United Kingdom *Microwave* Group

Scatterpoint – *Issue 3*

October 2000

www.microwavers.org

10GHz receiver testing session at Microwave Update 2000

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About the UKuG

The United Kingdom Microwave Group was formed in Autumn 1999.

Membership subscriptions are currently UKP12.00 per year.

The committee comprises of the following:

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

There are also six ordinary committee members;

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

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

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

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

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

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

Front-end

Welcome to the third issue of Scatterpoint.

Since the last issue of Scatterpoint the UKuG committee has met for the second time. On the agenda was the subject of the Group project. At our previous meeting the subject of sponsoring beacons had been raised and an action had been raised to consider how this could best be done. From this a new idea was formulated. Perhaps we could turn the whole beacon project on its head? The resulting proposal was to establish a network of remote, rain scatter monitoring stations for use on 10GHz. G8KMH has included an article in this issue of SP, explaining how we propose to go about the project. It must be stressed, at this stage this is merely a feasibility 'study' and it may be that it is really not viable. However, the idea is both novel and worthy, and as such is worth trying.

By the time you receive this issue of SP the plans for the Adastral Park Microwave Roundtable 2000 will be well under way. This year we plan to extend the event to 1.5days. This will enable us to start measurements on the Saturday afternoon and conclude them on Sunday morning, thus allowing the measurement team to attend at least some of the talks on Sunday afternoon. You don't have to attend on Saturday, but if you do there will be adequate time to have your gear checked out on what promises to be one of the best collections of test gear you are likely to see anywhere!

Full details of the event appear on my website at www.btinternet.com/~jewell
For those of you without web access, you will need to contact John, G3XDY. His address is J H Quarmby, 12 Chestnut Close, Rushmere St. Andrew, Ipswich, Suffolk. Send John a SAE and including the full names of all the people in the party you are applying for. No tickets will be issued, but your application will be acknowledged. For those applying via e-mail to G3XDY@btinternet.com you will receive acknowledgement by e-mail and your name will appear on the attendee list posted on my website.

Saturday night hotel accommodation is being arranged by Jason Flynn, G7OCD and you can request a hotel room by e-mailing him at Jason.flynn@btinternet.com. For those without e-mail, Jason can be contacted at Jason Flynn, G7OCD; 32 Church Road, Felixstowe, Suffolk, IP11 9NF.

We will also be organising a Saturday evening dinner. Again, Jason is the person to contact.

The first AGM of the UKuG will take place at Adastral Park on the Sunday. This is being organised by our Treasurer, G4KNZ. An agenda will appear on the UKuG website in the near future.

That's all for now folks. See you at Adastral Park in November.

PS. I will need a 'ticket' to get in to Adastral Park as well, from now on!

73 de **Sam Jewell, G4DDK**
Chairman, UKuG

The DC Bands - 1.3 and 2.3GHz News

John Quarmby G3XDY

On the bands

Conditions so far this summer have been rather disappointing, with little tropo, and any that has been logged has been fairly brief and not very widespread. The 24/25th August was good, with G4BRK reporting a one way with OE5VRL at more than 1000km plus other QSOs into ON and PA on 23/13cm. GM4LBV (IO86) was worked in eastern England on 1.3GHz and G3LQR also worked him on 2.3GHz. As I finalise this column the M0CQZ Scilly Isles expedition has just concluded, unfortunately tropo conditions were poor during their stay but they made at least a few contacts on 1.3GHz, including G3LQR at nearly 600km.

Lets hope that tropo improves as we approach the autumn, and that the cumulative contests actually manage to align with an opening for a change.

1.3GHz in VHF NFD

We should see the results from the new style VHF NFD later this autumn, but from what I observed and conversations with others the level of activity on 1.3GHz seemed to be adversely impacted by groups choosing an ‘easier’ band like 50MHz. I was pleased to work GM0FRG/P from the Kintyre Peninsular (IO75FI), who had a good signal over a difficult path, and they also worked PA6NL at 740km. They are to be congratulated on making a good showing from an area more associated with good scores on the lower VHF bands than on 1.3GHz. If the new format has not improved the number of entries I hope we can put pressure on the VHFCC to encourage more operation on 1.3GHz rather than allow groups to opt out. In the rest of Europe this contest runs on all bands, so there was activity on 2.3GHz and higher for those with a good take off to Europe.

PCS1900 Amplifiers

Following my article on the PCS1900 amplifiers in the first issue of Scatterpoint, I had a few enquiries and as a result 3 more were brought over by Dave G4HUP on one of his regular trips back to the UK. These are now with their new owners and should be heard on the band soon. It appears that all the amplifiers available have now been sold, but it is worth keeping an eye open for other similar devices.
G4HUP has built a power combiner that allows 4 amplifiers to be paralleled for the ultimate in 2.3GHz QRO.
There have been reports that the 1.8GHz version has been successfully moved down to 1.3GHz (an example was on sale at the Weinheim VHF convention recently), but that the 900MHz GSM versions are not easily moved onto amateur frequencies.

Weinheim 2000

I went to the Weinheim VHF convention for the first time this year, a worthwhile if rather tiring weekend jaunt complicated by a French blockade of the Tunnel. Ferreting around the extensive flea market unearthed many items not often seen in the UK. Some of the more interesting finds are listed below.

1.3GHz Power Amplifiers

DJ3FI was exhibiting a 1.3GHz PA using a YD1332 which was claimed to give several hundred watts output. A web site with details of some of his other PA's is at:

http://www.qsl.net/nd2x/DJ3FI.html

The Mitsubishi 18W power amplifier modules (M57762) were available at around £40 each. It is rumoured these are no longer in production so now is the time to buy if you need spares or have a project in mind. In the UK they are available from G3WDG and from GH Engineering.

Beko (http://www.beko.cc) were showing some very nice MOSFET high power amplifiers , including a 280W output model for 1.3GHz with integral mains supply. Their web site lists a 560 watt model as well, and there appear to be plans for a 1kW version in the future. Simon GM4PLM is listed as their UK rep.

SSB electronics still produce the 2x2C39A PA used by many stations, there were also a few "clones" of this design available elsewhere in the fleamarket. SSB also produce solid state amplifiers to 100W on 1.3GHz and 10W on 2.3GHz. (http://www.ssb.de)

Kits

DB6NT (http://www.db6nt.com) is already well known in the UK for his high quality kits and finished modules. Other suppliers with extensive ranges of kits for the UHF range included Eisch-Kafka Electronic (http://www.eisch-electronic.com) including kits for the DK2DB 2.3GHz 10W PA, and the DF9LN oven controlled crystal oscillator for high stability oscillators in the 90-135MHz range. They also have a range of kits targeted at packet radio applications, including a complete 1.3GHz packet transceiver with 1.5W output, and kits for 1.3GHz and 2.3GHz repeater/digipeater applications.

