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PRACTICAL WIRELESS

MARCH 2022 THE UK'S NUMBER ONE AMATEUR RADIO MAGAZINE SINCE 1932

REPAIR PROJECT | **A new series looking at repairing valved radios**

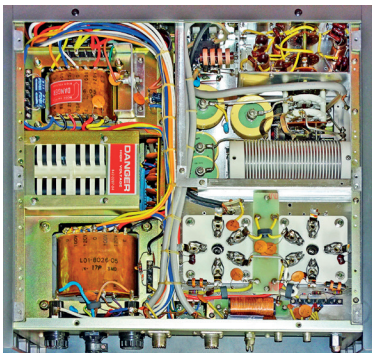
YAESU'S FTM-6000E

Practical Wireless REVIEW

An easy to use transceiver that offers great value

Portable Antenna

An easy to build 2m beam for portable operation



Kenwood TL-922

The ins and outs of this potent HF power amplifier

NEWS A First Listing of Regular UKVHF/UHF Nets

Extensive details of groups across the country from Ayrshire down to Devon

GEAR Finding the Best Linear Amplifier for You

A range of HF and VHF amplifiers that are available for budget prices

Seeing the Faces

Meeting the people behind the callsigns

Readers Write

Two pages packed with your letters

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Practical Wireless
Warners Group Publications plc
The Maltings, West Street
Bourne, Lincs PE10 9PH
www.warnersgroup.co.uk
Tel 01778 391000

Editor
Don Field G3XTT
practicalwireless@warnersgroup.co.uk
Designer
Mike Edwards
mike.edwards@warnersgroup.co.uk
Advertisement Manager
Kristina Green
01778 392096
kristina.green@warnersgroup.co.uk
Production Manager
Nicola Glossop
nicola.glossop@warnersgroup.co.uk
Production Assistant
Charlotte Bamford
Charlotte.bamford@warnersgroup.co.uk
Marketing Manager
Katherine Brown
katherine.brown@warnersgroup.co.uk
Marketing Executive
Luke Hider
luke.hider@warnersgroup.co.uk
Publisher
Rob McDonnell
robm@warnersgroup.co.uk

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Keylines

I am astonished to note that this is my 100th issue of *PW*. That means 100 *Keylines*, 100 deadlines and so on. While I still have a long way to go to match my predecessor Rob's 25 years at the helm, it's amazing how quickly the time has gone. I do get a lot of satisfaction from editing the magazine. As the only remaining bookstall magazine in the UK devoted the hobby, it's very much appreciated by our diverse and enthusiastic readership.

Small Station

You'll have seen from **Joe Chester M1MWD's** last column that he is bowing out for the time being. Joe has had some health problems in recent months, on top of losing his wife last year. I'm sure we all wish him well and look forward to his eventual return to these pages. As Joe says, he and I took something of a leap into the dark when we started with the series but it took off in a big way, leading to invitations to give club talks, a presentation to the online RSGB Convention and other possible avenues to develop the *Small Station* theme. Well done Joe and many thanks!

Radials Again

I have finally got round to putting down a reasonable set of 'permanent' radials for my lowband vertical antenna, but I gave up on trying to bury them – too much like hard work! Instead, I have used lawn staples to staple them down in the hope that, by the spring, the grass will have grown and hidden them sufficiently flush with the soil that I can cut the lawn without chopping them into pieces. Time will tell!

Linear Amplifiers

In this issue **Daimon Tilley G4USI** talks about linear amplifiers in his *On a Budget* series and **Bruce Taylor HB9ANY** describes the still popular TL-922 amplifier. Many radio amateurs spend their amateur radio careers running 100W or less, with plenty of success and enjoyment. In my case, when I bought my first linear amplifier (a Yaesu FL-2000) many years ago, it transformed my DXing experience. I had no real possibility at that location for 'gain' antennas on HF, but the amplifier allowed me to compete,

at least to a degree, with the 'big boys'. Subsequently, at my next house, I was able to put up an HF triband (20, 15, 10m) Yagi, which made a big difference because, of course, a decent gain antenna improves reception as well as transmission. But gain antennas are, for most of us, unrealistic on the low frequency (40, 80, 160m) bands, where the amplifier continues to be, in my view, an essential part of the DXer's armoury.

And generally speaking, a linear amplifier stands the tests of time better than a transceiver – there really isn't a lot that can be done to improve its 'performance'. The main changes over the years have been a steady migration from valves to solid-state, although there is still a lot to be said for valve-based linear amplifiers, but also the incorporation of much-improved protection against high SWR, excess drive and the like. Which takes me back to my own TL-922, which I owned for many years until I loaned it to the local club for a special event operation and it was blown up by a club member unfamiliar with tuning valve amplifiers!

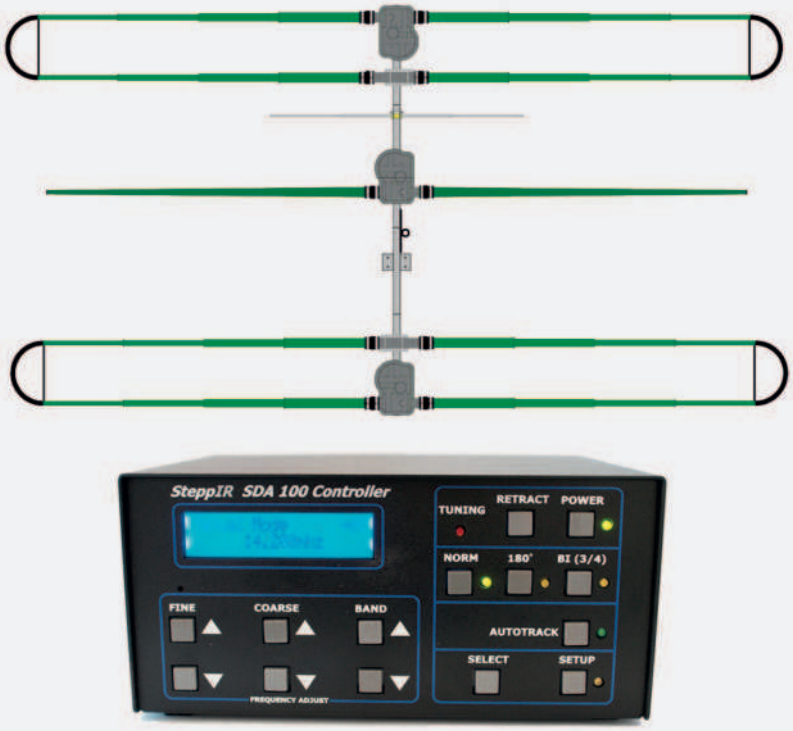
Correction

Although we got **Simon Pryce's** callsign (**G0EIY**) correct in the results table on p.29 of last month's issue, we managed to print it as G0IEY on the following page. Apologies both to him and to **Simon Tribe G0IEY**.

Don Field
Editor, *Practical Wireless Magazine*

Newsdesk

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



ML&S take on SteppIR

Since 2001, SteppIR Communication Systems has manufactured thousands of mechanically adjusted, remotely tuned, frequency optimised HF/VHF Yagi, Vertical and Dipole antenna systems for Commercial, Amateur, Military, Emergency Communications and Consumer Markets.

In December 2021, SteppIR appointed Martin Lynch & Sons to retail & distribute their range of antenna products. For more information see: HamRadio.co.uk/steppIR

John Mertel WA7IR, SteppIR President & CEO commented *"Martin Lynch & Sons represents a significant step forward for SteppIR Communication Systems. Never before have we had such a well-known, highly respected ham radio reseller as a partner, to assist in the overseas sales, service and maintenance of SteppIR products. It takes a serious commitment to offer the kind of customer service we expect at SteppIR, and we believe ML&S is up to the task and more. We look forward to working with the ML&S team to help build new and lasting relationships with our valued customers in the UK and beyond".*

The 3 element Yagi is the original SteppIR antenna and uses their proven technology giving continuous frequency coverage (no gaps at all!) from 6.8 to 54MHz. There have been many improvements over the years such as the addition of a 40/30m rotatable dipole and the now standard electronic controller, the SDA100. With a 16ft boom, the antenna models that are programmed into the controller deliver solid gain and exceptional front-to-rear ratios.

steppIR COMMUNICATION SYSTEMS

New from Moonraker

Moonraker's latest press release features products from Sharman Multicom. These include the AV-508 desktop microphone, with suitable connecting leads available for all the main base station radios. This sells for £69.95. The AR-600XL antenna rotator, with base control unit and InfraRed remote control is designed for use with smaller (VHF/UHF) antennas and retails for £179.99. The AV-6075NF power supply is a lightweight switched mode power supply that can deliver up to 75A, making it suitable for 200W radios such as the Kenwood TS-480HX. It retails for £349.99.

New Licence Level Proposed for Ireland

ComReg, the Irish telecommunications agency, plans to introduce a new level of amateur radio licence at either a novice or entry level, targeting younger licence candidates in particular. Ireland presently has only one class of amateur radio licence. The recommendation is outlined in the agency's recent statement on a Strategy for Managing the Radio Spectrum from 2022 to 2024. ComReg describes the rationale behind the introduction of the new licence, which would not require full knowledge of HAREC – the Harmonised Amateur Radio Examination Certificate. The document further states that Ireland is interested in *"nurturing, developing and deploying STEM talent and the availability of a novice licence would enable the amateur radio service to act in the national interest."*

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

ESSEX HAM NEWS: For the second year in a row, Covid has taken its toll on amateur radio events, but Essex Ham still managed some activity with four Field Days in Galleywood: the June Summer Solstice, and other events in June, July and December. The team was at the Earls Colne Airfield for the Air Ambulances on the Air event in September, as official supporters of the Essex & Herts Air Ambulance, and supported a very busy GB1BEL JOTA at Belchamps in October.
A new community workshop, the East Essex Hackspace launched in 2021, and the group was invited to run a special event station for the opening, as well as activating the Hackspace later in the year for the Essex 2m Activity Day, and when the BBC Essex Quest paid a visit.
Essex Ham was out promoting the hobby at the Belfairs Academy Careers and Community event in October, and were alongside Hamtronics UK at the September Suffolk RED gathering, with handouts for newbies. Oscar 2E1HWE ran an Essex Ham net as part of the GOTA (Gateways On The Air) activity week from Hadleigh Castle.
2021 also saw the launch of the HamNews UK podcast.
Training was a strong focus for 2021, with Essex Ham running 24 courses with a total of 2,422 students. The group's nets continued through 2021 – thanks to everyone who took part, especially to Dorothy M0LMR for running the YL Net.
A video of the year's events can be found at:
sxham.uk/21

PLATINUM JUBILEE : Ofcom has kindly agreed to an RSGB request that radio amateurs licensed by Ofcom may celebrate the Platinum Jubilee of Her Majesty The Queen by using the special RSL 'Q'. This will be available for use throughout June 2022 and will require a Notice of Variation that will be available via the RSGB website. The Society is also working on other events and activities that it hopes will appeal to a wide range of people. Further details will be released over the coming weeks.

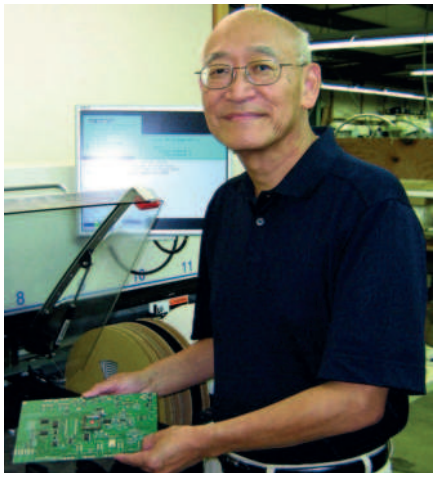
NEWS FROM THE RSGB: The RSGB Board is pleased to confirm the appointment of Chris Wood GD6TWF as Honorary Treasurer. Chris is a Fellow of the Association of Chartered Certified Accountants and has spent many years as a senior accountant within the banking industry, with roles including director level responsibilities and audit. Chris lives on the Isle of Man and continues to enjoy his long interest in yachting as a volunteer with the Isle of Man Sailing for the Disabled Charity. The Society welcomes Chris to his new role.
Jonathan Groves M0VRI has been co-opted to the RSGB Board until the AGM 2022 to carry out a three-month review of RSGB youth activities and opportunities. He has been an active member of the Examinations and Syllabus Review Group for some time and will be presented to the membership for endorsement as a Nominated Director at the forthcoming AGM.
Are you a member of a university or college amateur radio club? Would you like to find one to join? Or are you keen to revive or even start a new one? The RSGB is drawing together a list of names and contact details to help university radio amateurs contact each other. To see the list and how to add your details, visit the RSGB website at:
www.rsgb.org/university-corner

MEDWAY AMATEUR RECEIVING AND TRANSMITTING SOCIETY, 100TH ANNIVERSARY: MARTS is this year celebrating its centenary, starting early on, marking their founder G6NU with the special event callsign GB6NU from what would have been his birthday on 1 January.
William Nutton G6NU was the founding President of MARTS (1922). At the opening of The Great War, William took up the rallying call to the colours and signed up with the Royal West Kent Regiment as a signaller. His Battalion was to find itself deployed to India and William was soon to find himself fighting insurgents on the Northwest Frontier. As a signaller he was to learn the Morse Code and how to signal using heliographs as well as the mule packed radios that were being made available to military operations at that time. William was to become highly efficient in the art of Morse Code and gained a real passion for all things to do with the science of wireless. He left the Army upon demobilisation, and took his skills as a Signals Instructor back into civilian life, although perhaps unsure at that time how this would fit into his ordinary life in the grocery trade.
As broadcasting made its first steps onto the air waves, he and a number of like-minded folk from Gillingham started meeting in each other's houses to admire their simple receivers and share tips on how to make them work better. William had the advantage of his Service training and took an early lead in organising and motivating his radio-minded friends. This was in 1922 and was the first organised step that radio amateurs in the Medway Towns took on a journey that has lasted for 100 years and is still going strong. In 1922, William and his radio enthused friends affiliated themselves to the Wireless League, an association set up in Great Britain by the owner/publisher of *Wireless World*.

From meeting in each other's homes, the interest in all things wireless had taken off in the Medway Towns and William established the Gillingham Wireless League, having gained the use of a classroom at Richmond Road School. At this juncture William was supported by Reginald Hammans and Bill Moffatt, later to gain amateur transmitting licences as G2IG and G2CM respectively. Reginald Hammans was to go on to work as a senior radio engineer with the BBC and was President of the RSGB in 1956.
In 1929 William provided sufficient evidence of his competence in wireless technique to be issued with the callsign 6NU, which later had the international prefix 'G' added to make his call G6NU.

HAM MEETS MILITARY: On Friday 1 April the Royal Dutch Army will organise Ham meets Military. Eight special stations consisting of two military operators and one amateur with callsigns PA01MIL up to and including PA08MIL will be on air on HF from 0700UTC until 1900UTC.
The main goal is to introduce the young military operators to the world of amateur radio. The amateur is there to help and improve their antennas but all contacts have to made with military equipment only.
They will operate with manpack radios or with a vehicle setup in a Mercedes 290GD. They would like to hear as many amateurs as possible to train these operators. Please use the NATO phonetic alphabet and have some patience. The best operators could be active in the future from PZ5JT.
More information on the QRZ-page of PA01MIL:
https://qrz.com/db/pa01mil
hammeetsmilitary@gmx.com

MFJ AT 50: Many readers will have items of equipment from MFJ. Martin F Jue started his business in 1972, 50 years ago. He decided to build a Morse code filter kit for $9.95 and an SSB filter kit for $12.95 using the new high-tech operational amplifiers. He placed the first MFJ ad in *Ham Radio Magazine*. It was a tiny 2 x 2in ad and was full of technical engineering jargon. If you read the ad today, you wouldn't even understand



it, but he sold over 5000 of those filters in a couple of years with those tiny ads.
After the ad ran, orders started trickling in to his personal student mailbox. Martin rented a broken-down hotel room in downtown Starkville for just $16 a month. It was a room that couldn't be rented to anyone else because the plumbing didn't work and there was no furniture. It was in a pretty sad shape. He was doing everything by himself – etching, drilling, stuffing and soldering the PC boards, taking the orders, shipping the orders, writing the ads – everything. After a few months the hotel manager ran him off. Martin was making too much racket and stinking up the place!
When he started selling assembled, wired and tested filters he used to take these little bags of parts to the classes that he was teaching and asked if any of his students wanted to put these filters together for 25 cents a piece – MFJ's first production line!
Today MFJ Enterprises Inc. is one of the best-known amateur radio equipment manufacturers worldwide with more than 20,000 items in its catalogue.
In order to celebrate its 50 years of activity in the field of amateur radio communication and if you are a MFJ enthusiast, MFJ ask you to share with them the pictures of your MFJ equipment no matter if old or new. They will be happy and proud to share on the Official MFJ Telegram Channel:
//t.me/mfjenterprises
Feel free to contact MFJ and send your pictures to
ambassadoreuit@mfjenterprises.com

SDR-CONTROL FOR ICOM: Marcus Roskosch DL8MRE has developed an App for iOS and macOS that supports control of the IC-705, IC-7610 and IC-9700. It requires a Mac that runs at least Catalina, ideally Big Sur or Monterey. You can find more about this App on:
sdr-control.com

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

Our third decade starts with the September 1952 issue, **Fig. 1**. Much of the content was related to TV and radio broadcasting along with hi-fi. The featured project was an electronic organ, quite an ambitious project and, of course, valve based.

Licence Changes

The editorial in that issue covered, among other topics, a recent amendment to the amateur licence, which is of interest if only because it shows the degree to which the Post Office still controlled what radio amateurs could and couldn't do:

"THE Post Office announces that it has decided to amend the licences under which the operators of amateur wireless transmitting stations may transmit from alternative addresses or under portable conditions. A new licence will be available, at a charge of 10s., entitling an amateur to operate for a period of up to one month at a temporary address. This licence is designed to cater for amateurs who wish to carry on their transmitting experiments during annual holidays or at other times when they are away from home. Alternative Address and Portable Station licences will continue to be available at a charge of 10s. a year, but in their new form they will permit certain additional facilities. For example, the holder of the new licence will be permitted to operate from his alternative address and at another temporary address as well, and he may operate his portable station within five miles of any notified location for a period of 48 hours, provided that in both cases the Post Office Engineering Department has been notified in advance by registered letter or telegram of the particular location. The use of a portable transmitting station on certain inland waters and lakes will also be permitted. This new licence is an experimental measure and the position will be reviewed early next year.

The price was a hefty 1/- (one shilling) at the start of our decade, and had doubled to 2/- by the end (August 1962).

Advertising

There were many more pages of advertising than we see nowadays, with lots of UK-based suppliers selling everything from surplus equipment (such as the ubiquitous 19 set, **Fig. 2**) to valves and other components. And it was during this period that transistorised portable broadcast receivers started to appear and be advertised. The magazine also started to feature articles about using transistors (largely surplus red spot types or Mullard OC71). I recall my grandmother buying me a one-transistor portable receiver in the early 60s – it cost 10/- as I recall. Other advertisements featured early TV receivers (usually enormous and featuring just one channel!) and there were also plenty of advertisements for training courses in radio and electronics, presumably reflecting the demand from industry for people with such skills.

I was also taken with the ad for single ex-Forces men under 30 to join the New Zealand Air Force – probably quite tempting at the time! And I notice that at some point Codar had come along (**Fig. 3**) with, among other sets, their Mini Clipper, a one-valve regenerative receiver using Denco coils, which was my very first receiver in the mid-60s before moving on to a Lafayette KT-340.

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Fig. 1: Cover of the September 1952 issue. Fig. 2: Ad for the 19 set. Fig. 3: A Codar advertisement, featuring a range of their products.

The Amateur Licence

On the subject of the amateur radio licence, though, I was struck by the following letter in the September 1953 issue:

SIR, -Being one of many novices who would very much like to become an amateur transmitter, I heartily agree with the remarks made by Mr. Hector Coles and Mr. C. Roberts on the subject of 'Amateur Radio and the Novice'. It is my opinion that the time is long past whereby the amateur transmitter is licensed on the pretext of conducting experiment and research. Such work should be left to the bodies of highly-skilled technicians which are formed for that sole purpose, and I maintain that amateur transmitting should be regarded as a very pleasurable hobby. I would advocate the abolition of morse test and a simplified theoretical examination; let the novice use a limited power and compulsory crystal control for the first year (with severe penalty for anyone breaking these two rules). I am sure that many will agree when I say that the novice will soon find out that to communicate any considerable distance he will have to learn morse and learn it well, or other hams will report signals unreadable. -A. MACRO (Cardiff).

It would be many years before the 'powers that be' recognised the strength of this argument, perhaps not helped by those existing radio amateurs who wanted to preserve the mystique of the hobby (yes, there are still some who feel that way). The editor throughout this period was still the founder and driving force – **FJ Camm**.

The Yaesu FTM-6000E

Richard Constantine G3UGF
practicalwireless@warnersgroup.co.uk

Richard Constantine G3UGF finds the Yaesu FTM-6000E to be "Easy to Operate yet feature packed".

As manufacturers re-style and add features to their radios so as to move up-market, their aim is often to enhance the product offer and hopefully leapfrog the competition. The downside is that they open the market up to others, at the more price competitive end of the market.

Yaesu, having spent recent years enticing us to use C4FM Fusion and WIRES-X, recently introduced a new FM-only mobile radio, but why?

The answer must simply be, because they can. A number of Far Eastern manufacturers have lately emerged on territory traditional occupied by the big three names. The newly released FTM-6000 series is surely Yaesu's response.

I say, *"because they can"*, because they've already done the hard work developing the hardware, electronics and software that's being utilised in other radios from their range. My impression is that for some time they've been developing a common platform and there's no mistaking that this new radio shares much in common with the superb but more costly FTM-300D.

While the head unit may look a little different, the transceiver pack when viewed alone, looks exactly like the FTM-300D that I reviewed in October 2020 *PW*. It's supplied with the same very substantial steel, spring release and lockable mobile mounting bracket, as standard. A point to which I will return.

It's perhaps no accident that the dual-conversion, wideband receiver covers 108- 999MHz in 13 switched bands. Understandably, the receiver sensitivity varies across such a wide range, but not unduly. In this guise it has been optimised for the amateur bands. 2m sensitivity is 0.25µV for 12dB SINAD and 70cm is slightly better at 0.2µV. The radio consumes 0.5A on receive and 10A on transmit for 50W output. RF output can be reduced to 25 or 5W output, with appropriate current reduction.

Wider Markets

In common with several other manufacturers, Yaesu's market is much wider than the needs of radio amateurs. Indeed, in mid-2021 they registered a product in Japan for the 2.4GHz band.

It doesn't take a genius to work out that the FTM-6000 has other potential markets in its sights. I feel sure that Airband, Marine and PMR transmit capability plus other commercial, military and security market options are already hidden inside. All that's needed is a little software change, a few engineering tweaks, including unwanted harmonic filtering, and an appropriate head/display unit clipped on to the transceiver pack.

Taking a Look

Removing its upper and lower metal covers and top mounted speaker that delivers 3W of excellent audio quality, reveals the same robust cast alloy chassis as the FTM-300D. The Funnel Air Convention Conductor system (FACC) is designed to draw air though the whole of the underside of the chassis, utilising the identical rear-mounted, near silent running fan. This gives the radio the possibility of worldwide operation in temperatures of

Photo 1: The FTM-6000E *'Easy to Operate'* Mobile.
Photo 2: FTM-6000E and accessories (What you see is what you get).
Photo 3: Backlit Keyboard for low light (mobile).
Photo 4: Cool 50W PA with FACC.

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–4C to +60C. I'm not doing that test, so I'll take their word for it!

The SSM-85D DTMF, keyboard microphone plugs directly into the main pack unit and there's the familiar cut-out on both sides to allow the cable to exit the radio for convenient left- or right-hand drive vehicles and mounting.

The control head unit detaches and can typically be dashboard mounted with the transceiver pack under a car seat or other suitable secure location, if required. It's also useful for fixed installations and for those with limited desk space. Yaesu's optional MMB-98 suction cup mount for the head unit worked on my desk but my dashboard wasn't smooth enough to make it stick reliably.

The package includes as standard the cheap and cheerful but adequate, desk mount for the head unit. I've previously criticised this as not being up to Yaesu's otherwise good quality standards.

Most annoyingly there's no RJ series extension microphone cable provided. You have to spend an additional £10.00 or make one with a suitable length of computer cable, RJ45 connectors and a plug-to-plug adapter. This assumes you have the correct crimp tool to hand. Of course, not everyone needs to remotely mount their radio.

To me. it's somewhat puzzling, as to why they would do half a job. I can't help thinking that it's a marketing opportunity lost. Surely, the radio would be even more price competitive if the complete microphone/head unit kit was a separate option as in earlier models, not half and half. Alternatively, include the missing microphone cable and make it even better value against its competitors – very odd.

Unlike other models, using an MH-85A-11U camera microphone doesn't provide a solution. It cannot connect or be used via the data socket on the side of the head unit.

Which leads me to another item that is an option, the BU-4 plug-in Bluetooth unit. Adding this module, plus obtaining the excellent SSM-BT10 single-ear headset if necessary for around £60.00 for the pair, increases usability and safety. A must for modern day and increasingly challenging driving situations or for those with restricted mobility. This package is a really worthwhile addition. However, there's no mention of VOX operation in the Menu options or the handbook, only conventional PTT, activated from the headset.

The review model didn't have the BU-4 fitted and VOX isn't mentioned on Yaesu's website. I do like it that when using Bluetooth in 'Auto-mode', the radio's internal speaker is muted and directed to the earphone. This is great for monitoring, travelling with passengers or other quiet settings. I often listen to my local club's net from a different room, while doing other things.

Now we come to what is described as E20-III or 'Easy to Operate III'. I love the way they describe it as a *"Basic function feature packed mobile transceiver"*. When I went to school 'basic' and 'feature packed' used in an essay would be described as something of an anachronism and subject to a vigorous red pen! You simply can't have both, so which is it? However, I think I know what they really mean.

Hiding behind the deceptively simple panel layout with a minimum of buttons and dials, there are 35 main menu choices accessed from the large *F Menu* key, located to the right of the display.

A number on the main list leads to further menu choices, by pushing the dial knob. The large *F1* key to the left of the large, clear monochrome display can be user assigned to the operator's personal, highest priority function – most useful when driving.

Memory Auto Grouping (MAG) allows any of the 1,100 available memories to be stored automatically in the same band. In memory mode the left-hand, *Band/Grp*

button below the display can be used to recall memories from the same band.

The central *V/M* button switches flip between VFO control on the main dial or Memory. Memories are stored within the radio itself and there's no requirement for an additional plug-in memory card.

All memories can be Alpha-Tagged, by a longer press on this same button. They can be entered manually if somewhat more slowly than using the free software from the company website, especially useful if you intend to name a lot of them at the same time.

Firmware upgrades can be done via either the side-mounted data socket or a duplicate socket on the transceiver body itself, with the head unit removed.

And There's More

This new radio includes Yaesu's latest feature – Primary Memory Group (PMG) as seen in their new FT5D handportable (see Jan 22 *PW*). Up to five most frequently used channels can be grouped together and accessed by a single push of the right-hand button, below the main screen.

In VFO mode and for those that don't want to step through unwanted bands just to get from 2m to 70cm, it's possible to set up the radio in Menu 18, to ignore any or all unwanted bands. For example, you might want to include another band such as Airband but maybe not Marine, etc.

Many of the above and more, customisable options can be recalled and/or assigned to the keyboard microphone to the user's personal preference. As expected, a range of scan options is available.

While it has a dual amateur band capability, the radio can only receive and display one frequency at a time. Therefore, initiating a scan of the popular PMG stored channels directly from the microphone definitely appeals. So too does the F1 *Home Channel* button to the left of the display and also available on the microphone, assignable directly to the operator's most used/favourite frequency. This makes it possible to quickly and conveniently jump directly to, say, the local repeater or simplex channel from almost anywhere else covered by the radio.

Naturally, Yaesu's radio includes CTCSS tone squelch, DCS digital coded squelch, as well as Pager function and Auto Range Transponder (ARTS) between suitably equipped radios.

As previously indicated, there's no digital capability but that doesn't stop this FM-only radio interfacing with the worldwide community via a cross-linked gateway or repeater, not forgetting Echolink.

3

The FTM-6000E has another trick up its sleeve, or rather on its rear panel. In addition to the single extension speaker socket this radio has a mini-DIN data port socket. It's a shame that the technical author of the User Handbook didn't include a pin diagram of the socket or any user information on the topic of data use. That said, there is a whole range of pre-made data cables available from most suppliers.

Including data capability as standard significantly raises the radio's profile, giving 1200/9600 baud Packet and full AX25 capability, something not available from most of the competition in its class.

Speaking with a couple of dealers about their early experiences of this new radio, I learned that there is renewed interest in packet radio. One dealer had already sold some units specifically for data use. He also observed that the further North you go in the UK, the more general activity there is and with it demand for, as he put it, *"no-nonsense straight-talking FM radios"*. Food for thought.

Conclusions

For those interested in obtaining a competitively priced, quality radio, from one of the popular manufacturers, a comparison with Icom's excellent IC-2730 is a consideration.

If you need simultaneous, dual-band monitor, crossband repeat, the Icom wins but at a significantly increased cost. It comes as a remote radio as standard and there's a cost to make it into a single piece conventional mobile with a mobile bracket.


4

Forgetting dual-band monitor, the Yaesu has a definite cost advantage, comes complete as a one-piece radio, but with the option to remote, and has a really nice mobile bracket as standard. It's ace in the hole is the data socket on the rear panel. Inclusion of the PMG function is another plus point from an operational viewpoint. It goes someway, but not completely to mitigate the dual-monitor function.

Small criticisms aside, my thoughts on the FTM-6000 are:

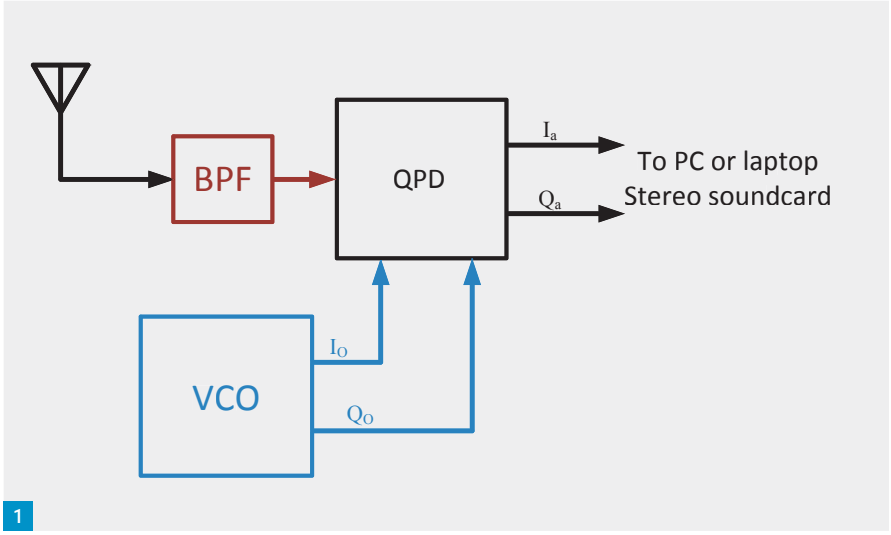
As a package it's a 4.5-star radio and a strong offering. It could easily score higher with a few tweaks to the offering.

In addition to mobile use, this radio will most likely find a place in many shacks as an easy-to-use voice radio while also being connected to a PC or laptop for data applications.

Available at £239.95 at time of press, it's definitely value for money.

My thanks to ML&S for providing the FTM-6000E for this review.

Dr Samuel Ritchie EI9FZB
samuel.ritchie.8@gmail.com



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Single Band Operation

In the third part of this project, **Dr Samuel Ritchie EI9FZB** turns to the 40m band to put the product detector to the test.

In this third part, I have a look at using the quadrature product detector (QPD) described in the January 2022 edition for use across the 40m band. I have chosen this band as it covers amateur radio, broadcast services and occasionally other users can be heard.

Block Diagram

This article covers two elements shown in **Fig. 1**; the bandpass filter (BFO) shown in red, and the voltage-controlled oscillator (VCO) shown in blue, which is used to tune across the band.

Buy a Filter or Build a Kit

QRP Labs supplies a kit for a double-tuned circuit (~$5) that is easy to build, and kits are available for ten HF amateur bands. In this top-coupled filter implementation, you do need to wind two transformers and then adjust two variable capacitors, but the assembly manual is excellent and provides a method to tune the filter without the use of a spectrum analyser or network analyser.

Fig. 2a shows my build of the QRP Labs 40m BPF, which is mounted onto a second PCB with BNC connectors for easy connection to my test equipment and subsequently to the QPD. **Fig. 2b** shows the transfer function of this filter (after careful adjustment). It has a flat bandpass, attenuation of 2.5dB with a bandwidth of nearly 500kHz, and symmetrical slopes.

Another option is SV1AFN.com who supplies built and tested BPFs (~€20) as well as partially assembled kits (~€11), using fixed capacitors and two variable inductors in his implementation. While I have not built his BPF kits, I can confirm that other kits of his that I have built are good quality.

A look through eBay will show a vast range of BPF kits of various styles and configuration covering one band to all the HF bands – so many kits but so little time.

Build a Filter from Scratch: The triple-tuned filter

Firstly, a triple-tuned BPF filter with the schematic shown in **Fig. 3**. This filter topology has been widely used in single-band receivers instead of single and double-tuned designs, as this higher order filter offers improved stop-band attenuation with little increase in insertion loss.

My built prototype is shown in **Fig. 4a** with the response of the filter shown in **Fig. 4b**. As a higher-order filter you can see the difference between this and the QRP Labe filter. For C3 and C5 I used two 12pF capacitors in series to achieve the required 6pF. When it comes to building this circuit for use, I would utilise class-1 dielectric ceramic capacitors of the C0G (NP0) type – I prefer these to mica capacitors or polystyrene capacitors, when I do not need 1% accuracy and they certainly cost less.

Built on a piece of PCB using three islands, I was able to space the components out so I could play with capacitor values, tinker with the toroids (seeing the effect of adding or removing turns from the primary winding), and see the effects of isolating input and output grounds from each other. Even with very long leads on a few components, and loose windings on the toroids, good results are achievable at these lower frequencies.

While tuning this filter I looked at my vector network analyser and suddenly wondered how I would be able to tune any filter accurately without such an instrument, and if any constructor would take on such a filter if they were not able to tune it once built (without at least some form of signal generator and RF power meter). So, I turned my attention to building filters using fixed components with 5 – 10% tolerance values. At least some certainty of success could now be offered to the constructor without test equipment.

