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# STRENGTH TEST

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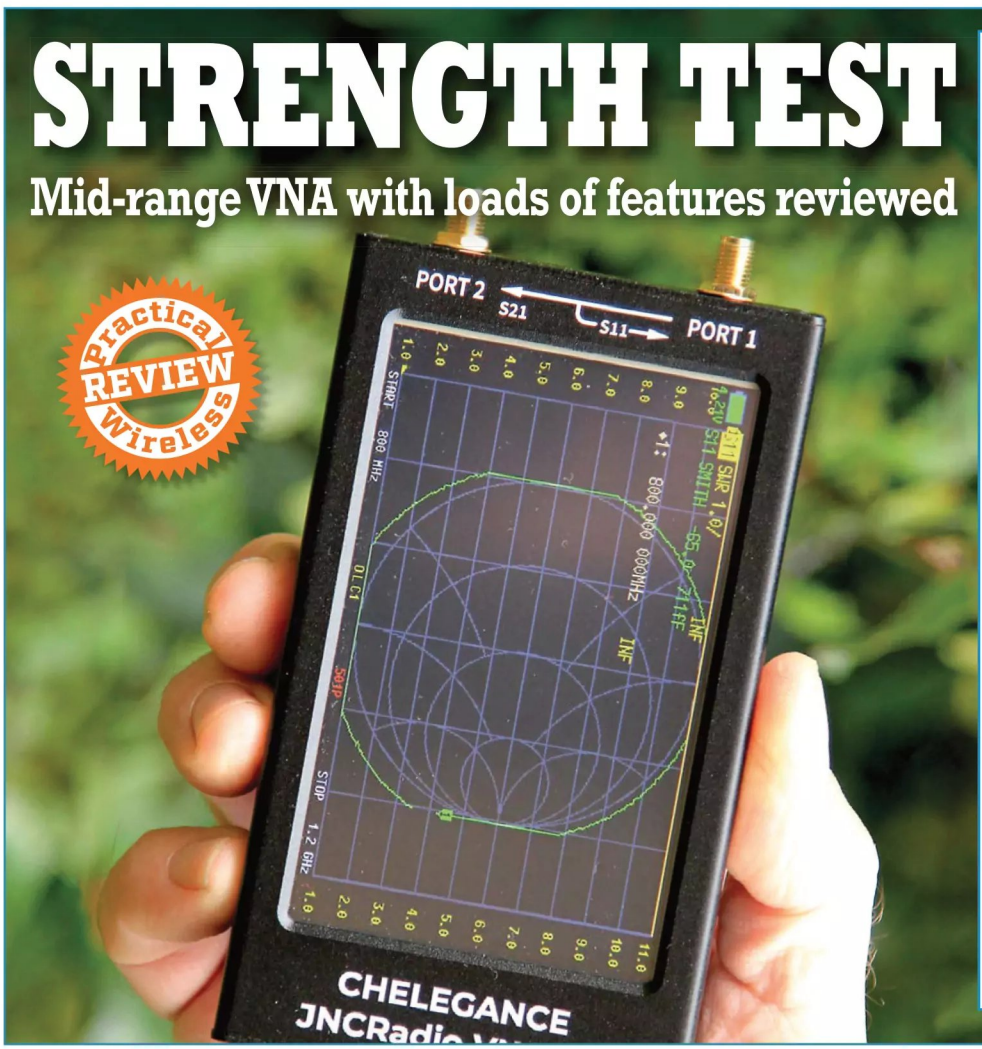


## Heathkit Mohican

Revolutionary shortwave transistor receiver recalled

## Chinese Takeaways

Reviewed - the new JPC-12 range of portable antennas

**HISTORY** Vintage Television and Radio

The issues with calibrating early Loudspeakers and Microphones


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# Keylines

I haven't done much operating of late although I did put in a token appearance in the ARRL 10m Contest. I made just over 100 QSOs on SSB, working across as far as Arizona. I must say, it was a pleasure to hear the band open again to the USA after what seems to have been an extended sunspot minimum. When it's in good shape, the 10m band can't be beaten. I recall, before I was licensed, sometime in the mid-60s, listening on an AR88 in the school's Combined Cadet Force 'shack' to US stations on 10m AM, tuning the band for callers! And they were loud, too. And I also recall, in the early 80s, converting a damaged TA33 triband Yagi into a 3-element monoband beam for the 10m band, putting it on top of a 20ft scaffold pole pointed towards the USA, and having a ball. Let's hope we see similar conditions returning over the next few years. I do remember a comment by the HF columnist in *Short Wave Magazine* many years ago to the effect that 10m was a 'gimmick' band, insofar as, when it was open, you could work the world with low power and a piece of wet string. If that's a gimmick, bring it on!

## Welcome

A warm welcome to readers who have joined us from *RadioUser* magazine. I do hope that you find enough in our pages to maintain your interest and I am always ready and willing to hear from you about the topics you would like to see included. Several authors from *RU* have agreed to contribute but I really need to know which areas of hobby radio are of most relevance to you.

Personally, I started my journey into radio through listening to the pirate radio stations in the 60s, moving on to general shortwave and medium wave broadcast DXing. But there are many other aspects to the hobby such as, nowadays, tiny transmitters carried aloft on high-altitude balloons, CubeSats of various genres and much more, including, of course, various means of linking radios to the internet. Do feel free to write, my email address appears close to the front of every issue.

## Home Construction

In my early days in the hobby I build a Codar Mini Clipper one-valve regenerative receiver and, later, a Lafayette KT-340 9-valve general coverage receiver. What they had in common was that they were kits – they came with all the metalwork, and a few bags of components. I did that because I really wasn't confident about 'chassis bashing'. Transistors changed all that.

One of my first transistor projects was a super-regenerative received for the 2m and aircraft bands built, if I remember correctly, on a wooden baseboard. Over the years I built several other projects, both from Heathkit (such as an HW-17 2m transceiver) and from parts. And a lot of fun it was too. But nowadays, I must admit, almost all my gear is commercial, because it simply isn't possible to achieve the same performance from homebrew (unless you are a very talented engineer indeed).

What this means for *PW*, unfortunately, is that I see fewer and fewer constructional projects coming our way, and have to rely on just one or two authors who still indulge. But I suspect there are actually many more of you who are building stuff and it's encouraging, for example, to read about the formation of the Southeast Builders Club (see *News* pages, p.8). Construction can take many and varied forms nowadays. I well remember a construction evening at the Reading Club where projects ranged from a Morse key (made in the member's workshop, with milling machine and lathe) to a 40m WSPR system based on off-the-shelf modules knitted together with home written software. Talking about which, Arduino-based projects always go down well with *PW* readers.

All of which is a roundabout way to seek out projects for publication. I can help you put the words together if need be. But do photograph your project at various stages of construction and keep notes. And what we pay for the article, while modest, may just cover the cost of your next project! **PW**

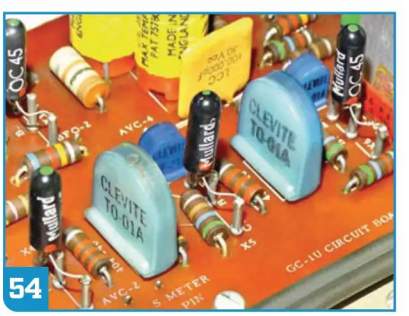
**Don Field G3XTT**
Editor, *Practical Wireless* Magazine

# Contents







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# Newsdesk

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


## Midland EK35 Emergency Radio Lifesaving Kit

Recently introduced by Midland for people who may be off the beaten track. The EK35 Emergency Radio Kit comprises two Midland XT30 PMR446 licence-free walkie-talkies with rechargeable batteries, an ER300 combined portable radio, a torch, an emergency dynamo crank handle power pack, plus a set of four thermal blankets. The complete kit sells for £119.95.

**www.nevadaradio.co.uk/product/ek35-emergency-kit**

## Hustler CB Aerials

Nevada carries four models of Hustler CB Aerials: These represent superb performance from a trusted US manufacturer. They are the F62B, F60B, F4B, and F3B.

**https://tinyurl.com/395yttaw**

## Counterfeit Icom

ICOM has reported seeing counterfeit copies of Icom radios available online, with some also arriving in the UK to unsuspecting buyers. These copies look like genuine Icom radios but, when examined more closely, are not and are significantly inferior in both quality and performance. Several buyers have contacted ICOM, believing they had purchased – and were receiving – a genuine ICOM product. On arrival, it turned out that the radios had an incorrect UK channel set, some channels were missing; and, in some cases, buttons were not functioning as expected. Most, if not all, of these counterfeit products, are found online; compared to genuine radios, they are priced very low. However, what might seem like a bargain or a great purchase, may soon become a disappointment and could affect how you use your radio, as well as your own and others' safety. If you are unsure, ask the seller for a serial number in advance of purchasing and call the ICOM customer service team in your region.

**https://tinyurl.com/3auarknd**

**VOLUNTEERS NEEDED FOR THE EXAMS AND SYLLABUS REVIEW GROUP (ERSG):** The RSGB are looking for additional members for the Exams and Syllabus Review Group (ESRG), formerly known as the Exams Group (EG). Membership of the Group now includes places for club tutors who hold a Full amateur radio licence and have taught the Full Syllabus for at least two years. To make an application or to find out more, email the Examination Standards Committee Chair at: **https://esc.chair@rsgb.org.uk**
Applications should include a brief description of your relevant experience professionally and/or in an amateur radio training capacity. Further information about the group, including its terms of reference and membership, at: **https://rsgb.org/esrg**

**RSGB LAUNCHES SCHOOL ZONE:** Following the success of University Corner, the RSGB's online list of universities with amateur radio clubs, the Society has launched School Zone: **www.rsgb.org/school-zone**
This brings together details of schools and colleges that have an active amateur radio club. If you have links with a school or college that has a club, why not see if they would like to be included in the online list - please send details to **comms@rsgb.org.uk**

**146/147MHZ NOV EXTENSION:** Ofcom has agreed to the RSGB request to extend the 146/147MHz NoV for a further year. It is available on a non-interference basis and the NoV is subject to a 30-day notice period of change or withdrawal. Full licence holders can apply for the 146/147MHz NoV at: **https://rsgb.org/nov**


# Moonraker & Steepletone

Moonraker is proud to be back and offering some Steepletone products. Moonraker first dealt with this company back in 1972, 'in the good old CB days', as some may say. Now the 2nd and 3rd generations of the family are at the helm and are running the business. Two new receivers are now in stock: The Steepletone MBR1051 7-Band Portable and SAB2019 14-Band Portable Receivers. The SAB2019 is advertised with the following features:

- High Sensitivity Multi-Use World Receiver • FM/AIR/MW/SW1-11; PLL Circuit
- Multi-Uses Rotary control for Volume, Tuning • Pre-programable stations; 4.5V DC Input Socket
- Headphone Socket for private listening (headphones not supplied)
- Stereo FM through Headphones • Seven-section telescopic aerial (53cm)
- Direct Key Frequency Input • LED Back Light; Carrying Strap
- Powered by 3 x AA Batteries (not supplied) • PU Travel Pouch; Colour: black
- 90 Min Sleep Function; Clock; Alarm Function; 30 Pre-sets per Band
- Dimensions: approx. 88mm (H) x 144mm (W) x 30mm (D)

**https://tinyurl.com/y73n8pjn**
**https://tinyurl.com/2s4x6hdk**



## New Publications

**Global Radio Guide**
**(19th Edition, Winter 2022-23)**
With tensions between Taiwan and China on the rise, and with the Russian-Ukrainian war raging on, radio hobbyists are following the latest news from the front lines using Short Wave broadcasts and various other radio services. You can hear these international events like the pros do, but you will need an accurate and comprehensive global radio guide to know where and when to tune in to the action. That is where you can count on **Gayle Van Horn W4GVH's** Amazon bestselling Global Radio Guide, as it has all of the details you need to catch up with the latest from these and other hotspots around the world.

As one of the only remaining publications available with international broadcast frequencies and schedules, the Global Radio Guide (GRG) puts everything a radio enthusiast needs to navigate the action right into their hands. The price for this latest edition – subtitled '*Troubled Waters*' – is US$8.99.

**www.teakpublishing.com**

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**Jahrbuch für den Funkamateur 2023**
(Ham Radio Operator's Annual) of the DARC is now available, in easy German. It offers a wealth of amateur radio information for which you will need little or no language knowledge.

**verlag@darcverlag.de**
**https://darcverlag.de**

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


## New Publications

**Radioworld (USA; December 2022):**
**https://tinyurl.com/3skyj97v**

**GEO Quarterly**
The December issue of the Group for Earth Observation (GEO) Quarterly Newsletter is now available for download from:
**https://tinyurl.com/39f8frew**

**UK Airband Frequency Guide 2023**
**Rick King's** practical UKAFG (UK Airband Frequency Guide) 2023 is a printed, ring-bound, book. It includes free UKAFG website access to frequency updates, civil and military callsigns and maps until the 1 Jan 2024. Key features: 8.33kHz conversion; Air Display Frequencies • Airports A to Z; Civil and Military • Common Frequencies; Dimensions: 16 x 1cm x 21cm • Frequency/ Channel list; HF VHF UHF • Squawk codes; UK ATC and high-level European
Available from Moonraker.
**https://tinyurl.com/5zreye3e**
**https://tinyurl.com/5xesjp6v**

**K9YA Telegraph (USA)**
The K9YA Telegraph is distributed as an Adobe PDF file. Since 2004, the Robert F. Heytow Memorial Radio Club has published its general interest amateur radio e-zine, read by amateurs in more than 100 countries. To subscribe visit the link below and click on the top menu 'K9YA TELEGRAPH' then select 'Subscribe'. You may also access substantial information via back issues there.
**www.k9ya.org**

**Radio Kurier 12/2022**
The latest issue from our German radio friends is available for members now:
**https://www.addx.de**


## New at ML&S: MyDel Mini Handheld FM Transceiver

The MyDel G63 UHF (400-480MHz) Mini Handheld FM Transceiver with Type-C USB charging facility is suitable for use with both the amateur radio UHF and the Ofcom simple business licences. ML&S can program to the UHF frequency allocated to you for a small fee. This transceiver is advertised as a great option for schools and colleges as classroom radios, health and safety support, and construction site comms.
**https://tinyurl.com/bdzpfvjr**

**SOUTHEAST BUILDERS CLUB UPDATE:** In July 2022 it was reported that Eric M0REQ and Graham G4NMD were proposing a regional hub for makers and home brewers of radio related projects. The first meeting was held in September 2022 and was attended by ten people with a further ten expressing interest by e-mail. After sharing their vision about a co-operative approach to making, and learning, in radio related activity, including pooling of knowledge, test equipment and books the assembled group were asked what they would like out of such a group. Out of that discussion came a variety of topics from construction techniques including kits and 'from scratch' builds through understanding test equipment, microcontrollers in the shack and on to specialist modes and wider-than-amateur related topics such as LoRa. The overriding factor was that the group was to be practice based.
The group met again in October with more members and because of the discussions around construction and SMD at the first meeting, and to test the venue as a place for hot soldering irons, they offered the opportunity to undertake construction of a 20W SMD dummy load as sold by KANGA UK. This proved a great success as the novices were supported by the 'old-hands' and completed dummy loads were produced. Testing dummy loads and questions of impedance and network analysis led to November's meeting being about VNAs and nanoVNAs and their usefulness in terms of understanding what is measured and what limitations they may have. After a short talk by Andy G4XYW the group engaged in practical 'shack related' experiments with a number of VNAs brought along on the evening. This reinforced the intended format of very short talks and a highly practical element to the meetings.
As there seems to be a core of around 15-20 'members', the November meeting agreed with the small steering group that the club was viable and that it would be known as Surrey Electronic Maker and Radio Club (SEMARC) and to that end have adopted a constitution and agreed subs for the coming year. Further to this the club intends to apply to be an affiliate of the RSGB.
From January 2023 the club will meet on the third Wednesday of the month 1930-2130 at Grafham Room, Horsham Road, Grafham GU5 0LJ.
The what3words address for the club is:
**///hiring.hedgehog.prayers**
**https://w3w.co/hiring.hedgehog.prayers**
**hamradiobuilders@gmail.com**

**HISTORIC BELL LABS HORN ANTENNA AT RISK):** Citizens for Informed Land Use, Preserve Holmdel and others are rallying to preserve the Bell Labs Horn Antenna, which they say is threatened if the 43-acre site it stands on is reclassified for residential development. The property at 791 Holmdel Road is home to the Bell Labs Horn Antenna, once used by Bell Labs scientists Robert Wilson, who still lives in the township, and Arno Penzias, to study microwave radiation from beyond the Milky Way, the organisation says. The site is also described by the group *"as the highest point in Monmouth County, providing remarkable views of Raritan Bay and Manhattan."* The scientists' research, *"confirmed evidence of the Big Bang Theory as the origin of the universe and earned both men a Nobel Prize in Physics in 1978,"* the land use group said in a news release. But on 22 Nov. 2022, the Township Committee approved a resolution directing the Planning Board to study whether the former Nokia site in the Crawford Hill section of Holmdel – the site of the Horn Antenna – should be reclassified as an 'area in need of redevelopment'.

**AMPLITUDE MODULATION AMATEUR RADIO SOCIETY (AMARS):** The AM Amateur Radio Society was formed in 2021. It has grown steadily since. The society held its AGM at the end of September 2022. That was an opportunity to announce a full programme of events for the year ahead. AMARS is a virtual club and its meetings are held on Zoom. These regular get-togethers are attended by members from across the UK, as well as those in Europe and USA. The society has members with an interest in older AM equipment, including several members of VMARS, for example. Then there are those enjoying AM performance of modern rigs, some of them new to the mode. And some have their sights set on modern designs and homebrew.

In January 2023 the society launched its newssheet, *Full Carrier*. This regular publication will include details of all up-coming events, including regular meetings and AMARS on-air activities. Already scheduled for 2023, AMARS has:

**27 January:** Emergency – Public Safety Communication Past & Present

**24 February:** One Man DXpeditions in the Pacific, a talk by ZL1BQD

**31 March:** Vertical Antenna Arrays, presented by **John Gendron NJ4Z**

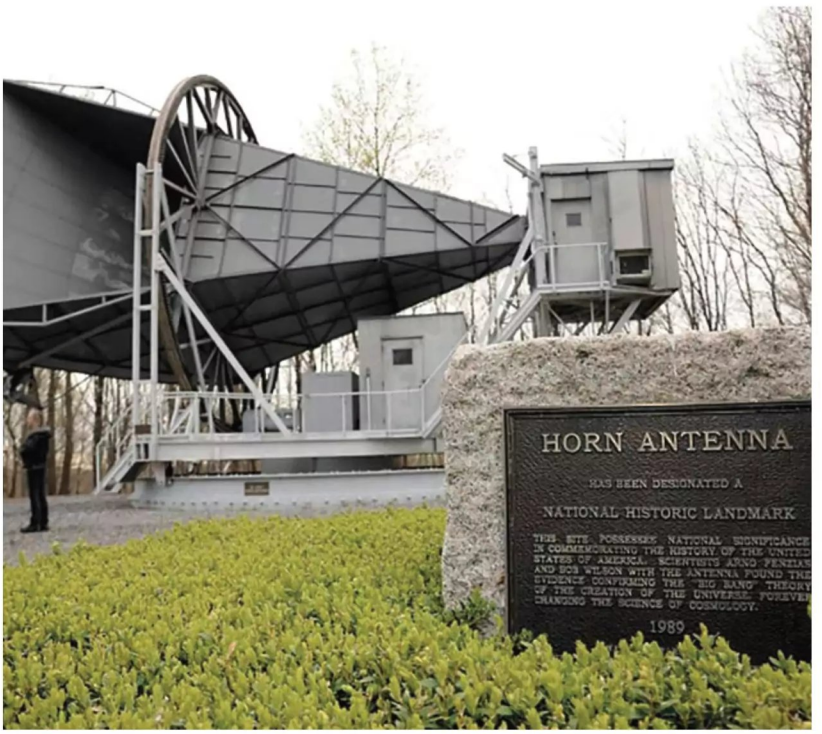
**28 April:** MW0NWM presents Auntie's War – the BBC 1939 – 1945

**20 May:** Taking a Broadcast Transmitter Home with You! An intriguing talk by **Philip Neidlinger KA4KOE**

**18–19. February 2023** The first AM QSO Party Operating Event

**22 April:** 60 metre Day

Contact Simon Taylor MW0NWM at **m3set@yahoo.co.uk**




**CENTRAL RADIO AMATEUR CIRCLE/ MARCONI RADIO CIRCLE (MALTA), MALTA OPERATION 2023:** The Marconi Radio Circle and Central Radio Amateur Circle will be setting up a join station in Imtarfa Malta for five days in October 2023 (2nd to 6th).

The two clubs will sort out the day to day running of the station. This is open to any full licensed amateur with a passport. Sorry but you need a full licence to operate in Malta.

Operators from the UK will need to sort their own transport and hotels in Malta. All you need for Malta at the moment is a current passport, there are currently no restrictions on travel, but people are advised to keep an eye on the situation in case anything changes.

Depending on airline, flights are from around £50 each way. Depending on what people want the hotel cost is typically from around £150 per person for just bed and breakfast. There will be a small charge of 25 Euros each. This is to cover the running cost of the station such as electricity, water and drinks.

There will be a rota for people to choose when they want to operate the station. No one will be expected to operate all the time. There should be enough time for people to have a good explore of the island and its culture.

Times of operation will be between 1000 and 1700, with the option of a late night if required. Anyone wishing to take part can contact the author via email to start with and he will send more information as and when it is available: **radio-circle@live.co.uk**

**DATES ANNOUNCED FOR RADIODAYS IRELAND 2023:** Learning Waves and the IBI have announced the return of Radiodays Ireland 2023. The two-day event will take place on 16 and 17 February 2023 at the Gibson Hotel in Dublin, three years after the last gathering. It is supported by the BAI and IMRO, and full details of the sessions and schedule will be released over the coming weeks. The last Radiodays Ireland event took place in 2020 shortly before restrictions on events were introduced due to the coronavirus pandemic

**LOCAL BBC RADIO SHARING PROPOSALS:** BBC Director of Nations Rhodri Talfan Davies and BBC Director of England Jason Horton have defended recent proposals to reduce the number of local programmes on Local BBC Radio. Appearing in front of the Digital, Culture, Media and Sport Committee, the two Directors answered questions about the plans to introduce regional programmes on 39 local stations outside of the weekday 6am to 2pm slots.

During the two-hour session, which can be viewed online (URL below), several pertinent topics were raised, including Rhodri Talfan Davies's salary, pointing out that it is ten times what the average journalist on a BBC local radio station is earning – a sore subject when bosses say there isn't any more money available.

**https://tinyurl.com/yf2zpksd**
**https://tinyurl.com/vjcfnfmw**

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**Richard Constantine G3UGF**
practicalwireless@warnersgroup.co.uk

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# The JPC-12 Vertical Antenna

**Richard Constantine G3UGF** takes an in-depth look at this range of new portable antennas from China.

I must confess to being more than a little confused when the latest portable antenna arrived for review, direct from China. The legend on the small zip around, compact, 'handbag' sported the embroidered legend of JPC-7. The antenna inside was in fact the JPC-12 a ground mounted, 100W maximum vertical.

The confusion didn't stop there, the component parts looked to be too small to provide a decent sized, meaningful antenna and only weighed around 1.4kg in total. To add to the confusion the foreign language handbook wasn't in Mandarin or Cantonese …not that I can read either. I discovered later with the help of a friend, that it was written in basic every day keyboard Chinese.

Translation efforts proved very limited, as my friend from Hong Kong doesn't understand any technical terms. The handbook is cunningly designed for more than one model of antenna. It's difficult when you don't understand Chinese and don't understand that to read about either of the two models, you simply turn the book over and start reading from the other end.

## If All Else Fails…

Despite my maxim 'If all else fails read the handbook', it was relatively simple to assemble the antenna without it. I was staggered to discover that from small beginnings it turned out to be twice my height, quite impressive.

Just for fun I later timed the assembly from opening the bag, planting the antenna and plugging in the coaxial cable (not included). My record was 4 mins 26 seconds, against the handbook quote of 3 minutes. Resonating and matching certainly takes more time.

I've experienced many mobile and compact antennas over the years and way back reviewed the original Buddipole, when it was still available as an online DIY project. The concept of this antenna is much like the single-ended Bud-Stick that was produced later. Mast sections of the standard Buddipole are 55cm each and their Mini version reduced to 28cm. This compares to the JPC masts at 35cm.

Looking through the package I recalled my basic physics and the sage advice of the Old Timers of my boyhood radio club. Experience has taught me that the junction of dissimilar metals is not a good idea unless you're deliberately looking to create a high resistance or a diode effect. Such things weather badly and must be kept very clean. This antenna uses 10mm studding bolts and brass alloy threaded sockets. There's plated stainless, plated steel, manganese steel, aluminium and more. Engineering wise, the metal parts are of a good standard and fit together extremely well on the flush faces

Of course, it's a portable antenna and realistically unsuitable for anything other than a temporary setup as it stands. Never throw it back in its bag and forget it, when it's been out in the wonderful wet British weather.

## From the Ground Up

Starting from the ground up literally, the 25cm earth spike is curiously light in weight, but of course this is a portable antenna so weight or lack of it, is important. Part of it isn't electroplated so as to give better contact with the ground. I quickly realised not to hammer it into the ground to prevent damaging the exposed thread. Perhaps a flush socket design as against an exposed thread would have been better. I discovered the best way to achieve a reasonable result was to attach the base-connector unit and/or the first of the four anodised alloy tubes and push down hard. Alternatively, to use a rubber tent peg hammer on the socket end of a tube and not the exposed ground spike thread.

It's worth noting for those like me that enjoy mixing and matching various antenna parts from different systems, in the vain hope of achieving the 'holy grail' of compact antennas, that this antenna is not compatible with others. It uses

**Photo 1: QRP on the Yorkshire Wolds. Photo 2: JPC-12 outdoors. Photo 3: Coil close up. Photo 4: ARRL Antenna Handbook 1964 (Reproduced by kind permission of ARRL, copyright retained.)**

a 10mm thread system and not the ubiquitous American, 3/8th UNC threaded antenna parts and mounts we came to know in the CB boom.

However, if you want to make up other mounts or play around, 10mm threaded bar and bolts are common fare at the local DIY emporiums. A mirror mount type bracket or G clamp with a 10mm bolt spring easily to mind

Attaching the loading coil section is straightforward, so too is the 2.5m, ten section, stainless telescopic whip. I was concerned that the combined weight of these two components at around 280 grams would make the antenna unstable. However, in round terms it's balanced out by the weight of the base connector unit that feels heavy on first handling. I can't decide whether this is a happy accident or good design.

The complete assembly is reasonably stable and certainly unobtrusive for a typical campsite. For hill topping, carrying some ground pegs and para cord is advisable as the coil/whip assembly certainly attracts some windage.

The package includes a single counterpoise made from ten-strand ribbon cable. It attaches by means of a ring connector between the ground stake and the base/connector tube. Unlike the thin, separate, spaghetti wires provided with some other portable antennas, it's one single strip 2.64m in length and 1.2cm wide. The handbook says it's 10m.

Perhaps lost in translation it actually means it's a quarter wavelength on the 10m band and therefore harmonically related only to the non -WARC bands. That said, when on the ground the single counterpoise that's incidentally handling 50% of the RF, becomes de-tuned anyway. This means its length isn't that critical. I was tempted to split the wire but vowed to make more like it for better results. Attaching more wires with a similar surface area at this point does improve things and can make matching easier on favourite bands but has not much effect on expanding the narrow bandwidth of the system. With a single wire counterpoise, carry a compass. It can help to point the RF towards a favoured direction.

This proved great for directing my signal to PY on 15 metres, or was it just that band conditions improved a little bit after I moved the wire, something to play with?

Note to self: Must make more grey counterpoise wires, not as garish as other colours or as discreet on a campsite as my green ones and less of a trip hazard in the early hours!

I was intrigued to know what was in the heavy sealed base unit. Does it perhaps contain a balun or an UNUN? Metering through showed no sign of a short circuit and therefore unlikely to contain a balun. I was guessing that it might contain ferrite rings to tame any RF on the coax feedline, so asked the question of the manufacturer. The reply came back in Chinese. The non-technical translation came out as being the presence of *"3 metal bars"*. From this I take it that my second guess was correct. Indeed, the coax proved RF docile under test.

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## Now for the Loading Coil

They do say there's nothing new under the sun. Immediately I unpacked it, this antenna jogged my memory of a DIY design in an old ARRL antenna handbook; back in the day when everyone made everything. I've always meant to build one but now I don't need to bother, see **Photo 4**.

Assembled, the coil sits at around one third of the total antenna length. Accepted wisdom is that it should be higher at around between 40-60% in order to maximise current distribution. It would be interesting to see what adding two more threaded tubes would do in terms of radiation and matching.

The translated handbook says that the 33 turn, silver-plated wire loading coil is wound on a Nylon former. The former is most likely moulded, not 3D printed, but the material makes me think of it. Unlikely to be pure Nylon because this can absorb water and is not good for antennas. At 45mm in diameter it's a good size in terms of maximising *Q* factor and better than some of the competition. An add-on coil with no tapping slider is said to be available to extend the antenna's use to 80m, subject to the use of longer counterpoise wires. Thus far, I haven't found a stand-alone 80m inductor available online.

Perhaps I'll find out in **Part 2** of this review (next month). Yes, there's more to come from this antenna system…


3

Mounted on a slider and using modern materials to maximise contact pressure, matching is achieved by means of a manganese spring steel contact. Longevity is an unknown quantity at this stage. It looks pretty resilient to me. Kept clean (with a contact burnisher, not sandpaper!) and with care it should last a long time. I wonder if you can buy a spare contact. On close inspection, it looks to be very much an easily replicable item.

The loading coil is short-circuited from the top down, not engaged from the bottom up as I originally guessed. There's a silver mark for the 40m band near the top and a lower gold mark for the 20m band.

40m and 20m markings are guidelines. Instructions say that on 20m the whip section needs to be reduced by 20cm. Of course, fine tuning is a movable feast when you factor in

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each individual portable location and ground characteristics into the equation. 30m isn't marked or listed, but it's somewhere in between the other tappings.

You also have to be careful that the spring contact only touches a single winding. To help, it's notched in the centre. Being a compact antenna on the lower bands, bandwidth is narrow. The quick way to match it is with one of the new pocket analysers, but is achievable by first maximising a received signal followed with a VSWR meter on transmit. Good matching is critical.

What I didn't know until the manufacturers kindly sent me the English version of the instructions is that for 15m, the coil is removed. The four lower rods remain and only seven sections of the whip plus 10cm of the next section are to use for resonance on 15m.

For the 10m band, the telescopic antenna is connected directly to the base alone. It's fully extended, less half the top section (fully extended for 11m, methinks). Reading this was my eureka moment. Of course, it's simple! From 15m to 6m, including WARC bands, it becomes a straightforward ground-mounted quarter wave. Why didn't I think of that before?

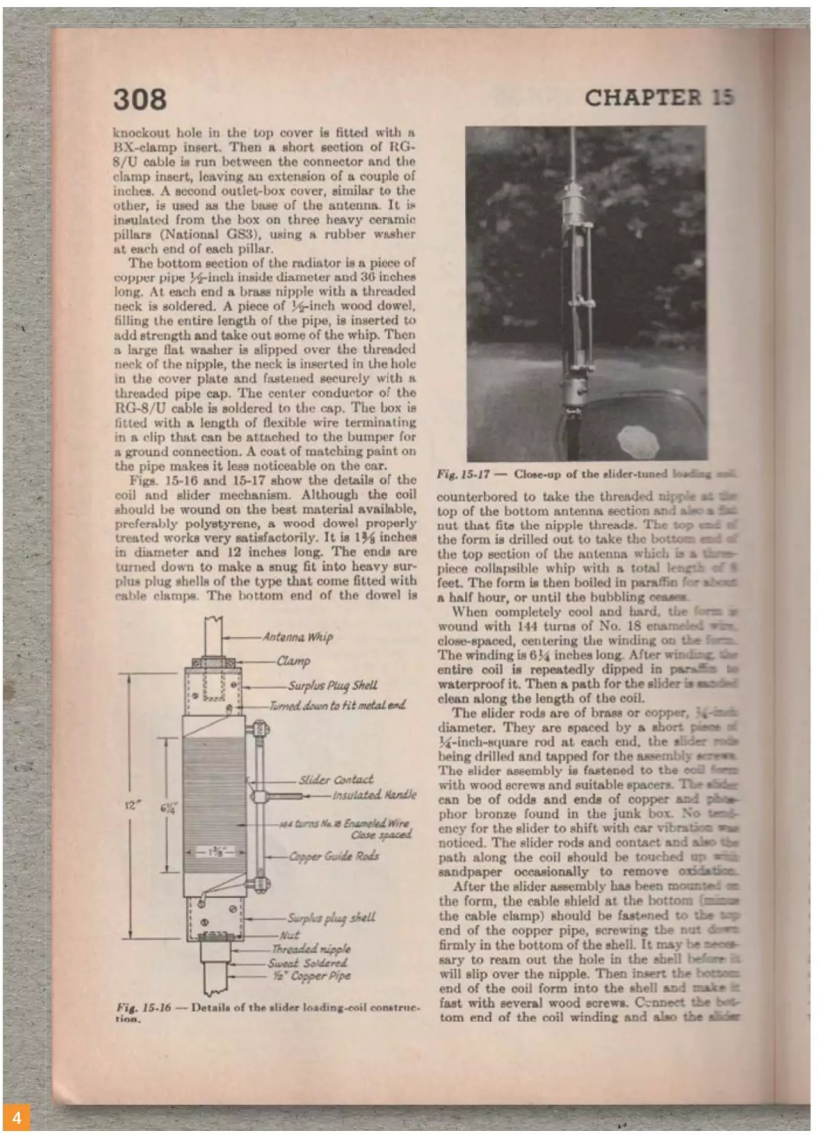
Matching this antenna changes with every change of location and ground condition. 1.1:1 or better is achievable on 40m as the specifications state. That is, given some time fiddling and fine tuning, damp ground and a decent earth. I've also experienced locations where this and anything better was difficult without the aid of an external tuner Not ideal for QRP where every watt counts.

The manufacturer states that 1:1 is possible from around 30m-6m but as yet I've never quite achieved that across the whole range. The higher in frequency you go the easier it becomes to find a decent match but I still go back to the need for additional counterpoises or better earthing to get good results.

That said, from an initial trial as supplied, in a quiet RF location, clear low angle takes off on G3UNC's campsite in East Yorkshire; 5 watts of CW produced good contacts all around Europe from Sweden to Spain, with very little effort on 40m. I prefer to make live contacts with real people because data hasn't really floated my boat, as yet. Nevertheless, I do think that this type of antenna lends itself very well to data contacts and WSPR, if larger antennas are not practical.

## What do I Think of It?

Over time the market for small, compact antennas has grown to offer a range of options and cost. Several have become costly to make and ship, especially those using high-end components, and include extras such as optional brackets, connecters, adapters coax and cases, etc.



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knockout hole in the top cover is fitted with a BX-clamp insert. Then a short section of RG-8/U cable is run between the connector and the clamp insert, leaving an extension of a couple of inches. A second outlet-box cover, similar to the other, is used as the base of the antenna. It is insulated from the box on three heavy ceramic pillars (National GS3), using a rubber washer at each end of each pillar.