Frank Koeditz Nachrichtentechnik (http://www.koeditz-nachrichtentechnik.de) has kits for a 13cm FM TV transmitter and a 23cm masthead preamp, plus a universal board for MAR/ERA style MMICs with plated through holes to provide good grounding at 10DM each. Also of interest is the MGA86576 broadband amplifier kit offering 1.6dB NF and 23.8dB gain at 3GHz, and usable from 500MHz to 10GHz.

ID Elektronik (DC6ID@aol.com) has a range of kits for ATV and Packet Radio applications at 2.3GHz, including a synthesised TX, and various PA's from 1.5 to 10W output. They also have a range of high performance interdigital filters for use as repeater duplexers and for transmit and receive filtering.

Other items

Many stands had equipment and cables with 7/16 DIN coax connectors rather than N types. This connector is bigger than the N type and can handle a lot more power and is considerably more rugged. It is used extensively in the cellular radio world and is becoming well known in EME circles, and I expect we will see more of them appear on the UK surplus market soon. Some neat reflectometer heads were available for as little as £5 each with a 7/16 output connector on one end, input via an SMA on a short length of semi-rigid cable, and the sensor connections via miniature versions of SMB connectors.

An interesting new MMIC available at the show at an attractive price was the CGY196, made by Infineon (ex Siemens). These devices are capable of up to 1W output (for pulsed modes at 1.9GHz) and work over the range 800-3500MHz with >30dB gain at 1.9GHz. They should be good for medium power stages on 1.3, 2.3 and probably also 3.4GHz. They were around £3 each at the show, but they can also be obtained from Barend Hendriksen in Holland for 25 Guilders each (circa £8) (http://www.xs4all.nl/~barendh/Indexeng.htm), and full data is available at the Infineon site (http://www.infineon.com).

Picture

Whilst at Weinheim I met Jürgen DG1KJG who runs the impressive antenna system shown in the picture and puts a good signal into the UK on the microwave bands as a result. It is not known if the smiley on the dish improves the feed efficiency! On the left are the 144 and 432MHz antennas, to the right of the dish are 50 and 1296MHz, with the dish covering 2.3GHz-10GHz.

Sign off

As usual I will sign off by exhorting you to provide input for this column, please let me know your news and views. I can be contacted as below. Information for this column has come from G4DDK's "A View from East Anglia" web site, from the DX Cluster network, various internet reflectors, and the websites listed in the article, plus contacts on the bands.

73

John, G3XDY

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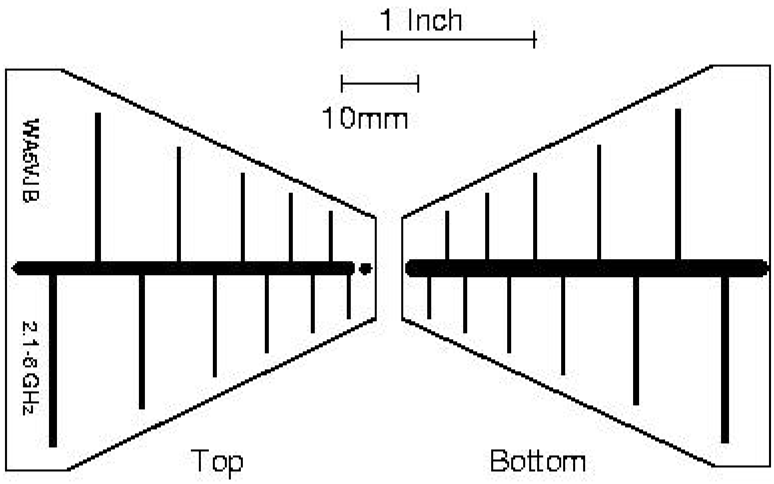
Designing PCB Log Periodic Antennas

Kent Britain WA5VJB

Over the last few years, I have developed 4 Log Periodic antennas from 50 MHz to 6 GHz. I wish I could say I have a secret design process, but there were many variations and metal tape on the early models. And while there are software programs such as IE3D than can analyze a log periodic antenna on a dielectric surface, I do not know of any programs that can design such an antenna. And as commercial antenna go, this is a poorly performing antenna. Instead of a flat -10 dB Return Loss, these antennas have dips, at 2.3, 3.4, and 5.7 GHz. As a radio amateur, I am willing to loose a little performance outside the call frequencies for better spot performance on the call frequency.

If you would like a copy of the PCB file in Tango format, just send me an email at WA5VJB@FLASH.NET I'm sorry, but I only have the PCB file in Tango.



And now for a few of the problems designing PCB Log Periodics.

PCB Asymmetry

A Copper trace resting on a dielectric has a velocity factor. That is, a 1/2 wave dipole is shorter resting on Fiberglas than it would be in free air. While the textbooks give you the velocity factor for a stripline over a groundplane, this is not over a ground plane! But it turned out to be close to the velocity factor of a normal stripline, about 60%. However that is in just one direction. While the elements are about half their expected length, the element to element spacing is only reduced about 20%. So you cannot simply scale a freespace Log Periodic by the PCB velocity factor and expect it to work well. As they say, "Been There, Done That"

PCB Dielectric Constant

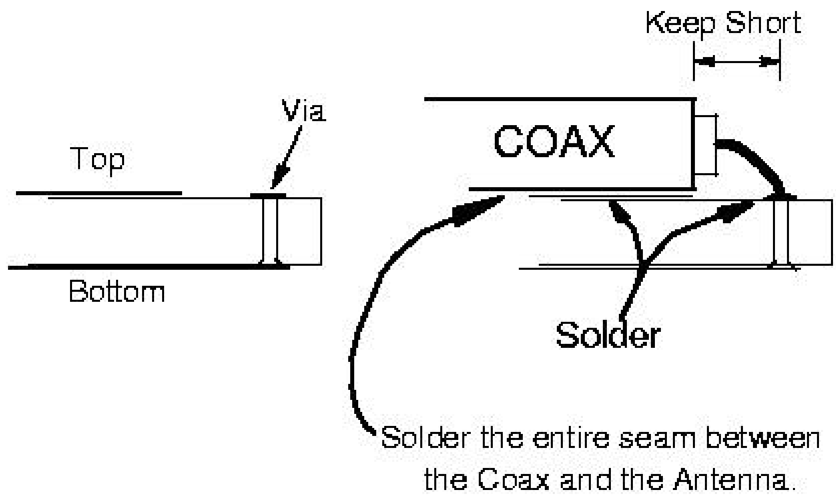
I also learned the hard way that the dielectric constant of most PCB materials vary with frequency. So while FR-4 type materials have a dielectric constant (Er) of 4.2 to 4.4, it can drop to 3.9 at 2 GHz, and even lower at higher frequencies As you move up in frequency, the relative thickness of the material increased. At 900 MHz the PCB thickness (1.6 mm) is about .5% the length of the element. By the time I was up to 6 GHz, the PCB material was up to 8% of the element length. So the Fiberglas dielectric has an ever increasing effect on the lengths of the elements, and companies just don't publish the Er of their non-Teflon PCB material above 1 GHz.