The bottom-coupled 'high-side' filter

These filters were popularised by **William E Sabin W0IYH** in *QEX* magazine Sept/Oct 2000. He used toroids for the inductors, which allowed some adjustment by spreading or compressing the turns on the toroids. The schematic of the 40m BPF is shown in **Fig. 5**. This filter configuration uses capacitive dividers at the input (C21 and C22), the output (C24 and C25), and a shunt capacitor (C23) coupling the two inductors (L21 and L22).

The prototype is shown in **Fig. 6a**. Again, I have used a PCB as the base and this time three Manhattan-style solder pads (Phoenix Kits, URL below). Each 2.5µH inductor is made from a 2.2µH inductor in series with a 330nH inductor, as I had these in my stock. The 2.2µH inductor is

Fig. 1: Basic block diagram.
Fig. 2. QRP Labs 40m BPF.
Fig. 3: Triple tuned filter schematic.
Fig. 4: Triple-tuned BPF prototype.
Fig. 5. Schematic diagram for the W0IYH BPF.
Fig. 6: W0IHY 40m BPF prototype.

a 10% tolerance component. Each 270pF capacitor is made up from a 220pF and a 47pF in parallel, and the 2.4nF capacitor is made up from two 1.2nF capacitors in parallel.

phoenixkitsonline.co.uk

Apropos the response of the filter (shown at **Fig. 6b**), you can see where the term 'high-side' comes into the name of the filter, as there is greater selectivity above the centre frequency than below the centre frequency. The passband attenuation is a little high and would reduce with shortened component leads, low-inductance capacitors and better construction. The filter has a nice shape to the response curve, and I am confident it is repeatable using fixed components with careful construction techniques.

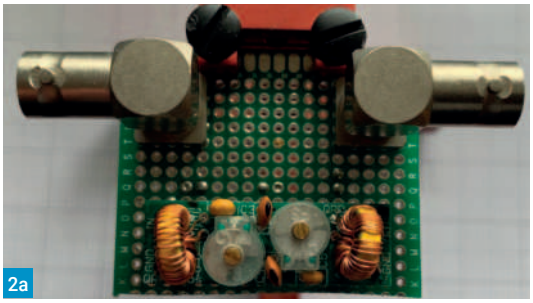
The fixed components filter

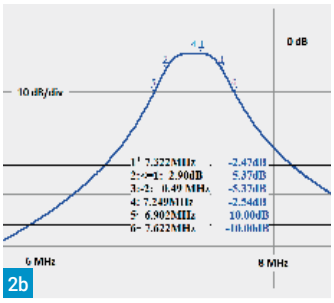
For those who would like to construct a filter but are wary of any 'tuning', or may have doubts about being able to reproduce the first two filters, I offer now a filter that uses all through-hole components with 10% tolerance components. The schematic of a 3rd order Chebyshev BPF is shown in **Fig. 7**. These are commonly found in wideband receivers, and BPFs implemented in this fashion are more than adequate for our purposes. Going to higher order filters using 10% tolerance components quickly becomes an issue, with strange filter responses being generated.

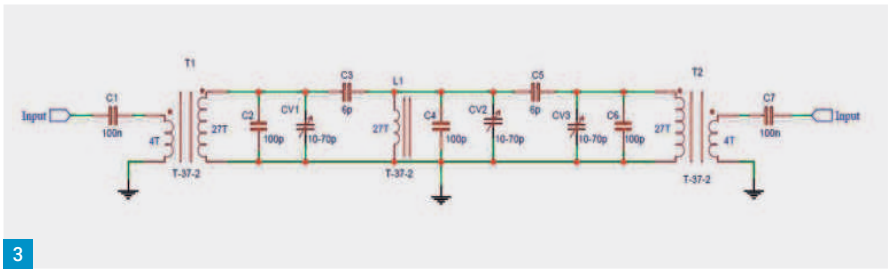
The prototype is shown in **Fig. 8a**. Some years ago I bought a pile of small PCBs from oshpark.com. This PCB fabricator allows designers to share their designs as long as the PCBs are bought from Osh Park, and searching under the name 'SmittyHalibut' will bring up a number of useful designs. Even though the board is marked HPF v1.0a (high pass filter), it is a bandpass filter board and can mount up to ten poles for a 5th order filter. It will take 1206 SMT capacitors or radial capacitors with 2.54mm spacing. It's laid out assuming FT37-43 toroids for the inductors, but works well for axial inductors.

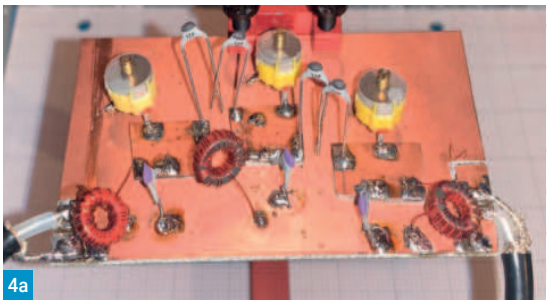
The SMA connector layouts will take either vertical or edge mounted SMA connectors. The purpose-made PCB is not necessary, however, and I have built a number of these filters on development PCBs with good results; it is just very convenient to use these purpose-built PCBs.

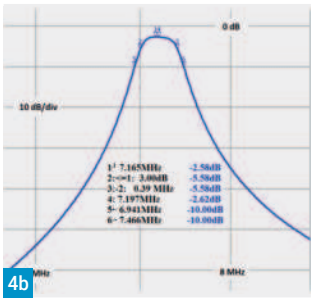
The response of the filter is shown in **Fig. 8b**. As a 3rd order filter the passband is wider (nearly 6MHz in this case), and the selectivity less than the higher order triple-tuned filter – but no tuning is required and you can be confident to get the expected response.

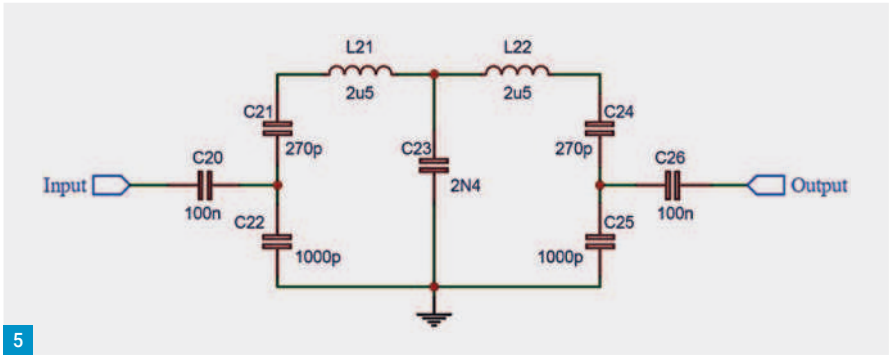


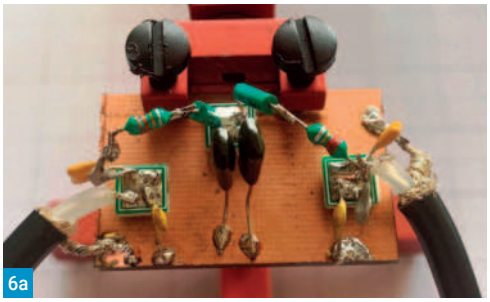


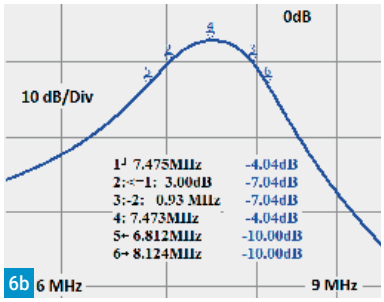












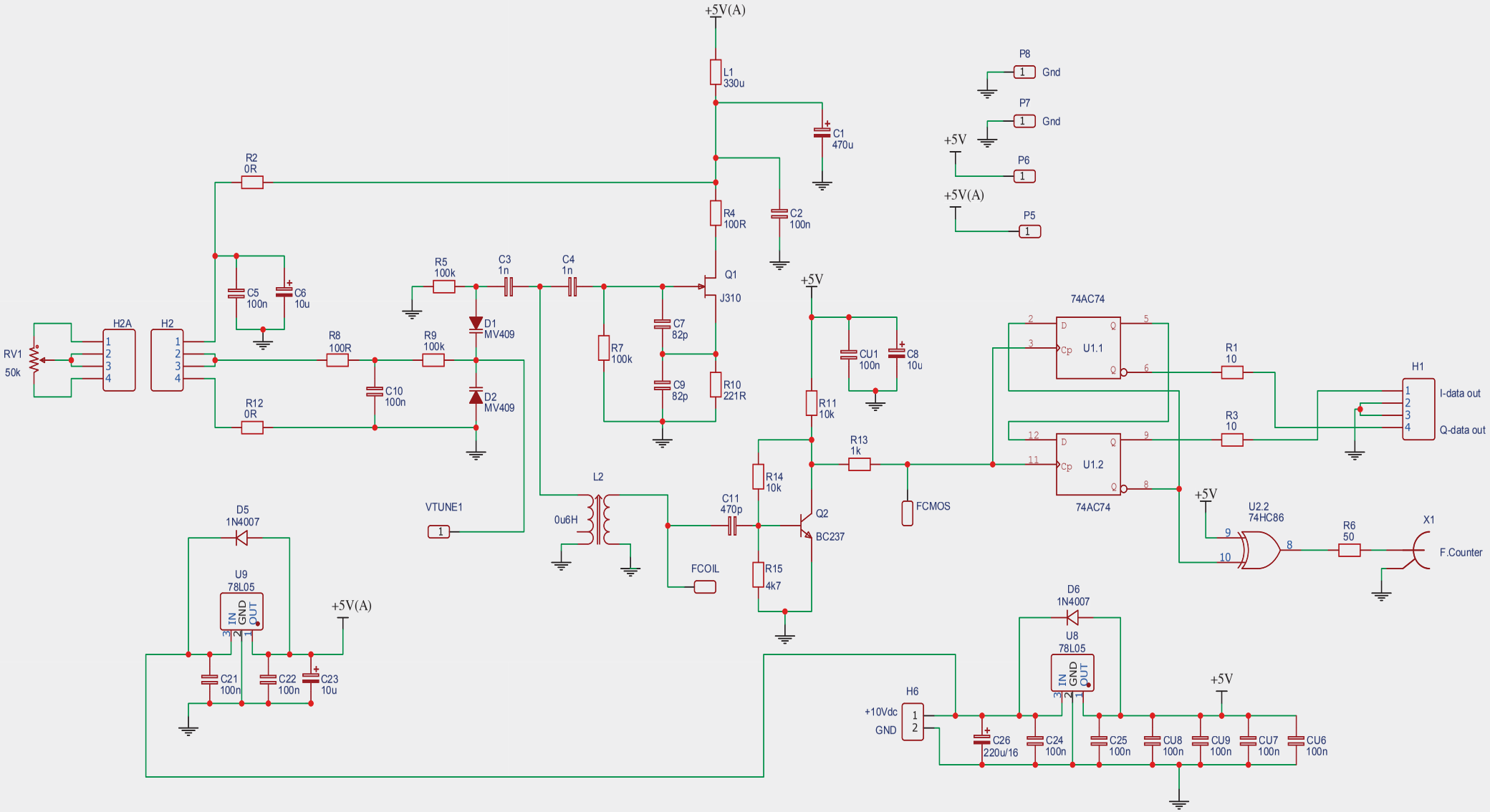
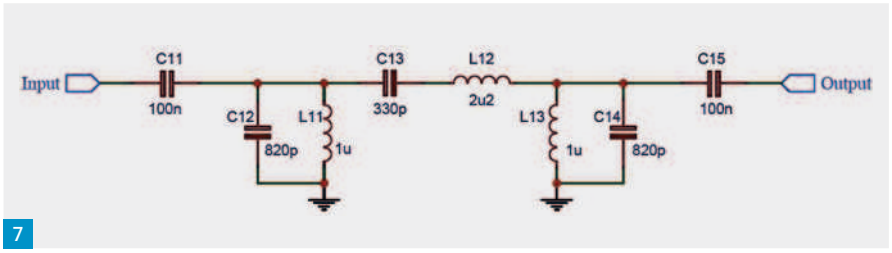

+5V(A)
L1
330u
C1
470u
R2
0R
R4
100R
C2
100n
P8
Gnd
P7
Gnd
+5V
P6
+5V(A)
P5
R5
100k
C3
1n
C4
1n
Q1
J310
+5V
74AC74
U1.1
U1.2
74AC74
R1
10
R3
10
H1
I-data out
Q-data out
C5
100n
C6
10u
H2A
H2
RV1
50k
R8
100R
R9
100k
D1
MV409
D2
MV409
C10
100n
R12
0R
R7
100k
C7
82p
C9
82p
R10
221R
CU1
100n
C8
10u
R11
10k
R13
1k
R14
10k
R15
4k7
Q2
BC237
FCMOS
L2
0u6H
C11
470p
FCOIL
VTUNE1
+5V
U2.2
74HC86
R6
50
X1
F.Counter
D5
1N4007
U9
78L05
IN
GND
OUT
+5V(A)
C21
100n
C22
100n
C23
10u
D6
1N4007
U8
78L05
H6
+10Vdc
GND
C26
220u/16
C24
100n
C25
100n
CU8
100n
CU9
100n
CU7
100n
CU6
100n

Fig. 7: Schematic for the fixed component BPF.
Fig. 8: Fixed component BPF prototype.
Fig. 9: VCO schematic.
Fig. 10: The VCO and supporting circuitry.
Fig. 11: Measuring the VCO.
Fig. 12: In action.



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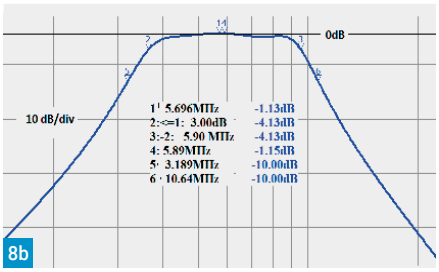

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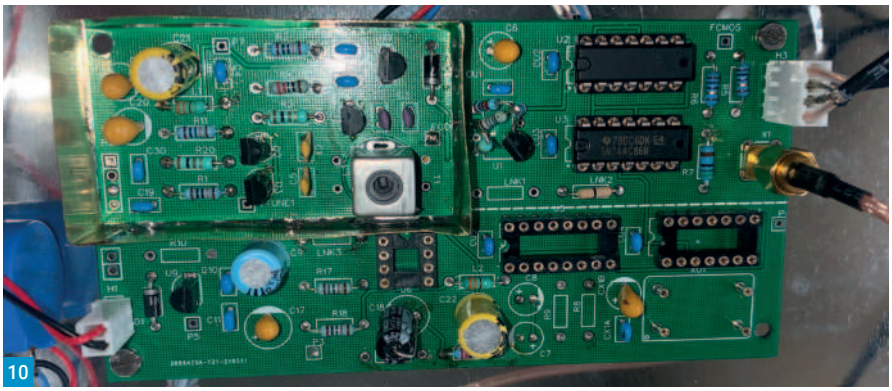
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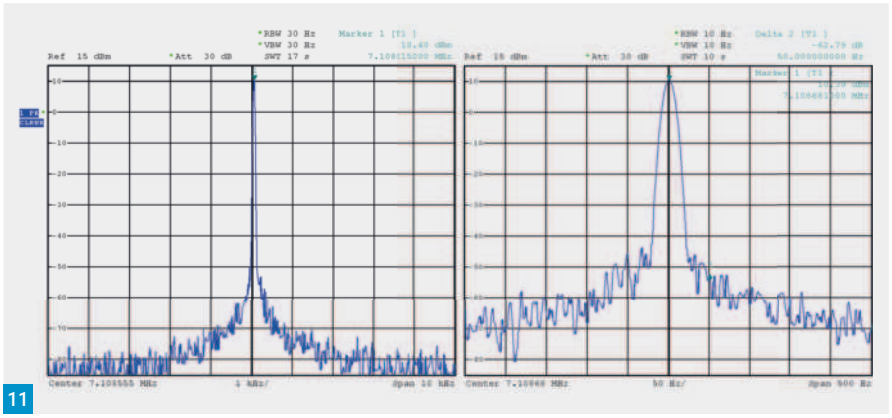
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The Voltage Controlled Oscillator

To cover the band 7.0 – 7.5MHz the voltage controlled oscillator (VCO) must run from 28 – 30MHz as we divide the output by four in creating the I_{osc}/Q_{osc} for the QPD. The schematic for my design is given in **Fig. 9** and the basis of the VCO used here is from the design in the book *Experimental methods in RF Design* (EMRFD). The VCO is tuned using a high quality ten-turn variable resistor (RV1) connected to two varactor diodes (D1 and D2). There is some flexibility in choice of varactor diodes, as C3 can be modified to compensate.

However, rather than couple to the source of Q1 as done in EMRFD, the use of a secondary winding on the inductor (L2) produces a better result. I used a high precision, high stability 10mm coil supplied by spectrumcomms.co.uk. Part number 0µ6HL has six turns on the centre-tapped primary, which can be adjusted from 0.4µH to 0.9µH, and one turn on the secondary. The circuit developed 4.8V across the primary and 0.6V across the secondary.

Q2 acts as a level shifter to get the 0.6V to a CMOS level to drive the 74AC74, which provides the I and Q outputs required to drive the QPD. You do need to use an NPN transistor with a DC current gain (hfe) of about 250 – 300, and I found my normal choice of NPN transistor, a 2N3904, inadequate in this role. As I had a spare XOR gate available I also buffered the output of one of the D-Type latches to run a frequency counter.

As suggested in EMRFD I used separate 5V regulators for the oscillator circuitry (U9) and the digital circuitry (U8).

The populated PCB is shown in **Fig. 10** and occupies the upper half of the PCB. I had put this PCB together to play with the stabilisation of VCOs using the Huff-Puff method, but for this application I do not think it is of great value as the VCO is very stable after a 15-minute warmup. Further, instead of adding another four ICs and a crystal oscillator module, I would rather use one of the many direct digital synthesis (DDS) solutions available.

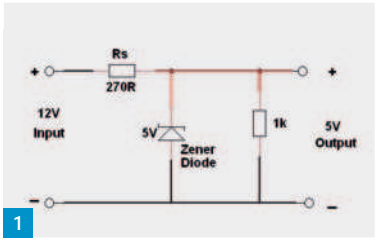
In order to keep mains hum (50Hz and its harmonics) at bay I took a number of steps, similar to that which many analogue oscillator designs require to perform well. The first was to build an enclosure around the VCO circuitry, which I made from shim stock. This is shown in the top left corner of Fig. 10, although for this photo the lid was removed. I also placed the whole PCB into a tin box that can be seen in **Fig. 12**, and took precautions to ensure all the RF connectors were grounded to the box and brought in the positive power supply via a feedthrough capacitor. Some might recognise the tin as a popular make of biscuit that has just been painted military grey to mask its original use.

The precautions resulted in an oscillator that reaches thermal stability in about 15 minutes (this would have been quicker if I had used a smaller tin), and **Fig. 11** shows what the spectrum analyser revealed. The free running VCO is stable enough to make decent measurements over short periods, and the 50Hz sidebands are better than 60dB below the carrier.

Shown in the lower half of Fig. 12 is the biscuit tin with the VCO inside, and the

Continued on page 20

Eric Edwards GW8LJJ
ericgw8ljj@outlook.com



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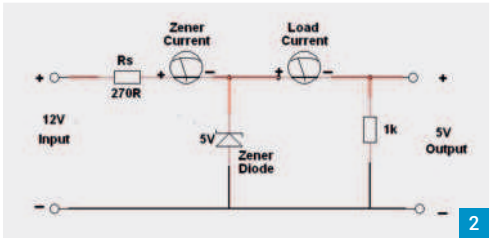

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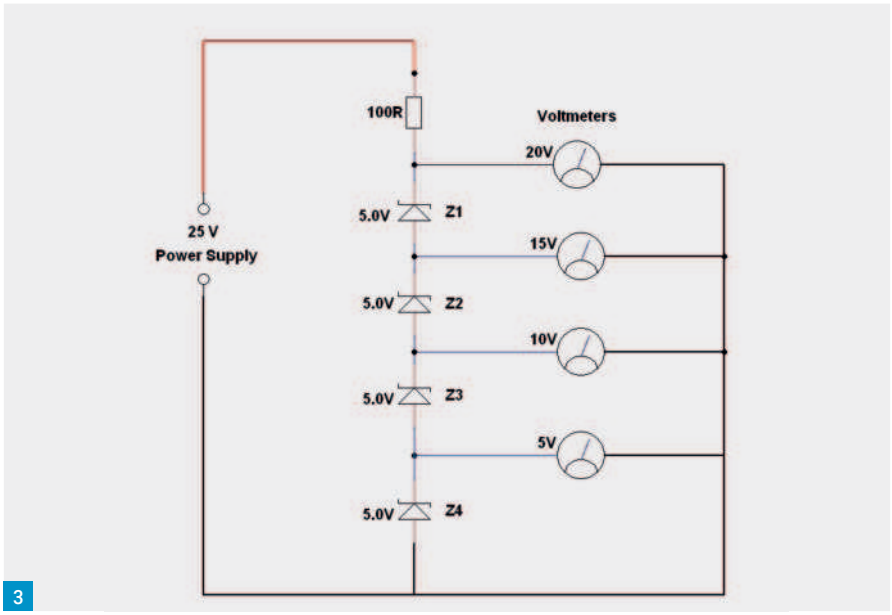


3

Semiconductors (Pt III)

Following on from part ll, **Eric Edwards GW8LJJ** looks at some other diodes, starting with Zener Diodes.

The term Zener refers to the reverse conduction of a diode when a certain voltage is reached, called the Zener voltage. Current flowing backwards in a conventional diode can damage it if the applied voltage gets too high and is known as avalanche breakdown. Zener diodes, also known as 'breakdown diodes', are designed to reliably allow current to flow backwards without damage when a certain voltage is reached. The current now flowing through the Zener diode increases dramatically to the maximum circuit value, usually limited with a series resistor. When this current is achieved it remains fairly constant over a wide range of reverse voltages and when the voltage across the Zener diode becomes stable, it is referred to as the 'Zener voltage'. This can range from less than one volt to a few hundred volts. This type of diode is used in low power, low current electronic supplies to regulate, or maintain the required output voltage over a varying load. When the anode is made positive with respect to the cathode (reverse polarisation for a Zener diode) it acts like a conventional diode.

Limiting it

To use a Zener diode to supply a regulated voltage for a circuit, it needs a series resistor for limiting the current through the diode and the circuit. The maximum value of this resistor is determined by the circuit load (resistance) and the Zener diode. Let's look at a circuit requiring 5V supplied by a 12V power supply. In **Fig. 1** a 1kΩ resistor is represented as the circuit loading (resistance). The 5V Zener diode is placed across the load, while the 12V power supply is applied to the Zener diode and the circuit via a current limiting resistor, Rs (series resistor). Without the resistor, there will be excessive current flowing through the Zener diode, which will destroy it. The Zener diode provides the reference voltage (5V in this circuit) and needs some current to perform this. For most low power circuits, a 400mW power rating diode is used so the circuit rating should be for about half this power dissipation for reliable operation but it needs more than 5mA to provide correct regulation.

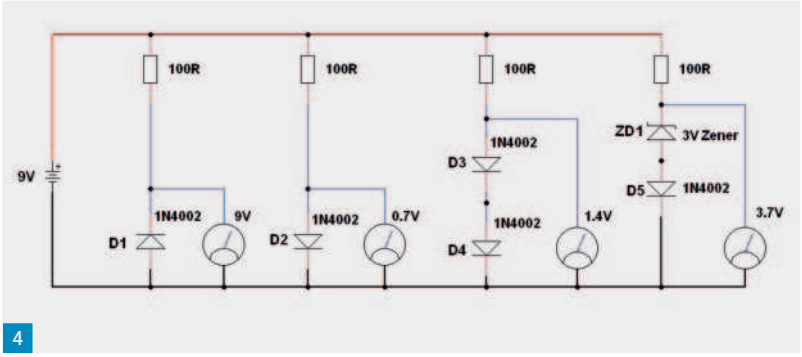
Calculate it

The resistor Rs in Fig. 1 is in series with the input power supply and the output required voltage. To calculate the resistance we use Ohm's law. First the voltage across the resistor is found by 12V – 5V = 7V, which is the input voltage minus the output voltage. Next is to determine the current drawn by the circuit and the minimum required for the Zener diode. The circuit load is 1kΩ (and let's add 25mA for the Zener diode) so the current, again from Ohm's law is: 7V/1kΩ = 5mA (circuit) + 25mA (Zener) = 30mA.

NB: When dividing kΩs into Voltage the answer will be in mA and as the circuit draws 5mA and a further 25mA for the Zener, the total current for working out the series resistor value is: 7V/30mA = 0.23kΩ (230Ω). Once again, when using mA as the divisor the answer will be in kΩs. Our resistance works out at 230Ω, so we use the nearest preferred higher value, which is 270Ω. We must consider the fact that no component used is an exact value, which means the Zener diode along with the resistors used has a percentage tolerance. Using a 270Ω resistor will be a good value to use in this example. The current through the Zener diode will change as the input tries to rise above 12V and the Zener will draw more current by conducting harder and therefore reduces the voltage across it to maintain the 5V output. The variation of the load (within reason) will not affect the current flowing through the Zener diode. In fact, the load can be removed altogether and the 'standing' current through the Zener diode will not change. It will only change with an increase in the input voltage by conducting until the required output voltage is obtained.

WhatWattage?

The power rating of the resistor is found by the voltage drop across it multiplied by the total current drawn by the circuit and the Zener diode: 7V × 30mA = 210mW. The resistor needs to dissipate this heat so



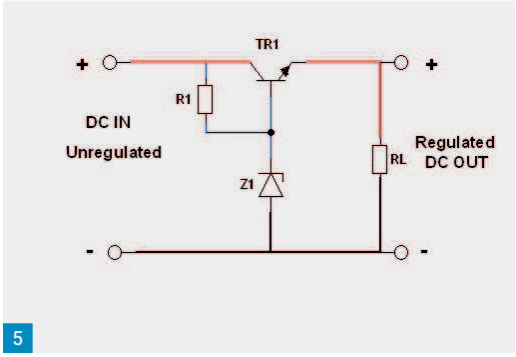
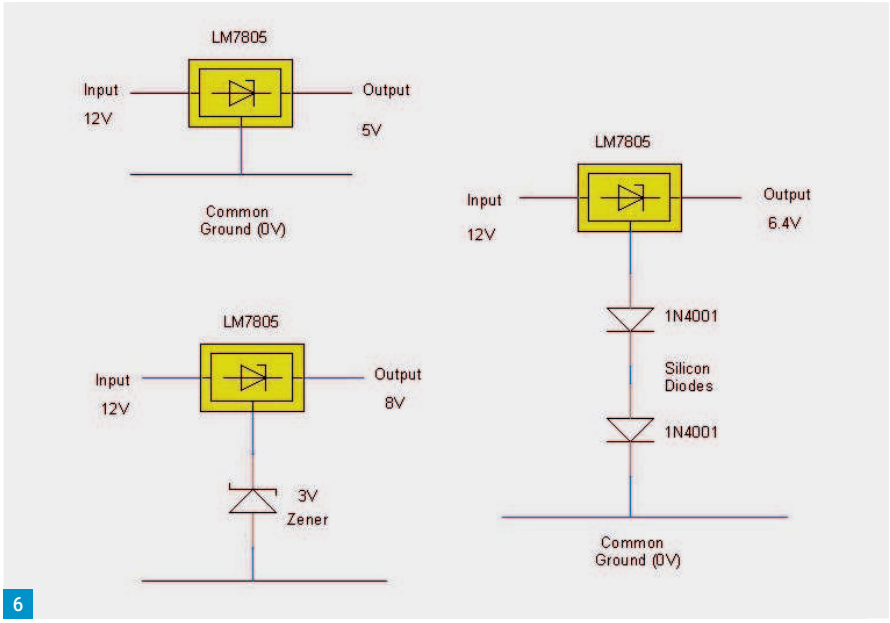


Fig. 1: Basic Zener diode circuit (the 1kΩ resistor represents the load). Fig. 2: Test setup. Fig. 3: The connections for a Zener diode dropper of four set voltages. Fig. 4: Using conventional diodes and Zener diodes in combination. Fig. 5: Using a transistor to increase the power handling capability of the Zener diode. Fig. 6: Three configurations of supply regulation using an LM7805. Fig. 7: A 13.92V output is achieved when using a red LED.



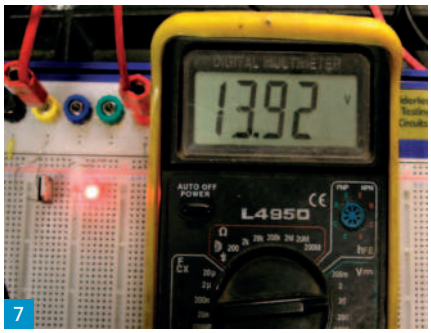
a 500mW (½W) resistor will be suitable. The maximum a 400mW Zener diode can conduct is about 40mA at an input of 18V (subject to tolerances!) so the resistor (7V × 40mA = 280mW) will be able to handle that, and it is unlikely, unless a fault condition arises, that the input voltage will increase to that amount. If it maintains a high input voltage, the diode will be destroyed, any fuse in-line will go open circuit and the circuit should be protected. Zener diodes come in various wattage ratings as well as voltage.

It will be prudent to use a power rating value (wattage) that is a little higher for handling the current. In this example, a 5V Zener diode with a current flow of 25mA, the power rating is found by multiplying the voltage by the current drawn by the Zener diode: 5V × 25mA = 125mW, which allows a 400mW Zener diode to be used. However, due to possible fluctuations in the input voltage this current will vary. Let's say it will increase by a further 15mA taking the total to 40mA, which still allows a 400mW Zener diode to be used (5V × 40mA = 200mW).

Let's prove All This

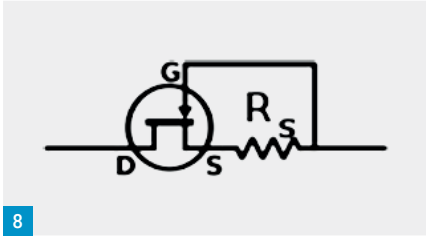
Using the setup as in **Fig. 2** the input voltage is supplied by a bench variable power supply set at 12V. A resistor we worked out to be 270Ω is connected to the positive terminal of an ammeter and the negative (common) terminal is connected to the cathode of a 5V Zener diode and to the positive terminal of another ammeter. The negative (common) terminal of the second ammeter is connected to a 1kΩ resistor, representing the circuit loading. The other lead of the resistor is connected to the anode of the Zener diode and to 0V of the power supply. The Zener diode ammeter is set to 100mA FSD and the load resistor ammeter to 10mA.

With this setup and the power supply switched on, the Zener diode current will be 25mA as seen on the ammeter while 5mA is displayed on the load ammeter. These will be very near values depending on the actual voltage of the Zener diode and the tolerance value of the 1kΩ resistor. The output voltage is available across the 1kΩ resistor and will be 5V or, once again, very close. If the input voltage is increased to, say, 14V the Zener current will increase to 30mA but the 1kΩ load current will remain at 5mA along with the 5V at the output. Increasing the input voltage further to 17V, the Zener diode current will increase to 40mA but the load current and voltage will remain at 5mA and 5V. The Zener diode is working well. It conducts more when the input voltage increases, thereby reducing the output to its working voltage, which is the required output voltage.



Voltage Droppers

Zener diodes placed in series across the terminals of a power supply can provide several voltages. If four 5V Zener diodes are connected in series across, say, a 25V power supply, a set of voltages can be obtained. **Fig. 3** shows the connections for a Zener diode dropper of four set voltages. The positive terminal of a 25V power supply is connected to a current limiting resistor to prevent 'burning out' the Zener diodes. The anode of a 5V Zener diode (Z1) and the positive terminal of a voltmeter are connected to the other lead of the resistor. The other Zener diodes (Z2 to Z4) and meters



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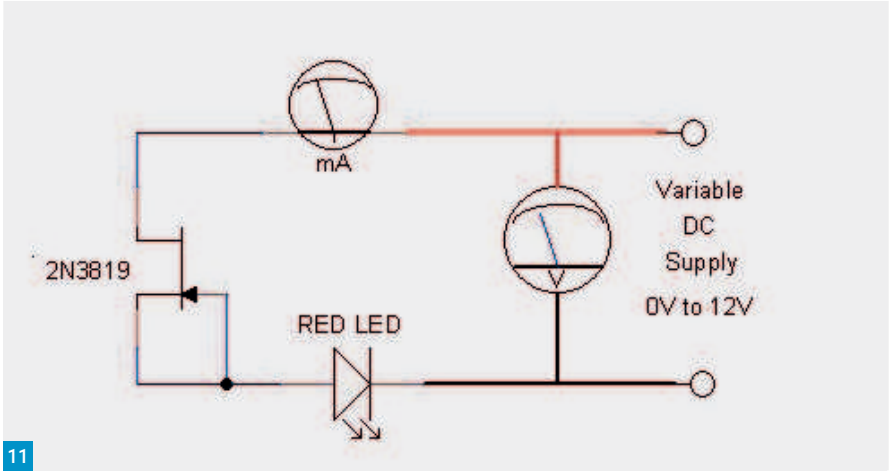

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Fig. 8: Internal structure of constant current diode. Fig. 9: Current and voltage readings seen when using an LED with a constant current diode type 1N5305 along with a 5V power source. Fig. 10: The current remains the same as in Fig. 9, even though the voltage has been increased to 25V. Fig. 11: Using a JFET with source and gate connected, in place of a constant current diode. Fig. 12: Readings taken with the circuit of Fig. 11. Fig. 13: Current and voltage readings when the supply voltage is increased to 12V.

are connected as in the diagram. The negative terminals of the meters are connected together along with Z4 anode and connected to the negative terminal of the power supply to complete the circuit. Switching on the power supply, the meters will show the respective voltages at each of the Zener diodes. Taking the top meter and Zener diode (Z1), it can be seen that there are four Zener diodes in series and across the power supply. The total Zener voltage is the result of all four Zener diodes (Z1 to Z4) adding together, that is to say 20V. The output at Z2 shown on the meter is reading 15V and all the meters are displaying 5V less than the ones above.

Conventional and Zener Diodes

Conventional diodes can also be used as a voltage reference either on their own or in conjunction with Zener diodes. **Fig. 4** shows some examples of this. With 9V as the power supply, a set of current limiting resistors (100Ω) and diodes are set up as in the diagram. The left-hand diode D1 is shown reverse biased so there is no current flowing through it and this is indicated with the meter connected across it by displaying the applied 9V. The next diode D2 is forward biased so that current can flow through the device. However, as we have learned, there is a barrier voltage that it must overcome for full conduction. For a silicon diode this is taken as 0.7V (usually between 0.6V and 0.7V) so the voltage on the meter shows this. If two conventional silicon diodes (D3 and D4) are connected in series and forward biased, the voltage across them will be 1.4V as they both have the 0.7V barrier voltage. Connecting a silicon diode D5 forward biased in series with a 3V Zener diode ZD1, the voltage across them will be 3.7V.