The bottom section of the radiator is a piece of copper pipe ½-inch inside diameter and 36 inches long. At each end a brass nipple with a threaded neck is soldered. A piece of ½-inch wood dowel, filling the entire length of the pipe, is inserted to add strength and take out some of the whip. Then a large flat washer is slipped over the threaded neck of the nipple, the neck is inserted in the hole in the cover plate and fastened securely with a threaded pipe cap. The center conductor of the RG-8/U cable is soldered to the cap. The box is fitted with a length of flexible wire terminating in a clip that can be attached to the bumper for a ground connection. A coat of matching paint on the pipe makes it less noticeable on the car.

Figs. 15-16 and 15-17 show the details of the coil and slider mechanism. Although the coil should be wound on the best material available, preferably polystyrene, a wood dowel properly treated works very satisfactorily. It is 1⅜ inches in diameter and 12 inches long. The ends are turned down to make a snug fit into heavy surplus plug shells of the type that come fitted with cable clamps. The bottom end of the dowel is




*Fig. 15-16 — Details of the slider loading-coil construction.*



*Fig. 15-17 — Close-up of the slider-tuned loading coil.*

counterbored to take the threaded nipple at the top of the bottom antenna section and also a flat nut that fits the nipple threads. The top end of the form is drilled out to take the bottom end of the top section of the antenna which is a three-piece collapsible whip with a total length of 8 feet. The form is then boiled in paraffin for about a half hour, or until the bubbling ceases.

When completely cool and hard, the form is wound with 144 turns of No. 18 enameled wire, close-spaced, centering the winding on the form. The winding is 6¼ inches long. After winding, the entire coil is repeatedly dipped in paraffin to waterproof it. Then a path for the slider is sanded clean along the length of the coil.

The slider rods are of brass or copper, ¼-inch diameter. They are spaced by a short piece of ¼-inch-square rod at each end, the slider rods being drilled and tapped for the assembly screws. The slider assembly is fastened to the coil form with wood screws and suitable spacers. The slider can be of odds and ends of copper and phosphor bronze found in the junk box. No tendency for the slider to shift with car vibration was noticed. The slider rods and contact and also the path along the coil should be touched up with sandpaper occasionally to remove oxidation.

After the slider assembly has been mounted on the form, the cable shield at the bottom (minus the cable clamp) should be fastened to the top end of the copper pipe, screwing the nut down firmly in the bottom of the shell. It may be necessary to ream out the hole in the shell before it will slip over the nipple. Then insert the bottom end of the coil form into the shell and make it fast with several wood screws. Connect the bottom end of the coil winding and also the slider

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From my initial observations and misgivings, I have come to appreciate that this is a very acceptable and unobtrusive device, particularly for operating /P just about anywhere, provided you accept its limitations.

It has a small footprint and is reasonably unobtrusive when erected. I really like that it's compact and lightweight, takes up surprisingly little space when packed, yet assembles into a good size at around 12ft, in old money.

Weatherproofing is minimal. To help with this I've made use of a £1.50 plastic funnel cut to provide a friction fit above the coil. For heavy weather, I'm considering up cycling a plastic drinks bottle with the bottom removed. I just need to find the right one.

I have a few concerns regarding the differing metals but to some extent it's unavoidable. As with almost all of these end-fed verticals, earthing or counterpoise is key to success. Adding three or four radials to the kit does pay dividends.

In the last few months advertising for this range from China has boomed, online. Traditionally, Chinese products are sold through agents. It can be a case of 'caveat emptor' for the unsuspecting buyer when dealing remotely.

Since receiving this antenna direct, several UK suppliers have taken it up under different branding. While there may be some cost difference buying from UK sources, delivery from stock and the knowledge that reputable dealers support their buyers is well worth it. Price wise at circa £199.00 in the UK, it stands up well against what else is available.

Overall, I like it and I'm using it. I'm also really looking forward to reviewing the JPC-7 dipole – Part 2 coming next month! **PW**

**Keith Rawlings G4MIU**
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1

# JNC Radio VNA 3G

**Keith Rawlings G4MIU** looks at a mid-range VNA that offers lots of features at a reasonable price.

The JNC Radio VNA 3G is a compact portable Two Port Vector Network Analyser (VNA) covering the range 50kHz to 3GHz* (see below). It can be used as a standalone unit and also with free PC software, which provides additional functionality. Some of its measurement features are VSWR, LogMag, Phase, Delay, *Q* Factor, Polar, Linear, Real, Imaginary, Resistance, Reactance and TDR among others.

With the VNA-3G a user can undertake tests and measurements on Antennas, Amplifiers, Filters, Attenuators, Duplexers, Diplexers, Cables, Discrete Components and so on. A basic Signal Generator has also been implemented, which works over the frequency range of 50kHz to 4.4GHz thus covering the main amateur bands from LF to 9cm. Above 135MHz output power is 'adjustable' with levels of 0, –3, –6, –9dB relative to output.

The VNA 3G is a variation of the well know NanoVNA analyser design, which has quickly become a firm favourite within the amateur fraternity. Now, at the fraction of the price of a traditional VNA, users are able to perform a multitude of Radio Frequency (RF) measurements with an accuracy that is more than satisfactory for amateur use, **Fig. 1**.

## Description

The unit comes well packed in a sturdy storage box, **Fig. 2**. A number of accessories are included: A USB-C cable, a Stylus, a Short, Open and Load SMA Calibration Kit(Cal-Kit), Male/Male and Female/Female straight SMA adaptors, Male/Female right-angle SMA adaptor and two SMA Male RG405 patch leads approximately 200mm long. All contents were a snug fit in the box, being held by foam packaging. No manual is supplied, users need to refer to the website to obtain latest documentation. I noted that no calibration parameters were supplied with the Cal-Kit.

The 3G is built within a sturdy aluminium case approximately 130 x 72 x 22mm not including protrusions. A wide viewing angle 4.3in touchscreen LC display is fitted to the top of the unit. To the left-hand side there are two female SMA sockets; the upper marked **Port 1** and the lower **Port 2** with legends for these on the top edge of the case with the port directions clearly marked **S21** (through) and **S11** (reflected).

The right-hand end houses a USB C socket, on/off switch, a USB A socket, and an 'internal' LED visible red when charging and blue when in use.

There are also three small side buttons used for animating the frequency markers and menu. There is an inbuilt 3.7V 5000mAh battery, which is quoted to provide some seven hours of use. Overall, the unit feels sturdy and uses good quality components. What follows is but a brief description of just some of the VNA 3G's capabilities.


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## In Use

The analyser is switched on by means of the slide switch on the right-hand end of the unit. After a short 'Splash Screen' the user is presented with the main screen. This is dominated with a 6x10 grid and two (configurable) coordinate scales either side. Tapping the screen anywhere from the middle to the right-hand side brings up the main menu where selecting an option brings up a sub-menu, which in turn will bring up further options depending on the function selected. A finger may be used on the screen but the use of the supplied stylus makes life a lot easier.

Up to four traces may be selected and each may be assigned to any 'Format', i.e SWR, LogMag, Smith Chart etc. Each may have its Reference Position set anywhere on the screen.

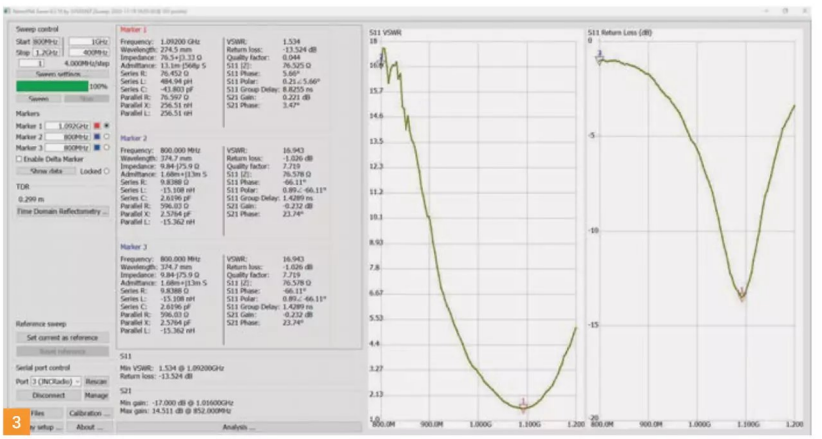
The menu may also be brought up by pressing the middle button on the right-hand end of the unit. The two buttons either side of this may be used to select menu options, and when not in menu mode they can be used to position the trace markers. Up to four sets of marker information may be displayed at the same time, each including frequency plus two other parameters. The diamond mark in front of the marker indicates the active marker and markers themselves can be dragged to position on a trace.

The range of the Frequency Sweep may be set in kHz, MHz or GHz under the 'Stimulus' option by entering the Start and Stop frequencies or Centre and Span using the screen keypad. Measurements are made via the two SMA sockets. Port 1 is for S11 reflection measurements and Port 2 S21 through measurements.

If extensive use is expected, then I would permanently add sacrificial adaptors to the device to save wear.

Before we can start using the unit it must be 'Calibrated' with a 'User Calibration'. Here a Short Open and Load are placed at the measurement plane, say the at the end of a coaxial cable, to fac-

**Fig. 1: The VNA-3G is compact. Fig. 2: The VNA-3G outfit in box with accessories. Fig. 3: NanoSaver Mode-S Antenna SWR and Return Loss. Fig. 4: VNA-3G Reading Mode-S Antenna VSWR. Fig. 5: VNA-3G set up as a Dip Meter. Fig. 6: DG8SAQ VNWA software Displaying saved .s*p of Cable Length. Fig. 7: BNC Cal-Kit in place for Dip Meter reading. Fig. 8: VNA-3G Signal Generator testing. Fig. 9: Some spurious outputs were observed. Fig. 10: VNA-3G measuring supplied load 3-4.4GHz.**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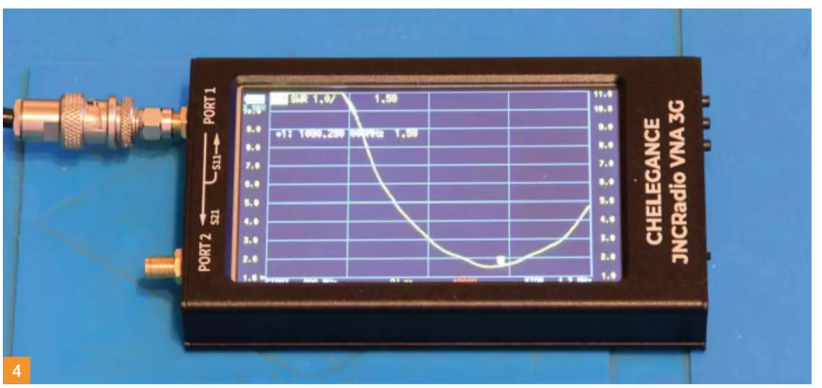

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tor out the effects of the cable and connectors, and then the calibration process run from the menu. If an S21 measurement is required, then a 'Thru' calibration is also undertaken.

Calibration settings may be saved into any one of 13 calibration memories for later recall. This is very useful for saving specific calibrations for different setups.

I could not find a way to enter Cal-Kit 'Calibration Standards' into the analyser itself, which may result in inaccuracies at the higher frequencies. However, a delay may be set in Nano Seconds (ns) or Pico Seconds (ps) to compensate for delays that are introduced by cables and connectors.

With the latest firmware (see sidebar) the number of scan (or sweep) points has been increased from 501 to 1001 points. This is a useful increase as the number of available scan points dictates the 'resolution' of the sweeps.

In use the unit gets warm and when charging, due to the current draw, a USB charger should be used rather than a PC USB port.

Due to the weather most of my testing was done indoors but I noted that when used outside on an overcast day the screen was readable, but on a bright sunny day I think I may have had to angle or shield the screen to be able to read it easily.

For this review I have concentrated on using the VNA-3G as a standalone unit but have included screen images from the optional free NanoVNA Saver software. This software greatly enhances the VNA 3G and is, in my opinion, recommended for when the VNA 3G is needed where tests require more detail and accuracy.

**Fig. 3** Is a NanoVNA Saver screen of SWR and Return Loss values of a 1090MHz ADSB antenna and **Fig. 4** from the unit itself.

## Analysis

The VNA 3G is capable of making a vast number of RF measurements. Taking it as a given that we can use it on antennas to easily evaluate VSWR and impedance here are a few other basic measurements it can make.

## Measuring Cable Lengths

The VNA 3G has a Time Domain Reflectometry function (TDR) and using this we can measure feedline length. The objects of my tests were a couple of lengths of RG58, one 4.2m long and the other 5m. I set Trace 0 to 'LogMag', Channel to S11(reflection) selected the TDR menu option, selected TDR 'On', set the velocity factor to 66% and left the filter setting at Band Pass.

The time span is set somewhat experimentally by selecting a stop frequency and dragging a marker to the right to see if the distance resolution in metres is suitable for the length of cable to be measured, basically the time length is the distance. I connected the 4.2m cable to Port 1 and was rewarded with a trace that looked very flat with a faint trace indicating a length of just over 2m, not what I expected. The 5m length was substituted and read 2.5m long. Clearly these dimensions are half the expected readings and therefore no surprise that the two lengths added together amounted to around 4.5m long.

I contacted **Gary Spiers M0TIG** at ML&S and after a few email exchanges I was given a link to download a firmware update, V1.1.0. The update was installed by connecting the unit to the PC by USB Cable, pushing and holding the middle side button on the VNA 3G and switching on. The device opens up as a disk drive on the PC and the updated firmware is simply pasted into the 'root' directory of the device.

I can report that the firmware update worked perfectly! Cable lengths are now measured correctly, the display is more like I would expect from a TDR measurement, and when I connected the two pieces of RG58 together with an inline BNC adaptor I could clearly see the disturbance in the trace at the point of the join and locate this point to within a few cm. This is great for checking damaged lines.

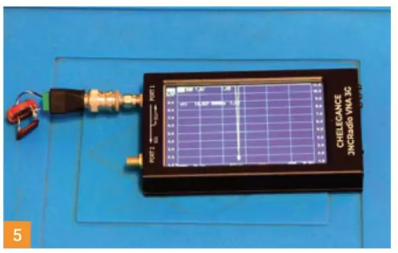
All measurements made on the VNA 3G may be saved as .s*p Touchstone files and opened up using suitable applications. See **Fig. 6** where the cable measurement data has been exported to the DG8SAQ VNWA software.

## Measure Cable Loss at 1 GHz

I made a two-port through calibration using the supplied patch leads fitted with BNC adaptors on the ends. No attempt was made to adjust the reference planes of the connectors. I used the 4.2m length of RG58 and measured an S21 through loss of 3.5dB. Incidentally attenuators and filters may be characterised using the same setup.

It may not always be possible to access the far end of a coaxial cable with the VNA, but it is still possible make an assessment of cable loss. I disconnected the cable from Port 2 and left the far end open.

Then making an S11 VSWR reflection measurement on the cable, which read 2.44:1, I looked up a Return Loss Chart and the 2.44:1 VSWR was converted to 7.707dB return loss. By dividing by 2, to allow for the cable return distance, this gave a loss figure of 3.85dB.



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## Dip Meter

The VNA 3G may also be used as a dip meter.

In my junk box I had an FT68-2 toroid with 23 turns of wire wound on it. I then connected a 47pF capacitor across it to form an LC circuit and put a single loop of wire through the toroid and connected to the VNA 3G as seen in **Fig. 5**.

Port 1 had been calibrated directly onto the socket, **Fig. 7**, Trace 0 set to 'SWR' with a span of 50kHz to 30MHz. The resulting trace can be seen in Fig. 6 where there is a 'Dip' at 13.527MHz. I calculated that a 23-turn toroid would have an inductance of around 3µH. With the 47pF capacitor added across it I calculated a resonant frequency of 13.403MHz. Allowing for component tolerances the VNA 3G was not far off, reading 13.527MHz, so not bad! **Fig. 8** demonstrates a NanoSaver screenshot.

## Signal Generator.

The unit has a basic signal generator function, useful for indication up to 4GHz. It has fixed output up to 135MHz and after that three levels of attenuation, –3, –6 and –9dB. The levels I measured can be seen in **Table 1**. The 6dB and 9dB settings appeared to give no output and the generator seems to produce some spurious outputs, **Fig. 9**. A 20dB attenuator was used to protect the spectrum analyser.

## Note

*Although this requires more investigation while evaluating the VNA 3G I found I could set a maximum frequency of, and calibrate up to, 4.4GHz.

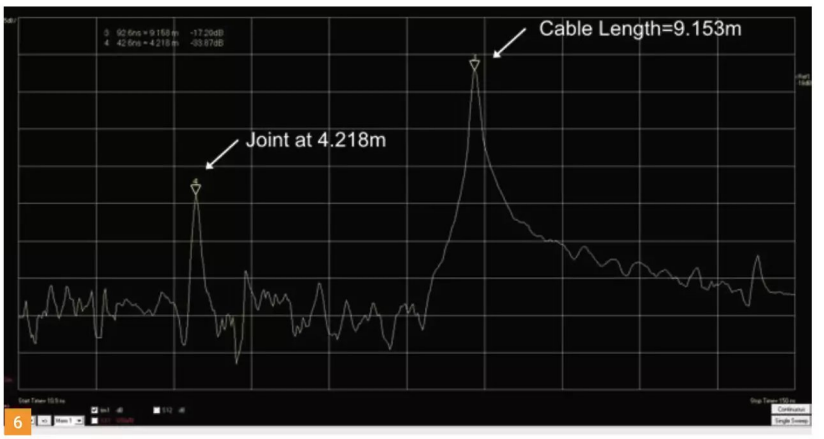
**Fig. 10** illustrates the supplied load swept after calibration using my Rosenberger kit. Note the spurious signal 3.347GHz.

## Conclusion

I certainly found the VNA 3G very useful. It is sturdily built and easy to use with the menu system well laid out and simple to step through. The outfit comes with all the basic items needed to get going. Battery life was good at roughly the quoted 7hrs. The device may be used to make quick and accurate measurements just about anywhere.

When used portable its durability and long battery life will make it valuable while setting up, or when changing bands, antennas can be adjusted for lowest VSWR and, if any antenna problems do arise, the VNA 3G can be used to diagnose them.

It has the ability to perform a large number of other tests and measurements, which will make it a valuable asset in the shack, where filters may be checked and aligned, relays tested for insertion loss, attenuators tested or calibrated, line lengths and any disturbances in that line may be measured, the list goes on. The ability to run computer software is an added bonus and I conclude that the VNA 3G is a great little device. Overall I would give it 4.5 to 5 stars, based on its functionality versus price.



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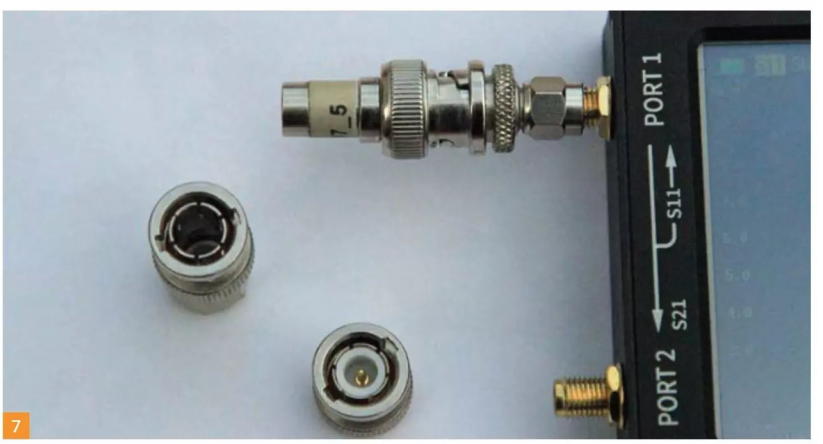

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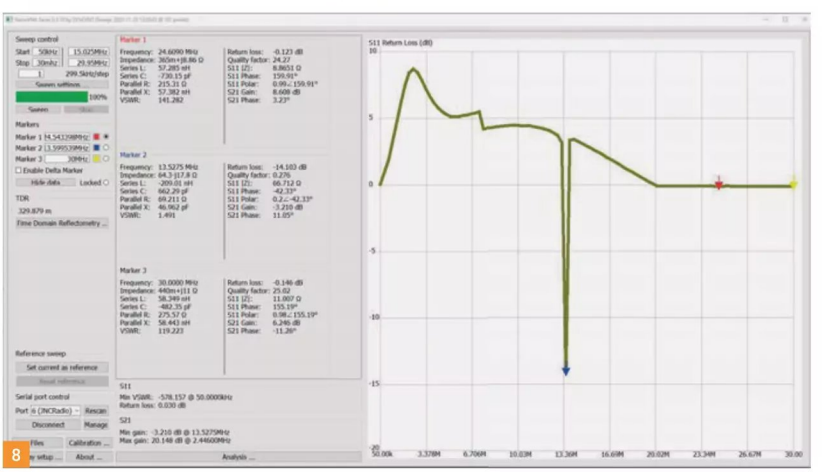

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My sincere thanks to ML&S for the loan of the review unit, to **Dan 2E0HKS** for arranging it and to Gary M0TIG for his prompt attention to my questions.

The current price is £174.96. Here's the link to the relevant page on the ML&S website:
**https://tinyurl.com/bdhwu4bw**

Full Technical Specifications:
**https://tinyurl.com/27aet7vh**

The latest firmware update includes:
1. Scan points increased to 1001 from 501.
2. When only channel S11 is turned on the acquisition and processing of channel S21 is automatically stopped to speed up scanning.
3. Correction to the sign of group delay value, and the group delay noise is improved.
4. Fixed the bug of TDR mode.
5. When 'save' or 'recall' command is sent with no arguments, the status of all save/recall slots will be printed.
6. Dark mode supported: copy 'dark_mode.txt' to the root directory of the VNA to enable dark mode.
7. Optimised the display format of the frequency range on the main screen.
8. Added a battery level icon.

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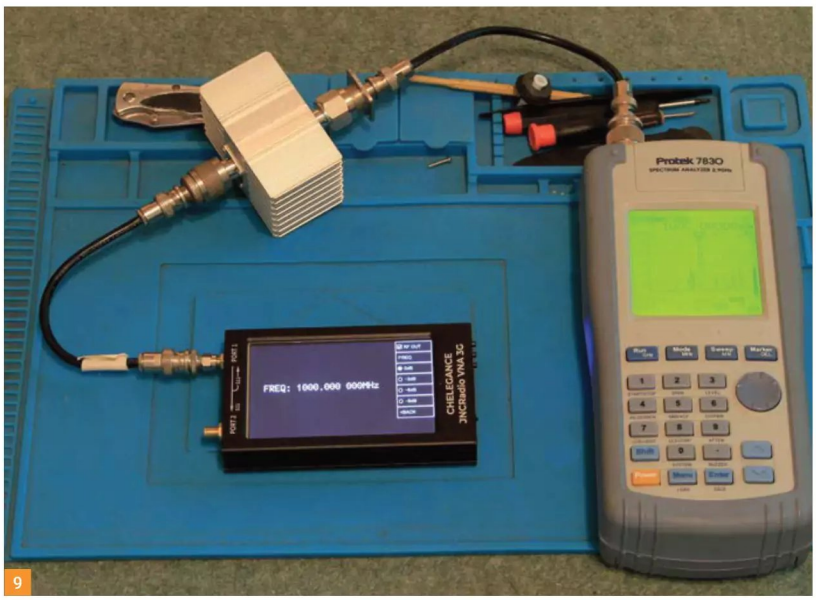

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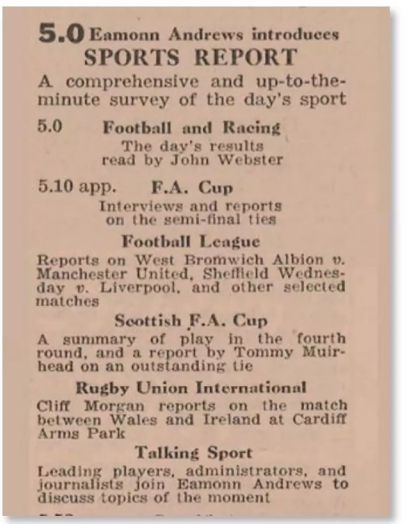
| Frequency | 0dB | 3dB | 6dB | 9dB |
|---|---|---|---|---|
| 1MHz | –8dBm | N/A | N/A | N/A |
| 135.1MHz | –31dBm | –31dBm | 0 | 0 |
| 1GHz (3kHz low) | –39dBm | –43dBm | 0 | 0 |
| 2GHz (6kHz low) | –38dBm | –41dBm | 0 | 0 |

**Table 1: Measured levels when used as a signal generator.**

**David Harris**
mydogisfinn@gmail.com

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# 75 Years of Sports Reporting

**David Harris** reviewed over 100 radio related books for Radio User from 2015 -2022. He is the editor of a local newspaper and also writes for Communication (Journal of BDXC) and Radio Listeners Guide.

The very first edition of *Sports Report* was broadcast on 3 January 1948 at 5.30pm on the BBC Light Programme (now BBC Radio 2). The new programme incorporated the classified football results and also provided comments on and interviews from football matches that had been played on the Saturday afternoon as well as other sporting events.

The author has been part of the *Sports Report* team since 1981 and has written over 40 sports books, including many biographies. The book is not an official history of the programme and does not follow a strict chronological approach. Instead, it has a thematic structure, which gives space for many anecdotes and recollections from a large number of people connected with the programme over the years.

Sport was very popular in 1948 with over 40 million people attending League football matches. It was also the year of the austerity Olympics, which were held in London. Although sports had been covered since the early days of the BBC there was relatively little coverage of football. From the beginning the *Sports Report* team cultivated relationships with football managers, which enabled the reporters to get post-match comments from them. In the first programme you could hear **John Arlott** giving his summary of the Portsmouth v Huddersfield match along with rugby news of England v Australia. The show was an instant success getting high listening figures.

In 1950 Irish presenter **Eamonn Andrews** joins the team as presenter, a role he held until he is lured away by television in 1964. In 1955 the programme is extended to 60 minutes to allow more report from football matches and coverage of other sports.

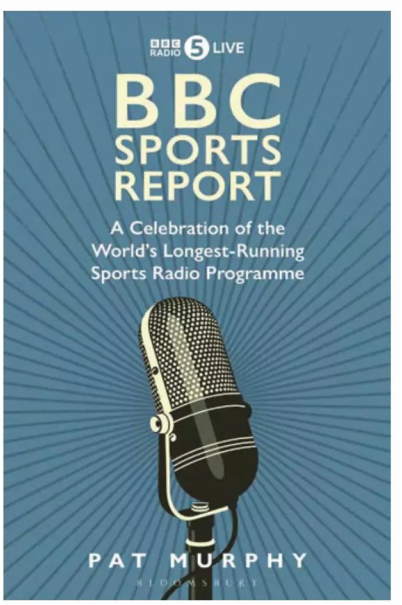
*Sports Report* involved very complex logistics in being able to co-ordinate a number of correspondents from all over the country as they sent in their interviews and match reports. The guiding light for the programme was its producer **Angus Mackay** who remained with the show from 1948 until 1972.

A whole chapter is devoted to *Sports Report's* famous theme tune 'Out of the Blue', which is a military march composed by **Hubert Bath**. Many people wax lyrical about this tune, which conjures up memories of going home on a Saturday after the match to listen to the results and commentaries. The tune was temporarily replaced from 1972 -1973 but was reinstated and remains unchanged over 75 years. In 1964 *Sports Report* moved from the Light Programme to Network Three (now BBC Radio 3). It was an unlikely bedfellow in this haven of classical music and moved back to Radio 2 in 1970. In 1990 it moved to the new station BBC Radio 5, which was rebranded as BBC Radio 5 Live in 1994. It remains with Radio 5 Live but is now only 30 minutes as 5 Live has live football commentary from 5.30pm onwards on Saturdays.

Over the years there have been many memorable programmes, which the author spreads over two chapters covering 1948 -1988 and 1989 – 2022. The Munich air disaster of 1958 in which eight Manchester United players and eight sports reporters were killed is featured along with an account of how *Sports Report* developed a close relationship with the American boxer **Cassius Clay** (**Muhammed Ali**). Hillsborough, Ibrox and Bradford are three of the football tragedies that were covered by live reports from the grounds by *Sport Report* correspondents.

One major change he chronicles over the years is the role of women in broadcasting. They went from being anonymous secretaries to becoming production staff and finally in the 1990s women became sports reporters. Today we are used to having women commentating on and presenting major sporting events. **Claire Balding** is given as an example of someone who started on *Sports Report* in 1994 and is today one of Britain's best-known sports presenters.

**Pat Murphy** also gives full coverage of the back-room staff that make the programme possible. He paints a picture of a very hectic working environment where everyone is part of a team playing their part to bring the programme together. Although the book is aimed mainly at sports fans it is also of great interest to anyone wanting to gain an insight into how programmes are produced. The book is right up to date covering major events of 2022 and is a worthy addition to the various books published recently commemorating the 100th anniversary of the BBC. **PW**




*BBC Sports Report. A celebration of the world's longest running sports radio programme.*
Pat Murphy. Bloomsbury 2022. £20.
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# The Inverted Lazy L Multiband EFQW

**Roger Wheeler G3MGW** builds a multi-band antenna for limited space.

Researches for an end-fed antenna usually result in End Fed Half Wave designs i.e. EFHW. These use a high ratio UnUn to provide a low impedance feedpoint (*see On a Budget in this issue – **ed***.). However, the use of a half-wave end-fed as a multiband antenna introduces some wide ranging feedpoint impedance values as we change from band to band. See [**1**] for a very readable and comprehensive review. Since a quarter-wave antenna has a low feedpoint impedance and hence a good match to 50Ω, I wanted to explore its multiband potential. The COVID-19 lockdown of 2020 gave me the impetus to do some research at home. I normally 'play antennas' and operate from my remotely located site set in the Essex countryside, see **QRZ.com**. Operation from this site was not possible during the early part of the pandemic, so I started with a 20m quarter-wave ground plane, on the gable end of my garage, in the garden of my bungalow. Bungalows usually have small gardens so any antenna must, of necessity, be small. Thus a quarter-wave ground plane seemed an ideal starting point.

## Construction

I used four 1.5m lengths of telescopic aluminium to make my 20m quarter-wave ground plane and mounted it at 2m above ground, on the gable end of the garage. Three radials were cut to 5m and spread out as follows:

- along the underside of the garage gutter.
- clipped around the soffit of the gable end.
- one was wrapped around, but not connected to, the metal frame of a gazebo that is on a small patio at the rear of the garage.
- a 1.5m ground stake was installed and connected to the radials.

Radials are a necessary and important part of any end-fed antenna, particularly a quarter-wave antenna. Radial ends were kept well out of reach to avoid anyone touching high voltages. The feedpoint is shown in the photo, **Fig. 1**.

## Performance

I trimmed the vertical length of the quarter-wave radiator to a final value of 4.92m and obtained the SWR and impedance values shown in **Table 1**. A low SWR does not guarantee a high performance but it will reduce feeder loss if the feeder is very long.

This worked very well considering the relatively low height and power used (50W). I checked the performance using the Reverse Beacon Network (RBN). RBN is a wonderful, free-to-use resource, that is so helpful for antenna testing [**2**]. RBN feeds indicated that my signal was several dB above the noise level from a range of stations across Europe. This was very encouraging and I was able have many QSOs and with other amateurs, who like me, were going through isolation during lockdown. Amateur radio fitted the lockdown guidelines exactly, in so many parts of the world. However, I wanted to operate on some of the other bands as well as 20m.

I decided that, having a point about 7m above ground i.e. the top of the quarter-wave for 20m, why not arrange a cord to pull up an LF antenna for, say, 80 and 40m? I took the antenna down and mounted a small pulley on the inside of the top-most tube. I made sure, using spacers, that the cord could not get jammed between the pulley and the inside of the tube. Below the pulley I made a small, downward sloping hole for the pull-up cord, making sure that I left no burrs that might snag the cord. Then I encountered a small a problem. I couldn't find 10m of paracord! So, I used some thin insulated multistrand wire, about 2mm diameter. I passed the wire up inside the 4.9m aluminium tubing, over the pulley and out to the outside of the tubing. The antenna was remounted on the gable end of the garage. I now had my pull up so I tried flying a flag, **Fig. 2**! I connected both ends of the wires, i.e. one on the inside and the other on the outside of the vertical, to the feedpoint at the base. This is shown in **Fig. 3**. The above arrangement worked in a similar way on 20m to the former antenna.

The 20m resonance is at 14.2MHz, with Z = 40.99 – j4.89 with SWR 1.25:1. These results were taken on a NanoVNA, using the free software 'Nano VNA Saver' [**3**]. The results were taken at the shack end of 7.6m of RG58 coaxial cable. The 'print screen' plot is shown in **Fig. 4**. A Nano VNA (Vector Network Analyser) is available at many sites online for a cost of around £40.

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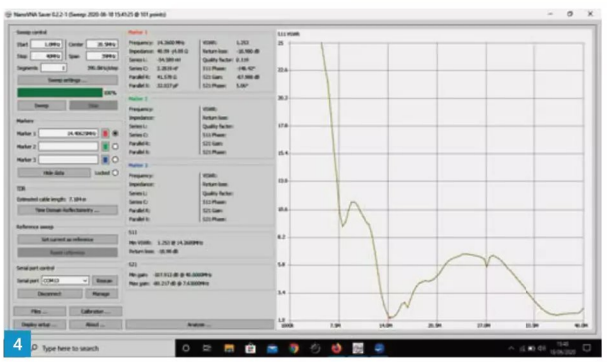

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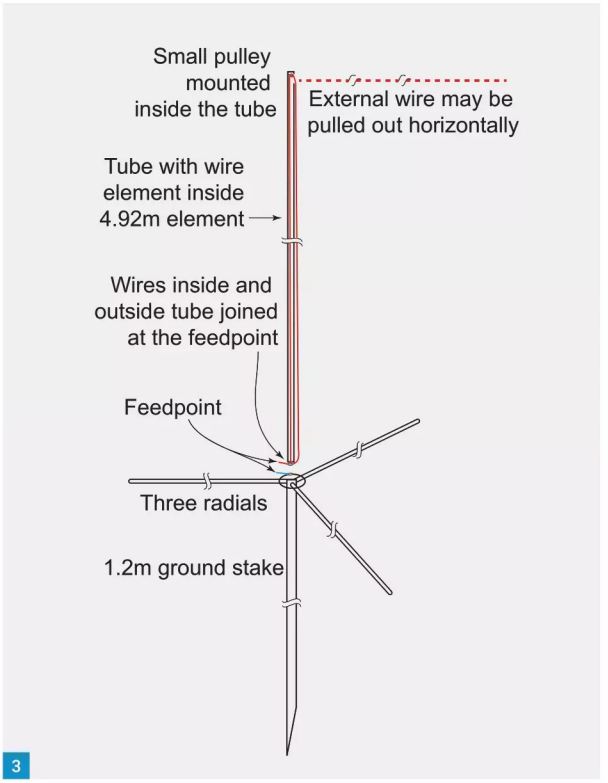


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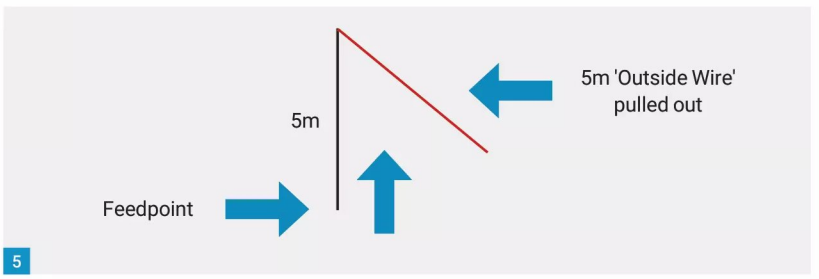


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**Fig. 1: The feedpoint, with radials.**
**Fig. 2: The basic antenna, along with flag!**
**Fig. 3: The schematic arrangement.**
**Fig. 4: VSWR plot of basic vertical.**
**Fig. 5: Another 5m added, brought out at an angle. Fig. 6: VSWR plot for arrangement shown in Fig. 5. Fig. 7: Now with added wire for 80m – the first dip is at 3.73MHz.**

Having the facility of a wire running up on the inside and down on the outside of the vertical radiator I disconnected the 'outside wire' from the feedpoint and pulled it out, at about 45°, tied this to a dogbone insulator and tethered to the farthest highest point in the garden, a shed.