Booms

The velocity factor of a stripline varies with its impedance. That is, the wave travels at different speeds for wide lines and narrow lines. When the transmission line is soldered to the antenna, that side of the antenna effectively has less inductance and a higher velocity factor. You really don't want the waves travelling at different velocities on the opposite sides of the antenna! So the line trace on the transmission line side has been narrowed to allow for the effects of soldering on the coax.

Coax

The 900-2600 MHz version works well with either .141" semi-rigid or the smaller .085" coax. But the 2.1-6 GHz versions get unbalanced with a really thick coax going down the boom. I recommend using either .085" semi-rigid coax on the 2.1-6 GHz antenna or one of the Teflon RG-174 style coax with a diameter of less than .1 inch, or 2.5mm. The coax only needs to be a millimetre longer than the antenna, then you can transition to 7/8” Heliax? if you like. Keep the free tip of the coax as short as possible, and the shield as close to the via as practical. This improves phasing, especially at 6 cm.



Grounding via at the back of the Log Periodic

Designing a Log Periodic to be grounded at the back of the boom helps solve many problems. The entire antenna is at DC ground and many low frequency response problems are eliminated. In high EMI areas, ungrounded LP's can allow many VHF signals to become intermodulation sources. Removing the via will lower the lowest usable frequency slightly, but introduce many new resonance’s into the antenna. Removing the back grounding via is not recommended.

Power

I wish I could test one of these antennas to destruction, but I just do not have enough power. At 900MHz, the antenna has a relatively large active area and could probably take 100 watts for short periods of time. As you go up in frequency, the active area gets smaller and smaller, and the dielectric loss goes up. At 6 cm, the max power is probably in the 10 to 20 watt range. I am expecting some feedback from local EME'ers.

Phase Centre

The phase centre is the point on the antenna that does the radiating. On an LP style antenna, the phase centre moves along the antenna as the frequency changes. Counting Elements from the small end, the 6 cm phase centre is about element #3. 9 cm is about element #6, and 13 cm is about element #9. One effect of the dielectric is the compression effect on the antenna, making it physically smaller. While the antenna has less capture area, the phase centre does not move as much as it would with a Teflon or air dielectric design.

Why didn't you build them on Teflon?

The short answer is money. If you know a PCB house that can make double sided PCB's with plated through holes from CAD files for less than $500 a panel, let me know! Also, I cannot use the current artwork. The elements will get about 20% longer, the element to element spacing will increase about 10%, and the asymmetrical booms would change. Both the 900-2600 MHz and 2.1-6 GHz versions went though the PCB house 3 times before I was happy, and a Teflon version would probably make several trips too. So a Teflon version would easily cost $2000 for me to develop.

As a Dish Feed

A Log Periodic is a compromise dish feed. How far down it is from an optimised feed depends on many factors, f/d, frequency, etc. But in general, a 3ft dish with an LP feed has about as much gain as a 2.5 ft. dish with an optimised feed, and during contests you only have to carry one antenna. Mount the LP with the phase centre of the highest frequency you plan to use at the focus of the dish. The lower frequencies are slightly beyond the best focus point, but the loss is usually less than a dB. Also the dielectric compresses the antenna, so the phase centre does not move as much as it would with Teflon or an air dielectric Log Periodic.

As finally, despite several requests, a 10 GHz or 24 GHz version is not planned.

Kent has kindly sent over a batch of 100 of his excellent 2 to 6GHz printed log periodic antennas. They are available to both members and non members. However the charge will be 4GBP to members to include postage, non members will be charged 5GBP each.

A proposal for a passive rainscatter monitoring system

Lehane Kellett, G8KMH

Introduction

The UK Microwave Group was recently discussing potential projects and the perennial discussion of beacons came up. In the UK, at least, it has become difficult to find acceptable sites or groups willing to take on the establishment of 10GHz beacons or for that matter beacons on other bands. There are already a number of beacons but these may not be in the best position to allow the determination of rain cells and hence a significant lost opportunity for 10GHz contacts.

Looking in reverse however, if there can't be enough beacons in the right locations then it might be possible to put receivers in sufficient locations to either receive a beacon or transmissions from stations probing to find scatter (or even tropo ducts).

Putting a receiver in place is one thing but there has to be some feedback path to the user(s). In an ideal world a nice high speed connection to the Internet would be available with FFT displays at the user end. In the real world the best we could achieve at present is an audio quality line from a GSM cellphone.

This paper discusses the approach for a simple beacon monitor and discusses what might be possible in the future. In essence the concept is to produce a self contained box which requires only power (240V AC or 12V DC) and siting on a mast or other convenient location.

Rainscatter monitoring

There is little point in covering what rainscatter is in this paper. There are plenty of references to it elsewhere.

For the purposes of the monitoring system there are two key points

?? The rain cells move fairly rapidly and therefore a path between two sites is only transient. A system must therefore have a reasonably large beamwidth to cater for many path permutations.

?? The signal suffers from dispersion due to the random Doppler from the raindrops. Ideally a system would cover a wide bandwidth with digital signal processing of the signals.

Whilst we can provide for a reasonable beamwidth using a horn antenna (at 10GHz) – in fact their small size is a positive bonus!

However, it is not easy to provide a large bandwidth, say 25KHz, and send processed data down a 3KHz audio or 9600bps digital link. So, for the first phase the receiver will be no more than a standard SSB receiver with 2.4KHz bandwidth. It may be possible to use a wider bandwidth and use some audio frequency folding - 4KHz becomes 0Hz, 6KHz translates to 2KHz, etc. This would best be done using DSP.

Phase 1 Remote receivers

Our first system is likely to use readily available components – a 15dB horn, LNA, 10GHz downconvertor and then a commercial (trans)receiver. It would be advantageous to create a modified receiver board (Plessey, Howes, etc) in place of the commercial unit, if only to reduce power requirements.

The GSM phone is key to the operation of the system. It is not known if a similar system has been used commercially – probably given some of the roadside boxes with 900MHz antennas - but it is understood that the approach has been used in clandestine operations.

It is not legally possible to take a cellphone, open it up, and attach wires to the keypad, reset lines, etc., although this would be easiest. Another approach has to be taken and some means of controlling the phone is required, as well as access to the normal hands-free / car-kit microphone and earphone connections.

Initially the search was for phones with a logic level ring indicator and answer system but this didn't prove fruitful. Next those with data connections were looked into and there are two main candidates – most Nokia and some Ericssons. The latter have an easy to use Hayes command set but crucially lack the ability to turn the phone on if it has been powered off (which may happen during a prolonged power outage). So a Nokia it is – probably a 6100 series. Unfortunately the protocol for the data connection is not published by Nokia (except under NDA) but has been reverse engineered by the Linux community and the details put on the Internet.

