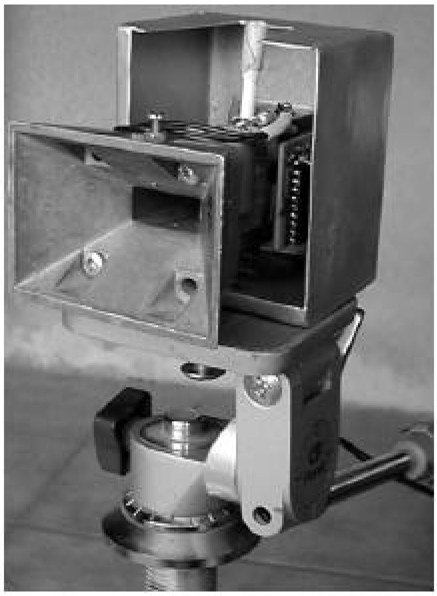
1KHz Amplitude Modulated 10Ghz Gunn diode

David Wrigley, G6GXK

A useful accessory for the previously published "Tuned Audio Level Meter" (ref. 1) is this simple 10GHz Amplitude Modulated Gunn Diode Oscillator.

Using this equipment, tests can be carried out on antennas and other parts of your 10GHz equipment, using the significant dynamic range of the tuned audio level meter





Basics

The obvious choice for a 10GHz source is a Gunn diode – it is very low cost, simple and easy to operate. The one problem is that it isn't so easy to amplitude modulate. The straightforward application of a modulating voltage to the Gunn diode produces lots of FM, which may well cause problems due to unexpected off frequency responses. A separate pin diode or FET modulator was the next thought, but that would require two transitions to get to SMA and back to WG and a horn. It was then that the Solfan combined Gunn diode and detector combination was considered as a possible source of AM. Such unit have been used in wideband transverters and one of these was selected for some preliminary tests. This particular unit came from a PW "Essex" WB transceiver had a piece of 2BA screwed plastic rod (knitting needle) entering the cavity as a fine frequency adjustment.
The Gunn was fired up with 7.0V and the output adjusted with the aid of a cavity wave-meter to be approximately 10368MHz. With a power measuring device (diode detector) in front of the Gunn diode assy, the effect of passing a 5mA current thru the

Solfan detector diode was checked. A quite definite change in output level was seen of about 10 to 20% in amplitude. The extent of this could be peaked by adjustment of the screws around the detector diode, which project into the waveguide. Further checks with a 1KHz modulating signal were carried out. These proved that the resulting modulated Gunn output had no problem in end-stopping the Tuned Level Meter when fed from a simple diode detector and small horn. This has surely got to be the simplest ,lowest cost method of getting 10GHz AM!

Audio Source

The next thought was to generate an accurate 1KHz signal. Past experience had shown that it is not so simple to produce a 1KHz signal with sufficient stability and accuracy to reliably pass through the narrow filters of the tuned level meter. The final solution was to use a PIC16F84 microprocessor to give precisely 1KHz . Well, within about 40ppm, and that is amply good enough. The program is based on the fact that the instruction period of a PIC microprocessor with a 4MHz crystal is precisely 1 microsecond. Therefore the program consists of two 500us delays interspersed with toggling an output line, and then finally looping back to continuously repeat the process. The result is a precise 1KHz square wave. Since the harmonics are outside the passband of the tuned level meter, there is no problem. The whole PIC generator consumes about 6mA including the LM78L05 regulator.. The PCB was designed to use “In Circuit Programming” so wires can be attached to the 5 pads provided and fed from the programmer socket. To program this PIC chip “in-circuit” you need to connect 5 wires to the appropriate pins of the programmer socket as detailed on the circuit in the zip file and just use the programmer as you would normally – the power is supplied from the programmer so no other supplies ar necessary. Alternatively you could program the PIC before assembly or a ready programmed PIC chip can be supplied (ref. 2). A zip file of the overall circuit, the PCB layout and the hex file for programming is downloadable from our website. (ref. 3). The PCB was stuck to the Gunn diode assembly using thick double sided adhesive tape. (as used in the automotive industry – this is so good that it will even stick on registration plates!). The picture on the left above shows the basic assembly.