This gave me an Inverted Lazy L antenna, with a total length of 10m. 10m is, of course, a quarter wave on the 40m band and also three quarters of a wavelength on 15m. The inner and outer wires could be part of a non-conducting support, or merely taken up to a point on a building. I just happen to have a support that is a quarter-wave ground plane antenna made of aluminium. The arrangement is shown in **Fig. 5**. The NanoVNA results are shown in **Fig. 6**.

In Fig. 4 I have added a red line showing the 1.5:1 SWR, this is just one of the many facilities available with the VNA Saver software. Note that the 15m resonance is on this line but the 40m resonance is slightly above but quite usable with my transceiver's internal ATU. The important and useful point here is that the total length (ie. Vertical plus the sloping wire) must be an odd multiple of quarter wavelengths at the required operating frequencies to achieve a low impedance feedpoint and a consequent low SWR.

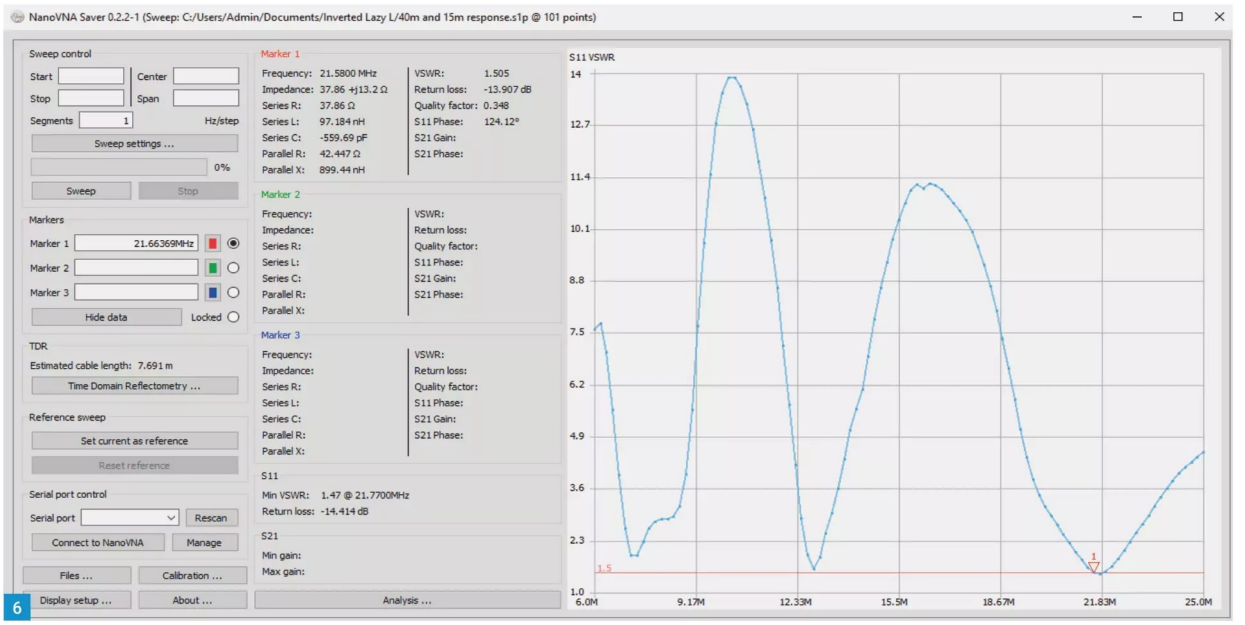
Here the resonances are at 40m and 15m, but note the dip at around 12.5MHz is close to 3/8 wavelength and also a low SWR and would be a good match, if we could use it.

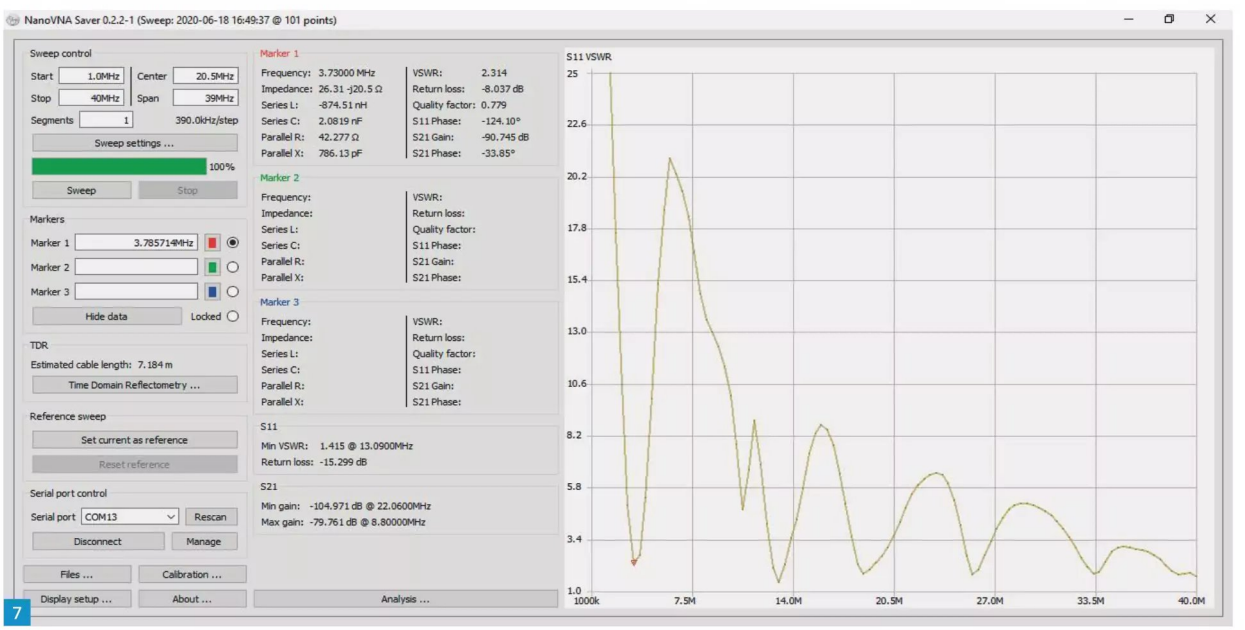
Using the above principle and adding a further 5m of wire giving a total of 5m vertical and 10m of wire (ie. 15m in total) gives three quarters of a wavelength on 20m, actually at 14.6MHz with an SWR of 1.35:1 plus one at 5.3MHz with an SWR of 1.7:1. At this frequency it is a quarter-wave antenna. The three quarter-waves on 20m gives a little extra gain, albeit a higher radiation angle than the quarter wave, which on some contacts has been useful. The length of 10m extension needs to be slightly increased to reduce the resonant frequency on both bands.

Changing the wire direction, by using another 'tether point', alters the direction of maximum radiation a little. This maximum is in the direction of the wire.

To add one more band I added a further 10m to the 'Lazy L' part shown in Fig. 3, giving me an antenna of 5m vertical with a 5m + 10m wire, a total of 20m, which is a quarter wave on 80m. The response is shown in **Fig. 7**. Here at 3.73MHz we get an SWR of around 2.5 :1. This is workable as an 80m antenna, but in my situation my transceiver tuner needs to be used with an outboard ATU. This extra length is about the limit of my rear garden and the tether point is rather too low, however this shows the principle of adding quarter wave extensions. I was able to work a few stations in the RSGB Club Contests. My extension wires were terminated with 'crimp bullet' connectors, which made band changing fairly quick!

To summarise the added lengths, on top of the 5m vertical and the 5m wire, for the various bands are as shown in **Table 2**.




## Conclusions

I need to optimise the wire lengths a little to put the responses into the band centres and improve my ground planes and add a better counterpoise for 80m. This antenna will not outperform a big beam but it will allow multiband operation from a small plot and not look too obtrusive. I found that a coaxial cable braid breaker of ten turns on a 2in diameter plastic former was necessary on some bands.

If the pull up facility is not for you, then a 5m wire attached to the top of a conducting 5m vertical would work in a similar fashion. However, among the advantages of a wire inside the tube, be it conducting or not, is that extensions can be added to the bottom end rather than the top.

I am grateful to the members of the Colchester Radio Amateurs DX Net for their help in giving me some reports. Also please look at the RBN Network, use the Spot Search, enter my callsign G3MGW, where you will see some of the results of my multiband testing. Please contact me and let me know how your EFQW worked! Stay Safe.

## References

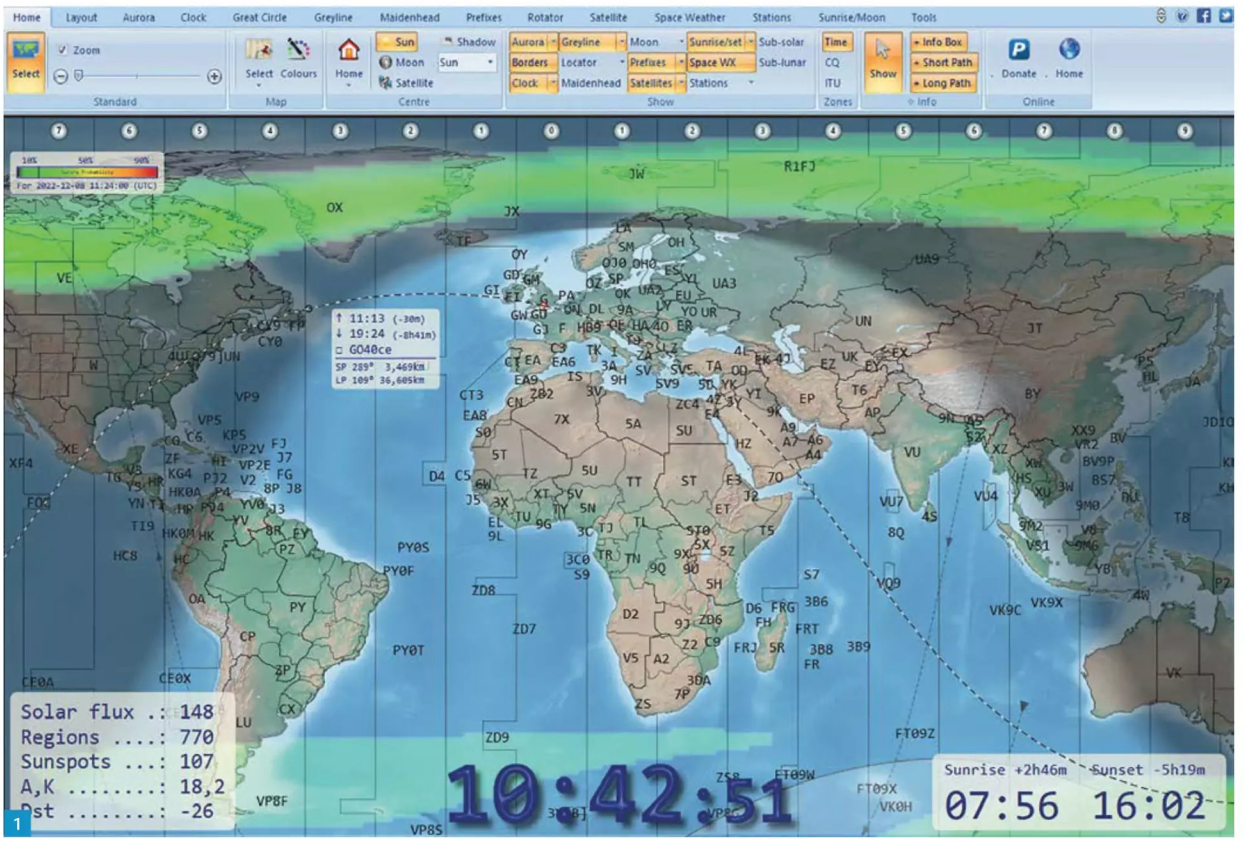

1. **www.antentop.org/w4rnl.001/ltv.html**
2. **www.reversebeacon.net**
3. **https://nanovna.com**


| Frequency MHz | Rs | Xs | SWR |
|---|---|---|---|
| 14.2 | 44 | +j17 | 1.5 |

**Table 1: VSWR and Impedance of 20m quarter-wave vertical.**

| Band | 80m | 40m | 20m | 15m | 17m | 10m |
|---|---|---|---|---|---|---|
| Length | 10m | 0 | 0 or 5m | 0 | 2.3m | 2.5m |

**Table 2: Extension lengths by band.**

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# More on World Map and VarAC

**Mike Richards G4WNC** brings readers his 150th column, with more on G4ELI's world map software and the latest on VarAC.

Well, this is my 150th *Data Modes* column for *PW*! If I've counted correctly, the first *Data Modes* went out in the September 2010 issue. That introductory column detailed the terms used in data modes signals such as telegraph alphabets, serial data and baud rates. Interestingly, The ROS mode was in its infancy in 2010, but it is still with us in a much-evolved form as the VARA-HF modem used to power VarAC.

## Simon Brown's World Map

As a learning exercise for Visual Studio 2022 and Direct2D graphics, **Simon Brown G4ELI** has completely rewritten his World Map application. As is typical for Simon, he has generously made the software available to us all free of charge. However, if you use the map or any of his other software, please donate to keep him in beer money and dog food! Simon has done an excellent job with the new map and built a superb feature set with very efficient code that can run on just about any PC running Windows 7 through to 11. The software can be downloaded from Simon's site at:

**https://g4eli.com/world-map**

Installation is a simple menu-led process. In its default state, you will see a World Map similar to that shown in **Fig. 1**. Simon has made it so that just about everything is configurable via the tabs at the top of the screen. The first step is to set your home location. This is done from the Home tab using the Home icon. In this section, you can set your home lat/lon in decimal degrees or locator and choose the symbol to display. The Home tab also lets you choose which map you want to use. Simon supplies a selection of 17 maps, but you can also add others if you have a special requirement. In this section, you can also change the foreground and background colours for the text displays such as the clock, space weather, etc. As with other modern mapping systems, the World Map displays additional information using superimposed layers over your selected base map.

The range of information available is extensive and includes aurora, borders, greyline, locators, Maidenhead, Moon footprint, prefixes, Satellites, sunrise/set, space weather and stations. Each of these overlays can be further configured via the tabs at the top of the main screen. The map is also scrollable using the mouse wheel, so you can very quickly zoom into an area of interest, though you will need to use one of the high-resolution maps if you want to zoom in close. Those running directional antennas will be pleased to see that the map has rotator support for the ERC Mini, ERC V4 and all Yaesu GS232A/GS232B-based rotators. The map is not intended to be a full-featured rotator driver but supports OMM (Orbit Mean Elements Message) XML files. This can be set up via the Satellite tab. The cursor behaviour can also be configured to provide additional information. In its default state, it is used to drag the map to the desired position and zoom via the mouse wheel. However, if you click the Show icon on the Home tab, you can display long or short path routes from the pointer to

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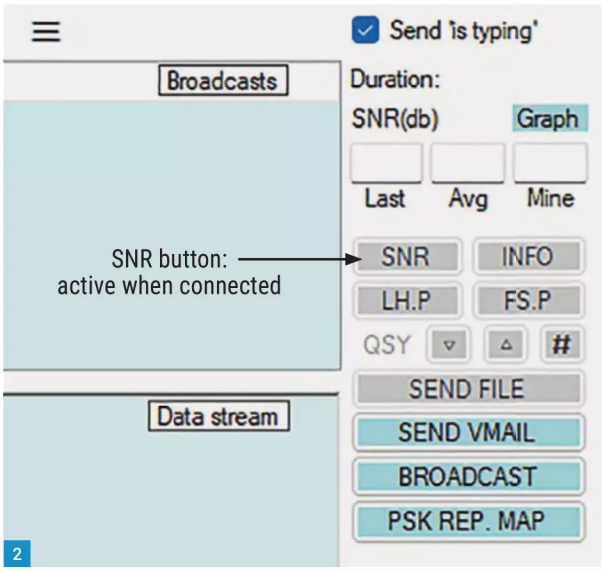


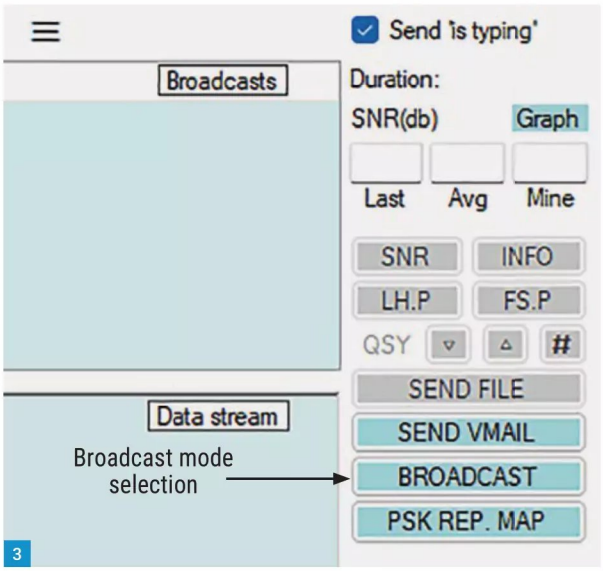




**Fig. 1: Simon Brown's new World Map.**
**Fig. 2: VarAC SNR tracking button.**
**Fig. 3: VarAC Broadcast button.**
**Fig. 4: VarAC SNR tracking.**
**Fig. 5: VarAC Broadcast message box.**
**Fig. 6: VarAC broadcast message display area.**

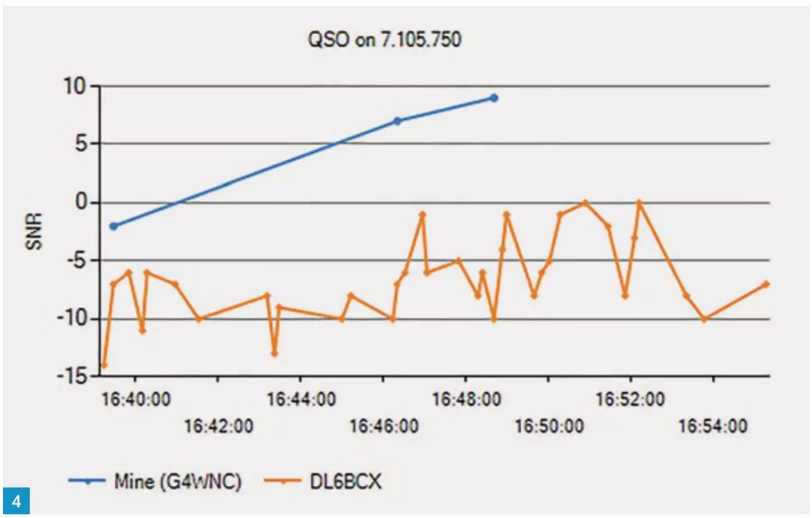
your home. You can also display an information box for the current pointer location. This shows the sunrise/set times, locator, plus the long and short path bearing and distance.

The map is particularly good at showing satellite tracks and provides for a single primary satellite plus the option for up to ten other satellites. It is in the satellite panel where you can download the latest orbital data to ensure accurate tracking.

I've only really scratched the surface of the possibilities of this excellent work from Simon but it is undoubtedly an excellent resource.

## VarAC Updating

VarAC continues to grow in popularity, and the developers have been busy adding new features to keep this an exciting project. Before I get into some detail, I think it might be helpful to clarify the upgrade process. As you may recall, there are two main components to a VarAC installation: 1) The VARA-HF software modem that manages the radio link and 2) the VarAC application that runs the program's main screen. VarAC has had many updates recently, which also require upgrading VARA-HF. This is because both programs' authors collaborate on this project, so new VarAC features often require changes to the VARA-HF modem. Fortunately, the upgrade process is straightforward but slightly unusual because of the dual upgrades. I recommend completing the initial installation of VarAC using three dedicated folders on the C: drive named: VARA, Vara-Monitor and VarAC. Here are the steps to upgrade VARA-HF and VarAC:

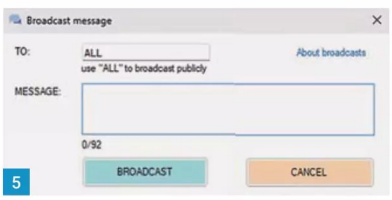



- Download VARA-HF from: **http://rosmodem.wordpress.com**
- This will download a zip file that you should unzip to a convenient temporary location.
- Right-click on the unzipped file, choose Properties and tick Unblock and hit OK.
- Double-click on the unzipped file to start the installer and follow the prompts.
- The latest version of VARA-HF will be installed in the default C:\VARA folder.
- Copy all the files from C:\VARA to C:\Vara-Monitor and overwrite the existing files. This step is required to update the second installation of VARA-HF that's used for monitoring.

That completes the VARA-HF upgrade.

To upgrade VarAC do the following:

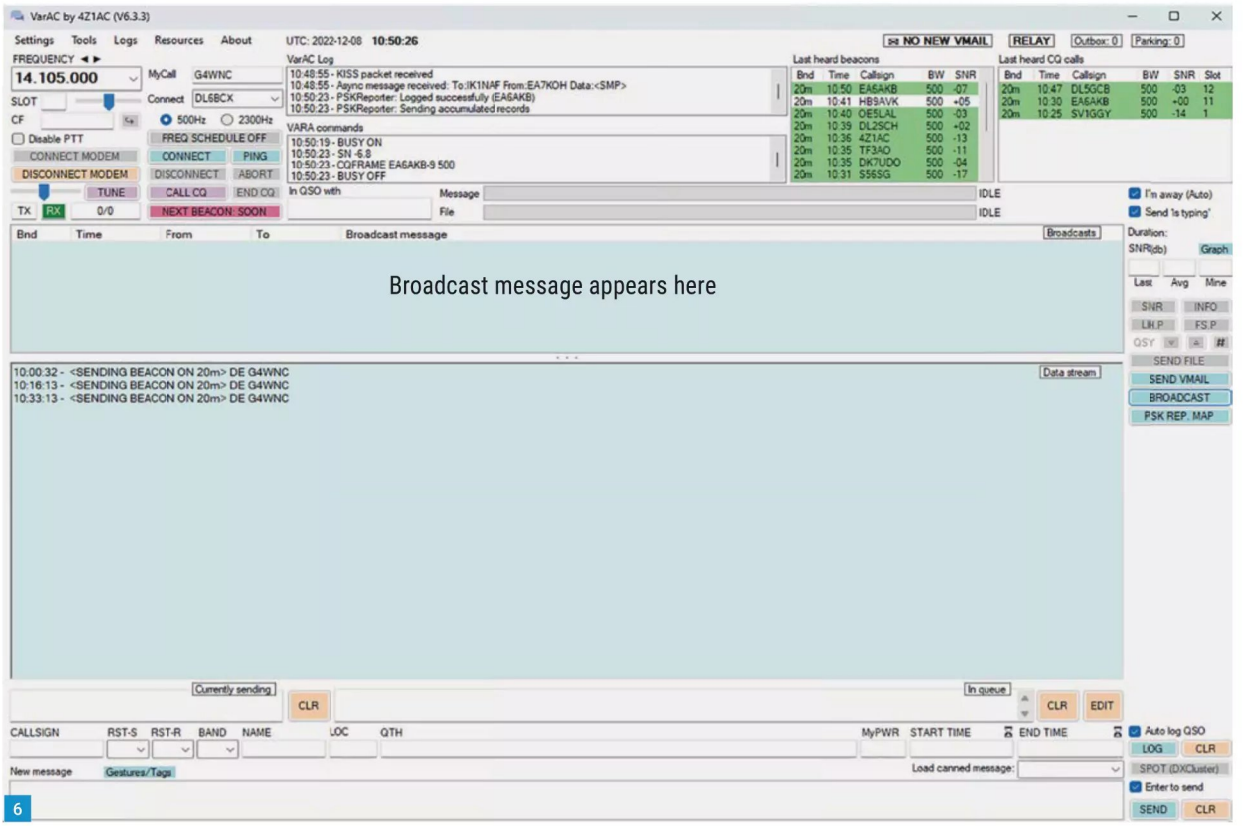
- Download the latest release from: **http://varac-hamradio.com**




- Unzip the download to a convenient temporary location
- Locate the VarAC application file, right-click, choose Properties, tick Unblock and hit OK.
- Open a second File Explorer window (Windows key + E) and drag the VarAC application file to your VarAC installation folder (C:\VarAC). When prompted, select Replace the file in the destination.

That's it; you've upgraded both programs.

One important extra step is to upgrade the CAT commands file. This is accessed via the




Settings menu and choosing: Download latest CAT Commands File. This will take you to the website, where you can download the file as a zip archive. Once downloaded, expand the zip and copy the extracted VarAC_cat_commands.ini file to the VarAC installation directory (C:\VarAC), overwriting the existing file. Restart VarAC to use the new file.

If you follow this upgrade process, your settings will have been preserved. Many, including me, have upgraded to the paid version of VARA-HF. The licence fee is 63 Euros and is callsign based. This means you can run VARA modems on any number of computers, provided they use your callsign. In addition to providing access to faster speeds, registration activates the Tune button in VarAC, which is very convenient. Importantly, registration also encourages Jose to continue his development work on this project.

## VarAC, More Features

In last month's column, I covered using VarAC for straightforward QSOs, but much more can be done. A good example is the Vmail system. This simple email messaging system allows you to send short emails to other stations using their callsign as their address. Vmails can only be sent while connected to a station, but you can also route emails via a third-party station. For example, if I want to send a Vmail to **Victor G3JNB**, I have a problem because by the nature of our antennas, we don't have a good direct path. However, we both enjoy excellent propagation into Europe. My solution is to connect with a strong European station and use them as a relay station for the Vmail. To do this, I begin by clicking the Send Vmail button on the right of the main screen. This opens up the Vmail panel where I can set G3JNB as the destination call, compose my Vmail and hit the Send button. This puts the email in the Outbox, waiting for my next connection with G3JNB. However, that connection is unlikely due to the poor path between us. I then connect with a solid European station that we both know. Once connected, I click the Vmail button at the top of the screen and select the Outbox. This is where my unsent Vmail is stored. If I right-click on the Vmail, I can choose to relay through the connected station. That triggers VarAC to transfer the email and store it in the connected station's email folder until that station connects with G3JNB, after which the email will be delivered.

VarAC now includes a novel live signal-to-noise ratio (SNR) tracking tool that you can use to display a graph of signal variations during a contact. I've shown a screenshot in **Fig. 4.** To activate the tracking, click the SNR button on the right of the main window when connected, **Fig. 3**. This will trigger SNRR commands every 15 seconds and these will retrieve signal reports from the distant station. You can then use the graph option to display a graph of the signal strength variations.

VarAC now has a useful broadcast mode to send a message to everyone or a targeted user. This opens the opportunity to create a VarAC net or group chat. To do this, all the participants need to meet on a pre-arranged frequency. The participants can send messages to the group by clicking the Broadcast button, **Fig. 2**, and using ALL in the TO: field, **Fig. 5**. The received messages will be displayed in the new Broadcast panel on the main screen, **Fig. 6**. Broadcast messages use AX25 protocol and are similar to the system used for APRS packets. There's no error correction in this mode, but it is workable as a group chat system, given reasonable propagation paths to the participants. Another helpful extra in the latest VarAC is the QSO summary displayed at the end of a QSO. This displays the frequency and duration of the QSO.

## VarAC on the Raspberry Pi

The latest version of VarAC has included a Linux compatibility mode to enable use on Linux hardware, notably the Raspberry Pi 4B and Pi 400. This requires the use of an x86 emulator and the WINE compatibility layer. This is still a work in progress, but I have had some success. Once I have a reliable solution, I plan to add it to my Data Modes card. **PW**

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# Can you Hear a WSPR

**Billy McFarland GM6DX** describes how he set up a WSPR beacon on the Isle of Man.

Weak Signal Propagation Reporter (WSPR) has been around for many years and is a weak signal reporting system (a form of beacon network). Transmissions are made in WSPR mode for a specific period of time with various power levels from 100mW to 100W. Amateurs who decode these signals can report them to the website (below) where you can see a live world map of transmitted and received signals with the ability to search on specific callsigns and bands. This reporting is done via software such as WSJT-X. So, if you are just sitting listening at your station, then you can contribute to these studies by selecting WSPR from the menu of WSJT-X and either transmit or receive, uploading your findings automatically.

**www.wsprnet.org/drupal**

**Roland HB9VQQ** has undertaken an international project where he offers a free WSPR transmitter that requires you to provide an antenna that covers 10-80m and must have the ability to run 24 hours a day seven days a week. For the full criteria of needs that must be met as well as more information on the overall project please visit:

**https://github.com/HB9VQQ/WSPRBeacon**

As you can imagine there is a cost implication with this project so transmitter locations are limited. There a few already installed in the UK but I had the ability to install one on the Isle of Man right beside the sea. Roland took me up on this offer and sent me the pre-programmed transmitter as seen in **Fig. 1**.

## The Construction

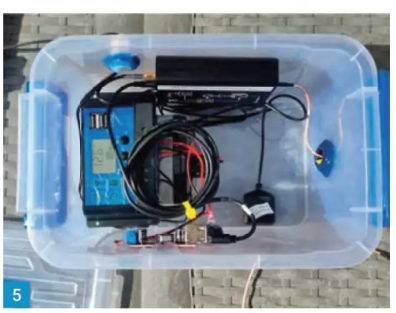
Now that the project was underway I had to develop a self-efficient power system for this project and it was at short notice as our next trip to the Isle of Man was expected pretty soon. I started to gather a few items such as battery, solar panel with charger unit, plastic enclosure, coax, switch, DC cable, 5V USB power supply and an end-fed antenna, which was sponsored by MM0OPX. Some of these can be seen in **Fig. 2**.

My first step was to install a few weatherproof cable glands into the plastic enclosure. This was to allow the DC cable from the solar panel to pass into the box as well as one for some coax. At this point I also installed two rocker switches, one to cut the power off to the transmitter and one to cut the power off to the charger unit from the solar panel. **Fig. 3** shows this. The ability to externally switch the device off saves on needing to strip the full project down, potentially in a hurry. I then took the 12V 5Ah battery, sitting it into the enclosure, and attached some self-adhesive securing pads, which allowed me to secure the battery in place. This 5Ah battery should last about 20 hours of operation when fully charged. I followed the same process for the transmitter and charger unit as I did with the battery, securing them in situ within the enclosure.

On to the wiring. DC cables come from the solar panel and connect to the charger unit on the relevant terminals. Between these connections is an off/on switch. Positive and negative wires come from the battery and connect to the battery terminals on the charger unit. The USB 5V power supply unit needed for the transmitter gets connected to the load terminals on the charger unit. There is also an off/on switch fitted between these connections. The full wiring diagram can be seen in **Fig. 4**. The wiring for this project didn't take too long to complete and the finished connections can be seen in **Fig. 5**. The final touch is to attach the solar panel to the lid of the enclosure. This is done with some cable ties holding it in place when at the final install on site.

## The Install and Test

I arrived on site and sat the project box in place, ensuring it had the most coverage of daylight



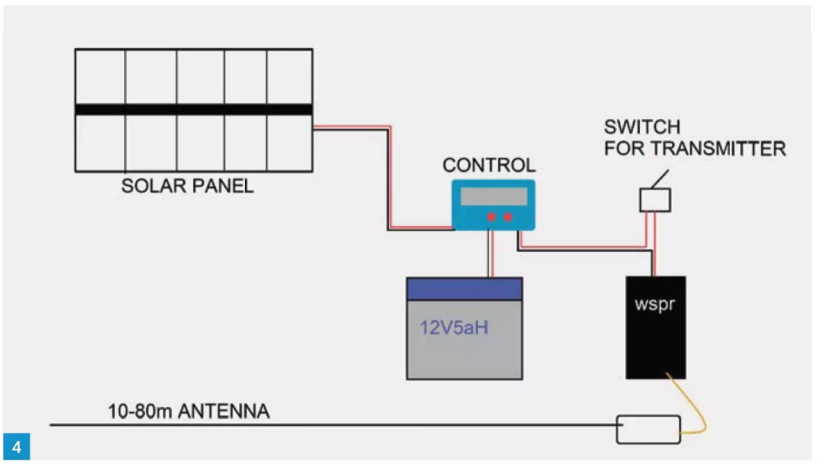



**Fig. 1: The pre-programmed transmitter, ready to go. Fig. 2: Some of the ancillary components. Fig. 3: Rocker switches to allow power to be disconnected. Fig. 4: The overall configuration. Fig. 5: Wired together and housed in plastic box. Fig. 6: Installed and under test. Fig. 7: The system in its final position.**

where possible. This gave the location for the copper ground rod, which I hammered into the ground allowing the MM0OPX end-fed antenna ground connection to be attached. Due to the length of the antenna (23m approx.) I fixed a 10m fishing pole onto the Scarlett Point tower handrail to give enough height to have the wire antenna in a vertical orientation.

Some final tuning of the end-fed took place due to ground conditions and the final stages of the WSPR beacon install was complete with a simple flick of the power switches. You can see the install at the site in **Figs 6** and **7**. This gave the ability of the WSPR beacon to run 24 hours a day seven days week on renewable energy. So far, the performance of the beacon has been good with propagation studies under way. Be sure to keep a look out for WSPR reports online and if you would look to contribute to the WSPR project, then contact HB9VQQ direct. If you have any questions of any part of the process, drop me an email:

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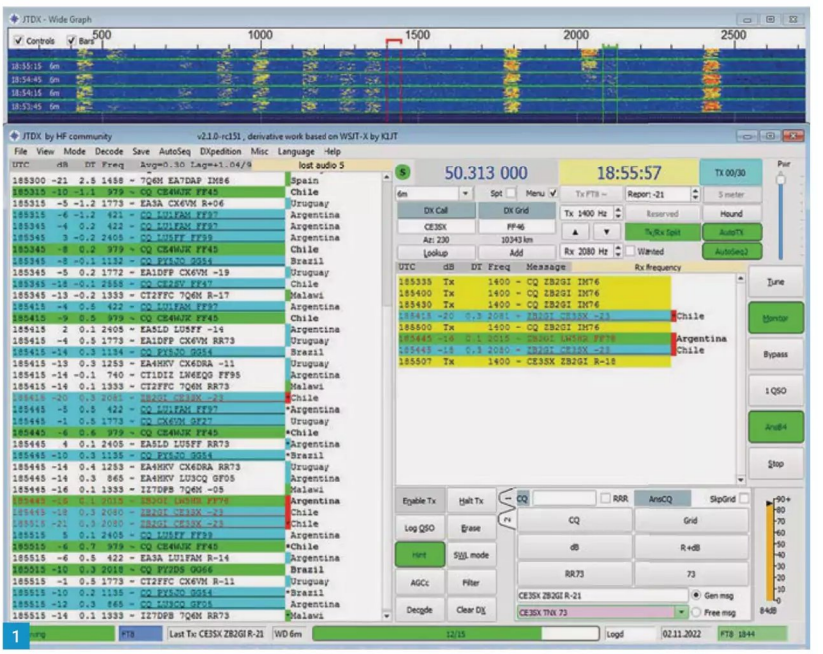

# In Search of Chatty QSOs

**Tim Kirby GW4VXE** has quite a mix of topics from chatty QSOs, through DVSwitch to the new GreenCube satellite and beacon news.