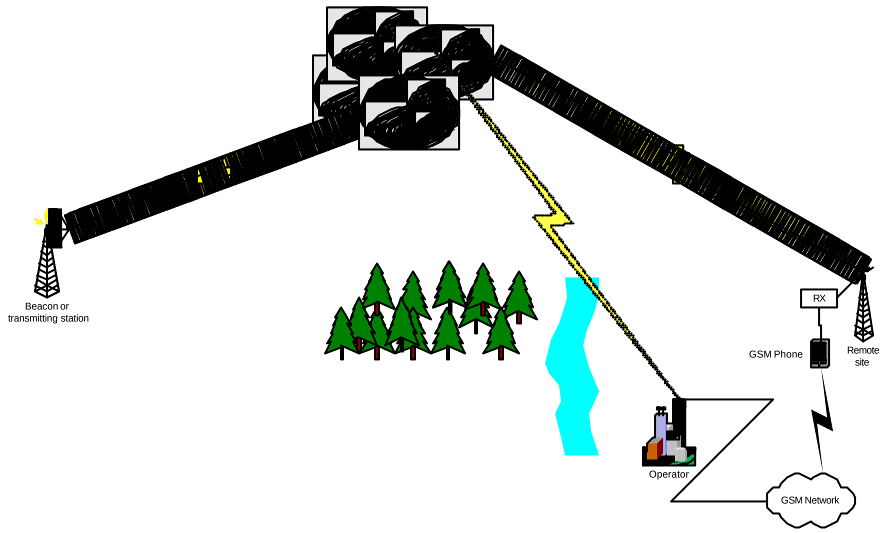
The cellphone (or at least the SIM) will be one of the popular pre-pay systems with vouchers that are valid for a long period without the need to top up the phone. Some allow incoming calls for 6 months after the expiry of the voucher.

A controller board will interface between the receiver and the GSM phone. It will provide for all the call control – answer, hang up after preset time, power on, etc. It will also have DTMF decoder for future options.

Phase 1 operation

In Phase 1 only the most basic operation is possible. Here the operator makes a call to the unit and then listens – either for other operators/beacons or transmits his/herself. By using different beam headings it would be possible to 'probe' for areas of scatter.

Of course, with sufficient units a local system may just be used to check you are still transmitting – very useful when there seems to be no-one else on the band!



Phase 1a,1b,2 – futures

Looking to the near future it should be easily possible to replace the commercial transceiver with a simple SSB receiver. It would then be possible to add some additional facilities, some of which are below:

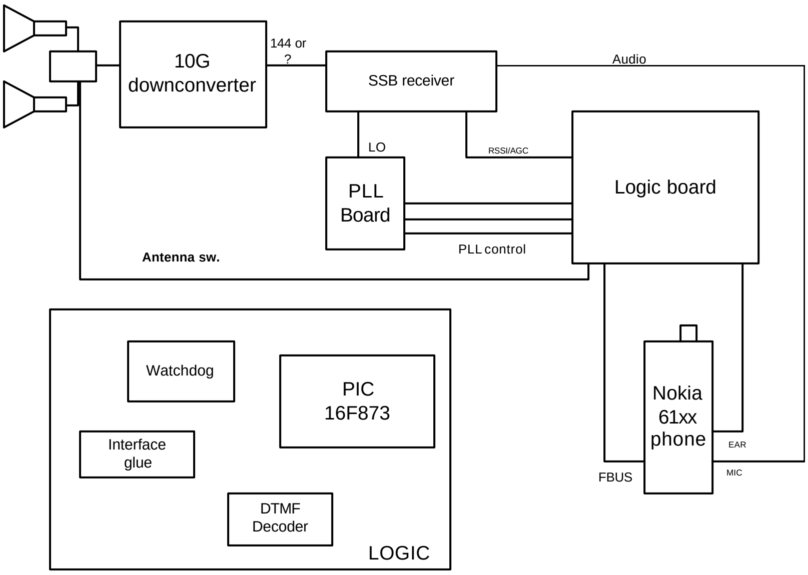
Switchable LO crystals or
PLL LO operation
Switchable filters
RSSI/AGC A to D conversion
Audio foldback (mixer and filter)

The PLL control of the LO would be very simple to add as most of the work has been done by Andy, G4JNT.

All these functions would be controlled by means of DTMF commands.

In the future it would be nice to add DSP capabilities and make the results available on the Internet via a push server. This may be possible if an academic establishment makes a site and bandwidth available.

With some care it should be possible to use a solar cell to provide the power, with the logic board monitoring the voltage levels and turning off the receiver if necessary.



Conclusion

A rainscattering system looks feasible and should be reproducible at low installed and running cost. How many could be established in the UK would depend on funding but certainly as many units as there are beacons should be a target. The use of a cellphone makes the unit almost completely self contained. Other bands could be incorporated or further units built.

Feedback on the idea is welcomed, as well as offers of sites.

Lehane Kellett, G8KMH – UKuG © The UK Microwave Group

Some Observations on Sun Noise Measurements

Neil Whiting, G4BRK

Introduction

Sun noise is an accepted way to gauge system performance on microwave frequencies, but apart from EME station reports there are few indications of what is a reasonable result on typical amateur microwave systems.

In the course of checking and optimising feed positions on a selection of dishes I made a number of measurements, which may be of interest to others.

Setup

Several home-built transverters were used to convert the various microwave bands down to 144MHz. My RATS system (G4PMK design) was used as a sensitive level meter on the transverter 144MHz output – the optional MAR-6 amplifier was required between transverter output and RATS receiver in order to get sufficient signal.
A calibrated attenuator (0-11 dB in 0.1dB steps) after the transverter served to give an accurate measurement of the Y-factor (difference between cold-sky and sun noise).

Measurements

The measurements were made by aiming the dish away from the sun and setting the RATS offset to get a convenient, low scale reading (cold sky) with the attenuator set to 0dB. The dish was then pointed at the sun and the reading maximised. The attenuator was then adjusted to give the same reading as the cold sky. The attenuation used gives the Y-factor.

Antenna	Frequency	RX NF at ant dB (?)	Antenna gain dBi	Y-factor dB	Theoretical Y-Factor dB
1.2m prime focus, 0.5f/d, RMX feed	2320	2.2	27.9	2.0	3.9
	5760	3.5	35.8	0.8	2.5
90cm prime focus, 0.4f/d, RMX feed	2320	2.2	25.4	2.0	2.6
	5760	3.5	33.3	0.5	1.6
90cm prime focus, 0.6f/d, RMX feed	2320	2.2	25.4	1.5	2.6
	5760	3.5	33.3	0.5	1.6
80cm offset, 10/24G feed	10368	1.5	37.1	2.0	2.2
	24192	3	44.5	2.5	0.8
80cm offset, RMX feed	2320	2.2	24.1	0.5	2.1
60cm offset, Amstrad feed	10368	1.2	34.8	3.5	1.8
35el Tonna yagi	1296	1.2	17	1.5	2.6
	1296	1.2	17	2.0 (horizon)	2.6
67el Wimo yagi	1296	1.2	22	1.6	5.3
	1296	1.2	22	2.6 (horizon)	5.3

Antenna gains for the dishes and theoretical Y-Factor come from the Ed Cole (AL7EB) spreadsheet available on the WWW. Dish efficiency of 55% is assumed. For the estimates of

23cm Yagi gains, the Tonna is based on simulation and the Wimo on manufacturers claims. RX noise figures are estimates.