It had been intended to supply the whole thing from a 12Volt Battery pack and the trial unit used a 7V 1.5A regulator, which was to hand. A small regulator PCB with an LM 317 will eventually be built to take over this job. The total consumption including the Gunn diode is about 100mA. And the TO220 style LM317 should have no problem handling the 0.5W dissipation without any special heat sink.

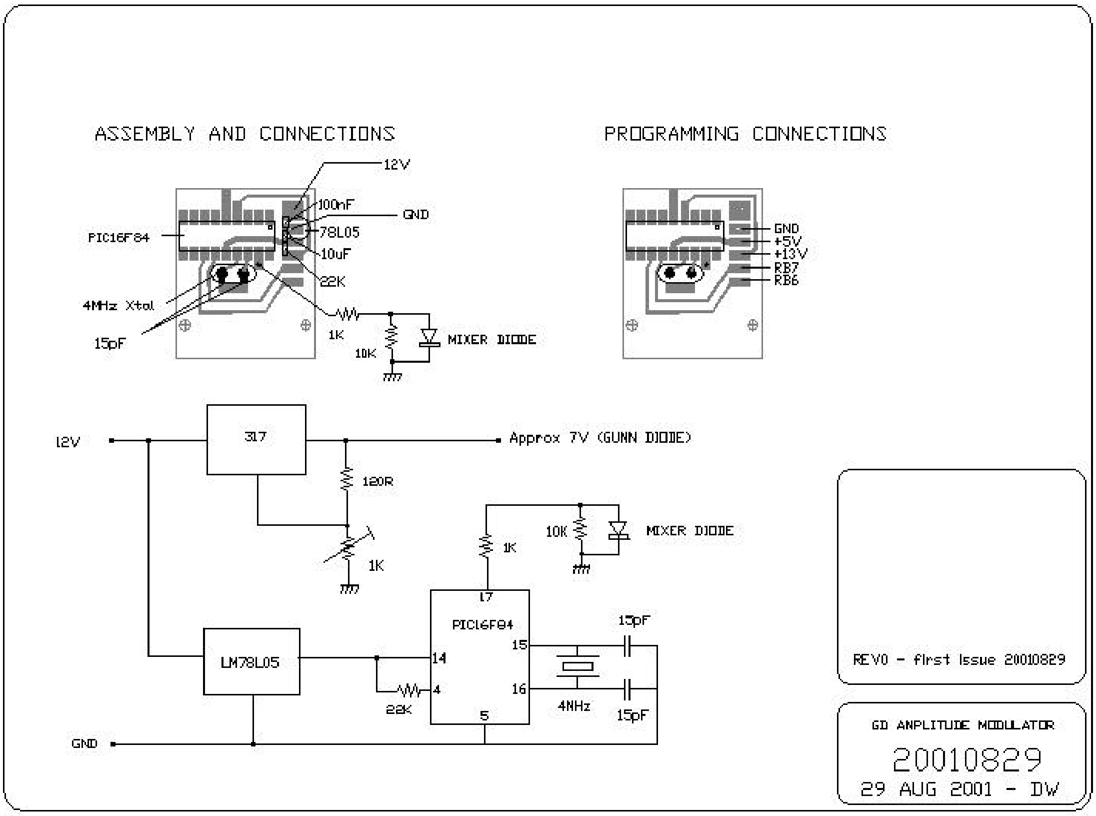
Once the basic system had been built up, further trials took place. At about 25metres the level meter showed about half scale on the –10dB range using a small horn. Use with a dish would give considerably more output and therefore this was considered to be acceptable.

Some further lessons were learnt from these trials:-

1. A proper fixing was required for a camera pan and tilt tripod
2. Some mechanical protection was required for the PCB and Gunn assy.