I wrote last month about apparent activity on VHF/UHF with a move away from lengthy voice conversations, something which I suspect affects amateur radio as a whole. As I pointed out this is something that is reflected in our use of mobile phones. More messaging, less talking. I think we can probably see this as a social trend, rather than anything affecting amateur radio in general. I appreciated **Ron G4LMN's** letter in the January *PW* – Ron prefers short QSOs to lengthy ones and doesn't feel he's missing out. Quite so. We should all operate the modes we enjoy and certainly not give way to those who would tell us that one type of QSO is more worthy than another!

We're all different and the hobby's breadth is one of its strengths and also, one of its challenges! **Andy Howlett G1HBE** wrote with a different view, "*Speaking as a bit of a stick in the mud who bemoans the virtual death of 70cm as a chat band but finds nothing attractive about FT8, DMR etc, it struck me that the idea for a simple beginner's licence may be the answer. After all, it has been done before. In the early 60s, the 'B' licence came into being, allowing those with an interest in VHF and UHF to try their hand without the need to pass the dreaded Morse exam. It kick-started the 70 centimetre band (432MHz) and later the 2 metre band (144MHz) and by the 1970s both bands were quite active. By the early 80s the 2m band was a hive of activity with weekends especially busy and sometimes a shortage of frequencies. It would be excellent to see this happen again, as some of us older hands just like to chat about our stations and radio in general without delving into the world of digital*".

I did reply to Andy that 'embracing digital' can help find those conversational QSOs. Generally speaking, those digital modes such as DMR, D-STAR and Fusion are worldwide in their reach, you can often make QSOs with people with the same interests as you. I remember in the early days of D-STAR having an excellent QSO with **Gordon G8PNN** in Northumberland about microwaves, one that we would have struggled to have any other way. The same could be said for digital voice QSOs that I'm able to have with **Patrick WD9EWK** about satellite operation in the USA – once again, we would struggle to have those conversations any other way. So, while the first impression of digital networks can be that conversations are short – deeper QSOs are taking place too!

## DVSwitch Client for Windows

A couple of months ago you may remember, I explained about how to set up a DVSwitch server on a Raspberry Pi computer, which would give you access to various digital networks; DMR, D-STAR, Fusion, NXDN and P25. I explained that you could run an app on an Android mobile phone or 'network radio' to give you access to these various modes and networks.

Since then, I've become aware of a very nice DVSwitch client that runs on Windows. It's written by **Lee Heonmin DS5QDR**. It is very nicely written and seems to work well and provides plenty of information about the station that you are listening to based on their QRZ.COM profile as well as the stations last heard on the talkgroups and reflectors that you are interested in. You can find the software at:

**https://github.com/ds5qdr/USRP-for-Windows**

(Note that there is a separate version USRP11.exe for Windows 11).

## GreenCube

A new amateur satellite is available, called GreenCube or IO-117. The satellite's primary mission was to experiment with growing plants in orbit. Now that the primary mission has been completed, the satellite has been reconfigured to provide a data communications digipeater to radio amateurs. The interesting thing about GreenCube is that it is in a Mid Earth Orbit (MEO), so has much greater coverage than the satellites in Low Earth Orbit (LEO). Because the satellite is higher, it has a greater footprint across the Earth than with other satellites. Being in a higher orbit means that you'll need more uplink and downlink capability than with satellites in lower orbits. That's not to say you won't be able to hear GreenCube with a simple vertical – because I have – but you probably won't be able to decode any/many packets from it. You'll probably want something like a 10-element beam or more to be able to decode packets reliably. Some stations have reported success with as little as 5W output, but you'll probably find somewhere around 20-25W a good place to start from.

You can download the software, which has been written by UZ7HO, from:

**http://uz7.ho.ua/greentnc.zip**

You'll need to tune your receiver (and transmitter) to 435.310MHz plus or minus Doppler. Because the satellite is 'further out', it does not move across the sky so quickly, so Doppler is less significant and if you don't have a rotator, you can adjust the beam by hand. If you want to control your rig by computer, for Doppler correction, rather than SatPC32, you will need to use SatPC32ISS, a program that comes with SatPC32, because SatPC32 cannot cope with the uplink and downlink being on the same band.

If you want to read a little more about the detail

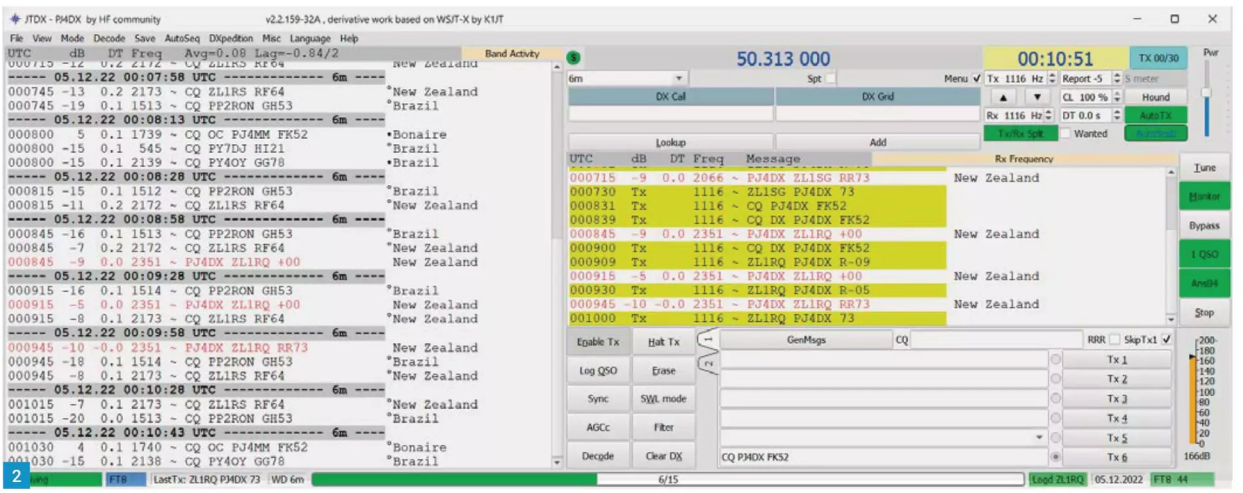


**Fig. 1: A 50MHz TEP opening to South America as seen by Kevin ZB2GI. Fig. 2: Steve PJ4DX worked into New Zealand on 6m.**
**Fig. 3: Joe KE9AJ wrapped up warm in Colorado to make his record breaking FO-29 QSO.**

of getting going on GreenCube, particularly if you have an Icom IC-9700, **Burt FG8OJ** has written an excellent guide here:

**https://fg8oj.com/news/greencube-digipeater**

Burt also notes that reducing TXDelay from the default 350ms, within the UZ7HO software, to 80ms is very effective in getting better throughput.

It's well worth getting on to GreenCube, as it puts places like the west coast of the USA and Japan within range of us here in the UK. If you have a go, please let me know how you get on. I plan to try it out myself – but need to renovate my old 70cm Yagi first!

Although the Soundmodem software has been written for Windows, I can see information on getting it installed on Linux – read here to learn more:

**https://tinyurl.com/4c2kpjvm**

## Six and Four Metre Beacon News

**Dave Thorpe G4FKI** reports that the Buxton 6m and 4m beacons are off the air, as well as the GB3HH repeater, which is co-sited with them. The building that they are in has been condemned by the site owner. It's not currently known whether they will return or whether a new site will have to be found. Dave reports that the Tring 6m beacon returned to service in November, but the 4m beacon is being rebuilt and should be back on air in early 2023.

## The 8m band

**Roger Lapthorn G3XBM** asked OFCOM whether it would be possible to make use of the Industrial, Scientific and Medical (ISM) allocation around 40MHz to radiate a 10mW signal. OFCOM replied, *"If it is radio equipment intended for telecommunications research purposes, it may be possible to obtain an innovation and trials licence from Ofcom. You can find more details on this here:* **https://tinyurl.com/2p98d58w**

*"If it conforms to the usage conditions laid down in IR 2030 you don't need to apply for a licence."*

You can read the details of IR 2030 for yourself here:

**https://tinyurl.com/2vy2ytrs**

For example, it might be possible to try 10mW of WSPR on 40MHz, if a frequency could be coordinated. This would not require an Innovation and Trials licence.

Using his Innovation and Trials licence, Roger's 2.5W to a low wire dipole was heard in the Canaries and Eire. Roger says that his signals haven't made it to the USA again, although a number of others have. **Robbie EI2IP** has been heard quite widely in the USA in recent weeks. Roger has also tried 10mW WSPR as described above and stations as far away as 17km have heard his signals, although Roger says that most people who did tests with him did not have resonant antennas for the band (and see Roger's report on page 74).

**Peter Taylor G8BCG** (Liskeard) says that the band has been very good to North America and elsewhere over several days this month.

## The 6m Band

**Kevin Hewitt ZB2GI** (Gibraltar) has found the band fairly quiet apart from a TEP opening on 2 November, **Fig. 1**, when Kev worked 9Y4D (FK90), CX6VM (GF27), EA7/YL3GS (IM76), LU4DJC (GF05), PP1BM (GG99), PU2KNM (GG55), PY1MHZ (GG98), PY2COY (GG55), PY2RC (GG67), PY2WC (GG66), PY2ZS (GG66), PY4AZ (GH80), PY4VE (GG77), PY5AM (GG44), PY5ZHP (GG54) and V51JH (JG77) from the Gibraltar club station using an FT-450 and a Hexbeam.

**Don G3XTT** (Wells) says that he has been interested to decode signals from PA, ON, F and EA most days, most probably by meteor scatter, but on 8 December, he came home to find three decodes of CQ calls from XT2AW on the screen. Perhaps this was TEP from Africa into the Mediterranean and from there to the UK by Es.

**Steve Telenius-Lowe PJ4DX** says he has very little VHF news to report this month: *"Shortly after sending last month's report, on 11 November I worked TZ4AM on 6m CW but, after that, the band was very quiet until 4/5 December when, during a 50-minute opening either side of 0000UTC, I worked ZL1AKW, ZL3RC, ZL1RS, ZL1SG and ZL1RQ, all on FT8* (see **Fig. 2**). *ZL1RS has already uploaded to LoTW, giving me a new one confirmed on the Magic Band. Apart from my local neighbours PJ4MM and PJ4GR, and the usual South American stations that come in via TEP here most evenings, the ZLs and TZ4AM are the only stations I have heard on 6m the whole month."*

## The 2m Band

**Keith Watkins G8IXN** (Redruth) has been quite active on 2m FT8, using both horizontal and vertical polarisation. Keith has an excellent path up the west coast of Wales and into Scotland and on 30 November, worked MM0ABM (IO75) using vertical polarisation.

**Jef Van Raepenbusch ON8NT** (Aalter) didn't find too much on the band – he took part in the UK Activity Contest as well as the FT8 activity period, but there was little that he regarded as DX.

**Simon Evans G6AHX** (Twyning) writes, *"On 4 December there was a contest going on in France on 144MHz and I worked TM5R (JN19). Then, I did the 144MHz UKAC contest on 6 December in the low power section. I had 14 contacts in 12 squares. My best DX was PA5Y in JO21 at a distance of 546km."*

**Ian Bontoft G4ELW** (Bridgwater) says he's found it hard going this month. He says that as well as looking at the Hepburn and F5LEN tropo forecasts, he's also found it worth keeping an eye on the G7IZU website (URL below), which

sometimes shows what Ian terms 'unforecast' openings! This led to a couple of QSOs on 3 December, when Ian worked F6APE (IN97) and F6IFX (JN08). Ian says both QSOs were hard going, but they completed in the end. Ian runs 15W to a 5-element Yagi at 4m above ground. **https://tinyurl.com/3k4z56vy**

It's great to hear from **Stewart Cooper G4AFF** (Norfolk) who moved from his well-known GM4AFF QTH in September. Stewart says that at present he has a single low mast for VHF and swaps antennas as required. He says that he has managed to work some nice DX on tropo from the new site, as far away as the Pyrenees and north-west EI in fairly flat conditions. He's found the UK Activity contests surprisingly hard going with some stations not hearing his calls. Stewart says he is amazed at the level of activity from JO02 on VHF during contests and says that the local Norfolk club are very active and do very well. Stewart says that he was concerned that the move might be the end of amateur radio for him but is starting to think that it might be OK – on VHF at least!

Despite 'only' having the 2m vertical available for FT8, I was pleased to make some nice QSOs during the month here at **GW4VXE** (Goodwick), including EI9KP (IO54), G0LBK (JO03) and MM0ABM (IO75). Putting up the 6-element horizontal beam has made things easier on a day-to-day basis, although no great DX has been worked yet.

## The 70cm Band

Jef ON8NT worked G4CLA (IO92) during the UK Activity Contest and then during the FT8 activity period, he worked G0BIX (JO01), G4NBS (JO02), G0GJV (IO91), 2E0DUE (JO01), G3ZPB (IO91), M0LMK (JO01), G4ZZL (JO01), M0IEP (IO91), G0LGS (IO81) and G7LRQ (IO91) – a very nice haul.

Simon G6AHX mentions that the colder weather seems to be affecting UHF propagation and notes that he is hearing a Fusion repeater in Weston-super-Mare, GB7IS, which he would not normally hear. Cold mornings with high pressure associated are often good news for VHF/UHF propagation.

## Satellites

Jef ON8NT monitored three ARISS contacts from the International Space Station on 22, 23 and 28 November.

Peter G8BCG says that he has been concentrating on QO-100 where he has worked some nice new ones, including 5H3SE/P, 5R8PA and XW4KV. Peter has been thinking about the GreenCube satellite and says he has all the bits, but not, as they say, necessarily in the right order!

Here at GW4VXE, it's been a quiet month on the satellites, but I was very happy to work VA7LM (CO54) on RS-44 once again on 21 November. **Joe**

3

**KE9AJ** has been breaking distance records on FO-29. On the 23 November, Joe worked EB1AO over a distance of 7642km, breaking the previous record by 8km! Congratulations to Joe and Jose for a great contact (**Fig. 3**).

Patrick WD9EWK has plenty to report in his email. He writes, *"On 4 December, the TEVEL-3 satellite was activated for 24 hours. This is one of eight TEVEL satellites. All of them have FM repeaters that share the same uplink and downlink frequencies, so only one will be active at a time. TEVEL-3 was turned on, and was popular on its passes over North America. I was able to work four passes, two in the late morning, and two more in the evening. I found that narrow FM works better on the uplink than 'normal' FM, and the downlink was easy to hear.*

*"Also in the past week, we now have a new satellite from China, CAS-5A. This satellite has three transponders that can operate simultaneously:*

*21.435MHz up/435.505MHz down, 15kHz H/U SSB/CW transponder*

*145.820MHz up/435.540MHz down, 30kHz V/U SSB/CW transponder*

*145.925MHz up (no tone)/435.600MHz down, V/U FM transponder*

*"After its launch, the transponders and telemetry downlinks were active.*

*"GreenCube, now also known as IO-117, has, all of a sudden, shaken up satellite operating. It has a 70cm packet digipeater, which requires different software to work. It is in an orbit 6000km above the Earth. Where there were limits on intercontinental satellite DX for those who have no access to QO-100, GreenCube has been opening up satellite DX like we haven't seen since the days of HEO satellites such as AO-10, AO-13 and AO-40. For those in North America, the possibility of stations in the Northeastern USA and the Canadian Maritimes working all 50 US states via satellite is now real. More operators claiming satellite DXCC awards could also be a reality.*

*"Starting 10 December,* ***Tyler N5UC*** *(ex-WL7T, ex-KL7TN) is in Honolulu working GreenCube and a couple of other satellites from grid BL11 on the island of Oahu for a few days. Several satellite operators have already reported working N5UC and can now claim satellite WAS awards. Exchanges through the GreenCube digipeater are similar to what we have seen through other orbiting packet digipeaters. With the 6000km orbit, passes can run for 60 to 75 minutes at a time.*

*"In mid-November, I made my third trip in 2022 to the rarely-heard grid DM31 in southern Arizona. I drove there early on a Saturday (19 November) morning, like I've done in the past. This time, I first visited the USA/Mexico border, then moved north a few miles to the visitor center at Organ Pipe Cactus National Monument to work passes in FM, SSB, and (via AO-27) D-STAR.*

*"On 3 December, there was a hamfest at a nearby college's parking lot. This hamfest was only 15 minutes away from my house, and I went out there with a table demonstrating satellite operating for the hamfest attendees. Unfortunately, a rainstorm went through in the late morning, bringing the hamfest to an abrupt end, but I had fun working a few satellites in FM, SSB, and (again, on AO-27) D-STAR for the crowds. Many were interested in seeing D-STAR via satellite, and were impressed with the D-STAR audio quality through a satellite. After a couple of years of COVID restrictions, it was great to see so many hams show up at this event.*

*"With AO-27 being available across almost all of the continental USA (the same is true across Europe) now, I hope to work more stations using D-STAR. With many IC-9700s in the shacks of satellite operators, along with some taking their IC-9700s out of the shack and into the field, there are many operators that could give D-STAR via AO-27 a try."*

That's it for this month. Thanks to everyone who's written in – but there's always room for new contributors. If you have been thinking about getting in touch – please make 2023 the year you do! **PW**

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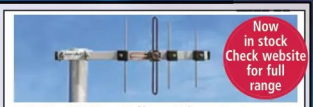

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# Repurposing an Old Band 1 TV Antenna

**Rod Angel G4ZUP** uses an old TV antenna to provide the raw materials for a simple 4m band beam.

*PW* has previously described an adaptation of a Band I TV antenna [**1**] but, since that was 40 years ago, and for an entirely different project, I thought the subject might bear being revisited now.

Even though several decades have passed since British broadcasters turned off the last of their Band 1 TV transmitters, some of the old receive antennas are still around; and if you're lucky enough to find one in a loft (as I did), it could be in surprisingly good condition. Once the cobwebs have been brushed off, and the metalwork given a quick polish, you could have almost everything you need to make an effective beam antenna for the 4m band.

Technically, these H-shaped antennas are two-element Yagi arrays, with one driven element and one parasitic reflector. The driven element (which is actually in two separate halves) is a half-wave dipole. This is easily identified by the weatherproof housing for the feeder cable connection at its centre. The reflector is (usually) also in two physical parts, but is electrically connected as one solid element, **Fig. 1**. It is slightly longer than the driven element.

In relation to the amateur 4m band, Band 1 TV was a little lower in frequency, and therefore its wavelength was a little longer. So, if we want to convert an old TV antenna into a 4m band antenna, all we need to do is chop the element lengths down a bit, and close up the element spacing. It really doesn't get much harder than that!

The converted antenna should exhibit a useful amount of directional gain over single-element types and, because it is formed from tubes rather than thin wires, will have sufficient bandwidth to cover both the FM and CW/SSB portions of the 4m band. It can be rigged with the elements either vertical or horizontal, as appropriate.

## Design Considerations

Antenna sleuths may spot an apparent anomaly here: TV antennas were (and are) designed for 75Ω systems, and we need a 50Ω antenna, but none of the usual impedance matching devices is included in our design. This gives a clue that, electrically, there is more going on than meets the eye.

In fact, the simplicity of the constructional task belies quite a complex interaction between element lengths and element spacing – and changing any of these will alter the feed impedance in some way.

The presence of the parasitic reflector makes the driven element appear inductive, but shortening the driven element a little is enough to add an equal and opposite amount of capacitive reactance.

Element lengths and spacing could be optimised for either maximum forward gain, or maximum front-to-back ratio; but in both cases the significant reduction in element spacing results in an awkwardly low radiation resistance.

The suggested design is therefore

**Fig. 1: The parts of the parasitic reflector are electrically connected as one solid element.**
**Fig. 2: A ferrite collar is one option for a choke balun near the feedpoint.**

something of a compromise. Its theoretical characteristics include a useful amount of forward gain, which is nevertheless slightly below the maximum possible gain. It has a wide main lobe with a broad shallow null to the rear, but not the deep null of a sharp cardioid pattern. The feedpoint impedance is pretty close to 50Ω, and almost entirely resistive. Inclusion of a balun near the feedpoint, **Fig. 2**, should reduce squint and ensure that the antenna is generally well behaved. I used a ferrite (because I had a spare one to hand), but other constructors have used a sleeve balun [**1**], or even just a coil formed from a few turns of the coaxial feeder cable.

I say 'theoretical' characteristics because I have never felt the need to actually measure most of these parameters. The antenna, as described here, clearly works and it seems to me that anything else is fairly academic. Should you wish to measure gain and/or front-to-back ratio, a procedure for doing that is described in the 1982 *PW* article [**1**], which can still be accessed free of charge in the wonderfully comprehensive archives of RadioWorldHistory.com [**2**].

And so to the nitty gritty of the design. This was theoretically based, and empirically tweaked.

## Element Lengths

The overall length of the parasitic reflector is 204.5cm. Assuming the metal tubes have a Velocity Factor (VF) of 0.95, this would equate to 0.504λ at mid-band. The parts should be cut symmetrically, so that the boom attachment point remains at the centre of the reflector.

Each tube of the driven element is cut to a length of 94.3cm but, since the feed assembly adds 3cm to this, the actual leg length is 97.3cm, **Fig. 3**. Assuming the same VF, this makes the whole driven element 0.480λ long.

This is very much in line with expectations for such an antenna: The parasitic reflector being slightly longer than λ/2, and the driven dipole slightly shorter than λ/2 to improve impedance matching.

## Element Spacing

For element spacing we do not need to apply a VF correction, because here we are considering the radiated signal in air, not the conducted signal in a metal tube [**3**].

A spacing of 91.5cm (0.214λ) gives a good combination of gain, front-to-back ratio, and near-50Ω radiation resistance with little or no reactance [**4**].


1


2

## Construction

If you want to realise the performance – notably the matching – described here, you should aim to do all your measuring and cutting to within a mm or two.

Construction is simply a matter of cutting four tubes to make the specified element lengths, and spacing those elements at the right distance on a boom. If the original TV antenna boom is too short, or is otherwise unsuitable for your purposes, you could use almost any rod or tube of about the right size to make a new boom. I used some old square-section aluminium that was lying around in my garage.

This antenna is big enough for windage to be a consideration – remember wind pressure scales with the square of wind speed – so, if using anything other than standard antenna hardware, it's advisable to have something reasonably beefy at the mounting point, **Fig. 4**. I tend to use aluminium parts with stainless steel nuts and bolts.

If you'd like to try out this antenna, but just

don't happen to have any leftover Band 1 TV antennas, it should not be a very big job to make one from scratch. If you do that, pay particular attention to the actual length of the driven element legs, and remember to include any extra length added by the feed assembly.

To reduce wind noise, the tube ends of TV antennas are blocked with small plastic bungs. If you don't have these, it would be advisable to start with the elements a few cm longer than specified. Check the impedance matching with a VSWR meter and/or some kind of analyser, and reduce element lengths incrementally until a good match is obtained.

## Rigging

The normal rules for rigging Yagi antennas apply here: If configured for vertical polarisation, the antenna should be stood off from any conductive mast; and it's best to avoid very close proximity to other structures, especially anything conductive.

If rigged for portable operation, a reasonably stout mast would be ideal. The lower sections of a telescopic fishing rod could be used, but in that case all the joints should be wrapped with sticky tape, and the mast itself should have at least two sets of guys, one at the top and another in the middle. Taller masts might need three sets of guys.

These guys should really be pegged with something bigger than camping-shop tent pegs. I use 50cm lengths of angle iron, with a long point at one end and some holes for shackles at the other.

## Test Results

With the antenna rigged for horizontal polarisation, atop a 3.8m mast, the indicated VSWR at 70.250MHz was 1.05:1. At the band edges, this rose to 1.1:1.

The results indicated by my VSWR meter were confirmed with a nanoVNA. So, within the uncertainty limits of hobby-grade test equipment, the specified design gives a near-perfect match across the 4m band.

## Operation

As with the split co-ax antenna previously described [**5**], this antenna is simple, effective, and quite easy to use – and it needs the same basic safety precautions. It should be rigged so that the element ends (at least) are well out of reach before any transmission is made. This is to prevent inadvertent physical contact, and the RF burns that could result from that.

Due consideration should also be given to EMF safety. If in doubt, use the RSGB/Ofcom tool [**6**] to estimate a safe separation distance.

## Conclusion

Whether you recycle an old TV antenna or build something from scratch, this simple antenna could give a useful boost to your radiated signal strength on 4m. Better still, it would also give the same boost to your receiver sensitivity, and improve your signal-to-noise ratio. What's not to like!

**Fig. 3: The feed assembly adds 3cm to each leg of the driven element.**
**Fig. 4: It's advisable to have something reasonably beefy at the mounting point.**

## References

[1] *2m Fox-Hunter* by D O White G3ZPA, in *PW* December 1982.
[2] **https://tinyurl.com/3xjuxfyr**
[3] Theoretically, the VF of air (relative to free space) should be applied but, since this is very close to 1.0, we can safely ignore it here. It will make no practical difference to our antenna measurements.
[4] *The ARRL Antenna Book*, 15th edition, Ch 11, pp 2 – 8.
[5] *An instant antenna for VHF FM* by Rod Angel G4ZUP, in *PW* January 2023.
[6] **https://tinyurl.com/35fw947p**

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**Steve Telenius-Lowe PJ4DX**
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# Transatlantic Centenary & New Digi Modes

**Steve Telenius-Lowe PJ4DX** reports on HF activity in November and looks forward to some interesting operations in February.

We start with November's 28MHz beacon report compiled by **Neil Clarke G0CAS**. *"New beacon IT9EJW 28250 was heard, very strong, for the first 15 days of November but then only on occasional days till the end of the month. Other Italian beacons followed a similar pattern. Sporadic E took place on more days than expected for November, some openings were strong and localised and lasted for several hours while others were weak and fleeting."* Neil logged 71 beacons from USA, far too many to report here, so he is reporting them by their call district: *"Beacons were heard from W2 and W4 call areas on 19 days and the W5 area on 23 days of the month. 4U1UN and W6WX, both on 28200, were heard on 26 and 6 days respectively. Both of these will not be included in their call areas as they run 100W, while the other beacons run far less power and so they would distort the overall picture. Staying with the worldwide beacon network on 28200, YV5B was heard on 17 days and VK6RBP on 18 days."*

## The Month on the Air

We continue where we left off last month, with a wide range of DXpeditions to work in the month from mid-November. A35GC from Tonga, T88WA from Palau and T33T from Banaba Island, Kiribati, were all well under way by the middle of November. According to the Rebel DX Group's Facebook page, T33T made 97,193 QSOs of which 93,731 were on FT8 or FT4, and just five on CW. They continued operating until they had exhausted their 600-litre supply of diesel for their generators.

1

These three operations were followed a few days later by TL8AA and TL8ZZ from the Central African Republic. As with previous Italian DXpedition Team operations, their logs were uploaded to their website in almost real time, allowing you to check that you were 'in the log' or, if not, to try again after just a few minutes. TL8AA made 52,404 QSOs on CW, SSB and RTTY, while TL8ZZ made a further 39,873 on FT8.

The CQ World Wide CW contest took place at the end of November with groups travelling the world to give contesters a rare multiplier. Many of these were active before the contest to check out their stations. One such was 3B8M from Mauritius, operated by G0CKV, KX7M, W6NV, K0AV, M0SDV and DK6SP, **Fig. 1.** Here on Bonaire there were two major multi-operator contest groups active: PJ4A and PJ4K. Two operators flew over from the UK to join the PJ4K team, **Martin GD4XUM** and **Dave G3NKC**. After the contest both teams got together with some of the local PJ4 amateurs for a celebratory dinner, **Fig. 2**.

## February DXpeditions

**Thierry F6CUK** will be on the French sub-Antarctic island of Crozet, FT4W (full callsign to be announced later), until March. In accordance with the agreement with TAAF, the authorities on the island, Thierry will only be allowed to operate on HF for a three-week period between 20 December 2022 and 26 January 2023. He was originally hoping to be active for the full three months of his stay on the island.

M0NPT, F5NVF and F5RAV plan activity from Gambia as C5C from 16 February to 13 March.

OK2WX plans activity as 9U4WX from Burundi from 4 to 27 February. He will be using 100W on 3.5 to 28MHz CW and SSB.

## FT4 Contest Series

Many readers of this column are active on FT8 but it seems far fewer use FT4. This is twice as fast as FT8, with 7.5-second Tx/Rx periods, making for 'quick-fire' contacts. The RSGB has an annual series of FT4 contests on 3.5, 7 and 14MHz. The first session of 2023 takes place on Monday 27 February between 2000 and 2130UTC. The rules are slightly different this year, with the 'multiplier' DXCC entities worked on each band instead of Grid squares, see:
**rsgbcc.org/hf/rules/2023/r80m_ft4.shtml**

## Amateur Radio Transatlantic Anniversary

The first two-way transatlantic amateur radio contact took place 100 years ago, on 24 December 1922, something well worth commemorating. Eleven historic callsigns – G5WS, G5AT, G6XX, G6ZZ, G3DR, GM5WS, GW5WS, GU5WS, GD5WS, GJ5WS and GI5WS – were operating on CW, SSB and digi modes on all bands from 1.8 to 28MHz during the whole of December. There was plenty of activity and after a few days I qualified for the Bronze award, **Fig. 3**.

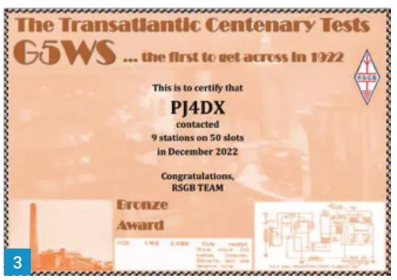
## VarAC

VarAC is the new 'keyboard-to-keyboard' digital mode developed by **Irad Deutsch 4Z1AC** which is getting a lot of attention now: see the *Data Modes* columns by **Mike Richards G4WNC**, in the December and January issues. One of the early proponents of VarAC is *HF Highlights* regular **Victor Brand G3JNB**, who sent in **Fig. 4** and wrote: *"I have been chatting with various European stations about the pleasure of getting back to traditional 'ragchew' QSOs on HF. As November progressed, it became apparent that a host of new operators were arriving on VarAC's most popular 20m frequency of 14105kHz and were much engaged in learning to use this comprehensive system. I managed to connect with* ***Chris ZD7CA*** *on St Helena with my 20 watts. He was sitting on the beach with a glass of local wine, chatting to me on his laptop over 20m VAR. Very smooth!*

*"PSK Reporter regularly shows my call copied in VK, ZL and USA/VE. A good link to a Comoros islands operator, calling CQ, was fruitless though as he was not looking at his screen! NC3Z in NC was my first connect across the pond and chatting with TF is a doddle! At night, the 40m channel is progressing nicely and I have high hopes for 30m by the New Year. Transmitting a regular Beacon signal is a sure-fire way to encourage new users as they can 'ping' your station to see how they are 'getting out' before going live and responding to stations calling CQ. For example, FR1GZ's Reunion beacon, on 20m, twice came straight back to my call during the month.*

*"I have had a reply to my enquiry to ARRL, about the need to have Logbook of The World (LoTW) accept logs for the VarAC mode, to say that they are already working on it and 'please stand by'."*

2

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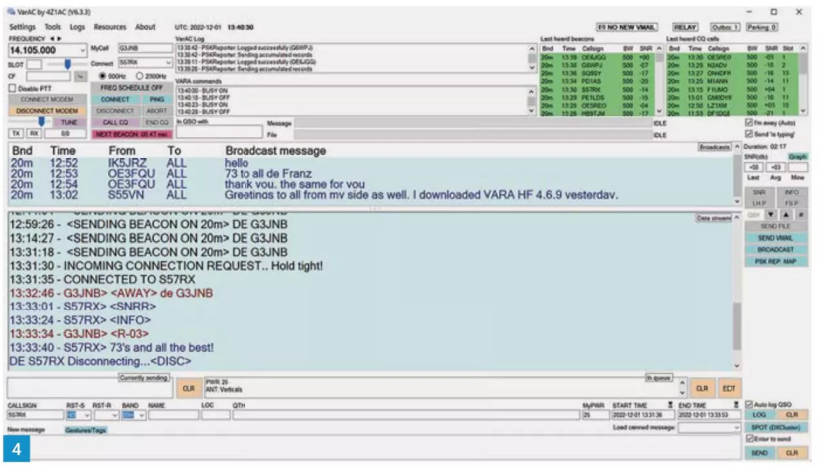


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**Fig. 1: Jamie M0SDV and Philipp DK6SP relaxing after a previous contest. They were active as 3B8/M0SDV and 3B8/DK6SP before their recent 3B8M operation. Fig. 2: Members of the PJ4K and PJ4A contest groups with local amateurs; left, from front: Scott W4PA, Dave N3RD, Jeff KU8E, Martin PJ4MM, John K4BAI, Martin GD4XUM; right, from back: John K3CT, Bert PJ4KY, Peter PJ4NX, Pat N8VW, Dave G3NKC. Fig. 3: Transatlantic Centenary certificate. Fig. 4: VarAC screen shot, showing keyboard chats and G3JNB beaconing. Fig. 5: Some of the aluminium in the air at the QTH of Etienne OS8D. Fig. 6: Reg G0OOF in his shack. Fig. 7: Parks On The Air 'Kilo' certificate awarded to Carl 2E0HPI/P. Fig. 8: John ZB2JK with home-made 10m beam at Coaling Island, Gibraltar.**

## Readers' News

Victor G3JNB took time out from operating on VarAC to return to his first love, CW: *"Back on the CW DX frequencies I was delighted to see hordes of stations chasing DXpeditions as they fired up again after the Covid restrictions and a truly dreadful sunspot minimum. As I mentioned last month, the 'big guns' were dominating the splits but I tried to pick my moment and was gratified to log J28MD Djibouti and 5V7RU Togo on 20m with TL8AA Central African Republic on 17m and 12m. Best DX for November? On 20m VarAC, I exchanged reports with the beacons of ZL2TNB and ZL1RM. On 12m CW, my last QSO [in November] was with PJ4/K4BAI on Bonaire."*

**Jim Bovill PA3FDR** reckoned that propagation was a bit 'up and down' this month: *"Some days very little activity from either EU or DX stations, other days there were long runs with good signal strength from North America and Asia, although I had fewer contacts with South America than in previous months. It was good to see good reception with Japan again after the poor reception from that country in the past months. This was particularly evident on the 15th of the month when I had a run of 11 successive QSOs with Japan in the space of 35 minutes. In that same session I made contact with three stations from New Zealand... I managed a few QSOs with new DXCC entities in November, Equatorial Guinea (3C3CA), Gabon (TR8CA), India (VU2FI) and Togo (5V7RU) and second contacts with Greenland (OX7AKT) and Rodrigues Island (3B9FR). And finally a touch of sunshine from the Caribbean island of Guadeloupe (FG8OJ), only the second time I have reached the island."*

**Etienne Vrebos OS8D** wrote *"most of the bands were wide open, but some of my friends here say that I'm missing half of the world after 1700UTC as I mostly use the radio between 0800 and 1700UTC and they tell me what happens after 1700... On 40m I usually work from 1600 to 1700UTC with my Icom IC-7300 with 100W only and reach all European countries, chatting with UK or German stations... I'm always interested to read what the other European stations worked all over the world... I suppose nothing can compete with good directional antennas: if I could, or were allowed, to push up a mast of 20m and a beam antenna... but my Hexbeam still gives me satisfaction after six or seven years, even at 8m."* Etienne added that he likes 'playing' with antennas but some of his neighbours told him he has more aluminium than trees in his garden – this sounds like quite an exaggeration to me, judging by **Fig. 5**!