Amplify it

The Zener diode is used for low power circuits where only a small current is required. To increase the power rating of the Zener regulated supply, a transistor can be used to provide higher current, **Fig. 5**. The Zener diode (Z1) is followed by an NPN transistor (TR1), in an emitter follower (common collector) circuit. The emitter always 'follows' the voltage on the base with the usual barrier offset of 0.7V. The Zener diode is only supplying the base current for the transistor with most of the power dissipation within the transistor, called a series-pass transistor when used in this mode as it is in series with the circuit load. In the circuit R1 limits the current and supplies the required voltage for the Zener diode and the base of TR1, which remains constant with changes of load resistance, RL. To achieve even higher output current, a Darlington transistor type can be used in place of TR1. This will be explained in a future article.

Better Regulation

Zener diode regulators are fine for light loads or heavier with power transistor fitted with either series or parallel current amplifiers. Better regulation can be obtained with dedicated voltage regulator integrated circuits. The function is to maintain a constant voltage at the output irrespective of any voltage fluctuations at the input and any load variations. They are obtained as fixed and variable voltage regulators. These are available in different packages and the most common fixed voltage type is the '78' series. These have different prefixes such as L, LM or MC. They have three terminals and are commonly found in a popular TO220 form (for ease of fixing to a metal heatsink). Their voltage regulations are from about 2.5V up to 40V. They are mainly 1A or 1.5A types but some of the smaller ones are in the 100mA range and are labelled as 78L.

The number that follows the 78 is the regulation voltage and a LM7805 indicates that it is a 5V, 1A or 1.5A (refer to manufacturer's datasheets for the current ratings) regulator and an LM7812 is a 12V regulator. The 78L types also follow the voltage rule with the numbers following the L indicating the regulation voltage. A 78L05 is a 5V 100mA voltage regulator and a 78L12 is for a low power 12V source. There is a negative type of the same series with

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79 as the first two digits, with the voltage following the same rule as the 78 series. An LM7908 will be a negative 8V regulator with a current rating usually 1A or 1.5A depending on manufacturing variations.

Fig. 6 shows the LM7805 used with three different configurations to provide some small variations in output voltage. When used on its own with 12V as the input voltage as shown in the diagram, the output is 5V for a 7805 regulator. The input can vary and be as high as 30V for regulators of several voltage outputs that are lower than the input voltage. If a 3V Zener diode is placed in series with the ground connection (centre pin on the TO220 package), the output will be 8V subject to slight Zener diode voltage tolerances. Replacing the ground connection with two forward biased silicon diodes can provide an output voltage of 6.4V, which is 5V plus the 0.7V forward drops of each of the two diodes.

Placing a red LED, **Fig. 7**, in the ground lead will provide an output of 13.92V whereas using a blue LED the output voltage will rise to 14.63V. Using green and yellow LEDs provides almost the same voltage output as the red LED. Different coloured LEDs have different voltage drops. A red LED, for example, has a 1.63 to 2.03V drop whereas the blue LED has 2.48 to 3.7V. Voltage regulators can be a topic for a later article in this series.

Constant Current Diodes

From Wikipedia, *"A **constant-current diode** is an electronic device that limits current to a maximal specified value for the device. It is known as a **current-limiting diode (CLD)** or **current-regulating diode (CRD)**"*.

It consists of an N-channel JFET with the gate shorted to the source, **Fig. 8**, which functions like a two-terminal current limiter or current source (analogous to a voltage-limiting Zener diode). It allows a current through it to rise to a certain value, and then level off at a specific value. Unlike Zener diodes, these diodes keep the current instead of the voltage constant, the current flowing through them remaining unchanged when the voltage changes. Some devices are unidirectional and voltage across the device must have only one polarity for it to operate as a CLD, whereas other devices are bidirectional and can operate in either polarity.

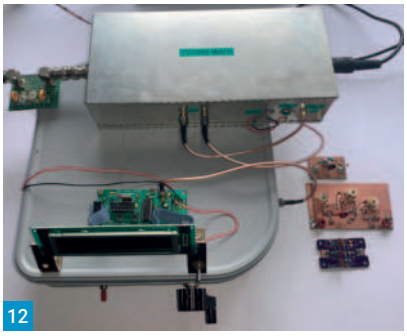
Limiting LED Current with a Diode

LEDs can be used with a various range of voltages without using a current limiting resistor by replacing it with a constant current diode. **Fig. 9** shows an LED with a constant current diode type 1N5305 with a 5V power source. The meter on the right is displaying the voltage and the left-hand meter is showing 2mA. The current remains at 2mA as seen on the left-hand meter when the supply is changed to 25V as can be seen in **Fig. 10**. The LED has the same brightness with the two different voltage settings.

Using a JFET with an LED

The constant current diode, as explained in Wikipedia (above) is an N-channel JFET with the gate and source connected together. To test this let's use a 2N3819 JFET with a red LED, **Fig. 11**, and vary the voltage to see what happens. Connect the LED and FET with an ammeter switched to the 20mA DC range and a voltmeter set at 20V DC. Connect a power supply set to 3V and the current will be 5.17mA as in **Fig. 12**. Change the power supply to 12V and the current will now be 9.4mA, **Fig. 13**. The actual readings are shown on the relevant meters used.

The LED brightness will be the same with both voltage settings showing that the current through the LED is the same. The 'extra' current difference drawn with the different voltages are taken up by the FET. The FET supplies a constant current to the LED.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N3ZI frequency counter I mentioned in Part 2 (see February *PW*) mounted on top. The knob for the variable resistor (RV1) is the only control, as the switch next to it is not used. The QRP-labs BPF is attached between the antenna and the input to the QPD, as it was convenient having BNC connectors. The other BPFs described in this article have been placed on the right-hand side for completeness.

As this is one of my stepping stones to the final product, I have not gone further with packaging the design at this stage. I have spent considerable time enjoying tuning across the 40m band using this setup. I am pleased both with the stability of the VCO and the quality of the signals it produces. I have not attempted to decode any digital modes, but have rather focussed on CW, SSB and AM broadcast stations.

End Notes

I have made further information available on my website (below). This includes larger schematic diagrams, high resolution pictures, in some cases more details on the components used, etc. There are links to PCBs with caveats as appropriate.
www.samuelritchie.com

At the risk of being swamped by PCBs I could be persuaded to receive your built triple-tuned BPF filter by post, tune it (note the 'it' and not 'them') up for you and then post it back, once you bear the registered mail postage costs involved, and you have BNC or SMA connectors on the PCB.

I have no personal connection with or financial interests in Phoenix kits, SmittyHalibut, Osh Park, QRP-Labs, SV1AFN or any of the software or component manufacturers mentioned in this article.

In the next instalment we are going to look at using the QPD for fixed frequency operation using a crystal oscillator replacement as well as a commercial oscillator with very precise accuracy and excellent stability.

Mike Richards G4WNC
practicalwireless@warnersgroup.co.uk

G4WJS – Silent Key

Mike Richards G4WNC reports the passing of a key member of the WSJT team before going on to further advice about using SDR-Console.

December 2021 saw the sudden and unexpected passing of **Bill Somerville G4WJS**. Bill was a vital member of the award-winning core WSJT-X development team that comprised **Joe Taylor K1JT**, **Steve Franke K9AN** and Bill. Joe Taylor reported that Bill was the first to join him back in 2013 when he formed the core development team for the WSJT-X project that has had such a wide-ranging influence on today's data modes operations. In addition to his skills as a C++ systems developer, Bill spent countless hours answering questions and patiently helping fellow amateurs with WSJT-X related issues. Bill lived independently but had a great friend and neighbour in **Paul Welford G4YKQ**. After failing to respond to phone calls, Paul sadly discovered that Bill had passed away seated in his shack surrounded by the things he loved.

I'm sure data modes operators around the world will miss Bill's contribution to amateur radio.

SDR-Console

This month, I'll continue my tutorial on this excellent software by reviewing the spectrum recording and analysis tools. One of the often-overlooked features of many SDRs is recording the digitised RF spectrum directly to a hard disk. In most systems, including SDR-Console, the selected RF bandwidth is recorded using an extension of the WAV file format known as WAV RF64. This format was initially developed for high quality, multi-channel broadcast audio but is ideal for RF spectrum recordings. When recording the raw spectrum in this way, the recordings will consume a lot of disk space very quickly.

For example, I recently recorded a 10MHz bandwidth centred on 5MHz using an SDR Play Duo. This consumed disk space at a rate of 40MB/s. I made the recording to help trace the source of some intermittent wideband interference that was becoming a problem. I ran the recording from 3.30pm through to 9am the following morning, which was a total of 17.5 hours. That amounted to just under 2.5TB of data. I usually use a separate external hard drive connected via a USB-3 port to handle this much data. The 40MB/s data rate is well within the capabilities of a standard, spinning disk, hard drive, so there's no need to go to the expense of a solid-state drive. As spectrum recordings are usually temporary, there's also no point in buying anything other than a standard retail unit. I typically have a few drives around the shack that have been recovered from old PCs. These can easily be slotted into a USB-3 hard disk enclosure to make a cheap SDR storage solution. However, if you have wideband receiver hardware such as the RX888 MkII, you have the potential to record the entire LF to low VHF spectrum. In that case, you will need to use a faster and larger capacity storage device.

Recording

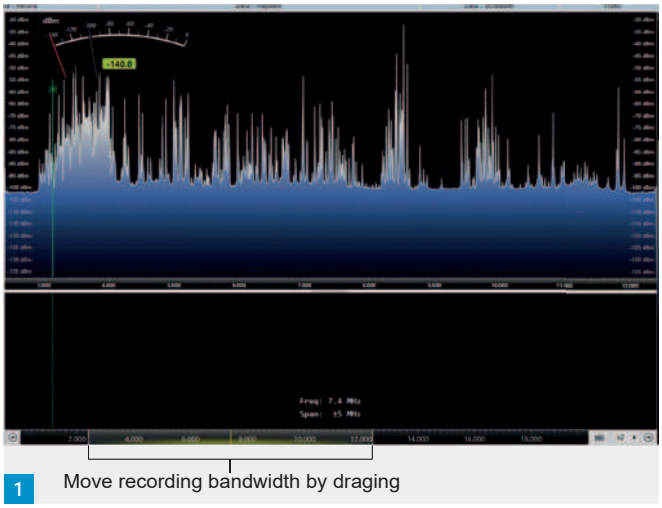
The first step is to configure the receiver to cover the spectrum you intend to record. Unless you need to see an extensive bandwidth, I suggest you use the Bandwidth control on the Home tab to restrict the bandwidth to the specific area of interest. The next step is to choose the frequency range you want to record. The simplest way to do that is to click and drag the highlighted block in the frequency scale at the bottom of the waterfall display, **Fig. 1**.

The size of this highlighted block is linked to the bandwidth setting, so it's easy to see the coverage. At this point, there's no need to configure the receive mode as we are recording the raw spectrum ahead of any signal processing or decoding. In most cases, you can leave the receiver's AGC, preamp and attenuator settings at their default. However, if the band you're recording is likely to contain powerful signals that may overload the ADC, you should consider adding some attenuation or reducing the RF gain to ensure the ADC is not driven into clipping.

That completes the receiver configuration, so we can progress to the Rec/Playback tab. You will find the three recording options; Audio, Data and Video. You will find the audio recording controls on the left of the Rec/Playback bar. These are used to record the demodulated audio, but our interest is in raw spectrum recording, which is controlled from the next section along the Rec/Playback bar. To configure the recording, hit the red Record… button. This will open the recording panel, **Fig. 2**. The top box is the title of the recording and is automatically populated with the centre frequency and bandwidth. I usually leave this with the default text, but this field is editable if you prefer a different title. Immediately below the title bar is the Scheduling option. If you tick this box, you will see the scheduling options for starting and stopping the recording, **Fig. 3**. The Storage section of the recording panel is where you select the drive and folder to store the recording. You can either find the storage location by browsing or using the convenient Recent option.

The File Size option is convenient for ad-hoc recordings that will automatically stop when the specified file size is reached. The next option controls the dynamic range of the recording. The 16-bit option is acceptable for most recordings, but if you are looking for very weak signals, you can select the 32-bit option. However, this doubles the storage requirement. You will notice that the Range entry is a clickable link that opens a new panel. Here you can select which receiver to use in multi-receiver configurations. This section also provides an alternative method of selecting the recording bandwidth. Towards the bottom of the recording panel is a helpful summary that shows the predicted data rate and space usage of the selected recording. Finally, you will see a Lock radio frequency checkbox. This should be left ticked to avoid accidental retuning of the centre frequency during the recording. That completes the configuration, and you can click the Start button to begin the recording or activate the schedule.

While the recording is running, you



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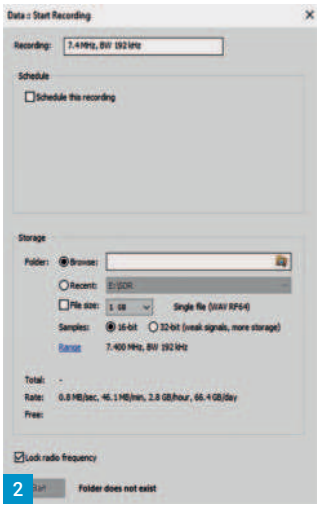

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can continue to do other activities on the computer but avoid doing anything that may stress the computer's resources, such as gameplay, high-resolution video editing, etc. As I often make recordings, I've set up a separate Intel NUC minicomputer to handle the recordings, **Fig. 4**. These PCs can often be found on auction sites at attractive prices, and I suggest you look out for a model with an Intel i5 or a faster processor.

Data File Analysis

Once the spectrum recording has finished, SDR-Console offers several methods to examine and use the data. The most obvious is to simply play the file. This is activated via the Data::Playback section of the Rec/Playback tab. The first step is to use the Open icon to select the required data file and, once loaded, you can use the Play button to start the playback. As you're playing back the raw IQ spectrum data, you are free to use all the receiver's normal controls to tune, filter and demodulate the received signals. This alone is a potent tool for examining the activity in a given spectrum.

To aid navigation within the recording, you can use the Seek icon to select a time period and then use the forward and back controls to skip back or forward by the chosen number of seconds.

A more powerful option is to use the Navigator. This opens up the navigation window for the entire recording, **Fig. 5**. Here you can see a matrix with the hours listed down the left-hand side, and the minutes are shown horizontally. As soon as you click on a square in the matrix, the receiver will start playing from that point. This is a quick way to navigate through the largest of recordings. Once you've had a look at your wideband recording, you may well decide that you need to home in on a narrow frequency band. This is where the SDR-Console Datafile Editor comes to the rescue. You'll find this in the Rec/Playback tab towards the right-hand end of the Data::Playback section. When activated, you will be presented with the editor panel, **Fig. 6**. This powerful tool enables data to be extracted from the main recording into a new file. The advantage here is that the new file will generally be much smaller than the original, so it's easier to store and faster to navigate and edit.

To use the editor, you begin by selecting the master recording as the input file. You then move on to the output file, where you should choose a fast drive, preferably an SSD. The output section is used to select the centre frequency and bandwidth of the sample to be extracted. There is a wide range of bandwidth options, ranging down to as low as 10Hz. You also have the option of specifying the file size of 100MB or 1GB WAV file or an unlimited size WAV RF64 file. If the output recording is larger than the selected file size, the editor will automatically split the output into multiple files of the selected size. You will also see from the editor panel that you can specify start and stop times within the original recording. Once you've extracted the desired data, the files can be played using the controls in the Data:Playback tab.

As you can see from this article, SDR-Console is a powerful analysis tool with a myriad of uses for data modes operators. For example, you could record the data modes section of a band and then use the repeat control to loop the playback and so have a continuous loop of data signals. You can then experiment with your decoder to find the settings that deliver the most decodes. You can also do a similar experiment to find the best way to extract very weak stations from a recording. Although I've shown how to carry out fundamental analysis of these recordings, SDR-Console has another powerful analysis tool that I'll cover in the next *Data Modes*.

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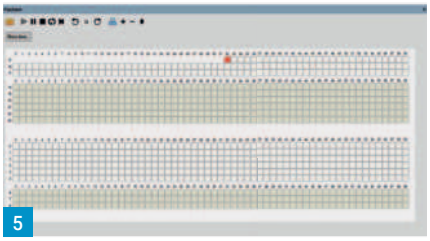

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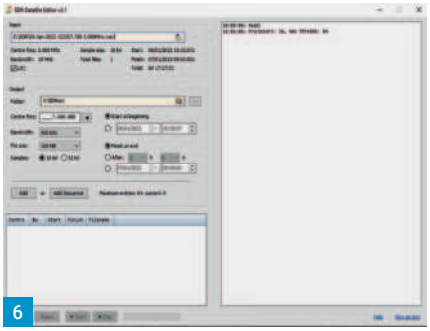

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Fig. 1: SDR-Console, spectrum bandwidth bar.
Fig. 2: Recording panel.
Fig. 3: Recording scheduler.
Fig. 4: Intel NUC mini-computer.
Fig. 5: SDR-Console recording navigator.
Fig. 6: SDR-Console data editor.

Geoff Budden G3WZP
geoffg3wzp@gmail.com

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The Royal Signals Museum

Geoff Budden G3WZP reports on recent developments at the Royal Signals Museum.

The Royal Signals Museum is based at the home of the Royal Signals in Blandford Camp, Dorset, and has an active Outreach Team that takes the museum to many venues and events throughout the region.

Pre-Covid the team had a busy schedule throughout the Spring and Summer months visiting schools, county shows, university open days and the five-day Chalke Valley History Festival, the latter attended by school groups and the general public.

Practical Activities

The emphasis has always been offering 'hands on', practical activities to participants to show the development of communications not only in the military but also in the wider world.

Morse code is always popular with a brief history of the code, via CQD from the Titanic rather than SOS, with the realisation that abbreviations were in use way before the advent of texting on mobile phones. Students can practice sending and reading messages to each other working in pairs using an original Royal Signals teaching unit from the 1960s.

This then leads on to the SOE radio operators in WW2 and their short life expectancy, an average of just six weeks, and the primitive nature of the equipment. A suitcase radio is on display together with a suitably weighted suitcase (15kg) and the realisation that a large majority of these agents were female.

Direction Finding is also demonstrated with a handheld receiver and loop antenna to find the direction of a CW transmitter (50mW output) operated by students concealed nearby.

The author also uses this activity to show the importance of the Y (intercept) service to intercept the enemy transmissions and pass them to Bletchley Park to allow the breaking of the Enigma code. The participation of radio amateurs in this vital activity is also emphasised.

The semaphore demonstration is very popular, especially among the younger audience, with frantic flag waving, which often has more effect in scaring the local bird population that actually sending messages!

A more tranquil activity is the Secret Codes and Cyphers area where simple encoding and decoding is demonstrated and messages enciphered to be read by the participants.

Alongside all this is the history of military communications with telephone handsets from the Boer War, a heliograph from the first Afghan war in the late 19th Century leading to WW1 radios used in the trenches and the WW2 counterparts and Clansman HF transceiver. It is interesting to note that PTT (Push-to-Talk) is a novel concept for most participants, being more used to normal duplex mobile phones!

In November 2018 the outreach team visited Hillview Academy in Bournemouth (pupils aged 5 > 11 years old) for a two-day event running the activities already outlined and with the addition of an amateur radio station under the special callsign GB100RSM (100th anniversary of the end of WW1 and Royal Signals Museum), a really popular addition to our activities with queues forming all through break and lunch times!

BBC Local Radio Solent sent a reporter to cover the event and the local press also contributed an article.

Schedules were arranged with special event stations in Ypres and Passechendaele but the high noise level in the school both electronically and acoustically meant only S9 signals could be heard and worked, a disappointment to G3YUZ who operated the station.

A New Approach

Post event conversations with **Ian G3YUE** (ex-Royal Signals and former RAE and CW pupil of the authors) suggested a self-contained radio station that could be sited away from local noise sources similar to the Royal Signals radio trucks used in the 1970s, a great idea but not very practical as these have long been superseded.

The project then evolved into a trailer-

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

Photo 1: The trailer.
Photo 2: The antenna support mast.
Photo 4: Stewart G3YSX (RSGB President), G3WZP and museum director Adam Forty.

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based dedicated radio station that could be used at any outside event and the then Chair of the RSGB Legacy Fund was approached to enquire if it was a project that the Fund would consider. Fortunately, the answer was affirmative and he also suggested approaching the RCF (Radio Communications Foundation).

Museum Business Development Manager, **Adam Forty**, and the author drew up a comprehensive project specification and then produced a detailed, fully costed, application, which was duly lodged with the Legacy Fund and RCF.

The application was approved with both organisations sharing the cost. Covid restrictions prevented an immediate start on the project but in January 2021 an order for an 8 x 5ft single-axle trailer with roller rear door and internal 6ft headroom was placed.

Delivery of the trailer to the author's home QTH enabled the interior benches to be installed and double socket mains outlets with individual ELCB wire via an Emergency Stop switch to an external two-pole + earth waterproof socket.

Two operating positions were catered for with coaxial antenna switches selecting either HF or VHF antennas.

A stainless-steel bracket attached to the trailer base held the 8m fibreglass telescopic mast with a further bracket mounted at the top of the trailer to securely fix the mast under normal weather conditions. This mast was then able to support a full size G5RV antenna or Bantenna with a Diamond Vertical for 2m/70cm, which had been purchased with a donation form Alfatronix Ltd, a power supply and power convertor manufacturer based locally in Poole.

At this point consideration was given to the possibility of obtaining modern HF and VHF equipment and Yaesu UK Ltd were able to support the project with the donation of an FT-991A, FTM-440XDE and an FT-70DE together with marine band and airband handhelds, an extremely generous contribution.

The first event, post-Covid, for the Museum Outreach team was the four-day Bournemouth Air Show in the first week of September as part of the Military Village, which housed youth engagement teams from all the services – Army, Navy, RAF and Royal Marines.

The trailer station was due to make its debut but at the last minute the local authority informed exhibitors that only LPG or diesel-powered generators would be permitted as there had been small fires in previous years started from faulty petrol powered generators. A suitable generator could not be sourced locally so the trailer station could not be used, much to our disappointment.

However, the large marquee housing the Museum proved a great attraction to visitors where various items were on display from WWI through to 1970s Clansman radios together with the usual hands-on activities – Morse, Semaphore, Military radio Maze, Codes and Cyphers – all proving very popular, especially with youngsters, and having seen the history of Military Communications the visitors were able to see the modern Royals Corps of Signals in their stand opposite.

The event attracted an estimated 800,000 visitors over the four days and at times the museum team were so busy it felt that they had all passed through our exhibition! In fact, the only time for lunch or comfort breaks was when the crowds turned their attention skyward for the Red Arrows displays. The extremely warm weather and seemingly unlimited sunshine made the whole event a success and the white marquee certainly proved a good choice for this weather. The other military exhibitors in their dark, camouflaged tents could often be found lurking in our tent to gain some respite!

Formal Launch and the Future

At the end of September the project sponsors were invited to the museum to see the completed trailer and despite the timing of the event in the midst of the petrol shortage Adam Forty hosted RSGB President **Dr Stewart Bryant G3YSX**, Radcom Editor **Elaine Richards G4LFM**, **Karl** and **Dean** from Yaesu (UK) Ltd, **Dan** and **Tony** from ML&S and **Keith Reilly** from Alfatronix Ltd. The only casualty of the petrol panic buying was **Steve Hartley G0FUW** from the RCF who was marooned in Bath!

Adam Forty, together with the author, welcomed all the guests to the museum and Ian G3YUE was on hand to operate the Yaesu HF rig into a Bantenna for the morning. After the vote of thanks Adam took the guests on short tour of the museum, which was videoed by Tony from ML&S and can be viewed on their YouTube Channel.

The trailer is now fully operational and it was hoped that its first operational role would be JOTA with the local Bournemouth Scout & Venture Scout group. However, it was not possible to provide enough Scout leaders to meet the Scout Safeguarding criteria for such events but it is hoped to run the station for Dorset Girl Guides' Thinking on The Air in February 2022 together with a Museum Outreach activity centred on Morse Code tuition.

The trailer is now available to recognised Radio Clubs/Societies for use at their own special events/field days/contests etc as a fully self-contained 'shack on wheels' and we are keen to encourage such usage to promote the Royal Signals Museum and amateur radio to a wider audience.

Please contact the author for details and to make a booking:
geoffg3wzp@gmail.com

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A weatherproof radio with true desktop-radio features, like auto-notch, noise reduction, RX/TX EQ and built-in fast Panadaptor.

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A liquid-protected housing, no through-holes, spatter resistant plugs with sealing rings and a special anodising layer on the case, ensures operation in extreme conditions.

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Allows you to operate from anywhere. The transceiver is only 30mm thick, including knobs, weighing only 0.55kg. Fold out the kickstands at the rear for use on a desktop or picnic table.

11 discrete RF bandpass filters

Discovery TX-500 has 11 discrete RF bandpass filters. The RF signal is only passed through one of the band-pass filters - any out-of-range signals are rejected.

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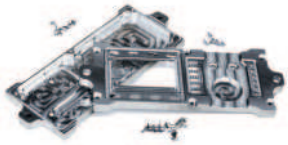
The transceiver features a built-in high-performance panadapter, for better search for new contacts and evaluation of band conditions - wherever you are, at any time.



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Good Conditions over Christmas

Steve Telenius-Lowe PJ4DX has reports from many readers who enjoyed a 'Christmas bonus' of good HF propagation.

The Solar Flux Index (SFI) rose to 122 on 17 December with the Sunspot Number (SN) at 127 and both remained above the 120 mark for well over a week, leading to some good propagation on 28MHz. Solar activity peaked on 22 December when the SFI reached 140 and the SN a remarkable 147, the highest in Cycle 25 so far. However, by 6 January SFI was down to 84 and SN to 24 and 28MHz was completely dead around midday here – even on FT8.

Kevin Gibeau VE3EN provides a great explanation of the various solar weather terms at:
solarham.net/help_center.htm

Table 1 shows the SFI and SN on the day this column is being compiled, as well as on the 11th six months ago and a year ago.

New Book

Dream Big and Dare to Fail (**Fig. 1**) by **Cezar Trifu VE3LYC** is a new 240-page book about Cezar's numerous IOTA adventures. It was printed professionally in the UK and includes over 500 full-colour photographs. Although I have no commercial interest in its sales, I should nevertheless declare an interest: I did the design, layout and desktop publishing of the book. It is now available from:
http://ve3lyc-book.weebly.com

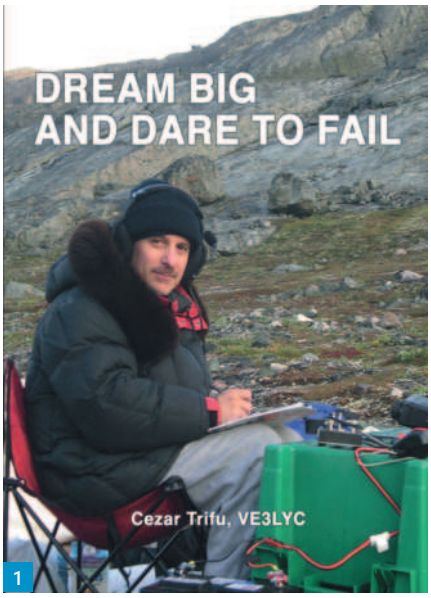
A Personal Challenge

Having decided to take part in the 2022 DX Marathon Challenge run by CDXC, The UK DX Foundation, I set myself a personal challenge: to attempt to contact 100 DXCC entities on 1 January, using any mode. I did not quite make it, working PJ2ND on Curacao on 10MHz CW at 2356UTC for DXCC number 97. Best DX of the day was probably 8J1RL in Antarctica on 18MHz FT8, while on SSB S79KW was the highlight on 14MHz. One DXCC entity I missed was my own – Bonaire: I heard no other PJ4 stations active on New Year's Day!
clublog.org/cdxc.php

DX News

Andy Chadwick 5Z4VJ (G3AB) has clocked up a remarkable 200,000 QSOs since becoming active from Kenya in October 2019. QSL Manager **Tim Beaumont M0URX** reports that Andy passed that milestone in early January.

Look for **Jacek ('Jack') SP5EAQ** to be active from the Austral Islands (Rimatara Island, IOTA OC-050) between 2 and 30 March (Covid permitting, of course). Jack will operate as FO/SP5EAQ except during the CQ WPX SSB contest on 25/26 March when he will sign TX5AQ. Jack operates SSB only and will be on all bands from 3.5 to 28MHz. More details are at:
australs.sp7dqr.pl/index.html



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Readers' News

This month we have not one, but two, new contributors to the column. First up is **Howarth Jones GW3TMP** who wrote: *"Last sunspot cycle I was active on 10m AM and hope to be again when the SFI rises a bit more. **Tom W0TDH** and I had many QSOs during that period but more recently we re-established our AM QSOs, this year on 15m usually about 21.420MHz."* Howarth uses a Heathkit DX-100U transmitter, which he says was probably built in the early 1960s but which he restored with new components about 15 years ago. For receiving, there is an Eddystone 680X receiver, which you can see with the DX-100U in **Fig. 2**. *"On 15 and 10m it's quite amazing how sensitive [the Eddystone] is. I am lucky re antennas as I have a Yagi with four elements on 15m and five on 10m."* I listened for Howarth and, after nearly 113,000 SSB, CW and data mode QSOs from Bonaire, had my first two-way AM contact from here. I used the Icom IC-7300 with its power reduced to about 30% into a linear amplifier providing about 100W carrier power. Signals peaked at 58/59 but with far more fading and local noise evident than on SSB.

Our other new correspondent is **Dr Bill Ward GM0ICF**, who has been experimenting with meteor scatter (MS) communications. Normally considered a VHF-only mode of propagation, Bill wanted to try MS on 28MHz. *"Between 10 and 13 December, over the peak of the Geminids, I worked GM0NAI, G4RRM, EI6GF, DK3EE and SM5EPO. DK3EE was 55 on SSB. He had an almost continuously readable signal, many small bursts merging into continuous propagation... My best DX was SM0EPO. This QSO was completed using MSK144 with bursts frequently lasting several seconds at up to +10dB... EI6GF was worked on JTMS. The strongest echoes came from my friend GM0NAI. Running 400W to a large tribander (eight elements on 28MHz) he was +16dB using MSK144. G4RRM was running 100W and a Spiderbeam [and] also using MSK144... My own station was 400W to a homebrew two-element Yagi at only 5m high... My next experiments will be to use my new three-element homebrew Yagi for slightly greater gain and better F/B* [front-to-back] *and at a greater height to see how that goes."*

Carl Gorse 2E0HPI used the /2ZE suffix permitted by Ofcom to commemorate the 100th anniversary of the first transatlantic reception of amateur signals (see last month's *HF Highlights*). He wrote *"December has been a busy month, operating from English Castles and Lighthouses with a total of 706 QSOs using 2E0HPI/2ZE/P and gaining the first silver award for the English Lighthouse Awards, **Fig. 3**. Lighthouses activated were Hartlepool Heugh and Seaton High Light, Roker Lighthouse and Parsons Rock*

Fig. 1: The new book by Cezar VE3LYC.
Fig. 2: The 1960s-era AM station of Howarth GW3TMP.
Fig. 3: English Lighthouse certificate awarded to Carl 2E0HPI/P.
Fig. 4: The 2E0HPI/2ZE/P Slidewinder antenna at Scarborough Lighthouse, ENG 121.
Fig. 5: The new station of Victor G3JNB, with Yaesu FT-450D to the front. Fig. 6: Sea mist in the Bay of Gibraltar. Looking down from the ZB2GI/P location at the top of the Rock.

*Lighthouse, South Shields and North and South Tynemouth Lighthouses and many others up the coast. Recently I purchased the 'Slidewinder' DX antenna by M1ECC Antennas, **Fig. 4**, which covers 40m to 6m. My first trip to Scarborough saw me work W9OO and N2BTD on 20m plus S51X/M, S59DXX, CU3AK, IV3OKU, EV1R, NT2A also on 20m with the Icom IC-705 at 5W."*

Our former *HF Highlights* columnist, **Carl Mason GW0VSW**, has been QRT for over a year for health reasons but was operating again during the GQRP Winter Sports event over the Christmas period using a Xiegu G90 at 1W to an inverted/folded G5RV. *"Conditions seemed OK some days with activity on most bands but the 1W struggled most of the time. I enjoyed the challenge even though there was no major DX in the log"*, said Carl (see 'Around the Bands').

"Forsaking the past 16 months of low-power-only operations, on 1 December I retired my FT-818 from base station duties," writes **Victor Brand G3JNB**. *"Yaesu's London dealer delivered a pristine FT-450D and a MyDEL power supply,* **Fig. 5**. *Just 9x9in, the little rig offers me 'Topband to Six' at 5 to 100W. Its large visual display and traditional knobs are more agreeable to ageing faculties and it nonchalantly auto-tunes my three fishing rod vertical aerials and long wire to resonance on all bands. The quiet receiver and excellent reports from initial test contacts indicated that, as requested, their service engineers had kindly 'fettled' the set to match my particular interest in CW DXing. It was ready to go!*

"Early the following Sunday morning, I checked on how the weekend 160m CW test was progressing. Anticipating low band occupancy, instead I was assaulted by a veritable wall of signals. It was both a chaotic and a wonderful sound, reminiscent of topband when I was a teenager. Stations were booming in from all around EU and as I tuned up and down something caught my ear. Beneath a powerful contester, I thought I caught a very weak letter 'V'. In fact, it was VO1HP calling CQ. I closed to 300Hz bandwidth to retrieve what I could. Yes, Frank in Newfoundland was in there working the odd station but largely ignored by the oblivious 'big guns'. Undaunted, I dropped in several 15W calls on the long wire and just sensed he was coming back somewhere beneath the incredible din. Eventually, in a momentary silence, I heard a whispered 'G3JNB NL'! So, my very first DX contact was not on HF... but on topband*! Awesome.*

*"And lo, it came to pass on the days before Christmas, sunspots soared and DX sang. I worked some really attractive calls, among the best of which was on 17m with the Ogasawara Islands DXpedition JD1BMH by **Harry JG7PSJ**. For us, these too were tidings of great joy. Yes, indeed".*

'Our man in Brussels', **Etienne Vrebos OS8D,** wrote that he is *"happy to have a nice shack and being able to talk to anybody whenever I want... It's still difficult to explain to walkers/neighbours what the pleasure is to talk to unknown people worldwide. On the one hand we are sitting alone in a shack with a lot of expensive equipment like a hermit, but on the other hand extremely social, speaking to the world... When I see people stopping in front of my house and looking at the antennas I often go down and explain. Sometimes they run away, sometimes they*

	Jan '22	Jul '21	Jan '21	Difference
SFI:	99	72	73	(+26)
SN:	38	24	0	(+38)

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.

listen but never understand (except when an older guy remembers CB).”