Conclusions

I set out to confirm feed positions for my dishes, and this was successful. It was noted that the deeper dish was more critical on feed position – 10% movement in distance from the dish is quite noticeable in the measurements, though only fractions of a dB. This contrasts with results by others which suggest position needs to be correct to a few mm – I needed 4cm on the 1.2m dish before I could see the Y-factor drop by 0.1dB.

The measurements also raise a number of questions, some of which I can attempt to answer:

On 2320MHz – why is the 90cm,0.4f/d dish as good as the 1.2m?
The WA3RMX feed is designed for deeper dishes, 0.3-0.4f/d, so over-illuminates the 1.2m dish. This adds ground noise from behind the dish to the cold-sky reading and less increase is therefore seen when aiming at the sun.

On 5760MHz, why is the 1.2m dish showing an improvement?
In this case I can only guess that the RMX feed gives a narrower pattern on 5760 and is relatively better on the shallower dishes.

Why is the 60cm dish better than the 80cm dish on 10368MHz?
The Amstrad feed on the 60cm is obviously working very well. The 10/24GHz feed on the 80cm uses a piece of 24GHz waveguide let into the back wall of a G4DDK feed. The 'DDK feed is designed for ~0.5f/d, so will be over-illuminating the 80cm dish, reducing the Y-factor due to ground noise contribution. There may also be a reduction is efficiency due to the 24GHz guide. The 24GHz figure, on the other hand, seems very good – it looks like this feed is accidentally working quite well!

How come the 67el Yagi is not much better than the 35el?
I don't know. The difference in claimed gains is ~3dB and the 35el simulates as worse than claimed. There may be a matching difference causing a change in the effective noise figure – I seem to get a higher background noise on the 67el. Some more investigation is required. It is interesting that I see more Y-factor when the antennas are mounted horizontally and moved towards the setting sun. I would have expected less due to part of the beam including the ground and increasing the off-sun background noise. It may be that I am seeing the effect of ground-gain – something that is seen by 2m EME stations. Any other ideas?

I learned something from making these measurements and can use them in the future to check the effect of improvements in each of the systems.

Some Practical tips - from someone re-starting on microwaves

Simon Chettle G8ATB

After a break of 10 years away from the hobby I moved into a QTH that allowed me to re-start.

During the mid eighties I was active on 23cms, with much assistance from G4DDK, using an inter-digital filter/ mixer for the receive and a DF8QK transmit board. However after 10 years in packing cases, three QTH moves and loss of design paper work the task of re-instating the original equipment was deemed too daunting. The decision to invest in new equipment and re-build the shack was taken.

During my 10 year absence from the hobby a lot had changed, lower activity, not so much home brew, some fondly remembered call signs no longer about, many more repeaters (on the lower bands), however the biggest change was in the technology ! A re-stock of surface mount components was required, out went part of the 1/4, 1/2 watt carbon film resistor stock, wire ended capacitors and Aladdin formers with some small regret- but at least you see them if you dropped them on the floor!

Storing Surface mount components - An idea from Martyn G0CZD - use empty 35 mm plastic film canisters, freely available from film process shops who throw them away.

An FT736 was purchased, with it's 23 Cms module, this got me a prime mover but no aerial - the old 23 element had suffered terminal damage. So the decision to build a new Aerial (a DL6WU optimised yagi) was made using published designs.

I required a method of mounting insulated elements through a round boom and without a source of nylon bushes.

After some experiment it became apparent that 3 mm PTFE tubing would slide over 3 mm aluminium rod and hence the basic insulation was arrived at. Now to fit this into the boom - a visit to a local (well 15 miles away) specialist engineering retailer provide a range if drills between 2.15 and 2.19 mm. The 2.17 mm drill proved to provide a perfect fit for the PTFE insulated rods.

Construction method:

Cut elements to required length, then cut a piece of 3 mm PTFE tube, make this approximately 5 mm longer than the diameter of the boom.
Slide the PTFE tube onto the element for about 10 mm then, if the right drill size has been used, gently push the PTFE tube and element through the boom. You should find that the PTFE tube passes easily through the boom until the element is about to enter the first hole in the boom, at which point the PTFE tube will form an interference fit between the element and the boom and will top moving - push, or tap, the remainder of the element through the boom and hey-presto you should have a firm mechanical fix.
If you find that the tube you use is slightly to small for the elements due to a thicker wall thickness of the tube, try "polishing" the element with course wire wool to reduce its diameter.

Drilling and marking the boom:

Not having access to a "V" block to hold the boom the, very, old workmate was the only method of holding the boom.   Marking the boom was accomplished by scribing a line down it's length using two lengths of copper pipe, then taping a steel measure along the Boom, and marking the element spacing with a steel point. The element position marks were reinforced by using a plumbers pipe cutter to scribe a circular mark around the boom, then using centre punch to mark the exact drilling point.

Drill the hole for the reflector and then push a long length of element, 30 cms or greater, through and fix using insulation tape, now move the boom and prepare to drill the hole for the LAST director, turn the boom so that the long length element is vertical and in-line with the drill bit, drill through the boom.   Now the trickier bit - to obtain alignment for the intermediate elements stretch a length of fishing line between the Director and Reflector and align the drill bit against the line.   Note: The line can be used to adjust the actual element positioning to obtain a symmetrical shape for the completed Aerial.

Testing and adjusting the Aerial:

My simple strip line coupler proved very erratic, being eager to get on the air I decided on the "tune for maximum smoke" approach. I constructed a simple folded dipole adjusting this for max forward power as indicated on the FT236.   This dipole was mounted on a 2 metre pole and along with the FT236 moved into the back garden. The new Aerial was mounted onto another pole placed approximately 10 metres away from the dipole, this distance should be enough to reduce near field effects, a 50 ? termination was fitted along with a diode and an electronic voltmeter.

Element lengths were checked by taping 20 mm bits of wire to each end of an element and cutting these to obtain a maximum reading on the voltmeter. The first director length was, as expected, very critical.   Once all elements were checked and adjusted new replacement elements were installed in the boom.