**Reg Williams G0OOF** sent in a photo of himself in his shack, **Fig. 6.** He says he did not have a lot of time on the bands this month, but *"nonetheless some nice DX stations were worked on FT8. One of my main aims was to work the DXpedition station K8H in American Samoa. My best option after trying other bands appeared to be 7 or 10MHz. Their signal was very weak with a good number of stations calling but very few being worked. No success for me after trying for a few days during the DXpedition's sunrise and sunset times. On to another DXpedition, TL8ZZ Central African Republic, worked fairly easily on three bands, 7 and 10MHz very late evening and 18MHz early morning. My best DX was AH0/WA7WJR, Mariana Islands, on 18MHz at 0750. This band has been very good especially in the early mornings working Oceania and Asia."*

5

**Tim Kirby GW4VXE** spent most time on 10m, usually operating as GW4MM. The period leading up to the CQWW CW contest was particularly interesting with a number of stations preparing for the contest, including V31CQ, P44W, PJ4K and VP2MJA. During the contest itself, Tim treated it as an exercise in DXing rather than contesting and enjoyed it... Some highlights from the 10m log were A71DX, CN3A, 3B8M, ZS6W, 3V8SS, E2E, BD7MM, 7Q6M, PJ4A, PJ2T, D4L, VP5M, V26K, PZ5CO, OX7AM, BG8SRK and A44A. Tim also pressed the 40m dipole into service on 15m, with surprisingly good results. *"Perhaps the most satisfying contact was giving big multi-multi operation M6T their only GW contact of the weekend on 15m! Since the contest, things have been quieter, but there have been a few nice*

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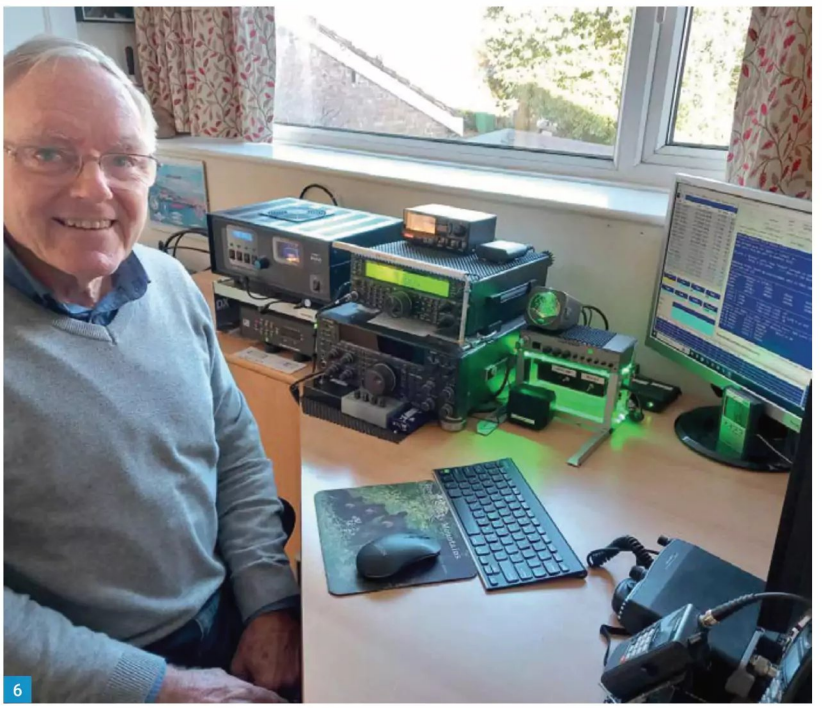

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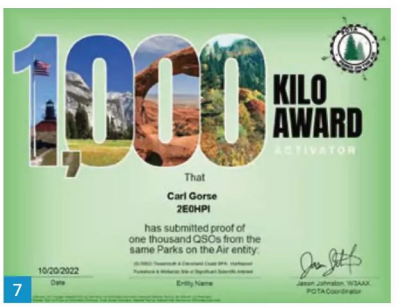


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*contacts such as KP2B, TO9W, ZD7BG, CX5FK, 9H1XT and TA1PB, all on CW."*

**Owen Williams G0PHY** said that the fall in the SFI numbers this month coincided with a falling off of his activity, though *"most of the activity was on 28MHz as there were openings to the East Coast of the USA most afternoons. As I write this the ARRL 10m contest is on and fortunately the SFI numbers have risen and the band was alive this afternoon."*

**Carl Mason GW0VSW** operated for a short time in the CQWW CW contest at the end of November: *"Running the Xiegu G90 at 5W with the inverted G5RV on 20m contacts included CN3A, CR3W, EA8RM, N2YO and PJ2T. I then operated GB100BBC when I could this week* [early December – ***Ed***]*, the first and only op to do so in Wales this year, and made 148 contacts on all bands 80 – 10 using both SSB and CW. Mostly 50W but I did try calling for QRP stations with 5W on the calling frequencies. Equipment this time was an FTdx3000 and my inverted G5RV. I managed 32 countries on 20m including 5W CW contacts on 20m with OE5ARN, 2 x QRP, and EA2BJ and then on SSB a 10W contact with EI8BLB and several other EU stations. Most of Europe was worked during the week using both CW and SSB."*

It was a pleasure to work regular contributor **Carl Gorse 2E0HPI** when he was operating portable from the Heugh Lighthouse in Hartlepool. Carl wrote: *"So far this month I've worked nearly 2000 contacts with QSOs into East Coast USA. Conditions are definitely improving with the odd solar flare but not really affecting propagation. I've also been working on my 'KILO' award,* **Fig. 7**, *at each POTA* [Parks On The Air – ***Ed***] *park here in the North East coast with my fourth nearly complete... I also travelled to Scotland to operate a POTA at GM-0099 Hirsel Country Park, just across the England/Scotland border."*

During the month **Kevin Hewitt ZB2GI** operated from his home station, from the Gibraltar ARS's club station, from the top of the Rock, and from Coaling Island with **John King ZB2JK**, **Fig. 8**.

## Band Highlights

**Jim PA3FDR: 7MHz FT4:** JI4POR. **7MHz FT8:** 9K2YM. **10MHz FT8:** 4J3DJ, VK5BC/P, VK7AC. **14MHz FT4:** CN22CWQ, K7TM, VK7YUM, VP8LP, ZS6ZA. **14MHz FT8:** HI8ARJ, JA2JKE, PY1SX, RA0SMS,YB3COY. **18MHz FT4:** TR8CA. **18MHz FT8:** 3B9FR, 4J3DJ, JA0FIL + many JAs, JT1CO, K7CMI, OD5ZZ, OX7AKT, R0AJQ, UN7PNF, VE7SZ, VK5PO. **21MHz FT4:** CX100B, JA2ATE + many JAs, PY2RAR, W7CT. **21MHz FT8:** BG0DAP, FG8OJ, JA1CIN, KP4PR, LU1FRD, PY5QW, R0AIV, ZL1LEE, ZL2AWW. **24MHz FT4:** R9SDV. **24MHz FT8:** 3C3CA, JR2UBS, RZ0SU, VK6AL, VR25XMT, VU2FI. **28MHz FT4/8:** USA.

**Etienne OS8D: 14MHz SSB:** 9M2GET, 9M2M, KL7WG, SU8YOTA, UN7LAN, VK1ZZ. **18MHz SSB:** TL8AA, UK8OM. **21MHz SSB:** 5R8PA, BH7FFR, FK4QX/P, P44X, SU9VB, TL8AA, TO9W, UK8OM, UN9GD, VK4BT. **24MHz SSB:** 5R8WP, C5YK, CX8DS, FP5AC, PJ7PL, TZ4AM, UK8OM, V31XX, VP5/WQ7X, XQ6CF, ZL4RMF. **28MHz SSB:** 4L4NW, 5R8PA, C5YK, CE7VP, EX2V, LU1XAW, PY4JW, TL8A , UK8O , UN6GDL, VK6VLF.

**Reg Williams G0OOF: 7MHz FT8:** 4S6SAD, FG8OJ, TL8ZZ, VU2FI. **10MHz FT8:** 5V7RU, A35GC, A41ZZ, HH18NOV, J28MD, TL8ZZ, P29RO. **18MHz FT8:** 3B9FR, 4I1FKB, AH0/WA7WJR, HL5BMX, JA2LMY, TL8ZZ, VK2OV.

**Owen Williams G0PHY: 28MHz SSB:** FR4QT, KI0F, KP2B, PV2G, TL8AA, V31XX.

**Carl 2E0HPI/P / 2M0HPI/P: 14MHz SSB:** VK3ZK (VKFF-0747). **14MHz FT8:** BH3BBJ, BD4STG, CX1RL, JA7UKM, LU1EEP, PJ4DX. **21MHz FT8:** PP5IP. **24MHz FT8:** CO2GL, PY3YD, V51LZ, YN1KK, YV1SW.

**Kevin ZB2GI: 5MHz FT8:** 9K2HS, VE1YX. **24MHz SSB:** N8II. **24MHz FT8:** J79WTA, K6BV, PU1JSV, VE6BMX, W7AL. **28MHz SSB:** 3G5P, CE7BL, KH7CM, LU1XMO, PY5ZAT. **28MHz AM:** WA1H. **28MHz FT8:** CE3FFC, CX9BU, HH2MK, HP3QQ, K6IPM, K7GQ, KL7NW, LU1FCP, PU1PZP, VE5MX, VP2EIH, YV5GRB. **28MHz FT4:** AA7EW.

## 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 April issue the deadline is 11 February. 73, Steve PJ4DX. PW

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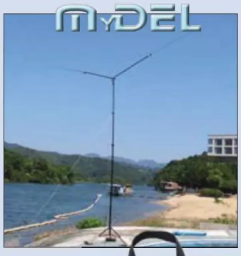

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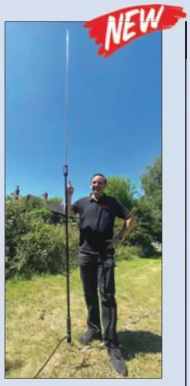

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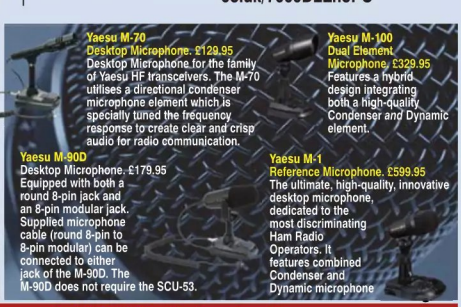

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**Tony Jones G7ETW**
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# The J-Pole Antenna

**Tony Jones G7ETW** discusses the pros and cons of the J-Pole antenna.

Making antennas is where I first started in the hobby. I had an old 'taxi-type' CB antenna with a centre loading coil and two whip sections. I bought a Diamond SX-600 (I still have it) and set to work with a ruler and hacksaw. The VSWR wasn't great, but my artless effort got me mobile on the 70cm band.Countless projects later, antennas remain a keen interest and some designs have become old friends. But the J-Pole (and its close relation, the Slim Jim) has persistently resulted in nothing but frustration. Thirty years on, it's time to lay that ghost.

## Anatomy of a J-Pole

Your common-or-garden J-Pole is shown in **Fig. 1**.

- Half-wave radiator fed at the bottom
- 'Lecher' stub
- Feeder connected to the stub part-way up

At resonance, an end-fed half-wave and a centre-fed twin quarter-wave dipole have the same current distribution (see **Fig. 2**) but the end-fed antenna's feedpoint impedance is much higher, in thousands of Ohms. Connecting a low-impedance feeder would result in a major mismatch.

The Lecher stub, invented by **Ernst Lecher** in 1888, is a tuned electrical quarter-wave section of closed transmission line, **Fig. 3**. It is widely used in antenna matching because at some point over its length, any desired impedance can be found.

I recommend you break off now and google 'J-Pole calculator'. As will quickly become apparent, consistency regarding the measurements is rare! I'm going to be radical here and apply some radio theory to this.

## The Stub

The stub is not a simple quarter–wave; it absolutely needs to be velocity-factor adjusted. Why? Because it's a transmission line, and RF slows down in a transmission line. It's just that simple.

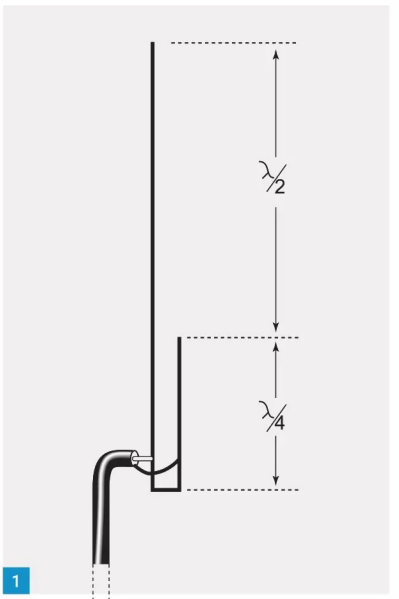
The stub's 50Ω feedpoint varies wildly design by design. I've seen it anywhere from 5% to 25% of the way up, with most web designs placing it suspiciously at exactly 10%. There is no formula for this I can find.

(Now that would be an interesting experiment: stretch out a couple of stiff copper wires in parallel on a piece of wood, short them at the bottom, put 3kΩ across the top, and map out the impedance. If anyone tries that, will you let me know?)

The spacing of the parallel conductors, providing it's constant, does not matter. Actually, that's not true; for wires of a given size, the gap determines the characteristic impedance but for J-Pole making it seems this can be ignored.

## Half-Wave Radiator

The radiator is a single conductor. When ribbon cable or ladder line is used, this is one side of the cable, the other side having been removed. This isn't a transmission line (any more) and velocity factor does not apply. The wire does need to be slightly shortened because of 'end-effect'.



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## Common-Mode Current Suppression

A J-Pole's radiator is unbalanced by definition; there is only one of it! The stub is balanced, and the coax feeder is unbalanced. To remove unwanted currents on the coax outer, some designs incorporate a choke comprising a few hundred Ohms at the desired frequency. This can be done by sliding ferrites onto the coax or winding a coil of a few turns in the feeder.

Ah, but where should this choke be placed? Even that is not clear cut. At the feedpoint, or a quarter-wave down the coax? (That's an actual quarter-wave by the way, not end- or velocity-factor adjusted.) On the grounds (no pun intended) that at the feedpoint current is a maximum, then a quarter-wave down the braid's outer it must be a minimum and easier to stop.

All that said, my J-Pole doesn't have a choke and touching the coax makes almost no difference to the match. This is curious, but results are results. More work is required, I think.

## J-Pole Sizing for any Band

Calculate the wavelength in metres using the usual 300 divided by frequency in MHz formula.

Find out (ideally measure) the velocity factor of what the stub is made of. In the absence of decent data, assume 91% for any open feeder.

- Length of the radiator
  L = 0.97 × (Wavelength divided by 2)
- Length of the stub
  l = Velocity Factor × (Wavelength divided by 4)

## J-Pole Gain over a Dipole?

Is there any aspect of amateur radio more muddled than antenna gain?

- A dipole (0dBd gain by definition) has 2.15dBi of gain; everyone knows that.
- J-Poles have '6dB' of gain; everyone except me seems to know that.

Even if that's 6dBi, that's not tiny. I draw the jury's attention, once again, to exhibit Fig. 2. A dipole and a J-Pole have the same current distribution. There's just no good reason to expect any, let alone significant, gain over a dipole. According to the RSGB's *Radio Communication Handbook* (13th and 6th editions), a Slim Jim (which is electrically identical; I'll show why later) has gain of 2.8dBi.

So, yes, a J-Pole does have gain: 0.6dBd. (Could that be where the confusion arises; a misplaced decimal point?) Now where did I leave my tin hat?

## J-Pole built from 450Ω Ladder Line

300Ω ribbon cable can be used, but I don't recommend it – it twists easily and has stranded conductors which, even when tinned, aren't very strong. 450Ω ladder line has thick conductors of solid copper that are rigid and robust even when the plastic insulation has been removed.

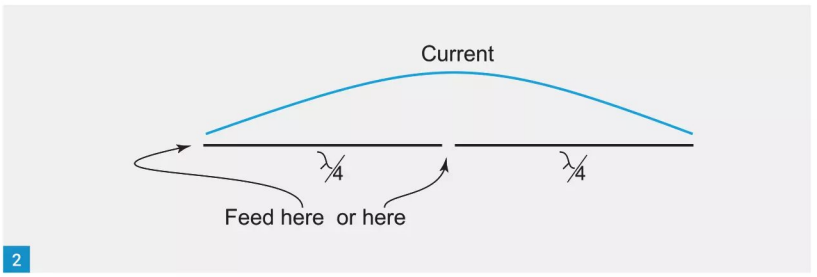
Applying my formula, using 450Ω cable of velocity factor 85%, my 145MHz J-Pole is shown in **Fig. 4**. Not knowing the 50Ω pickup point, I stripped the bottom 10% and made 'riders' to slide along the exposed copper wire. See **Fig. 5**.

I also 'tuned' my feeder. I used a 1.3m length of RG58, which is a velocity-adjusted wavelength for 145MHz. This may seem over-the-top but given the grief I'd had in the past, I thought this was worth the trouble.

## Seeing a Stub in Action

I soldered the coax to the riders, the coax centre going to the side that becomes the radiator. I started with the riders close to the top and saw an impedance of 120Ω. Dropping the riders down to near the short, I saw 31Ω on my club's MFJ269C analyser.

Thank you Science! To see theory in action was satisfying, and a few attempts later I'd found a narrow region 7.5% of the way up where the impedance was consistently close to 50Ω. (The



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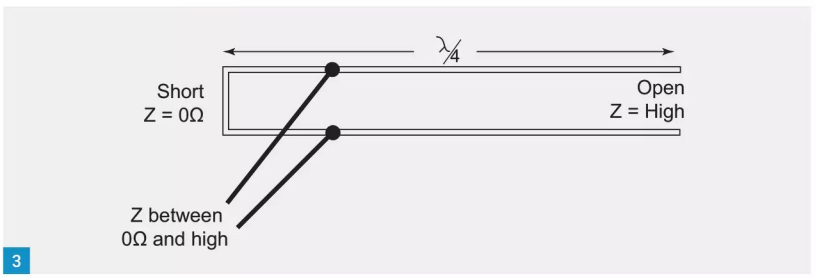

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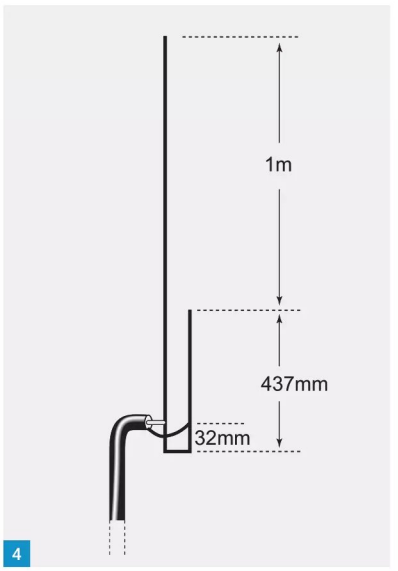

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*Radio Communication Handbook* shows this as 15%, so the internet's 10% is not so far off.)

When I removed the riders and soldered directly to the stub, the match did change but only fractionally. **Table 1** shows my results. Bearing in mind that my target frequency was 145.0MHz, I'd say the radiator is 2 or 3mm too short.

## Slim Jims

**Fig. 6** shows an end-fed whole wave antenna at resonance. **Fig. 7** shows how the radiator can be folded back on itself in stages. **Fig. 8** shows how the second half-wave ends up on top of the first with the same current distribution in it. Add a stub as before and we have a Slim Jim, **Fig. 9**.

How many half-waves do you see in Fig. 9? **Bernard Spencer G3SMW**, a great friend of mine, explained it like this: *"At this frequency, these are the same wire"*. Imagine the top join was of zero length – now do you see one radiator comprising two strands? Even a biggish gap (2cm for 450Ω ladder line) is small compared to a wavelength in metres.

Why bother with the 'second' half-wave radiator then, if a Slim Jim is the same electrically (and consequently has the same gain as) as a J-Pole? Good question. Simplicity of construction is perhaps the answer. If a Slim Jim is made out of open feeder, by cutting one piece approximately 1.5 wavelengths long, almost all the work is done. And solid plumbing pipe or rod designs, which requires short connecting bars top and bottom, are very robust.

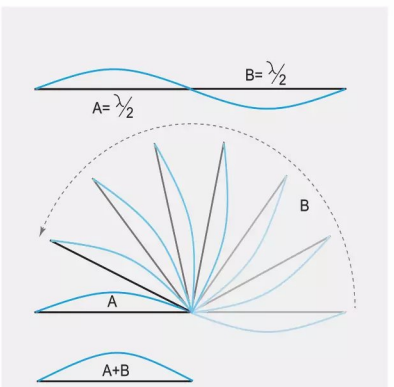
## More Gain in a J-Pole

See **Fig. 10**. Identical up to the top of the radiator, the Super J-Pole antenna is extended by another quarter-wave shorted stub and half-wave radiator combination. The stub's open terminals are half a cycle out of phase, so the two radiators are driven in phase. The stub can be bent round in a circle, 'halo' style. Gain is only 2.5dBd because the radiators are too close not to affect each-other's radiation pattern.

A variant of this is the Super J-Pole Collinear, which does away with the phasing stub and uses an inductive coupling to connect the radiators. This does offer gain in 3dBd increments, because the half-waves are further apart.

**Continued on page 48**

**Fig. 1: Basic J-Pole configuration.**
**Fig. 2: Current distribution across a dipole, whether end- or centre-fed. Fig. 3: Lecher lines.**
**Fig. 4: Dimensions for 145MHz J-Pole.**
**Fig. 5: 'Riders' connected but able to be slid along the exposed copper wire. Fig. 6: Current distribution in an end-fed full-wave antenna.**
**Fig. 7: Folding the radiator back in stages.**
**Fig. 8: Half waves folded back to coincide with each other. Fig. 9: And lo, we have a Slim Jim!**
**Fig. 10: The Super J-Pole.**



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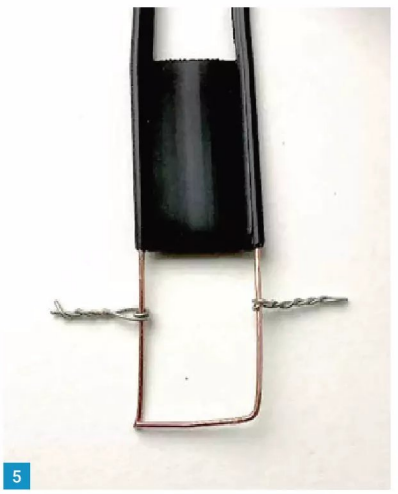
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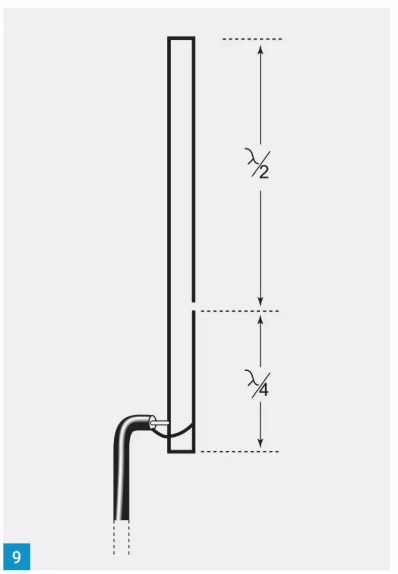

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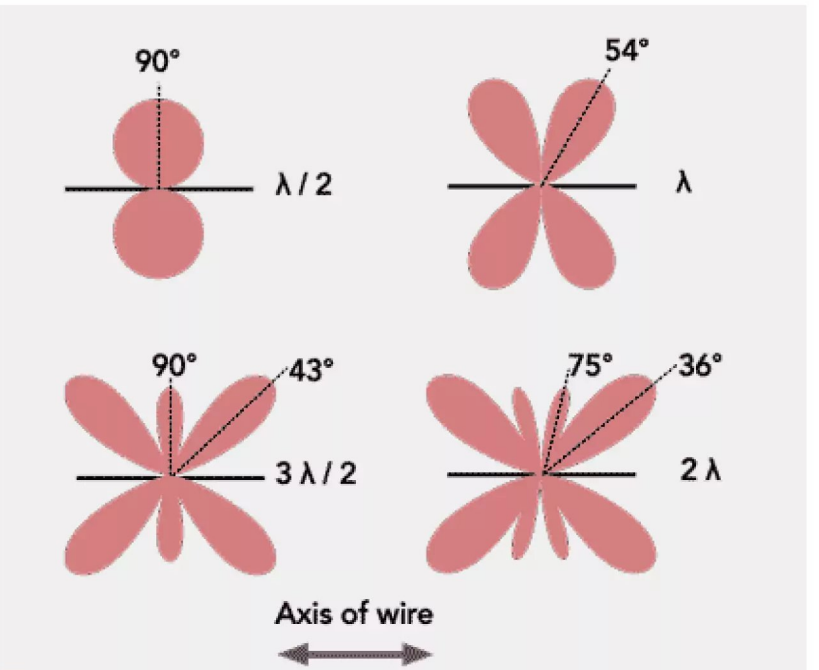


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# Building an End-Fed Half-Wave Antenna

**Daimon Tilley G4USI** explains how to build your own EFHW and have multi-band capability.

In June 2021, in this series, we looked at a variety of HF antennas with the aim of encouraging people who had never built one before to have a go. In this article I am going to walk you step-by-step through the complete build of an End-Fed Half-Wave (EFHW) antenna, including the essential transformer, in this case a 49:1 transformer.

First, let's start go back to basics and describe what an EFHW is. At its most basic it is an antenna that is designed to a length where it is resonant as a half wave on the lowest frequency you intend to operate, the fundamental frequency. So is a dipole, but instead of being fed in the centre like a dipole, the EFHW is fed, as its name implies, at one end.

What are the advantages of that? Primarily there are two key advantages. First, unlike a centre-fed dipole, which has a low feed impedance (around 72Ω) on every odd harmonic of its fundamental frequency and a high feed impedance (several thousand ohms) on every even harmonic, an EFHW, being fed at the end, has a similar high impedance on every harmonic, which can make it a very useful, yet simple, multi-band antenna. For example, it is well known that a centre-fed dipole cut for 7MHz, will also work at 21MHz – the third harmonic – providing two bands from the one antenna. In the case of an EFHW cut for 40m however, it is usable on 7, 14, 21 and 28MHz – four bands from an antenna occupying the same amount of space!

Things get even better if you can fit in an EFHW for 80m, which is not an inconsiderable 40m (134ft) long. While this is too long for many modern gardens, there is a way to achieve one in a much shorter space (22.5m), which we will examine later. However, if you are lucky enough, like me, to be able to accommodate a full size one for 3.5MHz, then with care cutting and tuning it, you can readily achieve usable SWRs, well below 2:1 on every band from 80 – 10m. The radiation pattern does vary as you get higher in frequency however, and while you may wish to use this antenna on all those bands, the pattern is better (less lobes and nulls) on the first few harmonics. The diagram shown, **Fig. 1**, displays the radiation patterns at a half-wave (the fundamental frequency), a full wave, one and a half wavelengths and two wavelengths long. So, for a 40m EFHW, roughly 66ft or 20m long, the patterns shown are relevant for the 40, 20, 15 and 10m bands.

It is worth mentioning at this point that before setting out on a build like this, there are two 'best' bands to cut this antenna for. One is for 80m, which will basically give you a resonant antenna on every non-WARC band, and adequate SWR to be able to use it on the WARC bands of 30, 17 and 12m too. The other is for 40m, which will give coverage of 40, 20, 15 and 10m.

What about the other key advantage? Well, quite simply the EFHW is easier to install as you do not have to support weighty coax in the centre. In fact, the 49:1 transformer, which is the interface between the wire antenna and the coax back to the shack, can be located right next to the shack itself, minimising coax runs. In my case, the 49:1 transformer is screwed to the outside house wall about three metres high, just outside the ground floor shack window. The wire runs from this transformer over the garden and the far end is 132ft away and suspended from the top of a 12m tall conifer. There is some sag in the centre due to the weight of wire, but I have resisted the urge to put in a centre support as it would be in the centre of the lawn.

Just like a dipole antenna, maximum radiation is from the centre section, so an inverted-V or similar configuration would be ideal, but you work with what you have. People successfully use sloper, inverted-L and inverted-V and U configurations. If you can achieve perfection, i.e. a perfectly straight line at a height of half a wavelength above the ground, then great, but don't get hung up about that. It will still work in far from ideal configurations. Don't be afraid to have doglegs or less than ideal height – any antenna is better than no antenna at all.

## Any Snags?

So, it can't all be 'sweetness and light' can it? Well to be honest, the only real disadvantage of using an EFHW is the need to have a matching transformer between your 50Ω coax and the antenna wire. Why is this? Well, the feedpoint impedance of a centre-fed dipole is generally accepted as about 72Ω, close enough to the 50Ω that our rig is designed to match to, and the coax we use. But with an EFHW, the very fact it is fed at the end means that the impedance at that point is in the order of 2,000 to 4,000 ohms! A 49:1 transformer acts as a matching device, 49 x 50Ω is 2,450Ω – in the range of our antenna. Some people prefer to use a 64:1 transformer, and 64 x 50 = 3,200Ω. I personally usually use 49:1 as my ratio.

These matching transformers are often known as UNUNs, which is a contraction of Unbalanced-to-Unbalanced. Our coax feeder is an unbalanced feeder, and an EFHW is an unbalanced antenna.

The transformer is the hardest part of this antenna build, but it is not difficult – it can just look daunting to those who are not experienced constructors. It is actually pretty simple. It merely

**Fig. 1: Expected radiation patterns at the fundamental frequency and harmonics.**
**Fig. 2: The transformer arrangement.**
**Fig. 3: The main components. Fig. 4: Using zip ties to secure the core. Fig. 5: The wound cores.**
**Fig. 6: The UNUN mounted in its box.**
**Fig. 7: The completed UNUN with air vent added.**

consists of you winding a specific number of turns of enamelled copper wire onto one or more ferrite cores in a particular way, then soldering a capacitor to the wires and the wires to your antenna coax connectors of choice, usually SO-239 or BNC connectors. It is possible to buy transformers of this type if you want to skip building one, but still put your own antenna together. However, you cannot be sure of the quality of the transformer unless you build it yourself, as some of the cheaper transformers have been found to use cheap and inefficient ferrite cores. Basically, if you can count, follow a simple diagram and solder just five joints, you can build one easily, and it is much more satisfying making contacts on an antenna you built yourself than one you purchased.

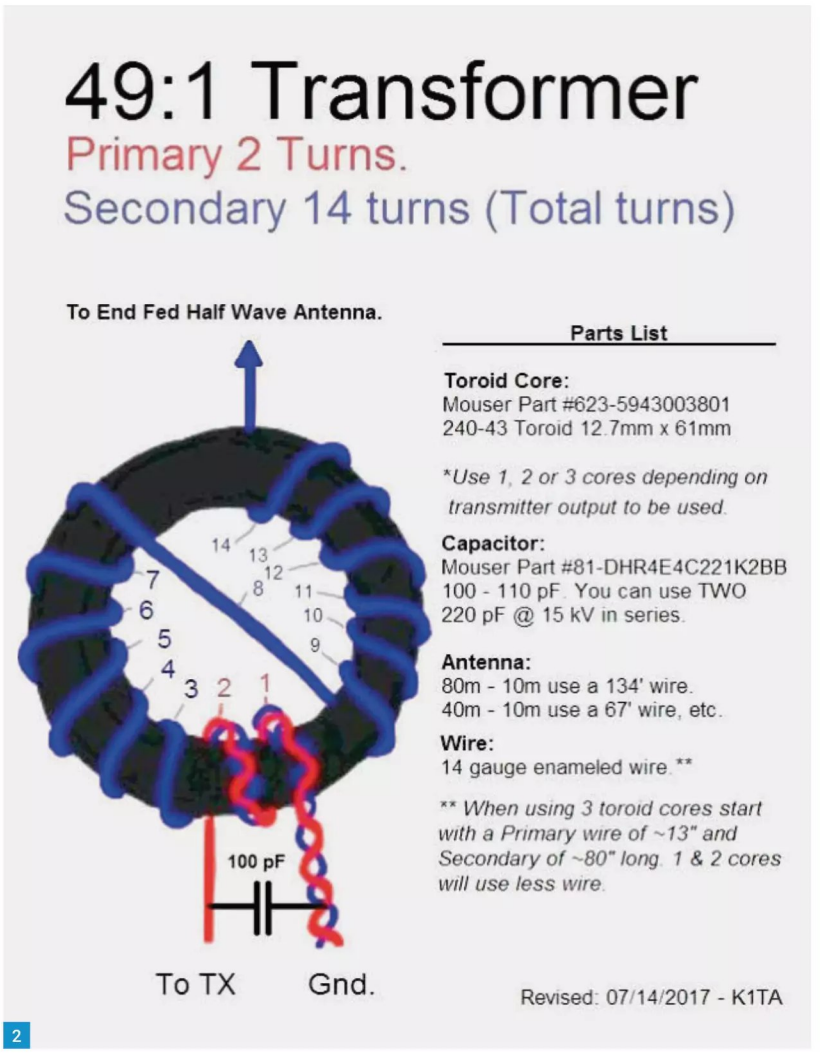
## Building an EFHW

To start, let us look at what the transformer or UNUN looks like. The diagram of the transformer shown, **Fig. 2**, clearly depicts a number of turns of wire around one or more ferrite cores. There are two windings. The primary winding, in red, is two turns of wire around the core, and the secondary winding is in blue and consist of 14 turns. At this point it is important to define what constitutes a turn. That might sound odd, but it might not be what you think! A turn is defined as the wire passing once through the centre of the core. Take a look at the blue wire in the diagram and you can see that there is a number next to the wire, wherever the wire passes through the centre of the ring. Now look where the blue wire crosses the core diagonally. It leaves from the top surface of the core just after number 7 and passes underneath the core before the number 9. The fact that this length of diagonal wire has gone from the top of the core to the bottom means it has passed through the centre, and is itself one turn. Don't let that concern you though. As long as your winding looks exactly as the picture, particularly the number of times the wire passes through the centre of the toroid, you will be fine. You will also notice that the winding consists of two lengths of wire, a blue one and a red one. The blue and red are twisted together for the two primary turns before separating again.

OK, so, having set the stage, let us now create a shopping list of what you need, **Fig. 3**. We will start with a transformer that will suit most people operating up to 100 watts on SSB/CW and around 40 – 50 watts of 100% duty cycle modes such as FT8.