Kevin Hewitt ZB2GI says he had *“two good openings on 15m SSB from the club station this month. I went up the Rock with **John King ZB2JK** twice after noting an opening on 10m, only to find the band had closed by the time we set up our station! I operated 10m FT8 when I went up the Rock to operate Meteor Scatter.”* **Fig. 6** shows the weather conditions that Kevin experienced from the top of the Rock.

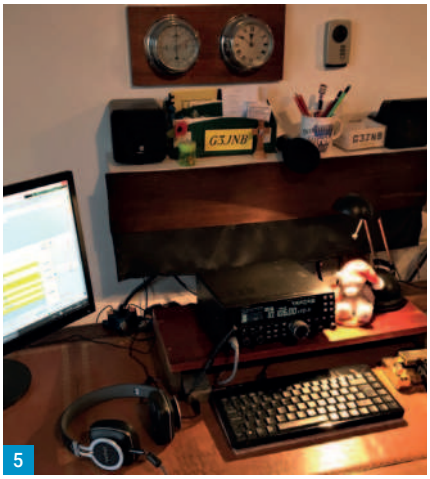
Our 28MHz ‘beaconologist’, **Neil Clarke G0CAS**, wrote that *“Small, weak and localised Sporadic E openings took place occasionally, for example on 3 December beacons IW4EIR 28194 and ED4YAK 28251 were copied, while on the 4th DB0BER 28273 and DB0UM were the strongest from Germany and SK7GH 28298 from Sweden. From the 15th solar flux levels increased significantly, which allowed F2 propagation to the Greek beacons SV2HNE 28201, SV2RSS 28265, SV6DBG 28269 and SV2HQL 28271 to be heard most days to the end of the month. The Turkish beacon YM7TEN 28224 was audible most days along with the Israeli beacon 4X6TU on 28200. Both ZS6DN 28200 and FR1GZ 28214 were also copied most days, which provided an excellent indicator for propagation southwards across the equator. There were only three days in the month when no beacons were heard.”*

Tony Usher G4HZW is another 28MHz aficionado. He wrote *“28MHz found its feet during December with the SFI >100 every day from 15 to 28 December. 213 contacts over the whole period... A milestone for me on 27 December, with ZL heard on FT8 for the first time on 28MHz. Not worked, unfortunately. On 19 December, some G stations reported working ZL on SSB and at 1130UTC long path to JD1 (Ogasawara)! In the late evening of the same day, some auroral signals and I watched a GM station working W6 and 7 and an OZ working KL7. Early evenings were good for W stations as far as the mid-west and, at one time, four stations were calling me!”*

Tim Kirby GW4VXE also sent in a 28MHz report: *“10m perked up around the Christmas period and I was pleased to work CX2BK, our old friend 3B9FR, W8AV, XQ6CF, LW2DOD, TA7I, K3RA, VE2CHI, K1RM, K7SV, ZD7BG, CT3MD and FY5KE. One morning I did hear VK6VZ, but by the time the amplifier had warmed up, he was gone. The same with HS3NBR this morning!”*

Owen Williams G0PHY noticed that *“the increase in the SFI certainly gave some interesting propagation, but getting ready for Christmas and then the New Year tended to get in the way of ham radio. Special event station TX60CNES from New Caledonia was very strong beaming long path to Europe on 14MHz on a couple of mornings for about an hour each time. Unfortunately, the pile-ups were just too strong to break. However, I did manage to work TO60CNES in French Guiana on both 14 and 21MHz.”*


4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6

Around the Bands

Carl 2E0HPI/2ZE/P: 7MHz SSB: GI0AZB/P (SOTA GI/SM-007), OK1POP/P (GMA OL/JM-015), OZ7PR/P (WWFF OZFF-0227), SP1MVG/P (WWFF SPFF-0999), SQ9BQW/P (SOTA SP/BZ-082). **14MHz SSB:** EA4HIH/P (SOTA EA4/MD-052), IV3/S55G/P (WWFF IFF-2745).

Carl GW0VSW: 3.5MHz CW: F6GWL. **10MHz CW:** HB9DGV/P. **14MHz CW:** RG22NY, SX200ME, YT21YOTA. **18MHz CW:** SK75AT, SZ200ERS. **21MHz CW:** EA8/OE6FEG/P, OF9X, S513OZ.

Victor G3JNB: 1.8MHz CW: VO1HP. **7MHz CW:** 9K2MU, FM5FJ, J42CPM, V31MA. **10MHz CW:** CT9/DL5CW. **14MHz CW:** 3B9FR. **18MHz CW:** 5Z4VJ, 9Z4Y, C6AAE, CX5FK, JD1BMH, TZ4AM. **21MHz CW:** 5R8AL, PJ7/NZ1C, PY2ZEA.

Kevin ZB2GI: 5MHz FT8: 5B4AJG, VE9CD, WB2WMF, ZA/IK2RLM. **7MHz FT8:** 4Z1KD. **14MHz SSB:** DB0YOTA. **14MHz FT8:** AA4VT, KC8YDS, KJ4WVT, VA2QA. **18MHz SSB:** N2BJ. **21MHz SSB:** VA2AM. **21MHz FT8:** AC5V, EA8DKE, K1NH, KA2D, KB9JJF, KW8I, W0AQ, VA3DX. **24MHz FT8:** 5Z4VJ, FG5FI, HS0ZOY, NF1G, OD5ZZ, VA2GA, WA6DKZ, WB4EVH, WP4WW. **28MHz FT8:** AA9RR, AC4PQ, HZ1SK, K0KO, K1FEV, K3FM, K5AUP, KB1YNT, KH6M, VA2QR, VE3ISO, VK6AS, W2PP, W8RLS.

Etienne OS8D: 3.5MHz SSB: W2VP. **7MHz SSB:** 3A2MG, TO60CNES (FY). **14MHz SSB:** 4U1UN (UN HQ, new DXCC for Etienne), 8G13A (Indonesia), CN0S, UP30RK. **21MHz SSB:** 4K3ZX, CX2DK, KP4WQ, LU6DCN, PZ2YT, UN30RK, ZC4GR. **28MHz SSB:** FY5HB, TO60CNES, VK5MRD.

Tony G4HZW: 28MHz FT8: 4F1OZ, CX1AZ, E20EHQ, FG5BZ, HC1MD/2, HI3T, HK3TK, HS0ZNR, HZ1SK, PY2CYE/PP5, UA9CJM, V31MA, VK2AAH, VK5PW, VK6AS, VK6RK, VP8ADR, VU2MB, XT2AW, YB1BZV, YC0SAS, YV5JLO, ZA/IW2JOP, ZS6BJU. **28MHz FT4:** NP2SS, PZ5RA.

Owen G0PHY: 14MHz SSB: TO60CNES, VE6SV, VO1RAC, VY2DS. **21MHz SSB:** 7X3YOTA, TO60CNES.

Signing Off

Thanks to all contributors. Please send all input for this column to teleniuslowe@gmail.com by the 11th of each month: for the May issue the deadline is 11 March. 73, Steve PJ4DX.

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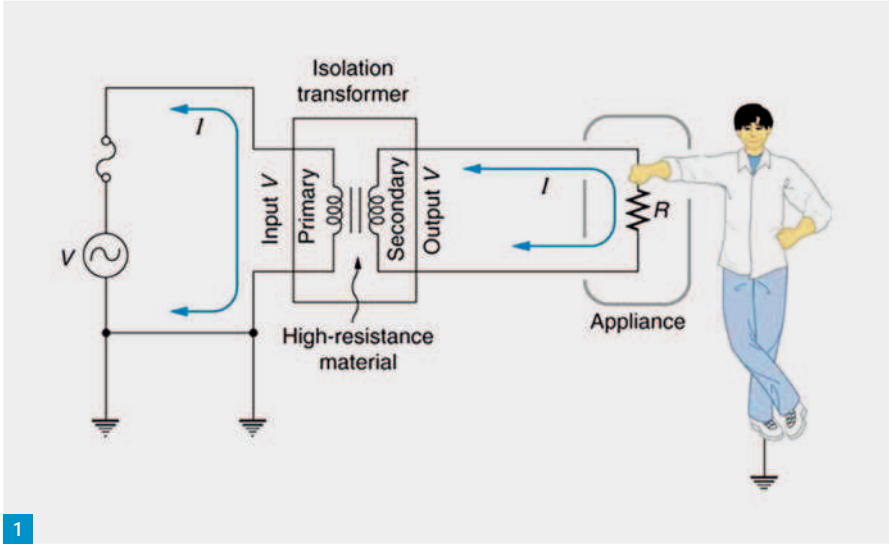

1

Valved Radio Repair (Part I)

Bernard Nock G4BXD embarks on a new series explaining the ins and outs of repairing valved radios.

I often get asked *"how does one repair a valved radio?"* It's a tricky question to answer as there are many types of valved sets, some simple, some quite complicated. There is a basic method though that will work on any set. How complex a set you can fix depends on how deep you want to delve into the art of valves and their circuits.

Hopefully I can give a few basic pointers as to how to at least start on your valve odyssey, the sort of tools needed, suitable equipment that makes life easier and the basics of a standard valved radio and how to go about getting it back to working condition. Of course, nothing beats a little reading, I know that 'books' are a thing of the past but even the modern internet can be a real wizard at supplying information on this art. I cannot stress enough that you really should read more about this subject though.

Safety

In this day and age there has to be the obligatory notice about safety. Oddly, many years ago when every radio amateur used valves for receivers and transmitters, transmitters with 2000V or such being used, there was little thought about safety. I guess it was assumed that anyone working with such voltages would have the common sense to take care.

Today it has to be pointed out that even a domestic valved radio will have access to 240V AC voltages as well as the 200-300V DC voltages needed for the valves. Also, some sets, even some Eddystones, are what are called AC/DC sets. In these the actual mains voltage is used directly to power the valves and extra care is needed but more about that later.

So, working with 240V AC can be dangerous. That should be fairly obvious but, with thought and consideration, working on mains radios should not be a problem. One item for the workshop could be an isolation transformer. The main purpose of the isolation transformer is safety and protection of electronic components and persons against electrical shock. It physically separates primary side (connected to mains) and the secondary side connected to electronic components and grounded metal parts that are in contact with the person. Basically, the transformer secondary side is isolated from the grounding.

An isolation transformer is a transformer used to transfer electrical power from a source of alternating current power to some equipment or device while isolating the powered device from the power source, usually for safety reasons. Isolation transformers provide galvanic isolation and are used to protect against electric shock, to suppress electrical noise in sensitive devices, or to transfer power between two circuits which must not be connected. A transformer sold for isolation is often built with special insulation between primary and secondary, and is specified to withstand a high voltage between windings. (Wiki)

So how can the isolation transformer be used for electrical safety? It all comes down to what a transformer actually is. In the simplest terms it is two coils of wire around an iron core. However, the point to grasp here is that there is no electrical connection between the input and the output. The link is done by magnetism. This means that the output is 'isolated' from the input, hence the term isolation transformer!

The isolation transformer still has a nominal output voltage of 230V between its output conductors, but there is no link to earth. This means that you can safely touch either conductor without risk of electric shock. You will still get an electric shock if you touch both conductors however! A quick look on eBay shows them at £30 or so but do be sure to read up on this subject.

Tools

So, let's assume you have your isolation transformer fitted and supplying a multi socket adaptor screwed to your workbench. On the subject of a workbench, it's handy if you can find somewhere to work on your radio with ease. The kitchen or dining room table may not be a suitable location, partly because your partner will not like it but really because it means moving everything every time you want to play.

What tools do you need? I would suggest wire cutters, pointy nosed pliers, a pair of long-nosed pliers, which are great for picking up the washer that has been dropped down inside the set, screwdrivers flat and crossed in at least a couple of sizes, a wire stripper, a soldering iron and solder and a test meter or two. Soldering irons come in many sizes, usually labelled in Watts. A 25W iron is fine for smaller joints and transistor sets but where you have valve bases and large components a 100W solder gun is to be preferred. There's nothing more frustrating than trying to unsolder a big re-

Fig. 1: The benefit of an Isolation transformer.
Fig. 2: A selection of tools to start with.
Fig. 3: Digital Multimeters.
Fig. 4: L to R: Avo Signal Generator, below: Avo Multimeter, above: Avo L/C Meter, below: Frequency Counter above: Oscilloscope above: PSUs, Digital L/C Meter.
Fig. 5: Old and Older, Marconi Signal Generator and WW2 LM-14.

sistor with a small iron.

Test meters. You will need something that can at least measure AC and DC voltages along with current and resistance, in ohms. There are plenty of quite good but cheap digital multimeters available these days that measure a load of things as well as volts and current such as diodes, capacitance, frequency (to a point). However, my preference is for an analogue meter, that is to say one with a moving pointer across a scale, such as the Avo range for instance. The good old Avo 7 or 8 are wonderful tools and when you have your head in a set you can touch a point with your probe and glance at the meter to see the deflection on the scale.

There is no need to read the scale. If the meter is set on the 250V range, say, and you see the pointer halfway across you know it's about 125V, a quarter way is 60 odd volts, etc. It does make for speedy checking of voltages within a set. Of course, later on you might want to know an exact voltage. Here the digital meter is ideal but with use you will find even the moving pointer meters are more than enough to be usable.

There are, of course, many other tools such as spanners, nut spinners, grips, adjustable wrench, knife, files, etc but even with those mentioned earlier you could work on a basic set and get good results.

Test Equipment

So, what test equipment would you need to repair or service, for example, a standard domestic receiver or even a good old set such as a 9R59DS, Heathkit RA1 or Hallicrafters SE-38? In addition to a test meter, your trusty Avo 8, it would be nice to have a signal generator. Again, these are available on the likes of eBay, for example an Advance E2 signal generator, 100kHz to 100MHz at £25 seen today, or from your local club junk sale.

For basic sets you don't need anything fancy. I do have a Hewlett Packard all singing and dancing oven-locked 0-2.6GHz generator but I also have an old Avo Signal Generator (yes, Avo made everything), which is more than enough for most HF

set repairs. You will need something to give you a modulated RF signal from, say, 100kHz, including a typical IF frequency such as 450kHz to perhaps 30MHz at least, which will cover the range of most short-wave receivers. You want it to be modulated as it makes it easier to tune a receiver if you can hear an audio note and allows you to use your multimeter to measure that signal while you align the set.

Other items such as oscilloscopes and frequency meters are handy instruments to have but understanding oscilloscopes and getting the best out of them is another course of tuition in its own right.

In addition to buying a commercial signal generator there are other options. I have a WW2 heterodyne frequency meter, an LM-14 as used by the US Navy, a version of the famous BC-221, which would do equally

well, and even this has a modulated signal with a very good frequency stability and calibration. I use it on one of my benches if I need an HF signal for testing or such.

Starting

So, you have assembled your tools. You have acquired an isolation transformer and wired it to a block of 13A mains sockets. You have your test equipment and are raring to go. You bring out the subject to be operated on. What to do first?

Ensure you have enough space to have the set, tools and test gear near to hand. There's nothing more frustrating than having to keep moving things due to a small working space. The first step might be to plug the set in and see what state it is in. Are there any lights and sound from the speaker? Or even a hum in the speaker, which would signal some signs of life. Can you see if the valves are glowing? Or is the set totally dead?

In my experience a dead set is usually easier to fix than a deaf set or, even worse, a set with an intermittent fault. Those really are the worst things to work on because the fault never shows itself while you are watching, only when you walk out of the room and then come back to the fault.

Once you have had a think and observed the patient it's time to open it up. Unplug the set, safer and easier because if you drop it when plugged in, the cord will pull other things off the bench, believe me!

I always keep a few of the aluminium trays that ready meals and the like come it. They are ideal to drop all the screws in so they are not rolling around the bench. I am a firm believer in being tidy. I do not drop wire cuttings or solder on the floor, and I regularly tidy up the workbench to make life a lot easier. Talking of the bench, I have one of those rubber mats with ribbing on top of the wooden bench. The ribbing stops things rolling and helps keep them steady.

Having removed the screws, sometimes this job in itself can be a task, they are put to one side and the case or wooden cover in the case of a domestic set is removed and placed well away from the work area. Now you will have the chassis exposed and should inspect for any obvious signs, broken components, wires, anything looking burnt or fried. Your sense of smell should help there.

Turn the chassis over and examine the internals of the patient for similar signs. I should say at this point, every effort should have been taken before the job was started to try and get a copy of the circuit diagram. The worldwide web these days can throw up nearly any circuit needed and I can assure you, repair or restoration is a lot, lot easier with a decent circuit diagram.

4

5

Next time we will start looking at just what a valve is, what to look for, what to expect and the basics of a simple receiver design and how to start repairing our radio. Remember, do read up on this subject.

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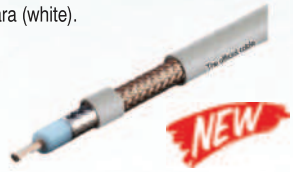

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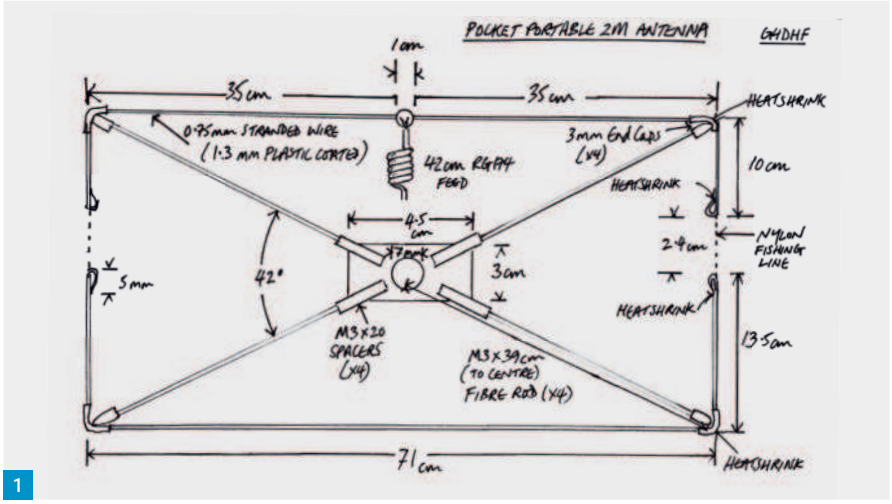


1

A Pocket Portable 2m Beam Antenna

David Johnson G4DHF describes and easy to build antenna that's ideal for portable operation.

The prospect of returning to the hills and islands around our coast and possibly coupling into sea ducts and Sporadic E openings on 2m, where distances over many hundreds of miles are possible with simple equipment, has always been appealing. The aim was to build a simple 144MHz antenna that provided some forward gain and was small enough to be carried in a pocket. By doing away with metal rod elements and fittings, the whole antenna could be folded into a small pouch, making it ideal for travelling light. Such an antenna would also have potential for stealth, SOTA or holiday travel. Being only a two-element reduced-size Yagi type, this isn't going to set the band alight, but if it means that you can take it away with you to somewhere where you wouldn't have expected to be active, then it's a bonus. You're in the VHF propagation lottery with a ticket!

If the antenna could be made from readily available plastic-coated 0.75mm stranded hook-up wire with an outside diameter of 1.3mm, then it could be folded away like a ball of string. In addition, the supporting structure would not have to be too strong as we're not looking for a permanent installation. The use of kite making materials for the framework would provide both the strength and lightness required.

Looking at the Moxon

There has been a great deal of information written about the excellent Moxon antenna, designed by **Les Moxon G6XN**, which is essentially a two-element close-coupled beam [**1**]. As the ends are folded back, the overall size is reduced to around 70% of an equivalent Yagi, with a central feed impedance of 50Ω. It possesses a gain of around 4dBd and exhibits a great front-to-back ratio, which is useful for nulling out QRM and local noise. There is an excellent PC program available by AC6LA for designing free-space Moxons [**2**], which works very well and is to be recommended. There are problems, however, when using plastic coated wire on VHF because there is a velocity factor that must be determined to make the antenna resonant. As I wanted to use very thin multi-stranded plastic-coated wire, this had to be found by experimentation.

The Build

I was able to source all the parts on a well-known online auction site. The four support struts are made from 3mm fibre composite solid rod, sourced as kite or window blind materials. The total length to the centre of the hub for each support is 39cm. Mine were cut to 38cm as they located into four M3 fittings mounted forward of the central hole. I suspect that the kite material is carbon fibre, which has little effect on the performance of the beam as the struts are not in the element plane and the four ends are lifted by plastic end caps. I would advise some caution when handling this material.

Wear protective coverings and avoid breathing the fine powders when cut. I have cut each of the four struts into three sections (14, 14 and 10cm) and have used eight 2cm plastic outer couplers to allow them to be joined during assembly. It is also possible to use thin 4mm or 5/32nd aluminium tube, available in most model shops, if a suitable plastic material cannot be found.

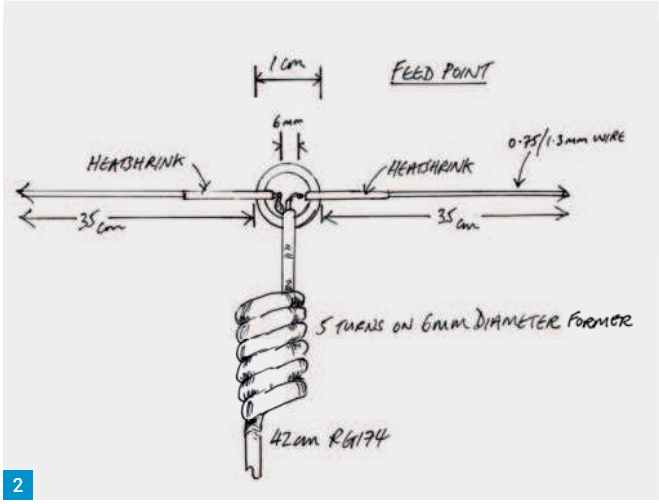
Depending on the nature of the material used, it may also be desirable to cover the remaining exposed fibres in heatshrink. The central support does not have to be large. I have used 30 x 45 x 4mm acrylic sheet, which can be purchased cheaply as offcuts. The support struts are inserted into each of the four M3 x 2cm plastic spacers, blocked at one end, that have been filed to provide a flat surface for attachment. These are glued to the central support at an angle of 42° and aligned using a paper template.

A central hole of around 7mm allows the antenna to have a compression fit onto a fishing pole used as a mast. I have also used a variety of plastic knitting needle sections that have been cut and glued onto additional acrylic cuttings to provide an interface for mounting vertically.

Experimentation determined the velocity factor of the wire to be around 0.95% of the free space model. The feedpoint is mounted into a common flatpack furniture plastic moulding. Cuts were made in the sides to accommodate the driven element and RG174 feeder tail. As with the four strut-end support caps, it is highly recommended that heatshrink is applied to these bending points to reduce wear each time the antenna is re-assembled. The feedpoint is then potted in epoxy resin to increase rigidity and for waterproofing.

Resin can also be applied to the endcaps that attach to the wire elements to maintain the shape of the structure. When the elements are measured, add an additional 5mm to each of the ends and bend this back on itself to form small loops. Thread four small lengths of heatshrink before the loops are closed.

It is important that the element ends are not detuned, so they are held in free space 2.4cm apart by nylon fishing line tied into the small loops. To reduce weight, a 42cm length of SMA-terminated RG174 was used to attach to the main feeder. The antenna is essentially a balanced system, so five turns of



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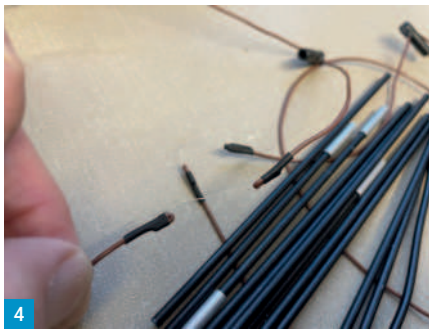
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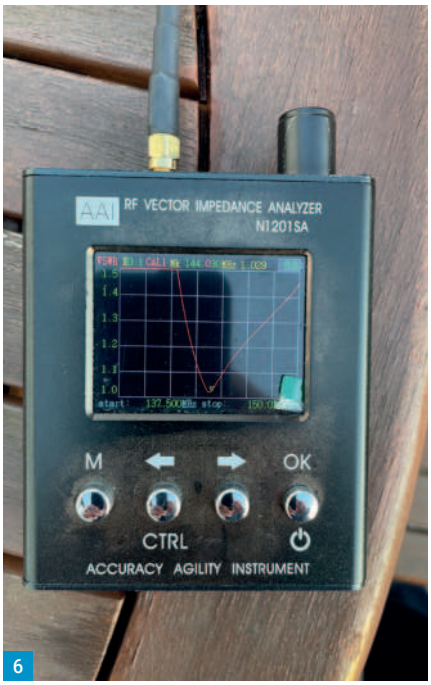

6


7

Photo 1: Overall dimensions.
Photo 2: Feedpoint detail.
Photo 3: The components needed.
Photo 4: Securing the element ends.
Photo 5: Packed and ready to go.
Photo 6: SWR curve as measured on the analyser.
Photo 7: The finished antenna on a fibreglass pole.

the cable were wound on a 6mm drill bit and then glued to provide a simple choke at the feedpoint, thereby reducing RF on the outer of the feedline. I use around 2m of RG58 with strain support to the radio for handheld use.

A lightweight £2 selfie-stick was purchased and modified into a mini handheld support. The top camera mountings were sawn away to provide a flat plastic base so that a small piece of acrylic could be glued in place. This had been pre-drilled to accommodate a stub of tapered fishing pole of around 7mm, on which the antenna is mounted.

A section of plastic knitting needle could also be used. This arrangement is ideal for lightweight and rapid antenna deployment, hopefully allowing operation that in any other circumstances would be impractical. It was never the intention to operate powers much above 5W near to the body, so consideration must be given to EMC compliance and safety.

Calculations confirm that the system described with the power levels suggested is compliant [**3**]. Over ten of these antennas have been constructed, each with excellent results. I hope that this little antenna provides a great deal of fun and I am sure that many would be interested to read what has been worked in future editions of **Tim Kirby's** excellent *World of VHF* column [**4**].


8

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1. https://tinyurl.com/bdcr3beu
2. https://ac6la.com/moxgen1.html
3. https://tinyurl.com/2p856jub
4. Thanks to **Julian G4YHF** for his independent calculations.
Thanks to **Tim GW4VXE** for Beta Testing and his feedback on the antenna.

Roger Dowling G3NKH
practicalwireless@warnersgroup.co.uk


1

The Faces behind the Calls

Roger Dowling G3NKH meets a couple who are a regular presence on digital radio.

It all started with Citizens Band radio. **Linda G0YLM**, **Fig. 1**, from Morecambe was persuaded by a friend to get into CB when she was in her late teens. Through CB they both met their husbands – in Linda's case Manchester-born **Ian Maude G0VGS**, **Fig. 2**, who had been involved in CB since 1981. Ian was then going to college with a view to taking the Radio Amateur Examination.

Meeting Linda delayed these studies and it was not 1994 that – with the help of local radio amateurs – he successfully took the RAE as an external candidate at Trafford College in 1994. He passed the Morse test a year later.

Meanwhile, Linda – then following her mum into the library service – was already getting into amateur radio herself. A keen shortwave listener, she acquired her own 'B' licence as G7SNS; she still winces at the appellation 'Sexy Nylon Stockings' by which she was occasionally known on air.

The RAE followed and presented no problem – she had always been good at exams and as a girl had always been more interested in technical matters than dolls. She also found Morse easy and was up to 15wpm after only seven weeks. *"I think being musical helps"*, she told me. *"Morse is like a series of musical notes, and besides having a musical mother I used to sing in several choirs at the time"*. Despite finding the Morse test one of the 'most terrifying' experiences of her life, she passed with flying colours and proudly gained the licence G0YLM ('Young Lady from Morecambe') a few months after Ian had become G0VGS. *"I was lucky to be able to choose my callsign from the last of the G-zeros, so it was rather out of sequence"*, said Linda. *"For months people used to think I was a pirate!"*

Ian had moved from Manchester to the seaside town of Morecambe when his parents bought a boarding house there in 1972. From school he took up a three-year apprenticeship with what was then Post Office Telephones, now British Telecom, and enjoyed a long career as an engineer and later as a professional sales consultant in the business sector. He took early retirement in 2007 and then started helping a friend who had a business, which in due course became an Apple repair centre; this led to him becoming an Apple Certified Mac Technician and Certified iOS Technician around 2014. Ian finally retired in 2019.

2

Many Interests in the Hobby

Ian and Linda's shared enjoyment of amateur radio has involved them in many aspects of the hobby over the years. Linda enjoys DX hunting, with around 270 countries confirmed, while Ian particularly enjoys the 'cut and thrust' of contesting.

Over the years Ian has also taken a keen interest in the RSGB Islands on the Air (IOTA) programme, setting up several stations for a week on various islands around the coast of Britain. *"We've always done it seriously"*, says Ian. *"We've made a point of making our own antennas, which has been a great learning experience"*. The expeditions proved very successful. *"On our first visit to Arranmore, an island off the west coast of County Donegal in Ireland, we had 16,500 contacts in the week."*

Between them, Ian and Linda have used a range of HF-band radios over the years. Ian has always been an Elecraft enthusiast. His main radio is currently an Elecraft K3S, still a very highly regarded transceiver covering all bands from 160m to 2m. He also has an Elecraft P3 Panadapter, a KPA500 linear and an autotuner. *"I've been using Elecraft gear since 2004 when I bought a K2 as a kit"*, Ian told me. *"I still have it now – it was a great design. I've worked the Philippines on the K2 with 10 watts of SSB into a horizontal loop antenna around the garden. It's a contact I'll remember for ever!"*

Linda also has a taste for older radios, though last year she flirted with a new Yaesu all-band FT-991A transceiver covering all bands from HF to 70cm. *"It's an amazing little radio"*, she says. *"How did they manage to pack so much into a such a small box?"* But then the opportunity arose to acquire a JRC245, produced by the Japan Radio Company around 20 years

Fig. 1: Linda Fig. 2: Ian.
Fig. 3: Ian and Andrew. Fig. 4: Narrow boating.

ago. *"It really is my pride and joy"*, says Linda. *"It covers all bands from HF to 6m and its performance is absolutely superb, even compared with present-day radios."*

For HF antennas, the couple have the use of a trap dipole for 80/40m and a Cushcraft R6000 for 20m to 6m.

Always interested in extending the reach of amateur radio, Ian set up the GB7MBC DXCluster, the first in the UK to use internet linking, some 25 years ago. The cluster, of which Ian remains System Operator (Sysop), is now one of Europe's busiest, running under Linux/DXspider and accessible from the website: www.gb7mbc.net

Digital Radio

This interest in computer-enhanced radio also led to Ian and Linda's involvement in digital radio. They are joint Sysops of a 70cm repeater GB7MB, which is permanently connected to the North West Fusion Group (NWFG), a group of connected radio repeaters and gateways in the north west of England based around the Yaesu System Fusion digital radio system. NWFG also have another reflector YSF41142. The Group enables radio amateurs anywhere in the world to access its infrastructure via Wires-X room 41755 or a hotspot connected to either YSF41142 or FCS00428 reflectors. Last year another Wires-X room, 44222, was launched for members of the Blind Veterans Amateur Radio Society.

They are also Sysops of a 2m gateway MB7IMB, connected to the North West AllStar Group that was set up in early 2021 to promote this as a method of linking repeaters and simplex gateways around the world using analogue FM.

"The great thing about these very friendly amateur radio groups is that they include a wide range of specialists who are brilliant in their particular field", said Ian. *"Linda and I, as Sysops, find this enormously helpful as, of course, do other members of the groups."*

And YouTube Videos

I asked Ian about the high-quality videos for which he has become well known on YouTube, covering a wide range of digital radio topics ranging from Operating Practices to Programming Fusion Radios. He explained that he originates the videos at 4K 60fps on his iPhone and then edits the many segments using DaVinci Resolve video editing software before uploading in HD to YouTube.

Other Interests

Outside amateur radio, Ian very much enjoys his guitar and his banjo. *"I started playing guitar back in the 1970s"*, he told me. *"I used to play in a couple of folk groups at that time. We even performed once at the switching on of the Morecambe illuminations!"*

On one occasion, in 2014, he was able to combine his love of both amateur radio and his banjo by giving an impromptu 'performance' during an IOTA DXpedition to the uninhabited island of Tanera Mor, the largest of the Summer Isles in the Inner Hebrides of Scotland, with fellow Morecambe radio amateur **Andrew Scarr G0LWU**. *"Andrew is an excellent fiddler and as it was a lovely day we thought we'd take a break from amateur radio and step outside to record our interpretation of Red River Valley"*, recalled Ian. *"It's still there on YouTube and I see it has notched up over 7,000 viewings so far!"* (**Fig. 3**)

Another long-time interest of Ian and Linda is narrow boating, **Fig. 4**, when they can take along a handheld to keep in touch with the world of radio as they enjoy the ever-changing scenery. A favourite is the lock-free Lancaster canal, one of the UK's few coastal canals, which wends its leisurely way past Morecambe over the 41 miles between Preston and the hamlet of Tewitfield.

Ian is also a lover of craft ales, yet another interest that has resulted from his amateur radio activities. Fellow radio amateur **Mike Dent G6PHF** had started his own microbrewery over his apple shop in Lancaster, which in due course became the Accidental Brewery and Micropub. *"Mike then set up a brewery here in Morecambe and we've been to many beer festivals together"*, said Ian.

When not on the air, housewife Linda also keeps busy looking after the social media aspects of the Fusion and AllStar groups, which are active on both Facebook and Twitter. And when time permits she likes nothing more than joining Ian to catch up with the world of F1 motor racing on television.

With a glass of wine – and a craft beer – can there be a finer way of ending the day?

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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

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ICOM

IC-R8600 Professional Communications Receiver

The IC-R8600 is a super wideband communication receiver that covers the radio spectrum from 10 kHz to 3 GHz. It also has the capability to decode selected digital communication signals including, D-STAR, NXDN, dPMR and P25. The IC-R8600 incorporates the latest software de-modulation technology incorporated on Icon's latest HF Amateur radios, providing superior performance and intuitive operation. With the optional remote control software for a Windows PC, received audio and spectrum scope data can be transferred through an IP network for monitoring from remote locations

KEY FEATURES

- Ultra-wide frequency coverage (10kHz-3GHz) with RSSI (Received Signal Strength Indication) function
- Fast moving, real-time spectrum scope and waterfall functions
- Decodes multiple digital protocols, including D-STAR, NXDN, dPMR and APCO P25
- Large 4.3 inch TFT colour touch screen display
- Clear audio quality using FPGA/DSP base architecture with superhet-erodyne circuitry
- Optional RS-R8600 PC remote control software allows control of all receiver functions
- I/Q signal output for use with third-party SDR software and/or external decoding
- An SD card slot for received log, decode log and voice recording
- Optional SP-39AD external speaker with integrated power supply

All for just

£2699.00

2699 WATTS

GET TWO FREE ANTENNAS

- Moonraker Whizz Loop V3 40 - 6m QRP Antenna
- Skyscan 25 200MHz Scanner Sntenna

ICOM

IC-7100 HF/VHF/UHF Portable & Mobile Transcieiver

A first for an Icom transceiver, the IC-7100 is designed to the 70MHz band in European versions where 70MHz is open to Amateur radio enthusiasts. Touch Screen Control Portal An amateur radio first! The radio control head features a large, multi-function, "touch screen"' DOT-Matrix LCD display that is positioned for easy view and operation. This is an important feature as the controller display not only provides information, but is your control portal to the IC-7100's feature settings and menus.