3. A simple sight was required for the initial lining up of the transmitter. Even a small horn is quite strongly directional.
4. It is essential to make sure that the batteries in the tuned level meter are fully charged before a long measuring session. Failure to get a sensible reading can result in all sorts of unnecessary checks and adjustments.

The first three items were dealt with by designing a sheet metal cover to support and protect the assy. This cover was built from 0.8mm thick Zintex (zinc plated steel) sheet which was folded and MIG welded. This could equally well have been soldered with large fillets. The cover had a simple sight (hole and cross-wires) built into it. It also had two 0.25inch x 20tpi nuts welded in to provide tripod attachment. A full sized drawing for the cover is downloadable from our website within the zip file previously mentioned. The picture above right shows the final assembly mounted on a camera tripod.

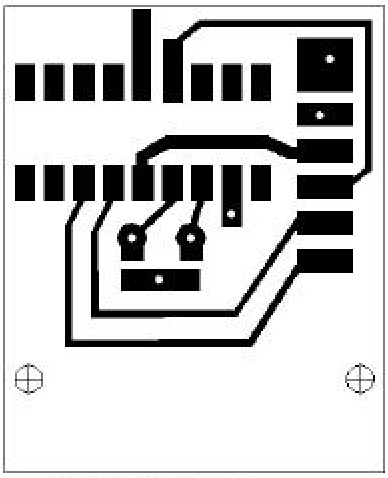


Conclusion

So having built up the 10GHz transmitter, this completes the equipment required to carry out comparative tests on 10GHz antennas. These are:

1. Modulated Gunn diode source with small horn – as described here.
2. Battery and regulated power supply for the transmitter
3. Waveguide mounted diode detector assy and small horn (would be normally fitted directly to the illuminating horn of the dish under test or via a transition to an SMA connector output of the horn)

4. AF tuned level meter to the Roger Blackwell design published in Scatterpoint- issue 4 and 5.



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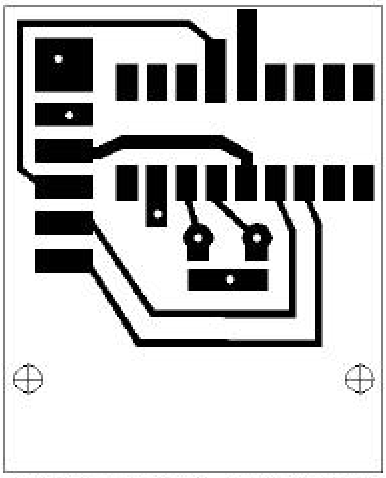

MIRROR IMAGE
FOR IRON-ON RESIST

10GHz is perhaps the most commonly used microwave band – it certainly one of the easiest to get onto. This equipment will help us to get the best from our equipment and also demonstrate when we have succeeded in improving it

References

1. Tuned Audio Level Meter for RF Measurements, Roger Blackwell G4PMK, "Scatterpoint" –issues 4 and 5.
2. Email the author: davidwrigley@ntlworld.com
3. UK microwave group website: www.microwavers.org

Antenna measurements at Adastral Park 2001

Report by Sam Jewell, G4DDK

Introduction

Having discussed at RSGB Microwave Committee meetings for several years the possibility of setting up an antenna gain measurement facility I finally ran out of excuses as to why it couldn't be done. So at Adastral Park 2001 I finally got round to setting up a 10GHz antenna range with the help of Kent, WA5VJB, and the loan of some critical items from Simon, G3LQR. I had decided early on that it would have to be limited to just one or two bands because of the shear amount of equipment needed for each individual band. In this case it would be 10GHz and, time and facilities permitting, maybe also 2.4GHz. By limiting the measurements to one or two bands initially I thought I would be able to manage the logistics better.

The principle of short range antenna measurements has been known for years and antenna gain measurement on all bands from 50MHz to 24GHz has been a regular feature of VHF and Microwave events in the USA for many years. The results of these measurements are often reported in various ARRL publications and specialist newsletters. The principles have also been explained in many of these same publications as well as in a notable article by WA5VJB here in Scatterpoint, issue 1.