The minimum shopping list for this is as follows:

**1.** A waterproof enclosure of a suitable size to contain the transformer and allow space for wiring internally.



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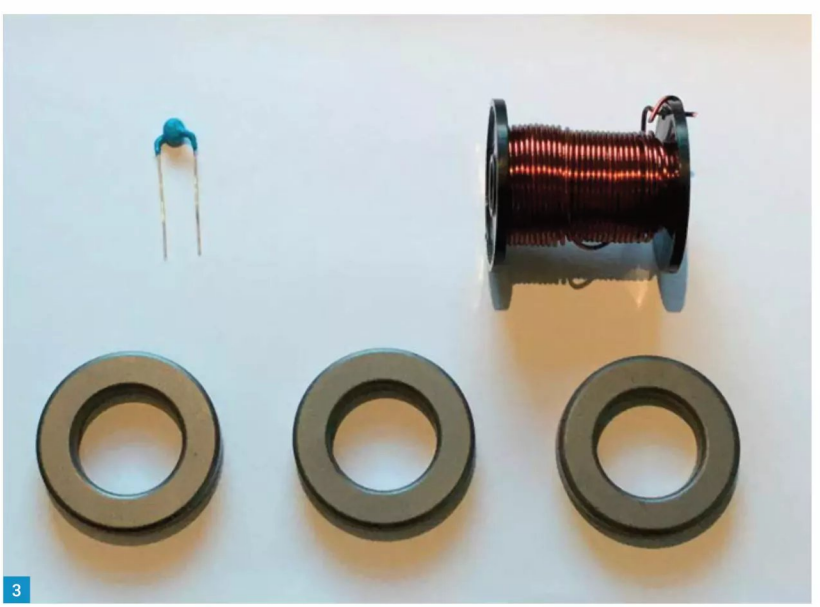
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**2.** One SO-239 bulkhead socket. By preference, choose one with four screw mounting holes as they resist twisting when adding coax.
**3.** One FT-240-43 toroid core. I recommend using a good brand such as Fair-Rite. I purchase mine from a company called Qubits in the UK. A direct link to the correct core, costing £7.49 is here:
**https://tinyurl.com/4u37mntk**
**4.** A high voltage capacitor, of between 100 – 110pF and rated at least 3kV (very high voltages are present at the feedpoint, so keep it and the antenna wire high enough away from prying fingers).
**5.** Two M3 or M4 bolts, about 25mm long, along with eight matching washers, and two matching wing nuts, all stainless steel. These are for your antenna connection and ground wire/counterpoise.
**6.** An M3 or M4 stainless steel eye bolt.
**7.** A ring-type crimp connector of suitable size for your antenna wire.
**8.** Three metres of 14 SWG enamelled copper wire for high power use, or 20 SWG for up to 100 watts.
**9.** A method of securing the finished core in the case. I used self-adhesive zip tie mounts (pictured, **Fig. 4**) but you might use other methods, such as potting compound etc.
**10.** A method of waterproofing the coax connection, e.g. self-amalgamating tape.

A quick note here concerning the shopping list. If you are a regular digi-modes user, e.g. FT8 or RTTY, and use powers of 50 watts or higher, I recommend using two type 43 cores for better heat dissipation and efficiency. If you run up to 400 watts of SSB/CW, then I personally use three FT-240-52 cores and a 100pF capacitor rated at 15kV – plenty more than required. The FT-240-52 cores are more expensive at about £14 each, so over £40 for the three, but will handle powers up to 1.5kW, so there is plenty of 'headroom'. These are available here:
**https://tinyurl.com/yf6ea286**

When using more than one ferrite core, you simply stack them together, secured by superglue. Of course, the more cores you use, the more wire you need, but the number of turns and method of winding remains the same. For three Type 52 cores, you will need about 35cm for the primary winding and 2.2m for the secondary. Using only one or two cores requires less wire.

So, having gathered your parts let us start to build the transformer. I will talk you through the process and use pictures of my own build as an example. Note that my build uses three Type 52 cores for high power use, but the process is exactly the same whether you are using one, two or three cores.

Start by checking your toroids are in good shape with no chips and cracks. If using more than one, apply a few small dots of superglue around the upper flat surface of one and join them together. They stick rapidly so a good way of aligning them is to stand them on their edge, so that they are vertical, and slide them together on a tabletop while keeping them aligned along a straight edge at the rear. For example, on a kitchen worktop against the back wall. Be careful not to get glue on your surfaces though as it can be difficult to remove, so use a sheet of paper for protection.

Once glued, cut two lengths of your wire. The lengths I give here are for three type 52 cores, but I have included the rough lengths for a single FT240-43 toroid in brackets. Cut one length of about 35cm (22cm) and one length of 2.2m (1m). Now we need to wind the first part of the two lengths together. Take one end of each wire and place them together so they both start at the same point. Move down the length of the combined wires to a point about 9cm before the end of the shorter wire. At this point, clamp the two wires together in a vice, but be sure to clamp them between two pieces of wood, to prevent the vice scratching the enamel. You should now have two equal short ends of the wires protruding from one side of the vice, and the remainder from the other. Take the two short ends and insert them into the chuck of an electric or hand drill. If you don't have these items, you can make do with a pair of pliers. Now use your drill or pliers to slowly twist the short ends of the wires together into a pigtail. Use your judgement here, but do not make the twists too tight, or you may fracture the wire. Equally they do not want to be too loose. Please see the photograph of my wound cores, **Fig. 5**, to get an idea.

When that is done, remove the wire from the vice. It is now a matter of winding the wire onto the cores. The 14 SWG wire, if you are using that, is quite heavy gauge, so it needs care and a little strength to keep it under tension as you wind, making turns over the edge of the toroids compact and tight to the core. Your aim should be to have windings that are not sloppy and not able to move around on the core without you applying some effort, regardless of the wire size you use.

Now, to start the winding, I recommend that you hold your toroid(s) in one hand and pass the twisted wire up through the centre of the core from underneath. The aim here is to have the majority of the overall length of wire underneath the core. You want to adjust the wire through the core so that the twisted section of wire begins at the bottom of the core and pokes up through the middle and above the core. Remember that you will have the untwisted short section of wire, about 9cm, underneath the toroid. When the wire is positioned like this, pinch it in place against the toroid with one hand, with it nearest to you, and with the other take the twisted section coming out of the top and fold it toward and around the outside of the toroid to the right and down, so it is pointing downwards. Take this same piece of twisted wire and fold it tightly towards the centre of the toroid and up through the middle again and to the right of the first piece and then outwards, away from the centre. You should now have the long single wire still pointing to the

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floor and the twisted wire should have passed through the centre of the toroid twice, in an anticlockwise direction.

Congratulations, you have successfully wound the primary turns! If you look closely, you will realise that not only have you got two primary turns, but because the wire is twisted, you also have two secondary turns already.

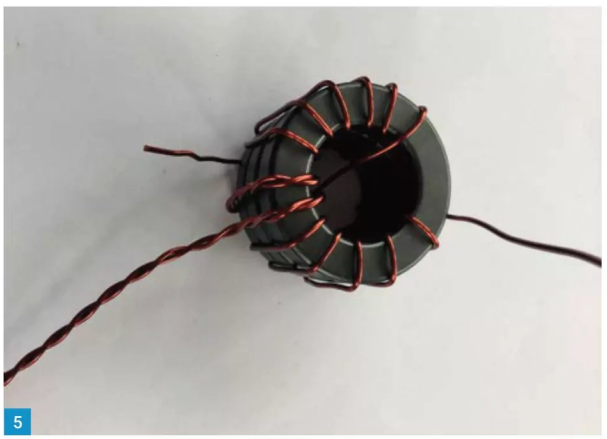
Now, swapping hands, begin to wrap the long single wire tightly around the outside of the toroid, up the side and down through the centre, in a clockwise direction. Pause here. That is three turns of secondary completed.

Continue to wind this wire, as tightly as you can, in the same direction, counting as you go, with each downward pass through the centre counting as one turn. When you have completed turn seven, pause. Look at the diagram and see what happens next. As you bring the wire around from the bottom and up the side, begin to pass it down through the centre but now direct it towards the underside of the opposite side of the core(s) aiming to finish just to the right-hand side of your twisted pair. This does not look like the previous turns, but it has still passed through the centre and it counts as turn number 8.

Pause again and look at the diagram once more. You can see that you now start to wind in a counterclockwise direction. Follow the diagram closely for turns number 9 through to 14, finishing with what was the long single wire exiting from underneath the core, almost 180° away from where you originally started. Now compare your finished winding with the diagram. Make sure it matches exactly the same number of turns (the amount of wires seen passing through the centre).

Now trim each of the three ends of wire (one twisted and two single) to about 9cm, being careful to ensure this leaves enough wire to meet the connection points in your chosen enclosure.

Examine carefully the photograph of my transformer inside the enclosure, **Fig. 6**. You will see that in the bottom right I have placed the eye bolt. This is used as strain relief for the antenna wire. I pass the transformer end of the antenna wire



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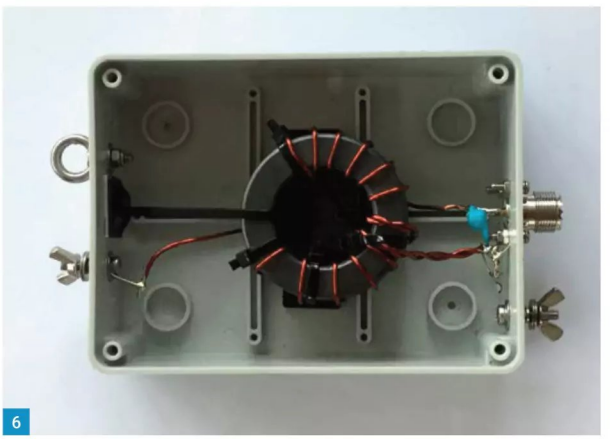

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twice around this eye bolt, and then with a little slack I terminate the wire in a round end crimp terminal, which I usually solder as well. This attaches to the stainless-steel bolt, under the wing nut, on the top right, once the transformer is mounted in its final position.

You will see that the final piece of our winding, the single tail, is soldered to a solder tag attached to this antenna wire bolt on the inside of the enclosure. Scrape the enamel off the wire using a craft knife before soldering.

At the bottom of the box, you can see the bulkhead SO239. These use four bolts to secure them to the box. Under one of these bolts is placed a solder tag, and the twisted pair of wires is soldered to this tag. A further length of wire connects this tag to the solder tag of the wing-nut bolt just to the right-hand side. This is used for the ground or counterpoise connection (see later).

The untwisted end of the twisted pigtail that exits from the bottom of your core(s) is scraped and soldered directly to the centre pin of the SO-239. The 100pF, 3kV or 15kV capacitor is then soldered across the two wires, which are connected to the SO-239, again remembering to scrape of the enamel.

Make sure these joints are all soldered well, with enamel well removed, and given the amount and gauge of the wire, you may want to use a higher powered soldering iron with a large bit. I recall I used a 100W soldering gun for this task.

Finally, you can see from the photograph, Fig. 6, that the cores are mechanically supported to the box by means of zip ties and self-adhesive zip tie anchor points, which are also pictured.

## Finishing Off

You should at this point consider condensation and ventilation. Inevitably, depending on power and duty cycle, some heat is generated by the transformer. This can have two effects. Too much heat is a sign of too much power for your type and number of cores, so efficiency can fall. Additionally, any warmth inside a waterproof box might lead to condensation on a cold day. As a minimum, you should drill a couple of small (say 2-3mm) holes in the bottom of the box to allow pooled condensation to escape. As my transformer was built to handle more power, I decided to also add a circular air vent, **Fig. 7**, from the local DIY store to the front cover, of the type often used for tumble dryer outlets. I am not sure this was necessary, but I decided to take a 'belt and braces' approach.

Now, if you have an antenna analyser, or QRP rig with an antenna SWR sweep function, you can test the transformer on the bench without an antenna. Merely add some resistance between the antenna bolt and ground/counterpoise bolt (top right and left in my photo, Fig. 6) and sweep the bands. You should use something like 2.7kΩ to 3kΩ of resistance, which could be achieved, for example, by a single 2.7kΩ resistor or three 1kΩ resistors in series, the precise value is not too critical. If the transformer is working well, you should see SWR figures of below 2:1 (probably below 1.5:1 in many cases) across the HF bands from 80 – 10m. If they are not in this range, check everything again, including the number of windings and all your soldered and mechanical connections. An analyser will also allow you to see the impedance figure.

If you don't have this facility, then install your transformer out of harm's way of people, say about 3m high, and connect your chosen length of wire for the fundamental (lowest) frequency you want to work at. Then using an SWR meter and low power, say around 1 to 5 watts, on a quiet portion of that lowest band, raise and lower your wire, adjusting the length for best SWR.

It is important to choose the frequency you trim the antenna to quite carefully. Here is the reason why. If you are lucky enough to have enough space for an 80m EFHW, then the length will be around 134ft or so. If you recall, the antenna works on other bands on each harmonic, or multiple of the fundamental frequency. So, if you tune your antenna for best SWR at just above 3.5MHz, in the CW portion of the band, it will have best SWR at exact multiple of that, so 7, 10.5, 14, 17.5 and 21MHz, etc.

But if you adjusted best SWR for the top phone end of the band, just below 3.8MHz, then resonance and best SWR on other bands would fall at 7.6, 11.1, 14.6, 18.1 and 21.6MHz – somewhat high for most bands (The higher resonances will not in practice fall at exact multiples, because of end effects, but we can ignore that here).

So regardless of which band (and therefore length) of antenna you are building, bear this in mind. Adjust your antenna length for the best SWR at a portion of the lowest band you intend to operate, which works out reasonably at other harmonics.

The best way of doing this is to cut it a little long to start with and then fold the far end back on itself, a bit at a time, to electrically shorten it until best SWR is achieved. In this way, if you shorten too much, you can extend the length again slightly, which is difficult to do if you have cut the antenna! When you have the correct length, then you can make it permanent. Again, an antenna analyser can really help here because, as you trim, you can see the impact on all bands. In my case, I mostly operate CW, which is in the bottom portion of each band. By tuning my antenna length to best SWR at 3.5MHz, I have less than 2:1 SWR on every band up to 10m. In actual fact I achieve SWRs (across the whole band) as shown in **Table 1**.

| Band | Measured SWR |
|---|---|
| 80m | 1.5 to 1.7:1 |
| 60m | 1.6:1 |
| 40m | 1.3 to 1.5:1 |
| 30m | 1.1:1 |
| 20m | 1.3 to 1.5:1 |
| 17m | 2.5:1 |
| 15m | 1.3 to 1.5:1 |
| 12m | 1.9 to 2:1 |
| 10m | 1.9 to 2.4:1 |
| 6m | 1.9 to 2.4:1 |
| 4m | 2.5 to 2.8:1 |

**Table 1: SWR by band, as seen on the author's antenna.**

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## In Summary

All of these bands, even those higher bands with greater SWR, have SWRs well within the reach of most internal rig ATUs to 'touch them up' if desired. Remember, of course, with each multiple from the fundamental (lowest) frequency you will get more lobes and nulls. Personally, I only use my 80m EFHW for 80 – 30m, preferring other antennas, verticals and Yagis, for the other bands. That said, I have successfully made contacts on all the bands listed, even with the compromises that some of the radiation patterns on higher bands bring.

So, having built the transformer, which will work for any HF band, you next need to determine the length of wire required. Remember this is nothing more than an end-fed dipole at the lowest frequency, so the age-old formula of 468/frequency (MHz) will give you the length in feet (142/f for the length in metres.) I tend to add a little for good measure and trim from there. Cut for the lowest frequency of the band of choice. Using this formula, and adding a margin for adjustment, I suggest starting lengths of 136ft for 80m and 68ft for 40m are about right. If you are a little cautious then feel free to add an extra foot or so to start with.

An 80m bonus prize? What if you don't have room for a 132ft long EFHW, but would still like to work 80m? Well, there is a way to make a shortened EFHW, which has a total length of only 75ft or 23m. Working on 80, 40, 20 15 and 10m, it will use exactly the same transformer we have made but the wire portion is configured differently, using a home-made loading coil. Rather than try to describe that here, if that configuration interests you, there is a good article describing how to build and tune it here:

**https://tinyurl.com/4sfzf9hb**

And finally, having added your antenna wire according to the lowest band you wish to operate on, before adjusting it for SWR, we need to consider the issue of a ground or counterpoise. Opinions vary on this and you have choices to make. There are basically three key options.

Option one, consists of running an earth wire from the earth terminal on your UNUN to an earth stake as nearby as possible.

Option two is to run a short counterpoise wire from this 'earth terminal' down to the ground and along it or just underneath the surface. The length of this is not critical. Many sources recommend 0.05 of a wavelength of the fundamental frequency, so just 2m or so on the 80m band.

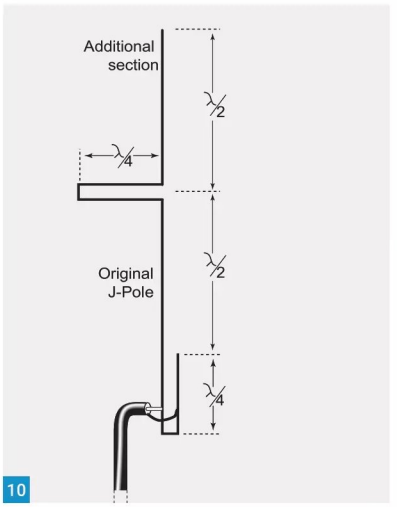
Option three is not to use either. In this case, the outer shield of your co-ax will act as your counterpoise. To prevent problems with RF back in the shack, you can add a common mode choke, but at the end of the coax nearer the end of the transmitter rather than the antenna, which is usual in other antennas. This will permit the shield of the co-ax to act as a counterpoise up to the point of the choke.

In my case, I used option one, and also added some good quality clip-on ferrites on the co-ax about 3m from the UNUN.

As a slight aside, I also predominantly use an EFHW antenna when portable. In this case the UNUN can be much smaller and more cheaply made for QRP levels, and I use option three, but without the choke, which I find unnecessary at QRP levels.

So, that is it. Hopefully you now have the confidence to build your own 49:1 UNUN and EFHW antenna. By doing so, you can be assured that high quality ferrites are used for maximum efficiency and have lots of fun making worldwide contacts on an antenna made with your own hands. Good luck and please drop a line to our Editor to let him know how you get on! **PW**

**Continued from page 43**

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| Frequency (MHz) | (R+jX)Ω | VSWR |
|---|---|---|
| 145.95 | 47+j0 | 1.0 |
| 144.95 | 56+j10 | 1.2 |
| 143.95 | 66+j10 | 1.5 |

| VSWR | FLow (MHz) | FHigh (MHz) |
|---|---|---|
| 2.0 | 142.8 | 148.3 |
| 1.5 | 143.9 | 147.1 |
| 1.2 | 144.7 | 146.6 |
| 1.1 | 145.0 | 146.2 |
| 1.0 | 145.3 | |

**Table 1: Measured results.**

## Operation on 70cm

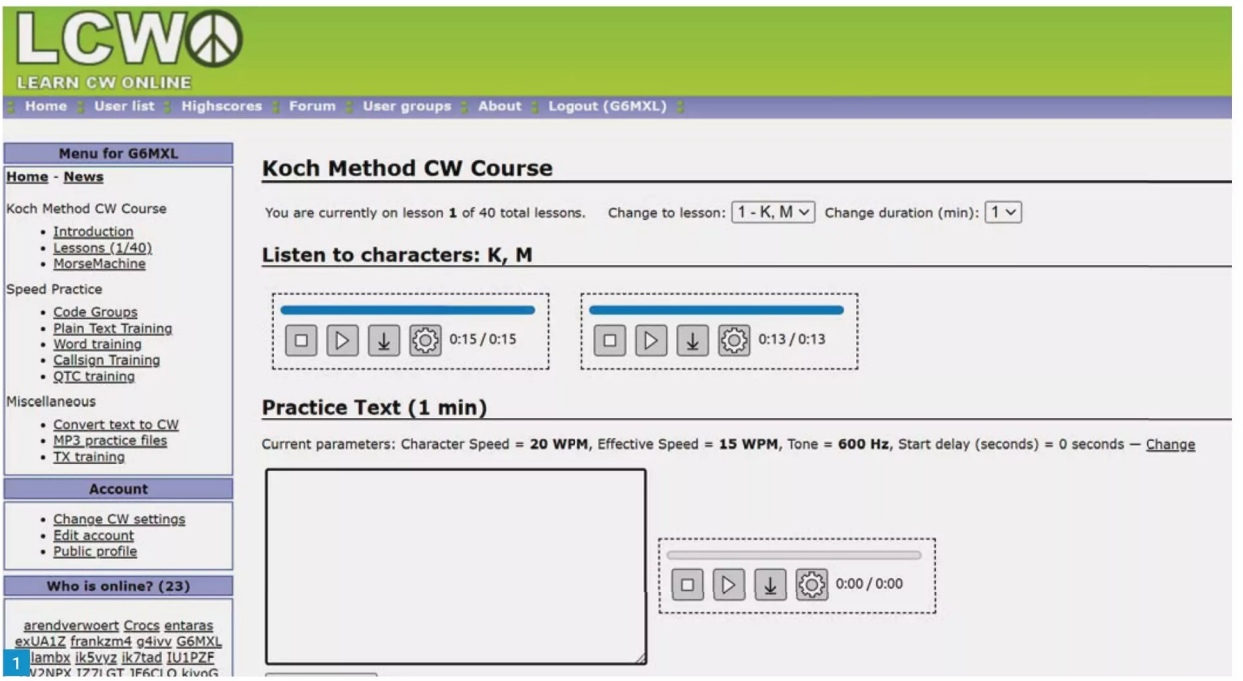
A half-wave radiator on 2m is three half-waves on 70cm so this 2m J-Pole should work on 70 cm, albeit with a higher radiation angle. In the past, when I've had J-Poles with VSWRs in excess of 2.5:1 I've found they match (and perform) almost as well on the third harmonic, but this one has a match of about 5:1 on 435MHz and I think I know why.

I found the feedpoint was about 3.2cm offset from the short. This is for a stub for 2m. For 70cm, that distance would need to be about 1.1cm, and the impedance at 3.2cm will be much higher, several hundred Ohms I expect. I don't know what it is exactly; on an MFJ-269C you don't get R + jX on UHF.

So it's ironic; by designing a better 2m antenna, I've eliminated its accidental dual-bandedness. I might experiment with a 4:1 balun (made of coax) to see if I can get it back.

## Conclusion

Interesting subject I thought; there is a lot more I could have written. I hope, even if you never make one of these, you find this of interest. I somehow doubt that's the end of the J-Pole and Slim Jim gain conspiracy. I look forward to the next *Letters* page but I've done my best! **PW**




**Colin Redwood G6MXL**
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# New Year Resolutions

**Colin Redwood G6MXL** is back with some great advice for those new to the hobby (and old hands too!).

Welcome to the first *What Next* column of 2023 and a special welcome to previous readers of *RadioUser*. I'm using the occasion to look at a few things that may have featured in readers' New Year resolutions starting with the various amateur radio licence exams. Then I'm going to look at source of operation information for various amateur radio equipment.

**Training Courses**

Since the pandemic, the range of local amateur radio clubs offering training courses for the various amateur radio exams has reduced. The information on the RSGB website is currently very much out-of-date. For example, the details of my local club showed an old meeting location on the map and out-of-date contact details. Our club secretary had to get the RSGB to 'raise a ticket' to get the data corrected. If you are looking for face-to-face training, then it is certainly worth contacting your local club. Many will only run a course if someone shows interest, and may not publicise courses until they know for certain that they will be running. Besides a limited number of local clubs offering training, there are a number of online course providers who have got an excellent reputation for the quality of their training and the support they provide.

Essex Ham run frequent Foundation courses that last three weeks and start at roughly monthly intervals. The Online Amateur Radio Community (OARC) also run frequent Foundation Courses, which cover the material at a faster pace. OARC also run a 'very intensive' Intermediate course over just seven sessions and an equally intensive Full course in just eight sessions. The Bath Distance Learning Team run Intermediate and Full Licence Courses at a less intense pace. The Bath team usually run one Intermediate and one Full course each year, with the Intermediate usually starting in January and the Full starting in late August, with enrolment closing a few weeks in advance. Regular *PW* author GM6DX also has online training available.

**www.essexham.co.uk**
**www.oarc.uk**
**https://badarc.webs.com/bath-training**
**https://gm6dx.thinkific.com**

## Irish Licence Exam Book

While on the subject of training, the Irish Radio Transmitters Society (IRTS) have made the new edition of their *Amateur Station Licence Study Guide* available for download. In addition to being essential reading for those planning to take the Irish exam, this well illustrated book may be useful to those taking their UK Full licence exam as a way to read around the subject and get some extra clarification on a topic. Please bear in mind, though, that the Eire syllabus is different to the UK syllabus, most notably in the Licensing Conditions section.

**https://tinyurl.com/5e7tzh4c**

## On the Air

2022 has seen a noticeable improvement in propagation conditions on the HF bands. A friend of mine is given an RSGB *Deluxe Logbook and Diary* each year for Christmas by his wife. He has a resolution to fill his 2023 logbook.

## Learning Morse Code

Many amateurs have learning CW (Morse) or improving their speed as one of their new year resolutions each year. The 'Learn Morse Code Online' (LCWO) system by **Fabian Kurz DJ5CW** has been recommended to me. To use LCWO you'll need to register to enable you to save your practice settings, keep track of your learning progress, and compare your skills with others on the scoreboards. LCWO starts with a number of lessons based on the Koch method, **Fig. 1**. You can then move on to code groups, plain text, callsigns, word training and QTC.

**https://lcwo.net/morsemachine**

## QSL Bureau Stamps

If you collect QSL cards via the RSGB or a SWL bureau, a quick reminder that you may need to replace the envelopes you've lodged with your QSL Bureau sub-manager with envelopes affixed with bar-coded stamps. Originally Royal Mail announced that the last date to use non-bar-

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**Fig. 1: LCWO showing the first lesson using the Koch method to learn the letters K and M.**
**Fig. 2: A small selection of Nifty Mini-Manuals.**
**Fig. 3: A lightweight case to transport a Yaesu FT-891 transceiver.**
**Fig. 4: A SOTAbeams bag for a wire antenna.**

coded stamps was to be 31 January 2023. Royal Mail subsequently changed their plans and have announced that there will be a grace period of a further six months until 31 July 2023. After this six-month grace period, an item with a non-barcoded stamp will be treated as if there is insufficient postage. Any item that has insufficient postage will be subject to a surcharge by Royal Mail.

**www.royalmail.com/sending/barcoded-stamps**

## Operating Instructions

With the ever-increasing complexity of modern transceivers and receivers, the need to access suitable documentation to help perform even quite simple tasks is more important than ever – I even needed to refer to the manual to change mode on one transceiver! While modern equipment is usually supplied with paper manuals, these can easily be lost or not passed on when the transceiver is sold on. What can be done?

## Download Manuals

Most of the main manufacturers make their operating manuals available for downloading from their websites. I'd certainly encourage readers to download these for each piece of equipment that they own. It is also a good idea to have a read through the manual before purchasing a piece of equipment to get a feel for what will be involved in operating it. I'd also suggest downloading manuals for models that you might use at your local club or other group you belong to, so that you can make good use of the equipment on occasions when you may use it.

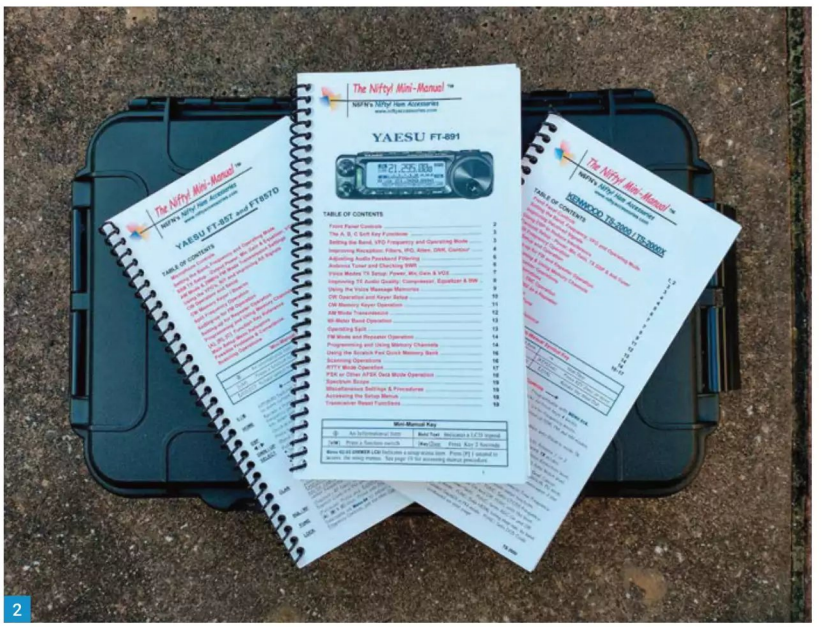
With the complexity of modern equipment, having quick access to operating manuals is needed more frequently than in days gone by. Storing these downloads on your laptop or mobile device can be particularly useful if you operate away from home. Where possible I also try to download service manuals as well. Incidentally I've found it useful to do the same for other items around the home from hi-fi to washing machines.

## Mods.DK

If you are looking for amateur radio operating and test equipment manuals, service manuals or modifications for models that are no longer in production, then I'd suggest visiting the Mods.DK website:

**www.mods.dk**

This has a wealth of information covering models from the less well-known and long-gone manufacturers as well as all the current manufacturers. Browsing through the list I came across manuals for equipment from Microwave Modules, AKD, MFJ, Mutek, Cushcraft, Mosley and Howes to take a few random examples. Be careful when selecting downloads, as many are available in a choice of languages and some are for variations of models not intended for the UK market – so, for example, may not cover all aspects of models that cover the UK 4m band. As there is a daily limit on the number of downloads you can make, I'd suggest downloading relevant manuals in advance of needing them. If you are tempted to try the modifications, please be aware that they will almost certainly invalidate manufacturers' guarantees!



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## Nifty Mini-Manuals

Besides the 'official' operating instructions from their respective manufacturers, Nifty books publish a series of small laminated booklets covering the essentials for many popular transceivers, **Fig. 2**. I find these really useful to take with me when operating away from home. I'd suggest purchasing these as soon as you can after buying your transceiver in case they are discontinued when models cease production. These mini-manuals are produced in the USA, so there may be a few aspects that are not relevant to versions of transceivers aimed at the UK market, and again may lack information on the 4m band

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where transceivers are suitably equipped. Martin Lynch and Radioworld are both listed on the Nifty website as stocking Nifty products and can be found by searching their respective websites.

## RSGB Books

The Radio Society of Great Britain (RSGB) publish a small range of books under the 'Radio Today' banner, each dedicated to a popular multi-band, multi-mode HF transceiver. The range currently covers Yaesu's FTdx10 and FTdx101 along with Icom's IC-705, IC-9700, IC-7300 and IC-7610 models. If you have one of these transceivers, you may wish to purchase the relevant book to help you make the most of your transceiver.

## YouTube

There are also numerous videos available on YouTube, which can be a helpful source of 'how to' videos. I'm a little cautious when referring to these, and look in the comments below each video to get a feel for the quality and validity of the advice given.

## Facebook Groups

Many popular transceivers have a Facebook Group dedicated to them. These can be a good source of advice, but I would suggest applying a sanity test before following some of the advice I have seen in some groups!

## Transporting Equipment

I'm sure some readers will have resolved to get out and operate away from home in 2023. One of the challenges in transporting equipment is providing sufficient protection so that they don't get scratched or the controls damaged without adding too much weight. I was looking for a suitable box for my Yaesu FT-891 transceiver so that I could take it in a suitcase on holiday without damaging it. Subsequently I have used the box to carry my transceiver to club activities. Solent Plastics sell a range of plastic boxes that are light-weight, strong and provide a good level of protection. I chose their Max MAX004S IP67 Rated Accessory Tool Box. Although advertised as a toolbox, it suited my needs perfectly, even leaving just enough room (internal dimensions 315 x 194 x 80mm) for a microphone, DC supply lead and an adapter to enable me to connect feeder terminated in a BNC to connect to the SO239 socket on the rear of the FT-891, **Fig. 3**. There are layers of foam to protect the transceiver and store the Nifty manual. In addition, there are holes around the sides, which could be used to padlock the case if you wanted an extra level of security. Solent Plastics offer a number of smaller and larger boxes, some advertised for cameras, some of the largest coming with wheels that enable them to be rolled along, in a similar manner to many luggage cases.

**https://tinyurl.com/vata2zw5**

## Transporting Antennas

If you need to store or transport a wire antenna, then I've found the antenna storage bags sold by SOTAbeams to be a good choice. They are available in red, green and blue, so that you use different colours to identify which antenna is in each, **Fig. 4**. They can easily accommodate wire antennas made from flexible wire. I don't think they are suitable for semi-flexible copper wires. There is a drawstring at the end to secure the contents. I find these can easily accommodate wire dipoles, which I wind on a SOTAbeams winder, along with some thin coax and even a few reusable cable ties.

For reasonably small Yagi antennas, I have used washing line covers to store elements and short lengths of boom. The bags do seem to perish after a while, so they may not be ideal, but I have yet to find anything better! **PW**

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# Back to Normal

**Roger Cooke G3LDI** is pleased to see Bootcamps up and running again and has some additional Morse-related news.

**Roger J Cooke G3LDI**
roger@g3ldi.co.uk

It was very enjoyable to see lots of people at the RSGB Convention we had not seen for nearly three years! Hopefully things are gradually getting back to normal again now we are all fully jabbed!

Locally the Bootcamps have started again. I received a report from **Andy G0IBN** from the Essex CW Club and they had a very successful day in a local village hall with several tables all quite full. This is what Andy had to say about it: *"Did you miss it? What a shame! Essex CW ARC's Boot Camp participants had a great day at their annual convention of CW enthusiasts. Some must have been masochists as they had returned for more punishment!*

*"Receiving and transmitting skills were analysed by the instructors and constructive criticism given, comments were few as standards have certainly improved.*

*"Free tea, coffee and cakes were enjoyed by all the attendees during breaks between sessions, if your brain could not take any more, you could go outside for a break in the sunshine.*

*"**Keith G3WGE** and Andy G0IBN gave a short talk on the different keys on display and advice on how to set the paddle keys correctly with a dynamometer (tension gauge) or home-made feeler gauges carefully calibrated with a micrometre, e.g. strips of printer paper and/or the silver foil wrapper from those spearmint soft mints!*

*"Straight key spring tension can be set using a plastic cup and the xyl's cooking scales; measure 50, 100 or 150g of water in the cup, place the plastic cup on the key knob and adjust the spring.*

*"The Russian programme RufzXP was used during the day for the 'Great Britain High Speed Championships!' All participants were encouraged to participate. **Enzo M0KTZ** managed an impressive 44wpm, 15065 points, to obtain the Gold certificate. **Steve G8XEV** achieved 27wpm, 5077 points , for the Silver certificate and **David M0WDD** achieved 29wpm, 4692 points. Very well done to the winners and to all those who participated.*

*"Why not join us next year, the more participants perhaps the bigger the prizes.*

*"Wouldn't it be great if we could get a team for the European High Speed Championships, which are held in a different European state every year?"* See: **www.youtube.com/watch?v=82ACUC0uaXk**

Andy has promoted the Bootcamp now for several years and he has people travelling long distances to attend. **Figs 1, 2** and **6** show how organised this event is.

Norfolk ARC ran one this autumn for the first time in three years. We had around 16 booked but then had several drop out at the last moment due to illness and other problems. So, we concentrated on head copy, contest operating with practice using Morserunner and RufzXP, together with accent on sending techniques. We hold our Bootcamp in my bungalow so cannot cope with too many! However, it was voted a success again so those that attended enjoyed the day, **Fig. 3.**

Please let me know if your club are holding Bootcamps this year. I am always pleased to give this as much publicity as possible. Please send a report with pictures to me at **roger@g3ldi.co.uk**

## RSGB GB2CW Test Coordinator

Following the sad death of **Phill G4NZQ** I was pleased to see the RSGB announce that **Eric Arkinstall, M0KZB** has been appointed as the RSGB's Morse Test Coordinator, **Fig. 5**.

