PRACTICAL WIRELESS

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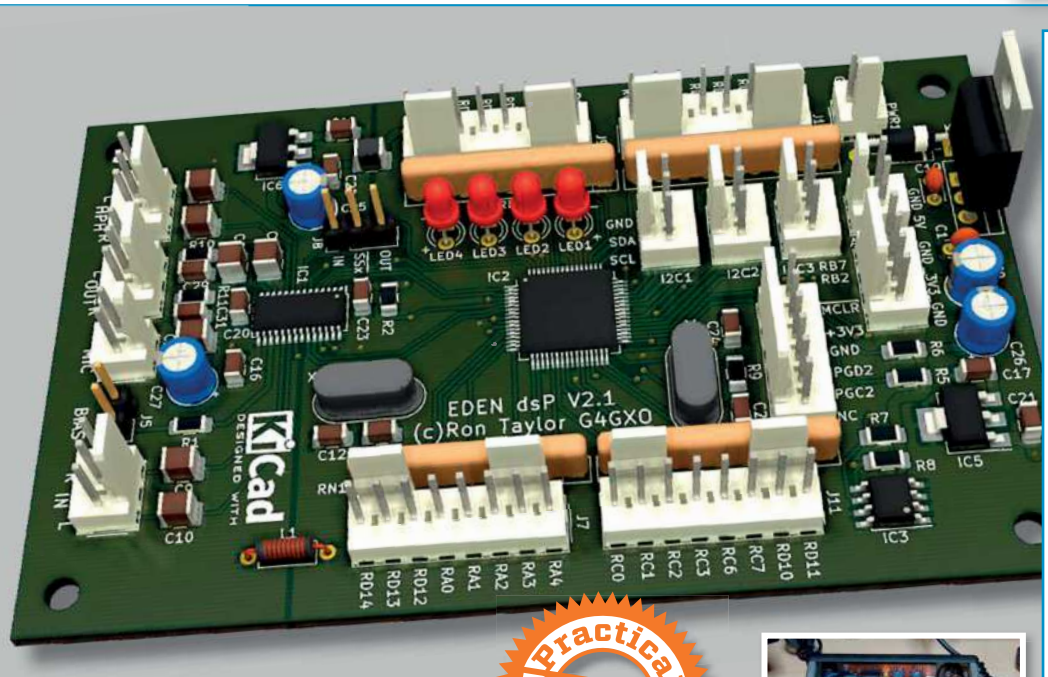


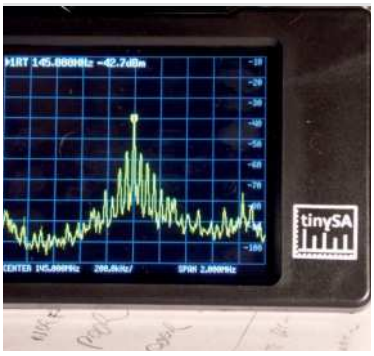
Practical Wireless REVIEW

EDEN PROJECTS

Using the versatile and compact Eden dsP processor in home builds

Meeting the Voice

The Face Behind the Call profiles Jim Lee G4AEH



Spectrum Analyser

We test the £50 TinySA to see if it's money well saved

PRACTICAL HF 9-Band Portable Antenna Project

Build a handy mobile antenna that covers nine HF bands from 80 to 10m

PRACTICAL Building an All-band HF Receiver Pt VII

This month we focus on the circuitry of our home build SDR-based receiver

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Contents

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We regret that due to Editorial timescales, replies to technical queries cannot be given over the telephone. Any technical queries are unlikely to receive immediate attention so, if you require help with problems relating to topics covered in PW, please either contact the author of the article directly or write or send an email to the Editor and we'll do our best to reply as soon as we can.

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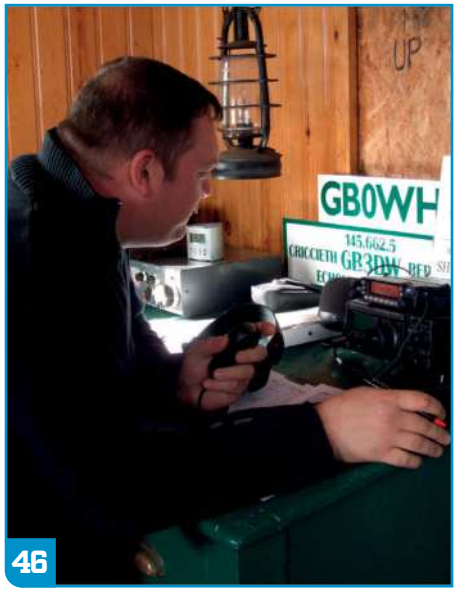
Keylines



Just one gathering for me this month (May), which was the CDXC (the UK DX Foundation) Convention in Loughborough. We had a great day with some fascinating talks, covering wire antennas, remote operation, an 8-circle receive array, using Smith charts and an insight into planning for the forthcoming Bouvet Island DXpedition. But, of course, the greatest aspect was actually meeting fellow amateur in person yet again – many of them I haven't seen since before COVID came along.

As for operating, my main focus this month has been on 6m and 4m, as the Sporadic E season gets under way. It makes a change from the winter when my focus is invariably on the low bands, especially 160m and 80m.

Valves

This month we feature a vintage valve transmitter and next month have a valve receiver, both as part of our 90th anniversary ramblings. I hope you enjoy them. Many of our readers grew up on valves and thought nothing of playing around with them. Nowadays, they are regarded by some as dangerous and to be avoided although I still rate valved linear amplifiers as generally being superior to solid-state ones. But I do find it amusing that my parents' portable radio used valves. I believe, from memory, that it was an Ever Ready model and used a dual-voltage battery, 1.5V (for heaters) and 69V (for HT). And one of my earliest electronic experiences was dismantling our old (single-channel, black & white, with cathode ray tube) TV for parts.

Your Reminiscences

On a visit to Malta a few years ago I went along to the radio club and was informed by the Chairman that several members owed their successful careers in electronics to a healthy diet of *PW* in their early days. And when giving a talk some time back to one UK club, I was confronted by not only a *PW* 'blueprint' from the 60s, but also the radio that had been assembled from it, which was still in good working order! As I say in this month's *'PW at 90'* feature, it would be great to have some similar reminiscences for publication in our 90th anniversary issue (October 2022 cover date), which means I'd love to have anything from you by early August as I will be preparing that issue in August (it will go out early September). It can be pretty much anything related to the magazine. I love to hear these stories of how *PW* has influenced earlier generations so do get in touch! The good news is that, unlike other radio magazines that have come and gone, we are still going strong thanks to you, our supportive readership.

What is a Communications Receiver?

Well, I haven't exactly been deluged with responses to my challenge last month, but my thanks to **Philip Moss M0PBM** for adding his personal take on what is meant by a communications receiver. You can find his explanation in this month's *Letters* pages.

This Month

We have another eclectic collection of articles this month, ranging from a 9-band HF wire antenna to one on antenna modelling at microwaves. And a look at the TinySA – these amazing pieces of test equipment just get smaller and cheaper!

And do check out the article on making your own PCBs – it's easier than you might think. The pity is that we generally need to order the boards from China or Hong Kong because UK suppliers require orders in their thousands rather than the penny numbers that we home constructors are interested in. The good news is that the boards come quickly and are of high quality – one friend of mine has been using them for quite complex double-sided boards using surface mount components and has been delighted with the results.

John Birkett SK

To finish, I was sorry, and I'm sure many *PW* readers will be too, to note the passing of **John Birkett** at the grand age of 93. He advertised in *PW for* many, many years. I wrote a short piece about his shop in the March 2020 issue of PW. Truly the end of an era.

Don Field G3XTT
Editor, *Practical Wireless* Magazine

BEAT THE PRICE RISE

Regrettably, to offset the increases in costs of energy, raw materials and postage charges the cover price of Practical Wireless has increased to £5.49; but you don't have to pay that!

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Newsdesk

Have you got something to tell our readers about? If so, then email **practicalwireless@warnersgroup.co.uk**

New from Nevada Radio

Nevada Radio have announced that they now have the new Tecsun DEGEN DAB119x portable radio in stock. This radio covers DAB+, FM stereo (with RDS display), Medium Wave and Shortwave and features Bluetooth 4.0 capability.

It will automatically tune and store stations into memory, has an alarm clock, date/time display and a built-in charging function. Shortwave coverage is from 2300kHz to 26100kHz with an extra-large LCD display to aid tuning and an external antenna input for DX reception. The Bluetooth 4.0 enables linking to other Bluetooth enabled devices for streaming music or other material through the radio. The radio can be charged from the included mains charger or through its USB socket. It will sell for £139.95 and is available from UK Distributors Nevada Radio:

www.nevadaradio.co.uk
www.hamradiostore.co.uk

Commonwealth Games Activities

The Commonwealth Games will be held in Birmingham later this summer. It will see around 4,500 athletes from 72 nations and territories, compete in 19 sports across 14 competition venues. The RSGB has published news of the various activities it is planning to link with the Games. You can get involved in one of the seven special event stations or gain one of two special operating awards. Find out more on the Society's website at:

www.rsgb.org/cwg

Icom Engineer Geoff Boakes G8PPQ Retires after 31 Years

Everyone at Icom UK was sad to see **Geoff Boakes G8PPQ** hang up his soldering iron and retire recently after 31 years of loyal service as one of their top Service Engineers. Geoff is now set for his well-earned retirement. He plans to keep himself busy with his hobby of making antennas and playing amateur radio.

Bob Stockley, Icom UK's Managing Director said, *"Having worked for us for so long we are incredibly sad to see him go, but not without our best wishes for the next stage of his life".*

The photo shows Geoff on the right.

Foundation Course

Leigh M5GWH is looking to run a Foundation course in North Staffordshire for those who don't wish to take the online route. No dates are yet set in stone but expect a start before the Summer with the course running from 10am to 1pm on Sundays. It will last for five or six weeks, including the exam. The course is open to everyone of all ages and the venue in Stoke on Trent is disabled friendly. Tuition is at a leisurely pace, suited to those who've not been in the classroom for a long time. The course costs £40, which includes revision materials, your RSGB exam fee and a contribution to the school radio club M0OHA plus refreshments. All you need to buy is the Foundation book. Contact Leigh who is listed on qrz.com or email:

dr55@rsgb.org.uk

Read more radio news and reviews at www.radioenthusiast.co.uk/news

G3BJ RECEIVES THE MICHAEL OWEN VK3KI AWARD AT THE CDXC CONVENTION 2022: In November, it was reported that the International Amateur Radio Union (IARU) had decided to give their highest award, the Michael Owen VK3KI award, to **Don Beattie G3BJ**, for 22 years of service to the work of the IARU. The award is not handed out every year, but only when the IARU's Administrative Council deem someone's voluntary work is worthy of this honour.

Michael Owen VK3KI was a former Vice-President of IARU, and a former President of the Wireless Institute of Australia. He worked tirelessly for the benefit of amateur radio services around the world and made many sacrifices at international level, even to the extent of taking a leave of absence from his position as a lawyer to move to Geneva with his family for two months in 1982 to attend the World Radio Conference for IARU.

Michael had an encyclopaedic knowledge of the international radio regulations and his skill in drafting amendments to those regulations on behalf of the amateur services was second to none. The award was established after his sudden death in 2012 to memorialise his commitment, and to recognise other people who have given their time and effort as a long-term volunteer.

When the IARU unanimously agreed that Don should receive this award, it was with instructions that the IARU President, **Tim Ellam VE6SH**, bestow it on him at a suitable venue. COVID restrictions made that a challenge, and the first opportunity for Tim to present the award in person was at the recent CDXC Convention in Loughborough.

In presenting the award, Tim said, *"Don has volunteered countless hours with IARU. He was Secretary of Region 1 twice (2002-2008), and President of Region 1 from 2014 to 2021. He has guided IARU Region 1 through a number of difficult issues. All told, Don spent 13 years on our Administrative Council and his contributions whilst on our board are too numerous to mention. I can tell you every person on the Council valued his work and commitment to the amateur services and he served as wise counsel to the IARU and to the officers in particular. I have indeed personally benefited from Don's insight and opinion on a number of matters".*

The photograph shows Don Beattie G3BJ receiving the award from IARU President, Tim Ellam VE6SH.

13 COLONIES SPECIAL EVENT 2022: G4EUZ Durham and District Amateur Radio Society (DADARS) is privileged to be participating as one of the bonus stations in the hugely popular 13 Colonies Special Event. The NoV special callsign GB13COL has been issued for this event and will run from the club station 1 July 1300UTC to 8 July 0400UTC. The primary focus of the event will be the HF bands, including VHF, UHF & Satellite for QSOs using SSB, CW, FM and various digital modes.

The 13 Colonies event began in 2009 as a way of celebrating American Independence with the original 13 colony States circa 1776. Since the UK was a major historical player in the Revolutionary War, GB13COL from England will present an added positive flair, historical significance and a challenge for radio amateurs to contact. During 2021, there were over 253,283 QSOs logged.

2022 QSL cards have been kindly sponsored by Canny Components. A warm thank you to **Amanda** & **Davey** for this.

Ken Villone KU2US (K2A operator) is the creator and manager of the event. Every year there is a different certificate theme for amateurs who make contact with either one or all participating stations, including the bonus stations. Ideally, amateurs taking part aim to get a 'clean sweep' of all 13 stations: K2A (NY), K2B (VA), K2C (RI), K2D (CT), K2E (DE), K2F (MD), K2G (GA), K2H (MA), K2I (NJ), K2J (NC), K2K (NH), K2L (SC), K2M (PA), plus WM3PEN, GB13COL & TM13COL operating as bonus stations. Contacts made will be endorsed on to the certificate along with your own personal callsign.

The theme for 2022 is the Revolutionary War. There is also an opportunity to exchange QSL cards with all 13 Colony State stations, plus the bonus stations. For further information regarding the 13 Colonies Special Event, please visit the website at:

www.13colonies.us

For UK QSL requests, please supply an sae to QTHR GB13COL. If you would like to visit the club or want further information on GB13COL, please contact **Ray G0VLF** on 07904196283 or email

g0vlf@yahoo.co.uk

2022 INDUCTEES TO THE CQ MAGAZINE HALLS OF FAME: The 2022 inductees to the CQ Contest Hall of Fame are:

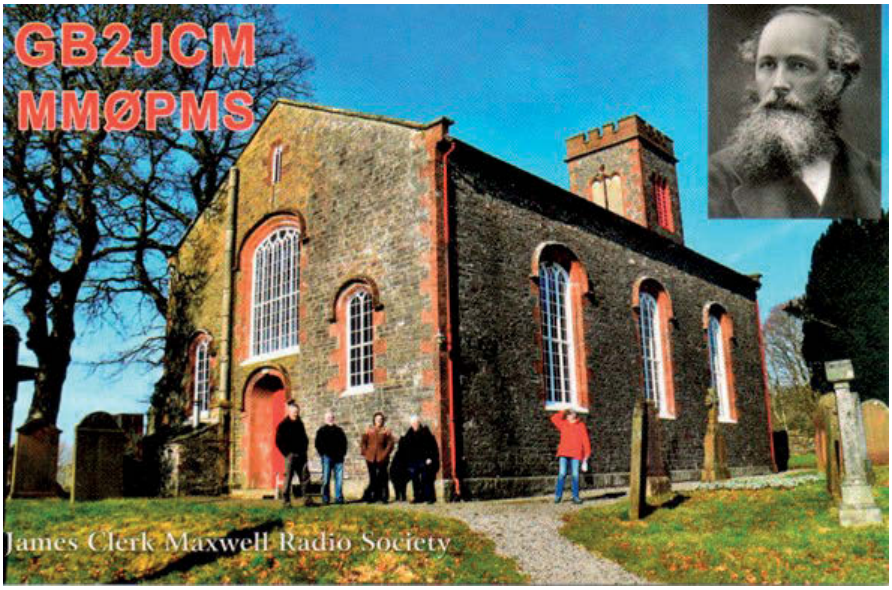
David Pascoe KM3T, a highly accomplished multi-op and single-op contester and, among other activities, is a volunteer pilot for two organisations that provide free medical-related air travel.

Craig Thompson K9CT, a world-class contester and promoter of youth in contesting. He is also involved in several amateur radio organisations, serving as treasurer of CWops, a board member of the Northern California DX Foundation (NCDXF), past president of the Society of Midwest Contesters and is currently chairman of the ARRL Contest Advisory Committee.

There will be no inductees to the CQ DX Hall of Fame for 2022, as the judging committee determined that none of the nominees met the high standard required for selection.

The 2022 inductees to the CQ Amateur Radio Hall of Fame are:

Franklin P. Antonio N6NKF (SK), co-founder of Qualcomm, whose chips underlie much of our modern technology. Antonio was also a philanthropist, donating $30 million to the University of California at San Diego as seed



money for a new engineering building.
Wolf Harranth OE1WHC/OE3WHC (SK), journalist and broadcaster on Radio Austria International; founder of Austria's radio documentary archive (DokuFunk), and 2017 recipient of the IARU Region 1 Roy Stevens memorial award for his work on DokuFunk.
Les Kramer WA3SGZ, inventor of lower-limb prosthetic devices used by some 3000 people worldwide, including two survivors of the Boston Marathon bombing; as well as multiple other inventions.
Roy Lewallan W7EL, author of the EZNEC antenna modelling software.
Peter Marks AB3XC, physician and head of the US Food and Drug Administration's 'Operation Warp Speed' program to combat COVID-19.
Bob Ringwald K6YBV (SK), well-known blind jazz musician in Sacramento; co-founder of the Sacramento Jazz Festival; known locally as 'the emperor of jazz' and, last but not least, father of actress and singer **Molly Ringwald**.
R. Scott Wright K0MD, physician and leader of Mayo Clinic team developing the use of Convalescent Plasma as one of the first treatments for Covid-19; DXer, contester, former editor of the *National Contest Journal*.

JAMES CLERK MAXWELL RADIO SOCIETY GB2JCM: Based in Southwest Scotland the society aims to honour the memory of **James Clerk Maxwell** by operating special event amateur radio stations on occasions relating to him.
This year they plan to organise special event stations at least twice, on the weekend of 11/12 June, to commemorate the anniversary of his birth on 13 June and in November, on a date to be confirmed, to commemorate the anniversary of his passing on 5 November.
They will operate from the Church at Parton in Dumfries & Galloway where Clerk Maxwell both worshipped and is buried.
As always, they are grateful to the congregation of Parton Parish Church for allowing access.
After two years of disruption due to COVID, they hope that this year, subject to any regulations in place at the time, the stations will be open to both amateurs and non-amateurs. Should you be interested in joining with the Society and taking part in any special event please come along on the day between 0900 and 1700. They can be contacted via QRZ.com (search for MM0PMS) or:
www.facebook.com/MM0PMS
Parton Kirk is on the left as you enter Parton from Castle Douglas on the A713 at DG7 3NE.

DISTANCE LEARNING FOR FULL LICENCE EXAM: Since 2011, the Bath Based Distance Learning team (BBDL) has helped over 900 students to obtain their Full Licence. Student feedback is always very positive and the pass rate continues to be well over 80%, compared with a national average of around 66%.
Having completed a second Intermediate Licence course in May, the team are now planning another Full Licence level course. The course will run from the end of August to December.
Students will receive weekly work packages via an online classroom and will have access to weekly online tutorials. Each student is allocated to one of the remote tutors who provide feedback and additional guidance. There are weekly quizzes to check on progress and at the end of the course there will be a number of mock exams.
There is no charge for the training but applicants must work through some pre-course material and complete a quiz to be eligible for a place. This focuses on the 'new' topics that were introduced to the Intermediate syllabus in 2019. The aim of the pre-course classroom is to make sure applicants can use the BBDL systems and to ensure that they are ready for the Full training.
Each student will need to provide their own RSGB Full Licence textbook and arrange their own exam at the end of the course. Advice will be provided as part of the course.
The deadline for course applications is Tuesday 26 July. To request full details and an application form, please e-mail BBDL Team Leader, **Steve G0FUW**, via
g0fuw@tiscali.co.uk

PW at 90 Years

As Practical Wireless approaches its 90th birthday, we take the opportunity to look back at its illustrious history, decade by decade.

Don Field G3XTT
practicalwireless@warnersgroup.co.uk

We're now into the 90s and through to the new millennium. September 1992 was an antenna special, with a review of the Nelson Electronics 21/28MHz cubical quad, Experimental 430MHz Wire Antennas, Experimenting with Beam Antennas in the Back Garden, a look at the MFJ-247 antenna analyser, a simple antenna tuning unit and RF bridge, a review of the Cushcraft R5 vertical antenna and an Antenna and Associated Equipment Showcase. There was also a reader offer to buy a portable mast and a competition to win a Kent Morse key.

Other articles included Getting Started the Practical Way by the late **George Dobbs G3RJV**, an Appreciation of **Fred Judd G2BCX**, Reflections by the late **Ron Ham**, Satellite Scene by the late **Pat Gowen G3IOR**, Mathematics for the RAE by **Ray Fautley G3ASG**, Back Scatter (HF Bands reports by the late **Paul Essery GW3KFE**, VHF reports by **David Butler G4ASR** and Broadcast Round-Up by **Peter Shore**) and Packet Panorama by **Roger Cooke G3LDI**. Yaesu were featuring the recently introduced FT-1000 by way of a full-page advertisement and Martin Lynch was celebrating two years trading under his own banner. And still lots of advertisers – I count 51 listed in the Index at the back of the magazine.

Diamond Jubilee

PW's Diamond Jubilee (60 years) was celebrated in the October 1992 issue, with congratulatory letters from the then RSGB President and from the Radiocommunications Agency, along with a number of reminiscences in response to an earlier editorial request for readers to send these along. They make fascinating reading. I'd welcome similar for our October issue this year, to be published in September, our 90th anniversary month.

There was a five-and-a-half-page article about *PW's* founder **FJ Camm**, again quite fascinating. **Bill James G6XM** wrote about his 60 years in the hobby, including some details of his early work on the 5m band, where he not only had to build the equipment but had to find the band itself using Lecher line techniques! **Richard Morris G2BZQ** was 13 years old when *PW* was first published in 1932, and wrote an article paying tribute to the many radio amateurs who contributed to the war effort during 1939-45. **Ray Herbert G2KU** looked back at the early years of TV, from the 30-line days onwards. The regular contributors were encouraged to look back too. And as something of an aside, I see that the full-page back cover advertisement was by Maplin for their latest catalogue. Now there's another company that has come and gone, unfortunately. Another new advertiser was Haydon Communications, set up by **Mike Haydon**, previously of Waters & Stanton.

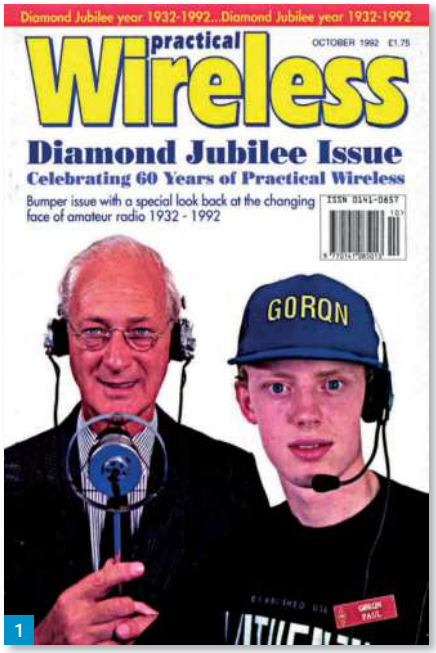


Fig. 1: PW's Diamond Jubilee issue, October 1992.

To 1997

By the middle of our decade, 1997, there was much more colour in the magazine, particularly the advertisements. The August 1997 issue featured a review of the Yaesu FT-920, quite a revolutionary transceiver at the time because it featured 50MHz operation in addition to HF. *PW* editor **Rob Mannion G3XFD** had been to the Dayton Hamvention along with *Short Wave Magazine* editor **Dick Ganderton G8VFH** and contributed a report on the event. Another review was of a VHF dual-bander from ADI Communications, the AT-600. I have to admit that I don't recall this company at all. But there was also a look at the Icom IC-706 Mk2, comparing it with its predecessor, the Mk1. Now there's a radio that I do remember. And I find **Ben Nock G4BXD** looking not only at his usual fare of ex-military gear but also at the Codar AT5, a set that I remember well as it was my first transmitter, while still at school. Oh, and I see **Mike Richards G4WNC** was already in harness, with a column called 'Bits & Bytes' looking at spectrum analysis and more. The monthly HF column at that time was in the hands of **Leighton Smart GW0LBI**.

The New Millennium

I thought it would be interesting to close this month by looking at the very first *PW* of the new Millennium – January 2000. Not that long ago, at least to my mind, although *PW* looks very different from how it is today. That said, colour has found its way onto most pages, not just advertisements. There is the offer of a *PW* Callbook CD, and discounts on a variety of 4m equipment (transceiver and antennas), along with a very generous competition prize from Nevada of a DX-70TH transceiver. SMC Communications were still going strong – I would have guessed they had ceased amateur radio trading before then (they are still around in the commercial world). Indeed, there were still lots of advertisements, with Haydon Communications taking three pages and Multicomm 2000, who I don't recall at all, were taking four pages. Waters & Stanton were still advertising in the their own right, with three pages at the front of the magazine. Colomor Electronics were selling army Bakelite and German Junker Morse keys, which presumably nowadays would be collectible and like hens' teeth to get hold of. WinRADiO were advertising what I guess would be the precursor to modern SDR radios.

The editor, (still Rob G3XFD, of course) mentioned that an increasing number of Letters were coming in over the internet, but the majority were still in paper form and reader advertisements took up two full pages. The internet, of course, has a lot to answer for – both commercial and private advertisements have very much found their way onto it, and the availability of much information has meant a loss of interest by many in buying books or monthly magazines. On the other hand, it means we can, for example, make *PW* available at reasonable cost internationally through electronic publishing, in an era when international postal rates have gone through the roof. And most of the material I receive nowadays comes in electronic form, with nothing on paper until my personal copy of the magazine drops through the door.

And, to finish, I was delighted to see a couple of well-drawn cartoons – maybe I should get our current art editor to pick up the baton on that one! **PW**

Charles Wilson M0CDD
practicalwireless@warnersgroup.co.uk

An HF 9-Band Portable Antenna

Charles Wilson M0CDD describes a handy portable antenna that covers nine HF bands, 80 through 10m, including 60m.

The inverted-V dipole antenna is a popular choice of antenna for portable use and appears in many guises, some of which allow up to five bands to be used.

Although the inverted-V is more convenient to erect than a conventional dipole when portable, the design and construction of the 9-band portable (/P) antenna described is really a compromise between portability and durability. It is also sensitive to the method of feed.

The Antenna Design

The 9-band portable antenna uses the design by **Jim Andera WB0KRX** known as the 8-band Backpacker Special [1]. It is based on inverted-V fan dipoles for 40m and 20m with extension wires for other bands. The lengths of the 40m and 20m dipoles are given in **Table 1.**

The dipole elements were made using seven-strand hook-up wire and cut to the appropriate lengths, then terminated together at the feedpoint, **Fig. 1**, and terminated with insulators on the low ends. As RF energy travels on the outside of the conductor, the thickness of the cable affects not merely the power handling but also its bandwidth.

Short tails were left at the insulators on the low ends and half an inch of insulation was stripped back and tinned. The insulators are not essential as nylon support twine is an excellent insulator.

The 40m antenna will work on 15m as a three half-waves antenna but due to the velocity factor of the antenna wire, the SWR will be high. Rather than use an ATU, a pair of extension leads 18in long – one for each dipole element – are added to the ends of the 40m antenna elements, which then makes a three half-waves antenna for 15m with a satisfactory SWR. The extra pairs of leads are added at ground level and the basic principle of the antenna can be seen. To use the other bands simply consult **Table 2** and add the appropriate length extension pair at ground level of course.

Creating the clip-on extension pairs is straightforward. Again, half an inch of insulation is removed and tinned at one end and a crocodile clip fitted at the other. It is important that the cable is securely fixed at the clip and strain relief given, otherwise the wires will fray and break. A small nylon tie that straps the cable to the body of the clip is ideal. It is advantageous to use different bright coloured wire for the extensions as this will help prevent mistakes when band changing and reduce the chance of extensions being left in the grass at the end of the day, **Fig. 2**.

In addition to the extensions cut from the dimensions of the chart, a pair 6in long for any fine tuning is valuable in case that becomes necessary from time to time, **Fig. 3**.

If it is intended to use 80m, then do bear in mind that the clip-on extensions are almost 33ft per side. Obviously, this will need to be taken into account when calculating the length of the support twine required if tying off to a stake, when configuring the antenna for other bands.

Once the antenna has been erected in the basic 40/20m fan-dipole configuration, carry out an SWR check on both bands. Using low power, sweep across each band from end to end observing the SWR. The dimensions given in Table 1 should give the lowest SWR in the CW portion of the band.

Then configure the antenna for any of the other bands of interest. Add the extensions as shown in Table 2 and again perform the SWR checks as above. The longer the overall dipole legs are, the lower the SWR in the CW portion of band, while reducing the overall length of the elements will give a low SWR in the SSB portion of the band. If it is necessary to increase the length, then the 6in extensions may be used or make the element lengths 6 inches longer and then fold back to suit.

Fig. 1: Dipole elements connected to the feedpoint balun.
Fig. 2: Colour coded extension pairs.
Fig. 3: Extension clipped to lower end of element complete with insulator
Fig. 4: 9m Larkspur mast with antenna attached ready to be extended.
Fig. 5: Replica WW2 spy set with companion amplifier and antenna.

If it is deemed necessary to reduce the length of the extensions, then quite simply twist the extensions back upon themselves. All that is required is to select the band to be used. For example, for 17m a pair of extension leads of 7ft 2in would be clipped to the ends of the 40m dipole and the extensions loosely wrapped around the support twine before proceeding to check the SWR. It should be noted that the 10 and 12m bands require two extensions in series per dipole leg.

From site to site, changes in SWR may also be encountered due to different ground conductivity and terrain.

In summary, the antenna works as a half-wave dipole on 80, 60, 40, 30 and 20, while operating as a three half-waves dipole on 17, 15, 12 and 10m.

Feed Considerations

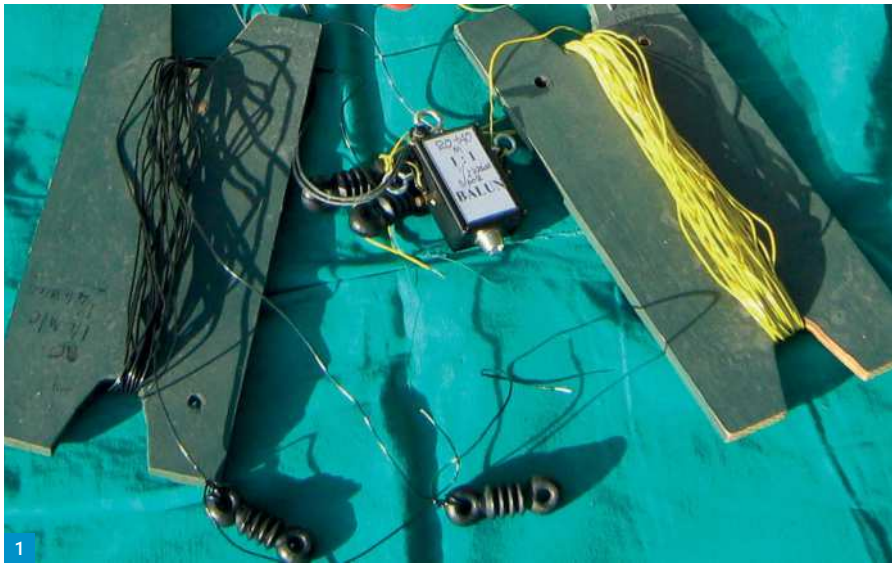
In the *RSGB Bulletin* of July 1966, **H D James G3HZP** wrote an authoritative and informative article concerning using a balun with an inverted-V antenna [2].

In the article he described the construction of a ferrite-core balun, which he then proceeded to evaluate in his inverted-V antennas over a period of four months. His description of his ferrite-core balun presents the reader with no surprises but the latter part of the article regarding evaluation of the balun in his inverted-V antennas does cause eyebrows to be raised.

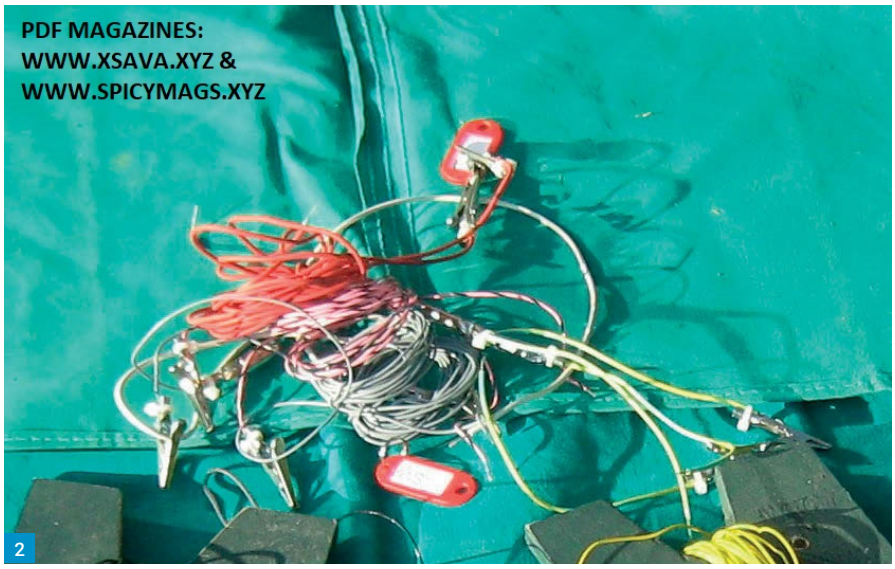
Prior to the construction of his balun, G3HZP used two inverted-V antennas, one on 40m and the other 80m. Performance of the two inverted-Vs was significantly inferior to a half-wave dipole at 50ft. Baluns were inserted into both of the inverted-Vs and subjected to the four-month evaluation. According to signal reports the gain increased by about 10dB, which is rather thought provoking. At the end of the article, G3HZP thanked eight stations for their help in evaluating the balun-fed antennas. The participants involved ranged from G to CN8, VE, VK and VP6! After reading the article several times, it was hard not to form the opinion that modern day antenna reviewers could take a leaf out of his book.

A good quality balun (see photo, Fig. 1, again) was obtained, which had an unexpected benefit in that all the connections are made by screw terminals, which will make any repairs in the field so much easier. Dark mutterings have been heard to claim that some modern transceivers with a built-in ATU behave so much better when working into a balun. Obviously I cannot prove, or, disprove such comments.

The balun was fed with good quality coax.



1



2


3

The Support Mast

To support my inverted-V, an ex-military 9m Larkspur mast was chosen, **Fig. 4**. Normally I would not consider using a metal mast but the Larkspur mast has an enormous glazed pot insulator at its base to keep it off the ground. I

Band	Each element length
40m	32 ft 9 ins (10.897m)
20m	17 ft 2 ins (6.147m)

Table 1: Lengths of 40 and 20m elements in WB0KRX design.

Band	Basic antenna	Extension
80m	40m	32ft 11in (10.03m)
60m	40m	9ft (2.743m)*

**A good starting point that can be shortened if required.*

40m	40m	None
30m	20m	7ft 2in (2.814m)
20m	20m	None
17m	40m	7ft 2in (2.814m)
15m	40m	1ft 6in (0.457m)
12	20	7ft 2in (2.814m) & 4ft
9in*	10	20**

**(1.448m). **Start with 7ft 2in (2.814m) and only add the 1ft 6in (0.457m) if necessary. If higher frequencies within the 10m band are to be used, shorten the extensions to suit.*

Note: The dimensions in the table will give a good match in the CW portion of the bands with the exception of 60m that may require the extensions to be shortened

Table 2: Extensions to element lengths to add further bands.

would have sought expert advice if the use of a carbon fibre mast had been contemplated, see [3]. So, backpackers may have to give consideration to much lighter components.

The Larkspur mast is superbly engineered but has a well-deserved reputation for trapping fingers if locking-rings are not fully tightened. Its reputation is fully deserved and the Lincolnshire Fens have resonated with my screams of anguish, closely followed by Anglo-Saxon invective on more than one occasion. Wishing to keep use of my fingers for the foreseeable future, I realised I needed a /P antenna that could be left erected with the band changing performed at ground level for all nine bands.

Although the mast would extend to 9m it was only ever extended to about 6m (20ft or so) in order to enable band changing at ground level. In future use and testing, short fibreglass poles may be used to elevate the ends of the extensions for both 80 and 60m, along with extending the mast.

The Portable Equipment Used

It was anticipated that the antenna would support 25W of RF and the transceiver would be powered by a discarded car battery. 25W is just one 'S' point down on 100W but consumes only 5 to 7A of battery power. Any signal disadvantage may be compensated by the judicious use of adjustable speech processing. The speech processing adjustability is desirable to avoid wasting battery power that could otherwise be saved.

4

The equipment to be used for my /P operation comprises an SSB/CW capable replica WW2 spy set and companion amplifier, **Fig. 5**. Both are solid-state despite appearances.

The transceiver was built over 25 years ago and was used to put out my very first CQ at Poldhu Cove with a W3EDP antenna supported by a kite. Since then it has had very little use, a situation I wish to rectify this summer. The back-up transceiver is an ex-military Clansman PRC-320, which will be used on bands not available to the spy set.

Conclusion

This inexpensive project presented me with no challenges either in the building or initial deployment. Though I did note there were small variations in SWR even when using the same site numerous times while testing, probably due to the portable antenna not being that high and the ends close to the ground, but it works!

Good luck with your /P work this year! **PW**

5

References

[1] *8-band Backpacker Special*, *QST* June 1996. Jim Andera WB0KRX.
[2] *The G3HZP Balun*, *RSGB Bulletin* July 1966. P D James G3HZP.
[3] Sotabeams at:
https://tinyurl.com/2p9656hd

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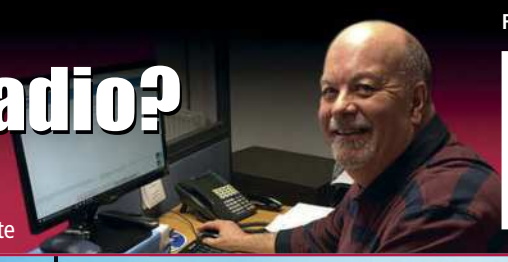

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The Eden dsP Card

Ron Taylor G4GXO describes a versatile and compact 16bit DSP processor for radio projects.

This project started as a New Year's resolution a little over ten years ago. I was developing an increasing feeling of guilt at not having delved into Digital Signal Processing (DSP) and having drawn a blank in my search for an affordable development kit to use as a learning tool, I decided to design my own. From the outset I chose the Microchip [1] series of 16-bit processors as they were available, well documented and supported by some excellent free tools, including an assembler and C compiler. (And in case you're wondering, yes that's where the 'dsP' in the board name came from). Within a few weeks I had the prototype built and running with a dsPIC33F processor at a leisurely 40MIPS (40 million Instructions per second). This original unit was used for the audio filter demonstration during my 2012 G-QRP Rishworth DSP lecture.

Since then, things have moved on considerably and the board described here uses a faster dual-core processor (effectively two similar processors in the same package) offering greatly enhanced performance over its predecessors.

So, what can you do with one of these? Well, aside from using it to learn about DSP techniques (which are more familiar to analogue electronics than you might expect), I use mine in a direct conversion HF transceiver, audio filters, denoisers, tone generators, VFO controllers etc, etc. It's not compulsory to use the Eden dsP purely for DSP projects, they also make really good general-purpose controllers for embedded projects, but it's the audio capability that makes it so versatile.

What's on the Board?

A block diagram of the Eden dsP card is shown in **Fig. 2**. The two main components are the 64-pin dsPIC33C processor and the Texas TLV320AIC23B CODEC (Coder/Decoder). The processor handles all the numerical and logic tasks whereas the CODEC serves as the interface between the analogue and digital worlds converting analogue input signals to numerical values representing amplitude, and in the other direction converting numerical values back into analogue signals.

Capable of sampling audio at a rate of up to 96k samples per second at up to 24 bits resolution, the CODEC has a stereo line input that will accept up to 1V RMS, a stereo line output with up to 1V RMS, a stereo headphone driver output with variable gain and a mono microphone input with optional bias supply for electret microphones. The Texas CODEC has been around for many years now but despite its longevity it remains in production and provides excellent performance.