KEY FEATURES

- Intuitive Touch Screen Interface
- Innovative Slant Top Controller
- HF/6M/4M/2M/70cm 70MHz
- D-STAR DV Mode Operation
- IF DSP Digital Processing
- Built in Speaker • Mounting Base Option
- Built-in SD card slot for voice storage and data cloning
- Built-in RTTY demodulator and decoder
- Multi-function meter
- SWR graphic display
- DSP controller RF speech compressor
- Total of 505 memory channels
- Voice recording and playback functions
- 0.5ppm high frequency stability
- Optional RS-BA1 IP control remote control

All for just

£999.95

999 WATTS

GET A FREE ANTENNA

- IC-7100 Portable & Mobile Transcieiver
- SPX 300S Plug & Go Mobile Antenna

ICOM

IC-9700 2/70/23cm Base Transceiver

The Icom IC-9700 is the first VHF/UHF/1200 MHz transceiver which introduces the RF direct sampling system for the 144 and 430 MHz bands, a real-time spectrum scope and waterfall function. The RF direct sampling system has already provided high performance in Icom's IC-7610 and IC-7300 HF transceivers. In addition, the spec-trum scope and waterfall function have been indispensable tools for operators to increase QSO opportunities, without missing weak signals. The radio has many other impressive features including a built-in 1200 MHz band, 4.3 inch TFT colour touchscreen display, full duplex with Dualwatch on separate bands, Satellite mode, D-STAR DV (Digital Voice) /DD (Digital Data) modes and Terminal/ Access point modes. Also, a newly designed power amplifier and cooling system provide stable and high-efficiency operation, even when continuously transmitting for a long time.

All for just

£1795.00

1795 WATTS

GET A FREE PSU & ANTENNA

- Sharman SM30 (20amp) Switch Mode PSU
- Moonraker SQBM3500N 2/70/23/cm Base Vertical

ICOM

ID-5100E Dual Band D-Star Mobile Transceiver

Icom's ID-5100E VHF/UHF dual band D-STAR digital mobile trans-ceiver enhances core features found in the celebrated IC-2820H mobile and incorporates the user-friendly technology found in the IC-7100. The radio features a large responsive touch screen and also integrated GPS, optional Bluetooth connectivity and support for Android devices. The standard version comes complete with multi-functional microphone and hanger, DC power and controller cables and CS-5100 cloning software

KEY FEATURES

- 5.5 inch display (320 × 128 pixel)
- 118–174MHz and 375–550MHz
- DV Dualwatch
- Integrated GPS Receiver
- DV/FM Repeater List Function
- Dplus reflector linking
- UT-133 Bluetooth® unit (option)
- VS-3 Bluetooth® headset (option)
- RS-MS1A Android™ application
- Menu-driven user interface

All for just

£574.99

574 WATTS

GET A FREE ANTENNA

- ID-5100E Dual Band D-Star Mobile Transceiver
- MRM-100P 2/70 Micro Mag Mobile Antenna with PL259

ICOM

IC-705 All Mode D-Star Portable Transceiver

The portable HF/VHF/UHF IC-705 Mobile Transceiver has many great features such as SDR platform, internal battery, GPS, Bluetooth and D-STAR, all in a compact and lightweight body. The Icom IC-705 uses the same 4.3-inch colour touch screen display as the bestselling IC-7300 and IC-9700 featuring real-time spectrum scope and waterfall display.
HF/50/144/430 MHz Multimode Operation - From HF to 50/144/430 MHz, you can enjoy a variety of bands in D-STAR DV, SSB, CW, AM and FM modes. The IC-705 receives continuously from 30 kHz through the 144 MHz band. You can also enjoy FM broadcast and Airband reception.

Buy the IC-705 for just

£1299.95

1299 WATTS

GET 50% OFF MAT-705 ATU

- Buy the Icom 705 Portable transceiver

AND the MAT-705 Plus ATU for just £1389.95

ICOM

IC-7300 HF/50/70MHz Base Transceiver

The IC-7300 is a revolutionary compact radio that will excite HF operators from beginners to experts. This new model has a high-performance real-time spectrum scope and employs a new RF direct sampling system.

KEY FEATURES

- 70MHz band (European versions only)
- Class Leading Real-Time Spectrum Scope
- High-Resolution Waterfall Function • Audio Scope Function
- RF Direct Sampling System • New "IP+" Function
- Class Leading RMDR (Reciprocal Mixing Dynamic Range)

All for just

£1199.99

1199 WATTS

GET A FREE PSU

- IC-7300 Base Transcieiver
- Sharman SM30 (20amp) Switch Mode PSU

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

£549.95

549 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

£279.95

279 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

£329.99

329 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 audio volume levels are adjusted by potentiometers on the front panel of the device.

Buy the STICK-PRO for just

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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
£179.99

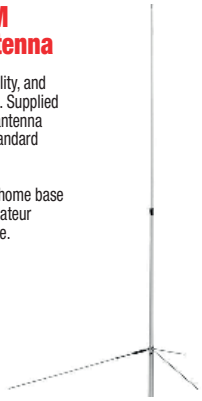
179 WATTS

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

Visit our website's product pages to see
Mini YouTube Clips

Mark Tuttle G0TMT
g0tmt@theshack.org.uk

Building the Audio Board

Mark Tuttle G0TMT starts construction of the Paston by tackling the audio board.

Starting with the audio board might seem like an odd choice as it's the last section of the receiver. However, there's method in my madness. Firstly, it's the simplest section to construct and test. Secondly, I aim to introduce Manhattan construction techniques to unfamiliar readers and finally, the audio board is a free-standing audio amplifier and CW filter, which can be used with any rig. You can use the headphone audio output of your shack HF rig with its volume set very low to test the audio board. You will be able to experiment with the bandwidth and centre frequency controls and how they affect the audio output.

Don't expect earth shattering, knife-edge filter performance out of two ICs but you should find it does a perfectly respectable job.

Circuit Diagram

The circuit diagram is shown at **Fig. 1**. The audio signal comes in and any DC component is removed by C1. This audio is then divided two ways. Some is fed through C13 and R1 to the front panel filter in/out switch and some goes to the CW filter. U1 and its associated components form an active audio bandpass filter. (This design came from **W4AMV** and featured in *Hot Iron* magazine #111). The centre frequency potentiometer sets the peak of the BPF from approximately 200 to 1200Hz. The Bandwidth pot actually adjusts the *Q* of the circuit and in so doing adjusts the bandwidth of the filter. I've set mine near minimum bandwidth (max *Q*) as the filter on the receiver board does a pretty nice job of cleaning up the audio, so this just tightens things in further. The TL072 is a dual-rail device so we need to bias the positive input at mid-rail voltage.

This is the job of R6 and R7 and it is smoothed by C5. The audio from the filter is selected by the front panel switch. The filter inserts a few dB of loss to the audio path so the 10kΩ resistor, R1, is there just to reduce the direct audio path by roughly the same amount as the filter. Without it you'll notice a sudden jump in volume when you switch the filter out. The audio is then passed to U2, the LM380N-8 Audio Amplifier. Many similar designs use an LM386 (**not** pin compatible with the LM380), which would do the job just fine but I find they tend to be more 'hissy' than the 380. They also require a few more components.

The audio is fed through the front panel 10kΩ Log AF gain control to the amplifier and the output goes to the speaker. If you want a headphone socket, simply wire one into the same output. A switched socket enables the speaker to be disconnected when the headphones are inserted. A small 2in speaker of around 8 – 16Ω is fine. Be careful. I bought a really cheap and nasty one first and it distorted the audio. A better quality 16Ω one was a much better choice and still offers plenty of volume.

General Note about Sourcing Components

The components list appears in the sidebar. Unlike a PCB, the size of the components you use with Manhattan construction is less critical. Clearly, if you're trying to fit a lot of components onto a small board there's no point in using 1W resistors and 600V capacitors but if you have a physically larger version of a component in the junk box and you can get it to fit, then it will do the same job. The values I quote in the parts list aren't always critical and if you have something close, try it.

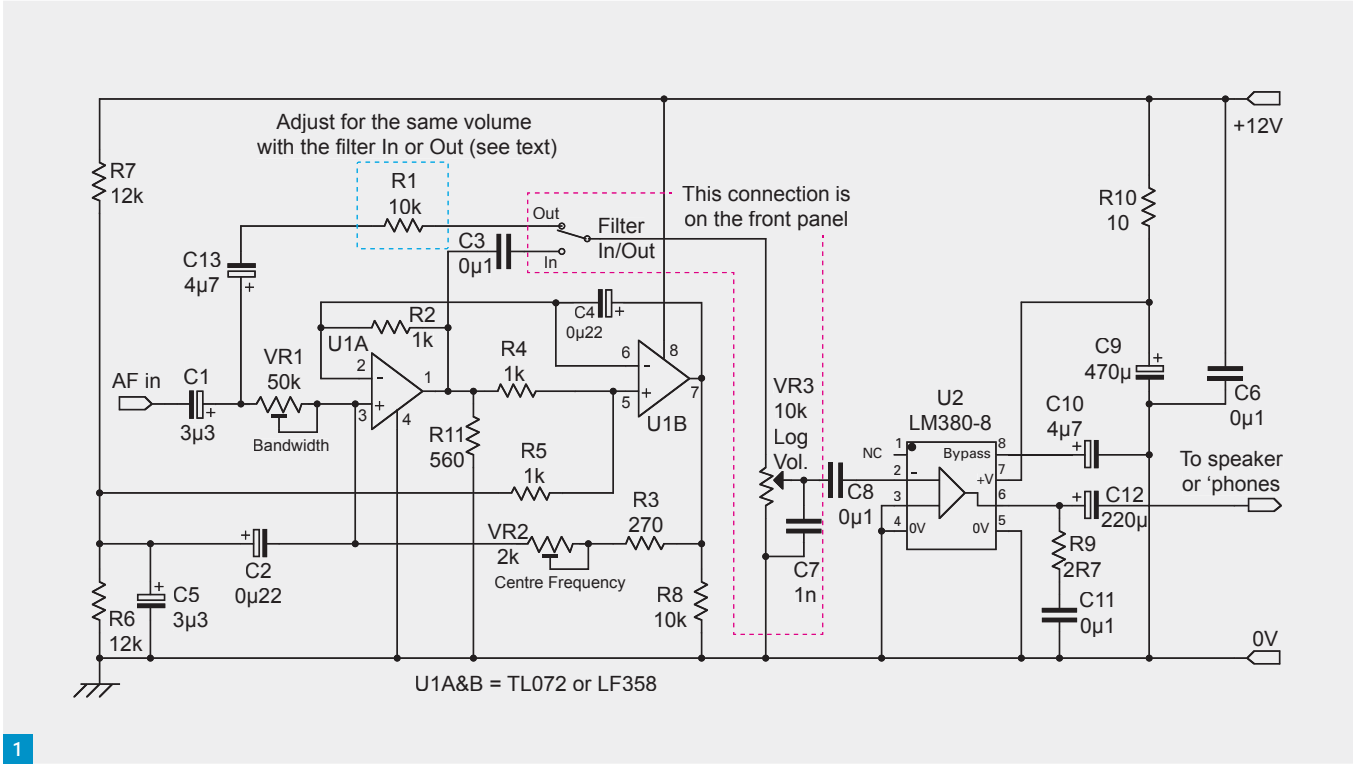
Try and work out from my text and circuit diagrams what that component actually does and whether your substitute might cause damage to other components. It's unlikely but, as a rule of thumb, going bigger is likely to do less harm than going smaller. It's more likely to have an effect on the signal by maybe distorting it or reducing it. I often tack in a pot where a resistor needs to go and then tweak it while watching the result on the 'scope. Don't always 'tune for maximum smoke' either as you are clearly pushing components to their limit. Better to back off a little so components are less stressed. That way they will last longer and keep their same value.

Transistors may be substituted with care. Firstly, an NPN must be substituted with another NPN. The same goes for PNP devices. Next, consider its function. If it's simply acting as a switch, so long as your substitute can handle sufficient current and voltage across it, then it will likely work. Transistors acting as amplifiers need closer consideration. Other parameters such as gain, noise figures, etc come into the equation and in general, unless they are small signal general purpose amplifier type transistors, I tend to use the actual active components the author suggests. A simple device such as a PEAK Atlas component analyser (see URL below) is a great addition to the homebrew shack. Not only will it tell you whether a component has died but also if its parameters come close to what you are expecting.

https://tinyurl.com/3u6xcrjd

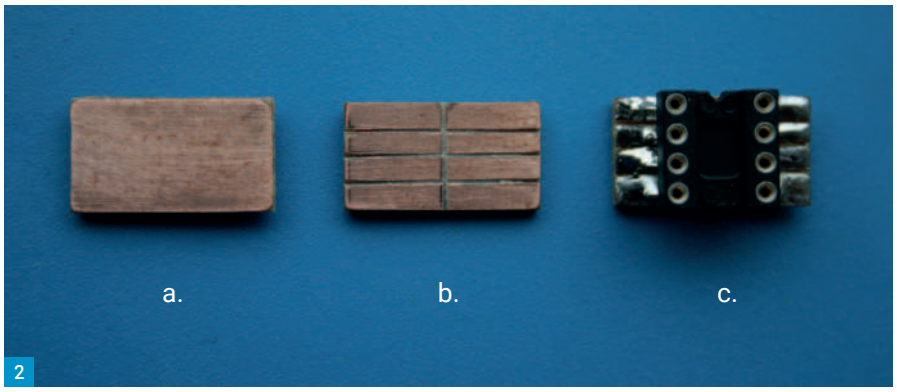
When buying components, do not be tempted to simply get one or two. For instance, in the component list for the audio board there are only two 10kΩ resistors. You are going to need quite a few more elsewhere. If you think you might get into homebrew, then buy a whole selection, 10 of each value from 1Ω to 10MΩ. It's often a lot cheaper to buy in bulk. In time you'll have a great selection of components for your projects. Don't discard the infamous Chinese distributors.

Basic components such as resistors and capacitors are pretty difficult to get completely wrong and they are significantly cheaper from these companies. However, I tend not to trust them for the more expensive RF components such as high-power transistors and the like. Also, if you need tighter tolerance components, you will probably be better off buying from a recognised distributor. It's 'horses for courses' as they say. I tend to buy multi-layer ceramic capacitors, electrolytics and disc ceramics from Chinese distributors and test them before fitting them. I'll get resistor packs off UK eBay suppliers and NP0 capacitors from UK distributors.



1

Fig. 1: Circuit of audio board.
Fig. 2: Creating an 'island' to take an IC.
Fig. 3: The finished board.



2

Manhattan Construction Overview

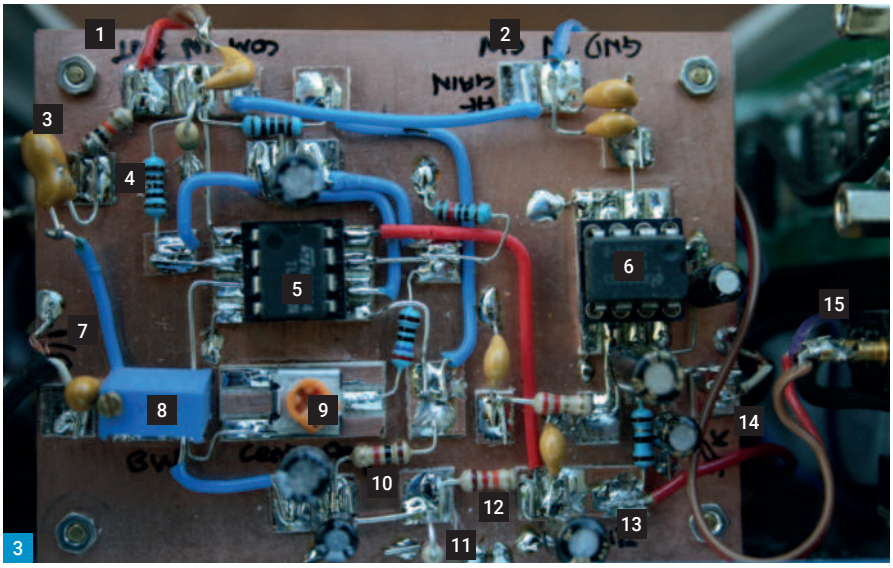
Manhattan construction, in case you didn't realise, is so called because it comprises little islands of copper clad board stuck to a ground plane formed by the main board, resembling the blocks of buildings in Manhattan. These little copper islands are mounted wherever two or more component leads need to be joined. If a component lead needs to go to ground, then you simply solder it to the ground plane. This has the bonus of (usually) keeping RF where it's supposed to be. I sometimes go one step further, as you will see when we get to the transmitter, by constructing mini circuit boards for amplifier stages and the like, simply by removing lines of copper. There are a number of good articles on Manhattan construction but I do like the ones written by **Chuck Adams K7QO**. He's written a good introductory article that is in downloadable PDF format, entitled *Manhattan Building Techniques*.

www.unixnut.net/files/manart.pdf

There's also an article I like by **Jim Giammanco N5IB** on the construction of a precision jig for cutting IC pads. It's also in PDF format and I keep promising myself to make one of these:

https://tinyurl.com/2p9fssd5

The trickiest islands to make are indeed the ones for ICs. Since the audio board requires two, let's bite the bullet and see how these are made first. For an 8-pin IC you will need an island measuring roughly 16 x 10mm. The outer dimensions aren't terribly critical except you don't want to cut much smaller than this. The spacing of the leads on ICs (and most components) is actually measured in 20ths of an inch so we will need to mark our little islands with eight equal pads using something metal and pointy. I'd call this a scribe but you might not have known what I meant so metal, pointy and very sharp is what you're aiming for. Take a look at the pictures of the various stages as I made one. I use a junior hacksaw to cut out the islands (**Fig. 2a**). These are marked out for the IC pins and then using a small, crafting coping saw, cut the copper between the pads (**Fig. 2b**). A junior hacksaw blade is a little too thick for this job. It's a good idea to test the continuity between each pad and its neighbours to ensure you've removed all the copper. Once you're happy with the cuts, clean the copper with some fine emery paper or steel wool. I always use IC sockets as it is much simpler to change the chip in the event of a problem and it's better to mess things up at this stage with a socket than it is with a chip. Bend each leg of the socket by 90˚ and then solder the socket to the island (**Fig. 2c**). I've found the best way to do this is to tin all the pads and the socket feet first. Then I just sweat joint each 'foot' to its corresponding pad. After that I run the scribe between the pads again to ensure there are no whiskers of solder between the pads. It's not a bad idea to check the continuity of each socket pin to the pad



1. To Filter Switch; 2. To Audio Gain Pot; 3. C13; 4. R2; 5. U1 TL072; 6. U2 LM380N-8; 7. Input; 8. VR1 - 50k Bandwidth; 9. VR2-2K Centre Freq; 10. R5; 11. R6; 12. R7; 13. 12V Supply Rail; 14. Output; 15. Filter Switch

Audio Board Component List

Resistors – All Resistors are ¼ or ⅓ Watt Carbon

R1, R8	10kΩ
R2, R4, R5	1kΩ
R3	270Ω
R6, R7	12kΩ
R9	2.7Ω
R10	10Ω
R11	560Ω

Capacitors

C1, C5	3.3µF	Electrolytic or Tantalum 16V
C2, C4	0.22µF	Electrolytic or Tantalum 16V
C3, C6, C8, C11	100nF	Multi-layer Ceramic (104)
C7	1nF	Multi-layer Ceramic (103)
C9	470µF	Electrolytic 16V
C10, C13	4.7µF	Electrolytic 16V
C12	220µF	Electrolytic 16V

Variable Resistors

VR1	10kΩ Miniature PCB pot
VR2	2kΩ 3296 type 10 Turn Pot
VR3	10kΩ Log Front Panel Style Pot (Audio Gain Control)

Semiconductors & ICs

U1	TL072 Dual Op Amp
U2	LM380N-8 Audio Amplifier (DIL 8-pin version)

Miscellaneous

2 x 8 Pin DIL sockets. I prefer the 'turned pin' type.
A small speaker 8 - 16Ω to suit your case. I used a 16Ω 2in speaker. See text.
Single sided Copper Clad Board. I prefer using the 1.6mm board as it is easier to cut. There are many sources but I have found Bowood Electronics (URL below) to be good quality and value. You don't need the photo-etch type as you will simply have to rub that layer off if you do use it. Again, you're going to need quite a lot so if you find a good cheap source, stock up.
https://tinyurl.com/3ra5rjvh
You will also need the usual Manhattan construction supplies; solder, super-glue etc.

and also the isolation from its neighbours. Yes, it's a bit fiddly but trust me, this is the hardest part and like anything else, once you get the hang of it, it becomes easier. You're going to need two IC islands for the audio board.

You're also going to need to cut a few strips of board about 5mm wide. From these you can easily make the little islands you're going to need for regular passive components. For trimpots I tend to make special little islands that match their footprint. I'm sure you'll get the hang of it by studying the photos.

The Main Board

Now let's think about the main board. If you've decided you're up for following my project, case and all, then you'll need two boards that are 75 x 50mm and two boards that measure 100 x 75mm. One of the smaller boards is the audio board.

I always start by drilling the mounting holes: One in each corner. Don't make the same mistake I've made in the past and not left any room for mounting the board, so I now make arrangement for this first. I use small brass hexagonal PCB mountings that have an M2 thread. They come in a kit of different lengths supplied with not nearly enough nuts and screws. If you have an alternative favourite way of mounting your boards, then use that. One advantage to the brass mountings is that the ground plane of the board is electrically connected to the chassis via the screws or nuts.

Now you need to decide where you want the take-off points of the board. By that I mean, what external connections are you going to need and is it important that they are along a particular edge? I have front panel controls for Audio Gain, the Filter Switch plus the headphone socket while at the back there's the input from the receiver board. You'll also need to decide how you're going to get power to it. I mounted my Audio Board vertically so you're looking at the components when you look into the left-hand side of the rig. I mounted the speaker in front of it. I put the output and the supply voltage on the right-hand side of the board, the volume control and filter switch connections along the top and the input on the left-hand side. I usually aim to get the layout of the board close to the flow of the circuit diagram. This makes it easier to understand the board when you come back to it a year or two from now. To this end, I'm going to put the LM380N-8 towards the right-hand side, which will leave the left-hand side of the board for the TL072 and all its associated capacitors and resistors.

Fig. 3 is a close-up of my Audio Board. Note how I've mounted a strip for the power rail, which can power both ICs. It's also a good anchor for the decoupling capacitor C10 and we can take R10 directly from it too. Try not to copy my layout too closely and see if you can work out where you're going to place each component. Glue little islands down with

super glue where you need them. Keep all the component leads you cut off; they make good interconnecting wire between islands. If you end up with a long run, use insulated interconnecting wire to avoid it touching the ground plane or other components. I prefer the solid core type for this purpose as it's easy to bend and shape from one island to the other and it will keep its form. I like to write on the board next to any external connection points so I know where it goes. A fine tip marker with indelible ink is perfect for this.

If you end up misplacing an island you can simply 'pop' it off by twisting a screwdriver under it. You'll need to clean up the ground plane again but this a small price to pay for such a versatile prototyping method.

Once you're happy that your board is complete, check and re-check it. Ensure your IC is fitted with the correct orientation. The little dot is pin 1. Using your DMM check the resistance between the power supply rails. If it reads zero, you've created a short somewhere. When you're happy it's right, connect a speaker, the supply wires to both the positive rail and the ground plane and a short wire on the audio gain wiper connection. When you apply power (12V) and touch the wire tip, you should hear a mains buzz from the speaker. If you don't, re-check your wiring.

There's plenty of room on the audio board. Try not to copy my layouts too closely. It's much better to work it out for yourself so you learn how to construct boards from circuit diagrams. When we come to make the VFO in Part 3 you'll see my layout is a right bodge. This is because I changed it so many times. Was I to construct it again I'd do it quite differently. I still intend to provide a photo because this is a 'warts and all' type of article but please do not copy it.

Testing

Hopefully, you've got the audio board completed so let's test it. If you have an audio signal generator and you're used to using a 'scope, then I doubt I need to tell you how to test it using those so let's talk about another way, using the audio from the headphone socket of your shack rig.

You'll need to make up a cable that will feed the headphone output of the rig to the input of the audio board. Set the rig to SSB, switch out all the filters and tune to the bottom end of 40m, or some other open band so you can receive some CW. With no filters you might be hearing more than one station. That's ideal for testing your audio board. Keep the volume of the rig very low. We don't want to overload the audio board. Ensure the filter is switched out, the audio control of the board about a quarter up and apply power to the audio board. You should hear sounds very similar to what came out of your rig. However, the quality won't be nearly as good with the speaker on the bench. If you don't hear anything, try increasing the rig volume a little. Once you can hear your CW signals again it's time to switch in the filter. There should be a considerable reduction in noise. While you're listening you can experiment with the centre frequency and bandwidth pots until you've got them in a comfortable listening position. If they're set correctly, your wanted signal should be loud but any adjacent signals will be much reduced. Switch the filter in and out and hear the difference.

Congratulations, you've finished the audio board. Put it somewhere safe because in Part 3 we're going to tackle the all-important VFO board.

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Regular FM activity

Tim Kirby GW4VXE has a first listing of regular UK VHF/UHF nets.

Tim Kirby GW4VXE
longworthtim@gmail.com

Last month, I asked you for details of any regular VHF/UHF net activity so that I could start including a list of nets in the column. My hope is that it may give newcomers (and others) something to listen for on VHF FM at a given time and frequency, rather than switching on, tuning across the band, finding it dead and then switching off again.

The response has been excellent. I'm very pleased to be able to include the first version of the list in this month's column, **Table 1**. The nets included so far are from people that wrote in response to my request for info last month, along with a few clubs that I've recently been in touch with.

As I've written this up, it's clear that there is some complexity with, for example, some clubs having nets every other week, or one week the net is on Fusion and the next it's on D-STAR. Without taking up a lot of space, it's hard to represent this, so I have tried to do my best in the space available. If you're not sure, hopefully searching for the club website with the information shown in the description will help. At least you'll know something is happening. If your club doesn't have a net listed here, please drop me an email with the details and I'll be delighted to include it. I'm keen, if we can, to get a wide geographical spread of information, so that wherever you are, you stand a chance of hearing something! For the time being at least while the list is still growing, I'm planning to be publishing the information on a monthly basis.

One or two people that I corresponded with about the nets said, quite rightly, that it wasn't all about nets and that people should remember to call CQ on FM. It's surprising how many people are listening and you never know who will call you. And if you hear a CQ, try to make it a rule that when you can, answer the CQ – even if it's just a quick QSO. It could make all the difference to someone's operating experience that day.

The 6m Band

Roger Greengrass EI8KN completed some 6m meteor scatter (MS) QSOs during the Geminids meteor shower between 10th and 14th December, working DL0HEL (JO50), PF7DKW (JO21), OZ1DJJ (O55), ON7EQ (JO21), SP2ERZ (JO94), EA2B (IN91), S59A (JN76), SP6CPH (JO81), PA3GCV (JO32), G0DLV (IO70), DK2OY (JO44), EB1DJ (IN52) and CT1DIZ (IM58). I was interested to read that Roger also made some Q65 QSOs on the band, working GM0SCA (IO85) and GI0OTC (IO65).

Looking back through his 2021 log, **Jef VanRaepenbusch ON8NT/OS8NT** (Aalter) worked 59 DXCC countries on the band, running 10W to a V-2000 vertical.

The 4m Band

Jef ON8NT worked 17 DXCC countries on the 4m band during 2021, using 10W to his V-2000 antenna.

Roger EI8KN caught a little MS activity during the Geminids, working DL6BF (JO32), DL8BDU (JO43) and LA4YGA (JO48). During the Quadrantids, Roger worked OK2ZAW (JO80) and OZ1JXY (JO46)

The 2m Band

Simon Rodda G4PEM (West Cornwall) was pleased to work a couple of SOTA stations on 2m FM during December, one on Snowdon and one near Leek in Staffordshire. Very good distances on FM. It just shows what a good site can do (at both ends!). On FT8, the highlights of Simon's log were EA1M (IN53), F6KHM (IN78), F4HBY (IN97) and F5DYD/P (JN03). Simon says that he could hear F5DYD/P on 70cm, but sadly could not attract his attention. Simon also notes that on FT8 he quite often sees one period decodes of very distant stations. Initially he wondered whether they were false decodes, but after investigating on PSK Reporter, realises that they are genuine decodes. They're most often, although not always, meteor reflections – Simon received this type of signal from OM2RC (JN88), DG7CAH (JN58), OY1OF (IP62), OK7SE (JN79), I6/IZ8EFK (JN63), EC2BBS (IN93), SP9DWV (JN99), IV3BLQ (JN65), OE6IWG (JN77),

Fig. 1: ZB2GI's setup used for receiving the SSTV pictures from the International Space Station.
Fig. 2: Endaf N6UTC making satellite QSOs from the Mojave Desert.
Fig. 3: Arizona sunrise from the DM22/DM32 line, pictured by Patrick WD9EWK.
Fig. 4: Trying out G4DHF's dual-band Moxon design on AO-91 from GW4VXE.

SN0N (JO73), IZ1MHO (JN45), IV3BLQ (JN65) and 9A2AE (JN86). Simon found the late November tropo event a good one and worked a lot of new squares while hearing stations well out to the east in the Czech Republic and Austria.

David Johnson G4DHF (Spalding) writes, "*Last night (16 December) I closed down the G4DHF station, went into the lounge and worked as G6LI with the antenna outside the window at 10ft fixed South. I did run QRO with a massive 28W leaving the shack and had a ball! I was easily able to break the 1000km barrier and worked, EA1G (IN53) 1125km, EA1JH (IN53) 1161km, EB1FNS (IN73) 1110km and EA2XR (IN83) 1077km as well as stations in IN95, JN04 and JN03*". David was using the portable 2m Moxon, which you'll read about elsewhere in this issue.

Writing later in the month, David says, "*I was watching with interest as stations on the Western side of the UK were working some remarkable distances on 2m and 70cm tropo. The long DX was often weak and unstable with me as I was not always coupling into the tropo duct effectively. As the high pressure and duct moved eastwards on 22nd, all that changed and it was nice to work into I2, which is something quite rare as the airmass around the Alps often blocks signals propagating further. I worked ten Italians in JN45 and JN44 using FT8. It was particularly pleasing to work I2FAK (JN45) 1108km, I2XAV (JN45) 1093km and IZ2XZM (JN45) 1070km on CW, all with good, consistent signals*".

Simon Evans G6AHX (Twyning) enjoyed the opening to the south on 16 December, working EA1HRR, EA2XR and EA1MX all on the north coast of Spain in IN73 and IN83, as well as a number of stations in France, the best being F5ICN (JN03) in the Pyrenees. During an opening on 14 January, Simon worked PE2JB (JO22), ON4MPA (JO20) and DL1KFS (JO30).

Tony Collett G4NBS (Cambridge) said that the December tropo opening was a great reminder to him of why he fell in love with VHF/UHF all those years ago. He says he worked many areas that he hasn't managed in a very long time and, thanks to FT8, in a quantity never seen at the height of activity – all that despite Tony's severe noise levels. During the period of 15-22 December, Tony


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made 118 QSOs in 56 squares in 15 DXCCs. He worked stations in G, GD, GI, GJ, GM, GW, DL (19), EA (8), F (43), HB (14), I (7), LX, ON, OZ and PA (10). Almost all of the contacts were on FT8, but F5ICN (JN03) F4EZJ (JN05), HB9SJV (JN36) and F0DBU (IN98) were all worked on SSB.

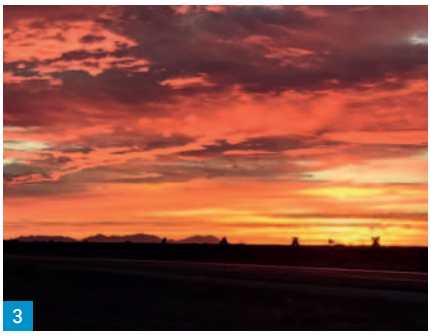
Tony says it was the first time he had worked Italy on tropo and that five Italian stations called him after he had struggled with the first one! Best DX was IK4CBO (JN54) at 1118km.

During the Geminids meteor shower, Roger EI8KN made some nice QSOs between 12 and 15 December, working EC2BBS (IN93), IW2EQR (JN45), F1HQM (JN23), CT2HXM (IN60), SM6TZL (JO67). Roger enjoyed the December tropo too, making many excellent QSOs, although the highlight must be some QSOs into Italy on 16 December: IZ2MHO (JN45) and I1FAK (JN45). During the tropo in January, Roger worked into western and southern France, with the best being F5DYD/P (JN03) on 15 January.

During the December tropo, Jef ON8NT made many FT8 QSOs to France, Spain, Isle of Man, Eire and Northern Ireland

Kevin Hewitt ZB2GI (Gibraltar) worked four stations during the Geminids meteor shower, running 50W of FSK441 to a 5-element Yagi. Stations worked were G1KAW (JO00), F6GRA (JN04), IW4ARD (JN64) and PA5Y (JO21).

Roger Daniel G4RUW (Newbury) found conditions good on 16 December, working EI3KD (IO61), EA1HRB (IN83), F6FUJ (IN96), GD6ICR (IO74), EB1G (IN73) and F5MVK (IN97). On the 22nd, Roger worked HB9TQJ (JN37) and PA2MD (JO22). Roger says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that he could see the Italian stations being worked, but they were not 'audible' at his location.

Ian Bontoft G4ELW (Bridgwater) was active on 16 December too, working G0CNN in Darlington, EI3KD, F6DBI, EA1HRR, F4GWG and EA2BHE. Ian runs 15W of FT8 to a V-2000 on the Somerset levels.

Richard Brooks GW1JFV (Haverfordwest) enjoyed the December tropo, working a good number of Spanish and French stations, including EA1HRR, EA1UR, EA2XR, EB1B, F0GOW, F4BKV, F4FGN, F4FRG, F5APQ, F5HIJ, F5MYK, F5RD and F5SRH. HB9TQJ was also worked. Richard runs a modest 2-element quad and 50W and says that the FM part of the band was also very lively during the opening.

Tim Hague M0AFJ (Helston) says that things have been fairly quiet, but the best of the tropo for him was on 20/21 December when he worked DK0A (JN48), F5DYD/P (JN03), HB9DFG (JN37), F1NZC (JN15), F6GRA (JN04), F4HER (JN06), F5NTD (JN25), ON7AVL (JO20) and F5JGL (IN95).