After building the Aerial it became apparent that a pre-amplifier was required - the G3WDG design was selected. Having some copper sheet I decided to build a suitable box. However the soldering of the seams and lock nuts presented a small problem as no gas hob / ring was available. The gas powered Blow torch was tried but this delivered to much heat and was difficult direct heat at specific points. Then I tried the Hot air blow torch - this provides a variable heat source and after fitting a couple of plumbing reducers managed to get a focused heat source through a 10 mm nacelle. There is the added safety point that there is no naked flame involved, though things do heat up and I would recommend all such soldering operations are performed well away from flammable items and substances.

Testing Times – 2

© Lehane Kellett, G8KMH

Well, it seems an age ago when I wrote the last piece, when I even had a lab! For those who've moved QTH will know, it really creates havoc and twice in 14 months trebly so. That said the new lab is taking shape and all the test gear is now in its proper place and the QRO 24GHz system is under construction. So on with the show….

Sweepers

Some people may think this is my favourite topic! But if I had to keep one piece of professional RF equipment then this would be a sweeper. What's a sweeper? A signal generator where the frequency can be linearly varied over time by a ramp voltage. A super VCO. There's more to it than that, you can specify the start and end frequencies and the time taken for the sweep and some have markers so you can 'spot' a particular frequency, like the centre of a filter bandpass. As an aside, one of the professional magazines described the idealised filter response as the 'Barthead'! Think about it…

As I mentioned last time sweepers are available if you keep your eyes open at rallies, from some of the dealers or on the Internet from the USA or Germany. In the UK probably the most common is the HP 8620 which is both quite small and very versatile since it accepts a range of HP oscillator plug-ins covering 10MHz to 22GHz. A basic 8620A without a plug in you'd pay between £30 and £60 for. A late model 'C with the options, such as HPIB, goes for up to £300. The bad news is that without one of the plug in oscillator modules it makes a reasonable door stop and not much else. The second piece of bad news is that there are quite a few non working units too! So choose carefully at rallies, that bargain may be useless or difficult to fix. The range of plug ins is listed on the website www.microwavers.org/sweepers for reference. There may be others and some options increased the range of the 18/22GHz units (usually options beginning H).

Another sweeper which you may find is the HP 8690. This is a larger unit than the 8620 and has a wider range of modules – even some 3rd party to 140GHz. Many of the plug ins use Backward Wave Oscillators (BWO's) which have a finite life. So, even one working now may not have much left to go –see if it has an hours indicator on the chassis. The 8690 doesn't seem to appear as much as the 8620 in the UK but is more popular in the USA. However, shipping costs make it prohibitive to import and you could buy 2 8620's for the cost of the FedEx bill….but that's another story.

The 8620 was superseded by the 8350a/b. These are *really* nice digital units which accept an even larger range of plug ins than the 8620. Even better, with the 11869a adapter you can use your old 8620 oscillators in the new mainframe – just as well as the 835xx series are still fetching 4 figure sums after 15 years and you can buy a decent Skoda for one of the wide range 10MHz to 20GHz units. If you get the 11869a adapter then check if it has the loose BNC plug on the purple co-ax. This is the FM connection to the 8350 back panel and makes phase locking the unit possible without trailing co-ax through the back of the 11869a adapter. If it is missing you can get the co-ax connector for the D-type (Arrow?) and make your own with a length of RG174.

Finally, you may see the Marconi 6600. This is quite large and very heavy and like the HP 8690 has a range of BWO plug-ins up through the mm-wave bands. Getting a bit old now but if the unit is working then still worth buying.

Interconnecting these with your other test equipment can be a bit of a nightmare, especially as you are likely to want to change things around frequently, unlike a professional lab. No, I don't have a clever answer to this but since the connections are mainly BNC it isn't too much of a chore (as I've just rebuilt the shelving for the test gear I can tell you that not having it all against a wall is a big help) and in some cases you can use BNC T pieces to feed two items a once.. Those with time on their hands, having completed the Telegraph crossword, may like to ponder over a nice relay matrix to solve the problem.

If you are starting off then you probably want to use the sweeper with a scope and a detector. The problem is the output from the sweeper is almost always 0 to +10V and a few scopes want +/- ve on the X axis. Not a big problem as you can convert it with an op-amp on dual rail supplies. You can also use an op-amp if you need a greater voltage swing. You can use an op-amp to work the other way around as the popular 141 spectrum analyser sweep output has a +/- 5V swing – yes you can use the first LO as a limited range sweeper.

Next up are the scalar network analysers. The two I know of currently in circulation are the Wiltron 560 and the Marconi 6500. These differ in that the Wiltron requires a sweep signal input and the Marconi generates the sweep signal. Connecting the Wiltron is simply a matter of following the information on the back panel but the 6500 won't directly connect to an HP 8620 BNC's, although it will the 8350. Russ, G4PBP, has successfully connected the two by using the sweep input connection on the 50 way accessory/programming connector. Pin 28 is the sweep input and Pin 43 is ground. Russ brought these out to a SMC connector on top of the back panel, taking care to ensure that the socket clears the top cover. Connect the SMC to the 0-10V BNC on the 6500 and follow the programming cards in the 6500.

Finally, there is the 8410 vector network analyser. Whilst this is a very specialist instrument it is extremely versatile – tuning multistage filters up is even more of a doddle than using a scalar network analyser and, of course, it is *the* tool for antenna measurements. I'll take some time in another issue to describe the differences between the two types.

The 8410B/C works well with both the 8620C and 8350 sweeper but really needs a programming connector cable to carry some additional control signals – the 8410A doesn't have this capability. Of course, these never come with the units. Fortunately there are only three connections so it is easy to make one up.

Connection	8410B/C J17	8620 J2	8350 J13
Stop Sweep Pulse	Pin 7	Pin 34	18 and 20
Seq. Sweep Trigger	Pin 1	Pin 26	24
External Trigger	Pin 9	Pin 50	n/c
Ground	Pin 11	Pin 43	19

That's all there is space for in this issue. Next time around I'll go through some more on basic lab equipment and alignment, and on noise figure meters. And no sweepers, promise. ✍

Control and monitoring of remotely mounted microwave systems

Sam Jewell, G4DDK
This paper was first published in the proceedings of the 15th AMSAT-UK Colloquium, Amsat Space 2000, University of Surrey, July 28th - 30th, 2000.

Background

Increasingly, amateur microwave operators are moving over to remotely mounted microwave systems to take advantage of the lower feedline losses available when equipment is located close to the antenna feedpoint. This has become more practical with the relatively availability of solid state amplifiers with moderate output power and high gain, low noise preamplifiers.
It is now possible to obtain 10 Watt output GaAs FET amplifier to cover 10368 to 10452MHz for under £400 and 10W output 5668 to 5760MHz amplifiers for under £150. There have also been a number of 50 Watt output 2320 to 2400MHz ex-PCS amplifiers available for less than £100.