The processor is available in several versions, which include single-core 'dsPIC33CK' devices but as you have the option of operating a dual core as a single core device, for maximum flexibility it's probably best to build the board as a dual-core unit using one of the 'dsPIC33CH' processors. Each core has a 'DSP Engine', a set of hardware and instructions designed for DSP operations such as an addressing scheme to implement circular buffers and multiply and accumulate (MAC) instructions. These features make it easier to implement filters and other DSP constructs.

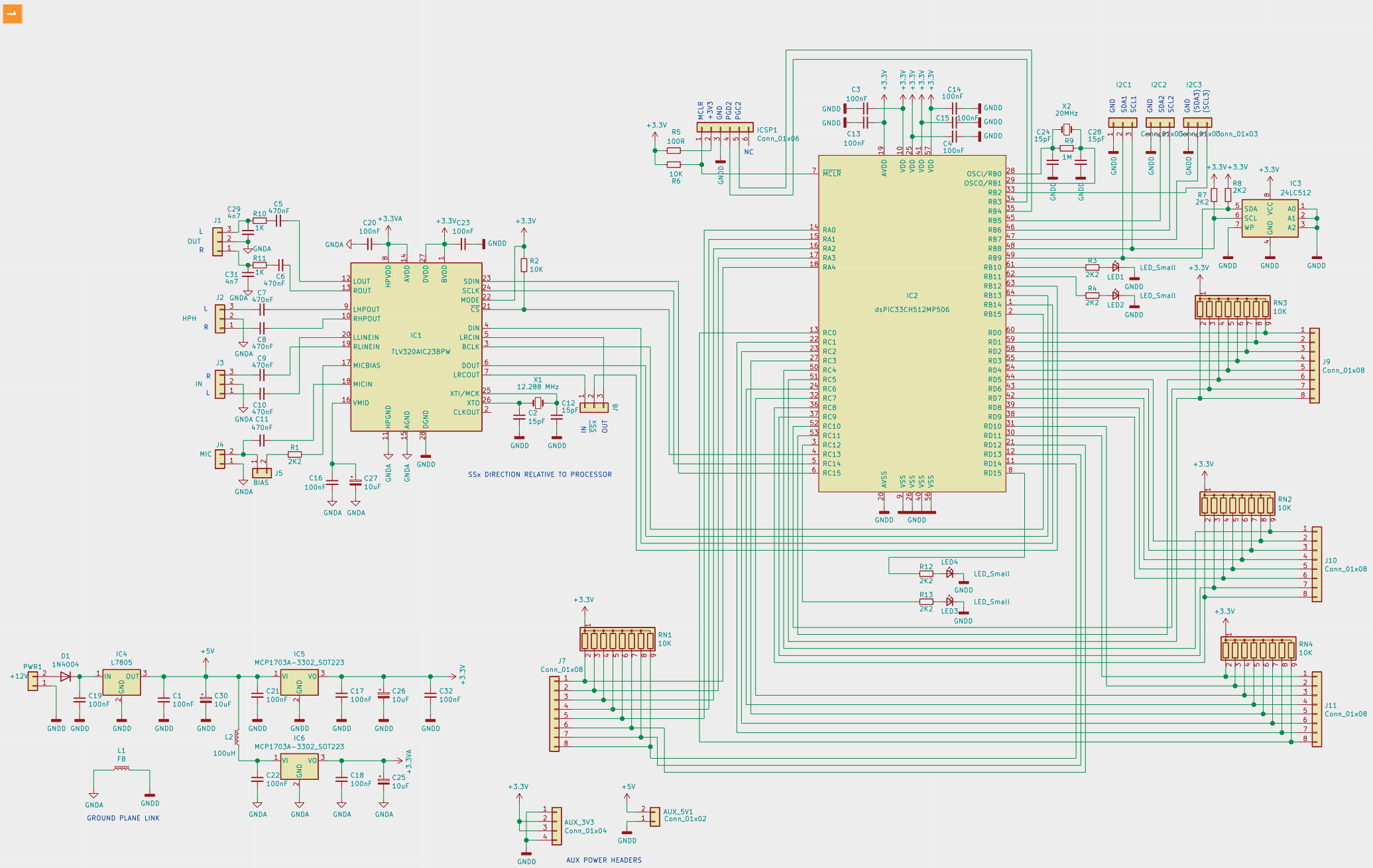
Also on the board are voltage regulators to generate the supply rails, four LEDs to show processor state, an I2C EEPROM for data storage, I2C interfaces and analogue and digital headers galore to provide connectivity to your project. The LEDs may be assigned to either core. On my projects I prefer to use two for the Main and two for the Secondary with colours green and red to signal operating state.

The board runs from a nominal +12V and with a suitable main regulator heatsink could be powered at up to +35V, although I haven't dared try this yet!

24 of the processor package's I/O pins are brought out onto headers along with three I2C ports. This provides plenty of scope for interfacing to controls, displays, etc. Pins may be assigned to either processor core using the Peripheral Pin Select (PPS) feature. Provision has been made for optional SIL (Single In Line) pull-up resistors to be added to provide a 'strong' pull up condition for control inputs.

In common with all PIC and dsPIC processors, there is a rich suite of peripheral modules, including timers, analogue-to-digital converters (ADC), pulse width modulation generators (PWM), serial interfaces (UART) etc. Refer to the datasheets for a full description [1].

The Eden dsP schematic is shown in **Fig. 1**. The board layout files are deliberately not pre-


IC1
TLV320AIC23BPW
IC2
dsPIC33CH512MP506
SSx DIRECTION RELATIVE TO PROCESSOR
GROUND PLANE LINK
AUX POWER HEADERS
ICSP1
Conn_01x06
X1
12.288 MHz
X2
20MHz
IC3
24LC512
IC4
L7805
IC5
MCP1703A-3302_SOT223
IC6
MCP1703A-3302_SOT223
D1
1N4004
LED_Small
RN1
RN2
RN3
RN4
10K
J7
J9
J10
J11
Conn_01x08
AUX_3V3
Conn_01x04
AUX_5V1
Conn_01x02
I2C1
I2C2
I2C3

Soldering SMD Parts

The following tools are essential:

- An illuminated bench magnifier for assembly and a jeweller's loupe for inspection (Better still, a binocular 'dissecting' microscope at around x10 magnification – the luxury alternative!).
- A low wattage (25W-60W) fine tipped soldering iron or ideally a low-cost rework station with variable temperature iron and hot air gun.
- Stainless steel tweezers for holding parts.
- Flux pen.
- Solder wick.
- Fine, rosin cored solder.
- Useful but not essential, solder paste, which can be used for hot air re-flow soldering.

Soldering ICs

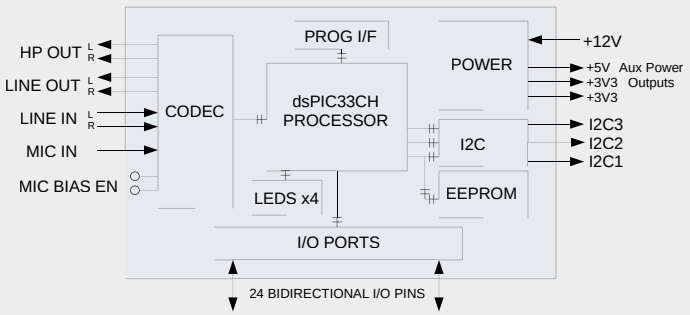
1. Place the IC onto the board, checking orientation and pin alignment with pads.
2. Hold the IC in place, apply a spot of flux to the pins on one corner. Load the soldering tip with a small amount of solder and tack a corner pin to its pad to hold the IC in place.
3. Check that all pins remain in alignment and adjust if necessary.
4. Tack the opposite corner of the device to prevent the IC from moving and recheck pin alignment.
5. Run solder flux along one row of pins and solder the tips of the pins from the free corner towards the tacked end. Do not attempt to avoid or be concerned by solder bridges between pins.
6. With all pins soldered, apply solder flux along one row of pins. Place the solder wick onto the pins and heat it with the iron to draw the excess solder from the pins beneath. Repeat along all rows until the device pins are clear of excess solder and show good joints to the pads.
7. If bridges form behind the pins and cannot be removed with solder wick, strip the enamel off the end of a piece of thin copper wire, flux the end and pass behind the row of pins to the bridge. Apply heat from the iron to the device pins. The solder will melt and tin the end of the wire. Remove while still hot to prevent it from bonding.

Passive Parts

1. Preload the iron with a small amount of solder.
2. Using tweezers or some form of probe, press down on the part to hold it in place over its pads.
3. Apply a dab of flux to one end and solder the end. The part will now be held to the board, check alignment and if necessary, correct.
4. Clean the iron, and bring iron and solder to the other end of the part to solder it to the pad.
5. IMPORTANT Return to the first joint and re-solder using either solder and the iron or by re-fluxing and reheating. If there is too much solder on the part, remove it with solder wick.

Hot Air Soldering

If you have a rework station it's also possible to re-flow solder parts with hot air by first applying a small amount of solder paste to each pad, placing the part onto the pasted pads and then heating gently in a slow airflow until the paste melts and fuses with the part and pads. As the paste melts the part will align with the pads under surface tension. In this way several parts may be soldered at the same time and with practice this becomes a quick way to populate sections of a PCB with passive parts.



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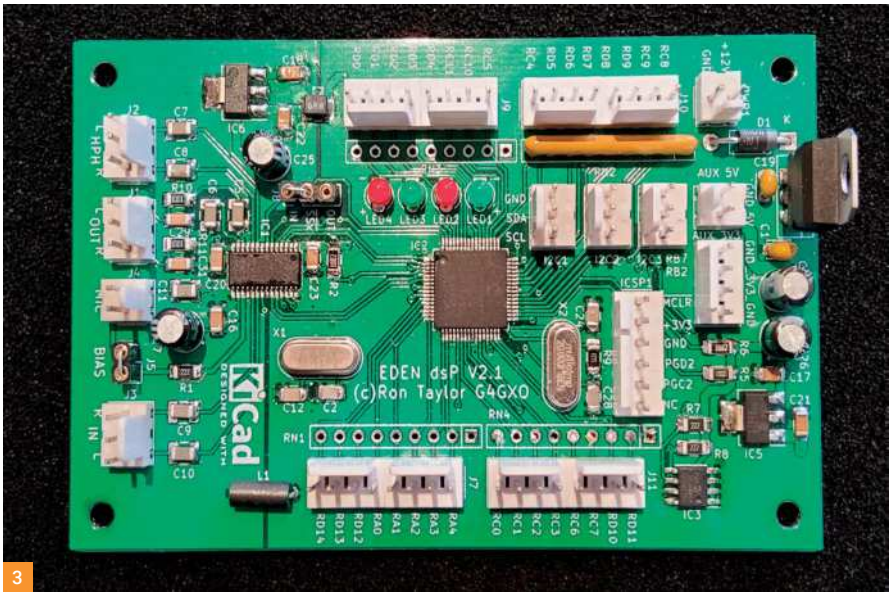


3

sented here as it would not be possible to make a PCB from them. However, the Gerber files are available online (see later).

Two in One

The dual-core processor deserves further mention. If you're struggling to understand what a 'core' is, just view it as a single microprocessor. The dual cores within the dsPIC33CH are just that, two near identical processors within the same package, joined by a high-speed serial communications bus to allow them to share data. The cores are referred to as Main and Secondary with the Main core handling processor start up and initialisation. (**Note**: In line with modern sensitivities, Microchip is in the process of updating its documentation and software tools to reflect the move away from the use of 'Master' and 'Slave' to 'Main' and 'Secondary' cores, so be aware that mixed terminology will be around until they complete this).

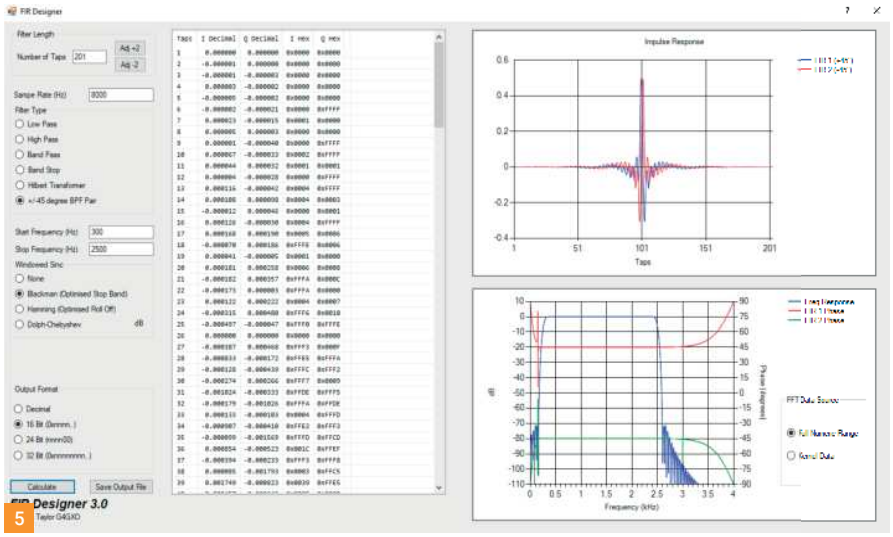
The Main core operates at 90MIPS and the Secondary at 100MIPS – one instruction every 10nsec. In my projects I use the faster Secondary core to run all of the time critical signal processing functions, which for speed are written in assembler. The Secondary core communicates and controls the CODEC but has little or no other connections to the outside world other than its status LEDs. All of the control functions such as rotary encoders, buttons, displays and synthesiser tuning are assigned to the slightly slower Main core. The code to do all this is not as time critical as the signal processing functions so for convenience is written in a very common high-level language called 'C'.

Building the Eden dsP

To aid construction, larger format Surface Mount Device (SMD) parts are used. For passive components such as resistors and capacitors, these are 1206 and 1210 size. Active parts are SOT-223 for the regulators, 1.27m pin spacing SOIC-8 for the EEPROM, 0.65mm pin spacing TSSOP-28 for the CODEC and 0.5mm pin spacing TQFP-64 for the processor. A photograph of the assembled PCB is shown in **Fig. 3**.

Even with these larger pin spacing parts, assembling a small board like this can be very daunting. But don't worry, with some common sense, a little preparation and care it's surprisingly straightforward. I've summarised the approach

4



5

I use in the Soldering Techniques panel, which may be useful not just for this article but also for other SMD based projects.

The recommended order of assembly starts with soldering the processor, CODEC and EEPROM followed by the SMD regulators, then working outwards with the passive SMD parts. After meticulous inspection and testing for solder bridges, higher physical profile parts such as the +5V regulator, electrolytics and LEDs can be installed.

Only the power and programming headers should be fitted next to allow programming and testing. Leaving the other connectors off the PCB keeps access to the processor and CODEC relatively clear should it be necessary to return to these with a soldering iron to resolve any undiscovered soldering faults. Finally, with the board functioning the remaining headers may be soldered in place and you're ready to go!

Testing and Using the Eden dsP

The board is programmed using the Microchip 'Integrated Development Environment' (IDE) and a suitable programmer such as the PICkit 3 or one of the lower cost clones. The IDE is free to download from the Microchip website [2] and runs under Windows, Linux and MacOS. It's a powerful tool, which along with the free XC16 compiler supports programming and debugging in assembler and C. The Eden DSP Groups.io site [2] carries many programs that can be used direct or adapted to run on the board. Downloading and using one of these is a good starting point for getting to grips with programming and using the board.

For a newly-built board, a simple test program is available on the EdenDSP site, which when loaded, signals operation of both cores by flashing the LEDs.

Several projects are available on the EdenDSP Groups.io site, one of which is the 'EdenSDR'. This configures the board for use with the SoftRock Ensemble, the RSHFIQ or the Veteran SDR to produce a self-contained SDR HF transceiver. My 10W SoftRock/Eden dsP rig is shown in **Fig. 4** and is great fun to use. Distant stations are often surprised to hear that not only is the transceiver homebrew but so is the software!

Adding extra features such as additional filters or even a new mode rarely involves a soldering iron. All of the changes are made in software. I recently added AM and had great fun one evening on 80m having a QSO with a station who was using a WW2 19 Set.

Adapting the EdenSDR software for use with other similar direct conversion radios is straightforward for anyone with some experience of programming the dsdPIC33 in C and assembler.

Audio Filter Design

A brief mention should be made about designing and implementing audio filters on the Eden dsP. One of the most common DSP components is the Finite Impulse Response (FIR) filter. This filtering workhorse produces predictable, stable results with no surprises and is capable of levels of performance that are simply not achievable with analogue electronics. The FIR filter is not only the foundation of DSP filtering but also phase shifting, an essential function in DSP SSB transceivers.

The code behind an FIR filter is surprisingly simple, running to about a dozen lines of assembler instructions, involving multiply and add operations of signal data held in a delay line. This simple block of code is common to all filters but the filter it produces is defined by a separate data table called the 'filter kernel'. This is a set of constants that are used to multiply the delay line signal data to produce the required filtered output. Generating a filter kernel is a fairly intense mathematical task. While it is possible to do this using spreadsheets or even (for the very brave) just a pen and paper, this is not an area for those without an understanding of the supporting mathematics.

To make things easier, much much easier, I have written a Windows program called 'FIR Designer', **Fig. 5**, which is available as a free download on the EdenDSP site. By selecting a filter type and entering parameters such as start and stop frequencies, sampling rate etc, FIR Designer produces an on-screen plot of frequency and phase performance along with kernel values, which may be exported in several formats as data files to be included in your project.

For a deeper insight into the workings of DSP and C programming, two excellent books, one of which can be browsed on-line for free, have proved very useful during my journey into DSP and are listed in [3] and [4].

Fig. 1: Eden dsP schematic.
Fig. 2: Block diagram of the Eden dsP card.
Fig. 3: The assembled PCB.
Fig. 4: The author's SoftRock/Eden dsP rig.
Fig. 5: FIR Designer.

Where do I get One?

The Eden dsP board is not available ready built or as a kit (as far as I am aware!). The design files and software projects are available for download on the EdenDSP Groups.io site [2]. Send the Gerber board files off to your PCB fabricator of choice and within a week or two you will be in possession of some nice PCBs ready to be assembled. I recently have been using JLC PCB in Hong Kong with excellent results. I have no affiliation with this business other than being a satisfied customer. **PW**

References

[1] www.microchip.com
[2] https://groups.io/g/EdenDSP
[3] *Digital Signal Processing, A Practical Guide for Scientists and Engineers*. Steven W Smith. ISBN 0-7506-7444-X Also available as a free document online.
[4] *The C programming Language*. Kernighan and Ritchie. ISBN 0-13-110362-8

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1

The Face Behind the Call

Roger Dowling G3NKH meets broadcaster Jim Lee G4AEH.

If you ever find yourself working G4AEH on phone for the first time and think the voice sounds familiar, there's a good reason. Its owner is Nuneaton-born **Jim Lee**, **Fig. 1**, who regularly modulates the BBC's transmitters as a freelance continuity announcer and newsreader on BBC Radio 4 and the BBC World Service.

Licensed since the age of 17, Jim told me that he has his mum to thank for his introduction to amateur radio. *"As a teenager, I was a keen listener to pirate stations like Radio Caroline and my mum got fed up with my monopolising the family radio,"* Jim recalls. *"So, one day she came back from a church jumble sale and presented me with an enormous old valve radio."*

Jim soon noticed to his delight that the radio had a short-wave band and, tiring of pirate radio one day, he found himself tuning around the 40m amateur band and being surprised to hear a radio amateur coming through loud and clear. Further experimenting led him to the 20m amateur band, and this time he heard a near-neighbour **Graham Clarke G3YTW**, a newly-licensed station who was tentatively trying out his new KW2000A transceiver. This was long before the age of emails, so Jim wrote him a letter, launching a friendship that has lasted to the present day.

"Graham made me very welcome and invited me round to his shack," said Jim. *"I was very impressed on one occasion when he worked **King Hussein of Jordan JY1** and the King actually said Hello, Jim!"*

Graham continued to help Jim by easing him through his Radio Amateur Examination, sending him slow Morse on Top Band and even accompanying him to the Humberside coastal station to take his Morse test. Graham also gave him a Codar AT5 to get him started on Top Band and 80m.

Getting Started

Jim's full licence arrived in April 1971 and even now he has vivid memories of his first QSO. Clearing his throat, he put out a tentative call on Top Band, only to receive an immediate response: *"You are interfering with military communications. You must close down at once!"* Somewhat shaken, he realised after a few moments that it was a local amateur radio leg-pull. Or was it?

Meanwhile, Jim was under pressure from his school to give some thought to his future career. In truth, his big ambition by now was to become a radio DJ, following in the footsteps of his pirate heroes. Realising that this would receive little encouragement from the careers master Jim appeased him by offering to move into banking. Two years with a local branch *("I hated every minute!")* led to a Business Studies course at Liverpool Polytechnic – and a stroke of good fortune that was ultimately to lead to a complete change of employment. As it happened, the commercial radio station Radio City had just started in Liverpool and Jim took the opportunity to make himself known there by writing a dissertation on the station's launch. Then, a pharmacist friend at Coventry Hospital, **Mike Riley G4CSZ**, tipped Jim off that his office was only a few doors away from Coventry Hospital Radio – perhaps this might be of interest?

Indeed it was, and it led to him helping out there as an engineer. But more good luck was to follow. *"A chap called **Gary** invited me to choose the records for his show one day, but never turned up. So, I had to do the show myself. I was on the air at last."* (By coincidence, Gary later became F5VLO and Jim recently had the pleasure of working him at his Brittany QTH).

Mercia Sound, the Coventry commercial radio station, started up in 1980 and Jim voiced commercials for them for a period. This led to nine years with them, presenting programmes in all time slots. Then followed a move to the BBC as a senior producer at its new Coventry local radio station BBC CWR ('Coventry & Warwickshire Radio') that launched in 1990. Sadly, the station folded after five years, having found it hard going as its commercial competitor Mercia had built up such a large audience by that time. (Ironically, the BBC admitted it had made a mistake in closing CWR and the station is now successfully back in operation).

After a spell at BBC Pebble Mill in Birmingham, Jim – by now a freelancer – was tipped off that the BBC in London were seeking new regional voices for their team of continuity announcers. For many years, the image of BBC announcing had been one of 'received pronunciation'. In the very early days at Savoy Hill announcers were even required to wear dinner jackets before gravely addressing the nation. Although this soon became a thing of the past, a 'bath' was still a 'barth', and 'grass' was decidedly 'graass'. In its wisdom, the BBC decided in the 1990s that its presentational style should better reflect the whole nation and, as the owner of a distinctively regional voice, Jim launched his new career as an announcer on Radio 4 and the BBC World Service, **Fig. 2**.

Jim kept his amateur radio licence going throughout this period of change, though his broadcasting commitments meant that were inevitably fewer opportunities to frequent the amateur radio waves. But in recent years the balance has changed and Jim is once again a regular presence on the amateur radio bands. He now has an enviable range of transceivers (*"More than I can possibly use!"* he admits). An Icom enthusiast, the main rigs at his Nuneaton QTH are an IC-7610 and an IC-7300, the latter being acquired mainly for its 4m capability. Other rigs include an IC-706 for VHF and a Yaesu FT-897. His antennas are a Butternut vertical and a dipole. Jim also has an Anytone AT-D578, which he purchased to try out DMR, but he confesses that he's still a listener at the moment.

Fig. 1: Jim at his home QTH.
Fig. 2: The Radio 4 news studio in Broadcasting House. Fig. 3: G8BBC in 'Arthur Askey's flat' at the BBC. Fig. 4: Jim receives a TS-590SG from Kenwood sales manager Mark Haynes M0DXR.

Jim also operates occasionally as GI4AEH using an Icom IC-756 Pro3 at his second home in Belfast, which he shares with partner and popular presenter of Gardeners' Question Time **Kathy Clugson**.

Jim's favourite band these days is 40m. He would love to get back on Top Band on AM where it all started, but laments the high noise level that makes it virtually impossible these days. *"But AM is still around, if you're lucky enough to hear it"*, said Jim. *"Recently I was amazed to work **Marcelino CT1EHI** in Faro, Portugal on 20m – my first AM QSO in years!"*

G8BBC

Jim's announcing shifts at the BBC involve regular trips to London, so in addition to his normal call G4AEH, Jim can now regularly be heard operating from Broadcasting House as G8BBC, **Fig. 3**. This all came about because a few years ago Ofcom served notice that it intended to revoke the callsign, which had fallen into disuse. Jim joined forces with BBC colleague **Jonathan Kempster M5AEO** to set up a new London BBC Radio Group of engineers, journalists, producers and on-air talent in both TV and Radio. For a shack, they were lucky enough to persuade the BBC to make available the small room on the eighth floor of Broadcasting House once known jokingly as 'Arthur Askey's flat'. Kenwood kindly donated a TS-590S, **Fig. 4**, and with a Yaesu FT-920 (currently set up for FT8 operation), an HF Windom and a VHF vertical, the station was on the air. It was formally opened by the then BBC Director-General **Lord Tony Hall** in October 2017.

100 Years of the BBC

The centenary of the BBC is being celebrated throughout 2022, and the London BBC Radio Group (now renamed the BBC Radio Group to reflect its expanded membership around the UK) were quick to recognise that amateur radio activity would be an ideal way of spreading the message around the world. After discussions with the ever-helpful Ofcom led by **Steve Richards G4HPE**, the BBC Radio Group was granted an extended special event radio licence GB100BBC to operate throughout 2022.

Jim was delighted to be invited to launch GB100BBC from the Broadcasting House G8BBC shack at exactly midday on 1 January and within minutes stations all over the world were clamouring to contact the special station and secure their place in the GB100BBC log.

*"I was joined by **Gareth Mitchell M7GJM**, who works in the BBC World Service,"* said Jim. *"We had some tremendous pile-ups – I think callers were quite surprised to find they were talking to one guy who read the BBC news and another who presented BBC science programmes!"*

2

3

Looking Back

Jim has notched up many years behind the microphone as a licensed amateur and as a broadcaster. I asked him what had been the highlights.

"One was a memorable occasion back in the late 1970s," said Jim. *"As part of a Raynet activity we provided radio escorts over several weeks for St John Ambulance and the Red Cross, who had stepped in when the West Midlands Health Authority suspended its ambulance service."*

Away from amateur radio and back in his days at BBC CWR as presenter of the Drivetime show, Jim remembers relaying – live – the whole of astronaut **Helen Sharman's** question and answer sessions with Harrogate College from the Mir space station. *"Obviously we couldn't hear the Harrogate end so I had to fill in the silent bits, which was quite a challenge!"* recalled Jim.

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But in many ways, Jim is finding the current sessions operating GB100BBC are proving the most rewarding of all. *"I have been amazed at the number of stations all over the world who have been so keen have a QSO with someone from the BBC,"* he said. *"Like other present and former BBC staff members, I've commonly been spending over four hours at a time working the pile-ups on the various bands. Such is the interest from the amateur radio community in getting through to GB100BBC."* **PW**

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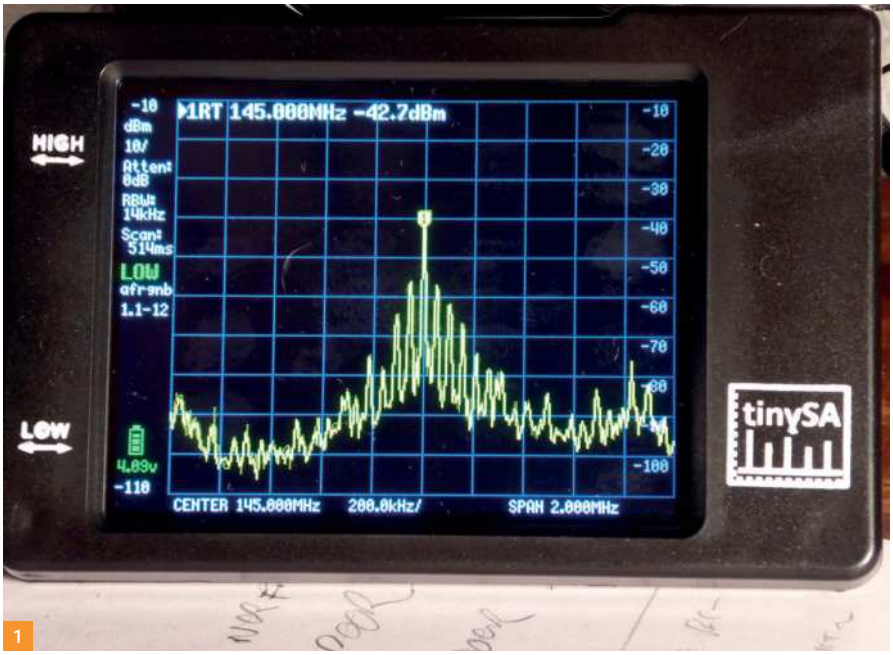


1

TinySA – a Spectrum Analyser for £50!

Michael Jones GW7BBY Gets up close and personal with a tinySA analyser.

One piece of equipment coveted by radio amateurs is the Spectrum Analyser. Until recently these would be laboratory grade instruments which would set you back £1000s. You would have needed deep pockets even for a second-hand one. I have had long term plans to build one, but other more pressing projects have kept it on the back burner. However, prices of small spectrum analysers on eBay, among other sites, are falling, RF explorer has been around for a while now, but at £200+ it is still out of my price range. Others take the form of an add-on for a PC and are not unreasonably priced (£60 to £80), but the lowest frequency of operation is about 35MHz, which is no use for HF measurements. Relatively new on the market is tinySA, **Fig. 1**. This is a palm sized, 100kHz – 900MHz spectrum analyser costing about £50. For this sort of money you won't get a laboratory instrument, but I believe that you will get a very useful piece of equipment.

Essentials

TinySA has two inputs, one for low range from 100kHz to 350MHz and a high range from 240MHz to 900MHz.

- Input impedance: 50Ω
- manual or automatic attenuators
- Absolute maximum input power is +10dBm (0.71V_{RMS} or 10mW)
- Manually selectable Resolution Bandwidth[1] filters of 3, 10, 30, 100, 300, 600kHz.
- Automatic selection from 57 resolution filters.
- 1dBcompression point[2] +2dBm with 0dB internal attenuation.
- 3rd Order Intercept Point[3]: +15dBm with 0dB internal attenuation

Notes

1) Resolution Bandwidth (RBW) is the bandwidth of the bandpass filter that is scanned across the range of frequencies of interest. Small RBW will enable more detail to be resolved, but will increase scanning time.

2) 1dB compression point occurs when the input level is increased to a point where the gain of an amplifier is reduced by 1dB. Say an amplifier has a gain of 10dB: a signal of 5dB is applied to the input, the output will be 15dB. However, there is a point where the amplifier will be unable to supply 10dB of gain: put simply, an amplifier's output cannot swing greater than its supply rails so trying to force things will cause some compression of output. If we apply an input of perhaps, 20dB to the same amplifier, the output might be only 29dB instead of the expected 30dB, a compression of 1dB.

3) 3rd Order Intercept Point (IP3 or TOI) is found by projecting the gain slope of a fundamental frequency beyond the 1dB compression point. If the slope for the 3rd order products is also extended, the point where it intersects the fundamental slope is the 3rd Order Intercept point. A high IP3 indicates good linearity in a device, while a low IP3 figure indicates that 3rd order products could interfere with the fundamental.

The performance on the High Range is not up to the standard of the Low Range. For instance, the input impedance is frequency dependent, 3rd order intercept is –5dBm and 1dB compression point is –6dBm. I understand that further software development is under way to improve High Range performance.

The battery takes about an hour to charge and provides two hours operating time. Fully charged voltage is about 4.3V. The battery icon is green while the battery has sufficient charge. It turns red when the battery level is below 3.3V and the device shuts down shortly after, **Fig. 2**.

Signal Generator

As a bonus tinySA will function as a signal generator with sine wave output from 100kHz to 350MHz on Low Range. Output level is selectable in 1dB steps from –6dBm to –76dBm. AM, Narrow FM and wide FM modulation is available, **Fig. 3**. A sweep output function up to the entire Low Range is possible. On High Range only FM (Wide or Narrow) modulation is available, and the output is a square wave between –13dBm and –38dBm. The Sweep function is limited to a slow sweep over a narrow span.

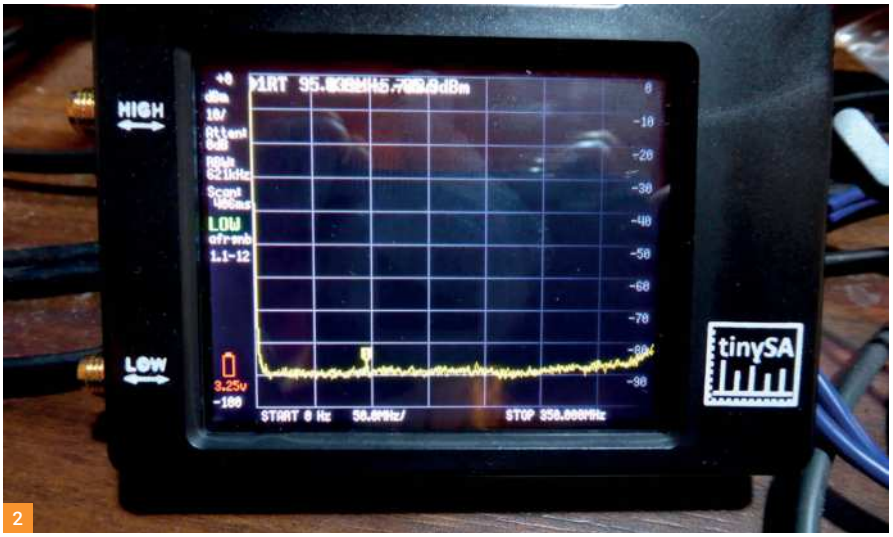
First Use

TinySA comes in an attractive cardboard box with a blown plastic tray for the analyser and accessories, **Fig. 4**. The box is covered in a textured vinyl making it quite hard wearing. Included in the box are a telescopic antenna, a USB-C cable for charging and connecting to a PC, two Male SMA to Male SMA leads, a female SMA barrel connector, a wrist strap with a guitar plectrum and a plastic stylus for using the touchscreen. No instructions are supplied, but comprehensive instructions are available on the tinySA website. There are many online reviews and demonstrations from various contributors.

For the full specification and much more valuable information visit the excellent tinySA website:

https://tinyurl.com/bys3a2sf

Turning the unit on brings instant gratification as you are presented with the typical spectrum analyser display running from 100kHz to 350MHz, **Fig. 5**. With the supplied antenna attached, a large spike at about 240MHz was



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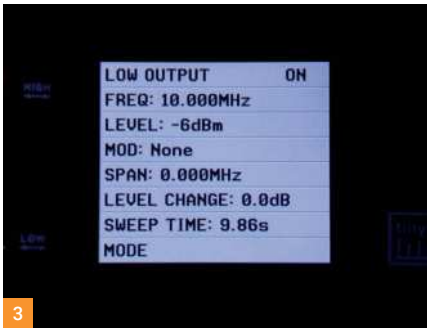

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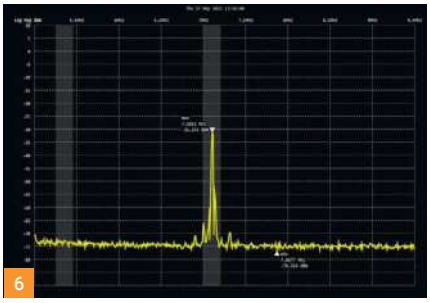
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present here in West Wales, which I suspect is a local DAB transmission. Then I fired up my HF transceiver, there was a nice spike exactly where it should be at 7.100MHz, **Fig. 6**. I then repeated the test on the 2m band and was presented with a nice spike at 145MHz (Fig. 1 again). So, basically it works!

Setup, Calibration and Testing

The calibration and testing functions are pre-programmed. Connect Low and High together with the supplied SMA cable and select Config/Self Test first. This takes about 12 seconds and goes through a 10-step systems test. Then select Config/Level Cal/Calibrate. This will take about two seconds. That's all there is to it.

Screen and Controls

At first, I thought the 2.8in screen would be too small, but a surprising amount of detail can be seen by adjusting the bandwidth and resolution to zoom into an area of interest. However, a big plus point is that tinySA can be operated over USB from a PC, thus making a bigger display, and keyboard/mouse available.

There is a lot of information on the screen (Fig. 1 again), the trace is the central feature. Marker information is in a banner across the top of the screen. The left panel contains settings and battery status. A banner across the bottom contains the scan information: start; stop; centre etc. A waterfall display can be added if desired.

Controls are minimal, an on/off switch and a left/right jog wheel that can be pressed downwards to select menu items, **Fig. 7**. Between the jog wheel and the on/off switch there is a flashing blue LED when the unit is turned on. Next to the USB-C socket is a red LED to indicate a USB connection/charging. Control and navigation is by either the jog wheel or touchscreen. The jog wheel works well, although in general I find the stylus the easiest way of operating. Using a finger on the touchscreen is quite good, but sometimes gets the wrong response. Perhaps it just needs practice or perhaps it's me as I am also frustrated by smartphone screens!

Fig. 1: TinySA Spectrum analyser showing a peak at 145MHz. Fig. 2: Battery Low indicator at lower left. Fig. 3: Signal Generator menu. Fig. 4: TinySA, as supplied. Fig. 5: Menu, top layer. Fig. 6: Screen shot Transmitter output at 7.1MHz. Fig. 7: Top Controls. Fig. 8: Filter test setup. Fig. 9: Noise source output from 0 – 50MHz. Fig. 10: Noise source output from 20 – 70MHz Fig. 11: 48.055MHz filter as tested on NanoVNA. N.B. This included SWR trace. Fig. 12: 48.055MHz filter as tested on tinySA. Fig. 13: Shinwa 30MHz LPF response. Fig. 14: Home-made 30MHz filter response – more work needed!

Menu

The menu system is extensive, but intuitive to use. Tap anywhere in the main screen, or press the jog wheel down, and the menu bar will appear to the right (see Fig. 5). At the first level you can set stop and start frequencies, alternatively you can set centre and span.

Level: set the Reference level, Scaling in units

per division, Attenuation, Units, normally this is dBm, but dBmV, dBµV, Volts or Watts can be selected. Compensation for external amplifier and trigger.

There are many other menu options, more than can be described here. For detailed descriptions refer to the tinySA website.

FilterTest

For testing filters with a Spectrum Analyser, a tracking signal generator would normally be used to provide the test signal while keeping the spectrum analyser trace synchronised to the sweep frequency. Aside from the cost of a tracking generator, this is not an option for tinySA. However, a wideband RF noise source will yield similar results, certainly sufficient for most amateur purposes. Noise sources exploiting thermal noise characteristics of Zener diodes can be built quite easily, many suitable designs can be found on the internet. I tried two, one for £9.00, the other £20.00 from eBay, **Fig. 8**. The performance of both is very similar, on the low range, the output is perhaps a little flatter, but of much the same amplitude. One common feature is that they both get hot quite quickly. I can't help feeling that this may lead to premature failure unless some form of cooling is devised, either a fan, a heatsink or both.

The output from these noise sources is not perfectly flat as the screen shot from 0 to 50MHz shows, **Fig. 9**. Once the span is reduced to the sort of level needed to look at the detail of a signal, say from 20 to 70MHz, then the output is acceptably flat, **Fig. 10**, from –17dBm at 20MHz to –24dBm at 70MHz.

Readers may recall that in an earlier article (*PW* May 2021) I tested the response of a 48.055MHz bandpass filter using the NanoVNA, **Fig. 11**. Using the noise source for the input signal I tested the same filter with the tinySA and obtained a comfortingly similar result, **Fig. 12**.

Out of interest I tested a Shinwa 30MHz low pass filter (LPF). **Fig. 13** shows the roll off at 30MHz to –45dB reduction at 33MHz. Sadly, a home-made LPF, **Fig. 14**, started rolling off at just over 25MHz to –32dB at 29MHz

PC Control

Connecting tinySA to a computer brings the benefits of a large screen, keyboard and mouse control, **Fig. 15**. Most of the images used in this article are screenshots from a PC. I find 'tinySA-App by OneOfEleven' the most useful. It is not highly sophisticated, but has some very good features. The immediate and most significant is the much larger display, in addition:

- Any point on the curve can be measured using the cross-hair cursor.
- The 'delta' measurement points can be moved very easily.