Here at **GW4VXE** (Goodwick), things were good to the south from 15 December onwards, with plenty of French and Spanish stations worked. Highlights were F4VTP

Day	Time (local)	Frequency	Description	Area
Every	0810	145.400	Cheltenham ARA	Glos
Every	0810	GB3CG	Gloucestershire activity	Glos
Every	0830	145.450	Norfolk activity	Norfolk
Every	1030	145.450	Ayrshire ARG	Scotland
Every	2000	GB3NE	Newbury area	Berkshire
Every weekday	AM	70.475	Manchester area 4m FM	N West
Every weekday	1530	145.325	South Essex ARS	Essex/Kent
Sunday	0830	50.220 USB	Cheltenham ARA	Glos
Sunday	1100	GB3DN	Appledore RC	Devon
Sunday	1800	144.550	Bury RS	N West
Sunday	1930	145.450	Ayrshire ARG	Scotland
Sunday	1930	MB7INP	Pembrokeshire Radio Society	Wales
Sunday	2000	433.450	Horndean and District ARC	Hants
Monday	1100	GB3DN	Holsworthy RC	Devon
Monday	1930	GB3DN	Holsworthy RC	Devon
Monday	1930	145.400	Bromsgrove ARC	Worcs
Monday	1930	GB3NB	Norfolk ARC	Norfolk
Monday	2000	144.6125	Oldham ARC Fusion/D-STAR	N West
Monday	2000	433.450	Nunsfield House Amateur Radio Group	Derbys
Tuesday	1600	145.575	Afternoon Tea Party Net	Essex/Kent
Tuesday	1900	145.450	South Normanton, Alfreton and District RC	Derbys
Tuesday (2)	1930	145.550	Stockport RS	N West
Tuesday (2)(4)	1930	145.525	Mid Ulster ARC	N Ireland
Tuesday	2000	144.550	Bury RS	N West
Tuesday (4)	2000	GB3DA	South Essex ARS Monthly	Essex/Kent
Tuesday	2030	145.300	Bushvalley ARC	N Ireland
Wednesday	1100	GB3DN	Holsworthy RC	Devon
Wednesday	1930	145.400	Bromsgrove ARC	W Mids
Wednesday	1930	145.375	Horndean and District ARC	Hants
Wednesday	1930	GB3MR	North Cheshire RC	N West
Wednesday	1930	MB7INP	Pembrokeshire Radio Society	Wales
Wednesday	2000	145.425	Oldham ARC	N West
Wednesday	2030	1297.500	Manchester area 23cm FM	N West
Thursday	1930	GB3MR	Stockport RS	N West
Thursday	2000	145.300	Nunsfield House Amateur Radio Group	Derbys
Friday	1100	GB3DN	Holsworthy RC	Devon
Friday	1600	145.575	Afternoon Tea Party Net	Essex/Kent
Friday (!)	1900	144MHz	GI on the air (SSB or any mode on 2m)	N Ireland
Friday	1930	145.400	Bromsgrove ARC	W Mids
Friday (2)	2000	145.425	Oldham ARC	N West

Table 1: VHF/UHF Nets known to be active around the UK.

(JN14), F6GRA (JN04) and F1HFW (JN03). Try as I might, I just couldn't complete with F5DYD/P (JN03). I enjoyed the Geminids meteor shower, working EA1BHB (IN82), F4CWN (JN03), CT2HXM (IN60) and EA4HFK (IN80) all on MSK144 on 13 December. The Quadrantids though, was a complete non-event here, with no period of sustained good reflections noted. Perhaps I listened at the wrong time.

The 70cm Band

David G4DHF was testing his new portable 70cm Moxon antenna during the UK Activity Contest in December and heard F1BHL/P (IN99) with the antenna inside at 5ft above ground and says that he worked a station in IO94 with 2.5W from the FT-818. David writes, *"On the 20th, I connected the 70cm Moxon to the G6LI station and am pleased to report that I worked beyond 1000km running just 6W on FT8! The DX included, EA2XR (IN83) 1077km, F5DYD/P (JN03) 1069km, F6CIS (IN94) 931km, F6APE (IN97) 612km and F1DUZ (IN97) 608km".*

Tony G4NBS made 93 QSOs in 46 squares and ten DXCCs during the December tropo, working G, GJ, GM, DL (14), EA (6), EI, F, (44), HB9, ON (4) and PA (12). Once again, most contacts were on FT8 although SSB contacts were made with F6CIS (IN94), F5ICN (JN03), F4IAA (JN05), F4EZJ (JN05) and F5DYD/P (JN03). There was even some CW, with a contact with F4BKV (IN95). Best DX was EC1AP at 1052km but HB3YFC was Tony's first Swiss station on the band in over eight years.

During the 70cm FT8 Activity on 12 January, Tony worked 74 stations in 28 locators. Highlights were G7RAU (IN79), M0AFJ (IO70), EI8KN (IO62), GI4SNA (IO64), GM0EWX (IO67), GD6ICR, GI6ATZ (IO74), GM4CXM (IO75), GM0HBK (IO77), GM4FVM and GM8MJV (IO85). To the east, Tony saw DJ5AG (JO51) and DL1DBR (JO41) but couldn't raise them, so the best were DL5FN and DL2W both in JO40. OV3T (JO46) was worked just after the end of the contest.

The highlights of Jef ON8NT's log from 16 December include F6CIS (IN96), F4BKV (IN95), EI8KN (IO62), F6HRO (IN88), F8DBF (IN78) and F6GLQ (IN89), all on FT8.

Ian G4ELW decided to try 70cm FT8 using 15W to his vertical for the first time during the tropo event on 16 December. His log is inspiring to those of us who haven't got around to trying out simple 70cm FT8 just yet. Ian worked F4IAA, EA1U, F8DLE, GM3SEK and EA2XR. He says, "*Looking at the map there was a definite line from GM*

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Geoff Theasby G8BMI
geofftheasby@gmail.com

RF Spectrum Analyser and Dummy Loads

Geoff Theasby G8BMI covers two very different topics in this month's column.

For years, a spectrum analyser was an unobtainable item of test equipment for radio amateurs, due to the expense. While less sophisticated units have appeared of late, there hasn't been one for the experimentally minded to get to grips with.

Until now. There have been software versions, operating at audio frequencies, and later, SDR receivers that were capable of operating at real radio frequencies but again restricted by the desktop computer's limitations.

The LTDZ module (eBay and elsewhere) is a genuine RF spectrum analyser, with a tracking generator, even though it does not meet all the claims made for it, but then, it only costs about £30!

Background information suggests that suitable software is WinNWT/LinNWT4000, and that it will work on Windows and Linux operating systems. I spent several days trying to find this, tracing it back to DL4JAL but found no trace of the software itself. There are several attempts at user notes-cum-manual online. Eventually, <Sigh> I found that **Vitor CT2JSA** has the current software, NWT5.

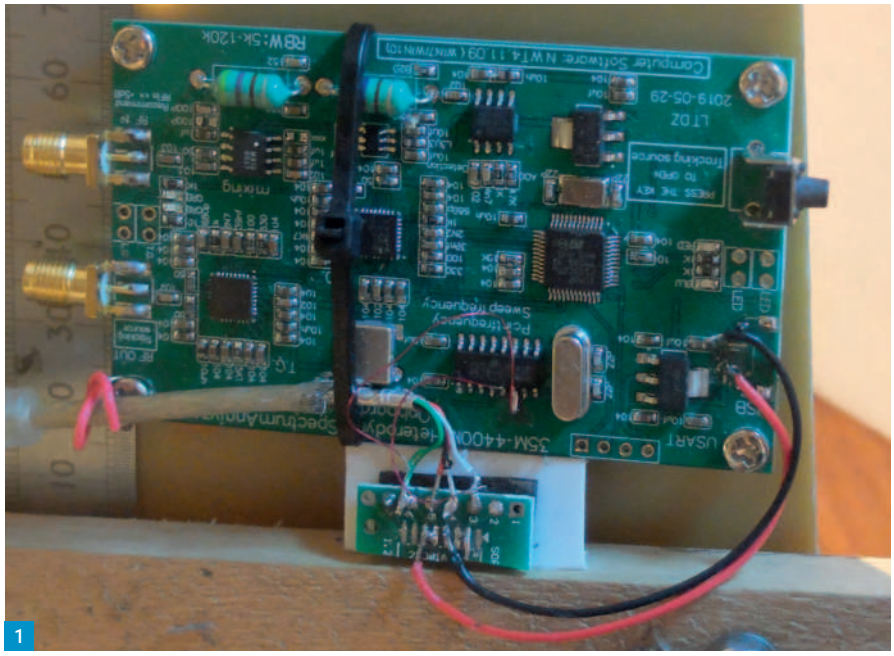
This is Windows only, there is no Linux version now. Download it, requesting the appropriate licence, and Go!

In preparation for testing, the USB socket ripped away from the PCB, due to poor soldering in the factory, **Fig. 1**. I managed to retrieve the situation with the aid of a microscope (*PW* Aug 2020) and miniature soldering iron (*PW* Nov 2019).

Plan A was to resolder the socket and reconnect using 36g wire. Plan B was better, with the socket mounted on an SOP10 (0.5mm spacing) carrier PCB intended for replacing conventional 0.1in pitch DIL ICs, cutting it in half lengthways to get close to the pins, **Fig. 2**. Sleeping on it, Plan C was conceived, abandoning the mini-USB socket in favour of a Type A USB plug-to-bare wires converter soldered to the easiest reachable points on the PCB, via the above half-PCB as an outboard rigid base to solder the tiny wires.

This worked very well, **Fig. 3**. Meanwhile, back at the bench… the Manual from DL4JAL is not very good. CT2JSA's is better, in my opinion...

Having acquired the activation code from Vitor, I tried to set it up on a Windows 7 machine, but had further unrelated problems. Finding no answers online, I put it to one side, pro tem.



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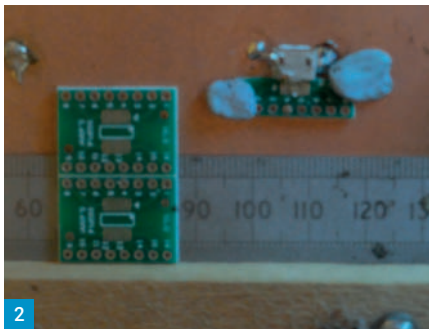
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Dummy Loads

Reading up on another subject entirely, I saw mention of dummy loads and how they behaved at VHF. This led me to check my own collection, using the NanoVNA I bought a few months before.

Received knowledge states that ordinary power resistors are inductive, even the metal-film types, which are factory trimmed by cutting a spiral into the resistor body. If so, it does not seem to be a problem on HF, in practice, in most cases.

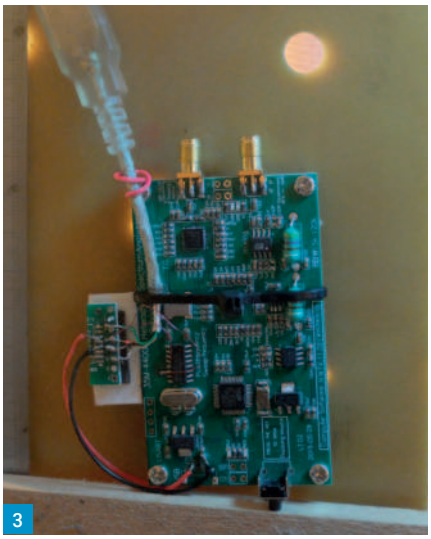
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Fig. 1: The PCB, USB location at bottom right. Fig. 2: Interim solution, USB socket on daughter board. Fig. 3: Finally! Fig. 4: PL259 version. Fig. 5: 25W/BNC/SMA types. Fig. 6: 120W dummy load and power meter.


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The following are all coaxial, as used by most radio amateurs. There is no reason for them to be so in a circuit board, especially when using surface mount components, where their small size allows operation up to very high frequencies.

First, I tested 'Old Faithful', a dummy load I made 40 years ago by soldering a 3W metal film resistor into a PL259 plug, **Fig. 4**. Results are 1:1 up to 25MHz, falling to 1.7:1 at 150MHz.

A BNC termination was next, from a piece of test equipment. 1.2:1 up to 200MHz.

An SMA termination supplied with the VNA, 1:1 up to 500MHz.

A commercial 25W dummy load, 1.95:1 at 150MHz, **Fig. 5**.

And finally, my bench dummy load rated at 120W, 1:1 up to 20MHz, deteriorating to 5:1 at 30MHz, **Fig. 6**.

Continued from page 52

to EA including the French stations worked, which I presume was the duct providing assistance".

The 23cm Band

Roger EI8KN made some FT8 QSOs during the December tropo, working F4BKV (IN95), DF2VJ (JN39), G3XDY (JO02), all on 16 December. Roger worked F6DBI (IN88) on SSB on the same day.

Tony G4NBS mentions that the FT8 Activity sessions on the band will not just be FT8 but can include all data modes. It will be interesting to see what mode the activity settles on. We should know more next month.

Steve Macdonald G4AQB (Bolton) writes,"*Tropo conditions were excellent here on 23cm during the final UKAC just before Christmas. The band was very active with stations from the south coming in very strong. As well as working many UK stations, I managed to work three French stations F6APE (IN97), F1BHL/P (IN99) and F4BKV (IN95) all with just 2W. Although openings on 23cm are rare at my location, when it does happen the band really shows what can be done".*

Satellites

Jef ON8NT monitored ARISS contacts on 10 and 16 December and received SSTV from the ISS during the period 26 to 31 December. On RS-44, using FT4, Jef worked G4PEN (IO93), GJ6WRI (IN89), AK3Y (FM19) and AC9DX (EN45).

Kev ZB2GI also mentions receiving the SSTV images from the ISS between 26 and 31 December, **Fig. 1**, as does **Phil Oakley G0BVD** (Great Torrington).

Patrick Stoddard WD9EWK (Phoenix) has been out on the road again and writes, *"In mid-December, I made my first multi-day road trip over to southern California, helping **Endaf N6UTC/MW1BQO** make contacts in different grids on some VHF/UHF bands, plus a road trip to the northern end of the Mojave Desert for the DM15/DM16 grid line north of Los Angeles.*

"Endaf asked me if I would be interested in helping activate the DM15/DM16 grid line in mid-December when the Mojave Desert isn't hot. In fact, the temperatures out there were below freezing around sunrise. We drove toward the town of Trona, and both of us set up stations on that grid line. N6UTC worked FM satellites with a Kenwood TM-V71A and Elk log periodic antenna (**Fig. 2**). *WD9EWK was on SSB satellites with a Yaesu FT-817 and Icom IC-R30 receiver, along with an Elk log periodic. WD9EWK also had an Icom IC-W32A, ready for action on FM satellite passes. On previous trips out there, N6UTC was close to having 100 confirmed grids via satellite for a VUCC award.*

"Once we got out to the grid line and took pictures to document our stations on the DM15/DM16 grid line, N6UTC was ready to work an AO-91 pass that covered most of North and Central America. As N6UTC was on AO-91, I worked an XW-2A pass, followed by a JO-97 pass. N6UTC had more 'customers' on AO-91 than I had on the two SSB satellite passes, but we were both making satellite operators happy with being active from two rarely-heard grids.

"On a western AO-91 pass late that morning, I joined N6UTC with my IC-W32A and Elk log periodic. Endaf was hoping to confirm both DM15 and DM16 while he was operating from that area, and we targeted that AO-91 pass to make the contact. We worked each other early in the AO-91 pass, and then we both worked other stations along the US west coast. N6UTC worked one more pass, on PO-101, before we left the area.

"On our way back to Los Angeles, we stopped at the DM05/DM15 grid line for an SO-50 pass. N6UTC went the air, working one station and hearing another station, on a pass that went down the US west coast. Later that night, when we uploaded our logs to Logbook of the World for the DM15/DM16 trip, N6UTC had confirmations for 100 grids from the Mojave Desert via satellite. Mission accomplished! [Llongyfarchiadau Endaf!]

"One of my recent trips around Arizona took me to the DM22/DM32 grid line in southwestern Arizona. I drove out there in darkness, arriving just before sunrise (**Fig. 3**). *While waiting for the first satellite pass, I took some photos of the eastern sky. After sunrise, I started with an AO-27 pass, and worked over a dozen passes in FM and SSB during the next few hours. Many stations thanked me for the new grids, that's what makes the trips to these spots worth it for me.*

"I am looking forward to hearing the new satellites with FM repeaters that were just launched on a SpaceX Falcon 9 rocket. The group of eight TEVEL satellites from Israel, along with EASAT-2 and HADES from Spain, could be interesting for satellite operators. I understand that only one of the TEVEL satellites should have its FM repeater activated at a time, as all eight satellites are using the same uplink and downlink frequencies for their FM repeaters".

Not many satellite QSOs at GW4VXE this month, although it was fun testing the new dual-band 2m/70cm Moxon kindly sent by David G4DHF, **Fig. 4**, on AO-91. On a 1° pass, on 17 December, I worked VE1CWJ (FN75) and G0ABI (IO80).

Rallies & Events

Due to the ongoing Coronavirus situation, the calendar remains very changeable at the moment, and there will be more cancellations and postponements. Information published here reflects the situation up to and including 21st January 2022. Readers are advised to check carefully with the organisers of any event, before setting out for a visit. The Radio Enthusiast website will have updates, please check here regularly. To get your event on this list, e-mail details as early as possible: **wiessala@hotmail.com**

10 February
AMERICAN RADIO RELAY LEAGUE (ARRL) NATIONAL CONVENTION: Orlando, Florida 32821, USA. (See also next entry)
www.arrl.org/arrl-expo

11-13 February
ORLANDO HAMCATION: Central Florida Fairgrounds and Expo Park. Second-largest ham radio convention in the USA. More than 65 commercial traders, a huge boot sale area, US ham license tests. HamCation is also excited to host the ARRL National Convention.
www.hamcation.com
www.arrl.org/arrl-expo

20 February
RADIOACTIVE FAIR: Mid Cheshire ARS; Nantwich Civic Hall, Cheshire CW5 5DG (BB | CR | D | FP | RF | RSGB | TS).
https://midcars.org
http://www.radioactivefair.co.uk

5 March
LAGEN VALLEY ARS RALLY: Hillsborough Village Centre, 7 Ballynahinch Road BT26 6AR. Doors open at 11 am. Covid restrictions permitting. Please check before travelling.
www.lvars.uk

6 March
EXETER RADIO & ELECTRONICS RALLY: America Hall, De La Rue Way, Pinhoe, Exeter, EX4 8PW.
g3zvi@yahoo.co.uk

13 March
HAMZILLA RADIO FEST: Discovery Science Park, Gateway House, Ramsgate Road, Sandwich, Kent CT13 9FF. Tickets are available now from £3/ Tables £12. Those who bought tickets and tables in advance will have their booking carried forward to Hamzilla 2022. .
https://hamzilla.uk

27 March
CALLINGTON ARS RALLY: Callington Town Hall; More information from Roger, 2E0RPH.
Tel: 0785 408 8882

9 April
YEOVIL ARS 36TH QRP CONVENTION: The Digby Hall, Sherborne, Dorset, DT9 3AA. Doors are open from 09:30 am to 2:00 pm; Admission is £3. No dogs except guide dogs. (BB | TS | Club Stall). Supported by RSGB, RAFARS & BYLARA.
https://tinyurl.com/fyj9vtca

24 April
CAMBRIDGE REPEATER GROUP RALLY: Foxton Village Hall, Hardman Road, Foxton, Cambridge, Cambs CB22 6RN; Doors open at 9.30 am for the public (7.30 am for traders). Admission is £3. (BB, CBS, CR, TI, TBS).
rally2022@cambridgerepeaters.net
www.cambridgerepeaters.net

1 May
NARSA (NORTHERN AMATEUR RADIO SOCIETIES ASSOCIATION) EXHIBITION: Norbreck Castle Exhibition Centre, Blackpool FY2 9AA
Tel: 01270 761 608
dwilson@btinternet.com
www.narsa.org.uk

2 May
DARTMOOR RADIO RALLY (BANK HOLIDAY MONDAY): The Yelverton War Memorial Hall, Meavy Lane, Yelverton. Devon, PL20 6AL. Doors open at 10 am and admission is £2.50 (BB | CR | FP | TS).
Roger, Tel: 07854 088882
2e0rph@gmail.com

7 May
CDXC DX CONVENTION 2022 (LOUGHBOROUGH)
http://www.cdxc.org.uk
https://tinyurl.com/3tfetch5

BB Bring-and-Buy **CBS** Car Boot Sale **CR** Catering /Refreshments **D** Disabled visitors **FP** Free Parking **L** Lectures **RF** Raffle **RSGB** (RSGB) Book Stall **RU/PW** RU/ PW in attendance **SIG** Special-Interest Groups **TI** Talk-In (Channel) **TS** Trade Stalls

Daimon Tilley G4USI
practicalwireless@warnersgroup.co.uk

1

Linear Amplifiers

Daimon Tilley G4USI looks at a selection of amplifiers, both HF and VHF, available for budget prices.

As we continue to build our budget station, this month I turn my attention to linear amplifiers. But before we get into the meat of this and look at options, we should first consider why we might wish to own such a device.

In order to do this we should first of all consider our antennas and our preferred operating modes. Regarding antennas, I would strongly encourage readers to consider whether just pumping more power into their existing antenna is the best way forward. I am going to give an example at VHF frequencies because directional antennas at these frequencies are smaller, cheaper and better suited to urban gardens, etc.

Let us assume that we are using a 2m rig putting out 20W of RF power into a collinear antenna. A typical 3m tall 2 x 5/8 wave collinear will have a gain of about 3.8dB (x2.4) over a dipole. I am going to assume the coax run is short and therefore ignore coax loss.

In this case (in a perfect world!) your antenna is giving your 20W multiplied by a gain factor of 2.4, or delivering 48W of Effective Radiated Power (ERP). This power is evenly spread in all directions. Now, we could attach a linear amplifier but, when purchased new, these are not typically very budget priced. A new Microset VHF linear that will take your 20W of drive and deliver 200W of output is going to set you back about £450.

Instead of adding a linear though, we might choose to spend about £80 on a decent quality Yagi beam antenna (plus the cost of a rotator too, unless using the 'Arm-Strong method'). I always take manufacturers' claims a little sceptically, but a ZL7 Yagi with seven elements and just 170cm long, has a claimed 11.5dB gain over a dipole.

This amounts to a 14.1 times increase in power, or it turns our 20W into a little over 280W! Not only that, but it puts those 280W in the direction you want it, focussing that power to achieve greater distance.

Of course, if we fed such a Yagi antenna with our 200W linear amplifier, then multiplying that by 14.1 gives us an ERP of about 2,820W!

All I am trying to demonstrate here, is that in terms of 'bang for your buck' and overall effectiveness, always do your best to have the most efficient antenna you can in the first instance. An £80 Yagi for the 2m band is both more effective, and more cost-effective, than a £450 linear amplifier. This applies at every frequency you wish to operate.

Of course, we live in the real world and many of us are very limited for garden space in the UK, or we may need to have a discreet antenna for the sake of family and neighbourly harmony, so adding more power to our existing antenna might be the best we can do to try to gain greater DX.

Let's then take a look at how we can achieve amplification on a budget.

VHF/UHF

When I was first licensed in the early 1980s, VHF rigs often had rather low output power. Usually this varied between 1W for portable equipment (my old TR-2300, for example) and 10W for mobile/base station rigs.

Indeed, my venerable Kenwood TS-700, which I am listening to as I write this, is a very considerable size and weight but only puts out 10W.

By contrast, modern rigs are much more powerful. It is not uncommon to find mobile rigs capable of 80W or so. I have a Yaesu FT-2980 in my vintage Land Rover that is capable of 80W. With powers like this, you may well not feel the need for a linear at all. But what options are available to you if you are using lower powered equipment? The answer is that on the 'new' market there are fewer options than there used to be. This is a direct result of more modern, higher powered transceivers being available as well as declining use of VHF/FM traditional modes.

In these circumstances, my best advice is to look to the second-hand market. Two big names from the eighties were Microwave Modules and BNOS. Lots of these amplifiers were sold and a number of different power outputs were available from low drive levels.

A couple of years ago I was on the hunt for a linear to be driven by my TS-700's 10W when I found the perfect match for sale on a social media site. It was a BNOS amp, **Fig. 1**, with built-in pre-amp and was designed to provide 180W of RF output for 10W of drive on FM or SSB. The seller, in Wales, was a fellow amateur who was honest enough say that the power output was more like 130 than 180W. We agreed a price of just under £100 posted and it works very well for me, although it is a large piece of gear.

Other VHF options in this range, currently advertised for sale online, include:

- BNOS: 50W out for 1.5 – 3W input, £59
- Tokyo Hy-Power: 30W out for 1-5W input, £59
- Naval Electronics PV-35R: 35W out for a couple of watts input, £50.
- Daiwa LA-2080H: 80W out for 5W in, £100

On the new market, prices seem high. The Mirage B-1018G costs £700 to deliver

Fig. 1: The author's BNOS 180W 2m amplifier.
Fig. 2: The WA3TFS linear amaplifier.
Fig. 3: The 10W amplifier from QRP Labs.
Fig. 4: Chinese made MX-P50M amplifier.

up to 200W from 10W of drive and the Mirage B-310G can deliver up to 100W for £450.

The RM Italy RMLA145 delivers 85W for up to 4W input and their RMLA250 claims to deliver 200W for 1-20W input at £499. Zetagi market an LA0545V, which claims 45W output for 3W of drive at £100.

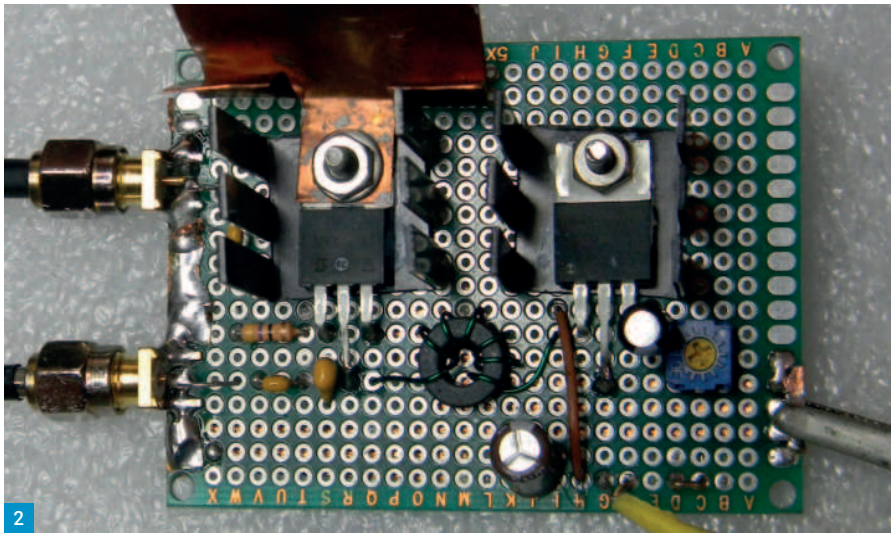
I would just urge a little caution with this cheaper end of the new market. You should ensure that the amplifiers have sufficient filtering and protection circuitry as this is often minimised or non-existent in some of these models. In my personal experience, I sadly cannot recommend the RM Italy amplifiers. I have had a total of three at HF, mostly for experimentation, and all failed fairly quickly despite proper care in both driving them and SWR. The fact that some of the re-sellers of these amplifiers now also advertise replacement transistors is a bit of a clue. Of course, my experience may not be typical.

At UHF, with a little help from Google, I found a couple of Alinco ELH-730G linears that will provide 30W out for 3W in at £48. I also came across some products I had not heard of before. On eBay I discovered a Vero VR-P25DU amplifier, which looks very interesting. You connect it to a handheld radio and it provides up to 30W output for 2-6W of input and works with FM and digital radios. This could be a neat option for using a cheap handheld in a vehicle or as a base station.

HF (up to 100W)

I am going to split the HF category into two parts, up to 100W and over 100W. The reason for this is that at *On a Budget* levels many might be using homebrew, kit or commercial QRP rigs, with outputs from typically a few hundred milliwatts (homebrew) to 5 or 10W.

For QRP levels there are a number of options from homebrew to commercial. Let us start with some homebrew ideas. If you have built a homebrew transmitter with just a few milliwatts, it could be given a welcome boost by building this pictured, **Fig. 2**, simple WA3TFS linear that was published on a Facebook group earlier in the year. It uses the IRF 510 transistor, which is cheap and readily available, and could be easily built for less than £10, delivering up to 5W of output. Being a linear amplifier means it works for SSB as well as for CW.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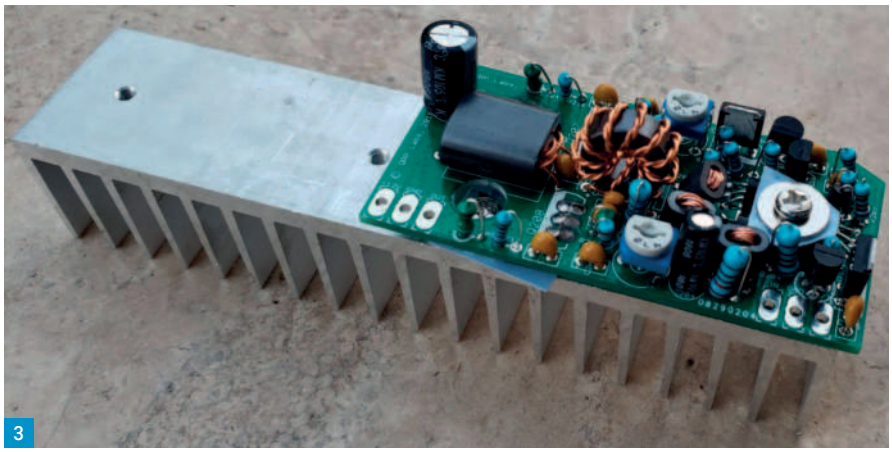
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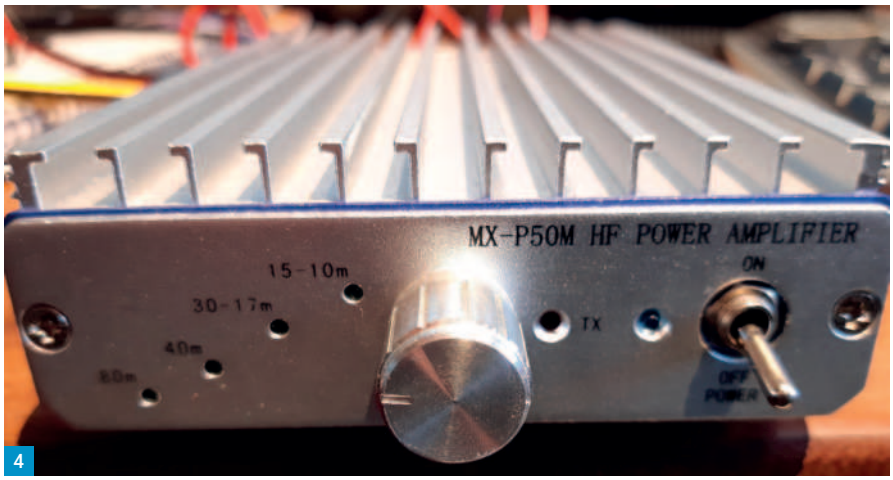

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Another design, for scratch build, using the IRF-510 is from **Ashar Farhan VU2ESE**, designer of the now famous BitX range of transceiver kits. His linear is designed for all modes on two bands, and is capable of delivering 25W pretty cheaply. Details are at his blog:

https://tinyurl.com/2p8w67um

If you want a selection of kits to choose from, then I would recommend those from QRPLabs. **Hans Summers** produces excellent kits (and instructions), making these kits suitable for beginners. His amplifier kits include:

- A 5W CW amplifier at $20
- A 10W linear for SSB and CW (**Fig. 3**) amplifier kit for $26. This kit can also be powered with up to 20V, providing up to 20W output.

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Fig. 5: The author's Hardrock 50 amplifier.
Fig. 6: The Xiegu XPA125B.
Fig. 7: The author's Acom 1000 amplifier.
Fig. 8: The Ameritron AL811.

- A 50W CW-only amplifier (at 20V) or 25W at 13.8V, designed for single-band use only, to accompany any transceiver but designed to accompany the QCX transceiver range.

Other options include the MX-P50M amplifier, **Fig. 4**, from China and available on auction sites. These amplifiers are actually quite good in my experience and are well filtered, putting out a clean signal. I have had one for a few years and they provide up to 45W output in any mode for 5W drive at about £150. They use manual switching for Low Pass Filters and are small and compact. Just be a little careful though – I twice accidentally over-drove mine with about 9W instead of 5W and blew the final transistor, although I did manage to source replacements and repair it.

Also, if you plan to use digital modes, the amplifier can get hot, particularly on FT8, and if you plan to use that mode, I would recommend reducing drive below 5W and maybe adding a computer fan on top. That said, I found the amplifier invaluable to provide a little bit of extra boost from my 5W.

Also around the 50W level is the Hardrock 50, **Fig. 5**, from the US supplier Hobby PCB, and based on an award winning design by **Jim Veatch**, who runs the company. Providing a solid output of up to 50W on 160-10m and 35W on 6m, for up to 5W of drive, the kit is high quality, with digital display and SWR metering and retails at $349 plus shipping from the US. I was recently lucky enough to buy a used ready-built version for £200 and am very pleased with it. Support is excellent, as when I thought I had a problem with it (which it turns out, I did not) I emailed the company and had several exchanges with Jim himself, who was very helpful.

If we move up to the 100W amplifiers, things can start to get a little more expensive. Indeed, if you are starting out and are not sure whether or not to buy a QRP or QRO rig, you should bear in mind that a commercial QRP rig and commercial amplifier to get to 100W will usually be much more expensive than just buying a 100W rig and then turning down the power for QRP if you want to. For example, the Yaesu FT-891, a compact and competent 100W rig, is available at the moment for £680. That is the price of many new commercial QRP transceivers, and nearly half the price of the Icom IC-705. Buying a commercial all-band QRP rig and then adding a decent 100W amplifier would add up to much more than the FT-891.

At the cheaper end of the HF linear market are the RM Italy amplifiers once more. Make sure to buy one with Low Pass Filtering to prevent harmonics and to comply with your licence – many of their amplifiers are designed for CB and have no or limited filtering for that band, and it is not always obvious which does and does not. An example from the range is the HLA-150 at £389. This claims up to 150W of output and does have filtering for each band.

For not much more money, you can purchase the Xiegu XPA125B amplifier, **Fig. 6**, reviewed in the March 2021 issue of *PW*. This amplifier covers HF and 6m, and will deliver 100W. The bonus is that it includes one of Xiegu's excellent ATUs. While I have not used this amplifier myself, I know many who are pleased with it, and indeed it is now being marketed by some distributors as a good companion for the IC-705. The new price is £450.