His role comprises two main tasks:

Contacting approved Morse assessors around the country and emailing them the contact details of candidates wanting to take a Morse test

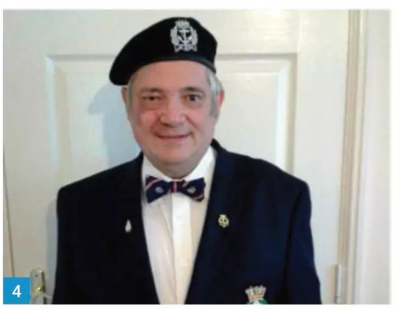
Emailing a Certificate of Competency to the candidate after a successful test

Eric is also a GB2CW volunteer and teaches

**Fig. 1: Ed G1RUZ, Roger G4ZZL, Keith G3WGE, Steve G8XEV, David G0WDD, Peter G4ENC and Tim G4YBU at the Essex Bootcamp. Fig. 2: The spacious hall where Essex Bootcamp was held. Fig. 3: L/R Mui M0MUI, Mike G4DYC, Ian G3JQT and Malcolm G3PDH at Norfolk ARC Bootcamp. Mui is one of our star pupils and is very capable at 25wpm+. Fig. 4: John Stevenson MW7WJS. Fig. 5: New GB2CW coordinator M0KZB. Fig. 6: High speed champion Enzo M0KTZ. Fig. 7: Morsum Magnificat.**

Morse code on the air weekly. For further information about Morse and the Morse test, see:
**rsgb.org/morse**

Eric has just let me know that **John Stevenson MW7WJS** has taken and passed his Morse Proficiency Test at 15wpm so let's hope this is the first of a stream of successes. John is shown in **Fig. 4.**



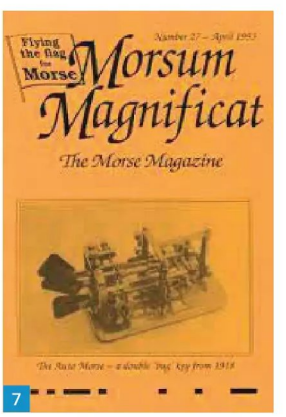
## Morsum Magnificat

*Morsum Magnificat,* **Fig. 7**, is no longer in print but was a very respected publication in its day. I have a few on my shelf here. The one thing about Morse is that it never really dates. OK, the technology changes over time and there are more software packages coming along, plus the inbuilt keyers in rigs and various Morse programs. However, the basic connection of a key to a rig is still the same and there is a lot of good, still relevant reading in this library.

**Zyg Nilski G3OKD**, the copyright holder, has generously granted permission for the download of these documents for personal use. This permission does *not* include downloading or distribution for commercial purposes.
**www.n7cfo.com/Tgph/Dwnlds/MM/MM.htm**

This is an opportunity for all Morse aficionados and should not be missed!

Please send all your comments, offerings, information and especially pictures to:
**roger@g3ldi.co.uk**
73 and may the Morse be with you! **PW**

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**Dr Bruce Taylor HB9ANY**
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# The Heathkit Mohican

**Dr Bruce Taylor HB9ANY** describes a ground-breaking shortwave transistor receiver.

Although the Heath Company started producing electronic kits in 1947, and the US manufacturer had sold a crystal controlled three-valve CW transmitter as early as 1952, it was from 1956 that the Heathkit brand name became well known in the world of amateur radio, with the launch of the popular DX-100 transmitter. This was followed in 1959 with the first of the *Native Indian Tribes* series, the Apache transmitter and Mohawk receiver. All these rigs were vacuum tube designs, for transistors with high performance at HF were expensive at that time. (The retail price of a humble OC45 in mid 1959 was 35/-, about £43 in today's money).

But in March 1960, three years before Eddystone launched the transistorised EC10, and four before National introduced the transistor version of the HRO, the fully solid-state Heathkit GC-1 Mohican receiver kit was produced using ten transistors, four diodes and a Zener voltage stabiliser. This was followed in 1962 by the more successful GC-1A version, with improved audio quality and better HF stability. These attractively styled sets were some of the earliest of what became the extensive series of successful Heathkit *Green Machines*.

Although it was possible to import US Heathkits to the UK, they often had 115V power supplies and were subject to high customs duty and purchase tax. Hence Daystrom Ltd (a subsidiary of the Daystrom Group that owned the Heath Company at the time) decided to produce a British version of the Mohican that used largely UK components, including Mullard transistors instead of 2N series types. It was designated the GC-1U, **Fig. 1**.

In its heyday, Daystrom Ltd employed almost 200 people and occupied part of a large facility near Gloucester, **Fig. 2**. It also had Heathkit Centres in London and Birmingham and a mobile showroom that displayed kits at amateur radio events across the country. US advertisements claimed that an experienced amateur could assemble the GC-1A from the kit in around 30 hours. The GC-1U required less work because the RF front-end was preassembled and Daystrom also offered ready-built sets for a cost supplement. During the golden Heathkit years, some Daystrom employees (and at least one teenage son) earned a bonus doing 'out working', assembling kits in their homes in the evenings to keep up with demand.

The GC-1U kit was launched in the UK in August 1961 at a price of £38.75. (About £920 in today's money). It remained in production until 1969, when the price of the kit was £37.88 while the ready-built model (A/GC-1U) cost £45.88. Short term hire purchase was offered, but modern day XYLs would be astounded that in the zeitgeist of the 1960s any married woman who applied for this credit was required to submit the employment details of her husband! Today, Mohicans are typically offered on eBay and at swap meets and SK sales for around £50-150, depending on condition. While this classic receiver is outperformed by modern sets, it was a historic milestone in portable shortwave transistor radio development and makes an interesting restoration or educational training project.

## Design

Because the Mohican is a conventional single-conversion superhet that uses discrete components, and was designed for home assembly, it is particularly straightforward to work on and restore to original specifications. The 60-page GC-1U instruction manual, which in 1961 could be purchased separately for 88p, specifies every step of the assembly in minute detail and contains all the information required for a complete strip-down and rebuild of the receiver. Normally a manual should accompany a built receiver but if it is missing, original ones can be found for around £15 on eBay, while a digital file can be purchased for even less. The numerous assembly drawings are much more comprehensive than those given in the maintenance manuals of any ready-built radio equipment. Nine of the diagrams in the manual were even provided in the form of separate folded 34 x 43cm sheets for attachment to the wall above the working area. An example is shown in **Fig. 3**.

I've provided the original factory circuit diagram and some documents for the GC-1U here:

Schematic diagram:
**https://tinyurl.com/GC1USchematic**
Parts list:
**https://tinyurl.com/GC1UPartsList**
Performance graphs:
**https://tinyurl.com/GC1UPerformance**
Sales brochure:
**https://tinyurl.com/GC1USalesBroch**

Note that the 2.2kΩ collector resistor of IF transistor X5 is missing from the schematic diagram. A minor inconvenience is that the component designations (R1, R2, etc) shown in the diagram are not carried over to the parts list.

The Mohican provides continuous coverage from 550kHz to 30MHz in five bands (the GC prefix stands for General Coverage), so it is suitable for both MW broadcast reception and general shortwave listening. On the shortwave bands the receiver has adequate sensitivity of 2μV for a signal-to-noise ratio of 10dB at 50mW audio output.

**Fig. 1: The 10-transistor Mohican was a milestone in portable shortwave receiver design.**
**Fig. 2: Until 1976 Heathkits were produced in a part of this large facility near Gloucester.**
**Fig. 3: Seven large assembly drawing sheets complement the figures in the instruction manual.**

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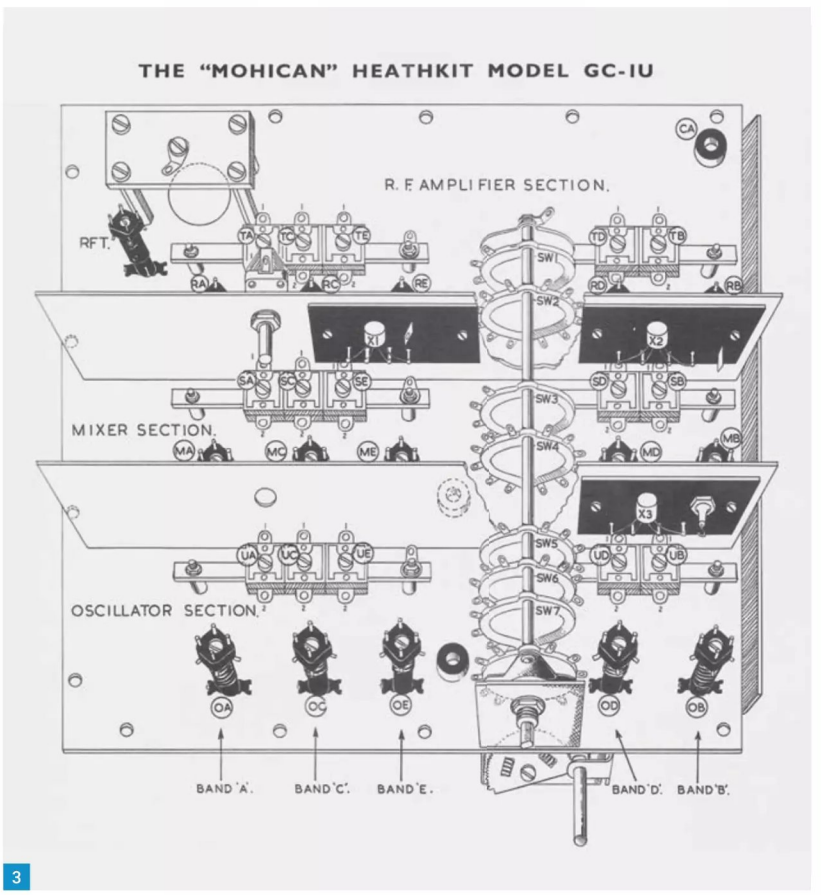


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But delicate manipulation of the tuning, RF and AF gains, antenna trimmer and BFO is required to resolve SSB signals satisfactorily.

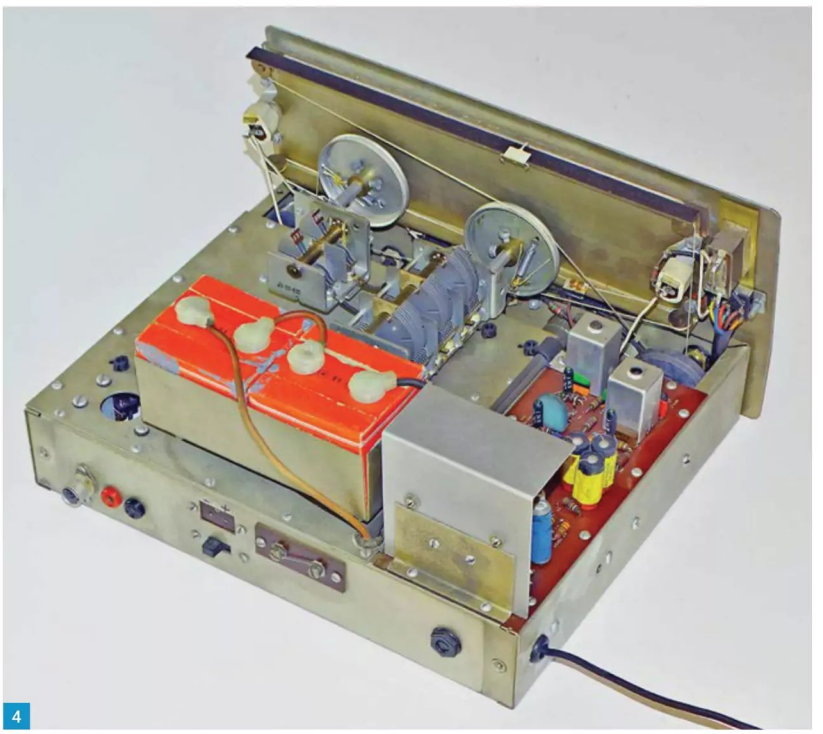
The main tuning is supplemented by a separate control that provides calibrated bandspread tuning specifically for the 10, 15, 20, 40 and 80 metre amateur bands, as well as an additional general logging scale with 100 finer subdivisions. This is achieved by a small two-gang variable capacitor effectively in parallel with the oscillator and mixer sections of the main three-gang tuner, **Fig. 4**. The US GC-1A has only a single-gang bandspread capacitor, which tunes the oscillator.

Both of the 24cm wide slide-rule scales have quite different calibration from those of the GC-1A, reflecting the different amateur frequency allocations in Europe at the time. For example, the 4th bandspread scale of the US receiver covers the range 26 to 29.7MHz, thus including the 11m citizens band, whereas the GC-1U spreads the narrower range 28 to 30MHz over more than 75% of the dial width. Of course, the absolute accuracy of the wide bandspread scales depends on the precision of the main dial setting. Note that the main tuning calibration is only correct when the bandspread tuning is at the 'Set' mark at 97 on the 0-100 logging scale. The tuning drives of the GC-1U are smooth and they both have anti-backlash split gears and lead flywheels, but the plastic knobs are of poorer quality than the metal ones fitted to the GC-1A. Only the small knobs have internal metal bushings and the bandswitch knob in particular is easily broken if its set screw is overtightened.

Although they use different transistor types, both the US and UK receiver models have an RF amplifier, three IF stages, a simple impulse noise limiter, a BFO that is tuned by a varicap diode and AVC that can be switched off for CW and SSB reception. They have a useful 1mA edge-reading relative signal strength meter, calibrated from 0 to 10 rather than in S units. An important difference between the GC-1A and GC-1U for amateur station use is that only the UK model has RF input transformers with low impedance primary windings for a 75Ω coax antenna input. Both models have sockets for a higher impedance wire antenna and a ten-section telescopic whip that can be extended to a total length of 131cm. When the coax input is in use the whip antenna can easily be unmounted to prevent the pickup of local interference and RF when transmitting. Contrary to what is stated in the manual the high and low impedance inputs are not switch selected. A front panel antenna trimmer is provided by a 20pF variable capacitor that parallels the main 290pF RF tuning one. Since Daystrom Ltd couldn't find a UK supplier for the whip antenna, this component had to be imported from the US. To avoid delaying shipments to early customers the kits were sent out without the antenna, and this part was supplied at a later date after they arrived in the UK.

Three Mullard AF115 transistors are used for the grounded base RF amplifier and local oscillator of the GC-1U, as well as the common emitter mixer stage. There is no trap to reduce IF breakthrough. The other seven transistors are mounted on a single-sided PCB, **Fig. 5**. Four OC45s are used for the common emitter IF amplifiers and the grounded base BFO. The audio amplifier uses

**Fig. 4: This general view of the Mohican chassis shows the rear panel components and the cord-driven main and bandspread tuning capacitors.**
**Fig. 5: A single printed circuit board carries the IF strip, the detector, the noise limiter, the BFO and the audio output stages.**
**Fig. 6: The IF characteristic is shaped by Clevite transfilters (light blue) and emitter traps (dark blue). Fig. 7: All the trimmers and cores for the realignment of the RF front end are readily accessible.**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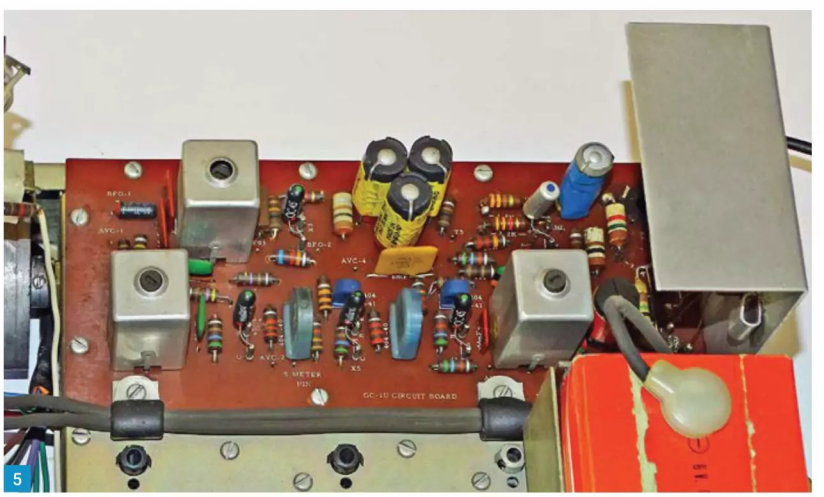
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an OC81D driver transistor, transformer-coupled to match the lower base impedance of a pair of push-pull OC81s that are capacity coupled to an internal 25Ω loudspeaker. This loudspeaker is disconnected when headphones or an external loudspeaker are plugged into a jack socket on the rear panel.

The 1mm cadmium-plated sheet steel chassis and 1.3mm front panel are well made and quite sturdy, but the construction hardly compares with the machined aluminium castings of Eddystone receivers of this era. The dual-tone stove enamelled paint finish of the front panel is durable but the silk-screened control markings tend to wear off. There are no markings to identify the sockets, terminals and switch on the rear panel. Instead, the kit included a full-size gummed paper sheet with appropriate lettering (see URL below, at 100% scale). This appears to have been an afterthought, as there is no mention in the manual of how it was intended to be used. (The lettering could be cut out, or the entire sheet stuck to the panel and holes made in it for the components.)
**https://tinyurl.com/GC1URearPanel**

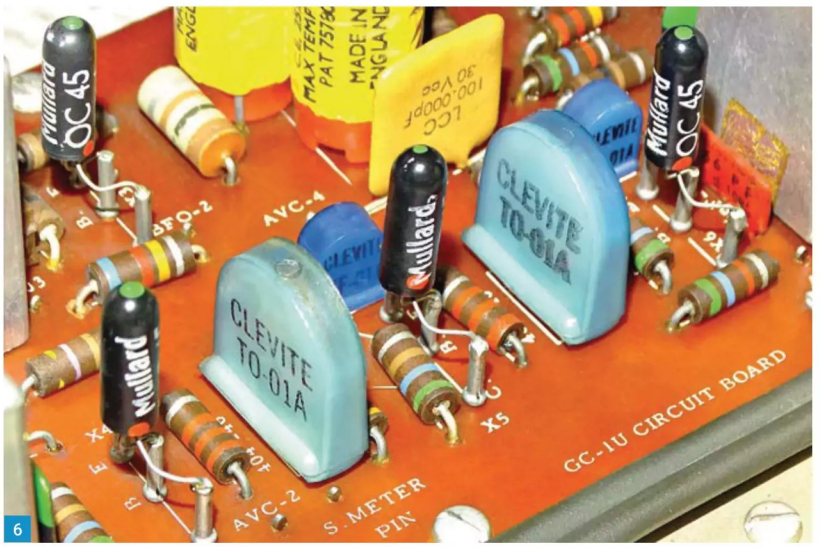
The elliptical loudspeaker of the GC-1A is mounted inside the top of the cabinet, and the carrying handle can optionally be fixed to the top or to the right side. While a case of this type is shown in early catalogue pictures of the GC-1U, most production kits had the loudspeaker mounted on studs inside the right-hand side and the handle can only be mounted on the top.

## Alignment

The 455kHz IF characteristic is shaped by a pair of Clevite TO-01A piezoelectric overtone ceramic transfilters in conjunction with conventional double-tuned input and output IF transformers and TF-01A emitter traps, **Fig. 6**. The traps increase the selectivity by providing an RF bypass of the emitter resistors at their series resonant frequency. The passband is about 2.9kHz wide at 6dB down and 3.7kHz wide at 10dB down. The transfilters require no alignment, a good feature for a kit that might be assembled by people without test equipment. They are normally reliable and in the case of performance degradation they can be opened to allow the discs and spring contacts to be cleaned with isopropyl alcohol.

If a wobbulator is not available, the IF transformers can be aligned simply by adjusting the upper and lower cores in each transformer for maximum signal strength, after setting the signal generator frequency to the peak of the transfilter response. Image rejection was specified as 'average 30dB over the five bands' but with a 455kHz IF and only one RF amplifier stage, it can be as low as 12dB on the higher frequency bands. The core in the BFO coil is adjusted for zero beat with a signal that is centred in the IF passband and with the front panel control set at the midway position.

To avoid the problem of home alignment, the RF front-end of the GC-1U was supplied as a preassembled, wired and aligned unit, **Fig. 7**. However, the compound securing the ferrite cores of the inductors is not entirely stable and even a newly built kit could normally benefit from realignment. Before starting the work, adjust the positions of the dial cord pulleys on their shafts such that the tuning and bandspread capacitors are fully closed when the pointers are at the left-hand end of the scales. Then move the bandpass tuning to the 'Set' position near the opposite end of the scale. Realignment follows normal procedure, iteratively adjusting the cores of the coils at the low frequency ends of the ranges and the trimmers at the high frequency ends and checking that the image signal has not been tuned in error. Note that on the highest frequency band the local



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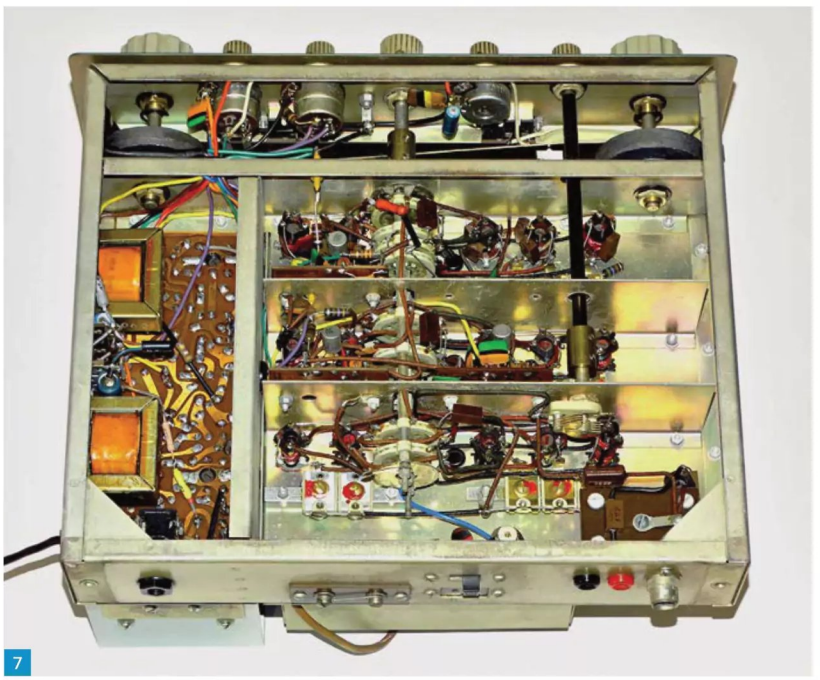
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oscillator is on the low frequency side of the signal instead of the high side. However, it may be found that performance is improved by aligning it on the high side instead.

## PowerSupply

Since the Mohican was designed to be suitable for portable or mobile use, provision is made to power it at 12V from batteries housed inside the case. The battery box of the GC-1A takes eight C-size 1.5V cells, which are held in place by a pair of long coil springs. For mains operation, the entire pack can be unplugged and replaced with a 117V AC power supply through a large opening in the rear panel. This optional 12V 200mA mains power supply, Model XP-2, was sold in kit form for $9.95 at a time when the receiver cost $109.95 as a kit, or $193.50 assembled. It is a simple design with no voltage regulation and a two-section 0.483Ω/1000µF RC filter instead of a smoothing choke. As the dial lamps in the receiver act as a bleeder resistor, they are permanently on when mains power is in use and the voltage will rise if they fail. Since most US users installed the XP-2, the original GC-1A battery boxes became separated and are now somewhat rare.

On the other hand, the GC-1U battery box, **Fig. 8**, is permanently fixed to the chassis and is designed to hold a pair of 6V batteries such as Ever Ready PP1, GEC BB21, Vidor VT1 or Leclanché Type 812. To secure the batteries in place the box has an internal foam lining that disintegrates with time, but can easily be stripped out and replaced. It should be noted that whereas all these batteries have the same press-stud connector spacing of 35mm, on some they are oriented at right angles to those on others. Today these batteries cost about £10 each, and it is more economical to power the receiver from an external rechargeable battery or a small mains power supply. In 1963, Daystrom offered a Model UBE-1 230V AC 'battery eliminator' for the set for £2.88. The external supply can be selected by a switch on the rear panel and a socket is provided to connect it with a special polarised plug, **Fig. 9**, that was provided with the kit. The supply should be fused, since the plug has male pins, so there is a danger of accidental short-circuit when it is not inserted. Since the GC-1U wasn't designed to accommodate an internal mains power supply, its cabinet is not provided with ventilation holes.

In 1961 I fitted a GC-1U in my 307E Ford Anglia van and used it until 1969 as a normal car radio for broadcast reception. During my daily commute I also operated it very successfully as GM3NZI/M on the 80m band with a 25W transmitter, a boom microphone and a centre-loaded whip antenna. Since the Mohican has PNP transistors its chassis is positive, which is compatible with the electrics of many vehicles of that vintage. The external power supply input is filtered by a 1.1mH RF choke and 1000pF bypass capacitor and there were no problems with alternator noise.

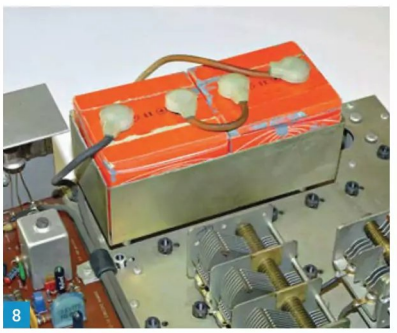
## Modifications

After the printing of the Mohican instruction manual, Daystrom made a number of modifications to the circuitry and published the list of errata that I have provided here:

**https://tinyurl.com/GC1UErrata**

The values of several resistors were changed and the 8V Zener diode was replaced by a 6.4V one having a lower temperature coefficient. Hence the voltages of the first stages are lower than indicated in the table in the manual. Frequency pulling can be reduced by adding a second Zener diode to stabilise the oscillator bias separately from the RF amplifier and mixer. A 0.05µF capacitor was added between the cathode of the detector diode and the slider of the volume potentiometer. The audio driver transistor was changed from an OC78D to an OC81D, while the audio output transistors were changed from OC78s to OC81s. Towards the end of production a Mk.2 version of the GC-1U was produced but these are very rare.

When the AVC is switched off, a reverse polarity voltage can be applied to the 8µF electrolytic capacitor C27. Failure of the capacitor can be averted by changing it to a non-polarised 0.1µF component, while adding an 8µF or 16µF electrolytic capacitor across C96 to restore the AVC time constant.



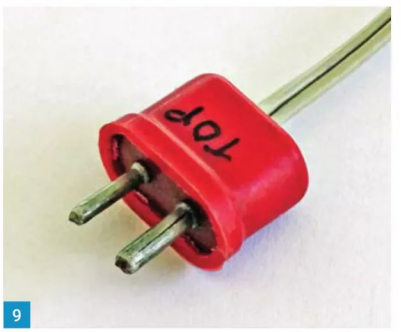





**Fig. 8: Unlike the US Mohican, the GC-1U accommodates a pair of 6V PP1 batteries. Fig. 9: A polarised plug is used for connecting an external power supply. Fig. 10: Higher power audio output transistors can be mounted on an extended heatsink. Fig. 11: An output transformer (right) for a larger 3Ω loudspeaker can be fitted under the chassis.**

Unlike the GC-1A, which has a momentary action dial lamp switch when battery power is in use, the UK Mohican has a normal on/off type. The original dial lamps are rated 6.3V 110mA. They are connected in series with a 12Ω resistor and this chain draws about 100mA from a 12V supply, more than the quiescent current drain of the receiver itself. This can be greatly reduced by replacing the lamps by a pair of LEDs with an appropriately larger value of series resistor.

The muting terminals provided at the rear of the GC-1U chassis allow the positive pole of the internal battery or external power supply to be disconnected from chassis ground by a relay or switch when transmitting. These terminals must be jumpered when muting is not in use. If the output of the external power supply is not floating, this configuration can't be used and the muting terminals can be rewired in series with the black wire from the main power switch instead. This will also prevent the dial lamps being extinguished on transmit, which is less than ideal in most circumstances. The antenna switch should ground the input to the receiver when transmitting and if the receiver is used in the proximity of a powerful transmitter, it may also be advisable to protect the RF amplifier transistor further by adding a small relay to short the input to C10 to ground during mute.

Since it was intended that the Mohican could be powered from dry batteries, it was designed to have a very low current consumption (with the dial lamps switched off) of around 35mA. As a result, the audio output power from the internal 25Ω loudspeaker is rather inadequate for the noisy conditions of mobile use. The power can be increased by replacing the OC81 output transistors by an IC amplifier or by higher rated ones such as OC206s mounted on an extended heatsink, **Fig. 10**. These can drive a more powerful 3Ω speaker via an output transformer that can be fitted easily under the chassis, **Fig. 11**. It's worth inserting a miniature connector inline with the internal loudspeaker cable to avoid having to remove the speaker or manipulate the whole cabinet when working on the chassis of the receiver.

## Restoration

The glass encapsulated OC-series Mullard transistors used in the GC-1U are quite reliable but the AF115 transistors in the front end often develop internal short circuits due to the growth of very fine tin whiskers from the surface of their metal cases. The whiskers tend to grow even in unused transistors with no internal electric field present. This problem is not unique to transistors and has also been known to cause bridging between soldered joints, especially with modern lead-free solders that have a higher tin content than earlier alloys. The troublesome whiskering phenomenon is not well understood, although it has been known since at least the 1940s and is believed to have been the cause of the loss of the Galaxy IV telecommunications satellite in 1998 and the temporary shutdown of Millstone Nuclear Power Plant in 2005. For the GC-1U, replacement of the AF115 transistors by more modern types is the only sure solution to the problem. Occasionally such whiskers have been successfully cleared by tapping the transistor case, or fused by discharging a capacitor between the case and the affected pins, but they generally grow back later.

Other defects commonly found in any 60-year-old receiver are leaking or open-circuit electrolytic capacitors and carbon composition resistors that have drifted high in value. The faulty components can be located by voltage checks and individual testing with a DMM. But if an efficient desoldering tool is available (and this is a very useful accessory to have in any amateur workshop), the best approach can simply be to clip them all out and replace them with new ones. Snip the components in the middle and then extract the wire stubs individually from the PCB using the heated suction pump. Equivalent modern components are readily available and are not expensive.

Since the Mohican was designed for home construction, the receiver can be very simply and rapidly completely disassembled by reversing the detailed instructions. With new capacitors, resistors, wire and dial cord this creates a replica kit that can be built by a beginner to learn about electronics and acquire useful practical skills. In addition to the assembly instructions, the manual includes detailed circuit descriptions, construction notes, component drawings, information about chassis wiring and soldering technique, a glossary of radio terms and even a short introduction to alloy junction transistors.

In these days of complex factory-made black-box rigs that can't be serviced or modified by the average amateur, such a kit makes a valuable educational trainer for a novice. As with the original Heathkits, the sense of achievement evoked by the experience of successfully building the receiver can inspire an interest in amateur radio and electronics that could lead to an enjoyable hobby or a rewarding career. **PW**

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# RF Vector Network Analyser Basics

**Keith Rawlings G4MIU** looks at how VNAs have transformed antenna measurement.

**Keith Rawlings G4MIU**
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A Vector Network Analyser (VNA) is a versatile tool for anyone who is interested in the design, measurement and testing of RF 'Networks'. They are used to characterise the performance of RF systems and components that include, but are not limited to, antennas, tuned circuits, inductors, capacitors etc. With a VNA magnitude and phase are measured independently and the results are combined to calculate the impedance of the network being measured. They will also measure insertion loss, return loss and S-parameters, and are very useful when used in the development, testing and manufacture of most things RF. A VNA almost enables the user to 'see' into an RF circuit, much the same as an oscilloscope is used to see into an electrical circuit.

Something that has held back the use of VNAs by the average radio amateur in the past is that commercial units are generally expensive. They often cost many thousands of pounds, even on the second-hand market, and those that are cheap may be old or even faulty in some way. Calibration Kits can likewise be expensive.

Happily, things are different now. With the introduction of the embedded micro-controller amateurs have access to a multitude of 'station accessories' that are relatively cheap and a VNA is now one of them.

## My Beginnings in Antenna Measurement

When first licensed as a teenager I wouldn't have known what a VNA was even if I had been hit with one, let alone have afforded one. Like many I tended to rely on a VSWR meter to check that my antennas were matched correctly. This was relatively simple. Holding a Class B licence, I was limited to 144MHz and above. I was using commercial beams and verticals that required minimal adjustment. My HF receiver, a Yaesu FR50B, mainly had a piece of wire that was cut to fit the available space and fed into it via an ATU (AMU) so I wasn't too worried whether it was resonant or not.

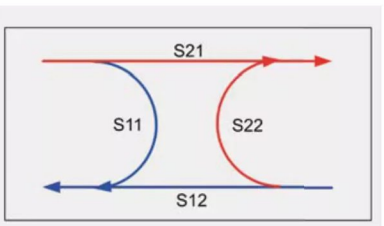
As I became more interested in HF and started to think about experimentation and transmitting, I bought a GDO (Gate Dip Oscillator in this case) and a Cambridge Kits RF Noise Bridge. With the bridge I would be able to tell if my wire was 50Ω, or not!

However, with an amateur bands only receiver, if the wire was not 50Ω, then there was no way of knowing if it was too short or too long, resulting in me always making things much too long and trimming to resonance.

After getting my then Class A licence I used a KW2000E on HF but this also had an amateur bands only receiver.

I then spotted an advert in *RadCom* from the USA for a Palomar Engineers R-X Noise Bridge. According to the blurb, using this nifty little device I would not only be able measure resistance but also reactance. I would able to tell if the antenna was too long or too short. I would be able to find the resonant frequency of series and parallel tuned circuits, measure inductance and capacitance plus lots of other useful measurements that I just knew I had to make. This was the tool for me, so I bought one.