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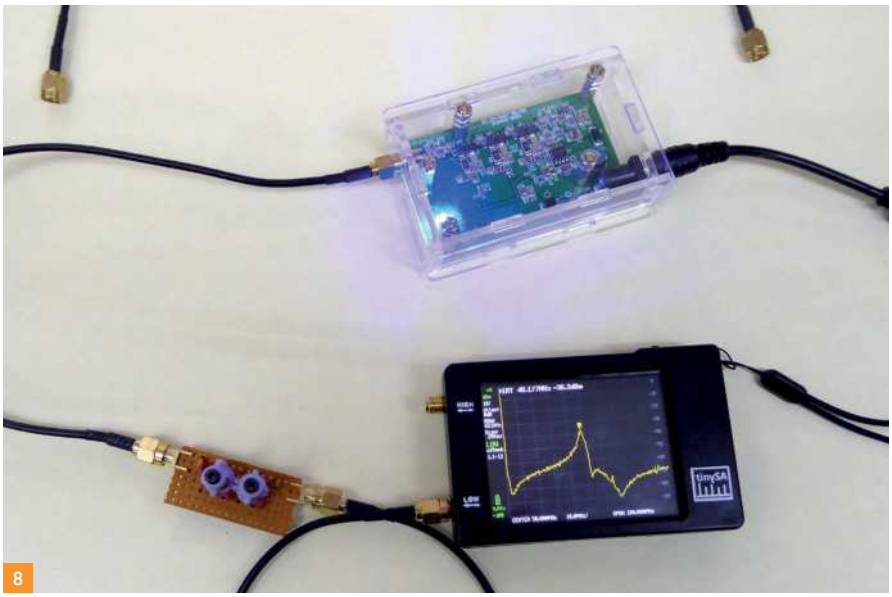

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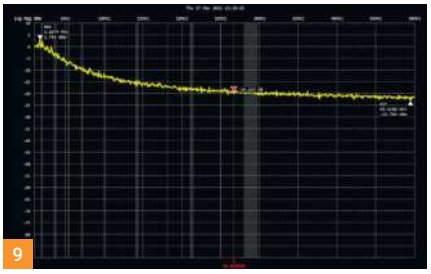
- A wide range of basic test parameters are available from a drop-down menu: Log Mag, Lin Mag, Phase, Group delay etc.
- The image can be captured as a *.jpg, *.png or *.bmp file or as a CSV file for later analysis in a spreadsheet.
- The averaging function is very good for producing a smoother curve.
- Three memories can be set up for regularly used settings.
- There is a wide range of user interface settings
- The PC software is used to update the tinySA firmware
- Test parameters can be changed by right-clicking anywhere in the display area.
- In stand-alone operation the number of points to scan can be selected between 51 and a maximum 290 regardless of the size of the span. When using the tinySA in combination with a tinySA-App up to 30000 measurement points are possible as tinySA-App splits the required scan into 290-point segments and strings them together.

In summary, PC control elevates tinySA into an even more versatile piece of test equipment.

Attenuators

Attenuators are important. The first reason is that the maximum input level to tinySA is +10dBm and exceeding this puts you in the danger zone. Above +20dBm and tinySA will be destroyed. External SMA attenuators are not expensive. You may already have some BNC-based attenuators that could be used with suitable adapters. 10dBm is equivalent to 0.707V RMS (2V pk-pk), which is 0.01W. So, do not connect your transmitter directly to tinySA. Connect via an attenuator. In practice I would use a sniffer probe in the vicinity of a dummy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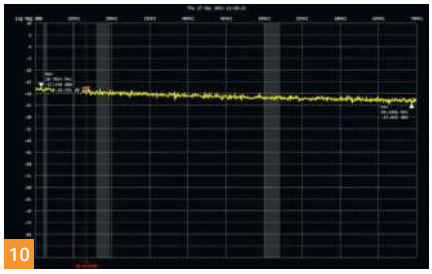
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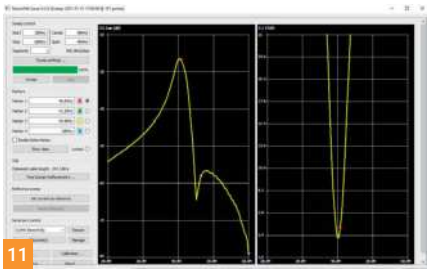
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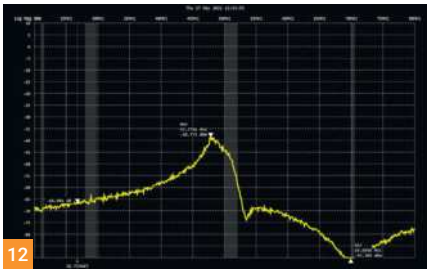
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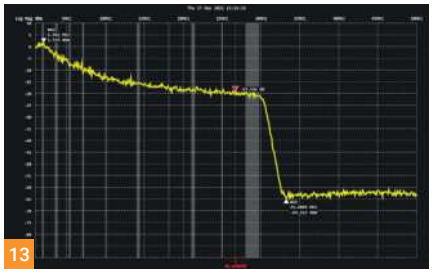
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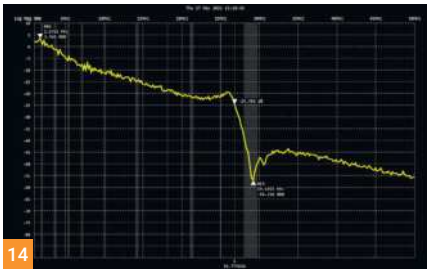
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load, but would still use suitable attenuators to bring the peak level to –10dBm or less.

The second reason that attenuation is important is because one of the limitations of tinySA is that high input levels can cause artefacts from the DSP process or perhaps mixer products to appear in the display.

Limitations

Input levels are best kept low; below –25dBm to prevent the appearance of mixer products and/or artefacts from DSP processing. This is where the internal or external attenuators are useful.

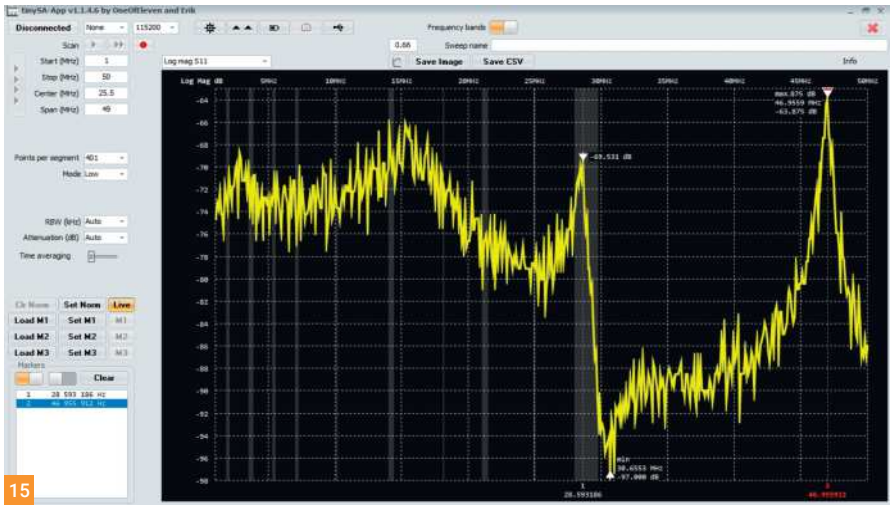
Auto mode is fine for most 'ballpark' tests, but for close in analysis of, say, a modulated signal, tinySA test parameters need to be set manually for the best results.

As the minimum RBW is 2.7kHz it is impossible to look at details inside a 2.7kHz wide SSB signal. With careful setup it is just possible to check the alternate sideband rejection or see the carrier rejection.

SMA connectors are a bit fragile for frequent use in a test environment. Even the best SMAs costing £12 to £15 each are only rated for 500 connection cycles. This is only achieved if the connector is correctly torqued to 3 – 5 in lbf (0.3 – 0.6 Nm) with a 5/16in torque wrench. I can't find a specification for the cheaper connectors, costing maybe £1.00 or less each, but I suspect that maybe 100 connection cycles would be achievable. However, I find them fine for internal wiring where they are not be disturbed too often.

Care needs to be taken to avoid stressing tinySA's SMA connections by attaching heavy adapters and cables.

BNC connectors are the standard used for test equipment so it makes sense to make up short leads to interface from the SMA BNC, leaving the SMA permanently connected, thus isolating the tinySA from unnecessary stress.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Caution

Beware of static charges that can appear on a full-size outside antenna and this applies to any piece of test equipment. At the very least short the antenna leads together and to ground to discharge any accumulated static before connecting an antenna to any test equipment. Better still two back-to-back diodes across the tinySA input will limit the voltage input to 0.6V. Going further a gas discharge tube and a Transient Voltage Suppressor (TVS) across the tinySA input will protect against all but the worst static charges.

If you have firmware v1.3-3 or later. Go to CONFIG/VERSION. If the last line of the displayed version info is 'ESD protected', then back-to-back diodes are already installed.

TinySA does not have all the features of expensive commercially available Spectrum Analysers, but I think you have to consider what are the most valuable features, which ones do you use most? If a 10GHz bandwidth is not something you would use, there is no point in paying for it. Balance the value of these features against reality and cost. Finer RBW might be nice, but is it worth paying a lot more for? Is the RBW of tinySA adequate for your needs? Perhaps it takes a bit longer to set up and analyse. At the end of the day, my opinion is that having tinySA is by far better than not having tinySA.

Although assembled in China, tinySA was designed in the Netherlands by **Erik Kaashoek**. It is recommended that when ordering you ensure that you are getting a genuine unit rather than a clone. Aside from robbing the design team of their due rewards and credit, the clones that have come to light so far are of poor quality and fail to function according to specification. Visit the tinySA website to ensure you get a genuine unit. **PW**

Notes

tinySA website:
https://tinyurl.com/kdabhdjs
IMSAI Guy on YouTube has some excellent down to earth presentations on using both tinySA and NanoVNA.

Billy McFarland GM6DX
gm6dx@outlook.com

1

That's Fritzing Amazing!

Billy McFarland GM6DX describes how to design and produce a PCB the easy way.

For years I have been reading in amateur radio magazines the various ways of creating PCB designs via homebrew means and although this was explained clearly, I wanted to create my own PCBs for amateur radio projects but I wanted them produced professionally as I never had the time nor material to fully homebrew my own PCB. I started to explore PCB designing and after some discussion with a friend, **Ross MM0OBT**, I downloaded a simple to use PCB design software known as Fritzing. Available at:

https://fritzing.org/download

or you can download a version from my one drive here:

https://tinyurl.com/3xdf7dpe

The software is very easy to use and allows you to export the finished design as a Gerber file type, which you then turn into a .zip file and upload to a PCB provider's website for production; more on this later.

Once you download the Fritzing software and run it you will see a home screen, click on PCB tab at the top and you will then be presented with a screen similar to that seen in **Fig. 1**.

The bottom right shows the dimensions of your PCB in mm, simply change this to the size you need. Once you get experienced with this you can even change the PCB to one that fits on top of the Arduino Uno, known as an Arduino shield.

Above the PCB size option you will see a gallery of the various components that you might want to use. To create your own custom component, sizes, shapes etc. isn't the easiest of tasks. However, there plenty of people who have done so already and their designs can be downloaded from:

https://github.com/fritzing/fritzing-parts

For the purposes of this article I will create a simple two-way antenna switch allowing the ability to switch between two antenna feeds. You will need to download my SO239 and Relay Fritzing part available on my one drive here:

https://tinyurl.com/mtsj8cvt

First Step

The first step is to open my custom Fritzing parts, File > Open then select the part (.fzpz file). Once they have been imported, select the part via the top right column (you might need to search for it, for example by entering SO239) as seen in **Fig. 2**. Drag the part across onto the PCB and position where you want it. Do this a further two times as seen in **Fig. 3**.

Step Two

The second step is to connect all the ground connections of the SO239 connectors. To do this simply click on one of the connection points until it is highlighted then, while keeping it held, drag across the screen to the other connection points. Do this until it is complete as seen in **Fig. 4**.

Step Three

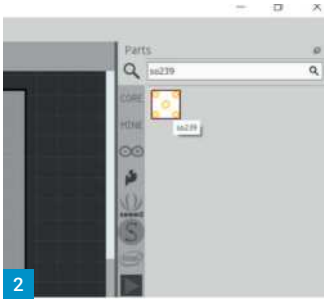
The third step is to search and add the DPDT relay onto the PCB. Just follow the same steps as you did for the SO239. Once the DPDT relay part is added to the PCB, connect the centre of the common SO239 (the one that goes from your switch to the transceiver) to the relay part. Again, you simply click between the connection points. Once you connect these two parts you will notice that the connection colour is the same as the previous connection lines that you created for the SO239 ground, yellow.

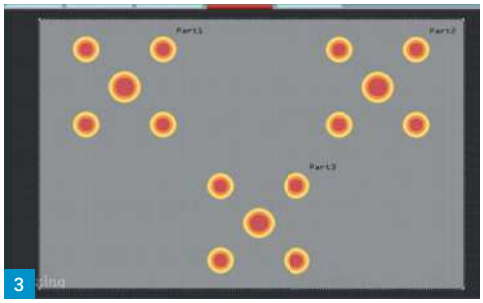
This means that all the connection lines that are the same colour will be connected electrically together. This is important as your PCB won't work if all the connections are on the same connection layer (or same colour). As my connection from the relay goes over the ground connection line, I need to change this connection to the opposite layer of the PCB. The PCB has a top and bottom layer separated by insulated material. So, by switching around the layers this will prevent connections being 'crossed' and connected together accidently. Right click on the connection layer and select 'Move to bottom layer'. Then you will see that the connection line goes dark orange showing you that the connection line is now on the bottom layer. All this can be seen in **Fig. 5** and this process is the same for any parts used.

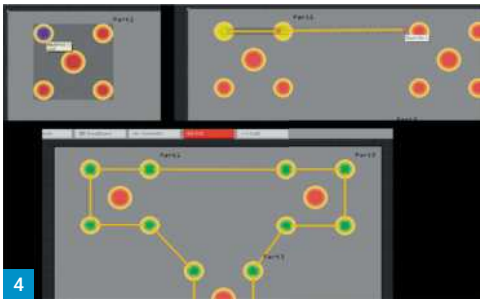
To Finish

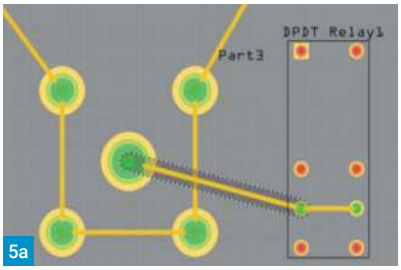
Now connect the remaining two SO239 centre connections to the relay. When doing so be careful not to cross over any of the connection holes as seen in **Fig. 6**. If you have this issue, click on the connection line and drag it about the PCB, then unclick. The connection line will then remain in that path. You can see this complete in **Fig. 7**.

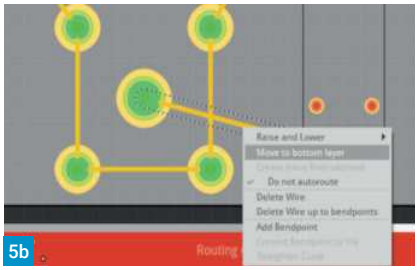
All the RF connections are made, now it is time to connect the relay electrically for the 12V DC supply. Add a diode for protection. Again, type 'diode' into the search bar at the top right of the program and click on the part you want. You can change from surface mount (SMD) to through-hole. I use through-hole as seen in the image. To turn the diode (or any part) around, right click on the part then select Rotate > Rotate 180. Connect the diode to the relay and also add a screw lock connection. Search 'screw' in the top right window and you can see the various screw lock connectors to choose from. This is where you will connect a 12V DC supply to the PCB in order to allow the relay to work, **Fig. 8**. If you would like to add some text to the PCB, again it is the same as before. Search for 'text' and drag the text box onto the PCB, then simply change the text at the bottom right of the program. In Fig. 8 you can see I added NEG (for negative DC connection) and











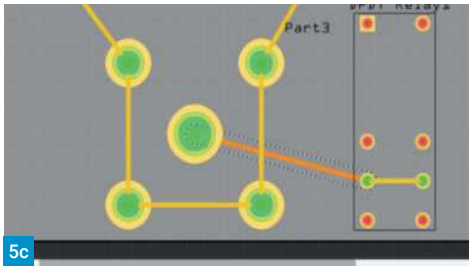
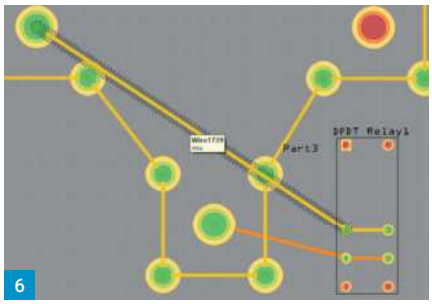
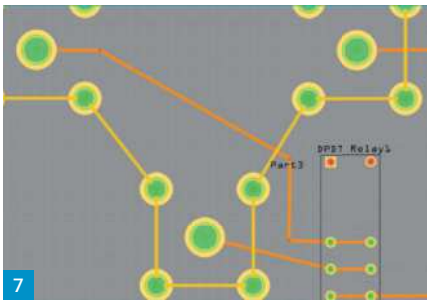
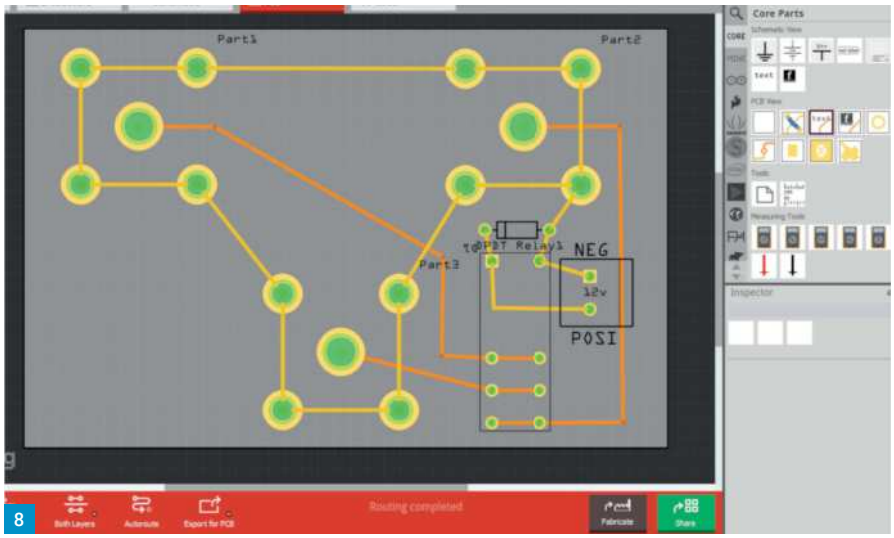


Fig. 1: Home screen of Fritzing software.
Fig. 2: Selecting the wanted part.
Fig. 3: Creating multiple SO239 connectors.
Fig. 4: Linking the ground connections.
Fig. 5: Linking via the bottom layer (in orange).
Fig. 6: Oops, crossing a hole! Fig. 7: The problem fixed, routing to avoid the hole. Fig. 8: Connections added for the relay and 12V DC supply.
Fig. 9: Exporting the Gerber file. Fig. 10: Selecting colour and other options when ordering.







POSI (for positive DC connection).

The final stage of this PCB design is to get it ready for the professionals to produce. Down at the bottom of the software select, Export For PCB > Extended Gerber, as seen in **Fig. 9**. It will look for a folder so make sure you have a folder ready to save the files into. Once you have the files saved into the folder, turn it into a zip folder. Right click the folder and select, Send To > Compressed (Zipped) Folder. That is us all done with the PCB. How the circuit on the PCB works is that the common SO239 is connected to one of the antenna ports via the relay, when voltage is applied to the relay (ie the PCB has 12VDC to it), then the other antenna port becomes active, therefore creating a two way antenna switch.

PCB Manufacturers

Looking online there a few PCB producers available. The one I use is JLCPCB at:

https://jlcpcb.com

You can change the colour etc of the PCB as seen in **Fig. 10** and it is always better ordering a few PCB designs at once, as the postage will be cheaper. Also make sure you select *Standard Global Direct Line* for the cheapest postage option. If you want to get started in making PCBs, then I would suggest you start with something simple such as this two-way antenna port PCB and then move the difficulty level up when you have mastered using the software. Have fun and if you have any questions drop me an email at

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Bad News and Good News

Steve Telenius-Lowe PJ4DX starts with the loss of two well-known operators and then turns to news of what has been happening on the bands.

The solar flux peaked at 164 and the sunspot number at 119 on 22 April after which both declined somewhat. However, the trend is still upwards, as can be seen in **Table 1** and solar cycle 25 is continuing to be higher than predicted for this stage of the cycle.

Silent Keys

Unfortunately, hardly a month goes by without news of well-known and respected radio amateurs becoming Silent Keys. Last month it was **Zorro JH1AJT** and this month comes news of two more SKs.

Roger Western G3SXW became a silent key in April at the age of 75. A superb CW operator, Roger had taken part in numerous DXpeditions. He was a former President and was a Life Vice-President of FOC, the First Class CW Operators' Club, and had been inducted into both the *CQ* DX and *CQ* Contest Halls of Fame. I first met Roger in 1978 in Tehran, Iran, when on my first overseas work posting. (Roger was licensed as EP2IA, **Fig. 1**, and, after a five-month wait for the licence, I became EP2SL.) Although I was a 100% SSB operator in those days, and Roger was 100% CW, because we shared an interest in DXing and contesting we quickly became firm friends. During the difficult times of the Iranian Islamic revolution, Roger invited me to celebrate Christmas with him and his family – what a great friend! In 2019 he suffered serious injuries from an accident at his home and was in hospital, and then a nursing home, until he passed away.

On 8 May came news that **Franz Langner DJ9ZB**, **Fig. 2**, also became a Silent Key. Franz was one of the world's best SSB DXpedition operators and seemed to have an almost uncanny ability to pull a callsign out of the pile-up! He had been taking part in DXpeditions for well over 40 years. I had known Franz since 2002, when he visited the RSGB HF Convention to give a presentation on the XR0X San Felix DXpedition, **Fig. 3**. More recently Franz teamed up with Zorro JH1AJT and was the main SSB operator on DXpeditions to Bhutan (A5A, A52ZB), Eritrea (E31A, E30FB), and Myanmar (XZ1A, XZ1J).

DX News

It has been difficult to report on future DX operations in this column for the last couple of years for reasons that we are all too familiar with. Quite a few DXpeditions have been planned but then had to be postponed or cancelled altogether due to Covid. However, now that travel restrictions are being eased in many countries more DXpeditions are being planned.

The summer months are usually a quiet time for DX operations, mainly because of the 'summer doldrums', when HF band conditions tend to be somewhat depressed, usually picking up again in September. This year is no exception, with (at the time of writing) no major operations announced for July or August. Come the autumn and winter, though, it is a different story, with plenty to look forward to. The following DXpeditions are scheduled to take place later in the year:

- CY0S, Sable Island, by WA4DAN and a US team, October (dates and callsign TBC);
- TY5RU, Benin, by the Russian DXpedition Team, 10 – 25 October;
- J28MD, Djibouti, by the Mediterraneo DX Club 29 October – 7 November;
- TL8ZZ (FT8) / TL8AA (other modes), Central African Republic, by the Italian DXpedition Team in November (dates TBC);
- FT/W (callsign TBC), Crozet Island, by F6CUK, December 2022 to March 2023;
- 3Y0J, Bouvet Island, by Norwegian-led international group, January 2023.

More details on all these operations closer to the time.


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RSGB IOTA Contest

Although the IOTA programme has been run by Islands On The Air (IOTA) Ltd, a not-for-profit company, since 2016, the RSGB is still the organiser of the annual IOTA Contest. This year's event takes place on 30/31 July, from 1200UTC on the Saturday for 24 hours. This is a contest for everyone: there are separate sections for CW only, SSB only, and both modes; for high-power, low-power (maximum 100 watts), and QRP operators; and for those who wish to operate the full 24 hours or only for a maximum of 12 hours. And, because everyone in the British Isles is on an island, you are the ones in demand by the rest of the world.

Last year activity in the contest from island DXpedition stations was down due to Covid but it's looking more promising for 2022. Taking part in the 12-hour, high-power, SSB-only section, last year I was the top scoring station in South America, **Fig. 4**, and I hope to work more *PW* readers in this year's contest.

Readers' News

First on parade this month is **Victor Brand G3JNB,** who despite the ever-improving propagation, has discovered what might best be described as 'the little pistol's paradox'. *"No fooling on 1 April! HS3NBR in Thailand worked me on 20m CW at 1640BST. A splendid start to the month, particularly as earlier in the day there were no DX signals to be heard. 2 April at 1730BST on 15m,* ***Jose KP4JRS*** *in Puerto Rico obliged. On 3rd PJ5/SP9FOW St Eustatius on 15m and WP3TT Puerto Rico on 10m both heard me. 4th brought in JT1CO on 15m plus ZS1ANF in Cape Town on 10m and then* ***Mark 9Z4AT*** *Trinidad popped up right beside me with a colossal signal and responded first call...*

"Good contacts continued throughout the month but I was experiencing an increasing number of failures to break the pile-ups. And, thus, there appears to be a paradox! The welcome improvement in HF propagation, and the concomitant reappearance of juicy DX, is attracting the 'Big Guns' back onto the HF CW bands. DX operators, faced once again with a wall of RF, are constrained to reducing RF gain, the narrowing of filters and are probably less likely to notice a whiff of RF from my station's fishing rod antennas. The predicament probably explains why I have often worked some of my best DX during the low periods of the solar cycles! Nonetheless, my improved loggings, like FY5KE

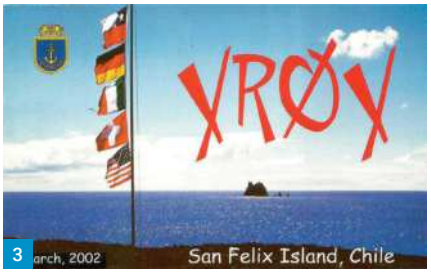

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Fig. 1: Tehran, 1978: left to right Roger G3SXW/EP2IA, Marvin Carter W4ZMQ/EP2PZ, John Dunnington G3LZQ/EP2WR, sadly, all now silent keys. Fig. 2: Franz DJ9ZB (SK), right, with Steve PJ4DX (then 9M6DXX) at Friedrichshafen, 2008. Fig. 3: One of DJ9ZB's many DXpeditions to very rare locations was XR0X, San Felix, 2002. Fig. 4: The IOTA Contest is on 30/31 July this year. Give it a go! Fig. 5: John King ZB2JK at the top of the Rock with the 10m backpack. Fig. 6: ZB2JK with the home-made 10m Moxon.

and TZ4AM on 30m, were most welcome and I did manage to squeeze past the heavyweights to work the outstanding team at JW0X on both 17 and 20m. Can't really complain!"

Neil Clarke G0CAS monitored the 28MHz beacons every day during April and concluded that it was actually rather a poor month for Sporadic E. "*Saying that, several small localised openings did take place particularly to Italy and Spain. For example, on the 20th during mid-evening a small Sporadic E opening to Spain took place with ED4YAK 28251 and ED4YBA 28263 heard and then the following morning a similar opening occurred with ED1YCA 28226 and ED4YAK 28251 logged. By far the best opening took place during the afternoon and evening of the 28th with paths open in every direction within Europe and many beacons heard for the first time this year. The next morning, the 29th, beacons were heard only in Central Europe and Italy. Further afield via the F2 layer North America was well down compared to previous months with only the 12th and 27th, when numerous beacons were logged. VE3TEN 28175 was heard for the first time this solar cycle on the 12th. As expected, paths to South America improved with PY4MAB 28270 heard every day except for the 5th and 16th. The three South American beacons LU4AA, OA4B and YV5B all on 28200 (part of the world-wide beacon network) were only heard on 27 days of the month. Also on 28200 ZS6DN and 5Z4B were logged on 25 days and 15 days respectively. Slightly further east FR1GZ 28215 was heard most days. 4X6TU 28200 and YM7TEN 28225 appeared in the log most days."*

	May '22	Nov '21	May '21	Difference
SFI:	116	87	78	(+38)
SN:	62	37	36	(+26)

Table 1: Solar Flux Index and Sunspot Numbers on 11th of the month: this month, six months ago and one year ago. The final column shows the difference between now and the same time last year.

Jim Bovill PA3FDR reckoned that *"April was a month of two halves for DX, with far fewer QSOs during the first two weeks compared to previous months. Nonetheless, I managed to log several*

interesting contacts during that period, including Saint Helena (ZD7BG), the Pacific island of New Caledonia (FK8HM), US Virgin Islands (KP2B), Iceland (TF2MSN) and Georgia (4L8A). Things began to improve as we moved into the second half of the month with QSOs with Kyrgyzstan (EX2G) on the 16th, Burkina Faso (XT2MAX) on the 19th, Rodrigues (3B9FR) in the Indian Ocean on the 20th, the Republic of Kosovo (Z61EK) on the 21st and Kuwait (9K2HN) on the 26th, all new DX entities for me.

"Having spent my first 35 years living on an island (Ireland), islands have always fascinated me, especially small, remote ones such as New Caledonia and Rodrigues. And contacts with islands continued this month, with new QSOs in the Philippines (DU1IVT), a land with over a thousand islands, New Guinea (YB9UA), Madeira (CT3IQ) and Corsica (TK5IH). Much nearer to home I managed QSOs with two interesting islands: Bornholm (5P5BI), a Danish island in the Baltic Sea, and Åland (OH0EG). The operators from Bornholm were a Belgium expedition team… from 24 April to 1 May. Åland is the largest island of the Finnish Åland Islands archipelago, at the entrance to the Gulf of Bothnia in the Baltic Sea. The operator was ***Wieslaw SP1EG****. I had no idea as to the location of these two islands, nor of some of the other island QSOs until looking them up in Google. Thus, in addition to the many benefits of our hobby, it also enhances our knowledge of geography."*

In this column last month **Etienne Vrebos OS8D** reported the sudden appearance of an S9+40dB local noise source that wiped out the 3.5, 7MHz and part of the 14MHz bands. Now he writes, *"The noise problem I had disappeared suddenly and didn't come back till now. It's a great relief to watch my S-meter at less than 1 on 80 and 40m. Of course, no explanation, but I saw people and trucks from the public electricity company turning around and from the telephone company. They were very helpful by telephone (of course) to propose their help if any noise would continue in my HF reception. The noise came and disappeared discretely: nice to know that people here are concerned about our hobby and quickly react to my mails."* Etienne added that on 21MHz he worked many Japanese stations, saying that they all came back to his CQ calls, so it is always worthwhile putting out a call even if the band seems to be very quiet.

Tim Kirby GW4VXE enjoys the CWOps CWT activity sessions on Wednesdays. *"It's been interesting to see the bands staying open later over the last few weeks and I've been pleased to make some nice QSOs into the USA on 15m especially during the 2000 – 2100UTC slot. There have even been a few times when 10m contacts have been possible. I don't operate much FT8 on HF, but I was testing the aerial on 14 April and thought that was a quick way to check things out. I was pleased to find things seemed to be working well when, after a few minutes, I had CO8LY, KP2B, JS1IFK and YD2ULK all in the log. It was good to catch 7X3WPL on 15m CW – a callsign I am very familiar with on the VHF bands.*

*"**John G8CQX** has kindly given me one of his loop antennas with a loop amplifier board. Although the loop is still inside, it's proved a very useful antenna for listening around with. I've been using it connected to a SDRPlay RSPPro receiver and running CubicSDR on my Mac. The plan is for the loop to go outside and it will be very interesting to see how it works in what I hope will be a fairly noise-free location.*

*"Although the majority of Ukrainian stations are off air, **Dmitry UW1GZ** was offered free use of a Remote Ham Radio site in Croatia until the end of the war. It has been nice to make a few CW QSOs with him and of course he has been quite popular on the air."*

Owen Williams G0PHY noted that *"The increase in the SFI last month continued this month with plenty of VK stations audible in the early morning as well as the occasional early morning opening to the Caribbean and USA. In fact, KL7KK was well over 59 with me one morning. The JW0X DXpedition was very active and I managed four band slots with them and on International Marconi Day I managed to bag HV0A on 18MHz. The TX5N DXpedition was a bit of a disappointment. I note that nearly 50% of their contacts were on FT8 and although they were a good signal on 14MHz for a couple of mornings the pile-ups were huge and at times when there was propagation to Europe, they were calling for North America and Japan."*

Kevin Hewett ZB2GI reported on his activity with **John King ZB2JK**: *"John made a 10m station in a backpack, comprising a Superstar 3900 modified for 10m, a 7Ah SLA battery and a centre-loaded mobile whip with a coiled counterpoise wire. He worked PP1WW from the top of the Rock with the backpack strapped to his back,* **Fig. 5***. We also spent a sunny Saturday afternoon up the Rock upgrading the home-made Moxon,* **Fig. 6,** *replacing the plastic water pipe boom, plastic chopping mounting plates and cable ties with a fibreglass boom, galvanised pole mount and U-bolts. On completion we used an antenna analyser to peak the Moxon for the SSB portion of the 10m band."*

Around the Bands

Victor G3JNB: 10MHz CW: FY5KE. **14MHz CW:** JW0X. **18MHz CW:** E29TGW, JW0X. **21MHz CW:** CO8LY, E29TGW, HS0ZIF, JT1CO, KP4RS, PJ5/SP9FOW, VU2TMP, YV5IUA, ZD7BG. **24MHz CW:** FY5KE, HS3NBR, KP4JRS. **28MHz CW:** 9Z4Y, PY2XL, WP3TT, ZS1ANF.

Jim PA3FDR: 7MHz FT8: KC1BUF, OH0EG. **14MHz FT4:** FK8HM, HS5NMF, JA1FON, JR5XPG, KP2B, TF2MSN, VK3BOB, W5RYA, YB2HND, Z61EK. **14MHz FT8:** BD4STG, BI1LGG, BX6ABC, EA9ACF, EX2G, JA7UKM, NZ2X, VA3AQB. **21MHz FT4:** 3B9FR, 4K3ZX, A65DR, CN97PA, DU1IVT, HS0ACS, HS5NMF, HZ1CY, JA0FIL, JA1WSK,


6

JA5DIM, JA6FIO, JA8JLC, JH0RVY, YB1NXR, YB9UA, YD2ULK, XT2MAX, ZB2R ZS6SKY. **21MHz FT8:** 4L8A, 4Z5TK, 9K2HN, AB8O, BG7BDB, JR7ANB, JE8KDQ. **28MHz FT4:** CT3IQ, CX4AD, JT1CO, LU6VEK, OD5PY, PU5CVB, TK5IH, ZD7BG, ZR2BK. **28MHz FT8:** 4J3DJ, 5Z4VJ, PP5HR, TA9J, ZS4JAN, ZS6AF.

Etienne OS8D: 14MHz SSB: 4L1WW, JW0X, JW/NP4G, UK8FAI. **18MHz SSB:** JR7TKG, JW0X, VK2BY, VK2PW. **21MHz SSB:** 4I1EBD, 4L5C, B3CRA, B5CRA, DV1DLX, JA2XLV, JW0X, TI2CC, YB0AZ, YB1KI, YC5AKH, YC7UDD, ZF2RX. **24MHz SSB:** EX2V, FM5DN, JW0X. **28MHz SSB:** 8A23D, 9J2RD, CX1AV, KP4PUA, LU1DX, LW3DG, NP2AR, P40L, PU2MBO, TR8CA, UN6LN.

Owen G0PHY: 14MHz SSB: 8P5AA, AX5PAS, KL7KK, NE1QP, TI8CF, VK3XXY. **18MHz SSB:** 9K2JJ, S79VU.

Kevin ZB2GI: 14MHz SSB: VK5MRD, W4SYV, WB2MHJ. **18MHz SSB:** IS0IYX/M. **21MHz SSB:** CE2MHB, KA2ABA, KP4PUA, W9ZX. **21MHz FT4:** AA3LX, KG4W, N1RR, PJ4DX. **24MHz SSB:** TO1Q, YV5OIE. **24MHz FT8:** AC8TO, CO8LY, JA4NLM, K0MB, K2TQC, K3DFL, K5EK, KB1EFS, KJ9X, W1KMA. **28MHz SSB:** 9Z4Y, CE5DSQ, HI8AT, K7JE, KP4NEL, LU1JBR, LU5LAE, LW1DG, LW5EJU, N6DSM, NP2J, PP1WW, PT2EM, PU3ELH, PU4MHO, PZ1EL, VA2ZE, VA3YV, VA5DX, VE1CSM, VE9WW, W6YA, WQ7X, YV5OIE. **28MHz FT8:** AE4S, CX4AD, HK3O, K2GLS, KC3MLR, LU1EFX, LU2NI, LU3BYZ, LU8HGI, LW6EQG, NJ8J, PU1RFZ, PY5EJ, VO1DZA, VU2PTT, W5TUF.

Signing Off

Thanks to all contributors. Please send all input for this column to teleniuslowe@ gmail.com by the 11th of each month. Photographs of your shack, antennas, or other activity would be particularly welcome. For the September issue the deadline is 11 July. 73, Steve PJ4DX. **PW**

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Digital Mobile Radio Explained

By Andrew Barron, ZL3DW

As many will have already discovered, getting started in Digital Mobile Radio (DMR) can be tricky. This book from Andrew Barron, ZL3DW provides his usual practical approach to the subject. He provides the information you need to get started with this exciting digital voice technology.

The *Work the World with DMR* practical approach explains the steps that you need to follow to make your new DMR radio work on your local repeater or hotspot, and for worldwide contacts.

For anyone interested in DMR or simply looking to expand their knowledge, *Work the World with DMR* will help you to become familiar with the complex terminology used by the DMR crowd.

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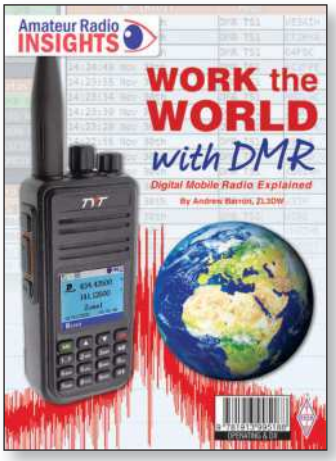

NanoVNAs Explained

A practical guide to Nano Vector Network Analysers

By Mike Richards, G4WNC

Vector Network Analysers (VNAs) have traditionally been out of reach for most radio amateurs because of cost but the introduction of low cost NanoVNAs has changed this. VNAs are incredibly useful in measuring antennas but they do much more too. However, getting the most out of these devices is not easy, and that is where *NanoVNAs Explained – A practical guide to Nano Vector Network Analysers* is designed to help.

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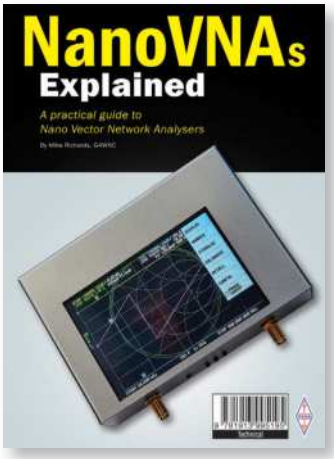

Mini DXpeditions for Everyone

By Billy McFarland, GM6DX

Many regard DXpeditions as complex events. However, it doesn't need to be like that, and this book shows '*you can do this!*' alongside the fun that can be had on a shoestring with a few friends or on your own.

DXpeditions are expeditions to a particular place for the purpose of operating DX (long-distance radio contacts) on amateur radio. A mini-DXpedition is of course simply a smaller-scale event - maybe a trip from the UK to Europe with 5 or less operators or a trip to a local island or beach.

Mini DXpeditions for Everyone shows that everyone can organise a DXpedition and most importantly the fun that can be had doing so.

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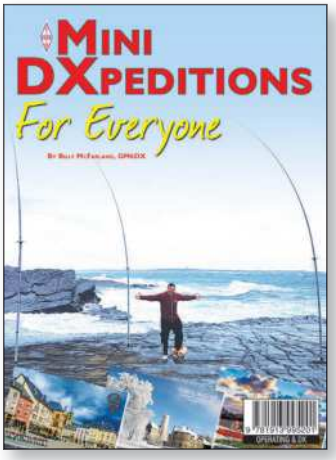

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Tim Kirby GW4VXE
Longworthtim@gmail.com

1

Allstar and the G7RPG Microhub

Tim Kirby GW4VXE has another full column, starting with news of an interesting hub for accessing an Allstar node.