Mounting these amplifiers at a remote antenna feedpoint is not without its problems, including power supply feedline voltage drop, cost and number of multi-strand cables, environmental housing and remote control and monitoring. This article proposes the adoption of an open standard for the remote control and monitoring of such equipment. Control and monitoring cables can be eliminated and the only cables required for each set of mast head equipment then becomes the connecting coaxial cable normally used for the intermediate frequency (IF) connection, perhaps together with a separate power supply cable. The idea may not be original, but the author knows of no other such current proposal. This is not a constructional project. I leave it to others to engineer a practical solution for the amateur microwave operator.

The proposal is based on the European Eutelsat open standard for switching satellite LNBs and more recently used to operate remote switches in Integrated Receiver Systems (IRS) for apartment and hotel blocks. The standard is known as DiSEqC™ and that stands for Digital Satellite Equipment Control. Although Eutelsat calls this an open standard, it is not known if they are amenable to amateurs using the standard in the proposed way. However, it is my understanding that this is just what an 'open' standard should allow!

Introduction

Early satellite TV systems used a simple Low Noise Block (LNB) with a single Dielectric Stabilised Oscillator (DRO) operating at 10GHz to mix the received satellite signals between 10.950 to 11.700GHz down to 950 to 1700MHz.

As satellite broadcasting has become more popular the satellite TV band has been expanded to cover from 10.7GHz to 12.75GHz. With a standard set top box it would therefore be necessary to tune the whole frequency range from 700 to 2750MHz if a single 10GHz DRO were still used in the LNB. This is a very large tuning range for a simple set top box receiver, but by allowing the set top box receiver to select either a 9.75 or 10.6GHz DRO local oscillator in the LNB, the satellite TV band can be tuned in two smaller bands each between 950 and 2050MHz. These so called universal LNBs use a 22kHz tone transmitted over the coaxial cable from the set top box to the LNB to select either of the two DROs. No tone selects the lower DRO frequency, whilst the presence of the tone selects the higher DRO. In this way no extra control wires are required between the set top box and the LNB other than the coaxial cable. Sky Digital set top boxes usually transmit the 22kHz tone continuously to select the higher satellite TV band used by the Astra satellites at 28.2 degrees east.

Incidentally, polarisation is selected by the use of either +13 or +17 volts supply over the same cable. Truly, the coaxial cable is being used for many purposes.

What Eutelsat have done is to expand the use of the 22kHz tone to enable the set top box to control a much wider range of functions, such as the selection of an alternative LNB where the same dish and coaxial cable are used to receive a second satellite, or to command an actuator to move the dish to another selected spot in the sky. This is done by modulating the 22kHz tone by turning it on and off as a data carrier. The actual modulation is applied as pulse width keying of the 22kHz tone. The modulated tone is superimposed on the +13 or +17 volt LNB supply on the coaxial cable. This will be explained in more detail in the next section.

A further development of the DiSEqC™ protocol allows the set top box to interrogate the LNB or other head end device to ascertain its status e.g. the DRO frequency. This makes the protocol a very powerful two-way data link and a candidate for use in our amateur microwave (and VHF/UHF) satellite and terrestrial stations.

A full explanation of DiSEqC™ can be found on the Eutelsat web site at www.eutelsat.com

The DiSEqC™ protocol

A full description of DiSEqC™ can be found at the above web site. Here, I have attempted to give my own shortened explanation.

DiSEqC™ expands on the simple universal LNB switching systems that use a 22kHz tone to switch the LNB local oscillator between two frequencies. In the DiSEqC™ protocol the tone is pulse width modulated in such a way as to be able to transmit either a '1' or a '0' bit. This then forms the basis of a digital data system.

A digital '0' is transmitted as 1ms of 22kHz followed by 0.5ms of no tone. A '1' is transmitted as 0.5ms of 22kHz tone followed by 1ms of no tone. This is shown in figure1 below. A '0' bit contains approximately 22 cycles of 22kHz, whilst the '1' bit contains approximately 11 cycles. The use of 1.5ms bit periods means the data rate is:

1000/1.5 = 666.667bit/second

This is fast enough for most data control and monitoring applications of this type. The end of the data message is signalled by at least 6ms of no tone.
A shorter data bit period would allow the data rate to be increased to, perhaps, 9.6kbit/s but the system would then become more critical due to the shorter period of time available to detect the presence or not of the 22kHz tone.

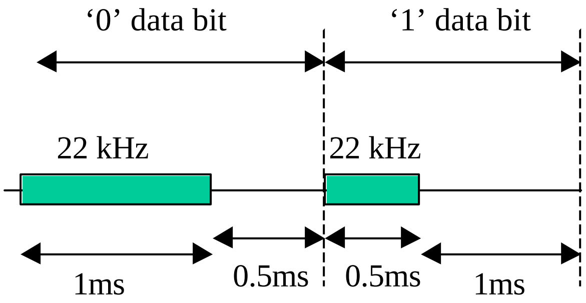


Fig 1 the DiSEqC™ modulation

DiSEqC™ messages are made up of one or more bytes of data formed from 8 bits as described above, with each byte followed by an odd parity bit. The most significant bit is always transmitted first. A basic control (command) message is made up of 3 (or more) bytes. The first is the framing byte, consisting of high level controls, a slave address byte and the command byte. Additional data can be carried in one or more subsequent data bytes.

Framing	P	Address	P	Command	P	Data	P

Fig 2 The basic messages format consisting of 3 bytes plus an additional data byte with a single odd parity bit between each byte.

A simple system is made up of a control or command unit (usually the set top box in the original proposal) and one or more slaves (usually the LNB or switches).
In a simple system the command unit will send command messages as in figure 2 and not expect any return acknowledgement from the slave units. This is covered by the DiSEqC™ level 1 protocols. DiSEqC™ level 2 describes a more sophisticated version where the slave units can signal back to the command unit a range of information such as local oscillator frequency, actuator position or even analogue values such as signal strength.

When a command unit wants to signal a control operation to a slave unit it will transmit a message as above. The framing byte consists of two nibbles of 4 bits each. The first is always HEX 'E' followed by HEX 0 to 7 depending on the function. Eight functions have so far been identified and published by Eutelsat. The first group of 4 is used with level 1 protocols only. The second group of four are the slave replies as specified in the level 2 protocol.

The address byte is divided into two nibbles of four bits to define a family and a sub-type. Although many of these have already been defined, a large block are reserved for OEM (Other Equipment Manufacturers) and it is possible the RSGB (or maybe Amsat?) could reserve one or more of these for future amateur radio use (well, it's a thought!).

The Command byte defines what the slaves should do. Many of the defined functions have no logical use in amateur radio, but a few do and these are ones of interest (together with some new ones I'm sure we could add). The 'set switch' positions selecting 'oscillator high' or 'low' and 'polarisation' seem to be the most useful of those defined. These would be used to select, for example, the position of a common 6 way relay as described in the section on practical uses.