Instead of trying to fight ground reflections, the normal bane of antenna measurements, the ground reflection is used in the measurement.

When the source is set up close to the ground then a ground reflection will occur, as normal. The direct and reflected rays combine in phase at some distance from the source and an increase in signal level will be observed. The distance can be calculated and then verified by probing this volume of space with the reference antenna. The volume is not too difficult to find and is shown by a volume of approximately 1 metre sides where the signal level does not change by more than about 1dB. In practice it is usually possible to find a common volume where the change is much less than 1 dB. Obviously, the volume changes with frequency but not enough to be a problem to our measurement set up.

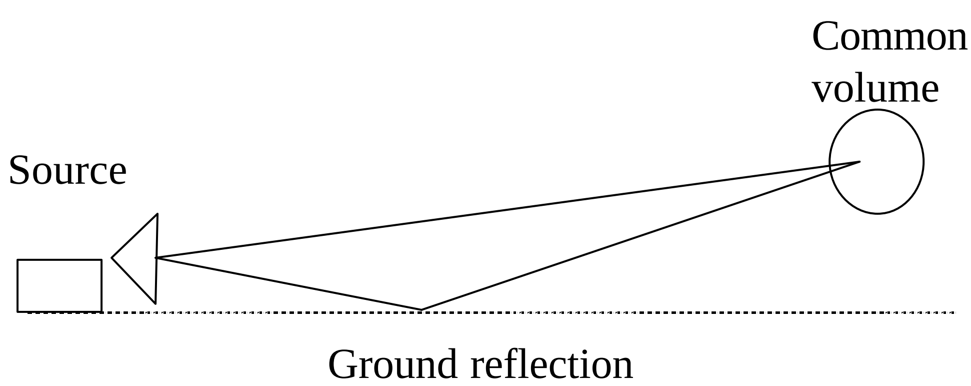

Figure 1 shows the ground reflection range with the source antenna close to the ground and the common volume in which the measurements are taken.

The source is set up on 10368MHz and set to an output level somewhere between 10 and 100mW. The signal in the common volume, which is found by probing with the reference antenna, is indicated on the measuring 'receiver'. This level is noted and represents the reference antenna gain. In the case of the 10GHz measurements, the reference antenna was a 16.5dBi gain horn. A horn is used because the gain can be accurately determined from the physical aperture, assuming the flare angle is reasonable etc. The gain of my reference antenna is known to be 16.5dBi at 10.4GHz, from the data sheet anyway!

By substituting the reference antenna with the antenna to be measured (taking care to ensure the feed point of the unknown gain antenna is in the same place as the reference antenna was located when the reference measurement was made) the increase or decrease in signal level can be read off the meter on the 'receiver'. The gain of the unknown antenna is then the reference antenna gain plus or minus the difference on the meter in dB. Simple!

The problems

As you might expect there are some catches.

A power meter such as the venerable HP 432 could be used to measure the level of the signal received from the source. And, indeed, often is used. With this arrangement a pure CW source is all that would be required as the transmitter. However, the drift-free dynamic range of the average power meter is very poor and the usual virtue of broadband operation is a serious problem.

With this simple (but workable) arrangement any stray RF will be indicated on the power meter with no indication of whether it is the wanted signal from our test source or unwanted pick up of the local 10GHz beacon, or even someone on a GSM phone, 2m handheld or the local taxi. This can lead to some very peculiar results if care is not taken to check the readings!

These limitations can be overcome by using a 1kHz (the standard) amplitude modulated source as the transmitter and a diode detector connected to a VSWR indicator as the receiver. All this is explained far better than I can do in issue 1 of Scatterpoint so I wont's take up space by repeating it all, again. Suffice to say the modulated signal is not easily mistaken by the receiver and the use of a detected audio signal allows relatively drift free, highly repeatable measurements with a surprising dynamic range of nearly 50dB under optimum conditions.