I've mentioned digital hotspots in the past, but in the last few weeks, I've had the opportunity to try an 'analogue hotspot' in the shape of an Allstar node. This is a box that contains a Raspberry Pi, a soundcard, a power supply and a Baofeng radio. It connects to your internet router by Wi-Fi or wired Ethernet connection.

Once you have set up an account on the Allstar network, you can create a node on the network and use these credentials on your Allstar node. I used the 'Microhub' built by **Peter G7RPG**, **Fig. 1**, and the process couldn't have been more painless, it was literally a question of plugging it in to 12V, tuning a 70cm FM handheld to the frequency of the hotspot and off you go.

You can tell the hotspot to connect to other Allstar nodes or gateways either by DTMF tones from your handheld or from a web interface accessible on your local Wi-Fi network.

You can connect to Hubnet, which is very popular in the UK, as well as other networks such as the Papa repeater system on the west coast of the USA. Once Echolink is configured with your details, you can use Echolink to drop in on repeaters and simplex nodes around the world. It works very well. While connected into the Papa system, I had a contact with NI6IW on the *USS Midway* in San Diego. Another interesting QSO was with **Endaf N6UTC**, a *PW* contributor, on a 220MHz repeater on the west coast of the USA.

The system comes into its own, if like me, you do not have any repeaters that you can access from a handheld. Now, with the Microhub, I can set up a connection to a node, system or repeater of my choice and use it around the house and for a range of around 400 yards, depending on the terrain, of course.

Other ways of connecting to the Allstar network are available, but I can certainly recommend the G7RPG Microhub. If you're interested, you can contact Peter at **g7rpg@hotmail.com**

Operating from a Sandbank in the Solent? It's GB1BB

Ed M0MNG contacted me to say that the Isle of Wight Radio Society were planning an operation from Bramble Bank on 18 April, using the callsign GB1BB. They would be active on HF, 2m and GB3IW. First of all, I had to look up where Bramble Bank is. It's in the Solent, off Cowes and is a sandbank, which is only exposed at Spring Low Tides, **Fig. 2**. Using the G7RPG microhub, I was able to listen to GB3IW via Echolink and listen to the pile-up being expertly managed by Lizzie M7CZW, who apparently was recently licensed, although you wouldn't have known it. I was pleased to be able to make a QSO before the tide had turned and the team returned to their boats. Via a repeater and Echolink it may have been, but it was still a very interesting contact. Congratulations to the IOWARS for a fascinating operation.

The GB3MBA 6m Meteor Beacon

Meteor scatter enthusiasts will be pleased to know that GB3MBA (Meteor Beacon for Astronomy) is now active on 50.408MHz from the Sherwood Observatory of the Mansfield and Sutton Astronomical Society (IO93JC). The beacon runs around 80W CW with an ID every 10 minutes. The antenna is a crossed Moxon beaming upwards using Right Hand Circular Polarisation.

The idea is that the signal should be receivable using a FunCube Dongle and wire dipole antenna. It is planned to have a network of receivers with real time feeds, which should enable some interesting measurements taken when the data from the feeds is taken back to a central point.

The hardware and development of the beacon have been funded by the RSGB's Legacy Fund. You can read more about the beacon at: **www.ukmeteorbeacon.org/Home**

The website is well worth a read as it gives an idea of some of the objectives of the project as well as contact details if you would like to get involved.

Martin Rigby G4FUI (Penrith) spotted the beacon coming on air within minutes and can hear it directly but is also hearing it by aircraft reflection as well as some meteor reflections.

Congratulations to those involved. **Peter G3PHO** is the Beacon Keeper, **Brian G4NNS** did the hardware design, **Andy G4JNT** designed the PA and **Heather M0HMO** built the website.

Need a Battery for your Yaesu VX-1R?

The Yaesu VX-1R was ground-breaking in its time as a micro-sized 2m/70cm dual-band transceiver. The problem was that the batteries failed over time. A few years back, I got a replacement, via eBay from Italy, but sadly, this battery didn't last long either. **Jules G4UET** recently got in touch to say that he had resurrected his VX-1R using a standard Li-Ion battery (14650). He bought two batteries and a charger and the cost was under £20.

The only problem is that the 14650 is just a little short. Jules decided to use the shell of the original battery and clip the 14650 inside that. Other solutions I've seen involve putting a small magnet or other packing shim on the top of the battery to bulk it out a little bit.

The 8m Band

Roger Lapthorn G3XBM (Cambridgeshire) writes with an update on his 8m experiments. He mostly uses FT8 on 40.680MHz, using his FT-817ND and a low wire dipole at around 3m above ground. Already, Roger's low power signals have been spotted in five countries, mostly by Es. Roger has

Fig. 1: The G7RPG Microhub – an analogue hotspot.
Fig. 2: The location of Bramble Bank in the Solent (taken from my 1937 copy of 'The Pilot's Guide to the English Channel').
Fig. 3: One of Tyler WL7T's operating spots in DM02. Screenshot from 'Theodolite' for iOS.

seen signals from five countries, with the farthest being ZS6WAB on FT8. Roger is hoping that his QRP 8m signals will reach the USA during the summer multihop Es events.

On **John EI7GL's** blog (URL below) he reports, "*A little bit of radio history was made on 21 April 2022 with the very first contact ever between Ireland (EI) and South Africa (ZS) on the 40MHz band.* ***Phil EI9KP*** *in the west of Ireland managed to complete two-way contacts with* ***Jan ZS6OB*** *in South Africa on 40.680MHz using the FT8 and FT4 modes, a distance of about 9570km*". EI9KP was using around 25W from an Icom IC-7300 to a homebrew two-element Yagi and ZS6OB was using around 30-50W. **Paul G7PUV** also heard ZS6OB and ZS6OB heard FT8 from G9PUV, which is the callsign that G7PUV uses on 8m.

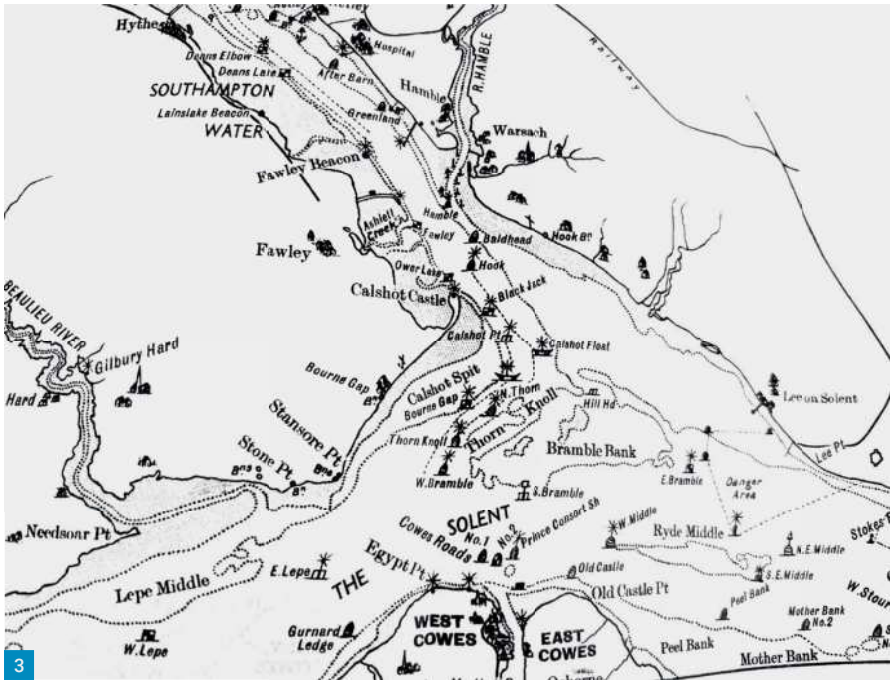
https://ei7gl.blogspot.com

John also reports that WM2XEJ from Georgia was heard by EA8BFK on 8m FT8 on 18 April. WM2XEJ is one of seven stations in the USA who have experimental licences for the 8m band. Several of the stations are using WSPR on 40.663MHz; WM2XCC in California, WM2XCW in Washington State and WM2XAN in Michigan. It will be interesting to see if any of these stations are heard in the UK by multi-hop Es over the summer or F2 in the autumn. There must be a good chance!

The 6m Band

Roger Greengrass EI8KN just missed the last deadline because he'd been busy working in the IARU Region 1 50MHz MGM Contest on 16/17 April. Roger says it was rather difficult without any Es but he managed a few tropo contacts as well as some meteor scatter. Roger worked a handful of stations outside the UK: F4ARU (N03), IK2HKT (JN45), HB9BBZ (JN37), HB9SHD (N36) and OE5XBL (JN68).

Roger noted a 6m opening between South Africa and Northern Ireland on the afternoon of 17 April. Roger only made a couple of decodes, but **David GI4SNA** and **Gordon GI6ATZ** were very busy and it was apparent that there were quite a few ZS stations on the band. On the evening of 3 May, Roger worked CE3SX (FF46), PY1EME (GG76), PY2XB (GG66), PY2EDY (GG66), PY2NF (GG66), PY2AD (GG67) and PU4JOE (GH91). During the same opening, here at **GW4VXE**, I managed to scrape a QSO with PY2XB with my vertical antenna. I put the beam up before breakfast the next day, but naturally, I've noted fewer TEP openings since! I was lucky enough to catch



LU5JCI (FF75) on 14 May who peaked up to a huge signal for 90 seconds or so here. Curiously, during this opening a few signals from the Caribbean were heard too: 9Y4D and FG8OJ. The other highlight for me was working GI0OTC (IO65) during the month for grid #500 on the band.

Don G3XTT found some TEP at the end of April, when he copied ZS6WAB and ZS6KED coming through and on the evening of 2 May, he copied a couple of LU and PY stations. Unfortunately, antenna problems prevented Don making contacts at that time. On 8 May, though, Don worked ZD7MY on St Helena for a new DXCC. These were all FT8.

Kevin Hewitt ZB2GI has found the 6m TEP openings less frequent this month, although he worked a few Brazilian stations from the Gibraltar club station using a Hexbeam. From home, using a monoband whip on a broomstick poked out of the window, he has started to make some Es QSOs including IK5YJY (JN53), S51U (N75) and G0ABI (IO80).

Tony Collett G4NBS (Cambridge) caught a little late afternoon Es on 8 May to EA/EA6 and 7X. Tony heard a Moroccan station but did not make a QSO. The UK Activity Contest on 12 May was noisy for Tony, but he had easy contacts with GI4SNA and G7RAU, with GD0AMD/P and 2E0VCC/P being more of a struggle. On 14 May Tony worked EA6ZS on Es.

Phil Oakley G0BVD (Great Torrington) has been testing out his 6m gear ready for the Es season and enjoyed FT8 QSOs with G4NBS (JO02) and EI4DQ (IO51).

The 4m Band

Jef VanRaepenbusch ON8NT (Aalter) uses 25W to a halo antenna mounted on a broomstick on his balcony. On 21 April he worked G3YHM (IO90) followed, next day by PA0VHA (JO21) and G3SHK (IO90), all on FT8.

Don G3XTT copied EA9IB on 8 May via Es.

The 2m Band

Jef ON8NT took part in the FT8 Activity period on 6 April with the highlights being DK6JU (JO33), G1BHM (IO70), 2E0IEI (IO81) and G3WAG/P (IO82).

Simon Evans G6AHX (Twyning) took part in the RSGB 2m UKAC on 3 May, with the best DX GI4SNA (IO64), making 26 contacts in 15 squares. He also took part in the European contest on 7/8 May, working TM5R (JN19), F6KCZ/P (IN99), F4KJP/P (JN29), OR6T (JO20), ON6MG (JO10) and DL0LN (JO30). Simon felt that conditions were pretty flat, but it helps when there are well equipped stations out on hilltop sites.

Tony G4NBS was monitoring FT8 in the afternoon of 2 May and worked M0EUK (IO95), G4JIX (IO94), G4VCJ (IO94) and GM4FVM (IO85). GS3PYE/P (Camb-Hams Expedition to Skye) popped up briefly for a marginal QSO, but later in the evening they came up on aircraft scatter again, but this time enough for a solid QSO. During the FT8 Activity session on 4 May, Tony made 68 QSOs in 30 locators including MM0CEZ and MM0ABM (IO75), GM1MYF (IO87) and a big signal from GS3PYE/P (IO67), EI8KN (IO62), EI2GLB (IO63), GI6ATZ, GD0TEP and GD6ICR all in IO74, G7RAU (IN79) and GU6EFB (IN89). The best to the east were DG2BCP (JO43) and OV3T (JO46).

The FM activity contest on 3 May was surprisingly good and Tony worked 17 stations in 10 locators, including 2E0VCC/P (IO70) and G4RRA (IO80). During the SSB session on the same day, Tony worked 2E0VCC/P and M0AFJ/P

(IO70) plus G4RRA (IO80) but only PE1EWR and PA3HFJ to the East. Tony says there were the usual GD/GI/GM stations but the band seemed better than normal into IO93/IO94.

The 70cm Band

Tony G4NBS took part in the FT8 contest on 11 May and made 71 QSOs in 28 locators, with one of the highlights being EI2GLB (IO63), which was a new square on the band for Tony. The best to the east were DF4IP and DK5IR (JN49), DG9BFE (JO33), DL1DBR (JO41), DJ4JB (JO44) and OV3T (JO46). During the FM Activity contest on 10 May Tony worked 2E0VCC/P and G4RRA easily and says it was much harder to find them on SSB! During the SSB session, Tony was unable to use ON4KST and was having problems with Airscout so, as he says, it was back to 'old school contesting'!

He made 93 QSOs in 23 locators but there was a lack of any distant stations in GM or EU. Tony says he was pleasantly surprised to be called by G8TZJ (IO84) in the last minute of the session and says it's rare for him to work a fixed station in that area.

The 23cm Band

Jef ON8NT has a Wimo flat panel antenna and used it to hear the Martlesham beacon, GB3MHZ on 19 April and to work G3XDY (JO02).

Microwaves

On a recent visit to Cheltenham I had an inspiring visit to the shack of **John Hawes G8CQX**. John uses a LimeSDR and wideband antenna pointing through a window to monitor the signals from the Shropshire beacon GB3ZME on 2.3 and 3.4GHz. John writes, "***Graham G3VKV*** *and I often look and compare notes in the morning on the microwave beacon from Telford and have found a consistent peak in signals just when the sun starts warming the atmosphere. 15dB of lift is quite common in anticyclonic sunny sorts of weather over this clear 95km path. There is also an evening peak, which Graham says is quite common around 9.30pm in activity periods. We also use Ventusky to look for temperature inversions. A couple of times over the past couple of years we have had extraordinary ducts, which have given up to +30dB lift on the signals".*

Satellites

Graham Jones G3VKV (Cheltenham) writes, "*I worked the two expedition QO-100 satellite stations, JW0X and JW100QO, on 22 April. They were located at JQ68TB Kapp Linne, Svalbard 78° North in the Arctic. Both stations were on at the same time on 10489.650 and 10489.900MHz, the rest of the transponder was virtually empty. Later in the weekend they worked DP0GVN at Neumayer III Station, Antarctica for the longest distance North to South QSO on the satellite. According to their log they worked 572 unique stations on QO-100. DP0GVN was also received here on DATV that weekend".*

Jef ON8NT monitored several ISS schools contacts on 6 and 11 April as well as receiving SSTV on 7 and 8 April. Jef continues his FT4 activity on the linear satellites, working DH4FR (JO43) on RS-44 and EA3AF (JN01) on FO-29.

Kev ZB2GI reports that **Antonio DL4EA** came to Gibraltar and brought some equipment to activate the QO-100 satellite from the Rock for the first time. Stations worked included JW0X (JQ68), JW100QO (JQ68), GB4LD (IN79), DL4EA (JN48), CU2AF (HM77), DB1GAW (JO31), DC1OA (JO43), DD3ZM (JO31), DG9BFC (JO42), DL2DCX (JO31), DL3IAS (JN49), DL6JZ (JO61), DL9RAN (JN68), EA2AZW (IN63), EA5TT (IM99), EU7SH (KO53), G0SYP (IO83), G0TKZ (JO01), GW8TIX (IO81), HB9WDF (JN47), IZ1AJJ (JN44), OM2DT (JN88), PR8KW (GI77), PR8ZX (GI64), PY1AX (GG87), SP5GNI (KO02), ZD7GWM (IH74) and ZS1RBT (JF95). Equipment for QO-100 was a Yaesu FT-897, DX Patrol up-convertor and power amplifier connected to POTY mounted on a 60cm dish for transmit and on receive, an LNB with TXCO fed via a bias tee, connected to an RTL_SDR dongle running on SDR Console with the Beacon lock feature activated.

Patrick Stoddard WD9EWK (Arizona) wrote his usual interesting report which I've had to shorten for space reasons. He writes, "*My road trip, on 30 April, coincided with* ***Tyler WL7T*** *hiring a boat and sailing to grid DM02 off the southern California coast* (**Fig. 3**). *I had worked previous DM02 activations from home, so I didn't need to do that again. Along with activating a few grids myself, I could work WL7T in DM02 from different locations around western and southern Arizona.*

"DM02 is one of the 488 grids used for the AMSAT GridMaster award, given to satellite operators who confirm contacts with all of those grids. The only landmass in that grid is San Clemente Island, a US Navy base. Access to the island is tightly restricted, but boats can sail around the island when those waters aren't being used by the Navy.

"WL7T/P reported he made 140 satellite QSOs from DM02, and 13 QSOs on 6m. These QSOs were confirmed in Logbook of the World within a couple of days. My road trip covered just over 600 miles, operating from four locations in five different grids. Since my main purpose was to work DM02 from different locations around Arizona, I didn't log as many QSOs as WL7T/P, but my day was still a success.

"Tyler WL7T plans to operate from grid EL84 near the Florida Keys in late June, over a weekend that is also the ARRL (and AMSAT) Field Day" **PW**.

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For more details see HamRadio.co.uk/DigiRig

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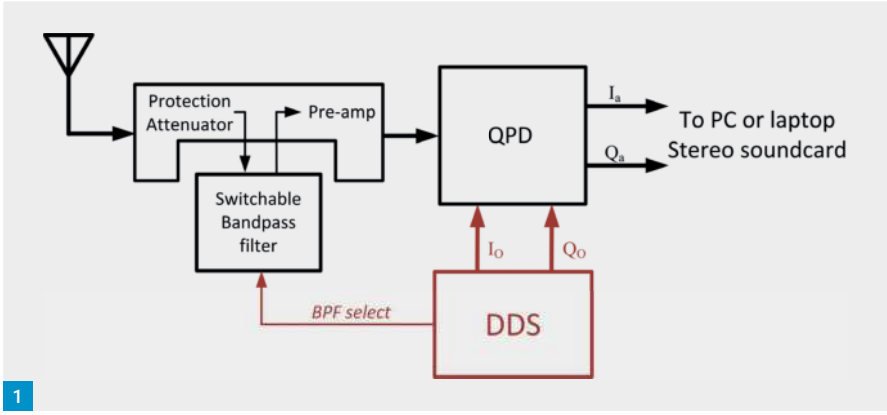

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Towards an all-band HF receiver (Pt II)

Dr Samuel Ritchie EI9FZB finishes the circuitry of the all-band HF receiver based on the quadrature product detector (QPD), as described in the January 2022 edition.

This article covers the one element coloured red in **Fig. 1**, a direct digital synthesiser driven by a Microchip microcontroller.

The two main requirements for this element were to provide coverage across 0.1 – 30MHz, and to control which of the eight bandpass filters (presented last month) is selected. It quickly became apparent that finding a kit or module to accomplish both of these functions would not be easy. While in the 1980s I had formally learned assembler programming, and had developed hardware and software around a number of imbedded controllers, this was my least favourite part of playing with electronics. In addition, my skills were decades out of date and I have zero enthusiasm for attempting to ascend the learning curve.

However, in the February 2021 edition of *PW*, in the *Kits & Modules* feature, **Geoff Theasby G8BMI** published his work on a 30MHz signal generator and how he had bought a pre-programmed microcontroller from **Joe G8KAM** that drove an AD9850 DDS module, which Geoff had purchased separately. This helped set me on the path to complete my project.

The AD985X range of ICs produce a frequency synthesised sinewave, which is used in many designs as a frequency source. To our advantage, the sinewave can be internally converted to a low jitter square-wave, which acts as an agile clock generator. As we want a square wave to drive our mixer (QPD) this removes the need to design our own sine-to-square wave converter. Of even greater advantage is that the high-speed comparator, used for the sine-to-square wave conversion, also provides a complementary clock output with synchronised falling and rising edges. This allows us to develop the required IQ clock pulses to drive the QPD from a frequency source running at twice the wanted frequency, instead of four times the wanted frequency as discussed in previous articles.

For this design I used an AD9851 module as shown in **Fig. 2**. I bought two of these modules from a far-eastern supplier on eBay for about €8 each – this is impressive as the Analogue Devices IC alone costs at least €30 through the usual sources. A schematic and a guide to using these modules were found online.

The Controller and Clock Generator

Having made contact with Joe G8KAM and explained what I wanted to achieve, he modified some existing code and sent me a programmed microcontroller, a schematic diagram, and a handbook detailing how to use all the functions offered.

I recaptured his circuit diagram, added voltage regulators, RS-232 level conversion, the I_{osc} and Q_{osc} generator circuitry, and produced a printed circuit board, which is shown fully populated in **Fig. 3**.

I have made the schematic diagram and the PCB available as open access on EASYEDA (if you want to duplicate or improve on my implementation). On the top left of the PCB in Fig. 3 are three rows of unconnected pads for development work or to correct errors. You can see some resistors, an LED and a FET (lying flat). These were required to invert one of the BPF control lines to correct a mistake I had made, which has since been corrected in the software and these components are not required from V4V4d of the software. The two missing resistors (R9 and R10) were required when using a mechanical rotary switch but as I moved to an optical encoder these were removed. These details are also explained on my website (below). The two vertical headers on the right-hand side of the PCB are where the switches are plugged in.

www.samuelritchie.com

Joe has done all the hard work and his software runs an LCD display, commands the AD9851 module, interfaces a rotary encoder and numerous switches, provides for BPF selection and allows control via a serial port. The handbook that Joe supplies details the use of the switches, how to calibrate the frequency output, apply a frequency offset (the usefulness of this was detailed in the February, 2022 article) and, among other functions, sets the output frequency to be twice what is displayed on the LCD. This last step is necessary as generating I_{osc} and Q_{osc} divides the output of the AD9851 by two. Version 4V4d of the software defaults to the required settings to run the QPD as per my implementation. That is, the AD9851 is set to run at twice the frequency displayed, the two outputs are 90° out of phase and an offset of 5kHz is selectable.

The controller and clock generator board was first connected to the QPD on the 14 August 2021, which is when the CW part of the Worked All Europe DX competition was on the go, and **Fig. 4** shows the HDSR display on the left and CW Skimmer working hard on the right – incidentally, no BPF was connected at this stage.

A Suitable Enclosure

Over Christmas 2021, all the various modules were integrated together in an enclosure as shown in **Fig. 5**. I chose to use a two-unit height, 19in rack as my enclosure. I bought a few used enclosures some years ago when they were available cheaply. These particular enclosures have the advantage that the front panel is a flat piece of aluminium that slots into a frame, unlike some racks where the front panel has slots and keys as it forms part of the frame, all of which make it difficult to machine or replace.

In Fig. 5 you may recognise the BPF (top left) made from PCB, the attenuator and preamplifier in its tin box (middle right) and the QPD in its larger tin box (right-hand side). The microcontroller with the blue PCB piggybacked on it is middle left. The power supply comes in two parts. The mains transformer, rectifier, smoothing caps and a DC/DC converter are in the top right-hand corner where the mains plug enters on the back panel. The linear rectifiers are on the PCB in the centre of the box.

The PCB lying on its side (bottom left) with four pushbuttons was removed once testing was completed, and version 2 of the software was installed.

Fig. 1: Basic block diagram.
Fig. 2: AD9851 Module as delivered.
Fig. 3: Populated microcontroller PCB.
Fig. 4: In use on 14MHz during the 2021 WAE DX competition. Fig. 5: Top view into the enclosure. Fig. 6: Power Supply Schematic. Fig. 7: Power Supply Boards. Fig. 8: Example of the front panel switches. Fig. 9: Design and build of the front panel. Fig. 10: The decal. Fig. 11: In action listening into numbers stations.

Power Supply

Each of the modules contains its own power supply; this is a consequence of various modules being developed at different times. So instead of one common input voltage for all the modules, we need to provide three different voltages (as shown in the schematic in **Fig. 6**).

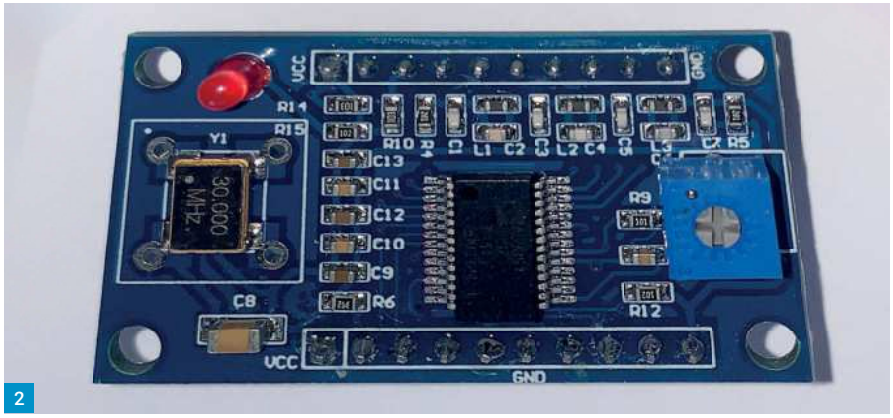
SW6 is a rocker-type mains switch on the front panel, and while its role is to switch the mains live wire it also needs the neutral line attached to light the internal bulb when the switch is in the on position. The transformer (T1) has two secondary windings connected in series. I used this transformer as it was on my shelf but it is not an ideal choice as the rectified and smoothed output after the capacitors (C16 & C17) is around 25V. This then requires U13 (7815) to drop 10V. At 0.5A this is 5W and U13 will, over time, get very hot. To overcome this I used a DC/DC converter to reduce the voltage presented to U13 to 18V.

These DC/DC converters contain the LM2596 IC and were purchased fully assembled off eBay for about €4.50 – so I bought a few as they are useful items to have around. **Fig. 7a** shows the transformer, bridge rectifier, solid-state fuse, the large capacitors, and the blue PCB containing the DC-DC converter.

U13 provides +15V to the QPD, which consumes less than 100mA. U14 provides +12V at 200mA to the preamplifier, attenuator and protection circuitry, which incidentally provides the 5V to the BPF. U15 and U16 combine to provide +8V at 200mA to the microcontroller board, which has its own 7805 voltage regulators. RP1 is used to set the output voltage at H10. **Fig. 7b** shows the PC with the regulators as well as the three LEDs and associated 1kΩ resistors on each output (H8, H9 and H10), which are not shown in the circuit diagram. The heatsink on U13 was not necessary once I had added the DC-DC converter.

Front Panel

In 2010 I bought a box of ITT Schadow Digistat switches off eBay and have been waiting for the opportunity to use them. These switches have a lovely tactile feel to them and during the 1980s and 1990s they were found on many professional pieces of test equipment and recording equipment. However, with this beauty come two disadvantages. First, you need to cut rectangular slots into the front panel instead of simply drilling nice round holes. Second, you need a PCB behind the panel onto which the switches are mounted as the switches need to just poke through the front panel and there is no way to attach them to the front panel.



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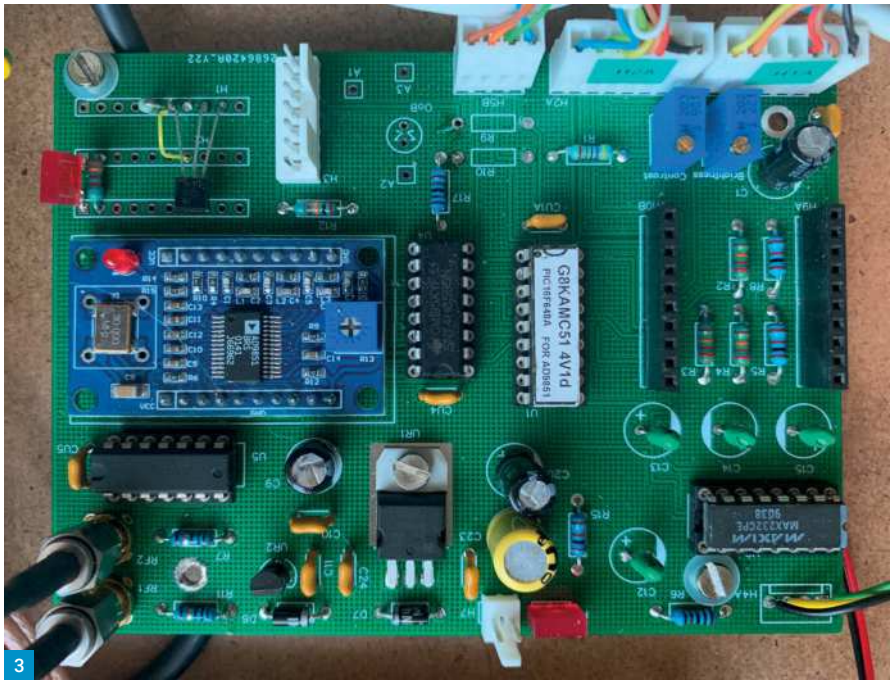

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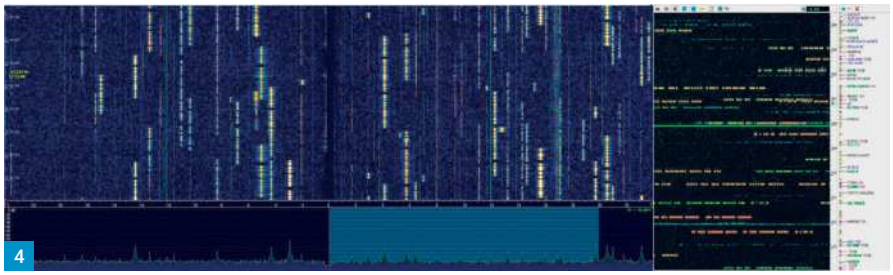
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An example is shown in **Fig. 8a** where I have balanced a PCB on the front panel. With reference to the schematics in last month's publication the first switch is the test button (SW1), which has a red led (LED 1) mounted in the switch. This is followed by the switch to turn the preamplifier on and off (SW5) and its green LED (LED 2), and then the attenuator selector switch (SW3) with its four LEDs showing which of the five attenuator settings has been selected (LED 3, 4, 5 & 6). The PCB is mounted using two M2.5 screws and 8mm pillars to get the right spacing so that the switches just poke through the front panel. I used M2.5 × 6mm countersunk, slotted machine screws and was able to countersink the heads of the screws so that they were flush on the front panel.

Fig. 8b shows the back of the PCB and contains U2 (debounce SW5), U12 (debounce SW2), U7 (count through the five attenuator options), the attenuator LEDs, and the voltage dropping resistors for the LEDs.

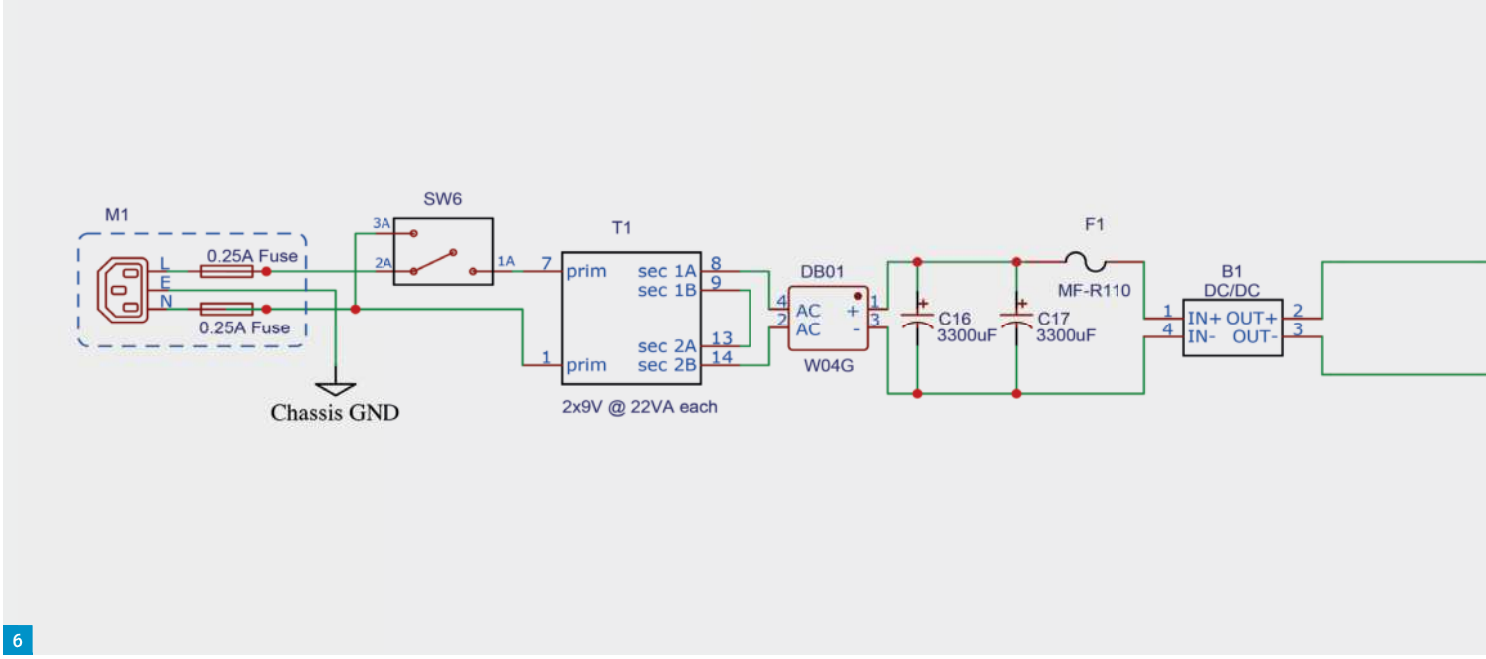

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Fig. 9 is included to show how the front panel was developed. Top picture – using Microsoft Visio I designed and drew the layout of the front panel on a 1:1 scale. This was used to cut the slots for the 12 switches, the slot for the LCD, and to drill the holes for the LEDs, screws and rotary encoder as shown in the second picture from the top. I have assembled the four switches used to select left, right, up and down to show how the switches fit and the value of using countersunk screws.

In the May 2020 edition of *PW*, I contributed an article about making professional looking front panels, and showed how to use film-free laser decal paper. Since then, I have been considering other options that may be better suited, particularly when using LCD displays where you want to perhaps cover up any slightly imperfect cutting and filing work. I came across a number of companies that let you design a hardy sticker or decal that can be used (for example, on windows or cars to advertise or display products).

Using Microsoft Visio, I expanded on the cutting template (Fig. 9 again) to add graphics and text, and the top picture in **Fig. 10a** shows a printout from Visio that has been checked against the drilled and populated front panel. You can see my hand-drawn changes on the paper. **Fig. 10b** shows the completed decal. I just saved the Visio design as a JPG image and uploaded this to Signomatic's webpage (URL below), made sure I specified the size of the decal and for less than €14 each (which including shipping and VAT), two decals arrived in the post within ten working days. It appears that the actual manufacturing takes place in Sweden.

www.signomatic.ie

I did not attempt to use the whole decal, which was blue graphics on a white background. Instead, I cut out the four blue sections using scissors, cut out the white where the switches, LCD and LEDs would need to poke through using a scalpel and then stuck these four decals onto the front panel once I had mounted everything. This approach allowed me to hide my mounting screws beneath the decal, cover up any cutting or filing imperfections, and achieve a professional result. I suspect this is the approach I will be taking in the future. The rotary encoder knob comes from JAB Electronic Components and is a Racal Finger Indent Tuning Knob (~£10 each). It is a nice size to operate, the finger indent is a convenient feature and there is a cover that goes over the large brass coloured screw.

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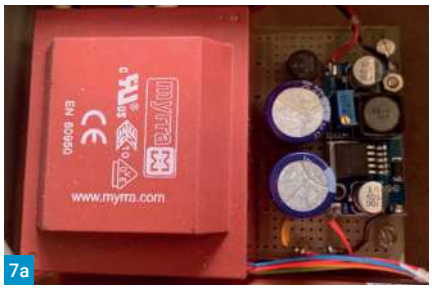

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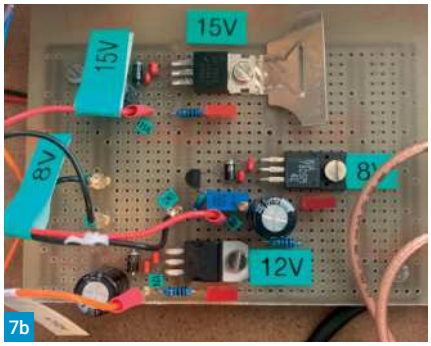


7b

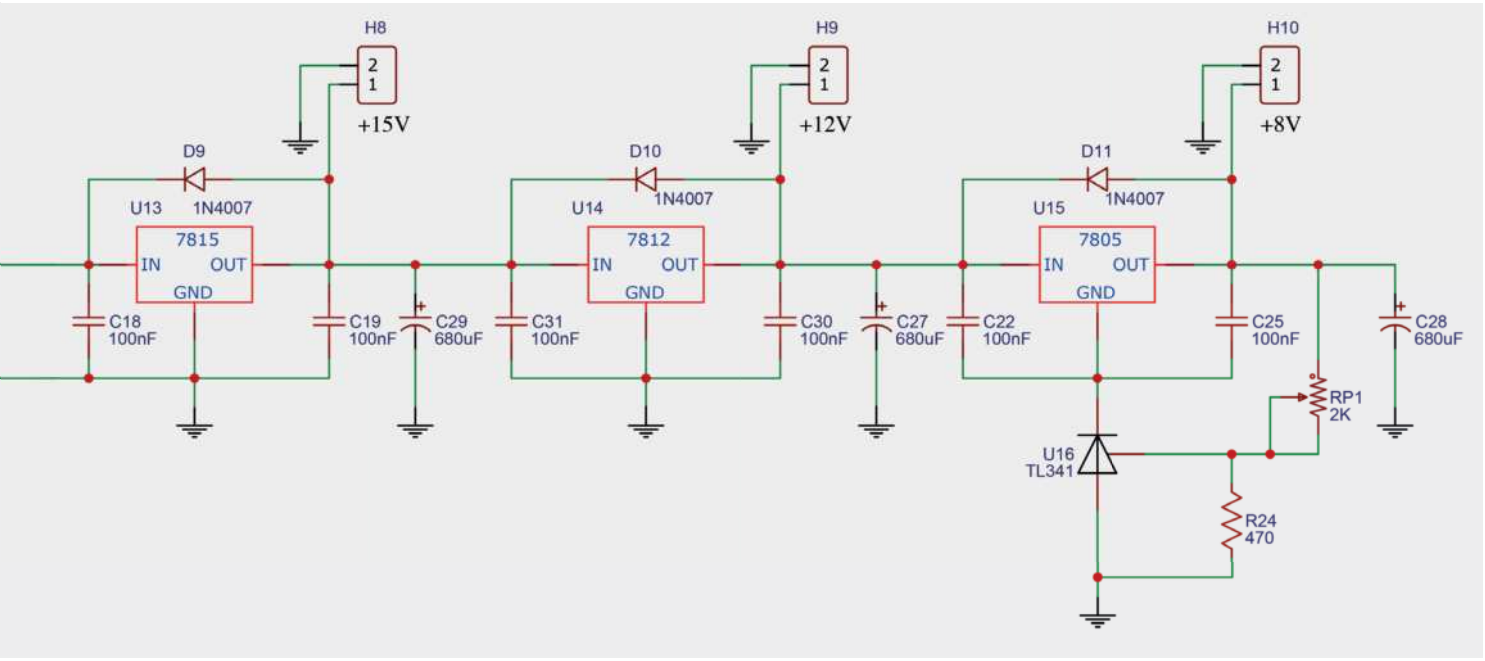
End Notes

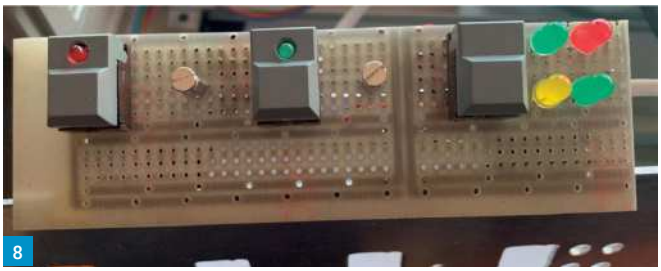
To purchase a programmed microcontroller please contact Joe G8KAM at **joe_nand@hotmail.com** and request the PIC928 microprocessor with the KAMC51 4V4d or later update of the software.