HF (400W and up)

It could easily be argued that as you look at amplifiers in this range, you are stepping outside of the purpose of this *On a Budget* series. I have some sympathy with that, but as I have said before, the top of one person's budget is the bottom of another's. Having said that I do intend to concentrate on the more affordable, often used, end of the market, as it is easily possible to spend £3-4,000 on a new kilowatt-capable amplifier.

Of course, here in the UK, we have a 400W upper power limit for full licensees, and additional, lower, restrictions on some bands. Why then might you want to buy an amplifier capable of a kilowatt? Well, there are many reasons. These include driving the amplifier at lower levels, which brings reduced output. For example, I have an ACOM 1000 valve linear, **Fig. 7**, covering 160-6m, which I bought used for £1,200. It requires about 60W to achieve up to 1200W out, but by reducing your drive level to lower levels, you can easily achieve the 400W limit while not straining the amplifier. Another reason might be if you use data modes a lot. The duty cycle of data modes is often higher, so you want to use an amplifier at less than its full capacity in order to minimise the risk of damage. A lower drive power of a larger amplifier will see you within the UK 400W limit without overly stressing the amplifier. A final advantage is that one amplifier can 'do it all.' In other words, driving my ACOM 1000 at just 10W will still deliver 120W out. This is a useful gain in power with just one amplifier that you know is 'future proof' should you wish to move to a rig with enough drive for the full 400 watts later.

Let's take a look at a few recent 'big linears' that come up on the used market from time to time.

I have already mentioned my ACOM 1000. I have now had it for a year and am very happy with it. It is a big and heavy unit but very well built. As a valve, rather than solid-state, unit it does require 'tuning' for each band and an initial 90 second 'warm-up' period at first power-up before operating. But in return for this minor inconvenience, the amplifier can handle and match SWRs of up to 3:1 with no ATU required, allowing some flexibility around antennas. Solid-state amplifiers are generally

Continued on page 61

Ian Liston-Smith G4JQT
ian.ls@hotmail.co.uk

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The HW-9: Heathkit's last QRP Classic

Ian Liston-Smith G4JQT describes the HW-9, its features and its flaws.

Many readers will know of the Heathkit Company, Benton Harbor, Michigan, USA. From the late 1940s to the early 1990s, the company produced a wide range of electronic kits.

In the 1970s, Heathkit introduced the first in a series of solid-state HF QRP CW transceivers, the HW-7, supplied between 1972 and 1975. Then came the HW-8 available from 1976 to 1983, which is widely said to be Heathkit's most popular amateur radio kit and is described with some of the popular basic modifications in my *PW* article published in November 2015.

Heathkit's final CW QRP kit was the HW-9, offered between 1984 and 1991. It had a superhet receiver rather than the direct-conversion receiver of its two predecessors and gave about twice the RF output power. With the optional WARC band components, it covered the CW portions of all the HF amateur bands from 80m to 10m.

Although exactly the same size as the Heathkit's two previous QRP CW kits, the HW-9 was a complete redesign with generally improved performance, which removed most of the HW-7 and HW-8 shortcomings, but also introduced a few of its own!

Like most of Heathkit's products, an extra month or two in the design lab might have ironed out some of the problems that subsequently came to light, particularly as some of the fixes are quite trivial. These include PA instability at some power settings, poor matching for the IF filter causing passband ripple, transmit frequency varying as CW power is adjusted, birdies on receive, binding or slipping dial, barely adequate receiver dynamic range, etc. Heathkit recognised a few of these and addressed them in their *Service Bulletin HW-9-1* [1]. All these issues and more are addressed in the many comprehensive sources for modifications listed below, some of which I will describe briefly later.

Main Features

The transceiver covers the lower 250kHz of 80, 40, 30, 20, 17, 15, 12 and 10m. However, the 30, 17, 12m WARC bands and 10m aren't included as standard, they come with the HWA-9 accessory pack. You can only tell if the components for these bands are present by looking inside at the oscillator circuit board.

The VFO covers 5.7493 to 5.9993MHz and is mixed with diode-switched crystal oscillators for each band. The HW-9 has an RIT with a range of about ±1kHz and a variable power-output control.

Heathkit used the same 8.83MHz IF crystal filter as in some of their SSB transceivers, and with a bandwidth of over 2.5kHz it isn't ideal for a CW rig. Strong signals inside the IF filter bandwidth, but outside the WIDE-NARROW audio filter bandwidth cause blocking and the S-meter responds to the stronger signal, not necessarily to the one you're listening to. This is a known 'feature' of the HW-9.

I built mine in 1990 and have done a few of the many published modifications. I've had three other HW-9s to compare so have a fair idea how they should perform. The rig's main specifications are summarised in the sidebar and these should be fairly easy to obtain in a fully working set.

Accessories

Heathkit provided the following matching accessories for the HW-9, although they could of course be used with other equipment.

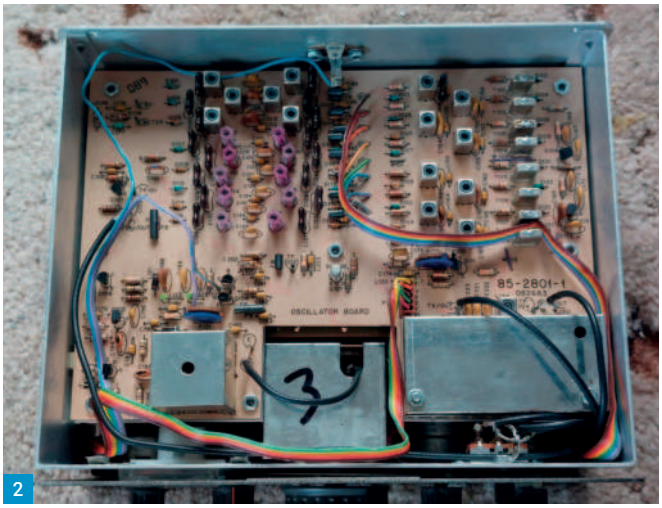
HM-9 wattmeter
HFT-9 antenna tuner
SP-99 speaker
PSA-9 power supply. As with the HWA-7-1 matching power supply for the HW-7 and HW-8, Heathkit didn't add any RF decoupling to the circuit. Liberal use of 47nF capacitors across the 12V output, rectifier diodes and the transformer secondary will reduce noise and the possibility of common-mode hum, particularly when used with direct-conversion receivers.

Common faults

Earlier HW-9s had a reputation for the dial slipping and binding. Of the ones I've used this wasn't a problem, but the *Heathkit Service Bulletin* listed below describes the cure. [1]

If you find low power output and low sensitivity, check the position of L118 as during alignment it will peak in two positions. The correct peak is when the core is near the middle of the coil not at the top. [1]

Low or no power output might be due to D405 and/or D407 going short-circuit.



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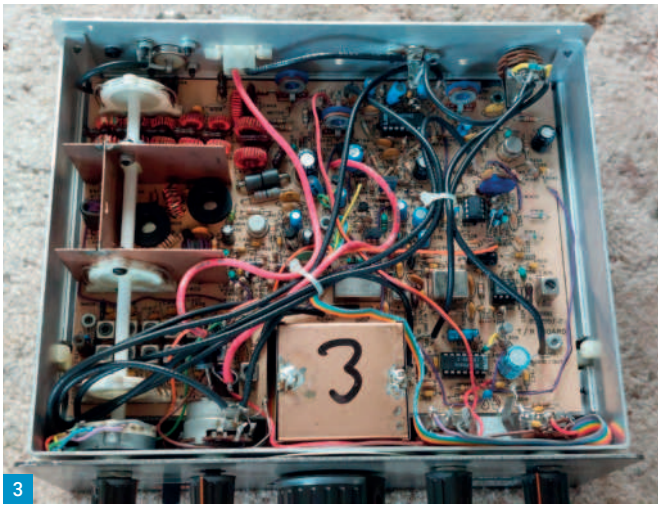

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Photo 1: The HW-9 with matching wattmeter and antenna tuner. Photo 2: Top view inside.
Photo 3: Bottom view inside.
Photo 4: Circuit diagram of output stage.

Also check the output transistors, Q405, Q406, which are both MRF237. But a word of warning; not all MRF237 transistors are the same. Those used in the HW-9 were manufactured by Motorola, and have the collector/emitter swapped compared with conventional TO39 transistors, with the tab indicating the collector, not the emitter. This is confirmed on page 103 of the manual and is not an error!

The original Motorola types are getting hard to find. I've not had to use substitutes yet, but if original types are unobtainable, it might be possible to cut and swap the tracks for Q405 and Q406 or maybe raise the transistors off the board and swap the E and C leads over. If this causes instability, then ferrite beads on each base may cure this. Substitutes might be also problematic as I believe the Motorola included emitter ballasting resistors in their versions, which help stabilise the PA stage. I don't know if this is the case with other makes of MRF237s. [2]

A Few Modifications

As with most Heathkit products, a quick internet search will reveal many modifications for the HW-9. However, before carrying out any of them, and assuming there are no obvious faults on any band, a careful alignment as described in the instruction manual will probably improve performance. It must be remembered the kit might have been last aligned well over 30 years ago by someone inexperienced and using nothing more than a multimeter. Leave the transceiver switched on for at least 15 minutes before alignment is attempted.

The first and most obvious modification is to add reverse-polarity protection. Goodness knows how many of these Heathkits have been destroyed by a moment's inattentiveness! There are a number of ways of doing this but the simplest is to add a diode in series with the positive lead before the ON/OFF switch, and using a 1N5819 Schottky diode will only drop about 0.3V rather than 0.6 to 0.7V of an ordinary silicon diode.

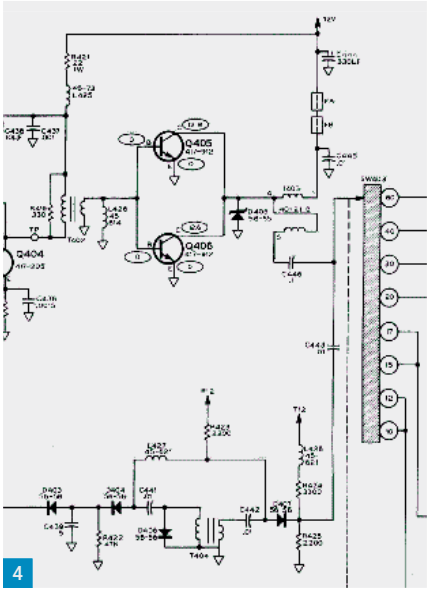
Please note that some of the ferrite cores are quite fragile and easily break if the wrong tool or too much force in used. But if any are broken and/or jammed in the former, all is not lost. The cores (except those in what look like metal IF transformers) can be unsoldered, and the cores turned around as they are slotted at both ends.

Four small white LEDs sandwiched along the top of the inner front chassis and the front panel with an appropriate limiting resistor will illuminate both the dial and meter.

I found the simple cure for the poor dynamic range of the receiver reported by some users – particularly on 40m at night in Europe. It appears to be caused by insufficient forward bias through D403 and D404. I added a 100µH choke across R423 (2.2kΩ). This significantly increases the current through these switching diodes, while R401 (3.3kΩ) still limits the current to a safe level. Keeping R423 in place removes any possible resonances in the choke. These diodes originally only had about 2mA to forward bias them causing intermodulation from the strong broadcast signals on the 41m band.

The transmitted frequency tends to vary as the CW LEVEL control is adjusted. A 1N4148 diode added between Q103 base and R132 with its cathode connected to the base of Q103 prevents this. [3]

There isn't much RF decoupling on the PA voltage supply. I soldered a 470nF capacitor across C445 (10nF), which stopped occasional PA parasitic oscillations under some load conditions. [2]



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Current consumption with 12.6V supply:
- Receiving approximately 190mA; transmitting on full power 1 to 1.5A depending on band
- Typical RF output into 50Ω:
- 4W on all bands, 3W on 10m
- Typical receiver sensitivity:
- Less than 0.5µV for 10dB S+N/N and 0.2µV for a readable signal

Heathkit overlooked the decoupling capacitor on the Vcc supply to the AGC amplifier U302. Add 47nF from pin 7 to ground. A 100pF cap between U302 pins 1 and 8 will also stop any spurious oscillation in the AGC amplifier. [2]

The VFO low pass filter isn't very well designed, which, among other things,

creates a number of 'birdies' while tuning through each band. The analysis of the problem by ND3P and the changes he suggests are a bit too long to describe here, but can be found in the sources info below. I found it a very worthwhile modification. [2]

It's worth carefully juggling the controls R329 and R333 to get the AGC and S-meter working nicely, otherwise the receiver will be a bit 'deaf' and the S-meter will hardly move. Also, if the S-meter tends to creep up at one end of a band, even when no signals are audible, then a bit of tweaking of the appropriate coils on the Oscillator Circuit Board might be required.

On a properly aligned HW-9 receiver sensitivity is very good, and I've managed to get mine to give a minimum detectable signal of about 0.05μV. In practice that's academic because noise on most bands will be much higher than that. Although the receiver is quite sensitive, as previously mentioned, selectivity and blocking leave something to be desired.

I've only included a few of the many HW-9 mods – the ones that are easy and really do make a significant difference. A Google search of 'Heatkit HW-9 modifications' will bring up plenty of others. The collections compiled by WD8RIF, AB7MY and ND3P are particularly useful. The *HW-8 Handbook* also covers the HW-9 and is downloadable free if you do a Google search, as are the circuit diagram and manual. There are also Heathkit HW-9 Facebook and HW-9 email groups, both with a very useful files section.

I have an Elecraft K2, KX3 and a **Hans Summers** QCX40. Although they completely outperform my HW-8 and HW-9 in every respect, I still find my two Heathkits much more fun to use. Each control does just one thing without all the wings and wheels of my modern equipment.

Heathkit's HW-9 never was an outstanding transceiver, but if you find one in reasonably good condition and give it a bit of TLC, it will be a perfectly capable little rig. Perhaps someone will update its circuitry for those of us who just want a really simple-to-use but high-performance multi-band CW QRP kit.

Sources

https://tinyurl.com/3ub54hd8 [1]
Modifications and improvements to the HW-9 ND3P (*QEX* Oct 1990) [2]
www.zerobeat.net/g3ycc/ab7my.htm [3]
https://tinyurl.com/bd3a3cvb
www.qsl.net/kk4kf/hw9-mods.html
https://tinyurl.com/52pxn4ps
https://tinyurl.com/2p8z4h4b
https://tinyurl.com/3umf5wcw

Continued from page 58

much less tolerant of SWR. While I paid £1200 for mine, I have recently seen one advertised for £1000, and it is very good value indeed at this price point.

Another quite common used find are amplifiers from Ameritron. These are owned by MFJ in the US and the AL-811, **Fig. 8**, is a reasonably common amplifier found in the UK. You can actually buy these new for around £1,600 and they appear moderately frequently on the used market for £800 - £1000.

The now venerable Yaesu FL2100B valve amplifier comes on the used market from time to time. While not equipped for the WARC bands, they do cover 80, 40, 20, 15 and 10 metres. Rarer is the Z suffix version, which covers 160 and the WARC bands too. When new they were claimed to deliver 800W on CW and up to 1200W PEP on SSB. You can pick these up used from time to time for around £200 - £300, which could be a very good purchase, but be sure to satisfy yourself of the power output on each band before purchase.

Kenwood produced the TL-922 which covers topband (160m) to 10m (with no WARC coverage) and is capable of 1kW. Expect to pay less than £1,000 used. *(see the article in this month's issue – **ed**.)*

Finally, Linear Amp UK are a highly respected amplifier manufacturer and it is not often you see used models for sale. However, some of their older models do come up from time to time and are well worth a close look. As an example, one of their older Ranger 811, 800W amplifiers was recently sold on an auction site for £720.

You will note that all the amplifiers I have listed in this category are valve based, at least in the final stage. Do not think of valves as old technology – they still have many enthusiasts for their rugged and clean signals at high power, and many amplifiers being built new today employ valves in the final stages. One thing you should be aware of though is the very high voltages present inside. Please do **not** open one up unless you are absolutely confident of your ability to know what you are doing and stay safe!

I hope you have found this article informative and it has given you some ideas for increasing your power as cost effectively as possible but, as I said at the beginning, if you can, put your budget and effort into more effective antennas first.

Next time we will take a look at the shack receiver and how we can achieve good receive capability at reasonable cost. Until then, happy operating!

Radio News

BANDPLAN CHART GENERATOR: Graham M7GRW says, *"I recently published a set of scripts/code on github that generate a graphical bandplan layout from datasets. The initial datasets are derived from the RSGB bandplans. I wrote the scripts as I wanted to generate myself a bandplan that while focussed on CW and QRP, did extend out to the band edges, as I've not got them all committed to memory, yet".*
You can see the code along with generated images at:
https://tinyurl.com/2p8uvxzu
The code is open source. It should be fairly easy to add new datasets for other regions etc. Details are on the github site.

EIGHT-SATELLITE TEVEL MISSION: The TEVEL mission, which consists of eight satellites carrying amateur radio FM transponders, launched on 13 January on the SpaceX Falcon 9 Transporter-3 mission, which also carried AMSAT-Spain's (AMSAT-EA) EASAT-2 and HADES satellites. The TEVEL satellites were developed by the Herzliya Science Center in Israel.
All eight satellites will use the same frequencies, as long as their footprints overlap, and only one FM transponder will be activated at a time. Beacon transmissions will be on 436.400MHz (9,600 bps BPSK). The uplink frequency of the FM transponders is 145.970MHz, and the downlink frequency is 436.400MHz. The satellites were built by eight schools in different parts of Israel. The TEVEL programme – tevel means universe in Hebrew and also is an acronym for 'Students Build Satellites' – was run in partnership with the Israel Space Agency and the Science and Technology Ministry.

ARISS HIGHLIGHTED AMONG NASA'S BEST SPACE STATION SCIENCE PICTURES OF 2021: NASA has recognised Amateur Radio on the International Space Station (ARISS) as a science education and research program. Two images of ARISS activity are among those singled out by the space agency as some of the Best Space Station Science Pictures of 2021.
ARISS team member Armand Budzianowski SP3QFE wrote, *"It is phenomenal that we were honoured as creating science. It is a proud moment that ARISS and amateur radio were honoured for the field of science and research by NASA!"*
NASA also shared the photos on its website.
https://tinyurl.com/msaf8rkm

Dr Bruce Taylor HB9ANY
bgtaylor@ieee.org

1

The Kenwood TL-922

Dr Bruce Taylor HB9ANY describes this potent HF bands linear power amplifier.

One of the delights of amateur radio is the possibility of making DX contacts on the HF bands with remarkably low transmitter RF power. But when propagation conditions are poor, or interference or QSB is severe, it can be helpful to maintain a quality R5 QSO by switching in a linear amplifier that can run up to the legal limit. Since Kenwood entered the amateur radio market in 1958, the company has earned a reputation for high quality products that are built to last. Although the first TL-922 power amplifiers, **Fig. 1**, are now well over 40 years old, examples in excellent condition can still be found at swap meets, SK sales and on eBay. And there is very little to go wrong with these fine rigs that can't be repaired by an amateur.

The maximum legal transmitter output power in the US is currently 1.5kW PEP, while in Europe the limit ranges from 400W in the UK, 500W in France, 600W in Switzerland, 750W in Germany, 1kW in Norway and Belgium to 2kW in most countries of the former Yugoslavia. The TL-922 is rated for up to 30 minutes continuous operation at 2kW on SSB, or up to ten minutes continuous key-down at 1kW on CW, RTTY and data modes. The amplifier has a gain of over 10dB and the exciter energy is added to the RF output. When it is on standby the exciter RF input is routed straight through to the antenna connector.

Design

A simplified schematic diagram of the TL-922 is shown in **Fig. 2**. The heart of the unit is a pair of high-gain 3-500Z power triodes operating as a Class AB2 amplifier in the grounded grid configuration, obviating the need for neutralisation. Negative feedback is used to keep the third-order intermodulation distortion below –30dB. The valves have a maximum average anode dissipation rating of 500W and grid dissipation of 20W. They can be operated with an anode voltage of up to 4kV, but in the TL-922 they are run at conservative maxima of 3.1kV on SSB and 2.2kV on CW. Typical measured performance data for an amplifier operating at the UK power limit from 240V AC mains in SSB mode on 14.175MHz are:

- RF output power: 400W
- 2nd harmonic: –43dB
- Higher harmonics: < –59dB
- RF input power: 32W
- HT voltage: 2.9kV
- Anode current: 400mA
- (Quiescent anode current: 200mA)
- Grid current: 80mA
- ALC output: –0.7V
- AC mains input: 8.1A

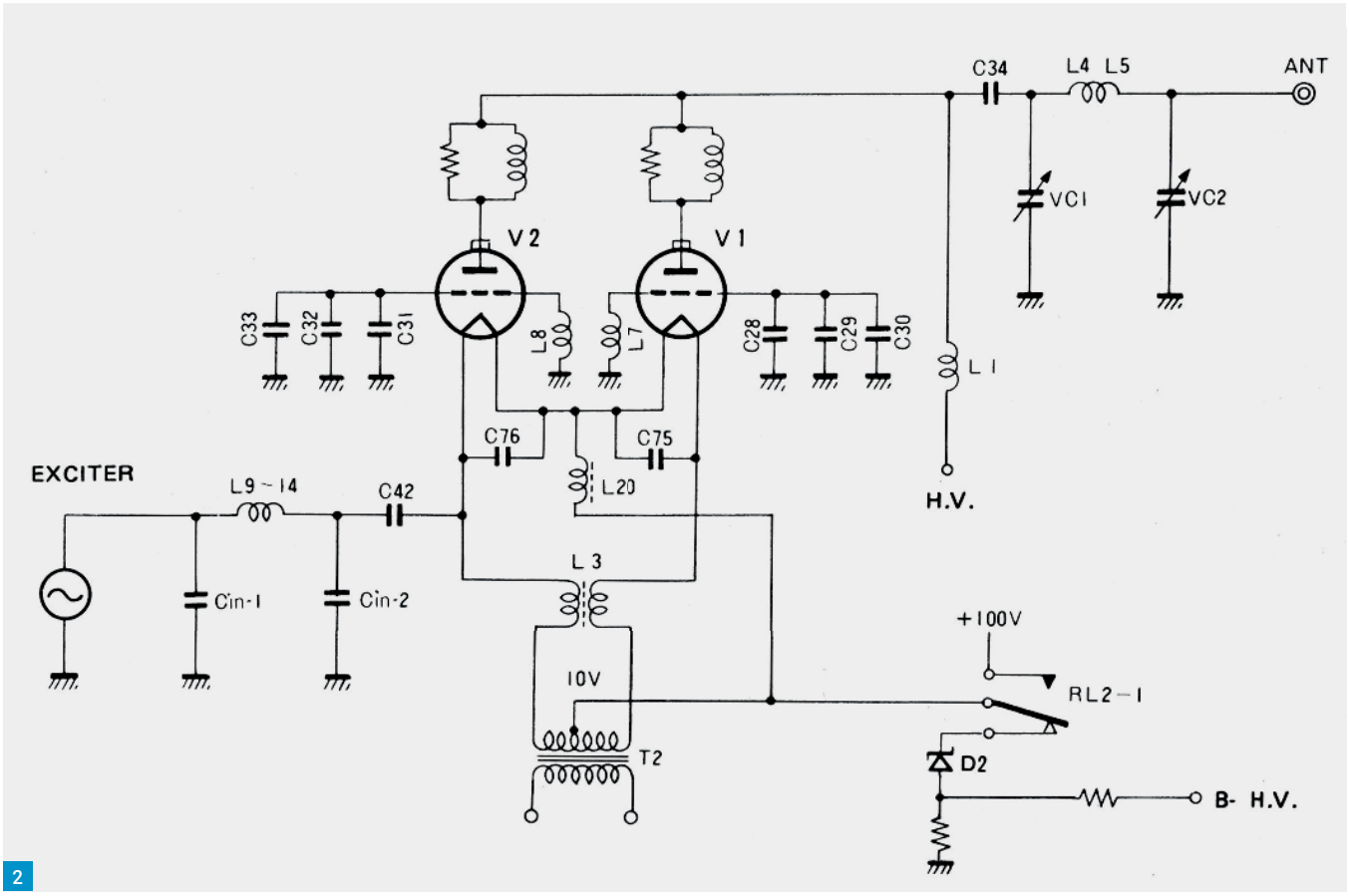
The original 3-500Z valve, **Fig. 3**, was manufactured by the US company Eimac, founded by **Bill Eitel W6UF** and **Jack McCullough W6CHE**, and much of the development work on the valve was done by **Bill Orr W6SAI**, well known for his *Amateur Service Newsletters* and his contributions to the OSCAR satellite programme. Eimac (now part of Communications & Power Industries) no longer manufactures these beautiful glass envelope valves, but only external anode types, and the last batch of Eimac 3-500Zs was of somewhat inferior quality. However, reliable graphite-anode valves were made by Amperex in Holland and France and satisfactory Chinese-made 3-500Zs are readily available from suppliers such as RF Parts and Penta Laboratories/Machlett (URLs below). Today, a matched pair of new Taylor-branded 3-500ZG valves can be purchased for about $360. Note that these valves cannot be rebuilt when they reach end of life.

www.rfparts.com
www.pentalabs.com

I've provided a high-resolution PDF of the full schematic diagram for the 120/240V 'K' version of the amplifier for download here:
https://tinyurl.com/TL922a

The power transformer configuration for the 220/240V 'W' version is provided separately here:
https://tinyurl.com/TL922b

To reduce the current, the filaments of both valves are connected in series and powered by the centre-tapped 10V 15A transformer T2, from which they are isolated by RF chokes L3 and L20. Hence the amplifier can't be operated with only one valve and it's unwise to use a differently branded pair, as they can have minor differences in filament resistance. T2 also supplies the voltages for the front panel lamps and the cutoff bias, relays and ALC. The grids of both valves are DC grounded through 470µH safety chokes L7 and L8 and grounded for RF by 220pF mica capacitors C28 through C33. To set the operating point, the filaments are biased positively with respect to the grids by the 1S265 7.5V Zener diode D2. The low operating bias voltage results in a zero-input quiescent current of about 90-100mA in CW mode and 180-200mA on SSB. This reduces distortion but results in an anode dissipation exceeding 200W in both modes. The bias can be increased by inserting one or more forward-biased rectifier diodes in series with the Zener. In order to prevent the generation of RF noise during standby, the valves are cut off by raising the voltage to about 100V.



The pi-network output circuit, **Fig. 4**, is designed to drive loads from 50Ω to 75Ω and the high voltage wide-spaced tank capacitor has a smooth 6:1 reduction drive for fine tuning. The input to the amplifier also uses six switched pi-networks, **Fig. 5**, designed to present an impedance of 50Ω to the exciter. The coil cores can be accessed from the top of the chassis on either side of the loading capacitor using a long-reach insulated alignment tool, such as the GC Electronics 8721. A VSWR at the exciter of less than 1.5 should be obtained when they are adjusted for the best match at the band centres, although this may be somewhat dependent on the length of the interconnecting coaxial cable.

Two illuminated meters allow the grid and anode currents of the valves to be monitored, as well as the RF output and the HT voltage. The RF meter gives a relative indication of the voltage at the output antenna connector and its sensitivity can be adjusted by a potentiometer on the rear panel of the amplifier. Forced air cooling of the valves is essential and this is provided by a muffin fan with a thermal delay relay that keeps it running for about two minutes after power off. Although the amplifier weighs 31kg, it is compact and can be carried easily by folding handles that are recessed neatly into the side castings of the case.

Fig. 1: The Kenwood TL-922 can deliver up to 2kW PEP on SSB and 1kW on CW on 9 bands. Fig. 2: Simplified schematic diagram of the RF section of the TL-922 amplifier. Fig. 3: With forced air cooling the Eimac 3-500Z can support an anode dissipation of 500W.

Variants

Two different versions of the amplifier were manufactured, for operation with a 50/60Hz AC voltage input of 220/240V or 120/240V. The current required for maximum power on SSB is 14A for a 220V or 240V supply and 28A for 120V. To minimise the voltage variation with load, the mains power line to the shack should be of heavy gauge and routed as directly from the switchboard as possible.

The voltage selection is made by jumpers concealed behind a panel on the rear of the cabinet, which can be removed by prising out a pair of snap fasteners. **Fig. 6** shows the jumper locations for 220V (lower) and 240V (upper) operation of the 220/240V version that was normally supplied in Europe. To ensure the correct cooling airflow, be sure to replace the panel. Both of the mains fuses on the rear panel should be the time-delayed type, rated 15A for any of the supply voltage configurations.

To avoid misuse of the amplifier by CB operators, a variant of the 120/240V version designated TL-922A that does not include the 10m range was supplied to some countries. For legal amateur radio use,10m functionality can be restored by reconnecting the bandswitch and removing the additional Phillips-head screw that stops it being rotated beyond the 21MHz position. Minor rewiring of the input coils L13 and L14 is also required to restore the connections shown in the schematic diagram for the 6-band TL-922.

Without any modifications the TL-922 can readily deliver up to 1kW on each of the

10, 18 and 24MHz WARC bands. Since the amplifier uses low-pass pi-network circuits, the bandswitch should be set to the nearest frequency above the WARC band required, i.e. 14MHz for 10MHz, 21MHz for 18MHz and 28MHz for 24MHz operation. The corresponding tuning control settings are approximately 3.5, 7 and 14. In the UK, an output power of 400W is permitted on a non-interference basis in the lower half of the 6m band from 50 to 51MHz. The TL-922 can be used on this 'magic band' with quite minor modifications to the input and output tuned circuits and the anode parasitic suppressors. Kits of the required components are offered on eBay for less than $10.

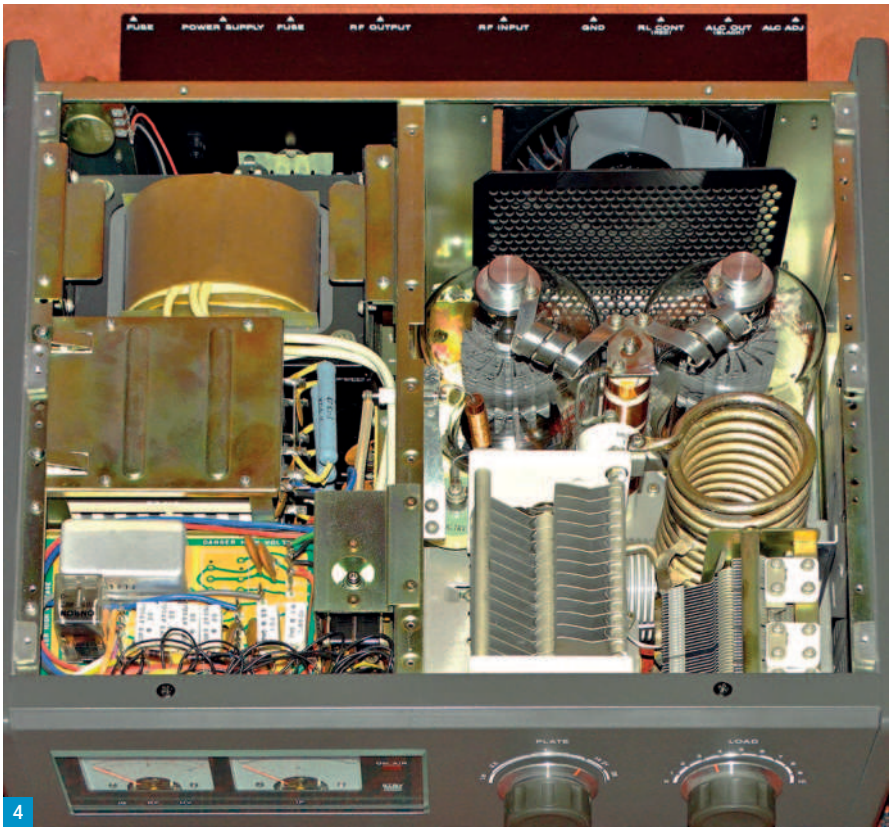
Safety

In view of the lethal voltage of the HT supply in the amplifier, several safety features are incorporated in the design. However, before any intervention the plug should be completely disconnected from the mains supply and bagged to avoid confusion with those of any other equipment on the service bench. When the top cover of the cabinet is removed, a double-pole switch automatically interrupts the mains power supply to the HT transformer, **Fig. 7** (upper). However, mains connections are exposed if the bottom cover is removed.

The eight series-connected 200µF 500V electrolytic capacitors of the HT voltage doubler are mounted in a stack of plastic spacers and enclosed in a metal box, **Fig. 8**, and these capacitors are bypassed by 47kΩ 7W metal film resistors. In addition to balancing the voltage across the capacitors, they serve as safety bleed resistors that discharge the capacitors in 20-30 seconds after the power is switched off.

The full HT voltage is present at the anode caps and parasitic suppressors of the valves, as well as the RF chokes and the doorknob blocking and bypass capacitors, Fig. 4 again. If the top cover of the valve compartment is raised prematurely, a simple spring leaf crowbar grounds the HT supply, discharging the capacitors immediately, Fig. 7 (lower). To conserve the contacts of the SSB/CW switch, which selects the HT tap directly, it's preferable not to change mode with the amplifier power on. The exciter should not be operated in CW mode while the amplifier is in SSB mode and the safety switches in the amplifier should never be defeated.

Because of the fine grid structure of the 3-500Z, Eimac recommended that fault-current limiting should be provided in the anode circuit. Since the TL-922 doesn't incorporate any glitch protection, it can be good practice to insert a 10Ω resistor and



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an inexpensive high voltage 1A microwave oven fuse in series with the HT supply to the anodes. A standard 250V instrument fuse is unsuitable as it may arc. Of course, the fuse must be installed on the valve side of the HT crowbar.

A 145°C thermostatic switch protects the HT transformer from overload that might be caused by running the amplifier continuously above its rating. If the switch is activated, it locks the transmit relay in the Standby position. If that happens, the power switch should be left on to allow forced air cooling, and in the meantime the exciter will operate straight through. To avoid arcing and overheating, all the areas in which dust collects should be cleaned regularly by vacuum or compressed air.

After changing bands, the amplifier should first be tuned approximately with reduced exciter power input and then finally with the minimum required normal drive. Take care not to move the bandswitch accidentally while transmitting, or to transmit with no antenna or dummy load connected! A spark discharge device installed at the T/R antenna relay dissipates any momentary high voltage during changeover. The amplifier is rugged. Mine survived a lightning strike to the antenna mast that destroyed two TV sets and a burglar alarm in the house, as well as a Sommerkamp (Yaesu) FT-480R transceiver in the same shack.