For the 10GHz range I used a borrowed Marconi 6058B tuneable Gunn source. These were originally made as sources for driving slotted line measuring systems. As such they already have facilities for internal 1kHz amplitude modulation.

The receiver was also a borrowed Marconi instrument. I used a Marconi 6593A VSWR indicator. These narrow band 1Khz tuned amplifiers with log detector are (subjectively) better than the better known HP415E VSWR indicators. I can confirm they are better as I had to give mine up to a well know American who insisted he needed it for measurements in the USA! Hence I had to borrow one to replace it.

The second catch is that the accuracy of the range can depend on how close the gain of the unknown antenna is to that of the reference antenna. As the gain difference increases, so the possibility of errors increases. There are several reasons for this. A higher gain antenna is usually physically larger than our reference horn. This means it may not accurately 'capture' all the common volume because part of the antenna may be outside the common volume. However, this isn't too much of a problem because the contribution from the outer areas of the dish to overall gain is usually decreasing due to lower edge illumination. Also the bigger antenna should ideally be further from the source than our small reference horn.

What this means in practice is that a 10dB gain difference is OK, 15dB is getting to be a problem and 20dB is asking for trouble. You will note that I asked in the original call for antennas on my web page (www.btinternet.com/~jewell) for people not to bring 4 foot dishes to measure as these would (if working properly) be more than 20dB above the reference gain antenna of 16.5dBi. These larger antennas would probably show lower gain than actually achieved due to this effect of the range gain compression described above.

The results
So, now you know how the range works on 10GHz, the results. Please note, that these have already been published in both the RSGB Microwave Newsletter and the North Texas Microwave Society newsletter. In one of these fine publications the table was incorrectly formatted, prior to publication, and some information was lost. Hopefully, this is the definitive version.

10GHz			
Callsign	*Antenna measured*	*Results (dBi)*	*Comments*
G3PHO	60cm Amstrad dish with W2IMU feed and extension	35.2	G3PHO version
G3PHO	As above without extension	34.2	
G8PSF	80cm Amstrad dish with W5LUA dual band feed	30.5	10 + 5.7GHz feed
G3LYP	BSB 35cm dish with feed based on LNB feedhorn	29.5	
G3LYP	PW dish with penny feed	29.5	After adjustment
G3LYP	Horn	19.8	20 dB commercial

			design
G8LSD	80cm prime focus with penny feed	34.5	
G3JMB	60cm prime focus with penny feed	27.5	
G3JMB	60cm prime focus with dipole and reflector	27.5	
G3JMB	PW dish with penny feed	29.0	
G3NYK	Horn	21.5	Commercial horn with large aperture
G3NYK	Elliptical Horn with Fresnel lens	19.5	Commercial
G3NYK	Small horn	15.8	Commercial
G4DDK	Andrew 60cm prime focus with shepherd crook and horn feed	33.1	The popular commercial surplus dish
G4DDK	RSGB '20dBi' horn from the Microwave manual	20.0	Calculates at 19.9dB at 10368MHz
G4ZXO	42cm dish with dipole and reflector feed	30.0	
G7JTT	Channelmaster minidish with tubular horn feed	30.3	One of the popular digital Sky dishes. About 42cm wide
G8GTZ	Grundig Sky minidish with G3PHO/W2IMU feed	30.3 !	Also one of the popular digital Sky dishes. About 42cm wide
G7JTT	16 slot (8 each side) waveguide	12.3	Typical beacon antenna
G3XGK	Horn	19.0	Commercial
G3XGK	25 inch prime focus with penny feed	32.0	Home brew fibreglass design

2.4GHz
So, what about 2.4GHz and why 2.4?

The first range I set up was at the University of Surrey, Amsat Colloquium 2001, I was assisted with the range by Dave, G0MRF. Dave arranged for a reference horn antenna to be made specially for the measurements.

The antennas measured were all for use with AO-40 satellite and featured circular polarisation. The measurements went well and we had many converts to the technique of the measurements and I'm sure the range will re-appear at next year's Colloquium by public demand.