Fig. 11 shows the receiver in action the day after Russia moved on the Ukraine. Here the receiver is tuned to 5404kHz and I am listening 5kHz higher (5409kHz) on USB to the number station known as *Obilque*, which emanates from Poland. Many of the Russian number stations in particular at this time seemed to be carrying a lot more traffic than usual.

I have made further information available on my website. This includes the schematic for the controller and clock generator, how to order your own PCB, larger high-resolution pictures, more details on some of the components used, what spray paint colour was used, the Visio file I used to make the decal, etc.

I have no stake in any items sold by G8KAM and no connection to Jab Electronic Components or Signomatic. **PW**

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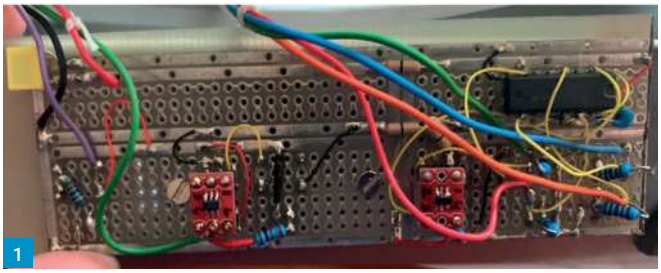
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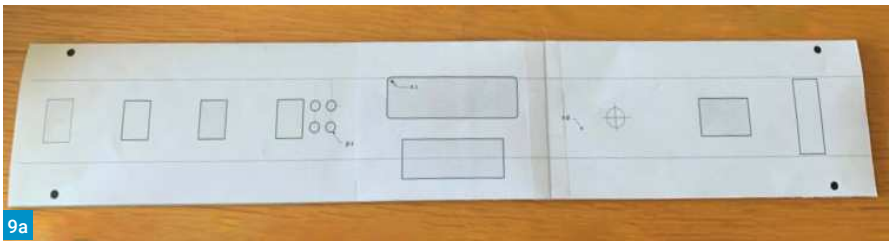
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10a


10b


11

Read more radio news and reviews at www.radioenthusiast.co.uk/news

WHISTLER

TRX-1E Digital Handheld Scanner

We have worked with Whistler to customise a UK band plan for the scanners! This ensures the radios cover UK bands in the correct steps and the correct mode. The TRX-1 will receive both amateur and commercial DMR transmissions as apart from the frequency they are fundamentally the same mode. The radio is supplied with software and users can select mode when writing memories or select auto and it will work out the mode itself!
This multi-system adaptive digital trunking scanner supports Motorola P25 Phase I, X2-TDMA, Phase II and DMR.

Buy the TRX-1E for just

£419.95

WHISTLER

WS1065 Desktop Radio Scanner

The Whistler WS1065 employs cutting edge technology to bring a high level of performance and innovative features. This model clearly raises the bar in the area of advanced trunking scanners. Frequency coverage is extensive including: 25-54, 108-17, 137-174, 216-512, 764-776, 795-805, 849-869, 896-960 and 1240-1300 MHz.
1800 memories are available and may be dynamically structured to bank sizes you prefer. Plus you can store 21 virtual scanners (so that is a total of 37,800 objects).
The large backlit LCD is four lines by 16 characters. The keys are also backlit. Supported trunking systems include Motorola Analog, EDACS, LTR and Digital APCO (9600 bps).

KEY FEATURES

- Alert LED • Audible Alarms • Automatic Adaptive Digital Tracking
- Backlit Liquid Crystal Display • Data Cloning • Digital AGC
- Flexible Antenna with BNC Connector • High Speed PC Interface
- Free-Form Memory Organization • LTR Home Repeater AutoMove
- Key Lock • Lock-out Function • Memory Backup
- Menu Driven Programming with Context Sensitive Help
- Multi-System Trunking • P25 NAC Functionality

Buy the WS1065 for just

£299.95

WHISTLER

WS1025 Desktop Radio Scanner

This 300-channel scanner can be categorized into 10 separate memory banks. Plus one-touch searches of marine, air and ham Frequency Range: 29-54 VHF Low Band. 87.3-107.9. 108-137 Civil Aircraft Band Includes 833 kHz steps. 137-144 VHF. 144-148 Amateur Band 2 Meters 148-174 VHF High Band

Buy the WS1025 for just

£89.95

WHISTLER

TRX-2E Digital Desktop Scanner

Buy the TRX-2E for just

£479.95

The radios will receive both amateur and commercial DMR transmissions as apart from the frequency they are fundamentally the same mode. The radio is supplied with software and users can select mode when writing memories or select auto and it will work out the mode itself!

This multi-system adaptive digital trunking scanner supports Motorola P25 Phase I, X2-TDMA, Phase II and DMR making it capable of monitoring the following unencrypted channels/systems:

- Conventional DMR (Entered as a DMR trunked system)
- Hytera XPT
- MotoTRBO™ Capacity Plus
- MotoTRBO™ Connect Plus
- MotoTRBO™ Linked Cap Plus systems
- NXDN & DMR out of the box

KEY SPECIFICATIONS

- Frequency: 25-54MHz, 108-136.99MHz, 137-174MHz, 216-379.97MHz, 380-512MHz, 764-781MHz, 791-796MHz, 806-960MHz (excluding cellular), 1240-1300MHz
- Simple Zip Code programming
- Easy updating via Internet
- APCO P25 Digital Phase I & II
- Removable, remote magnetic head
- Scanning at up to 70 channels/second
- CTCSS and DCS subaudible decoder
- IF Discriminator Out • Store Favourites Scan List
- User upgradable CPU firmware
- Spectrum Sweeper • Clock / Calendar
- Tuning Steps: 2.5, 3.125, 5, 6.25, 7.5, 8.33, 10, 12.5 ad 25 kHz.

WHISTLER

WS1010 Handheld Scanner

This 400-channel scanner lets you listen to FM radio bands and can be categorized into 10 separate memory banks. Also, it offers the convenience of one-touch searches of marine, air and ham
Key Features/Specifcations:
200 Channel memory - plenty of memory to store all your favorite frequencies in 10 separate storage banks. Backlit Liquid Crystal Display - easy to read and program data even in low light situations.. Data Cloning - allows transfer of the programmed data to another WS1010 scanner.

Buy the WS1010 for just

£89.99

WHISTLER

WS1040 Handheld Scanner

The WS1040 scans most common trunked radio system signalling formats, including Motorola, EDACS, LTR and P25 trunked radio networks. Talk group and individual call monitoring is supported.
When monitoring P25 digital systems, the exclusive Automatic Adaptive Digital Tracking instantly adapts the digital decoder to the digital modulation format of the transmitted signal, then analyses the signal over 50 times each second and adapts to any subtle changes caused by multipath or fading. No cumbersome manual adjustments are required.

Buy the WS1040 for just

£299.95

WHISTLER

TRX-1 Leather case

Keep your traesued TRX-1 safe with this high quality leather case

£29.95

MRW-TRX3 Antenna Pack

Three compatible antennas in this great pack

£39.95

TRX SD cards

A genuine replacement for the Whistler TRX-1 SD card

£19.99

BEST SELLER

UKAFG UK Airband Frequency Guide 2022

A printed ring-bound Aviation frequency guide, Includes free UKAFG website access to frequency updates, Civil and Military call signs and Maps until the 1st of Jan 2023

- HF VHF UHF • Civil and Military
- Common Frequencies • Airports A to Z
- UK ATC and high-level European
- 8.33khz conversion • Transmitter Sites
- Frequency/Channel list • Squawk codes

Buy this guide for just

£16.95

PR781 - AR Dynamic Studio Quality Microphone

A professional quality dynamic cardioid microphone for amateur radio that is specifically designed for use with most makes of Elite transceivers. This is a truly remarkable dynamic microphone. Heil engineers were requested by ICOM to develop a very special microphone package for their iC-7800 radio.

FEATURES
- Output Connection: 3 pin XLR
- Generating Element: Dynamic
- Frequency Response: 50 Hz to 16,000 Hz
- Polar Pattern: Cardioid
- Output Level: -55 dB
- Impedance: 600 ohms balanced out , 3pin
- Diaphragm: 1 1/8" Low-mass aluminium
- Weight: 14oz.
- Finish Black: Black Satin Epoxy

All for just
£199.99
199 WATTS

BM17DYN – AR Lightweight Dual Sided Boom Set With Dynamic Element

A lightweight dual-side headset designed for Amateur Radio use. To accommodate different radio setups, the BM-17 is available with a BM-17-Dynamic element. The speakers used in the BM-17 are very sensitive and don't require much AF gain from the transceiver. The frequency response is 200 Hz – 5 kHz with very low distortion. The ear pads are replaceable acoustic foam.
The microphone audio for the BM-17 series terminates into a 1/8" mono plug while the headphone terminates into a 1/8" stereo plug (1/8" to 1/4" adapter included).

The use of the AD-1 series mic adapters allows simple interface with popular transceiver inputs. The adapter cable has a 1/8" female input jack for the headset microphone while the 1/4" female that exits the adapter is the PTT (push to talk) line for the Heil foot switch or hand switch. The 1/8" or 1/4" stereo plug goes into the headphone jack on the transceiver front panel.

All for just
£119.99
119 WATTS

Proset 3 – Pro Stereo Studio Headphones

There is no better product than the Heil Pro Set 3 stereo headphones, to illustrate the fact that Bob Heil's ability to listen leads to his company, to build high quality professional sound products.

Anyone who has ever professionally recorded or monitored audio will tell you that the last thing they worry about is whether headphones look good… The fact that the Heil Pro Sound 3 looks so good is a bonus.

You get three detachable cables. A 1.8 M flexible straight cable; and a 1.8 M straight cord with mating iPhone/iPod compatible 3.5mm plug; and also, a 3 M coil cord – all twist lock terminating in a 1/8" (3.5 mm) professional gold plated screw-on 1/4" (6.3mm) adapter.

All for just
£109.95
109 WATTS

Proset Elite 6

The new Heil Pro Set Elite is the ultimate boom set designed for amateur radio operators and uses the Heil HC-6 wide response microphone element. The HC-6 is designed for full range audio or can be adjusted (with radio adjustment) for bright, articulate audio to cut through amateur radio noise and signal pileups. The Pro Set Elite offers dual side, highly efficient speakers mounted in acoustically tuned chambers which offer high rejection of outside noise. The exclusive Heil Phase Reversal feature allows the user to move the signal acoustically, which creates a spatial widening of the sound field that makes it easier to 'see' a signal inside a pileup while removing listener fatigue during prolonged use. The headphone's speakers fold up for easy storage.

The field-replaceable cushioned ear pads also come with removable cotton covers that can be easily removed for washing. The 6' coiled cable terminates in a 1/8" mono plug for the microphone, and a stereo 1/8" plug for headphone speaker connection. An 1/8" to 1/4" adapter is also supplied. The Pro Set Elite works with all Heil AD-1 adapter cables, which mate with just about every type of amateur radio transceiver.

All for just
£189.95
189 WATTS

PRO 7 - AR Industrial Headset

An aviation-style headset designed for amateur radio use in high noise environments. The specially designed foam-gel ear pads provide 26 dB outside noise reduction and provide exceptional comfort. A true dual channel, stereo headset, the Pro 7 Series feature an audio balance control which allows the user to adjust the level of the left earphone to match the right. A unique phase-reversal switch greatly helps the listener "dig out" weak signals. The latest version of the Pro 7 features a monitor jack which allows a second operator to plug in headphones and monitor audio. The flexible gooseneck mic boom on Pro 7s may be rotated for use on either the right or left ear.

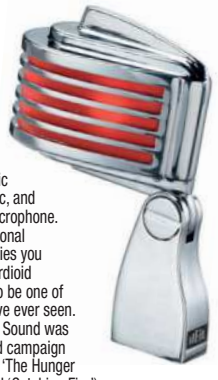
All for just
£289.95
289 WATTS

PMSIC – AR Pro-Micro Single-Sided Headset

The Pro Micro is a lightweight single-side headset designed for Amateur Radio use. The Pro Micro is available with a IC electret element. The speakers used in the Pro Micro are very sensitive and don't require much AF gain from the transceiver. The frequency response is 20 Hz – 17 kHz with very low distortion. The ear pads are replaceable acoustic foam. The Pro Micro IC: contains the Heil IC electret microphone element.

All for just
£84.95
84 WATTS

FIN RED – Professional Chrome Microphone



The Fin microphone from Heil Sound was featured prominently in the ad campaign for the 2012 smash hit movie 'The Hunger Games', (as well as the sequel 'Catching Fire'), for its amazing looks. The Fin combines that "vintage mic look", with a blend of futuristic, and TIMELESS, all in one shiny microphone. However, The Fin is a professional microphone with all the qualities you could ask for in a dynamic cardioid microphone, it just happens to be one of the coolest looking mics you've ever seen. The Fin microphone from Heil Sound was featured prominently in the ad campaign for the 2012 smash hit movie 'The Hunger Games', (as well as the sequel 'Catching Fire'), for its amazing looks.

All for just
£219.95
219 WATTS

PRASEQ – AR Parametric Receive Audio System EQ

The new receiver audio processing system for ham radio and general communications. It enables you to optimise your reception for band and signal conditions as well as for your personal hearing.

Midrange frequencies are the most critical for achieving clear voice articulation in receive audio. The PRAS allows operators to have unique control over these important frequencies. First, operators can adjust the parametric midrange filter (MID FREQUENCY) from 400 Hz through 4 kHz, with the recommended sweet spot being at 2.5 kHz. In addition, operators can control the presence of these midrange frequencies plus or minus 15 dB using the MID GAIN control. Combined with a low-frequency filter (LOW) set at 160 Hz, and a high-frequency filter (HIGH) set at 6 kHz, the PRAS provides operators unparalleled control and quality of their receive audio.

All for just
£219.95
219 WATTS

PR10 PKG -AR Dynamic Microphone with LB-1 Lighted base

This microphone will bring your radio to life with full speech articulation and perfect balance. This package contains Heil's compact PR10 microphone, an LB-1 table base with an LED-backlit transmit status light, and an adjustable 8" mic boom to bring the mic up to a comfortable operating position during use. Although compact in size this microphone is built around a full 1-1/8" diameter dynamic element, just as our other. Producing full articulate sound from 85Hz to 16kHz you will be sure to be heard with every transmission.

All for just
£249.95
249 WATTS

RigExpert

AA-2000 Zoom Analyser

SPECIFICATION
- Frequency: 0.1 to 2000MHz
- Frequency entry: 1KHz resolution
- Measurement for 25, 50, 75, 100, 150, 200, 300, 450 and 600-Ohms systems
- SWR measurement range: 1-100 in numerical mode / 1-10 in chart mode
- R&X range 0…2000, -2000…2000
- Dimensions: 230mm x 100mm x 55mm
- Weight:650g
- Operating temperature: 0-40 C (32-104 F)

Buy the AA-2000 for just
£849.95

849 WATTS

RigExpert

AA-1500 Zoom Analyser

SPECIFICATION
- Frequency: 0.1 to 2000MHz
- Frequency entry: 1KHz resolution
- Measurement for 25, 50, 75, 100, 150, 200, 300, 450 and 600-Ohms systems
- SWR measurement range: 1-100 in numerical mode / 1-10 in chart mode
- R&X range 0…2000, -2000…2000
- Dimensions: 230mm x 100mm x 55mm
- Weight:650g
- Operating temperature: 0-40 C (32-104 F)

Buy the AA-1500 for just
£699.95

699 WATTS

RigExpert

AA-650 Zoom Analyser

SPECIFICATION
- Frequency: 0.1 to 650MHz
- Frequency entry: 1KHz resulotion
- Measurement for: 25, 50, 75, 100, 150, 200, 300, 450 and 600Ω systems
- SWR measurement range: 1-100 in numerical mode / 1-10 in chart mode
- R&X range: 0… 2000, -2000… 2000
- Dimensions: 230mm x 100mm x 55mm
- Weight:650g
- Operating temperature: 0-40 C (32-104 F)

Buy the AA-650 for just
£619.95

619 WATTS

RigExpert

AA-230 Zoom Analyser

This analyser is designed for measuring SWR (standing wave ratio), return loss, cable loss, as well as other parameters of cable and antenna systems in the range of 100kHz to 230MHz A built-in ZOOM capability makes graphical measurements especially effective.

SPECIFICATION
- Frequency: 0.1 to 230MHz
- Frequency entry: 1KHz resolution
- Measurement for: 25, 50, 75 and 100-Ohm systems
- SWR measurement range: 1-100 in numerical mode / 1-10 in chart mode
- R&X range: 0…10000, - 10000…10000 in numerical mode /0…1000, -1000…1000 in chart mode
- Dimensions: 82mm x182mmx32mm
- Weight:236g
- Operating temperature: 0-40 C (32-104 F)

Buy the WS1010 for just
£339.95

339 WATTS

RigExpert

AA-55 Zoom Analyser

This analyser is designed for measuring SWR (standing wave ratio), return loss, cable loss, as well as other parameters of cable and antenna systems in the range of 60kHz to 55MHz A built-in ZOOM capability makes graphical measurements especially effective.

SPECIFICATION
- Frequency: 0.06 to 55MHz
- Frequency entry: 1KHz resolution
- Measurement for: 25/50/75/100/150/200 /300/450/600 ohm
- SWR measurement range: 1-100 in numerical mode / 1-10 in chart mode
- R&X range: 0…10000, - 10000…10000 in numerical mode /0…1000, -1000…1000 in chart mode
- Dimensions: 103mm x207mmx37mm
- Weight:310g (without batteries)
- Operating temperature: 0-40 C (32-104 F)

Buy the AA-55 for just
£299.95

299 WATTS

RigExpert

AA-35 Zoom Analyser

This analyser is designed for measuring SWR (standing wave ratio), return loss, cable loss, as well as other parameters of cable and antenna systems in the range of 60kHz to 35MHz A built-in ZOOM capability makes graphical measurements especially effective.

SPECIFICATION
- Frequency: 0.06 to 35MHz
- Frequency entry: 1KHz resolution
- Measurement for: 25, 50, 75 and 100-Ohm systems
- SWR measurement range: 1-100 in numerical mode / 1-10 in chart mode
- R & X range: 0…10000, - 10000…10000 in numerical mode /0…1000, -1000…1000 in chart mode
- Dimensions: 103mm x207mmx37mm
- Weight:310g (without batteries)
- Operating temperature: 0-40 C (32-104 F)

Buy the AA-35 for just
£209.99

209 WATTS

RigExpert

STICK PRO Antenna Analyser

SPECIFICATION
- Frequency: 0.1 to 600MHz
- Frequency input step: 1KHz
- Measurement for: 25, 50, 75, 100, 150, 200, 300, 450 and 600Ω systems
- SWR measurement range: 1-100 in numerical mode / 1-10 in graph mode
- R&X range: 0… 2000, -2000… 2000
- Dimensions: 185mm x 40mm x 33mm
- Weight:185g with battery
- Operating temperature: 0-40 C (32-104 F)

Buy the STICK-PRO for just
£349.99

349 WATTS

RigExpert

STICK 230 Analyser

SPECIFICATION
- Frequency: 0.1 to 230MHz
- Frequency input step: 1KHz resolution
- Measurement for: 25, 50, 75, 100, 150, 200, 300, 450 and 600 Ohm systems
- SWR measurement range: 1-100 in numerical mode / 1-10 in graph mode
- R&X range: 0… 10000, -10000… 10000
- Dimensions: 185mm x40mmx33mm
- Weight: 185g
- Operating temperature: 0-40 C (32-104 F)

Buy the STICK-PRO for just
£269.95

269 WATTS

RigExpert

TI-5000 Transceiver Interface

RigExpert TI-5000 is a new and powerful USB transceiver interface based on high quality stereo codec IC, for operating phone, CW and digital modes using personal computer.
All in one through a single USB port. Ideal interface for FT8 and WSJT modes!
Transceiver audio interface: Analog audio interface is a connection to transceiver audio output (external speaker connector or line output) and transceiver audio input (microphone connector or line input). Audio interface enables operating digital modes, recording and playing voice, as well as other useful functions (such as measuring levels of a signal from the air) by using a computer. Input (two channels) and output volume levels are adjusted by potentiometers on the front panel of the device.

Buy the STICK-PRO for just
£154.99

154 WATTS

SHARMAN multiCOM

AR-600XL VHF/UHF Antenna Rotator

The SHARMAN AR-600 VHF/UHF Antenna Rotator with Base Control unit and Infa red remote control is designed for use with the smaller antennas Typical suitable antennas are smaller 2m and 70cm beams or tv antennas The AR-600 has programmable antenna controller with Infra-red remote-control. AR-600 remembers up to 12 antenna directions with back up Control over all functions is either with the infra-red remote control or control unit.
The control unit displays location chosen and relative position. Rugged Light-duty rotator is built in a weather-proof one piece cast aluminium housing. Has precision metal gears and steel thrust bearings for durability. Supplied with rotator, controller, 3-device universal remote, mount clamps and hardware.

SPECIFICATIONS
- Mast size : 28 to 44 mm (1.1/8" - 1.3/4")
- Rotation time : approx. 74 sec.
- Rotation torque : 21.5 Nm
- Weight : 4.2kg
- Control unit : with digital direction indicator
- Operating Voltage 220-230VAC
- Requires 3-wire control cable (not included)

Buy the AR-600XLfor just
£199.95

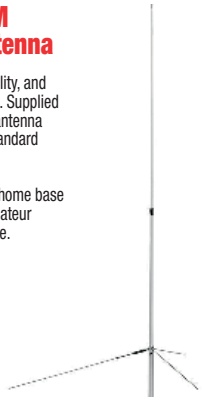
199 WATTS

SHARMAN multiCOM

V-2000 6M/2M/70CM Triple Band Base Antenna

GRP fibreglass outer shell for durability, and pre-tuned for the appropriate bands. Supplied complete with mast brackets. This antenna is a two section antenna and has standard SO239 connection fitting.

A good value for money triple band home base antenna for the 50/144/430MHz amateur bands offer outstanding performance.



KEY FEATURES:
- Frequency range - 50 / 144 / 430MHz
- Max power - 150W
- Gain - 2.15dB @ 50MHz 6.2dB @ 144MHz 8.4db @ 430MHz
- Length - 2.2M
- Weight - 1.3Kg

Buy the V-2000 for just
£69.95

69 WATTS

MC-4MT 4M 5D-FB Cable Kit SO239 to PL259

Buy the MC-4MT for just
£17.99

17 WATTS

SHARMAN multiCOM

SM-50II 50 AMP Switch Mode Power Supply Unit

Includes noise offset control to eliminate the pulse noise of the switching circuit. This patent pending function is specially designed for communication equipment use. Its effectiveness may vary depending on the frequency and mode.

KEY FEATURES/SPECIFICATIONS
- Input Voltage: 220VAC
- Output Voltage: 9-15Vadjustable
- Output Voltage regulation: less than 2%
- Output current: 50A
- Meter: Displays the supply voltage and current
- Cigarette plug terminal: 10A (max)
- Protection: Short circuit and automatic current limiting over 50A
- Dimensions:170mm (W) X 120mm (H) X 260mm (L)
- Weight: 3kg • Fuse: 8A

Buy the SM-50II for just
£129.95

129 WATTS

SHARMAN multiCOM

AV-508 – Deluxe Desktop Microphone

Suitable for most modern radios with required lead

FEATURES
High-sensitivity condensed microphone element - ensures better voice quality Runs on 2 AA batteries (Not included), Flexible goose neck supporting the microphone

Buy the AV-508 Receiver for just
£69.95

69 WATTS

SHARMAN multiCOM

AV-SW2M - 2 Way SO239 Coax Switch

KEY FEATURES/SPECIFICATIONS:
- Sockets SO239 • Power 2kW (DC-30MHz), 1kW (30-200MHz), 500W (200-500MHz), 250W (500-1000MHz)
- Range DC-1000MHz
- Insertion Loss: DC-500MHz 0.05dB, 500-1GHz 0.10dB
- Size 89 x 70 x 40mm • Weight 446g

Buy the AV-SW2M for just
£34.95

34 WATTS

BM145 -PL (SO239) Large Magnetic Base

Buy the BM145-PL for just
£19.95

19 WATTS

SHARMAN multiCOM

STORM 100 CB Base Antenna

The Storm 100 CB base antenna is ideal when you only need local range and a compact antenna.

SPECIAL FEATURES
- Frequency - 26-28MHz
- Max Power - 30W
- Length - 1m
- Radials -3
- Gain - 0.5dB
- Bandwidth - 500kHz

Buy the STORM 100 for just
£39.95

39 WATTS

SHARMAN multiCOM

AV-600 VSWR Power Meter

Treat yourself to the Sharman AV-600 VSWR / Power Meter. It reads RMS and PEP and covers from 1.8MHz to 525MHz. It uses two sensors with five power ranges 0-5W / 20W / 200W / 400W

KEY FEATURES/SPECIFICATIONS
- 1.8-160MHz (S1) • 140-525MHz (S2)
- Two Sensors • 5W, 20W, 200W, 400W
- 13.8V DC Lamp • 155 x 63 x 103mm • Weight 720g

Buy the AV-600 for just
£74.95

74 WATTS

SHARMAN multiCOM

AV-6075NF – 75 AMP Swtch Mode Power Supply

The Sharman AV-6075NF is a lightweight, high performance, high efficiency, durable, switching power supply with highly visible back light, easy to read dual meters and audio noise cancel function.

Buy the AV-6075NF for just
£349.95

349 WATTS

Derek Hughes G7LFC

Brickworks Relaunched for 2022

The RSGB explain the Brickworks scheme and what it might mean for you and your club.

Brickworks is an exciting and fun way to build on what you've learned while studying on your Foundation Course, returning to the hobby after a break, or wanting to explore new aspects of the hobby you've never experienced before – all in the friendly supportive environment of a Brickworks Accredited Club. It helps you build your confidence, expand your knowledge, gain a greater understanding of how to get the best out of your hobby, and enjoy new experiences.

Brickworks – Why the Relaunch?

Originally launched in 2020 as the 'Beyond Exams Club Scheme', Brickworks is a framework that clubs can use to support members as they explore different facets of the hobby. Unfortunately, soon after the launch, the pandemic resulted in clubs shutting down physical meetings and the amateur radio community turning to online resources for information and support. Webinars, videos, and websites became the go-to source for individual radio amateurs, which affected the uptake of the Club Scheme.

As clubs started to spring back into life earlier this year, they saw a return to a 'new' normal with lower numbers attending meetings. Also, recently licensed radio amateurs were observed on social media asking the sorts of questions that could easily be answered if they had the support of a local club. In response, the RSGB is relaunching the Club Scheme to give it the chance it needs to succeed, to support affiliated clubs, and to assist the large number of newly licensed radio amateurs that have been created over the last two years in a predominantly online environment.

As part of the relaunch, the scheme will revert back to its original name, Brickworks, giving it a modern, short, snappy, and memorable name that, together with its strap line, 'Building on the Foundation', symbolises exactly what it is all about; providing the construction blocks (activities) that build up the participant's knowledge, understanding, experience and confidence, to produce a strong radio amateur ready for a lifetime of operating, sharing, and progressing.

Why Should You Take Part in Brickworks?

The RSGB understands that taking the Foundation test and obtaining a licence is a giant step for many and that this technical hobby has many facets, which frightens some people. This has been compounded by the pandemic, especially when they've had to make their first contact solo.

Brickworks is being relaunched to provide a friendly and supportive environment for those new to the hobby and those returning to a hobby that has changed so much over the years. It provides clubs with a framework of activities that enable participants to get a taste of as many different parts of the hobby as possible.

By signing up with a Brickworks Accredited Club you can join a group that has committed to support you. The club will deliver sessions on various aspects of the hobby that are aimed at your level and follow these up with a range of unique practical activities, enabling you to experience them for yourself. Your fellow group members will support you too, providing help and advice if things go a little awry. To reward you for all your hard work and accomplishments, the club will present you with awards so that you can be proud of your progress and achievements.

Brickworks isn't just for those who are new, or returning, to the hobby. Many of us have used the same modes and bands for many years. Maybe it's time for a change, or something new intrigues you; Brickworks is for you too.

If you're already with a club that isn't yet Brickworks accredited, why not ask them to register. You can then take part in Brickworks together and reap the benefits and rewards.

BRICKWORKS
Building on the Foundation

How do You get Involved?

To participate, visit the website below to read more about it. The Brickworks Accredited Club Finder will enable you to locate a club near you.
www.rsgb.org/brickworks

Beyond Exams Continues

Brickworks remains a component of the Beyond Exams initiative URL below) and you are encouraged to make as much use of it as possible, individually and within your club:
www.rsgb.org/beyond-exams

It consists of:

- *RadCom Basics*: a bi-monthly digital magazine that explores key aspects of amateur radio in a straightforward and accessible way.
- Facebook Group: for newly licensed radio amateurs, and those returning to the hobby, to ask questions in a non-confrontational environment.
- Foundation Practical Videos: videos that show how to set up your radio station, use an ATU, make your first contact, adjust your antenna for lowest VSWR and using other non-voice modes.
- Practical Skills Videos: an introduction to some common constructional skills, including building a simple antenna, soldering a PL-259 plug to coaxial cable, using a NanoVNA to tune a dipole antenna, and more.

Continued on Page 51

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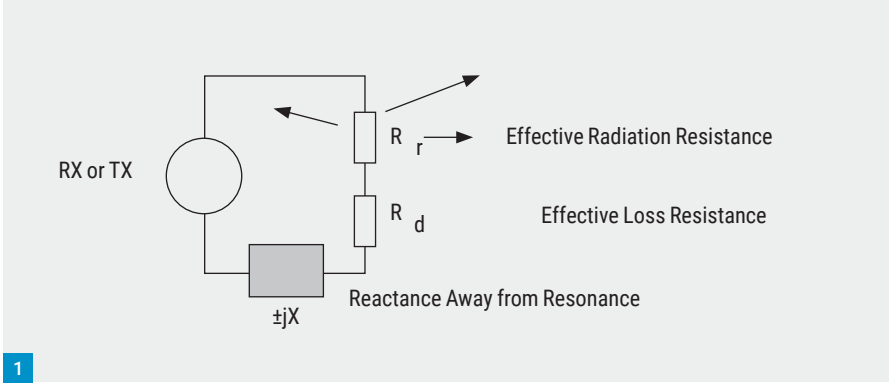

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Introduction to Microwaves (Part IV)

Ian Dilworth G3WRT turns his attention to EM Modelling, simulating Antennas and Radiowave Propagation parametrically in 2022

Antenna characteristics and radiowave propagation are inexorably linked, one way or another, at all frequencies. This applies to terrestrial, or earth space based or indeed spaced based applications such as the Webb antenna introduced in a previous part of this series. Especially and including microwave, millimetrewave and terahertz bands which are all addressed, albeit briefly, here. There are ways to do antenna modelling cheaply, yet thoroughly, compared to current commercial EM software products of which there are several [1] and they can run to £30k+ software just for rentals, then you need to become an expert to effectively use them. However, it is true to say that we are only at the beginning of the widespread application of these EM tools, which offer much potential.

The characteristics to be considered, in the modelling/simulation, include many important parameters. For example: Antenna impedance, the surrounding impedance (free space is 377Ω) but note a submerged antenna radio tag e.g. on a Salmon fish, must match far different impedances (I have experience there). Polarisation, including interaction with the troposphere, which is very significant especially in conjunction with the antenna characteristics. Then many propagation effects must be considered, which will be the subject of the next part of this series. The journey is certainly only just starting for hobbyists.

EM CAD

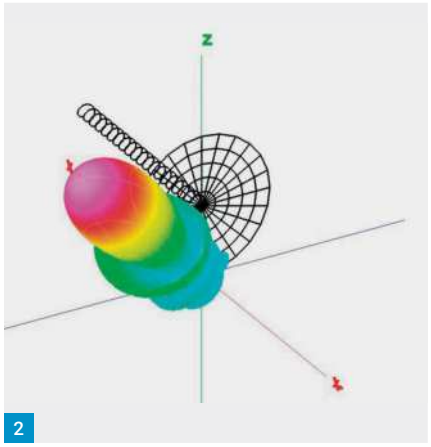
EM CAD is by far the best means to parametrically model an antenna design you may dream up, from LF, through HF to Millimetrewave and Terahertz, before building a prototype and testing it on an 'antenna test range'. The power of electromagnetically modelling (EM) an antenna is not in design but in parametrically examining what happens if something is changed in the design, so with CAD the 'Aided' is the relevant verb. Antennas radiate when the induced currents in a conductor are interrupted. For example, in the case of simple wire antennas if the electron flow (the RF current) is bent or reversed by a discontinuity or reflection or in the case of a waveguide a hole is made in the conductor surface. The radiation is maximised if the wire or the hole (slot) are self-resonant. I concentrate here on the method of moments (MoM), and this employs simple conducting wires of a given diameter (or pipes of a given diameter and metal) with which to model an antenna (or any structure). To use it effectively it is important to understand the limitations as well as what it can offer. It is not the only EM method available [1]. However, that used here is essentially free, £100 for the 'professional version'. Well worth the support to the developers and because it allows many wires to be incorporated, which is necessary at microwave frequencies because the wires need to be at least <0.1λ apart, which is 3mm at 10GHz and indicates the maximum diameter of the conductors that can be used and hence their surface area and ohmic loss, Fig. 1.

Modelling Terrestrial Antennas and the Ground, including Moonbounce (EME)

A key significant facility of some, but not all, antenna EM antenna CAD is the prediction of interaction of the antenna with the Earth (ground) with its height in wavelengths above a modelled earth (no hills considered and although far field no earth curvature) so really the close to 'far-field' the latter is when the wave approximates to a plane wave. So, it amounts to the elevated main beam angle above a flat Earth. That is the most significant aspect for terrestrial antenna interactions. Because I cannot afford 3D transmission line modelling (TLM) commercial software called Microstripes (£30k+), I am presently aiming at doing some radio-controlled drone measured far fields of HF and VHF antennas, at least when I can find professional help re-erecting my versatower! The ground can be modified to take account of its conductivity and permittivity (including sea water) but not ground undulation possible, in terms of wavelength. A 3D modelling technique like TLM would conveniently allow that. It is useful to know the elevation of the main beam above the ground, which occurs primarily in horizontal polarisation because of earth reflection, HF to microwave.

A circularly polarised antenna (a Helix, which radiates all polarisations) pointing at an elevated angle, so little interaction with the ground, is shown in **Fig. 2**. The same antenna, used terrestrially, exhibits polarisation-dependant interaction with the ground, which varies periodically with its height above the ground. **Fig. 3** indicates the V and H polarisation responses 10λ above ground in the conventional 'slice' representation shown by the red and black traces. The representation of the terrestrial helix antenna indicates the beamwidth and the sidelobes due to interaction with the ground in the 'far field'. A circularly polarised antenna such as this Helix has 3dB more gain than a single polarised antenna provided the orthogonal components vectorially add at the receiver and that the propagation for both is homogenous. However, the latter is not true in the case of ground interaction over non-perfect earth reflections. **Fig. 4** shows the 3D representation and the true nature of the elevated radiation lobes because of earth interaction. The lobes repeat at half wavelength intervals because of vectorial addition (and subtraction) with height.

Of course, real far field ground undulations and objects (including trees and their leaves at microwave) will likely change the symmetry of the radiation patterns azimuthally and in elevation. Notice that Horizontal polarisation additively reflects off the ground so the gain of that polarisation is greater than the vertical polarisation but only at certain (mostly low) elevation angles. For Earth space elevated paths (EME or satellite) where the earth may not be influential, then the 3D plot shown in Fig. 2



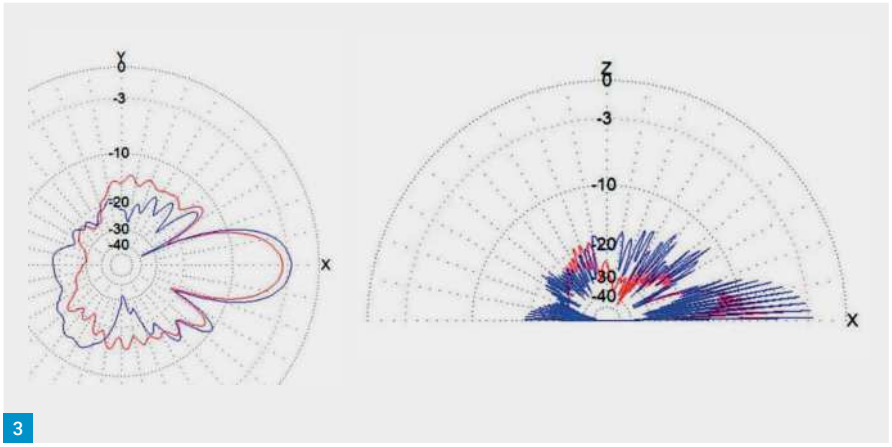
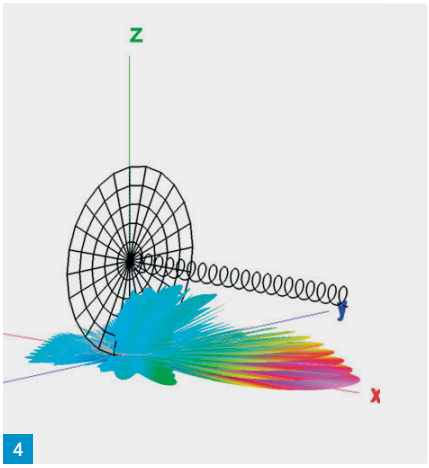
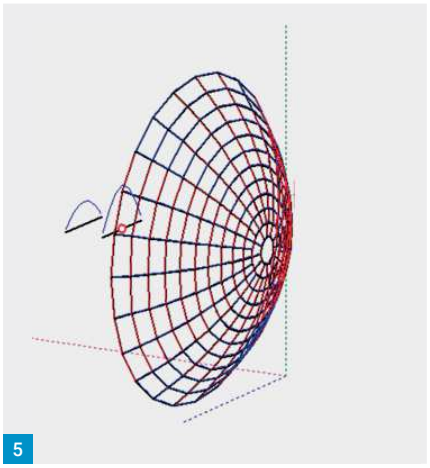
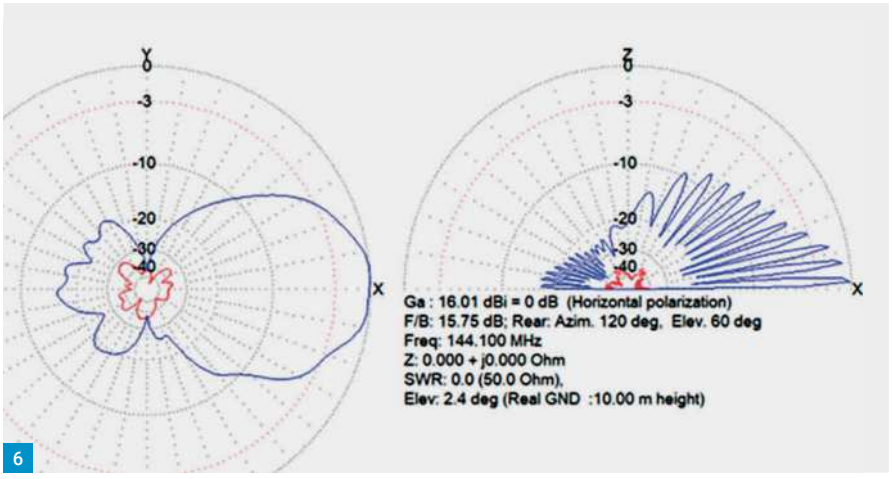


Fig. 1: A simple generic antenna model.
Fig. 2: All Polarisations Helix antenna pointed spaceward. No significant ground interaction.
Fig. 3: The terrestrial Helix antenna and its interaction with the ground. Note the elevated H polarisation and the red vertical polarisation.
Fig. 4: The Helix V and H vectorially add to produce an elevated radiation pattern.
Fig. 5: A Parabolic reflector, front fed horizontally polarised antenna, the blue lines indicate the current distribution. Just to illustrate the modelling. Not recommended.
Fig. 6: Just five wavelengths above ground the Parabolic antenna azimuthal and elevation slices.
Fig. 7: In 3D the parabolic reflector antenna pattern of Fig. 6.
Fig. 8: TLM model of a 3D human head showing mild resonances at 900MHz by the lighter series of circles on the right-hand side of the head. These are 3D standing wave areas +6dB compared to the surround and about -20dB relative to the exciting dipole antenna.
Fig. 9: FDTD modelled waveguide fed Horn antenna. Note the linear, rather than power representation.
Fig. 10: A commercial, 2022, MIMO 275GHz antenna array.







indicates the antenna characteristics and show the equivalence of H and V as we expect for a circularly polarised antenna. However, note the gain improvement at low elevation angles with interaction with the earth, often employed for EME propagation. This only works on horizontal polarisation, which then (annoyingly) creates a problem with so called 'liberation' fading from the moon. Actually, that is polarisation fading sometimes, confusingly described as 'liberation fading' when combined with the earth/moon's relative movements also resulting in doppler shift. The power of this EM (antenna and propagation) CAD now becomes significantly impressive, relevant, and so very useful in practice. It is clearly not a mere antenna design tool, LF to Terahertz it includes antenna and earth interaction.