In the level 2 protocol there are some useful bytes used to read analogue values back from actuators as well as polarisation skew. These could usefully be used to read temperature, supply voltage, relative output power or current drain in an amateur remote equipment system. It is also possible to write BCD strings to define frequencies in a synthesised local oscillator scheme. Although not a common requirement today, future microwave operators may regard this as quite useful.

This final section on DiSEqC™ describes the electrical interface conditions.
Since it is a single wire bus it needs to be terminated at the 22kHz frequency. The recommendation is that the load capacitance is no more that 250nF, and preferably no more than 100nF. Where level 2 protocol is used the command unit should present a terminal source impedance of 15 Ohm to the cable (at 22kHz) for the return direction.

The amplitude of the DiSEqC™ signal should be 650mV +/-250mV riding on a nominal +12V supply. The supply voltage can be as high as +17V to allow for voltage switched polarisation in early universal LNBs. It is recommended that the 22kHz detector work down to 300mV +/-100mV.

Implementation of DiSEqC™

DiSEqC™ is a good deal more complicated than a simple multi-strand wire control cable and although it can be implemented using discrete logic blocks in CMOS or similar, a better way is to use a microcontroller. Not only can this be used as a state machine but, if it is dedicated to the purpose, it can also perform the tone generation, detection and decode, all in software. Recognising this, Eutelsat have arranged with Philips Semiconductors for a low cost mask programmed microcontroller to be made available. Controllers also appear to be available as part of larger satellite TV integrated circuits, where their function is combined with other essential decoding functions. The Mitel VP310 appears to be one such device. Other manufacturers such as the German company Hirschmann GmbH use an ASIC in their range of professional TV distribution equipment.

Whilst it may be possible to purchase the Philips microcontroller in low volumes for amateur use, a better route may be for some enterprising amateur to develop a new microcontroller and PCB for use by amateur radio operators.

It is envisaged that surplus controllers, switches, LNBs etc., using DiSEqC™, will gradually become available in the next year or two, and because Eutelsat carefully control the open standard (sic), a large number of options will then be open to us to use in our stations.

Applications

Satellites like P3D will have increasing amounts of microwave band equipment on board. This means more amateur microwave ground stations. To minimise cable losses and achieve acceptable performance amateur satellite ground stations will tend to use transverters connected to indoor (shack) transceivers using coaxial cable that only has to carry relatively low frequency IF signals. However, if you have several bands remotely mounted, then the number of coaxial cables required, together with the number of control cables can be rather daunting, not to mention heavy and expensive. Using DiSEqC™ and a multi-pole relay much of this copper can be eliminated. Figure 3 shows how this could be implemented as a means of reducing the number of receive feeders required, together with control cables.

The use of the level 2 protocol would enable full monitoring of the conditions at the masthead equipment, such as relative power output, relay switching state confirmed etc.

One thing I have not mentioned is transmit / receive switching. I don't believe this should be implemented using DiSEqC™ as it might prove too slow when other functions also have to be signalled. I would prefer to use DC switching over the transmit feeder, such as would be available from a transceiver such as the FT290 or IC202, or from a modified transceiver of the TS711/IC275/FT847/FT736 variety. NOT RF switching! An adapter, that would increase the usual +13V supply, used on receive to +17V on transmit is quite straightforward and could easily become the accepted TX/RX switching standard for amateur radio pole-top systems, whilst also having the advantage of increased transmitter voltage at masthead to overcome increased volts drop to the current thirsty solid state amplifiers now appearing., e.g. Mikom at 10GHz.

Conclusion

It cannot be stressed enough, the success of DiSEqC™ in the amateur market will require that simple, low cost, kits or ready built equipment must be available, that can be successfully used in place of that multi-strand cable. I can't pretend that, given the choice, most amateurs will not opt to use the simpler multi-strand cable approach. However, the growing complexity of our stations, the move to mounting equipment nearer to the antenna, and the need to have more information about how that equipment is performing, will gradually force us to look at techniques like DiSEqC™.

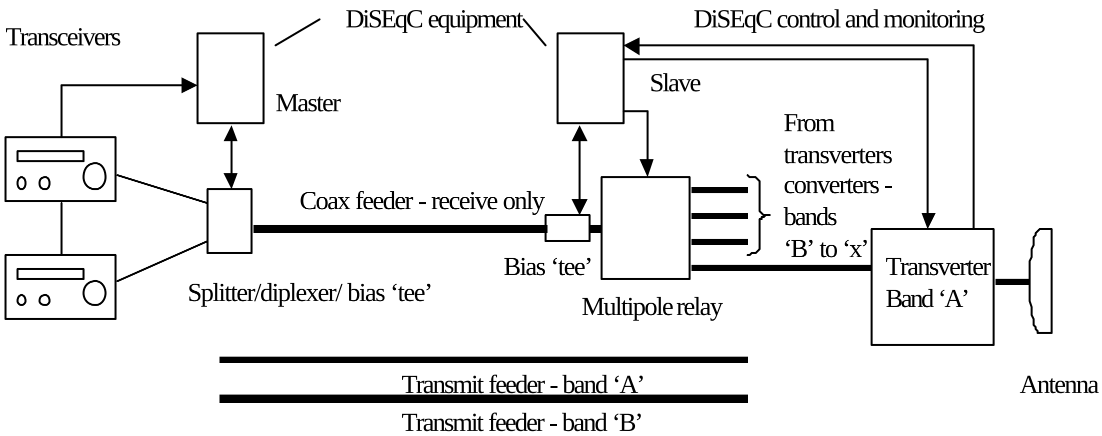


Fig 3 The use of DiSEqC™ to control a multi-pole relay that eliminates the use of separate receive feeders from the remote transverters. Separate transmit feeders are shown, but could also be eliminated in a similar way. It would be desirable to use separate power supply cables if high power amplifiers are to be mounted at masthead, to ease problems of power supply switching and incompatible supply voltage requirements.

Closedown

Manuals

I'm sure that this has been discussed before…
One thing I think would be a good idea is to maintain a database of operating and service manuals for both test equipment and radios which members have.

Whilst I know some would have reservations about loaning them out (*I suggest a refundable UKP20.00 deposit per manual – G0CZD*) and copying is either a chore or expensive, if at least it is possible to find the value of R31 or what the cal procedure is then it would be a great help.

If anyone has manuals they are willing to either copy, loan or make reference to (by phone or e-mail), then please let me know and I'll add a page to the web site and also make the list available on request.
Lehane, G8KMH

Feedback and Articles

Thanks to all the authors who have contributed to this issue. I still need more (articles and feedback) – now the evenings are drawing in and you are not operating /P every night, please consider producing something for Scatterpoint. Something simple, something complex – even something totally off the wall – it will be gratefully received.

The next issue is due at the end of December or early January depending on Christmas festivities and articles received – a reminder that (most) of your subscriptions will be due very shortly afterwards. Details to follow in Scatterpoint number 4.
Martyn, G0CZD