Probably most important, several very important lessons were learnt about helix antennas. How not to build them featured strongly!

The measurements were all published on the Amsat UK web site.

Unfortunately, the reference horn antenna was not available for use at Martlesham Adastral Park and so a patch antenna was substituted. Although we knew the gain of the patch quite accurately, the broad beamwidth of the patch together with its low gain caused some problems and I am not too confident of the results obtained. For this reason I won't re-publish the figures in Scatterpoint although they have appeared in the previously mentioned publications.

Analysis of the results

The results are quite interesting.

?? I am confident that up to about 30dBi, the gains measured are quite believable. Above about 30dBi the results look to me like there is some slight (~0.5dB) gain compression. I base this on the expected gain of the Andrew dish which should have been closer to 34dBi than the 33.1dBi measured. The loss of the coax to waveguide adaptor accounts for the missing fraction of a dB.

?? The PW dish and penny feed surprised me with how good it could be after years of believing that this arrangement was less than optimum.

?? I am impressed by the efficiency of the dual mode feed on the Amstrad 60cm dish. I'm definitely going to try this arrangement myself.

Lessons learnt

What lessons were learnt from the 10GHz range at Adastral Park?

?? The most important was to have a go. We have all assumed for some time that you just can't do accurate antenna gain measurements on an amateur test range. This assumption has persisted too long. Let's hope it's been put to bed once and for all.

?? There is great satisfaction is seeing the gain of your precious dish/horn/WHY confirmed by measurement. I would guess that many of the onlookers started thinking about trying that dual mode horn after all. It might just make it possible to work that extra path that doesn't quite go now.

?? Even small dishes such as the Sky minidish give very acceptable gain when correctly fed. Just the job for that mast head system where there isn't quite room for a 90cm dish on the short and already overloaded stub mast.

- ?? Microwave Roundtables aren't just about talks, sophisticated test equipment and bring and buy stalls.

In closing

I'm sure I have opened a can of worms with this article and all sorts of reasons will be voiced as to why the range wasn't worth doing. Hopefully, those who saw it working and participated by bringing antennas to measure will agree it was worthwhile.

My thanks to Mike Scott, G3LYP, for standing out in the cold and noting down all the figures, Simon, G3LQR, for the loan of the Marconi gear and Kent, WA5VJB, for the encouragement to have a go.

73 de Sam, G4DDK

Bondage….

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Flicked back to the cover? Yes, you are reading Scatterpoint and you haven't picked up the wrong magazine. I guess I should really have titled it Bonding but that may have been as bad. Let's straighten things out! I'm talking here about wire bonding – the 21st Century soldering iron. I was prompted to write this as I prepared to start some commercial prototyping and also many will have seen DB6NT's 47GHz amplifier at Martlesham.

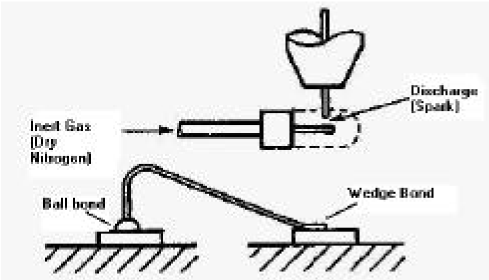
We are all now familiar with the use of SMD components and these, at least in commercial usage, get ever smaller. 0402 is a pretty common passive device size in many portable devices and SOT363 for actives. How do you get smaller? And why? One of the reasons is to get even more into one area and the second is that at even higher frequencies (>c.20GHz) lead lengths and package parasitics kill the device performance. So the only thing to do is to connect directly from the active device to the circuit lines/microstrip. And for this you need to bond to the die and the track.

Sounds easy?! Hardly, typical microwave devices (MMIC's) are 1.6mm x 0.8mm and individual FET's and capacitors even smaller. So as you can imagine the wire used is extremely fine – usually 25um (1mil) and made of exceptionally pure gold, although aluminium is used in other branches of microelectronics. As an aside, it is also exceptionally expensive – 20m of 1mil on a spool is $375. So we have the wire, lets solder it to the chip….