A reflector antenna provides a more representative example of Microwave antenna modelling as illustrated in **Fig. 5**. In this case I have chosen to model the antenna with a modest antenna diameter, modest F/D, and a dipole feed (for simplicity) and employ a director for additional gain. It is not an example I practically recommend. But note this is now a single horizontally polarised antenna aimed at taking advantage of earth reflections for EME. Consequentially this antenna is only ~5λ above ground but note will suffer from 300K thermal noise into its sidelobes. Notice the now much broader elevated lobes (2.5°) and the negligible red (Vertical polarisation), see **Fig. 6**. **Fig. 7** shows the fuller near perfect picture, which is unlikely to be exactly true in practice because of obstacles such as trees.

Scale HF – Microwave Modelling (literally)

I mentioned why in Part 3 (May 2022) doing antenna modelling in terms of wavelengths is most helpful. Particularly with respect to

the height above the ground. At HF this is particularly relevant. Practical investigations of antenna patterns, at HF, have been done by helicopter. The same thing could be done in quasi reality with a scale model in terms of wavelengths. For example, a plaster of paris model covered in aluminium foil and a light coating of soil/sand. I have seriously thought about doing that to model my HF antennas, which are on a small ridge. Then measure the model results at X band (~3cm) or Q band (~1cm) band to keep the scale model small enough and to scale! I think, for me, it is going to be X band for convenience of the hardware involved (I have a ridge of about five wavelengths at HF ~20m, so just 15cm at X band). It is on my bucket list of things I must do, so that I can compare it with my drone measurements. Reading Parts 1 and 2 (Nov 2021 and Feb 2022) of this thematic series will indicate how this might be achieved with hardware. I have lived in the same location over a few sunspot cycles so would like to illuminate by modelling my on-the-air experiences in terms of HF antennas. I already know how advantageous that small (relative to wavelength) ridge is in reality in certain directions even at HF (>20m), never tried on VHF and above, yet. I also know how quizzical people can be to the fact that a small ridge in terms of wavelengths can be so significant even at HF. I already know it can be so in practice. I am aiming to prove that or, of course, otherwise? Am I mad? Probably.

Practical EM Modelling

I have EM modelled many antennas using several EM CAD methods. I have confidence these methods agree with quasi reality. The last recent and most useful, for me, was using TLM (Microstripes), which is not even mentioned in [1]. However, I can confirm, a powerful EM tool. For example, I have modelled the 3D human head with it and shown RF standing waves exist in the head at 900MHz, **Fig. 8**. This software and other offerings [1] cost a great deal (~£30k+) and they require a contract for updates, so you never own the code or in fact can even keep using it because the dongles used 'time out', designed never to work again. It takes a significant effort to understand the limitations and how to use these CAD tools without making mistakes, so a considerable investment in time. Mistakes are easy to make. Not necessarily in the coding but in the interpretation of the methods employed because all have their foibles (see later).

In the parabolic reflector example, the wire mesh uses an average spacing of about 0.2λ just for my patience and sanity. This took about an hour of PC clock time (@3GHz = 10^{13} cycles!) to compute. Imagine doing the same for a millimetrewave antenna and we face many days of PC processing using the MoM (Method of Moments) code. That is the reality in 2022 on an i5 desktop machine with plenty of memory and running Windows 10. This brings me to an important practical point regarding antenna modelling. I have found that it is sensible to model all wires and structures in terms of wavelengths from the start. The caveat being that to model, for example, a Corner reflector of, say, 60° angle then the coordinates immediately become rather complicated as they are in the helix example. Those familiar with MMANA will find a box in the top right-hand corner used for this purpose.

Wavelengths and not the actual size become important because frequency/wavelength scaling allows an antenna modelled at one frequency to be scaled to another by just considering all parameters in terms of λ. Of course, if the physical constraints are such that this is not feasible, then the actual dimensions must be used. For example, in the reflector antenna used here, Fig. 5, as a modelled example, which becomes unlikely as the frequency increases. i.e. λ/10 at 144MHz is 20cm and λ/10 at 10GHz is 3mm. In this 144MHz example there are about 2000 wires making the spacing about, on average, 0.2λ, not the really required <0.1λ. I found this model to take about 60 minutes on my PC without much else going on except the 64-bit MoM software, at least I do not think anything else is operating! I am sure someone will point out a utility that would tell me. The same diameter 10GHz reflector antenna modelled to a wire spacing of 0.1λ then I estimate it will take around 100 hours or ~4 days. So, a UPS would be a wise investment!

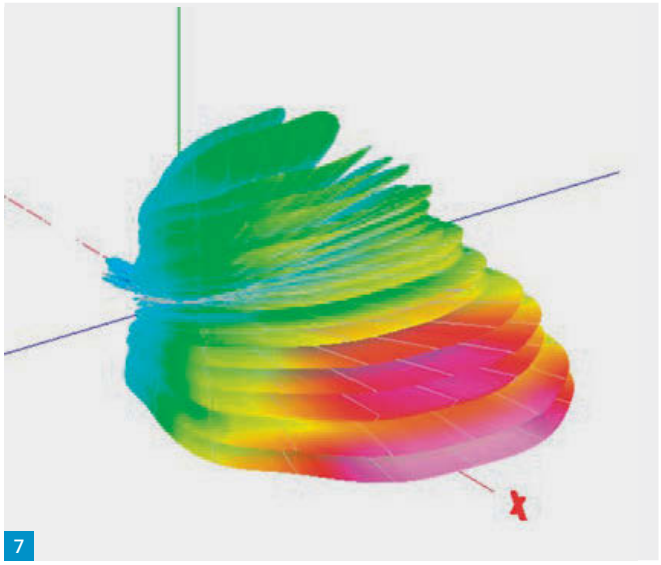
Free EM Modelling Code

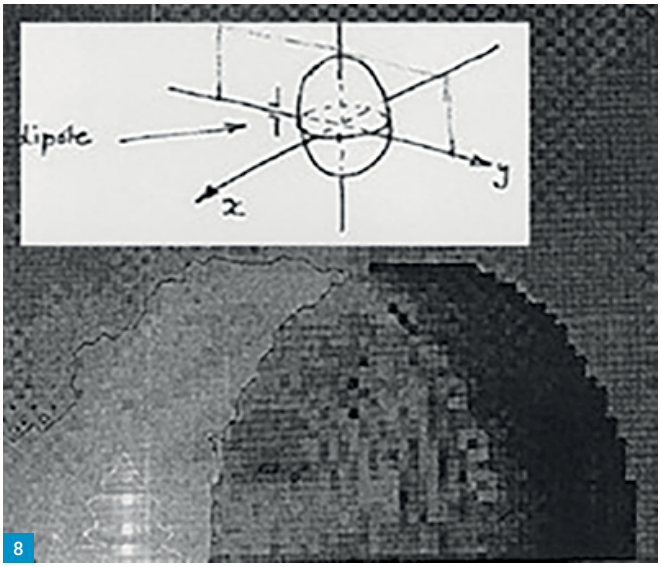
The various available 2022 commercial EM CAD use different methods to arrive at the same result. All have pros and cons. All have in common that they cost a significant sum, and all take time to learn. There have been several erudite reviews appearing from time to time, perhaps [1] is a useful starting point, but beware it is nowhere near complete. The only EM CAD I know well, presently, courtesy of the USA (because of their freedoms and respect for taxpayers' expenditure), that is free to use and is a variation on the method of moments (MoM) is a so-called NEC (numerical electromagnetic code). I use MMANA. MoM is well worth looking up, on Google etc, to understand the principles involved in the simple enough modelling process. There are readable tutorials to be found on the web. I deliberately avoid maths in this series because if the reader is interested, then very little effort is required to access those details by searching the key terms used here.

That brings me to another free antenna EM CAD software I have recently become aware of. That is a finite difference time domain (FDTD) method (also well worth looking up on the web to appreciate the simple principles involved) called 'OpenEMS.' Unfortunately, this requires a maths utility to generate working code but there are examples and tutorials available online. That is using MATLAB (£1k approx.) or its free open-source alternate called 'Octave'. I have yet to experience either by designing an antenna or feeder myself but shown in **Fig. 9** is a modelled waveguide fed Horn antenna. However, I think this method may well be significantly advantageous in the long run compared to MMANA in its capabilities at the cost of more time to learn and understand? Certainly, none of the available commercial packages are 'plug and play' but MMANA comes close for simple HF wire antennas so long as the ground is not too close in the modelling. Note that as with many math's-based calculations and software they default to linear rather than decibel representations, so the beamwidth depicted in Fig. 9 is far narrower than the logarithmic power representation that we usually require and are used to.

I use MMANA because it has a 'nearly good' man machine interface, is simple to use and is free in its limited form. I use the 'pro version, GAL-Pro' and anyone interested in microwave antenna development and modelling will need that version (£100 approx.), a complete bargain because it allows modelling of (reflector) antennas with many elements (wires). Essentially a wire is required every λ/10 or less. See Part 1 of this series (Nov 2021) and the spacing of PCB VIAs. Also bear in mind that surface roughness, which will be unavoidably introduced, depending on the wire/pipe spacing and diameter, will reduce the modelling accuracy as mentioned in Part 3 (May 2022) e.g. −10dB loss for λ/10 and −3dB loss for 0.06λ. Other EM CAD methods allow solid surfaces by different techniques, all rely on the induced RF current. MoM, even in 64-bit mode, is frustratingly slow on my current (i5 processor) 2019 PC but impossible to do on a PC/Mac just a few years ago and that is the reality of the requirement of so many millions of matrix calculations. This also applies to 'OpenEMS'.

I expect a few readers of *PW* will be students who maybe are considering an (undergraduate) project and one employing EM CAD. If expensive tools such as Microstripes, Ansoft etc. [1] are available, then I recommend you take advantage of the opportunity. It will be good for your experience and for your CV as many of my ex-students will attest to. Buying these packages, even for a short time, is an expensive reality.





Tool for EM Modelling Propagation, Parabolic Equation Method

This is a free propagation tool [2], though I have yet to try it. It appears to have potential although it needs to be combined with the antenna tools and interactions with the ground, the spherical earth, and the gradients of the tropospheric densities we observe. Then bolt on the perturbations in terrain. So far only used in statistics, but I think far more exploitation is possible in terms of amateur radio science and thus progress. Here I have simply concentrated on antenna modelling. In a further article I may discuss microwave radio propagation EM modelling in conjunction with antennas. In summary, the EM propagation method is based on the so called 'Parabolic equation method' (PEM). The software is called PET or PEC where 'C' stands for code. It is free, but there is a snag. To generate the code required needs MATLAB or maybe its free (subset 'Octave') version as previously mentioned.

Limitations

Back to MoM. If performed at microwave frequencies, then it more than likely introduces a limitation on the diameter of the conductor used for the wire/pipe (as well as its material) and hence the ohmic losses, as illustrated in Fig. 1. The radiation resistance and the ohmic losses and the return loss/SWR (matching) are all important parameters contributing to the overall efficiency. Typical efficiencies of microwave reflector antennas rarely exceed ~55%.

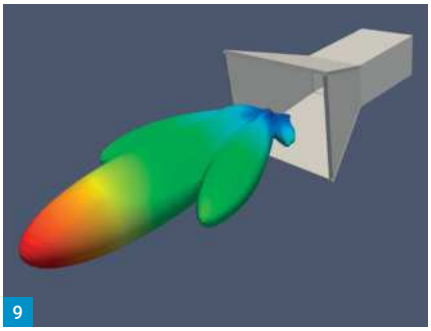
The Man, Machine Interface

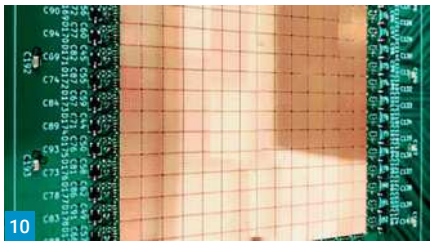
The Man, Machine Interface is centrally important in CAD. In practice the user interface of MMANA would benefit from some seemingly small developmental improvements, to allow more rapid wire model editing, for example. The primary one being a mathematical way of importing (parabola) coordinates or a Vivaldi shape into the software. It is likely those more skilled than me have discovered a way to do that. If so, please tell me! For example, to generate the maths you want on say, Excel (e.g. a parabola), and then paste those coordinates into MMANA. It should be easy but it is not. There is nothing fairer, though than free software that works in practice, and I have total confidence in it. It relates to reality as I have proven, for myself, several times by modelling and then measuring, then usually iterating the parametric modelling before finalising the developed antenna.

This process becomes particularly advantageous when developing small narrowband antennas near the 'Chu' limit on size versus wavelength. So, I am very happy to have such a tool I can use. Wires that are a quarter wavelength apart (at least) can act as high impedance RF chokes, as I described in Part 1. The free version of MMANA will not allow sufficient wires for microwave antennas and you need the GAL-PRO version at microwaves. I have total confidence in this MoM method of EM modelling provided enough care is taken to learn its limitations and despite my comments am happy to recommend learning how to use it and the purchase of the 'MMANA pro GAL' version, in the hope that will allow funding further honing of the interface. There are web-based tutorials available.

Near and Far Fields

A very significant and useful aspect is that MMANA predicts the antenna far field response in reaction to the ground, as indicated in Fig. 7, as well as making possible 'near field' analysis where 'plane waves' have not yet formed so close to the antenna. This brings another important consideration, how far away does one have to be to measure a reflector type antenna with a given aperture and frequency? Well far enough away that the radiation approximates to a plane wave. A few, hopefully useful, 'far field' examples are given in **Table 1**.





To conclude: MMANA is a serious, sophisticated tool, available to all. Superb, but with limitations. A welcome and a significant advance for amateurs. Some common types of small to medium reflector antenna arrangements are illustrated in Fig. 6 of Part 3 (May 2022). I know these will be of interest to EME enthusiasts, along with the current pioneers of millimetric and infra-red/light terrestrial communications. I will do my best to address those introductory practical aspects in the next part, which will deal with microwave, millimetrewave and terahertz, tropospheric and stratospheric radio propagation plus significant molecular interactions.

Far field calculator input yellow cells

Frequency GHz	wavelength cm	Diameter m	Gain dBi	=2D^2/λ Far field distance m
0.14	208.33	3.00	12.6	**9**
0.43	69.44	3.00	17.4	**26**
1.30	23.15	3.00	22.1	**78**
2.40	12.50	3.00	24.8	**144**
3.40	8.82	3.00	26.3	**204**
5.60	5.36	3.00	28.5	**336**
10.00	3.00	2.00	29.2	**267**
10.00	3.00	1.00	26.2	**67**
10.00	3.00	3.00	31.0	**600**
24.00	1.25	1.00	30.0	**160**
47.00	0.64	0.50	29.9	**78**
220.00	0.14	0.20	32.7	**59**
430000.00	0.000070	0.01	52.6	**287**

Table 1: Far field distance versus frequency and antenna diameter.

Obviously taking this MoM wire method to infrared wavelengths and Fig. 1 of Part 3, the Webb antenna, would make this a ridiculously impractical EM method to employ, although still valid and it will work. I estimate the number of wires required would mean the computing time required to be weeks in duration even with the best available 2022 PC/Mac processor! It is one of the reasons, even with super computers, the Webb satellite antenna took so long to develop.

The Future

Antennas are the centrally important component in any communications system. All the aspects briefly mentioned here are relevant and many I have omitted because of space considerations. We have yet to fully exploit 3D antenna designs. This is happening with so called 'MIMO' systems as an acknowledgement of the significance of multipath terrestrial radio propagation, particularly noticeable with existing 3-6G systems and also elsewhere as illustrated in **Fig. 10**, a current 275GHz commercial planar array, with built-in space diversity capability. For example, a simple (two antenna) diversity system offers around 4-6dB advantage. The significant point is now, for the very first time, amateurs have the tools to experiment with antenna designs by EM modelling.

Parametrically modelling antennas is the way forward and I think 3D multipolarisation and 'space' diversity designs are likely to be game changers in the near future, even at HF, let alone microwaves. Only limited by our imagination and of course physics plus practicality and at present, our monetary pocket depth for modelling. I will be discussing the equally important associated microwave radio propagation aspects in the next part of this series.

Acknowledgements

NASA is a wonderfully free resource. I suggest examining it, and I am grateful. It is a vast resource. I assume all the acronyms and key terms I have used are easily web searched for those interested so I do not include specific references here. Similarly, there is no single antenna book I wish to recommend. I have read many, have many, all with different qualities. These are reference books and therefore already out of date before publishing. IEEE/IET Electronic Letters and conference papers (not rigidly peer reviewed) etc. are on the pace with recent advances but cost to read and unfortunately, very annoyingly, never available free to read 'online', even decades later.

The reason it is so slow in changing is because universities and academic promotions only recognise peer reviewed publications such as those from the IEEE/IET. This is a very good and essential criterion and must remain, but it means that they are not freely available. Those papers that appear free are largely student MSc/Ph.D. projects, good for those and not to be deprecated. Two practical, cost-effective, microwave antennas suppliers were listed in Part 2 along with VNA test equipment. Others are available and I simply suggest a web search because this is ever changing, worldwide. Microwave antennas are certainly available commercially, second-hand and at rallies. **PW**

Continued from Page 46

- Individual Scheme: a more advanced version of Brickworks that encourages you to explore the hobby in more detail and develop new/enhance existing skills on your own, or together with friends.

In addition to all the above resources, the RSGB also provides Tonight@8 – monthly live webinars covering a range of amateur radio topics, some of which serve as perfect companions to the Brickworks activities. You can find out more at: **www.rsgb.org/webinars**

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For further information about Brickworks generally, contact **Chris Colclough G1VDP** via **be.coordinator@rsgb.org.uk**

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A Valve transmitter for 2022

John Seager G0UCP describes a QRP Van Winkle transmitter, recalling days of yore.

Issue 1000 of *PW* back in 1990 had a supplement with several valve (tube) circuits including a crystal oscillator/power amplifier (COPA) transmitter. The valves were the directly heated type developed for early handy–talkies in WWII. Power output on 7MHz was a modest 500mW.

Vacuum tubes were at the heart of early amateur radio and still have a certain enduring mystique. Lockdown gave me the chance to build two little valve transmitters. One was a 'straight through' COPA like the original *PW* design. With two 3A4 valves in parallel in the PA it ran about 1.5W on 80 and 40. However there was a tendency to 'chirp', a well-recognised problem when oscillator and PA tank are tuned to the same frequency. The second design, using half a 3A5 twin triode as a 7MHz oscillator and the other half as a doubler to 14MHz was far more successful (described in *Sprat* issue 190). Both transmitters were based on vintage circuits and used parts that had been in my junk box for many years.

Now *PW* is in its 90th year, the question was: Is it still possible to build a valve transmitter with easily found parts, a variable crystal oscillator (VXO) and a stable chirp-free note that puts out a useful signal on today's 20m band? I found that it was, and with the clarity that used to be called T9X.

Some old components, **Fig. 2**, are indeed hard to come by, but for QRP designs, polyvaricons can replace air-spaced capacitors and 'choc block' connectors make convenient crystal holders, **Fig. 3.**

Small ferrite and iron powder toroids are usually more efficient than antique RF chokes and air cored tank coils. The 7012kHz crystal shown is actually an HC49U in an old FT243 case. Remarkably, Langrex can supply the two directly heated valves, 3A4 and 3A5, two ceramic valve holders, a metal skirted holder and authentic screening can for a total of less than £20, **Fig. 4**.

The Circuit

In keeping with the vintage idea, all features can be found in designs of 70 years ago, with the very important exception of the keying arrangements. The circuit is shown in **Fig. 1**. The modified Pierce oscillator is run at a Zener-limited 35V to preserve stability. These valves need a high impedance load in the anode (plate) circuit [**1**] and this is achieved for V1A by the use of two separate windings on FT50-43 cores. The 7MHz output is coupled very loosely to V1B, which operates at the full 120V via an inductive load resonated to 14MHz by the trimmer CT2. The V2 grid current was predictably low, at 51mA. For maximum power out, the inductance of the tank coil L4 at resonance needs to be as high as possible with capacitance (CT4 and VC2) kept low. C8 isolates them from the high voltage supply. L5 is wound over the RF 'earthy' end of L4 (i.e. the one farthest from the anode). Output was measured on a Stockton two-way power meter permanently in circuit between transmitter and ATU.

Safety and Keying

Folk knowledge, reinforced by mishaps when working with valve equipment has faded with the passage of time and the use of low voltage transistor and digital gear. No one should attempt to build a valve transmitter, even with 'battery valves', without considering personal safety and caution. The HT of 120V is capable of life-threatening electric shock.

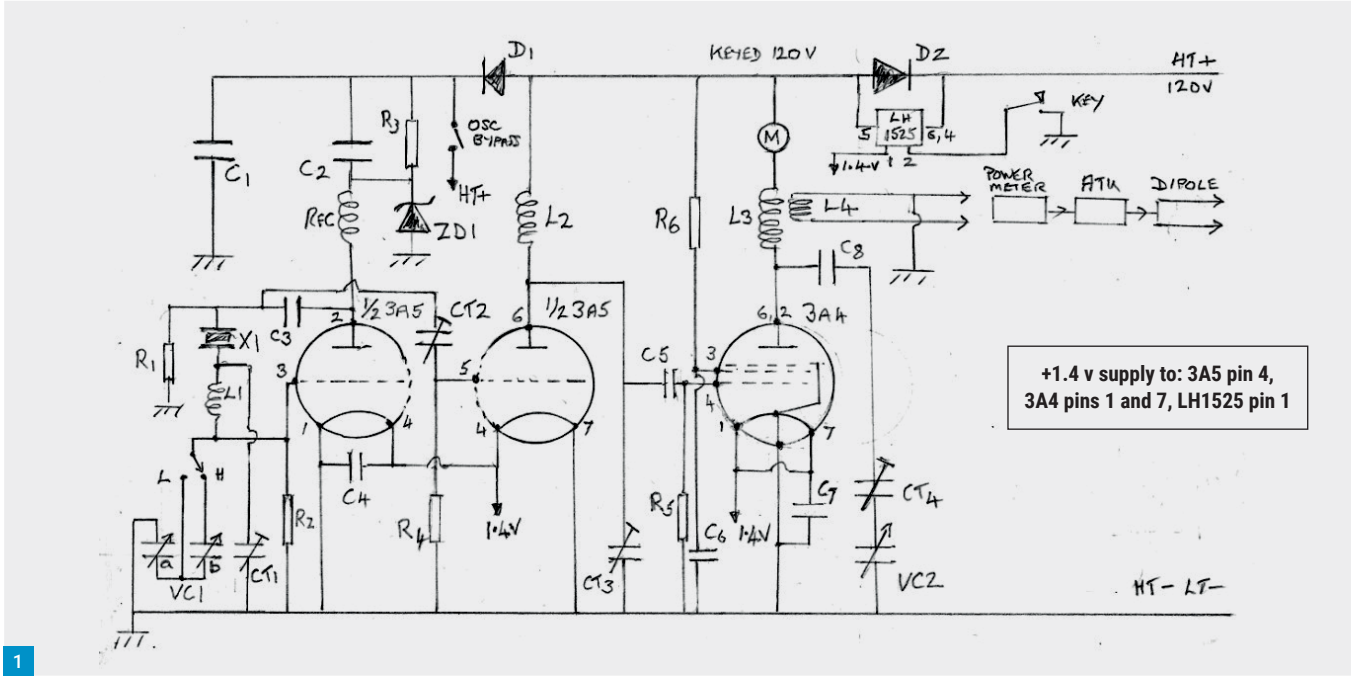

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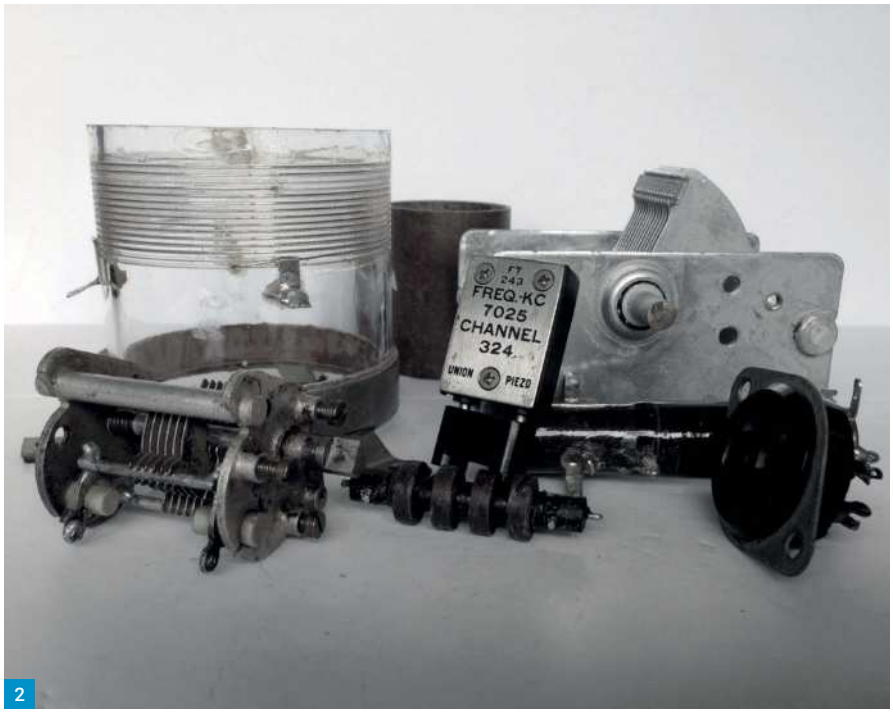
Fig. 1: The circuit. Fig. 2: Some older components are now a challenge to source. Fig. 3: However, more modern components can be used instead. Fig. 4: The valves are still available! Fig. 5: The completed transmitter in use. Fig. 6: The under-chassis wiring. Fig. 7: The signal as captured on a panadapter.

Keying the HT line was strictly avoided in the past because of this danger. Isolating relays fast enough to follow normal keying speeds were simply not available. Even now, I found high voltage reed relays would often fail when switching potentials far below their specified maximum.

Keying directly heated valves is a problem. Grid block or cathode block circuits are complicated by the absence of the separate cathode of the typical 'mains' valve. The development of solid-state optocoupled relays specified for high voltages provides a new way to switch the HT line with as little as 1.4V across the key contacts. This is the method I have used here, but in practice I run a screened cable from the key socket to a relay controlled combined changeover/sidetone unit that



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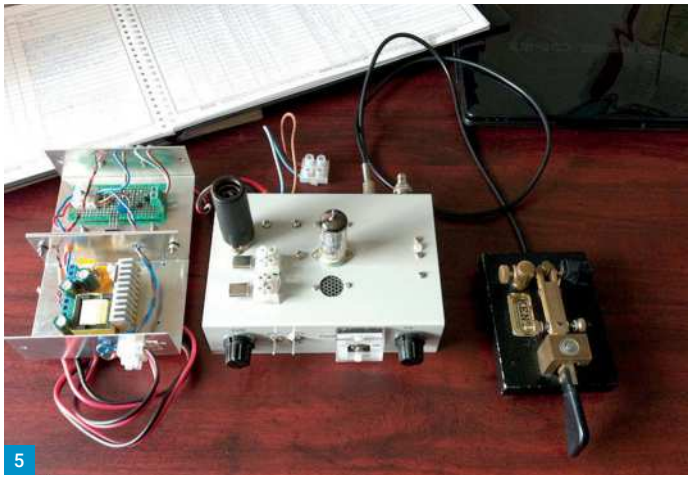

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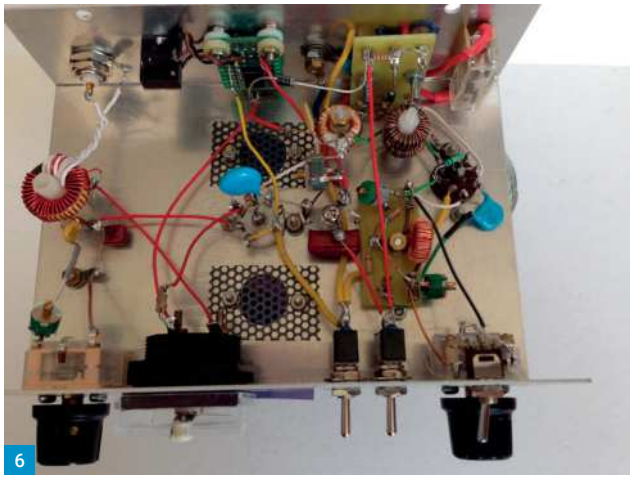

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permits semi break-in operation. This ensures an extra degree of isolation and will slightly alter the keying characteristics, making it possible to operate the rig with an SDR receiver panadapter.

Construction

Partly for reasons above and as there are many good ways to set things out, no detailed plan is offered. However, it should be possible to see how this was done. The header photo gives a good idea of the layout.

The aluminium box screens the two variable capacitors, which are isolated from the chassis. The switch below the VXO tuning capacitor selects a split-stator mode for VC1 (high) or a 285pF (low) range setting. The oscillator can be switched on for 'spotting' between transmissions. The extra switch was for LT supply should further valves be added to boost output. The 50mA meter is in the PA plate supply. VC2 is used in split-stator configuration. The only components on the top of the box are the crystal holders and two valves. Choc bloc connectors (3A size) are used as shown in P2 as crystal holders. With suitable spacing they will take the old FT243 type and they can be cross-wired to house either one HC-49U or two in parallel.

Two extra holes for valves were made with the chassis punch just in case of need. For mainly aesthetic reasons they were covered with perforated zinc. HT and LT connections, keying jack and antenna socket are mounted on the rear panel. Under the chassis, HT goes first to a 125mA fuse. This will protect some components but not the operator. The photo, **Fig. 6**, shows the under-chassis wiring.

Wiring is point-to-point with tag strips for small components. Toroids are held firmly on nylon spacers. A small piece of circuit board near the key socket holds the 8-pin IC of the solid-state relay.

Setting up and Operating

The 'high tension' power supply traditionally came from a battery. As current drawn is about 20 mA on transmit this could still be done, though thirteen 9V batteries is a daunting thought. An excellent substitute is a DC-to-DC converter run from a 12V sealed lead acid battery. The filaments require a continuous 420mA at 1.4V and I use a separate variable bench power supply for this.

7

Potentials at valveholder pins should be checked before plugging in the valves. The oscillator can be spotted using the station receiver, ideally with a panadapter. Adjustments are made to CT1, setting the two frequency ranges for VC1. A swing of 7 or 8kHz is optimal. Wider coverage is easily achieved, but can result in slight frequency shift on keying. With a 50Ω load and a power meter at the antenna socket, output can be checked and adjustments made. CT4 should be set to the lowest level that allows peaking with VC2. It will probably be necessary to add or remove a turn on L3 and it is well worth trying the effect of slight changes in the position and number of turns on L5. I found that six turns wound so that the last two were 'below' the end turn of L3 gave maximum power transfer.

The photo, **Fig. 7**, shows the nice clean signal captured on receiver panadapter when oscillator and PA were both keyed.

Down from the Mountainside...

The rig was completed in March this year. With a trap dipole 90ft long and about 30ft up, it made easy contacts with 11 of the 12 Italian special event (WRTC) stations active that month. In the Commonwealth Contest (BERU), contacts included Canada, Malta, The Gambia (thanks, **Don**!) and at 0728 on the second day a VK2 in New South Wales got my call, but with M instead of G. We exchanged 599 and he got my serial number, but not the correction. It's good to know that 1W and a two-valve transmitter can still (if only just) get round the world. The final photo, **Fig. 5**, shows the complete setup. **PW**

Parts List

C1	100nF 250V ceramic	(a)
C2, C3, C6	10nF 250V ceramic	(a)
C4, C7	1nF ceramic	(a)
C5	300pF	(a)
R1	390kΩ	(a)
R2	68kΩ	(a)
R3	27kΩ	(a)
R4	100kΩ	(a)
R5	220kΩ	(a)
R6	3.4kΩ (2 x 6.8kΩ)	(a)
CT1, CT2, CT4	35pF	(a)
CT3	50pF	(a)
VC1	285pF:285pF	(b)
VC2	140pF:60pF See text	(b)
ZD1	35V Zener diode	(a)
X1	HC49 7MHz range	(a) (b)
LH1525	Vishay solid-state relay	(a)

Inductors

L1	15.9µH, 57t. on T50-2
L2	2.3µH, 24t. on T50-6
L3	4.2µH 30t. on T68-6
L4	6t wound over 'earthy end' of L3. See text.
RFC	1.5mH 30t. On FT-43 x2, stacked in series.
Tag strip	(a)

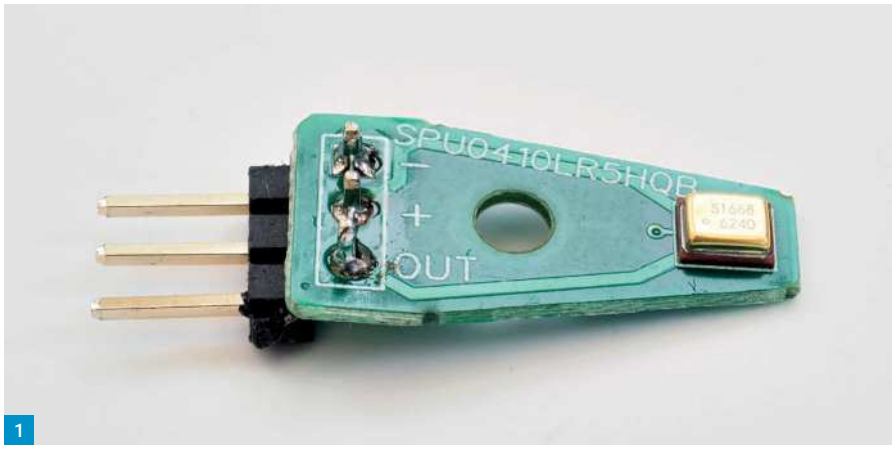
M 50 mA current meter There are plenty of analogue meters to be found e.g. at Farnell. It is far from essential, but it is nice to see the dip as resonance is achieved.
Boost converter A Google search for 'DC 8-32V to 45-390V power supply' brings up a variety of sellers from overseas. It is well worth getting two.
Valves, holders and screening can are available from Langrex.

Availability: (a) = Farnell, RS, Mouser etc. (b) = G-QRP club sales have them, with fixings for the capacitors. Membership fee of £6 pa includes Sprat. Similar parts will be found on the web if you prefer to pay more.

Reference

Bob F Burns G3OOU:
www.qsl.net/g3oou/valvecircuitsmenu.html

Mike Richards G4WNC
practicalwireless@warnersgroup.co.uk



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Extreme LF!

Mike Richards G4WNC goes some what batty this month, while exploring how to analyse data.

While sitting outside on these balmy summer evenings, imbibing in your favourite beverage, you've probably caught sight of the occasional bat flickering in your peripheral vision. Bear with me on this; I've not lost the plot as this will lead to a working example using **Simon Brown's** SDR Console Data Analyser! These fascinating, protected, creatures can be found throughout the UK and are usually seen at twilight as they start their hunt for flying bugs.

I have a particular interest in bats because my daughter is an environmental surveyor and has been specialising in bat habitats recently. She uses commercial monitoring kit to detect bat activity and identify the species. It seems you can identify the bat species by the frequency of the sonar pulses they use for navigation. That got me thinking about an alternative use for some of the popular SDRs that feature extended LF coverage, such as the SDR Play range and the AirSpy HF+ Discovery. These receivers are very sensitive, and their spectrum displays should make it easy to see the frequency of any received sonar pulses. The initial problem was how to convert the bat's sonar squeaks into an electrical signal that could feed the antenna socket of an SDR.

After some Web searching, I came across a Knowles MEMS (Micro-ElectroMechanical System) microphone module that is specified to operate to 80kHz ±10dB; ideal for bat sonar. The SPU0410LR5H-QB module is a tiny surface mount device, but is available on a convenient breakout PCB, **Fig. 1**, for just £10.44 from FEL Communications (URL below). There are only three connections: ground, supply + and output. The simplest way to power the module is to use a 3V lithium button cell, so I used the popular 2032 size cell in a battery holder. There's no need to bother with a power switch as the current draw is just 120µA. For the initial testing, I connected the microphone output to the receiver input via a 0.1µF DC blocking capacitor. This is necessary because the microphone output is DC coupled and runs with a standing voltage of about +700mV. The microphone output impedance is 400Ω so there is no need to worry about impedance matching in this application. I've shown the connections in **Fig. 2**.

https://micbooster.com

Recording with SDR Console

For my experiments, I used my AirSpy HF+ Discovery receiver with SDR Console. On the SDR Console Home tab, I set the Bandwidth to 192kHz and the Frequency to 50kHz with a span of ±50kHz to give a reception range of 0 to 100kHz. You can check that your microphone's working by setting the receive mode to USB and tuning to 1Hz. You should be able to hear your voice if you speak into the microphone module. One important point to note here is that the acoustic input is on the rear of the breakout PCB. To capture my first bat call, I used a 3m RG-174 cable between the Microphone and the HF+ Discovery, so I could fix the microphone outside the shack window aimed towards the sky. Rather than sit waiting for a call that might not happen, I used SDR Console's recording facility to record the raw IQ data to a hard drive. To do this, go to the Rec/Playback tab, click the Record button and you should see the Start Recording panel, **Fig. 3**. Here you can decide the storage location, set the file format and bit depth. I left the default values as they are, which is fine for this application. The lower section of this panel shows the predicted space usage and the free space available on the selected disk. I started the file recording from dusk through to darkness, as that's when bats are usually most active.

Having captured the recording, it was time to review the file and see if I'd captured any bat calls. To do this, I used the Playback tab – Open to launch SDR Console's Select Recording panel. Here, I could navigate to and select my recording, then press the Play button to play the recording through SDR Console. One of the delights of IQ recordings is the facility to use all the features of the software to tune through and analyse the captured information. To move backwards and forwards through the file, I used the Seek controls in the Data::Playback section. The first step is to press the Seek button and choose the time increments. Once this has been set, you can quickly step forward and backward through your file using the Back and Forward buttons, **Fig. 4**. Your position within the file is shown in the Status panel at the bottom of the waterfall display, **Fig. 5**, (You may need to click Status in the Playback area to reveal this).

Data File Analyser

An alternative way to find activity in any IQ data recording is to use SDR Console's Data File Analyser. This is not visible in the default layout, so you should use the following sequence to activate it:

- With SDR Console running, click the View tab.
- At the right-hand end of the ribbon bar click Select – More options.

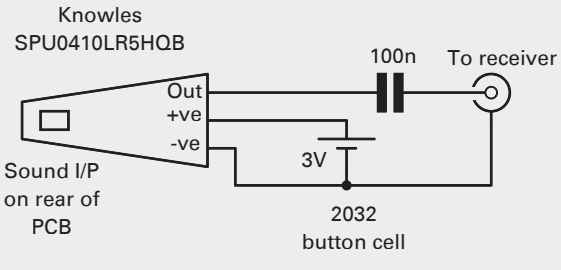

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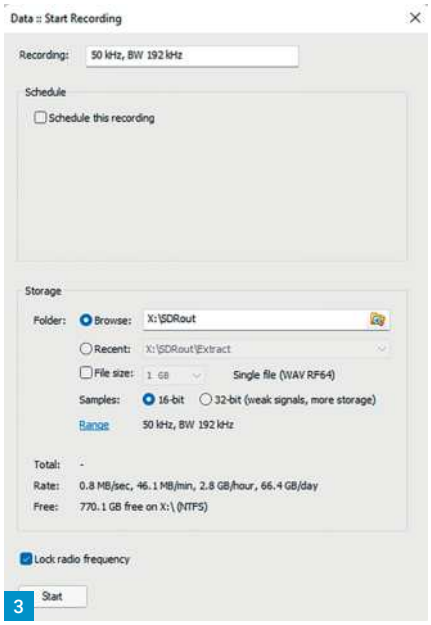
Fig. 1: Ultrasonic microphone breakout PCB. Fig. 2: Wiring up the ultrasonic microphone module.