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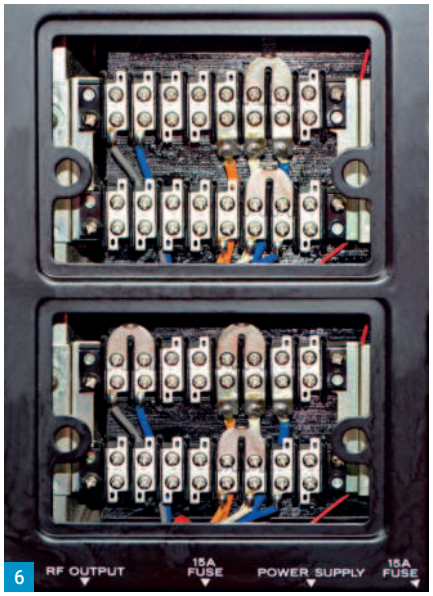
Valve Care

To protect them from shocks and vibration, the 3-500Z valves should be packed separately from the amplifier during transport. They should be stored vertically in dry conditions, as the Kovar that bonds the metal pins to the borosilicate glass is a ferrous alloy that can rust. The radiator anode caps should be fitted before installing the valves, aligning the grub screws with the dimples in the caps and taking care not to overtighten them. Check that the resistors inside the parasitic suppressors are not split, and shape the coils by hand so that they fit accurately between the mounting holes without stressing the glass anode seals of the valves, Fig. 4 again.

Filament voltage has a significant influence on valve longevity. A filament that is not heated sufficiently can suffer emission loss due to surface poisoning by contaminants that render it partly inactive. In continuous commercial service, the ideal regulated volt-



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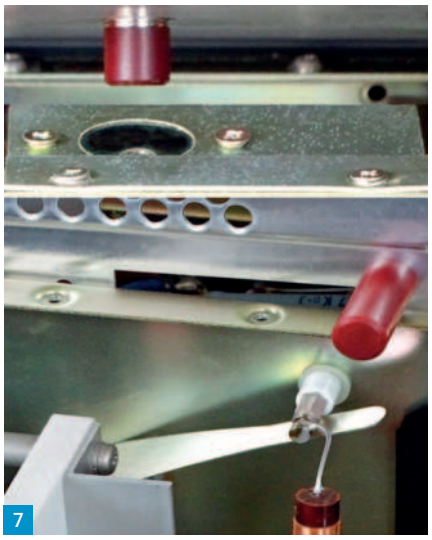
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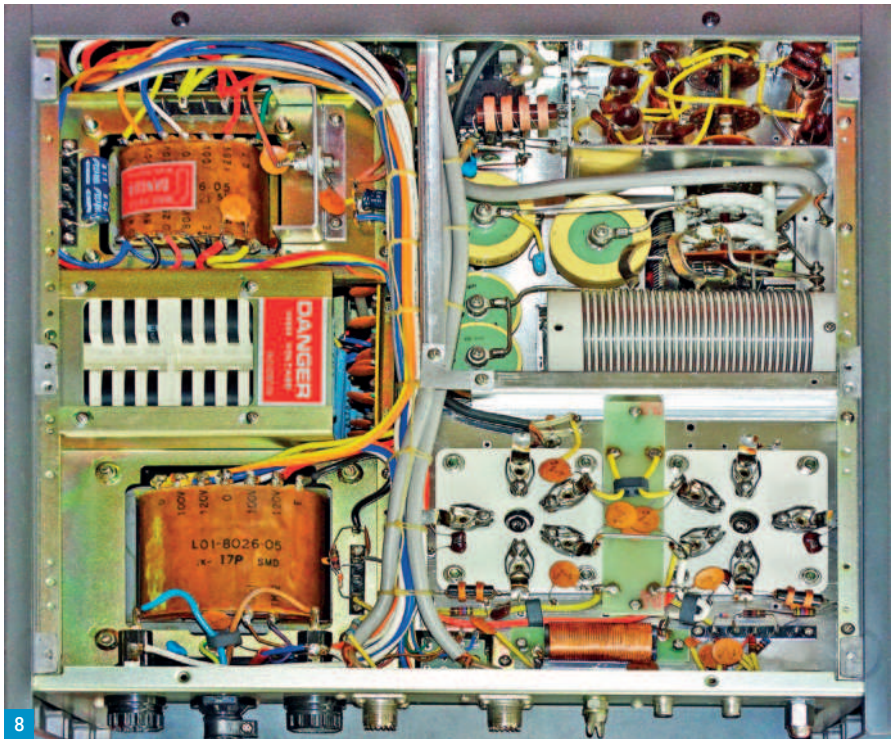

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Fig. 4: The power supply is on the left and the RF cage with the output pi-network and 3-500Z valves with their parasitic suppressors on the right. Fig. 5: The six input pi-networks are housed in a fully screened compartment under the chassis. Fig. 6: Jumper locations for 220V (lower) and 240V (upper) operation. Fig. 7: (Upper) Mains input interlock. (Lower) HT safety crowbar. Fig. 8: The mains transformers and HT box are on the left and the 3-500Z valve bases lower right.

age for valves with thoriated tungsten filaments can be managed by reducing the voltage until just before the RF output begins to decrease and distortion increases. Since this procedure isn't useful for amateur service with unregulated filament supplies, the AC mains jumpers should be selected to give an average heater voltage as close as possible to 5V. Use an accurate true-rms DMM, since the waveform can be significantly distorted, and keep a safe distance from the open amplifier after attaching the test probes right at the valve bases before switching on the power.

The measurements should take account of temperature rise in the amplifier and the local variation in mains voltage, which in winter is typically lowest around 8pm and highest around 4am. When making these measurements the amplifier can be operated upside down, but to avoid the filaments sagging and shorting to the grid it should not be powered while lying on its side, or even with the axis of the valves more than 10° from the vertical. Avoid cycling the filament voltage unnecessarily.

If the local mains voltage is such that the filament voltage can't be set correctly with the few available transformer taps, the jumpers should be set to provide the nearest voltage on the high side of 5V. Resistors of appropriate wattage should then be inserted in the connections from the transformer to the filament chokes at the valve bases. In view of the high current of over 14A, the small voltage drop required can also be achieved simply by replacing the wires from the transformer by lossier ones of a smaller diameter, provided they are protected by sleeving that can support the extra temperature rise.

The negative-going ALC voltage can be varied up to –8V by a preset potentiometer on the rear panel of the amplifier. It's important to adjust the ALC output to the exciter to keep the grid current below 200mA.

3-500Z Revival

A valve that exhibits low emission can sometimes be partially or completely revived by reactivating its filament. The procedure is most successful for the case where the thorium on the surface of the filament has been depleted by running the valve for some time at too low a heater voltage. In a test rig, apply 5V to the filament and connect the grid and the anode together to a 30-40V variable voltage DC power supply. Then allow the valve to 'cook' for many hours with a fan positioned to cool the envelope. As thorium gradually migrates to the surface of the filament, the anode (plus grid) current should begin to rise and the DC voltage should be adjusted periodically to keep it below the specified maximum of 400mA.

If you purchase an amplifier or old stock 3-500Z valves that haven't been used for a considerable time, the valves should also be degassed before the full high voltage is applied to the anodes. This is because gradual leakage at the seals could have caused enough air to enter the envelope for an internal arc to occur when the full HT is applied. The porous graphite anodes used in the 3-500ZG version of the valve are also subject to the slow release of trapped gas over time. Such a flashover would probably destroy the grid chokes and the Zener bias diode, **Fig. 9**, and possibly damage the HT supply as well as the valve itself. The 3-500Z doesn't have the type of flashed getter that produces the characteristic mirror coating on the inside of many smaller valves. Instead, the molybde-

num or graphite anode is coated with a porous zirconium alloy that absorbs residual gas molecules when it is heated during normal operation, with an anode dissipation of 250-500W. This power corresponds to the anode glowing from dull red to orange in colour.

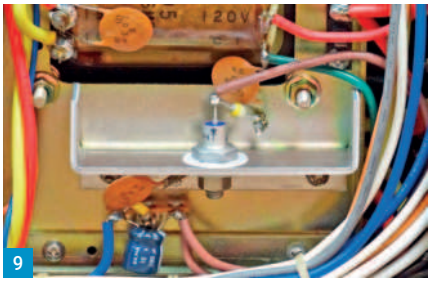
Degassing is best done with a test setup outside the amplifier, using an HT power supply of around 750-1000V. This is low enough for flashover to be unlikely but high enough for the anode to be raised to the gettering temperature of around 1000°C without exceeding the maximum cathode current of 400mA. The anode should be heated up slowly, as the getter absorbs different gases best at different temperatures, and then left to cook for several hours. Be sure to position a fan to keep the temperature of the base seals below 200°C during this operation.

The glass envelope of the 3-500Z allows the characteristic powder blue glow of a soft valve to be seen clearly. It also allows valves to be matched on the basis of their anode colour when delivering high power, something that is not possible with ceramic types. For matching purposes some new Chinese valves have a paper label carrying a number, which is the zero-bias quiescent anode current at an unknown test voltage.

Modifications

The six front panel lamps (two for each meter plus the Standby and On Air indicators) are of a special type (B30-0048-05) that is not readily available. Their life can be prolonged with only a small reduction in brightness by changing the series resistors from 10Ω to 22-27Ω, **Fig. 10**. A more radical approach is to slide the plastic lamp holders out of their retaining slots and replace them by LEDs with current limiting resistors of appropriately increased value. Since most LEDs have quite low reverse voltage limits, a diode or bridge rectifier and reservoir capacitor should be added to rectify the 8V AC supply before making this change. A paper strip can be inserted between the meter LEDs and the meters to act as a light diffuser.

Some TL-922 problems have been attributed to intermittent parasitic oscillations in the region of 125MHz when valves with above-average gain are fitted. Be suspicious of any indication of grid current, or of change in the anode current, when the tuning is varied with no exciter input. Such oscillation could potentially damage the output bandswitch contacts or create a short from the filament helix to the grid cage in a 3-500Z, overheating the filament transformer. A cure may be effected by replacing the coils of the original anode suppressors by ones having a lower *Q* at VHF. These should have an inductance of around 100µH and can be made from resistance wire. Resistance wire can also be used to replace the short copper wire that connects the plate on the top of the RF choke L1 to the blocking capacitor C34.



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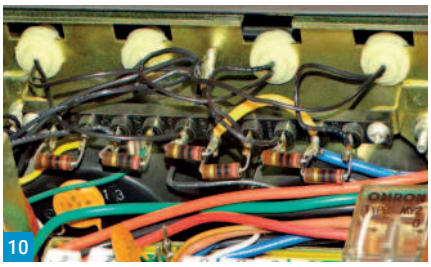
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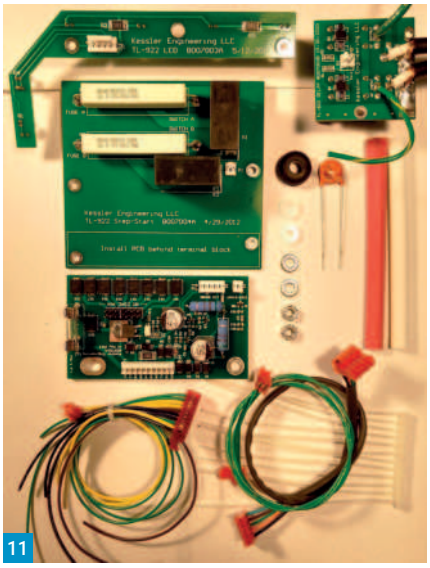
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Fig. 9: This 1S265 Zener diode sets the operating point of the valves. Fig. 10: The meter illumination lamps can be replaced by LEDs. Fig. 11: The upgrade kit for the TL-922 by Kessler Engineering includes 4 PCBs and the interconnecting cables.

Although the standard TL-922 normally performs very satisfactorily, several owners have devised modifications that improve the exciter compatibility or the reliability of the amplifier. **Tom Rauch W8JI** reviews the problems of valve arcing, stability testing and cure at:

www.w8ji.com/Amplifiers.htm

Although **Richard Measures AG6K** is now SK, a detailed description of his numerous TL-922 improvements is still available on the web at:

www.somis.org/QSK922.html

After 'Operate' has been selected, the TL-922 T/R relays are energised by the exciter grounding the Relay Control input to the amplifier. The open-circuit voltage on this line is over 100V, which isn't compatible with some modern exciters that have a low-voltage semiconductor switch rather than physical relay contacts. **Jeff Weinberg W8CQ** of Harbach Electronics (link below) can supply a soft-key interface that transforms the key closure requirement to 0.7V DC at 1.5mA. External relay buffers are available for owners who don't wish to modify their amplifier or exciter.

https://harbachelectronics.com

At initial power up, when the 3-500Z filaments are cold and the HT smoothing capacitors are uncharged, the TL-922 can draw a large inrush current. This can be mitigated by a simple step-start circuit that connects a pair of 22Ω 10W resistors in series with the primary windings of the mains transformers. The resistors can be short-circuited by a relay that is energised by a timer or when the HT rises to about 2/3 of its normal level, which takes less than one second.

The T/R bias and antenna changeover relays in the TL-922 are sturdy, but respond too slowly for satisfactory VOX operation on SSB or QSK on CW. If these modes are required, they can be replaced by fast vacuum relays of adequate power and frequency ratings, mounted to minimise their acoustic noise. The attack and release times of the relays should be sequenced to avoid the RF output relay contacts opening before the exciter input has been cut off.

Don Kessler KI6SZ of Kessler Engineering (link below) offers a modification kit for the TL-922 that adds the step-start, low-voltage soft-key switching and VOX/QSK features, as well as quieter T/R switching, electronic bias control and a LED strip for the front panel lamps, **Fig. 11**. The kit, which costs $360, utilises four printed circuit boards and comes with an excellent detailed installation manual.

https://tinyurl.com/KI6SZ

Whether in original or modified form, the TL-922 is a serious player that can add much enjoyment to amateur radio operation, especially for those who like experimenting with their transmitters. With a possible gain of almost two S-points the amplifier can significantly improve the quality of QSOs when conditions are good, and when conditions are difficult it can help to achieve successful contacts that would otherwise be impossible.

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Practical Antenna Models Volume II by ON5AU

Keith Rawlings G4MIU
practicalwireless@warnersgroup.co.uk

Keith Rawlings G4MIU recommends a book of particular interest to users of the EZNEC software.

I have previously had the pleasure of describing two of **Marcel ON5AU's** antenna modelling books in *PW*, namely *Advanced Antenna Modelling* (AAM) and *Practical Antenna Models 1* (PAM1).

AAM concentrates on the techniques of antenna modelling using EZNEC and also optimising these models using **Dan Maquire AC6LA's** application AutoEZ.

PAM1 follows up on these techniques in a practical sense and concentrates on the modelling of dipoles and variations of the dipole family.

Both of these books have a great deal of work put into them and are very informative, as are the accompanying downloadable files, which consist of completed antenna models that accompany each 'Episode' (each chapter of the book consists of various episodes). These models are all built and ready to be run by EZNEC.

Timely Arrival

Ignoring 'high end' EM simulation packages, amateurs have a choice of modelling software such as MMANA-Gal and 4NEC2, which are completely free.

EZNEC and AutoEZ are 'paid for' software with EZNEC coming in various versions with different capabilities/features and different price ranges. EZNEC is popular with amateurs and professionals alike as it is powerful but reasonably simple to use.

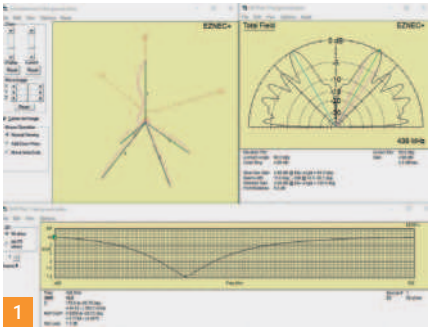
Things change, and **Roy Lewallen W7EL**, the author of EZNEC, has decided to retire and withdraw support for EZNEC. In return he has made EZNEC Pro/2 completely free to download (EZNEC+ may also survive but the NEC4 Pro/4 version will be discontinued).

Naturally this is going to generate a great deal of new interest in EZNEC and with the powerful features included in this version users may wish to purchase AutoEZ at USD$79 because, despite its sophistication, EZNEC has no options to automatically optimise a design.

With EZNEC Pro/2 being free this may well make the purchase of AutoEZ seem more attractive.

Inside Volume 2

Using plenty of charts, plots and diagrams PAM2 follows the familiar pattern of the previous books. This volume starts off discussing ground planes, effects of types of ground beneath the antenna and how the number of ground radials affects the model.



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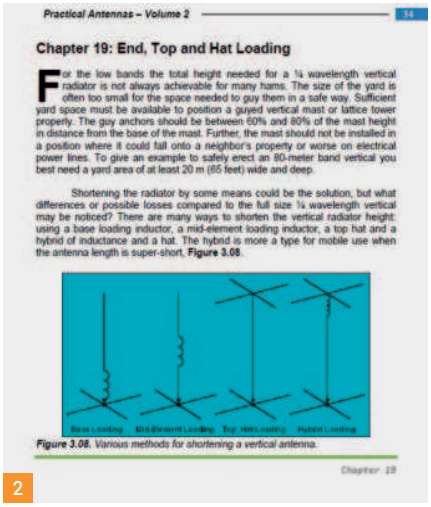

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Fig. 1: Accompanying EZNEC Model of a 1/4λ Ground Plane. Fig. 2: Screenshot from the accompanying Practical Antennas 2 eBook. Fig. 3: PAM2 front cover.

It then works its way through many vertical types such as Monopoles, shortened verticals, including Inverted Ls and Top Hats, the ever popular 5/8λ and J-Poles designs as well as Elevated HF Radials.

There is an interesting episode on using AutoEZ to model a tower as a vertical radiator and also an Episode on ATU/Matching circuits.

Like previous books PAM2 gives access to more than 135 pre-written models and files, which can be downloaded from the book's website. Naturally these models can be modified and experimented with at will.

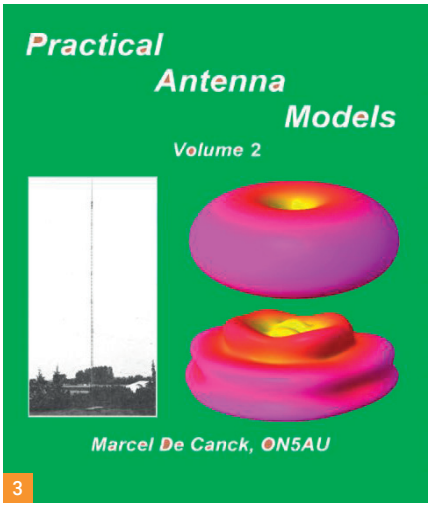
In addition, there are extra bonus files in the form of the 303-page *Practical Antennas Vol 2* e-book, .exe Wizards and 'Apps' for designing L-Networks and Tuners although I could not get the latter to run on a Win 10 O/S.

Conclusion

Clearly this book is aimed at those who model with EZNEC and AutoEZ and naturally they will find the greatest benefit from it.

A lot can be learned about an antenna's behaviour by modelling and where it comes to verticals this Volume gives good solid advice to show you how to model correctly while the accompanying models will save the reader considerable build time.

I personally found the Episode on the J-Pole of great interest, especially after spending much time over the years evaluating my own models.



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If you are interested in getting the best results when modelling vertical antennas using EZNEC/AutoEZ, then PAM2 can be thoroughly recommended as a great tutorial and reference source. It is available as a paperback and also in Kindle format. It has 202 pages and more than 245 illustrations and is currently priced at £17.50 for the paper edition and £7.42 for the kindle Edition.

Links

Amazon:
https://tinyurl.com/muj42w64
Marcel's Website:
https://tinyurl.com/mwahvu79
EZNEC Website:
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A description on how AutoEZ works can be found here:
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Units & the Hobby

Dear Don,

Following on with Imperial and/or Metric units I find it strange that Shannon Volmet use feet for cloud height and metres or km for visibility, with temperature in centigrade although they don't say degrees centigrade all in the same weather forecast. As it's just a bit higher than our 60m band I use it as a propagation aid.

I'm with **Len G8LXI** on how the hobby has changed. In my opinion it's become an operating hobby for the most part. I have an FT-817ND and talk to locals, which can be for an hour. Apart from that my main use of radio is on 5.262MHz using my 77 year old 19 Set.

What fun and sometimes hard work digging signals out of the noise but there's enough room on 60m so the lack of selectivity of the 19 Set is not a problem, although my next project is to build an external *Q* Multiplier from the 1973 *RSGB Handbook*. To me this is real radio!

I wouldn't want to pay £12,000 for a transceiver and must get round to putting the extra bands on my homebrew G4CLF-based tx/rx, which is being modified for them. It's QRP and basic, with no fancy unnecessary extras as shown by the loads of stuff on the 817 I have never used.

Like Len I also modified a Pye Bantam in the early 80s to work on 4m and pre-arranged skeds with two stations in the Stockport area when I'd walk up a hill and work back to them. Interestingly signals were sometimes better slightly downhill and off the top of the hill in their direction. Was this SOTA before SOTA was thought of?

Bill Kitchen G4GHB.
Ashton under Lyne

★Star Letter★

The Star Letter will receive a voucher worth £20 to spend on items from our Book Store, or other services offered by Practical Wireless

HF Signal Generator

Dear Don,

I would like to record my thanks to **Eric GW8LJJ** and *Practical Wireless* for his excellent Signal Generator article in the November edition.

I purchased the PCB and some of the components from Eric and built the Generator. It worked first time and performed as described. I subsequently made a couple of modifications which may be of interest to other readers.

I added an extra relay with a 200µH inductor to get an extra range covering the medium wave. broadcast band and 455kHz IF. I then changed the 22µH to 47µH to lower to the range of the second band.

I accidentally damaged my 10kΩ multi-turn pot while shortening the shaft so I had to replace it with a 20kΩ that I had in the junk box. A happy side effect of this was to decrease the lowest frequency in each band. I now have continuous coverage from 405kHz to 24.9MHz in five bands.

I also replaced the 78L09 regulator feeding the modulation circuit with a panel-mounted toggle switch. This avoids any possibility of stray coupling of the modulation signal.

I am extremely pleased with the final result and congratulate *PW* on the high standard of its articles and thank Eric for his friendly support.

David Hodgkinson GI7TPO
Crumlin

Various

Dear Don,

"Fancy a Chat?" Well, sometimes I do, particularly on VHF or UHF when HF propagation goes walk-about. Trouble is, as is often the case, I have to communicate with myself. Or go for a long walk.

Tim Kirby GW4VXE (February 2022), says that *"people often say to me that there is no activity on VHF/UHF"*. A lot of people say that to me too. Nothing new, of course. I've been hearing that refrain for yonks. And it might be the case that *"there is probably more VHF/UHF activity now than there has been since the 1980s"*. After all, you would think so, right? Especially since then and more so during the past 20 years or so, when VHF/UHF mobile and handheld rigs have been flying off amateur radio dealers' shelves seemingly quicker than most people who buy bread and milk each day.

So why is it, that even though zillions of VHF/UHF rigs have been bought and continue to be bought by the truckload, how come this ongoing trend has not brought forth an ongoing upsurge of activity on the VHF and UHF bands?

Where is everyone? And more importantly, why do people keep buying VHF/UHF rigs (some of which cost more to replace a decent washing machine or a posh fridge-freezer, something that might be more useful), and not use them? Are they merely decorative? Something that looks pretty sat in the shack? Are they used just for monitoring purposes? Not for communication? It seems so.

Tim also mentions that it would do *"no harm for the future of our hobby"* that *"OFCOM switch on a scanner and hear plenty of activity"*. I don't recommend that they do that in my neck of the woods. They'd hear nought. Anyhow, I stopped using my scanner years ago. Scanning silence became tedious.

On another note, I appreciated **Harry G3LLL's** glowing critique of my Heathkit article in the December issue of *PW*. As Harry pointed out, especially with regard to test equipment, a Heathkit alternative sometimes beat a similar manufacturer's item into a cocked hat. And it was a lot cheaper too. Okay, you had to build it (one reason why it was cheaper) but the odds were that if it died, you could bring it back to life again. Marvellous. Yes, as Harry so rightly says, *"Thank you Heathkit"*.

"What has Happened to the Hobby?", asks **Len G8LXI** (*Letters*, January). Time and technology has a lot to do with it. And like some other OTs (old timers), I can remember far too many long-winded QSOs, occasionally an hour or so in duration. I also remember AM Pye Bantams, receivers and transmitters so heavy that you risked a hernia if you dared to move them.

I can recall a time when I spent more time with a red hot soldering iron and a box of valves and assorted FETs etc than I did yakking on the radio, I remember when a 'ragchew' actually meant what it said on the tin, maybe two hours talking about the weather, the rig, the antenna rather than what a 'ragchew' means nowadays, *"you're 59, thanks for the contact, have a nice day and see you further down the log"*. And I remember a time when a few class A operators who had nothing better to do (other than making a nuisance of themselves on 20m, that is) than jamming local FM repeaters for the hell of it. Well, they did have a reason, even if it was totally ridiculous, that the concept of repeaters and a 'B' type amateur radio licence was an abomination.

Therefore, in the weird world that existed back then, some 'A' ops didn't converse with 'B' ops. Mind you, we had the situation recently whereby new 'M3' licensees were given the cold shoulder. So, nothing new, then.

Yes, we've all heard about someone knowing nothing about radio, yet by some sort of spooky happenstance can pass a novice exam. I know a few people who did just that. And once upon a time for those who for one reason or another, could not transfer the knowledge from their brain and articulate it onto a written RAE paper, they had to keep their fingers crossed, and hope.

Then along came the multiple-choice RAE (and later, practical hands-on sessions) and everyone was happy, except those who distrust change and the double-edged sword of democracy. You can never please everyone.

Lastly, the days of exclusive 'real amateur radio' have sadly passed away. Like telephone handsets in every house and compromised computers and black and white televisions.

Ray Howes G4OWY/G6AUW
Weymouth

Next Month

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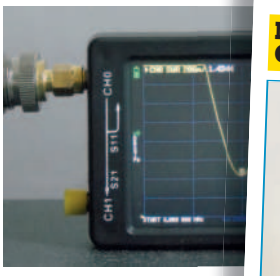

BUILD THE PW PASTON, PART 3: Mark Tuttle G0TMT moves this month on to the VFO board of the 40m transceiver project.

VALVE & VINTAGE: Philip Moss takes a look at the Hallicrafters S20R Sky Champion Communications receiver.

HOW TO CHECK PROPAGATION USING FT8: James Stevens M0JCQ explains how to use FT8 as an aid to understanding propagation and chasing DX.

USING THE NANOVNA AS AN ANTENNA ANALYSER: The NanoVNA costs a fraction of the amount of even the cheapest antenna analyser. Although it's a bit fiddly to do so, Steve Telenius-Lowe PJ4DX explains how this diminutive device can be used to measure an antenna's SWR.

There are all your other regular columns too, including HF Highlights, World of VHF, What Next, The Morse Mode and Data Modes.

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* Photo shows the FTDX101MP

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The Battle of Britain
IN COLOUR

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THE BATTLE OF BRITAIN IN COLOUR

The Battle Looms

The Battle of Britain was one of the most iconic battles of the Second World War, embedding itself indelibly into the nation's consciousness. Earlier, the Battle of France could easily have spelled defeat before the air battles got underway in July 1940.

After the outbreak of war in September 1939, there followed eight months of what became known as the 'Phoney War'. However, it was clear that large-scale fighting would ultimately follow, and a British Expeditionary Force was sent to France before the end of that year. As part of that BEF, a large Air Component was supplemented by an Advanced Air Striking Force. In total, these air forces amounted to 25 squadrons, six of which were Hawker Hurricane-equipped fighter squadrons. The remainder of the RAF force in France comprised largely light bombers and Army Co-Operation squadrons. Eventually, however, the 'Stukoteg' became the 'Blitzkrieg'.

On 10 May 1940, German forces launched their all-out assault on France and the Low Countries and what followed in Belgium, the Netherlands etc. was the complete collapse of those countries under the overwhelming might of German military power. Across France, German forces rolled inexorably onwards towards the English Channel and while the French and British tried desperately to stem the advance, so the situation became ever more hopeless.

Predicted Catastrophe

When the fighting had broken out in earnest on 10 May 1940, aircraft of the Air Component were in almost constant combat, and losses had to continually be made good from squadrons based in Britain. The Commander-in-Chief of RAF Fighter Command, Air Chief Marshal Hugh Dowding, had already stated as early as September 1939, that if he was expected to defend Britain's skies, then he would need 52 fighter squadrons. At that time, he had only 32 under his command and was told it would be impossible to produce the number he required. However, efforts would be made to provide him with a further eight.

During the fighting in France, increasing numbers of fighter squadrons were sent across the Channel, urged on by desperate appeals from the French Prime Minister, Paul Reynaud. Dowding saw his resources 'slipping away like

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BACKGROUND TO BATTLE

Left A Hurricane of 501 Squadron starts-up for an operational sortie at Bethenville, France, May 1940. Air Chief Marshal Hugh Dowding argued successfully against further wastage of the home-based RAF fighter force by sending yet more fighters to France to bolster a futile defence.

Right As the unstoppable juggernaut of German military might advanced across Europe, the deadly Junkers 87 Stuka dive-bomber came into its own. However, the RAF quickly learned how

aircraft, and this stood

when facing the Stuka i

Britain.

Below right Panzer

France in May 1940. Th

was rapid and overwhel

weeks France had colla

were evacuating fro

– 19 –

THE RAF FIGHTER PILOT

were not afraid that they were either liars or foolish. However, a strident jangling of the telephone could mean several things. Sometimes, to intense relief, it could send a message to 'Stand Down'. Other times, it called pilots to readiness, and then to the heart-pounding order: 'SCRAMBLE!'

Years afterwards, veterans of the Battle of Britain told how they hated the sound of a ringing telephone.

On the order to scramble, there was a mad rush by pilots to their allotted aircraft where the fitter and rigger were ready and waiting: the rigger on the wing ready to help in his pilot, and the fitter standing by with the starter plugged in on the starboard side of the engine. Heaving himself into the cockpit, the pilot went through a number of tasks: helmet pulled on, oxygen plugged in, radio jack-plug in its socket, magneto switches 'on', Ki-Gas cylinder priming pump given a couple of brief strokes and thumb ready on the starter. Meanwhile, leaning into the cockpit, the Fitter helped the pilot with his parachute harness straps, then his Sutton seat harness.

By this time, the starter button was pushed after a thumbs-up from the fitter, who unplugged the starter trolley, ensuring it was clear of the aircraft. Unable to communicate over the roar of the Merlin engine, the pilot and rigger exchanged thumbs up signals, the rigger slapping his pilot on the shoulder to convey reassurance and good-luck as he leapt from the wing. As he jumped, the aircraft was already rolling, and the rigger dodged out of the way of the tail-plane, buffeted by the slipstream which was kicking up dust and grass. Getting out of the way, he was hit by a blast of hot exhaust gasses. Now, the aircraft gathered speed ahead, into wind, bouncing and rocking across the grass airfield. Others careered along around it, in the organised chaos that was a squadron scramble.

Getting airborne, the pilots concentrated on keeping station as they selected 'Gear Up', closing the cockpit canopy while listening out for instructions from the CO or flight commander who was talking to the Sector Operations Room and garnering instructions as to heading, altitude and

Facing page **Pilots of 19 Squadron are delivered to their dispersal point at RAF Duxford ready for operations early one morning during the summer of 1940.**

Above **Their relaxed look perhaps concealing the tension, these Hurricane pilots of 501 Squadron pose for the camera during the summer of 1940. All of them saw action. Several of them shot down enemy aircraft and some of them were killed.**

what it was they were intercepting. It may have been an instruction along the lines of: "MITOR Squadron, ANGELS 18, Vector Two-three-zero, Fifty Plus. HUSTER." Listening in, the other pilots could interpret these coded instructions: "40 Squadron to climb to 18,000 ft on a heading of 230 degrees. Fifty plus enemy aircraft. Maximum cruising speed."

Mentally and Physically Draining

Settling into the climb, the pilots automatically slid into section order and the preferred squadron formation. Meanwhile, the CO or flight commander concentrated on setting course as the

THE RAF FIGHTER PILOT

ther pilots concentrated on what as going on in their cockpits: oil temperatures and pressures, fuel state, ygen contents checked and reflected h 'Oo', microphone not on 'Transmit' but could effectively block all other ansmissions), straps tight, gun-sight ne' and illuminated, straps tight and oopy firmly shut. A surprising number ould carry out a little good luck routine for feeling for a lucky charm, or even ressing themselves.

Now, the workload was high, and still ery needed to concentrate on formation eeping while permanently keeping weary eye open for the enemy and patrolling the sky in a relentless search. t moment of relapse could literally spell ath. The squadron 'Weaves', winding m side to side, kept a rather more wary e open than the rest, as the squadron ly closer by the second to their quarry. Brief instructions might crackle through the headphones: 'Close up Red 2' or, on receipt of further instructions from the Fighter Controller: 'Turning to Port, Go!'

Meanwhile, pilots fiddled with the dio tuner, struggling to tune and re-line their wireless sets in a constant ttle to receive and properly understand ir messages. Sometimes, a squawk of static drowned out everything, sometimes resulting in one section

having off suddenly, upwards or downwards, the rest of the squadron watching in bemusement and puzzled because they received no transmission, or else just couldn't understand what had been said. Meanwhile, constant juggling of the throttle setting with the left hand, and judicious adjustment of position through the control column and rudder pedal inputs, were all necessary just to keep station. It was incredibly hard work, and mentally and physically draining.

By now, the squadron was 'on oxygen', masks clamped securely to pilot's faces as cold began to permeate the cockpits. Now, with all the hard work of take-off, formation flying and getting to altitude, came further nervous tension with realisation that the enemy were near. Then, a tight knot of fear returned as the gunsight was checked and the SAFE and FIRE ring on the gun button turned, ready, to the FIRE position. Goggles pulled down. And then the shout:

'BANDITS! Ten o'clock, above. Coming down now! Break, break, break...'

Chatter Of Gunfire

Suddenly, to avoid the 'bounce' of fighters coming out of the sun, the squadron had dispersed in a pre-ordered plan. Now, the enemy fighters were among them. This time, there was no

Facing page **Although posed for a news cameraman, the squadron telephone orderly shouts instructions for a 'scramble' as pilots lounge in the dispersal hut. The smartly dressed officer is Duty Pilot – the pilot rostered for ground-admin tasks such as recording take-off and landing times etc.**

Above **It was not unusual for aircraft to return damaged after an engagement and with pilots wounded. This brand-new Spitfire had just been delivered to 602 Squadron at RAF Westhampnett when it was hit by cannon shells from a Messerschmitt 109 in a combat on 18 August 1940. The aircraft was written off and Flight Lieutenant Dunlop Urie wounded in his feet.**

chance of a well-ordered textbook 'Number One Attack'. Instead, it was every man for himself, but with 'wing men' desperately trying to maintain station and protect their section leader.

Now, the pilots were climbing and banging on their props, the sun glaring and blinding as they turned, all the while listening out and looking out. Now, there were shouts: "Behind you Blue 3!", permeated by chattering gunfire. A cacophony of shouts and static made communication unintelligible. One pilot may be drawing a bead on a

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