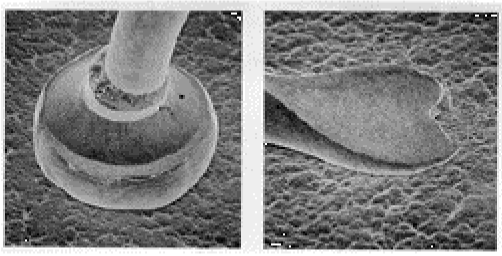
You first! My Acme soldering iron tip is a tad large. It just isn't feasible to use soldering techniques (OK, the smartass who said Indium solder gets a Gold Star) or even use conductive epoxy. The solution, which has been around for a very long time, is to weld the wire to the pads on the die and to the tracks. It really is welding too, the wire is pushed against the pad/track and enough energy applied to get the two to alloy and not enough that they melt completely – or destroy the die. Usually the materials are identical too which is why you see so much Gold inside commercial equipment.

So the trick is to have a machine that can spool the wire, hold it down and apply energy, then do it again and finally break the wire off. It may sound like a bit of a tall order but they exist in many shapes and sizes (and costs!) and are known as wire bonding machines, no surprise really. Well known names include Hughes/Westbond, Kulicke & Soffa and Hybond (the picture is a Hybond 572A at Queens University, Belfast)

The trickiest bits are getting the force right and applying the energy. The first is solved with some simple mechanics and in modern machines, strain gauges. And with the second there are two main methods of bonding – thermosonic/ball bonding and thermocompression bonding.

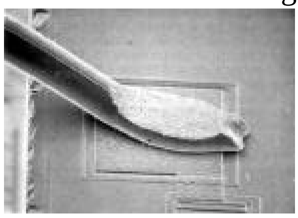


Ball bonding relies upon creating a blob of molten metal just a fraction of a second before the wire makes contact with the pre-heated die/track/package frame and then it is pressed down. Why pre-heated? If you think about it, putting a hot blob against a cold piece of metal isn't going to give an alloyed joint. This method of bonding is ideal for some devices and probably a large proportion of silicon transistors and IC's use this technique. The magic TLA here is EFO – Electronic Flame Off. The reader is left to other interpretations.



After the first bond is made to the die then the wire is pulled through the bonding tool and then pressed onto the track/frame and ultrasonic energy used to make the weld. Ball bonding isn't used much with microwave devices.

Thermocompression bonding is the workhorse of microwave electronics and is used for everything from mounting MMIC's to linking modules. In this case the tool used is more wedge shaped and the wire (or ribbon) is fed through the tool at an angle - 45° or 30° are standard. The wire is then compressed against the pad and a burst of ultrasonic energy used to create the bond. The tool then lifts and wire is fed through the tool until the second bond position is reached and the process is repeated. This may be the final bond or there may be another – this is used when the connection from the MMIC first goes to a decoupling capacitor(Di-Cap) before going to a supply track. The wire is simply broken by clamping the wire as the tool is moved upwards, it then breaks at the weakest point.



Heat is provided to the die/assembly on unit known as a work stage. Typically this is heated to 125C. Some processes call for the tool to be also heated in place of, or in combination with, the ultrasonic burst. Every MMIC manufacturer seems to have slightly different bonding parameters.

As you may imagine, all of this requires everything to be scrupulously clean, as any residues or particles will cause bond failure. Much commercial processing takes place inside clean rooms but it is possible to maintain sufficient cleanliness inside a filtered air cupboard, usually know as a Laminar Flow Cupboard – many universities do this. And in order to keep everything clean, the wire, devices, etc. are kept in a Dry Nitrogen atmosphere.

So, you fancy having a go? Well you can certainly pick up good used bonding machines from £800 up but you'll need to add the Nitrogen storage facilities, bonding tools, gold wire and clean room facilities. Say £3-5000 to start. Makes that soldering iron look a bargain, doesn't it!