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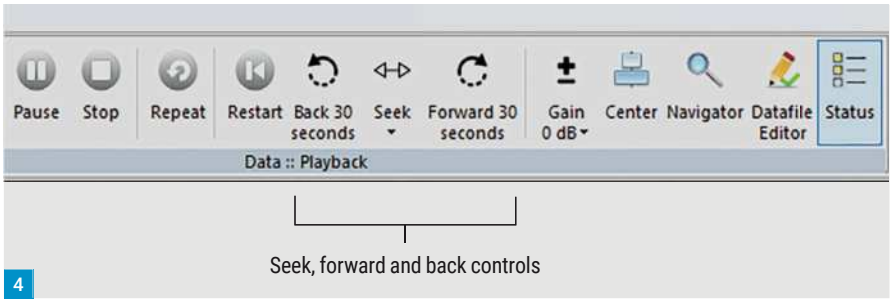

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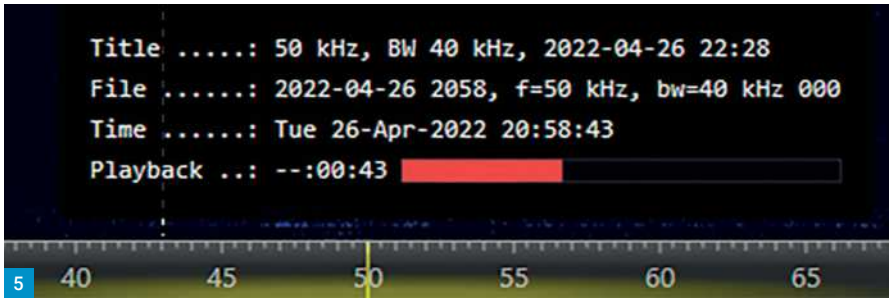

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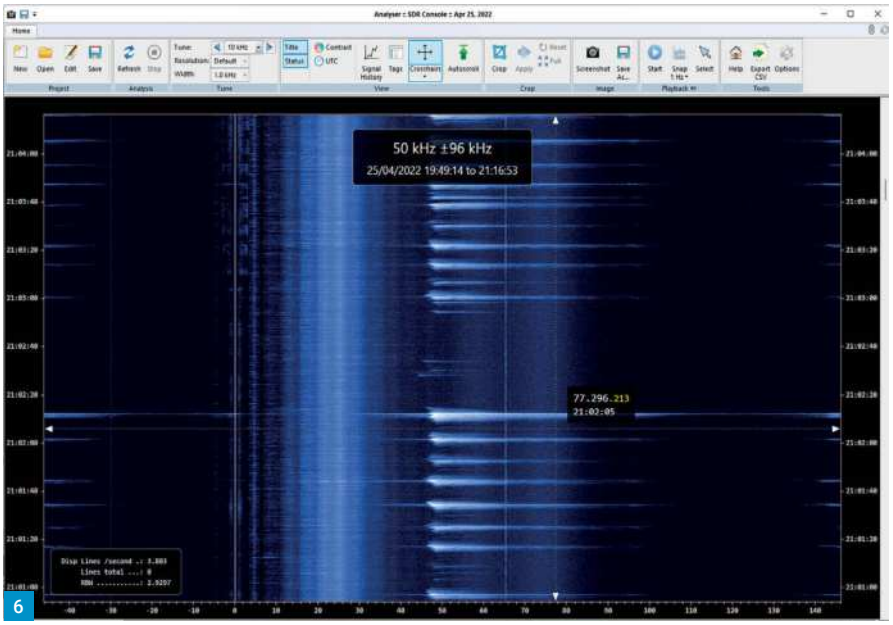

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• Make sure Analyser is ticked to enable it.
• Click OK to exit and restart SDR Console.
• You should now find Data File Analyser located at the right-hand end of the ribbon bar.

When you open the Data File Analyser, the first step is to create a new project by clicking the New button. This will open the recordings panel where you can select the recording that you want to analyse. Once selected, press the Play button and the General Settings panel will open with the available options. If you already know the time span you want to examine, you can use the Start and Finish boxes to restrict the analysis to just those times. In my example, I wanted to use the analyser to look at the entire file. With the required file selected, press the OK button to start the analysis. The time taken to complete the analysis will depend on the file size and the available processing power. With a fast PC such as 10th Gen i7 with an Nvidia 1650 Super graphics card, you will probably see a processing rate of around 1GB/s. For the fastest processing, especially with large files, you should store the data recording on a fast dive, preferably an SSD.

Once the Data File Analyser has finished processing, you will see a waterfall display of the entire file. This makes spotting activity extremely simple as you just scroll through the display looking for traces on the waterfall. In my example, I was looking for sonar bursts at around 45-50kHz and these were easy to spot, as shown in **Fig. 6**. The time display on the right of the screen shows that the bat was active from 20:44 to 21:06. The real hidden gem in the analyser is the facility to start playback from the analyser screen. To do this, first go to SDR Console and hit the Stop button to stop the receiver. Next, switch back to the Analyser screen and click Start in the top ribbon bar to begin playback of the data file. You can now click anywhere on the Analyser screen and the receiver will retune and play from that point. This is a fantastically powerful feature that has huge potential for signal analysis. It's hard to believe that such a powerful tool is available in a free software package! Due credit must go to Simon Brown for his very generous development work. If you enjoy using this software, please make sure you send a donation to Simon via the PayPal button on the Home ribbon bar.

Data File Editor

As I'd like to keep my bat recordings, but not the entire session, I used the Data File Editor to extract the segment containing the data. This is a very useful tool that lets you extract data from a large IQ data set. Before I describe the operation, I ought to explain that while SDR Console shows your large recordings as if they were a single file they are, in fact, recorded as a set of smaller linked files of about 110MB each. SDR Console handles these files sets with ease, but you may wonder why there are so many files if you use Windows Explorer to view the directory. The best bet is to always manage your IQ data files using SDR Console.

To save the bat calls, I started the Datafile Editor from the Data::Playback ribbon. The first task was to select the desired recording and select the Start and Finish times, **Fig. 7**. You will also see that the Datafile Editor includes an option to choose the centre frequency and the bandwidth.

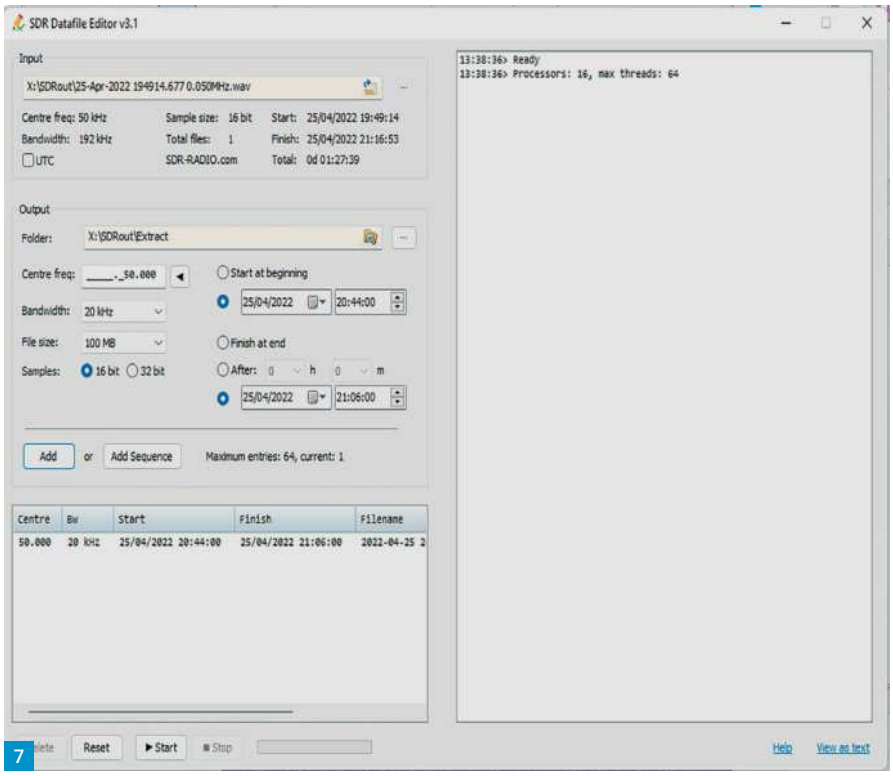
By setting these to match the desired signal you can further reduce the saved file size. In my case, I wanted to preserve the recording from 20:44 to 21:06hrs, but I only needed 20kHz of bandwidth centred on 50kHz. Once I had completed the settings I clicked the Add button to add the extract to

Fig. 3: SDR Console recording panel.
Fig. 4: SDR Console seek buttons.
Fig. 5: Playback status panel.
Fig. 6: Sonar pulses from a pipistrelle bat.
Fig. 7: Datafile Editor settings.

the queue, followed by Start to complete the extraction. I've shown these settings in Fig. 7. Using the Datafile Editor in this way, I was able to reduce the file size from 1.8GB to, a much more practical, 18MB.

Summary

Although my bat chasing project is perhaps an unusual example, it does serve to illustrate the process from capturing the raw IQ data to identifying and extracting a signal of interest. You might even be able to impress the family with the versatility of your radio kit! However, the techniques I've described here can be used to record, analyse and extract any part of the RF spectrum. In fact, these techniques have been used in the signals intelligence community for many years. In that environment, the IQ data is computer processed to find and extract messages that are subsequently searched for trigger words. **PW**



Mark Tuttle G0TMT
g0tmt@theshack.org.uk

Building the Transmitter Board

Mark Tuttle G0TMT turns this month to the transmitter side of the Paston transceiver.

In the last part we finished the receiver board and with it coupled to the audio board we built in Part 2 we should have a working receiver.

Now we turn our attention to the companion transmitter board that, in my rig at least, is mounted directly above the receiver board. It's the same physical size, 100mm x 75mm.

In my rig this board not only houses the transmitter but also the antenna changeover circuit. In this penultimate part I'm going to cover just the transmitter circuit. I'll cover the antenna changeover in the final part. However, there's no reason why it can't be built on a separate board if you prefer and have space.

The Transmit Mixer

As usual, let's follow the circuit diagram, **Fig. 1**. The first thing we need to build is the transmit mixer. Once again, I'm using an NE602 (SA612) as it's cheap and cheerful and does the job. Our VFO, as by now I'm sure you remember, is running all the time at around 2 to 2.1MHz-ish, so we need to mix this with an oscillator running at our IF frequency to get the final frequency we wish to transmit, i.e. around 7MHz. Again, we use one our 4.915MHz crystals in the NE602's oscillator. We need this oscillator to go off ideally at the same frequency as the incoming signal. Getting this right may take a little experimentation. Trust me, if you try to measure this frequency, you will change it.

The capacitance of your scope or frequency counter probe is more than enough to pull this oscillator off frequency so trial and tweak is the best approach here. It's also not a great idea to try and set it with a variable capacitor as they're not quite as stable as we want. It's all very well if the CW tone we're receiving changes slightly between overs, we can use the RIT to adjust that if we need to, but we want the signal we put out to be as steady as we can make it.

Remember that this won't be at the same frequency as the oscillator of U3 in the receiver. It's got to beat with it, just like the incoming signal. C3 will set the frequency of our transmit mixer oscillator (U1). You might need to be able to change it once you've finished the transmitter so make sure it's easily accessible. It will be very difficult to get the transmitter to be perfectly 'netted' on your incoming signal but you can get it pretty close.

I found the best way is to tune the receiver to a nice strong incoming signal where its tone is at its loudest. This should be at the peak of both your IF filter and your audio filter that you set up in the receiver. Now you should switch your antenna over to a dummy load and then press the key. The beat note you hear needs to sound pretty close in pitch to the incoming signal. If it's not, you can increase C3 a little by tacking a small capacitor across it. If this takes the beat note the wrong way, remove C3 and replace it with the next value down and try again. If it's gone too far, tack a small capacitor across that one and so on.

Once you've found the optimum value, try to replace the largest capacitor at least with an NP0 type. You might find my suggested value of 220pF is close enough but it all depends on the actual frequency of your crystal. If you can't get one of them close enough, you can always try another. You bought a hundred, right? You could be even more adventurous and measure the frequencies of your crystals and choose the best one. Of course, that will require a crystal checking circuit so get 'Googling'. This is how we learn.

Mixer Output Filter

The output of the mixer will have two components. IF + VFO, the one we want of course, and IF – VFO the one we don't want. So, I had a bit of a brain-fade here, just built another bandpass filter for 7MHz and put that in. It works just fine and you can do the same. Instead of the wound toroids you could substitute the 10K Toko style inductors we used for the input of the receiver if you prefer.

They do the same job. The thing is, we don't really need a bandpass filter, do we? The product of IF + VFO will be highest frequency product of the mixer so in reality we could save a few components and just use a high-pass filter set to around 5.5MHz or so. Obviously, this didn't dawn on me until later but you can give it a try. We're going to supply power to the mixer only when our Morse key is pressed so it's supplied from a rail I've called 12V Keyed Line. Our changeover circuit in the next part will provide this.

Amplifier Chain

The amplifier chain is a borrowed from an article by VK3HN entitled *"Pocket Sized 40m CW Transceiver"*. However, in that article he references an article in OZARP.com and a rig called MST3. So, like the audio chain of the receiver, it's a well-used and tested circuit. There are three stages of amplification following the mixer. The first is built around TR4; a common 2N2222A transistor. This just lifts the level to around 1V peak-to-peak and I've called it the 'pre-driver'. The second stage uses a bit beefier transistor, TR5, which is a BD139. This is the driver stage. This might get warm after a few minutes of transmitting so it's a good idea to give it a little heatsink. I used a small piece of tinplate bolted to the transistor tab. I spread some heatsink compound between the transistor and heatsink just to ensure any heat is conducted away from the transistor. Just be sure the heatsink isn't touching or shorting out other components or the ground plane.

Don't forget the measured outputs are into the load of the next stage. If you try and test them without the next stage in place, they will obviously be much bigger.

The Power Amplifier is based around TR6, the IRF510 FET. This one definitely needs to be fitted on a heatsink and the tab must be insulated from its heatsink because it is electrically the same point as the drain so use a TO220 heatsink mounting kit. If it's convenient for your layout, you could use the metal case of the rig as the heatsink.

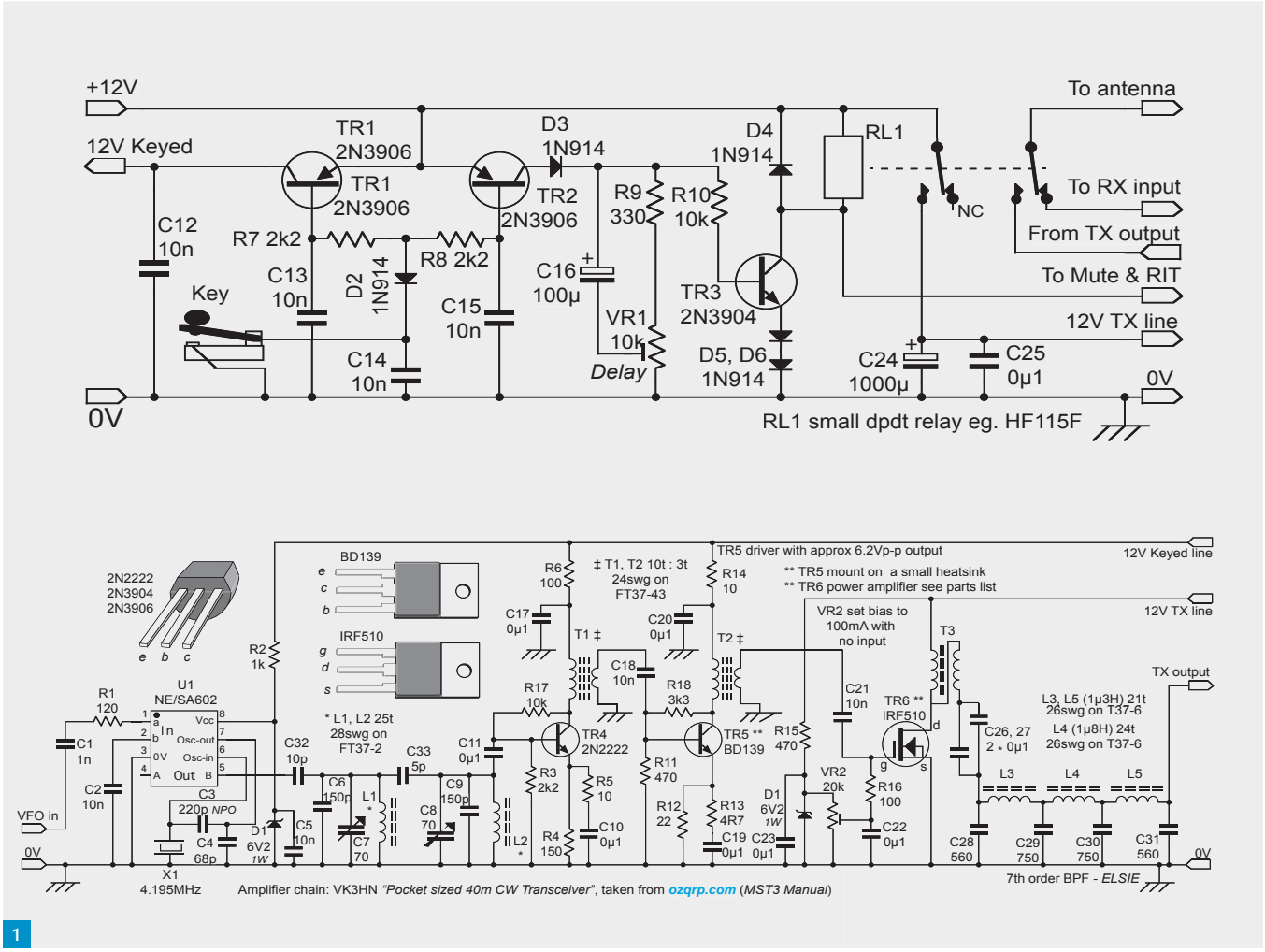
A word of caution though. Don't try and extend the leads of TR6 to reach the case. Stray inductances and capacitance could make this high gain stage go into oscillation on its own. This will quickly fry your FET and will be real pain to diagnose.

Output Low-Pass Filter

The output low-pass filter (LPF) network is a 7th order filter that will suppress any harmonics. I designed it using a great little bit of PC software called Elsie and tested with my nanoVNA. My main goal was to keep the second harmonic, which will be rich in this type of amplifier, to below 43dB down from the fundamental. It comfortably does that. I also confirmed it with my TinySA once the transmitter was built. It's actually nearer to –50dB. In other words, it's a nice clean signal. Higher harmonics are obviously attenuated even more.

Winding the Inductors and Transformers.

Follow the same rules for L1, L2, L3, L4 & L5 as you did when you made the coil in the VFO. Every time the wire goes through the centre, it counts as one turn.



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For the primaries of T1 and T2, follow the same rules: 8 o'clock to 4 o'clock or thereabouts. Now you need to wind the secondary windings, just three turns, over the primary, so the ends are on the opposite side of the toroid. Try and make the three turns cover a few of the turns of the primary. As before, leave about an inch or so at the ends and tin these too. With these transformers it's quite easy to see which is the primary and which is the secondary even once they're made but don't get them back to front or the circuit will not work.

Winding T3 is a bit different. This transformer is bifilar wound. This means it's wound with two lengths of wire that have been wound together. To make it, cut off two lengths of enamelled copper wire around 12 – 14 inches long. We've only got five turns to make so we won't need very much. The easiest way to wind the wires is if you have a drill that has a very fine speed control on it. Hold the two wires together and put two of the ends into a small vice or clamp of some sort. Stretch the wires out a little so they're taut and side by side and clamp the other ends into the drill chuck. Keeping the wires tight very slowly start the drill so the two wires start to twist. You don't need to be precise about this. Just don't overtighten it or the enamel might get scraped off. About four or five twists per inch is enough. Now remove the twisted wires from the drill and the vice. I always cut the two ends back a little as they may have been damaged. If you don't have a drill, then you can do all this by hand. Just be sure you've twisted both wires together and not made one wire twist around the other.

Now you need to wind five turns of your bifilar wire on to your little toroid. I used an FT37-43 to save space but an FT50-43 will work just as well. Leave at least an inch either end. We've not finished yet. We need to figure out which winding is which. Unravel the first few twists, nearly back to the toroid, and tin just the ends. Don't allow the windings to short out. Keep all four ends separate.

We now need a way to label them. I find a black marker pen works well. With your meter set to continuity, test from the start of one winding to its end. When you've found its end, label both the start and the end with your marker pen. There's no need to label the other wire but it's a good idea to measure its continuity and also to check there's no short between the wires. So, let's call the marked wire, wire A, and the unmarked wire, wire B. We need to take the end of wire A and twist it together with the start of wire B and then tin the ends together.

There should now be continuity from the start of wire A all the way to the end of wire B with a midway point joined together. That's T3 made. It's actually a 4:1 impedance transformer. You may even have made something similar for an antenna project. When you study the circuit you can see where the midway point is connected. It goes to the drain of our IRF510 power FET. The start of A goes to C26 and 27 and the end of B goes to the 12V transmit line. Actually, the transformer is symmetrical so it doesn't make much odds which way around you get the other two wires, so long as the centre tap is correct.

T3 is going to transform the output impedance of our FET amplifier, which will be around 12Ω or so, up to the antenna impedance which should be 50Ω. This is why we use a 4:1, or as we're using it, a 1:4 transformer.

Fig. 1: Circuit of the transmitter board (changeover circuit and main transmitter circuit). Fig. 2: The transmit board.

Transmitter Component List

Resistors
All Resistors are ¼ or ⅓ Watt Carbon

R1	120Ω
R2	1kΩ
R3,	2.2kΩ
R4	150Ω
R5, R14	10Ω
R6, R16	100Ω
R17	10kΩ
R11, R15	470Ω
R12	22Ω
R13	4.7Ω
R18	3.3kΩ

Capacitors

C1	1nF (1000pF) Multilayer ceramic
C2,C5, C12, C13, C14, C15, C18, C21	10nF Multilayer ceramic
C3	220pF NP0/COG type disc
C4	68pF Disc
C6, C9	150pF Disc
C7, C8	70pF miniature variable capacitor
C10, C11, C17, C19, C20, C22, C23, C25, C26, C27	100nF Multilayer ceramic
C16, C24	100µF Electrolytic
C28, C31	560pF Disc
C29, C30	750pF Disc
C32	10pF Disc
C33	5pF Disc

Variable Resistors

VR2	20kΩ Miniature potentiometer

Inductors

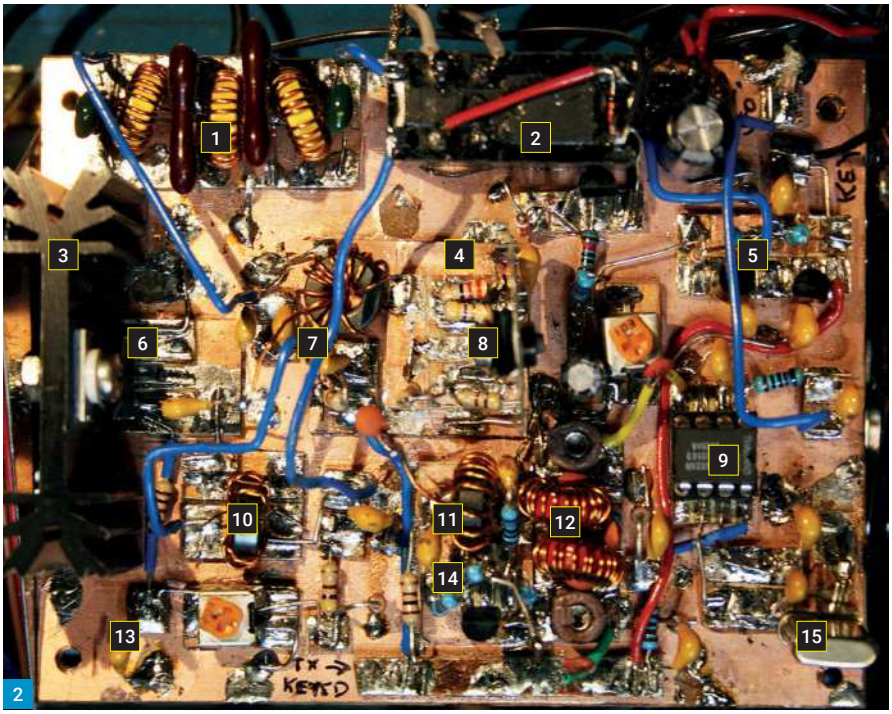
T1, T2	Primary: 10 Turns of 24SWG enamelled copper wire on a Ferrite FT37-43 toroid former. Secondary: 3 Turns of 24 SWG E.C.W. over the primary
T3	5 Bifilar turns of 28 SWG E.C.W (see text on winding if unsure)
L1, L2	25 Turns of 28 SWG E.C.W. on FT37-43 (2.6uH) (or 10K style TOKO inductors, see text)
L3, L5	21 Turns of 26 SWG E.C.W. on T37-6 powdered iron toroid (Yellow) (1.3uH)
L4	24 Turns of 26 SWG E.C.W. on T37-6 toroid (Yellow) (1.8uH)

Crystal

X1	4.915MHz Computer Crystal

Semiconductors

TR4	2N2222A
TR5	BD139 on a small piece of tin plate or aluminium as a heatsink
TR6	IRF510 on a Heatsink (see Miscellaneous)
D1 & D7	Zener Diode 6.2V, 1W



1. Low Pass Filter 2. Antenna C/O 3. PA Heatsink 4. Driver 5. TR1 & TR2 6. TR6 7. T2 8. TR5 9. U1 10. T3 11. T1 12. BPF 13. PA Bias Set 14 Pre-Driver 15. X1

Integrated Circuits

U1	NE602 or SA612 Mixer IC

Miscellaneous

- Small 12V DC DPDT relay eg HF115F
- FT37-43 Ferrite Toroid Former x 5
- T37-6 Powdered Iron Toroid Former x 3
- TO-220 Heatsink around 8°C/Watt or more
- TO-220 Thermal insulator pad and kit
- Small piece of tinplate or aluminium to heat-sink TR5 and a suitable nut & bolt from the junk box.
- Heatsink compound
- Hook-up wire •
- Thin screened cable eg RG174 or similar Copper clad board for ground plane and is-lands

Setting the Bias of the output PA

VR2 is a miniature 20kΩ potentiometer, which we will use to set the bias control of our FET to an appropriate level. When you install it, just ensure for now that it is set to the end nearest ground potential. I would recommend that be anti-clockwise so it's not confusing but it will be dictated by how you wire it in circuit. You can only really set this up once the PA and output LPF have been constructed and you are feeding into a 50Ω dummy load at the antenna socket. The PA is running all the time you are transmitting. It is only the previous amplifier stages and transmit mixer that are powered whenever you press your key down. To set up the PA bias you will need to disconnect C21 at the T2 end and short it to ground. This will ensure there's no signal entering the PA.

Now you need to insert your DMM in series with your the 12V transmit line that supplies TR6. Set it to read milliamps. Now, holding the key down you need to gently increase the bias voltage with VR2 so the PA is drawing around 100mA with no signal. Be careful as it will increase very sharply and can run away with you at which point it can destroy your power FET.

Also be mindful not to hold the key down for more than a few seconds or the FET will start to warm up. Your PA is now set up so you can reconnect C21 etc. A photograph of the transmit board appears at **Fig. 2**.

Correction

In the last issue, R7 (which is mentioned in the text) isn't labelled on the schematic. However, it's the only component that's not labelled and the value is correct in the parts list .

Next Time

In the final part I will cover the transmit/receive changeover circuit. For anyone keen to crack on it was featured in *PW* back in May 2007. It's an article by the inspirational G3RJV entitled *'T-R Box'*. So, you'd better dig out your back issues if you can't wait until next month.

I'll also include more photographs of my finished rig so you can get a feel for how I've fitted my boards in my enclosure but I'm hoping you were more sensible than me and used a bigger box! **PW**

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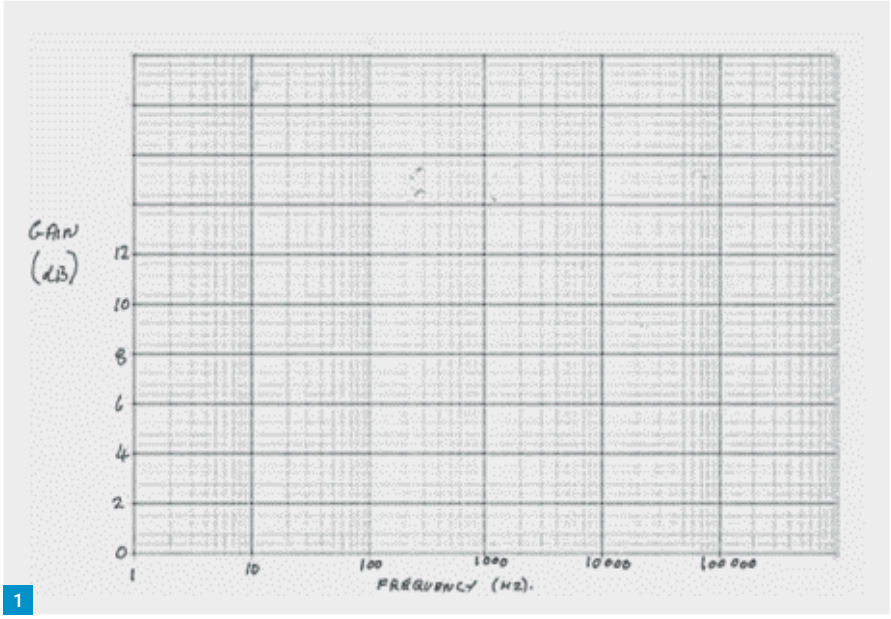


1

Multipliers and Powers

Jeff helps Natalie get to grips with large numbers and ratios, by using exponents and decibels.

As Jeff approached the lab he noticed that the lights were already on. Unusual thought Jeff as he was normally the first in because he liked to consume a couple of cups of tea and have a read of either his newspaper or the latest issues of *Practical Wireless* or *RadCom* before starting work.

As he entered the lab he saw that the lab's apprentice Natalie had beaten him as the first arrival this morning. *"Morning Natalie, what brings you in at this hour?"* Jeff asked. *"Oh, morning Jeff"*, Natalie replied. *"I came in early to have a quick look at the electronics reference books we have to see if there is anything about decibels in them". "I see"*, said Jeff, *"Would this have anything to do with your college work?" "Yes, it does. Yesterday we covered decibels and a bit of maths revision ready for when we start on alternating current principles after half term"*, Natalie explained.

"Mmm, I see", mused Jeff, *"And I suppose those will be our topics for discussion at lunchtime". "If you like"*, said Natalie with a grin.

After they had eaten their lunches, Natalie wandered over to Jeff's desk where he was looking at one of the books that she had been reading earlier. *"OK, where shall we start"*, said Jeff. *"Well Archie said he wanted to do a bit of revision on how to deal with numbers to the power of ten such as five times ten to the power of three. Some of the class left school some time ago and might be a bit rusty with their maths so Archie thought it would be a good idea to do a bit of revision". "OK"*, said Jeff, *"Since it is some time since I left school, you teach me how to deal with these numbers".*

"Well, for some numbers like when we use Gigaohms or Microamps, if we were to write them out in full they would involve a lot of zeros. But we can express such numbers using what is known as Standard Form. A number in Standard Form has two parts, a mantissa and an exponent. Let's say that we have a resistance of five point six Megaohms", said Natalie and wrote the number down:

5.6MΩ = 5600000Ω

"In standard form we express the mantissa as being a number between one and ten and the exponent as being the number of times we have to move the decimal point to either the left or right to get a number between one and ten. The exponent is expressed as ten to the power of the number of times we had to move the decimal point.

For the example of five point six Megaohms, the mantissa is five point six and we have to move the decimal point six places to the left. So, we can say that five point six Megaohms written in standard form is five point six to the power of ten to the six Ohms".

5600000Ω = 5.6 x 10^{6}Ω

"I see", Said Jeff. *"But what about small numbers like two milliamps?" "For numbers less than one"*, said Natalie, *"The exponent becomes negative. For your two milliamps we have to move the decimal point three places to the right so two milliamps is two times ten to the power of minus three Amps".*

0.002A = 2.0 x 10^{-3}A

"So", said Jeff, *"How does this help me with my calculations?" "Well, let's say that you want to find the voltage across a three kilohm resistor that has twenty microamps flowing through it"*, said Natalie. *"Writing this out in full we have":*

3000 x 0.00002

"Which is cumbersome. But in standard form it becomes":

3.0 x 10^{3} x 2.0 x 10^{-5}

"When multiplying numbers in standard form, we multiply the mantissas but add the exponents. So, for our example for the mantissas we have three times two, which is six to the power of three plus minus five, which is minus two. So, the answer is six times ten to the minus two which is sixty millivolts":

3.0 x 2.0 x $10^{(3+[-5])}$ = 6.0 x 10^{-2} = 60mV

"OK", said Jeff, *"I remember now. But what about division". "Well with division, we divide the mantissas as normal but subtract the exponents"*, Natalie explained. *"Let's say that we want to find the current in a two kilohm resistor when it has 50 millivolts across it. From Ohm's law we have 50 millivolts, which we can write as five times ten to the minus two volts divided by two times ten to the three Ohms".* Natalie jotted down the figures. *"Five divided by two is two point five and for the exponents, minus two minus three gives minus five. So, the answer is two point five times ten to the power of minus five. Which is 25 microamps":*

I = 0.05 / 2000 = (5 x 10^{-2} / 2 x 10^{3}) = 2.5 x 10^{-5} = 25μA

"I see", said Jeff. *"You say you covered Decibels as well". "Yes we did"*, Natalie replied. *"But I'm still a bit confused, which is why I was looking through the books earlier". "OK, let's start at the beginning"*, said Jeff. *"One of the characteristics of an electronic system in which we may be interested is the ratio of its output to its input. In other words, how much bigger or smaller the output is compared to the input. We usually denote the ratio by the letter 'A' and one way of expressing the ratio of any two values of power, voltage, or current is in terms of what are called Bels. The Bel though is quite a large unit so we normally do our calculations in one tenth of a Bel or decibels. For power, the decibel is defined as*

being ten times the logarithm to base ten of the ratio of power out to power in. The equation for voltage and current is slightly different which we'll come to shortly". Jeff wrote down the equation for power given in decibels:

$A\ (dB) = 10 \times Log_{10}(P_{out}/P_{in})$

"Let's do an example", said Jeff. *"Let's say that the output power from some electronic system is 50 Watts and that the input power is half a Watt. Putting these values into the equation we have":*

$A\ (dB) = 10 \times Log_{10}(50/0.5) = 10 \times \log_{10} 100 = 20dB$

"Because the answer of 20 decibels is positive, we say that the system has gain", Jeff explained. *"Let's have a look at another example".* Jeff wrote down another set of figures:

$A\ (dB) = 10 \times Log_{10}(5/20) = 10 \times \log_{10} 0.25 = -6\ dB$

"This time, because the answer turns out to be negative at minus six decibels, the system is said to have attenuation". "Yes, got that", said Natalie. *"OK",* Jeff went on, *"Let's look at this from a slightly different angle. Let's say that we're told that an amplifier has a gain of 20 decibels and has an output power of 50 Watts. What input power is required to produce 50 Watts? Using the formula we've used so far we can write":*

$20 = 10 \times Log_{10}(50/P_{in})$

"So, expressing the gain in decibels by the letter A we can rewrite the formula to say that the ratio of output power divided by input power will be given by the antilog of the gain, A divided by ten like this":

$P_{out}/P_{in} = Antilog\ A/10$

"On most calculators the antilog key is shown as 10^X *so from what we've written above we can say that":*

$50/P_{in} = Antilog\ (20/10)$
$50/P_{in} = Antilog\ 2$
$50/P_{in} = 100$
$P_{in} = 0.5$

"From the sums we find that the input power will be half a Watt", Jeff explained. *"What we've done is the reverse of the first example that we did". "OK",* said Natalie. *"You said that we can do the same with voltage and current but the formula is different". "Yes we can",* said Jeff. *"But, since decibels are a comparison of input and output power we have to manipulate the formula so that we can relate the voltages or currents as a power. The maths is bit fiddly but just try to follow the reasoning. If you remember, power can be found from dividing the voltage squared by the resistance or impedance. So, we can write the ratio of power out divided by power in as …".* Jeff jotted down the equation. *"Now, if the input and output impedances are the same, this boils down to the output voltage divided by the input voltage all squared".* Jeff added more equations. *"We can then use this in our formula for power in decibels, and if you remember that in logarithms if a number is squared, we simply multiply the logarithm by two so instead of multiplying the logarithm of the ratio by ten as in power we multiply by 20 for voltage and current",* Jeff explained:

$P_o/P_i = (V_o^2/R) / (V_i^2/R) = V_o^2/V_i^2 = (V_o/V_i)^2$

$A\ (dB) = 10 \times Log_{10}(Vo/Vi)2$

$A\ (dB) = 20 \times Log_{10} V_{out}/V_{in}$

"Let's do an example. But before we go any further it is important to understand that when using these formulas, you must use the same units for input and output power, voltage, and current. If the output power is expressed in Watts, then the input power must be given in Watts, not milliwatts or microwatts. Anyway, if an electronic system produces an output voltage of 80 volts for an input of six volts, what is the gain or loss of the system?"

$A\ (dB) = 20 \times Log_{10}(80/6) = 20 \times Log_{10} 13.33 = 22.5dB$

"OK, fine", said Natalie, *"But just one thing. You said that for what we've just done the input and output impedances had to be the same. What if they're different? Many amplifiers for example have a high input impedances and low output impedance". "I wondered if you'd spot that",* said Jeff, *"for a system with different input and output impedance you just have to modify the formula yet again".* Jeff wrote down another formula:

$A = 20\ Log_{10}(V_o/V_i) + 10\ Log_{10}(Z_i/Z_o)$

"Now you know how to calculate the ratios for power, voltage, and current in terms of decibels, do have any idea what they can be used for?" Jeff asked Natalie. *"Sort of",* she replied. *"One thing that they can be used for us to simplify how we calculate the gains and losses in a chain of circuits or systems". "Correct",* said Jeff. *"Give me an example". "OK",* Natalie replied, *"Let's say that we have two amplifier stages connected in series and one has a voltage gain of 100 and the other 200. To find the voltage gain we multiply the gain of the two stages, which gives 20,000, which if you write down for further calculations, involves a lot of zeros". "Now",* she said, picking up her calculator, *"if you work out the gains in decibels, they work out to be 40 decibels and 46 decibels. If we simply add these together, we get a total of 86 decibels".* Natalie wrote down the numbers. *"And if we work backwards to calculate the voltage ratio that equals 86 decibels, it works out to be 20,000, which is what we just calculated":*

$40dB + 46dB = 86\ dB$

$Voltage\ gain = antilog\ (86/20) = 20,000$

"So, if we know the gains or losses in decibels, we simply add them up to find the overall gain or loss".

dB	Power	Voltage/current
100	10 x 1010	100,000
50	100,000	316
30	1000	31.6
20	100	10
10	10	√10
6	4	2
3	2	√2
0	1	1
−3	0.5	1/√2
−6	0.25	0.5
−10	0.1	0.316

Table 1: Some handy ratios, shown as dB.

"Very good", said Jeff. *"There are a few useful things to know about certain values of decibels. Let's say that a system has a power gain of one. In other words, power out equals the power going in, neither a gain nor a loss. In decibels this works out to be zero decibels. Now let's consider a system that has a gain of two. So, the power out is twice what the power in is. This works out to be three decibels. Another example is where the output power is half what the input power is. This works out in decibels to be minus three decibels. We'll come back to these shortly as these are useful numbers to remember". "OK",* Natalie mused. *"But you said that those were for power. What about voltage and current?"*

"I was coming to that", said Jeff. *"For voltage and current a gain of three decibels represents an output divided by input ratio equal to the square root of two and for minus three decibels one divided by the square root of two".* Jeff jotted down the figures:

$3dB = voltage\ ratio \times \sqrt{2}, -3dB = voltage\ ratio \times 1/\sqrt{2}$

"For voltage and current, in terms of a doubling and halving of the ratios these work out to be six decibels and minus six decibels. There are a few other useful values to remember as well, I'll write a few down for you", said Jeff. **Table. 1**.

"By remembering these figures, you will often be able to do decibel calculations in your head without the need for a calculator. Let's say, for example, that we have an amplifier with an output of five Watts for a one Watt input and we want to know what the gain in decibels is. The output to input ratio is five. From what I wrote down, we know that a power ratio of ten equates to ten decibels and since five Watts is half of ten Watts, five Watts will be three decibels less which is seven decibels. Check with your calculator if you like."

"Ah, that's useful to know", said Natalie. *"You said that there was something special about three decibels. Yes", said Jeff. "You will often come*

Fig. 1: Log/lin graph paper.
Fig. 2: Plotting test results on log/lin paper.
Fig. 3: 3dB bandwidth plot of a tuned circuit.

across the term 'three dB points' in electronics. And another specification often provided to describe the performance of an electronic system is its frequency response and bandwidth. Many electronic systems have to deal with signals of a wide range of frequencies. An audio amplifier for example may need to amplify signals from less than one hundred Hertz up to twenty thousand Hertz or more depending upon its quality. Many of the components that the amplifier is made up of will have different characteristics at different frequencies and it is therefore difficult to design an amplifier that has the same gain at all frequencies. To test the amplifier we could measure the ratio of the input and output voltages over a range of frequencies from say 20 Hertz to 50 kilohertz and plot the results on a graph like this". Jeff took a piece of graph paper out of a draw in his desk.

"That's strange graph paper", Natalie said, examining the graph paper that Jeff had produced. *"Not so much strange as useful"*, *Jeff proclaimed. "It's called logarithmic/linear graph paper or log/lin for short. Let me just label the axes and I'll explain how it works."* Jeff duly labelled the axes on the graph. **Fig. 1**.

"Now as you can see, the vertical, or Y axis has increments that are the same distance apart and this is the linear axis. I've labelled these in decibels in steps of two. The horizontal, or X axis, is logarithmic and if you look at it you can see that there are ten increments that get closer together from left to right. The patten then repeats itself. If we were to plot frequency from zero to several kilohertz on a linear scale, it would need a huge piece of graph paper to make it readable and to be able to take reliable readings from it. But on a logarithmic scale we can plot the frequency in decades like I've just done", Jeff explained. *"I see"*, said Natalie. *"Am I right in assuming then that each of vertical lines represent an increment of ten? Twenty, thirty, forty for example between the ten and one hundred decades". "Correct"*, said Jeff.

"Now", Jeff continued, *"Let's say we've tested our amplifier and plotted the results which turn out like this"*. Jeff drew a curve on the graph, **Fig. 2**. *"As you can see, between 100 Hertz and 30 kilohertz the graph is flat and represents a power ratio of 10dB. But at frequencies above and below these frequencies the gain reduces. As we've said, a drop of 3dB equates to half of the maximum power and three decibels down on ten decibels is seven decibels." "OK"*, said Natalie. *"So"*, Jeff continued, *"If we draw a line across the graph from where seven decibels is marked on the Y axis, we see that it cuts the curve at frequencies of 40 Hertz and 40 kilohertz. These are called the three decibel or half power points and the frequency range 40 Hertz to 40 kilohertz the bandwidth." "I see"*, said Natalie. *"Can we fix what the bandwidth is?" "Yes"*, Jeff replied. *"All electronic systems have bandwidth and how wide or narrow it is depends upon what you want to use the system for. For an amplifier that needs to reproduce orchestral music the bandwidth will need to be fifteen kilohertz or more. The old analogue telephone system that only had to handle speech had a bandwidth of about three and a half kilohertz. A tuned circuit will have a very narrow bandwidth like this."* **Fig. 3**.

"One thing to bear in mind", Jeff continued, *"Is that the bandwidth of the complete system will only be as wide as the part of it with the narrowest bandwidth. Some circuits are purposely designed to limit the bandwidth. This might be because the signals outside of the bandwidth are undesirable. Such circuits are called filters, which no doubt we'll be talking about sometime. Filters can be designed so that they will only allow signals above or below a certain frequency to pass"*.

"Jeff, when I was looking through them books earlier I noticed that there were examples that had other letters after the decibel letters, I wrote a few down look said Natalie":

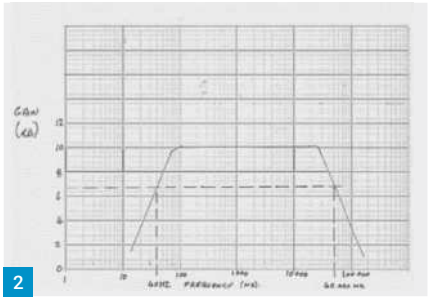
dBW dBm

"Yes", said Jeff. *"What we've talked about so far have been decibel calculations in respect of the ratio of input and output powers, voltages etc and have all been relative to each other. An output of 50 Watts relative to an input of two Watts, say. We cannot use them as an absolute measurement. To do that we need some kind of reference just like we usually measure voltage with reference to zero volts. The examples that you have written down stand for decibel Watt and decibel milliwatts and use one Watt and one milliwatt as their references. If we have 30 decibel milliwatts for example, from the figures I wrote down for you we know that 30 decibels represents a power ratio of 1000 so 30 decibel milliwatts will be 1000 times one milliwatt, which is one Watt"*. Jeff wrote down the sums.

Since 30dB = 1000, 30dBm = 1000 x 0.001W = 1W

"Likewise, ten decibel milliwatts is ten milliwatts", Jeff explained. *"For decibel Watts we use one Watt as the reference so 30 decibel Watts will be 1000 Watts and ten decibel Watts is ten Watts. Happy with that?" "Yes, I think so"*, said Natalie.

"OK", said Jeff looking at his watch. *"There are a few more things that we can use decibels for that will be useful in your radio exam studies such as signal-to-noise ratios and antenna gain but we're running out of time so we'll talk about them another time". "OK, thanks"*, said Natalie gathering up the notes. *"I'll copy these and pass them on to Poppy and Isla. They're always grateful for copies of what we talk about"*.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3

Class Examples

1. Calculate 560000 x 2300000 and write the answer in standard form (1.288×10^{12})
2. Calculate 76 x 0.000046 and write the answer in standard form (3.496×10^{-3})
3. Calculate 300,000,000 divided by 184,000 and write the answer in standard form (1.63×10^{3})
4. If an electronic system produces an output of 180W for an input of 6W calculate the gain/loss in decibels (14.77dB)
5. An electronic system has an output power of 200mW for an input of 3W. Calculate the gain/loss in decibels. (–11.76dB)
6. Three electronic systems with gains of 4dB, 20dB and –6dB are connected in series. Calculate the overall gain/loss of the system (18dB)
7. An amplifier produces an output voltage of 16V for an input of 600mV. Calculate the gain in decibels. (28.52dB)

Jeff's Examples

1. A current amplifier with the same input and output impedance gives an output current of 3.2A for an input of 0.8A. Calculate the gain in decibels. (12dB)
2. Calculate the input power required for an amplifier with a gain of 15dB to produce an output power of 60W. (1.9W)
3. An amplifier with an input impedance of 5kΩ and output impedance of 600Ω produces an output voltage of 2V for an input of 50mV. Calculate the gain in decibels. (41.2dB)
4, Calculate the output power of an electronic system with a gain of 20dBm. (100mW)
5. Without using a calculator, work out the gain in decibels of an electronic system that has an output of 25W for an input of 100mW. (24dB) **PW**

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1

German UHF in 1936

Bernard Nock, G4BXD describes a German UHF system that has recently found its way into his museum.

Many readers will be aware of the various military radio sets I talk about in my articles. Many will have even owned some over the years, those older will have played with them, modified them, taken them to pieces for components (bad people!) and even used them on the amateur bands.

Most of the sets operate in the lower short-wave ranges, 160, 80 and 40m for instance, sets such as the WS19, WS62, R1155 etc, all tune these frequencies and maybe up to about 18MHz or so if lucky. There are though a few oddities out there and the set being covered here is one of them.

Point to Point

If you are a military force either at home or elsewhere, it's usual to have a decent communication system. Much of this system will be by hard wire, i.e. telephone cable, field phones and exchanges. The popular field phone during WW2 was probably the Tele F type, which had a maximum range of about 14-16 miles using D8 twisted cable or 8-10 miles using D3 cable, not bad for a device using a 3V battery.

The set was fitted in a wooden carrying case, which incorporated a spring stop to retain the set in its working position. This afforded some protection in bad weather if being used outside. There were two other versions of the Tele F, the Telephone Set F Long Range, which incorporated an induction coil instead of the buzzer to increase range, and the Telephone Set F High Power, which incorporated a two-valve amplifier, but could also be operated as a normal F set. Thousands of miles of twin-core telephone cable were laid across many countries during WW2.

So, with field phones connected to small exchanges etc good distances could be achieved with some security. A problem could arise though if a wide valley was to be crossed, or wide river or some other location where getting a cable from A to B was difficult. Step up the radio link.

UHF Radio

What you would not want, though, would be a short-wave set broadcasting in all directions and therefore being easy to listen in to. What was needed was a very high frequency, highly directive radio signal that would be hard to intercept. For that task I give you the **SEG-2T** or **DMG-2T** UHF receiver transmitter, designed in 1936 and operating on the UHF band.

After receiving the set and its tripod mount at the museum the search was on for information about it. The first site found was the excellent website of **Arthur Bauer** [**1**], which produced some very interesting details, repeated here with his permission.

"Elster DMG 2T (DeziMeter Geraet 2 Tragbaer) of 1936 was a pack telephone radio set broadcasting between 475 and 525MHz. It remained a main communication set for German regiments and battalions until 1942. The frame devices behind the set are the double rhombus antenna, which are adjustable for signal polarisation.

"The Elster DMG2T (DMG 2T), a mobile UHF wireless telephone link, for 475 to 525MHz The Germans called it Richtfunkverkehr or simply 'RV' communication. It was manufactured by the C. Lorenz company. Its basic design goes back to mid-1930s."

The antenna used by this set was somewhat unusual at the time but, as many readers will know, I have already been using this type of antenna on the various microwave bands with good results. Its commonly known to amateurs as the Bi-Quad.

"The sawtooth like antenna arrangement (double rhombus, consisting of a director (nearest to us) and a reflector plane section), was based on the Chireix - Mesny antenna configuration. In contrast to what one would think on the first hand, its antenna polarisation, if quads are mounted side by side, is not horizontal but vertical! When two sets were employed near to each other, one polarisation plane could be rotated 90°, hence transmissions on the other set would be then horizontally polarized". [1]

There is another interesting website, that of the late LA8AK [**2**] whose website is still available, which has further details about this set.

"DMG2T early radio link transceiver. It has the following valves 2x DS310, 2x RL2T2, RV2P800. DS310 is an odd type of acorn valve, same base

Fig. 1: The SEG-2T on its tripod.
Fig. 2: Internal rear view.
Fig. 3: Internal side view.

as 955 = typ4671 and 958, but it must draw 20mA, so none of the actual replacements will give much result in the receiver, 6F4 has a different socket. RV2P800 is triode-connected for a mysterious reason, and could well have been RL2T2 instead.

"The frequency range is really from about 475MHz to 525MHz. At WW2 they called it the 60cm wavelength range. The output power is about 80mW into a load of about 600Ω. The Chireix Mesny antenna represents a very high impedance load. An alternative solution would be a full wave dipole (high input impedance, too) is also working very convenient". [2]

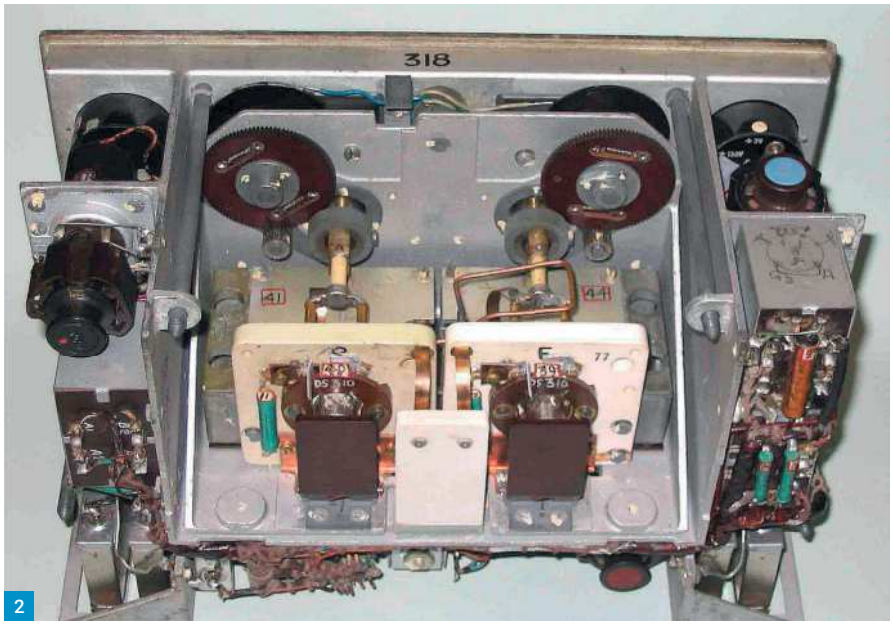
This website also states: *"The measured receiver sensitivity was really a surprise to me: 1µV into 50Ω (with an adequate transformation up to 600Ω) for a readable signal and about 100µV for an absolutely noise free signal! I think, it has been an outstanding transceiver during WW2".*

Another website [**3**] details the workings of the set and has an excellent image of the Bi-Quad antenna being used in the field.

It states: *"SEG2T, or **Sender Empfäng Gerät – 2T,** is a UHF transportable, tripod-mounted, single-channel, signal beamed equipment with provision for voice and for local and remote control. The transceiver, batteries, and accessories are carried in cases for standard German construction and the tripod in a canvas bag. The folding antenna is plugged into a four-point socket at the back of the transceiver case. Antenna, headphones, microphone handset key, remote control cable, spare tubes and induced current ammeter are carried in the accessories bag."*

This site goes on to describe the workings of the set: *"An acorn tube acts as a plate-modulated, parallel rod oscillator. The detector is a conventional, superregenerative, acorn oscillator. The two circuits are identical except for the grid leak of 5kΩ in the transmission circuit. A triode operating as a Hartley oscillator on 550kHz, coupled inductively to the detector, provides external quench. Quench voltage is preset by means of a 200Ω potentiometer across the coupling coil. Superregeneration is controlled by a 10kΩ variable resistance in the feed to both oscillators.*

"It is believed that special troops use this equipment in air-raid net or tactical net at Corps. Camouflaging this tripod-mounted gear and the necessity for an optical transmission path, make it vulnerable to 'spotting'. Approximately 1,000 SEG-2T Elster sets were manufactured (source Fritz Trenkle)".



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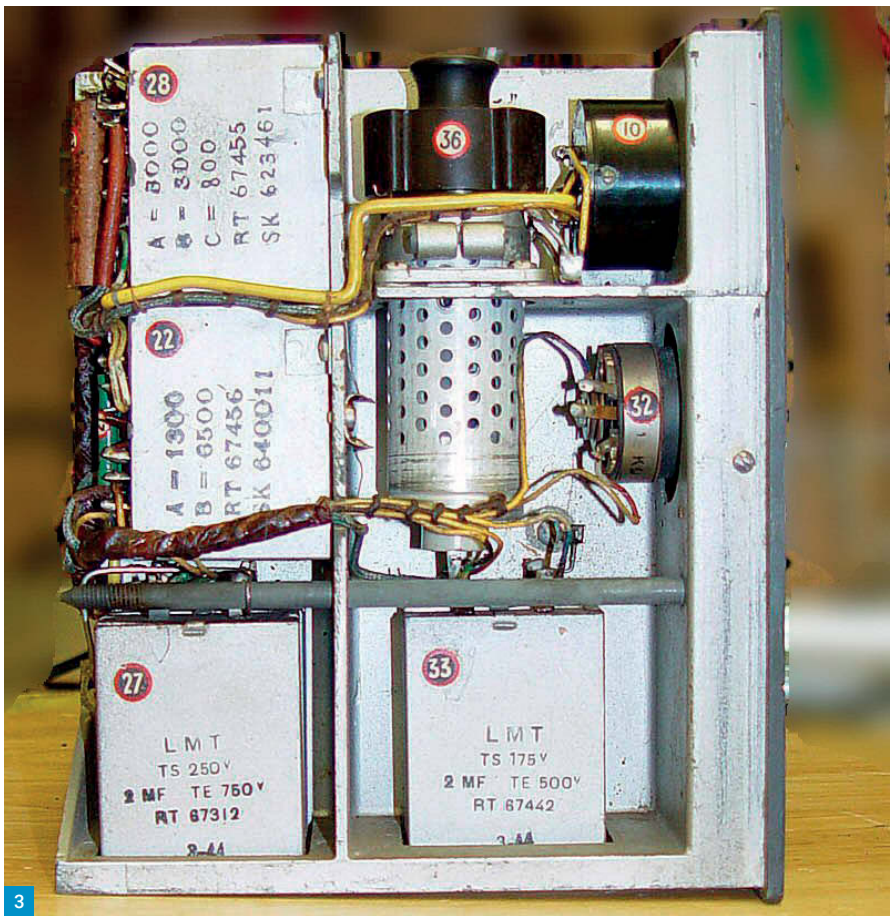

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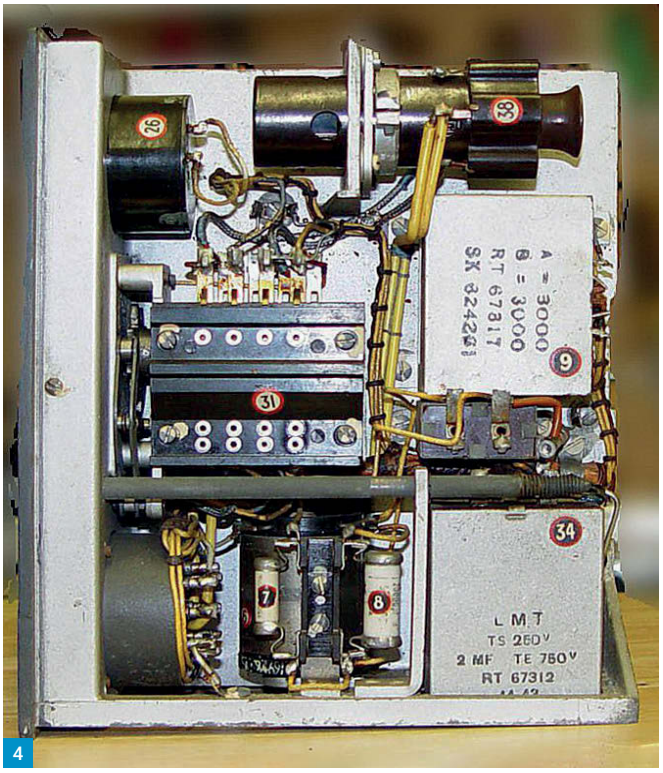
Phone Connection

The DMG-2T was capable of being connected to a wire telephone system so could be used as a link between two points that would otherwise have been impossible to connect. To this end there was another unit, a NTG2 (Netz Gerät Zwo), which not only provided an AC power supply for the radio but included the circuitry to connect the audio to and from a two-wire telephone line to the radio and back with the radio being remotely controlled by the phone line.

Goebbels Link

From Arthur Bauer's site there is an interesting reference to just how useful a radio link can be when faced with impossible conditions were a wire-based circuit cannot be used.

"For some time, this type of equipment had been employed in the 'Festung Breslau', during the final months of the war, in 1945 (besieged city of



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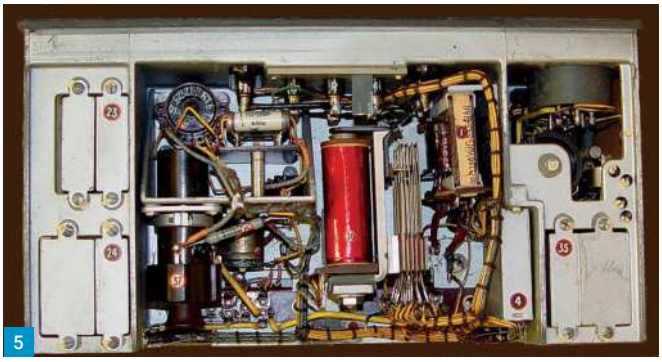
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Fig. 4: Internal side view. Fig. 5: Underside view. Fig. 6: The Bi-Quad type antenna. Fig. 7: Radio with battery box on tripod in use. Fig. 8: The NGT-2 unit, phone connection.

Breslau; since summer 1945 Poland, is called now Wroclaw). Elster apparatus was the only secret communication gear between those inside Breslau and the German military services outside.

"The Russians concluded, after due investigations, that there must exist communication between the in- and outside German services. Russian interception services could not, however, find German wireless traffic. They suggested that the only logic explanation was, an existing hidden telephone line connection. They decided to dig a deep trench around the city of Breslau, so as to disrupt any cable connection. What they weren't aware of was, that the Germans used an Ultra High Frequency Elster DMG2T set, placed on the roof of the main Post Office building. The German station on the other end of the line was erected in the mountains, about 125km away from Breslau (territory then still held by the German armed forces).

"In the book: Joseph Goebbels Tagebücher 1945 Die letzten Aufzeichnungen; (Joseph Goebbels Diaries. 1945. The last records) for 30 March 1945 (Hoffmann & Campe Verlages, Hamburg (1977?). On page 384: 'This also comes back to my consciousness when I suddenly get a phone call from Wroclaw in the evening. Hanke has managed to get a telephone line to Berlin in a way that he cannot describe to me in more detail. He expresses himself in this conversation'". [1]

And Finally

The next step is to see if this example of the radio actually works and to try and recreate the antenna assembly, which does not look that difficult though probably a non-folding type in the first instance will be easier.

When I mentioned my new find to my French friend, **Dominique**, a fellow collector, I was dismayed at his reply: *"Your German set with its tripod is fine, but the ears would be hard to find; good luck! I saw in old days this station, with accessories boxes, cables, power supply with phone/telegraph converter."* Things were a lot easier back then.

So, all in all I think you can agree it's a very interesting set that found a niche role during the war. Of course, in addition to a UHF point-to-point radio link the Germans also had an actual light-powered transceiver, a real point-to-point line-of-sight apparatus that was also used for otherwise difficult situations. The Lichtsprechgerat 80 is a two-way audio communication set with the signal being transferred on a light beam from a 5W bulb. I'll cover this when I acquire one. **PW**

References

[1] https://tinyurl.com/5n6c7nx8
[2] www.noding.com/la8ak/33a.htm
[3] https://kriegsfunker.com/radios/SEG2T.php
[4] www.cdvandt.org/elster_dmg_2t.htm


7


8

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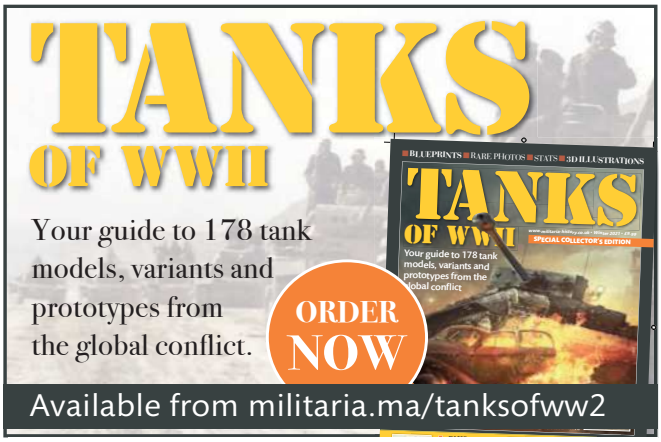

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Rallies & Events

Due to the ongoing Coronavirus (COVID-19) situation, the Rallies calendar remains changeable. All information published here reflects the situation up to and including 20th May 2022. Readers are advised to check with the organisers of any rally or event, before setting out for any visit. The Radio Enthusiast website will have regular rally updates, please check it regularly. To get your event on this list, e-mail full details as early as possible to: **wiessala@hotmail.com**

24-26 June
HAM RADIO FRIEDRICHSHAFEN: Messe Friedrichshafen, Neue Messe 1, 88046 Friedrichshafen. Exhibitors & visitors from 52 countries. (FM | L | TS). Plus, meetings, socialising, and more.
https://tinyurl.com/2p8up2rc
https://tinyurl.com/ycnxskle

25 June
GI-QRP CONVENTION: Tandragee Golf Club, 11 Markethill Road, Tandragee, Craigavon BT62 2ER. Doors open at 9 am; presentations start at 10 am. Held in association with the GQRP Club. (BA | CR | FP | D | L | LB | RF | SIG | TS).
Philip MI0MSO: 078 4902 5760
r8.giqrp@gmail.com

26 June
NEWBURY RADIO RALLY: The Newbury Rally is now back. It will take place at Newbury Showground, Priors Court Road, Hermitage, Thatcham, Berks. RG18 9QZ (Next to J13 of the M4). The is organised and run by the Newbury And District Amateur Radio Society.
https://www.nadars.org.uk/rally.asp
http://www.nadars.org.uk

1 July
DADARS SPECIAL EVENT (13 COLONIES): Durham and District Amateur Radio Society is privileged to be participating as one of the bonus stations in this popular event. The NoV special callsign GB13COL has been issued and will run from the club station from 1st July 1300 UTC to 8th July 0400 UTC. The focus of the event will be the HF bands, including VHF, UHF and Satellite, for QSOs using SSB, CW, FM, and various digital modes.
www.13colonies.us
g0vlf@yahoo.co.uk

2 July
LAUGHARNE RADIO RALLY: Millennium Memorial Hall, SA33 4QG. Doors open from 10-12 am.
Matthew: Tel: 0739 882 5024

3 July
BARFORD NORFOLK ARC RADIO RALLY
www.norfolkamateurradio.org

3 July
CORNISH RAC RALLY: Penair School, St Clement, Truro, Cornwall TR1 1TN. Doors open at 10 am. Admission is £2. (BB | CR | D TS | Local Club Stands).
Ken Tarry G0FIC: 01209 821073
pendennis38@btinternet.com
www.gx4crc.com

9 July
HOUGHTON RADIO CLUB FREE RADIO RALLY: The Dubmire Royal British Legion Club, Britannia Terrace, Fencehouses DH4 6LJ. Doors are open from 10 am to 3 pm. Open to trade, clubs and private sellers/exhibitors but table space is limited. No charge for tables. Free entry. Donations to the Royal British Legion Club. (CF | LB [11 am]).
Amanda M6LXK: 07787 155 745
westona84@gmail.com

17 July
MCMICHAEL AMATEUR RADIO RALLY & CAR BOOT SALE: The McMichael Rally begins at 09:30 am, with car boot setup from 8:30 am. The location is Reading Rugby Club, Sonning Lane (B4446) – just off the A4 at Sonning, east of Reading, Berkshire. Postcode: RG4 6ST, NGR SU 753 747. Admission: £3 per person. Car boot sale: £10 per pitch, no booking required. Sorry but no dogs are allowed, except for assistance dogs (site rule) (CBS | FP | SIG).
https://mcmichaelrally.org.uk
rally@radarc.org
traders@radarc.org

24 July
FINNINGLEY ARS RALLY: Car-boot style rally. Food bar. Near J2 M180, Doncaster.
www.g0ghk.com

31 July
WILTSHIRE RADIO RALLY, ELECTRONICS FAIR & CAR BOOT: Kington Langley Village Hall and Playing Field, Kington Langley, Wiltshire SN15 5NJ. 9 am to 3 pm. Admission free. Traders Welcome (CA | Covid-19 safe).
Brian, G6HUI
rally@chippenhamradio.club
https://wiltshirespc.org/wp/g3vre/rally

31 July
WILTSHIRE RADIO & CAR BOOT SALE: Kington Langley Village Hall and Playing Field, Kington Langley, Wiltshire SN15 5NJ. Doors open at 9 am; free admission. Traders welcome (CR).
Brian G6HUI
rally@chippenhamradio.club

7 August
BATC CONVENTION FOR AMATEUR TV 2022 (CAT 22) PART 1: Midland Air Museum, Rowley Rd, Coventry CV3 4FR. CAT 22 is a meet-up, show and tell, test and fix-it, and Bring & Buy event, from 10 am to 4 pm. Test facilities are available for 5.6GHz/Portsdown/MiniTiouner/Ryde/power amplifiers/preamps.
https://batc.org.uk/events

7 August
KING'S LYNN ARC 32ND GREAT EASTERN RADIO RALLY: Gaywood Community Centre, Gayton Road, King's Lynn, Norfolk. PE30 4EL. NGR TF638203. Open 9 am (trade from 7 am). Admission is £ 2.50. Outdoor pitch £8; indoor £10 per table. (BB | CF | FP | TS).
rally.klarc@gmail.com
http://www.klarc.org.uk

12-14 August
19TH INTERNATIONAL EME CONFERENCE (PRAGUE)
http://www.eme2020.cz

12 August
COCKENZIE & PORT SETON ARC 27TH MINI-RALLY NIGHT: Community Centre, Main Hall, Port Seton. 6 pm. Admission is £2.
www.cpsarc.com

14 August
FLIGHT REFUELLING ARS HAMFEST: Cobham Sports and Social Club Ground, Merley, nr Wimborne, Dorset, BH21 3DA. Talk in will be on S22. The gates open from 10 am to 6 pm; entry will be £4, which includes car parking. No dogs are permitted except Guide dogs. (L | TS | Indoor and Field Pitches).
Tony Baker G3PFM: 07743 475018
tbaker@tiscali.co.uk
www.frars.co.uk

21 August
RUGBY AMATEUR TRANSMITTING SOCIETY RADIO RALLY: Princethorpe College, Princethorpe, Rugby CV23 9PY. Open 10:00. Car boot sale.
Steve G8LYB: 07956 855816
rally@rugbyats.co.uk
www.rugbyats.co.uk

28 August
MILTON KEYNES ARS RALLY: The Irish Centre, Manor Fields, Watling Street, Bletchley, MK2 2HX (Opposite Dobbies Garden Centre), which has excellent modern facilities (FP | CF | D). The entrance fee is £3.00. Open to the public from 9:00 am. Outdoor pitches and indoor tables are available.
Brendan G8IXK: rally@mkars.org.uk
www.mkars.org.uk

28 August
TORBAY ANNUAL COMMUNICATIONS FAIR: Newton Abbot Racecourse Devon TQ12 3AF. Doors open at 10 am, with disabled visitors gaining access at 9.30 am. Indoor event (FP | BB | RSGB CF).
Pete G4VTO: 01803 864 528
Mike G1TUU: 01803 557 941.
rally@tars.org.uk

29 August
HUNTINGDONSHIRE ARS (HARS) ANNUAL RALLY: Ernulf Academy, St Neots PE19 2SH. Open for Traders at 7 am and the public at 9 am. Indoor and outdoor stalls are available. Talk-in on 145.550 MHz on GX0HSR. (BB | CR | FP)
Malcolm M0OLG: 01480 214282.
events@hunts-hams.co.uk
www.hunts-hams.co.uk

4 September
TELFORD HAMFEST: Harper Adams University (HAU) TF10 8NB.
Martyn G3UKV: 01952 255416
http://www.telfordhamfest.org.uk

11 September
CAISTER LIFEBOAT RADIO RALLY: Caister Lifeboat Station, Caister on Sea, NR30 5DJ.
Zane M1BFI: 07711 214790.
m1bfi@outlook.com

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Your Letters

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What is a Communications Receiver?

Dear Don,

I cannot agree with your definition of a Communications Receiver (hereafter Comms Rx), namely a facility to mute an associated transmitter. This in any event assumes that one only ever uses a Comms Rx in association with a transmitter.

If I follow that, then the following Comms Rx sets known to me are not Comms Rxs. Marconi CR100/B28, Murphy CR150/B40, R107, Eddystone 734 and 770, and EC10, although the /2 at least has a spare pair of contacts on the standby switch that one can wire for the purpose, through a grommeted hole in the rear. R209, Hallicrafters S20R and S 38A. Redifon R50 and R551. I don't think either the famous RCA AR88 or National HRO Senior had such a facility. Some of these sets had a stand-by facility, but that is not the same.

Before defining the set, one needs to define the term Communication and that in contrast to Broadcast. The latter is for all and sundry to listen to, the more the better, and it is for entertainment, education and information. By contrast, Communication is narrow-casting for a limited audience for a specific purpose, such as weather forecasts to ships and aircraft, safety warnings, and at the secret end, may be ciphered to just one person. The modes used are not likely to be ordinary AM or FM.

So, to the requirements for the receiver. While the set may cover broadcast frequencies, it may well not, or only to a limited extent, but it will cover frequencies that broadcast receivers are unlikely to, even the 'posh' ones with short-wave coverage, which traditionally if they had any extended coverage was of the band-spreaded International Broadcast frequencies, not the communications bands.

The next essential therefore after different frequency coverage is the ability to resolve other modes than normal AM, ie DSB AM and wide-band FM if covered. Essential is to receive CW, which requires a BFO, and nowadays SSB, which requires much the same, but at a much higher level, and is called a CIO (carrier insertion oscillator). With the need to resolve weak signals, either because the transmitter does not have anything like the power of a broadcast transmitter, or due to distance and fading, and stronger adjacent signals, one needs narrower and preferably selectable bandwidths, better selectivity generally, and for SSB, a filter for one sideband only of the IF signal. The ability to tailor the AGC time-constant is needed, if only between AM and CW, the ability to manually control RF/IF gain, and possibly both individually, are desirable. As one expects to be dealing with weak signals, both higher gain and a lower noise floor are essential. Traditionally obtained by having one or more RF amplifiers before the mixer, and extra tuned circuits at RF, with the especial aim to reduce image frequency reception. More than one IF amplifier was usual. It is true that better domestic sets also had an RF amplifier, and some had two IF amplifiers. The modes used need better stability of tuning, so the local oscillator design was more complex. If memories are fitted, as in modern sets with CPU control, then not only frequency, which many domestic sets have, but also mode, AGC, RF gain and BFO frequency are likely to be stored.

By contrast with a broadcast set, no nice cabinet, for presentation in the lounge, and if a speaker is fitted it will be low-fi. Cabinets tend to be for rack-mounting, and in any event, rugged, and therefore almost always metal. Audio quality is not the object. No bass response and 10% distortion is fine. Headphone operation however is essential, as is line-out to feed decoders for RTTY, FAX, and decryption equipment.

So, in conclusion I suggest a lot of different factors are involved in defining a Communications receiver, but having the ability to mute a transmitter is not one of them, though many will have it, and the starting-point for the definition is the difference between broadcast and Communication.

Philip Moss M0PBM
Surbiton

The NanoVNA Revisited

Dear Don,

I bought my Nano VNA second-hand so I have no comment on other versions, methods of purchase or even different suppliers, except to say I am pleased with my buy. However, as

mentioned in previous articles and YouTube etc. it's very construction can seem to make it a little fragile and to that end I constructed (modified) an enclosure for it.

I have not provided detail sizes of the box as all the parts were found 'in the junk box'.

The box was a defective dummy load (made in IOM, maker's name covered over) with two SO239 sockets and an on/off switch. The resistors forming the 50Ω load were on a printed circuit board and were a shade of brown I didn't like so they were thrown away. That left a large enough space to fit the little VNA to be secured with foam rubber or whatever is handy to stop it rattling around.

One SO239 was wired to the rotary on/off switch, now marked as 'open and short', which forms part of the calibration instructions. On the other socket I fitted a 50Ω dummy load and use that position just for safe keeping. When needed during calibration it is easily moved to the first socket ensuring the switch is set to open. Calibration can now take place without the three fiddly plugs.

An SMA plug with a short lead is soldered to the first socket and may be left in place when attached to the VNA, ensuring no stress is felt at the VNA when an antenna

is connected. My SMA plug was a right-angled one and I used it because it was in my collection already with a short length of coax.

While the lid is off the USB charging lead may be connected and when charged the little device is ready for action. The photos should give some idea of the arrangement.

And as a PS, I have now added a small toggle (on/off) switch with two 100Ω parallel resistors between chassis and the centre pin on the SO239, to replace the external dummy load. So, it is now self-contained.

Tony Skaife G4XIV

JY1

Dear Don,

Well, I never knew that! That **Rob Mannion G3XFD's** wife had at one time, been in the employ of **King Hussein of Jordan JY1**, as a child minder. I vaguely recall that 1990 *PW* issue.

The main reason this revelation hit me like a poleaxe, is because my best and late lamented friend, **Wayne Green W2NSD**, editor extraordinaire of *73* magazine, was partly instrumental in setting up amateur radio activity in the kingdom of Jordan, particularly VHF. Wayne made several trips to Jordan (I went there too, but not with Wayne). His friendship with King Hussein endured. Although, perhaps not surprisingly, negotiations with various other parties involved with internal and external communications sometimes became a little fractious. Jordan, at that time, was seen as an 'honest-broker' in the region. In passing, as a result of Hussein's interest, Jordan issued a set of amateur-radio themed stamps (see photo).

As a consequence of Wayne's input and friendship with Hussein, he was wined and dined, occasionally in spectacular circumstances. Anyhow, Wayne didn't hold back in describing all his Jordanian adventures, which he related in forensic detail in various issues of *73* magazine. I'll have to dig mine out and relive the adventure.

On another matter, that review, *Two Antennas from Moonraker*, I must confess, got my juices going. If only because operating outdoors is a big relief from annoying the neighbours and being able to cast to the winds the worry of doing your own thing without the XYL banging on the shack door asking if you want more coffee or another cold beer. Don't get me wrong, I'm not knocking her effort of humility, because it usually happens at the wrong time. As I'm about to hook a new one!

Ray Howes G4OWY/G6AUW
Weymouth, Dorset

PW June

Dear Don,

I'm disappointed (*Data Modes at VHF*, current issue p.20) that **Mike G4WNC** couldn't trade with the German supplier of the preferred en-

closure, on the pretext of some sort of Brexit difficulty. I've just received some specialist computer cards from Germany (can't get elsewhere, not even China!) and they arrived within four days of payment. Also, I've just had a pooled-production PCB order accepted by a German manufacturer. They were a bit cheaper than Chinese rivals. No problem there, German VAT was simply added to the total (helpfully converted to Sterling). I feel that, in some quarters, artificial difficulties are being raised with Brexit as an excuse, simply to make a political point. There are lots of myths about Brexit. It's done. We have new arrangements. It's down to vendors to get over it and concentrate on the job.

Godfrey Manning G4GLM
Edgware

*(**Editor's comment**: Thanks Godfrey and also for a PDF copy of the ZX Computing supplement that appeared with the December 1982 issue of* PW*, as I mentioned last month)*

Next Month

in the UK's best & only independent amateur radio magazine...

A SMALL MAGNETIC LOOP FOR THE HF BANDS: Maurice Webb GW0UGQ describes a small magnetic loop suitable for use by those with restricted space.

MOVING HOME AND A FRESH START WITH AMATEUR RADIO: In Part 1 of a new series, Richard White G6NFE recounts the trials and tribulations of starting afresh.

THE MARCONI 2955 RADIO TEST SET: Gary Clark G0BKR takes a look at the Marconi 2955 Radio Communications Test Set.

THE PW PASTON: Mark Tuttle G0TMT brings readers the final part of the build by adding the antenna changeover circuit.

VALVE & VINTAGE: Philip Moss M0PBM takes a look at the once popular Eddystone EC-10 receiver.

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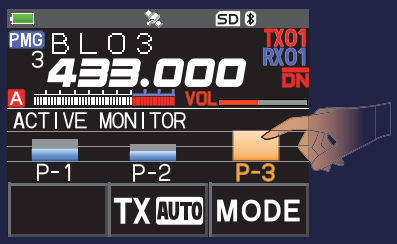

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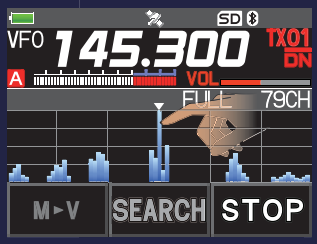

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