Had I have been more savvy about things like customs and import duty I may have found it cheaper to have bought a general coverage receiver to use with the Cambridge noise bridge or, perhaps, make a bridge of my own! Suffice to say, by the time I opened the box it had cost me a lot



2 Scattering Parameters

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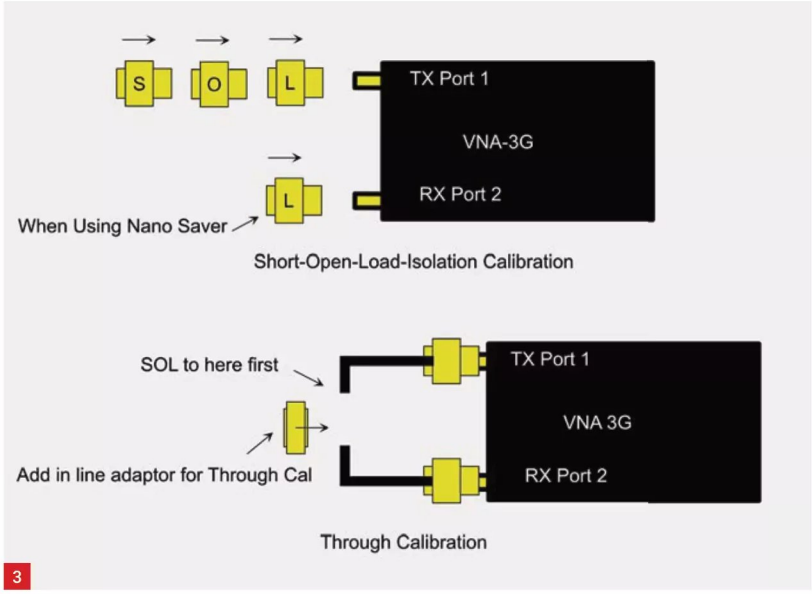


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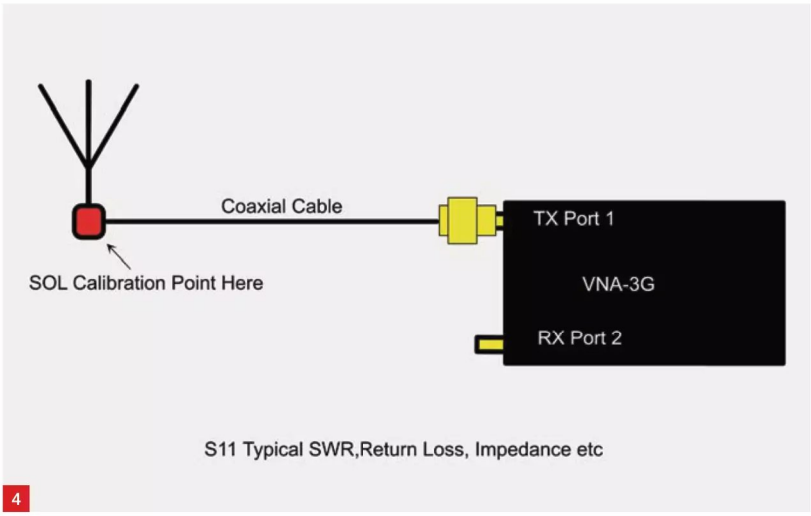


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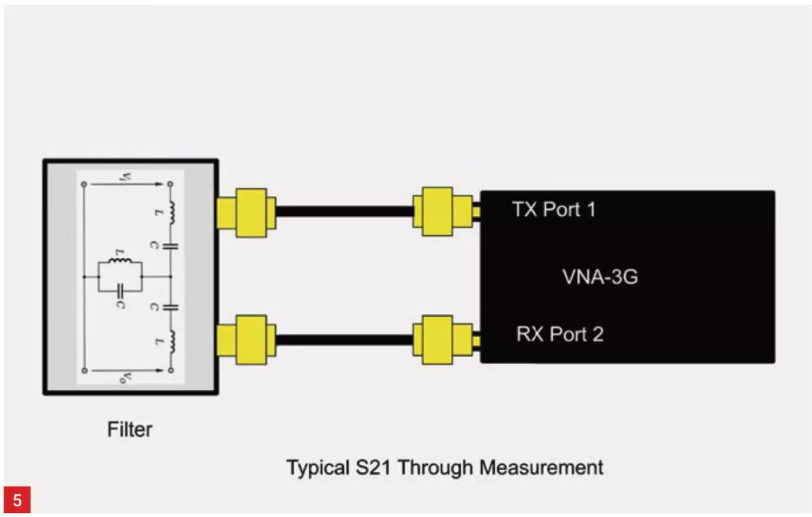


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**Fig. 1: Some of the author's analysers.**
**Fig. 2: Parameters measured by a VNA.**
**Fig. 3: Calibrating a VNA.**
**Fig. 4: How to measure an antenna.**
**Fig. 5: Through measurement, for example of a filter. Fig. 6: Calibration kits.**

more that I thought it would. Nonetheless, I found the R-X Noise Bridge extremely useful and used it successfully for many years.

Eventually I 'upgraded' to a more modern analyser, an MFJ 269B (Single Port device), which I used for both hobby and some work applications and which I still use today alongside more modern analysers.

Some while before getting the MFJ I had obtained an ageing Wilton Scalar Network Analyser for work. Unfortunately, some six years ago, after many years of reliable use, this large instrument swept its last filter and passed through the ionosphere to the great scrapheap in the sky. I needed another analyser, and as the Wiltron measured amplitude only, I wanted something a bit more capable. SDR-KITs advertised the DG8SAQ VNWA, a vector network analyser, it had good reviews and an active support group, so I went for one of these. It is mainly used now for bench work as I obtained an FA-VA5 for antenna work. I have found mine excellent and I now wouldn't be without it (the FA-VA5 has the bonus that it also runs the VNWA software).

The photo, **Fig. 1**, shows some of these old analysers.

Incidentally spectrum Analysers (SA) companioned with Tracking Generators (TG) have similar capabilities to VNAs. However, most SAs combined with TGs will not have the accuracy of a VNA and do not display phase data, which is vital in many RF test applications.

## Moving to VNAs

Looking at just a few of those in the price range of most amateurs, there are a lot of other VNAs presently on the market. The VNA 3G reviewed elsewhere in this month's *PW* (page 14) being just one.

There are Two Port devices such as the VNWA, NanoVNA, VNA 3G, Mini 600/1300 and Tiny VNA along with Single Port devices such as the DG5MK FA-VA5 and I include here the RigExpert range, MFJ and so on, which I view, technically, as network analysers.

Analysers like the DG8SAQ VNWA are a hardware 'front end' and need software running on a computer to display results, while the NanoVNA, VNA 3G, FA-VA5 and RigExperts can be run 'standalone', using their own displays or they can run on free computer software – AntScope in the case of the RigExpert range, NanoSaver with the NanoVNAs and the FA-VA5 can also run on the DG8SAQ VNWA software.

Analysers such as these range from the very

cheap, such as the variants of the NanoVNA, to the more expensive, such as the RigExpert AA-1500.

## Concept of Vector Network Analyser

A VNA measures the transmitted and reflected waves as a signal passes through a Device Under Test (DUT). By measuring the transmitted and reflected signals across the band of interest, or beyond, the characteristics of a device can be determined. If both transmitted and reflected signals are used to characterise the input and the output, then the device itself may then be characterised.

The beauty of the VNA is that it can measure both amplitude and phase and a measurement that includes these parameters allows a lot more detail to be discovered about the DUT. Phase is a crucial element in network analysis as a complete characterisation of devices and networks requires the measurement of phase as well as magnitude.

## Parameters

VNAs use what are called Scattering or S-Parameters to describe the behaviour of the ports of a network. A full description of S-parameters is a bit outside the scope of this description of VNAs, suffice to say the four parameters S11, S21, S12 and S22 can describe a two-port linear network, see **Fig. 2**. For a lot of work we use S11 and S21, S11 for reflection and S21 for through.

Using S11, the reflection at the input can be measured as this represents a complex reflection factor consisting of real and imaginary parts. Therefore, parameters such as VSWR and impedance Z can be derived mathematically. On most analysers these parameters may also be presented by means of a Smith Chart, which adds a visual way to assess results.

## User Calibration

To get accurate results from a VNA a careful User Calibration is required. Some instruments will have a Master Calibration (VNWA, FA-VA5 and I think the Mini-1300). Once calibrated, if the number of data points or start and stop frequency are altered, this calibration may become invalid.

A master calibration then acts as a 'fall back' providing sufficient accuracy to continue measurements but, for maximum accuracy, a recalibration should be undertaken if changes are made.

To make a calibration we need a Calibration Kit (Cal-Kit). These usually consist of a Short, Open and Load (SOL) in the form of the connector type being used for tests. In the case of the VNA-3G this is supplied with an SMA kit. The FA-VA5 would use a BNC kit. That said, different DUTs will have different connectors and for precise results a Cal-Kit matching the connector, including gender, is preferred.

Before we can make a calibration, the Calibration Standards of the Cal-Kit need to be entered into the device or software if it is being used. For the Short and Open a delay is entered depending on the Reference Plane of the part. For the Load the precise value needs to be entered. Although Calibration Standards are very accurate, as with anything there will always be some error and a 50Ω load may not be exactly 50Ω. For example, the load in my Rosenberger SMA kit measures 49.12Ω.

Entering the Cal-Kit parameters into the analyser or software makes allowances for this error. Incidentally if you use anything other than a 50Ω load, say 10Ω, the VNA will happily tell you all day long that it is reading 50Ω. It won't be of course, but the VNA won't know this!

Some analysers enable the Cal-Kit parameters to be entered directly into the device, others don't but where optional software is used it is usually possible to enter the details for use within the software.

In **Fig. 3** I have drawn the procedure for calibrating the VNA 3G directly on its Ports, other devices will be similar. After selecting 'Calibrate' from the menu the parts from the Cal-Kit are placed, in order, on the connector. (When using NanoSaver software a Load can be placed on Port 2). The top image depicts an S11 single port calibration but if we want to make S21 through measurements then we need to add any relevant leads and calibrate on the end of these leads. See bottom image of Fig. 3.

**Fig. 4** demonstrates the set-up and calibration point for an antenna measurement using the VNA-3G and calibrating out the effects of the cable and **Fig. 5** demonstrates a through measurement on a filter, again depicting the setup on a VNA 3G.

**Fig. 6** is a photo of three Cal-Kits, SMA and BNC from SDR-Kits left, and a 'cobbled together' Type-N calibration kit right.

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Cal-Kits can come with a huge price tag but those I have from SDR-Kits are reasonably priced and are more than good enough for amateur use.

I will continue on the VNA topic over the next few months.

## News

**Marcel ON5AU** recently introduced his latest volume of *Practical Antenna Models*, Volume 3 (see last month's *News* pages)..

This latest edition goes into great depth on how to use EZNEC and AutoEZ to simulate the design of loop antennas and also methods of matching them.

These later volumes build on the techniques described in Marcel's book Advanced Antenna Modelling and I will run a full review of Vol 3 in next month's column. In the meantime more details may be found here.

**https://tinyurl.com/ybr3s6mk**

AN-SOF Antenna Simulator have recently released a number of pre-built models for their simulator, the latest of which are Magnetic Loops for 3.5, 7, 14, 21 and 29MHz. These small transmitting loop antennas are simulated one metre above average ground, so the radiation pattern will not be doughnut-shaped as expected for a small loop in free space. The main loop has a 70cm diameter using RG8 cable with the coupling loop being 15cm in diameter using RG6 cable. The value of the tuning capacitor is different to obtain resonance at each frequency. The inductive coupling between the feedline and the large loop has a spacing of 2cm.

All models are in .nec format and may be run on the trial version of the software, including under the 'Run Bulk simulation' feature where all five models are calculated automatically.

**https://antennasimulator.com/index.php/blog**

See you all next month. **PW**

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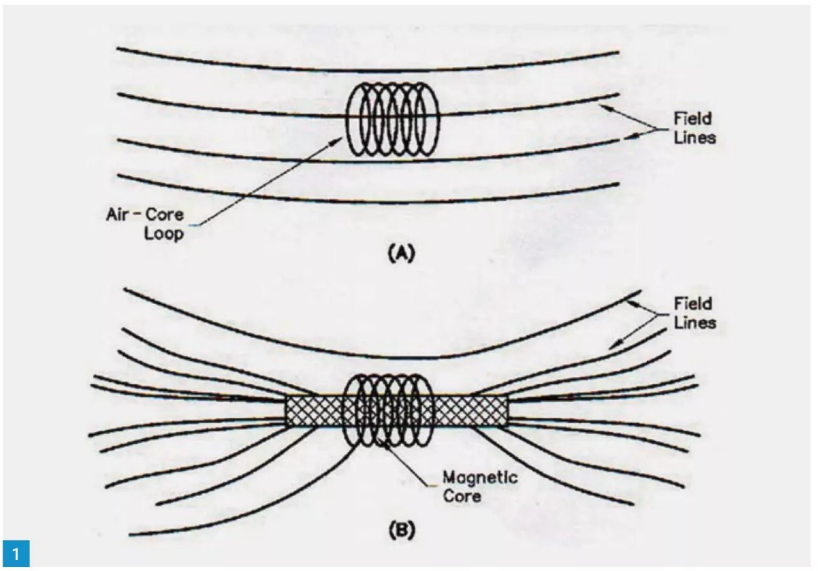


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# Using Ferrite Bar Aerials and Loops

**Georg Wiessala** takes a look at a range of magnetic ferrite bar antennas and loops, which you can deploy to receive and analyse signals from VLF to HF, to DX, and to infer general propagation conditions.

In this article, I am looking at both larger magnetic loop aerials and smaller ferrite rod/ bar aerials. The latter type are also known as *'loop-sticks'*, especially in the USA and Continental Europe. This is, arguably, the most accurate description.

The two types of magnetic aerial work in a similar way, with the one difference being that ferrite bars are often much more compact in their dimensions; they are frequently mounted on the inside of smaller devices.

This is because the copper loop, in the case of the ferrite bar aerial, is wrapped *around the bar*, instead of being out on view. Therefore, a loop such as the new Wellbrook ALA 1530LN is often simply called an 'air-core receiving loop' (e.g. *ARRL*, 1997, Ch. 5; 5-8).

It is well known that a larger loop aerial does not affect nearby field lines, whereas the ferrite core bar causes a concentration of the magnetic part of the electromagnetic field. It 'draws in' the magnetic field lines into itself, as it were, **Fig. 1**, but can also exhibit some degree of 'leakage-flux'.

The reason for this lies in the reluctance (*permeability*) of the ferrite material, which is lower than in the air that surrounds it. 'Permeability' is, perhaps, best seen as the ability of the ferrite material (zinc, iron, nickel, or manganese oxide) to 'gather', or 'bundle' magnetic field lines. It is, therefore, the magnetic analogy to 'resistance', while 'flux' is akin to 'current'.

This phenomenon results in an induced current that may be just as high as in a big, 'external' loop This is not the place to go into too much detail about this, you can find the calculations in the *ARRL Handbook* or any of the other resources indicated at the end of this article.

## Main Characteristics

In terms of the further electromagnetic workings of this type of aerial, a ferrite rod/bar, such as most of the ones I have used for this article, operates as a magnetic antenna. This means that the magnetic component of an electromagnetic wave induces a current in the antenna.

Like all magnetic antennas, a ferrite rod has a bi-directional, figure-of-eight, characteristic. This means that maximum reception pickup is transverse to the antenna's plane (longitudinal axis, 'face'), to the *right and left*. Reception is 'nulled-out' in the longitudinal direction, i.e. *to the front and back*. Some all-around reception can be approached upwards and downwards, but with much-reduced sensitivity.

Many of the aerials in this category (e.g. the ones distributed by *BAZ Spezialantennen* in Germany) contain a 'bundle' or a cluster of (NIZN, Nickel-Zinc) ferrite bars inside, which offer a high degree of permeability and excellent build quality, **Fig. 2**. Remember, though, that this aerial must be aligned with the signal source for optimal reception results. Any interference (QRM, QRN) can be nulled-out – to a lesser or larger degree.

This is why these antennas are often useful for a range of DF (Direction-Finding) applications. And is also why so many units of this kind of aerial come on a rotatable housing or base control unit. If you are in luck and have the right equipment, you might completely suppress an interfering signal.

## A Choice of Frequency Bands

Magnetic ferrite bars are used in all frequency sectors and bands. One of my most frequent uses for them is monitoring signals and natural radio emissions on the Extremely Low and Very Low Frequency (ELF and VLF) frequency bands. 'Feeling the Earth's Pulse', as it were.

Take a look at *RadioUser* (January 2022: 51 and March 2022: 38) and *The Spectrum Monitor* of October 2021 (pp. 21-26) to see what I mean, and then move on to the next section. These articles also included some of the images of the VLF loops and ferrite bars I use for solar and geophysical observations, and to catch military signals in the VLF band, e.g. transmissions to submarines, or SFTS (Standard Frequency and Time Signal) transmitters.

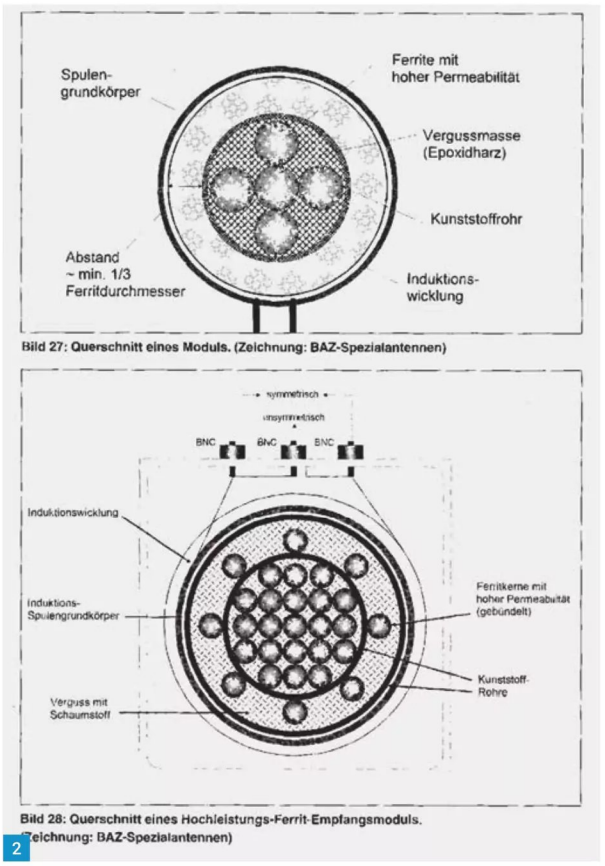
For the remainder of this present article, I will be looking more at reception systems from Long to Short Wave, and in particular at some of the (slightly older) magnetic ferrite sticks from the *Grahn* stable in Germany, simply because this is the type I have acquired the most units of – over some years I might say.

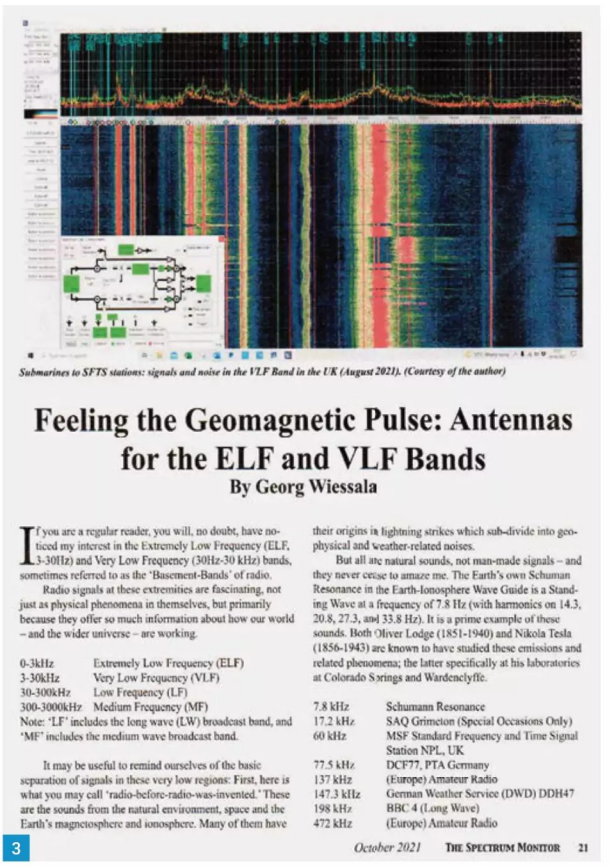
**Table 1** shows a list of the equipment I used during around two weeks of reception experiments. This included both traditional and 'vintage' HF receivers and an SDR, as well as loops and active ferrite rods.

## Exploring the Basement Band

You can make a good start at the very bottom – in the so-called 'Basement Band'. Here, you can listen to – and even evaluate signal strength, to a degree – in the Extremely Low Frequency (ELF, 3-30kHz) and Very Low Frequency (VLF 30-300kHz) bands at home. There are at least four ways in which you can achieve this:

First, you could use a general professional-





Submarines to SFTS stations: signals and noise in the VLF Band in the UK (August 2021). (Courtesy of the author)

## Feeling the Geomagnetic Pulse: Antennas for the ELF and VLF Bands

By Georg Wiessala

If you are a regular reader, you will, no doubt, have noticed my interest in the Extremely Low Frequency (ELF, 3-30Hz) and Very Low Frequency (30Hz-30 kHz) bands, sometimes referred to as the 'Basement-Bands' of radio.

Radio signals at these extremities are fascinating, not just as physical phenomena in themselves, but primarily because they offer so much information about how our world – and the wider universe – are working.

| | |
|---|---|
| 0-3kHz | Extremely Low Frequency (ELF) |
| 3-30kHz | Very Low Frequency (VLF) |
| 30-300kHz | Low Frequency (LF) |
| 300-3000kHz | Medium Frequency (MF) |

Note: 'LF' includes the long wave (LW) broadcast band, and 'MF' includes the medium wave broadcast band.

It may be useful to remind ourselves of the basic separation of signals in these very low regions: First, here is what you may call 'radio-before-radio-was-invented.' These are the sounds from the natural environment, space and the Earth's magnetosphere and ionosphere. Many of them have their origins in lightning strikes which sub-divide into geophysical and weather-related noises.

But all are natural sounds, not man-made signals – and they never cease to amaze me. The Earth's own Schuman Resonance in the Earth-Ionosphere Wave Guide is a Standing Wave at a frequency of 7.8 Hz (with harmonics on 14.3, 20.8, 27.3, and 33.8 Hz). It is a prime example of these sounds. Both Oliver Lodge (1851-1940) and Nikola Tesla (1856-1943) are known to have studied these emissions and related phenomena; the latter specifically at his laboratories at Colorado Springs and Wardenclyffe.

| | |
|---|---|
| 7.8 kHz | Schumann Resonance |
| 17.2 kHz | SAQ Grimeton (Special Occasions Only) |
| 60 kHz | MSF Standard Frequency and Time Signal Station NPL, UK |
| 77.5 kHz | DCF77, PTA Germany |
| 137 kHz | (Europe) Amateur Radio |
| 147.3 kHz | German Weather Service (DWD) DDH47 |
| 198 kHz | BBC 4 (Long Wave) |
| 472 kHz | (Europe) Amateur Radio |

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**Fig. 1: A ferrite core bar can 'draw in' the *magnetic* part of the electro*magnetic* field. (Wolfgang Friese, *vth Verlag*, 2007). Fig. 2: A BAZ ferrite-bundle, offering both high permeability and great construction quality. (Wolfgang Friese, vth Verlag, 2007). Fig. 3: A recent contribution to *The Spectrum Monitor* in the USA. (*The Spectrum Monitor,* Georg Wiessala). Fig. 4: My LFM/S1-N 15-70kHz by //C: 20pF-1.6nF: placed outdoors to reduce noise. (*BAZ Spezialantennen,* Georg Wiessala).**

grade or more specialised VLF hardware radio receiver; for example, the trusty AOR AR 7030, which goes down to 0kHz. If yours does not, you might want to invest in a simple VLF Converter, such as the ones offered by *Elettroficcina* or *Datong*. Or you can build your own, of course.

Many dedicated VLF monitors swear by the *Siemens D2008*, which offers a range of possibilities for magnetic bar aerial experiments.

**https://tinyurl.com/yybeutn8**

Second, if you wish to *see more of what is there*, avail yourselves of a Software-Defined Receiver (SDR). I have used the SDRplay *RSPduo* dual-tuner device for this article, on account of its antenna-input flexibility and because it can easily receive signals in the VLF band. The *AirSpy* is also a good choice, starting at 0.5kHz.

**www.sdrplay.com**

**https://airspy.com/airspy-hf-discovery**

Third, keep it simple and just connect a suitable aerial to your soundcard, then use software such as *Spectrum Lab* to visualise signals and test your aerials. I have written about antennas for ELF/VLF not too long ago, so I won't repeat myself here (cf. **Fig. 3**).

And fourth, the United Kingdom Radio Astronomy Association (UKRAA) offer a specialised VLF receiver for longer-term observations of Sudden Ionospheric Disturbances (SID), by studying VLF signals.

**https://tinyurl.com/yckkbavf**

There are some dedicated resources (e.g. **J Lashley** *et al*) showing you how you can receive and visualise VLF signals. Take a look at the reading list at the end.

## My Loops, Indoors and Out

Bearing in mind the wealth of possibilities for receiving VLF signals, I began my experiments with my favourite magnetic bar: I linked the hefty VLF Ferrite Bar from *BAZ Spezialantennen* in Germany (LFM/S1-N 15-70kHz by //C: 20pF-1.6nF) to my laptop and PC, via a 192kHz-resolution sound card (in my case, the *U-PHORIA UMC202HD*). The aerial was then placed outside on my balcony for this scenario, **Fig. 4**.


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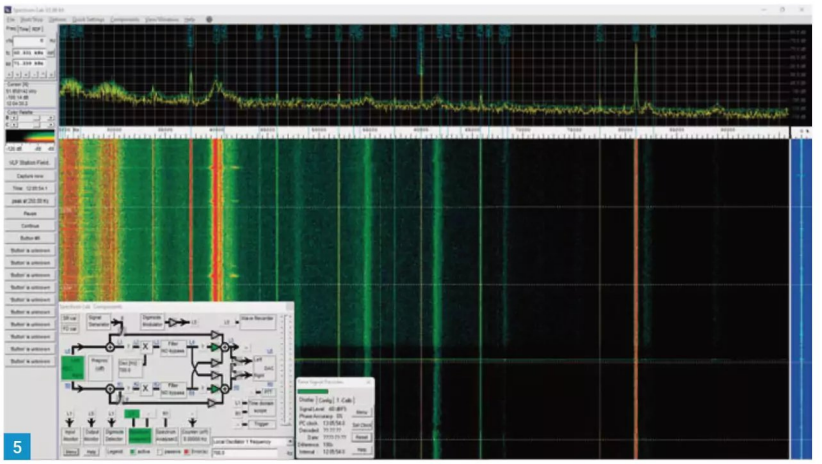
Adjusting input levels on the soundcard, I could subsequently display VLF signals from the world's Navies, SFTS stations, and many others, on the screen, as well as some QRM. I used the popular *Spectrum Lab* software (*V2.96b3*, August 2022) throughout my work for this section.

The traces towards the right of the screen show the two strongest SFTS stations I can receive at my QTH in the Northwest of the UK (DCF77, at 77.5kHz and MSF, at 60kHz).

There is also a close-by UK Navy transmitter on 80kHz (GYNZ). On the left of the screenshot, you will see a cluster of international VLF communications to the world's submarines; it is here that there has been increased activity of late – due, I am guessing, to the Russian invasion of Ukraine in February 2022, **Fig. 5**.

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



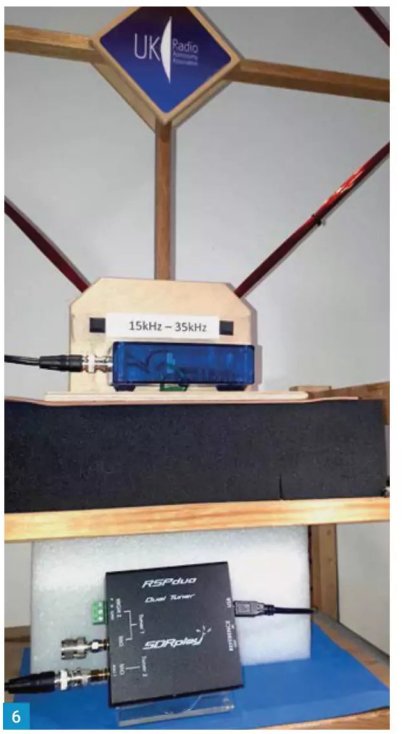




**Fig. 5: VLF Communications to the submarines of the World's Navies. (Georg Wiessala)**
**Fig. 6: Here, the UKRAA loop output was fed dinto the SDRPlay RSPduo SDR. (Georg Wiessala)**
**Fig. 7: The German Navy transmitter on 23.4kHz (DHO38) - A propagation lynchpin, and more. (Georg Wiessala).**

The BAZ LFM/S2-N works indoors and out. By the way, if you are indoors only, you can make your very own loop or deploy the VLF Loop made by the UKRAA, **Fig. 6**.

I fed the UKRAA loop output into the *RSPduo*, Fig. 6 again, using the *SDRuno* software to see the signals.

The two twin peaks just to the right of the *Main Spectrum Settings* box, **Fig. 7**, show the stable military VLF signals from the German Federal Navy transmitter on 23.4kHz (DHO38, 800kW, since 1983). This is the precise frequency the UKRAA loop is tuned to/centred on, for long-term observations (see next paragraph). On 80kHz is my local GYNZ again, much weaker with the indoor loop, but still there.

My final VLF Loop Aerial experiment involved a different setup. Here, I kept the UKRAA VLF loop and connected it to the latest version (August 2022) of the dedicated UKRAA VLF receiver. With the help of an Analogue-to-Digital Converter (ADC) and some specialised software (*Radio Sky Pipe*), I could now observe Sudden Atmospheric Disturbances (SID) on the Sun.

This happened indirectly, by monitoring the changes in the signals from the 23.4kHz transmitter over time, expressed as a voltage from the VLF receiver, **Fig. 8**.

Isn't it amazing what you can do with those aerials? Take a look at the Reading List at the end of this article if you want to know more about VLF signals.

Spectrum Lab: **www.qsl.net/dl4yhf**
BAZ: **https://tinyurl.com/2vmjx9wa**

## NAVTEX the 'Lazy' Way

My next experiment involved the reception of NAVTEX signals. This dependable, traditional, worldwide system covers 21 global NAVAREA regions. It is a text-based service and derives from the obligations of the Global Maritime Distress and Safety System (GMDSS, see last month's *PW*). NAVTEX messages come through very regularly as *SITOR-B* ('Simplex-Telex-Over-Radio'; FEC) signals. They are transmitted, very reliably, on 490kHz (national) and 518kHz (global).

You can catch the basic signal on a solid, traditional, HF radio covering LW/MW. Often, a good external aerial, such as the Wellbrook ALA 1530 Loop, **Fig. 9**, will produce very satisfying results.

For a little extra help, I have been known to resort to magnetic ferrite bars, such as the *Grahn LW 3* (75-400kHz) and *MW2* (400-1,800MHz) models, **Fig. 10**.

Feed a cable to a NAVTEX decoder on your PC (e.g. *SeaTTY, Zorns-Lemma 11.4.2, Mscan Meteo Pro, Frisnit* or *JVComm32*) and enjoy your regular daily decodes and maritime weather forecasts.

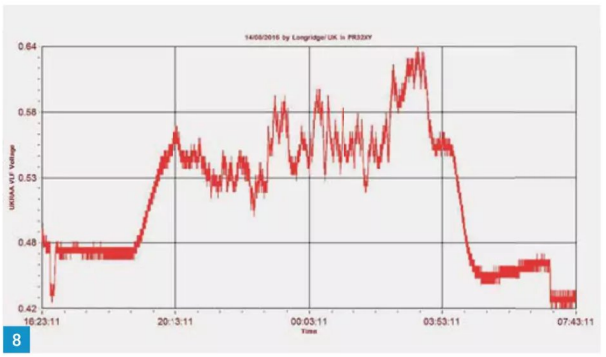
There are online receivers too, for instance, NAVTEX LIVE.

But where is the (radio) sport in that?
**http://navtex.lv/NAVTEX/MainTable**

The latest specialised receivers, with internal ferrite rods, such as the new *NASA BT-3 Bluetooth* NAVTEX receiver allow you to access your messages on your phone, with an app (*Blue NAVTEX 2*); and there are many more specialised NAVTEX receivers for all sorts of boaters and navigators, of course.
**www.nasamarine.com/product/2754**

The one I always seem to have the most fun with is the *Mörer Infobox WIB2D* (**Fig. 11**; *RadioUser*, October 2020: 30). I have had this little gem (103 x 62 x 26.5mm; 105g) for some years now, using it when transferring friends' boats, leisure-sailing, and, naturally, in the home shack.

It is a fully self-contained, sensitive, propa-



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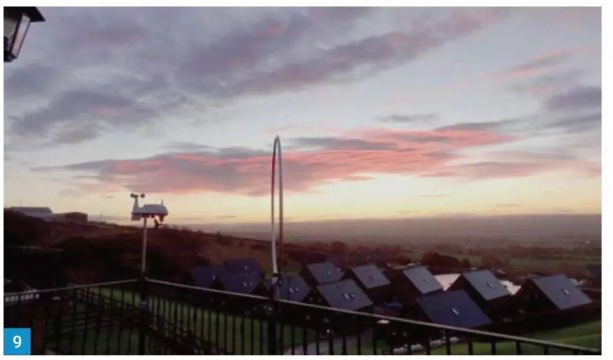
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**Fig. 8: Observations of signal strengths with a VLF ferrite bar and *Radio Sky Pipe* software. (Georg Wiessala) Fig. 9: The Wellbrook ALA1530 Loop: an old favourite. (Wellbrook Communications) Fig. 10: Magnetic Ferrite Bars made by *Grahn Spezialantennen*. (Courtesy of *Grahn Spezialantennen*) Fig. 11: The *Mörer Infobox WIB2D* has a small ferrite bar antenna built in. (*Mörer Schiffselektronik* Fig. 12: An inside view of the *Infobox WIB2D*. The ferrite bar aerial is on the left, in blue. (*Mörer Schiffselektronik*) Fig. 13: A dream on HF: *Reuter Elektronik* RLA3 Active Magnetic Indoor Loop. (Courtesy of *B Reuter*) Fig. 14: Fit for your travels: the Deshibo/Moonraker GA450. (Georg Wiessala)**

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**Fig.15: The new Tecsun PL-368 has a separate, small, ferrite aerial for MW. (Nevada/Tecsun)**

gation indicator and accurate barometer too. Normally, I am not too close to the coast here; but, in the right place, this works just fine, even indoors.

**www.moerer.de**

An inside view, **Fig. 12**, of the *Infobox WIB2D* reveals a small ferrite bar aerial inside (in blue). On account of the quite pronounced directionality of these little loop-sticks, getting the optimum signal is just a matter of moving the box around a bit – use a clear plastic bag if you are out and about; this radio is not completely weatherproof. Or leave it outside in a watertight plastic box.

## Last But Not Least: MW DXing

Now, for some daytime Medium Wave enjoyment When I am mobile with my radios, or when the big Wellbrook ALA1530 ALA or the new S/N FLX1530LN-3245 version (*RadioUser*, September 2022: 16) are just not practical or available, I often rely on some smaller but powerful aerials.

My first choice frequently falls on the models made by the specialist firm *Reuter Elektronik* in Germany, especially my (slightly older) *RLA3* active magnetic indoor loop (**Fig. 13**, top-half).

The most recent Reuter model is the *RLA4E*; *RadioUser*, May 2020: 18).

**www.reuter-elektronik.com/index.html**

The *RLA3* is a very comfortable unit. I like the way the control unit (*RLA3 Control*) allows you to (electronically) 'rotate' the crossed loops in 45° steps so that you can always achieve the best directional orientation and 'null-out' noise quite easily.

These effects are sharp and pronounced with the loop, which can be very good for the optimal reception of, for example, Non-Directional beacons (my closest one is WTN 337.5 at Warton, Northwest England).

On Medium Wave broadcasting stations, I have found the Reuter to be a well-performing travelling companion, but it can be a little awkward to pack. The units are sensitive, and the specific, multi-layered, circuit board material used for the detachable loop elements comes covered in a protective coating and may easily be scratched. Therefore, I had long been looking for a somewhat smaller loop aerial to take along with me.

I recently found a very neat solution in the *Deshibo GA450*, distributed in the UK by Moonraker, **Fig. 14**, with my *Philips D2999*. Alternatively – and 'closing the loop' as it were – I often take my 'collection' of *Grahn* magnetic ferrite bars with me, since they are both lightweight and practical, Fig. 10.

Finally, if you only have minimal room only in your travel pack, there is one recent radio that comes with its own rotatable ferrite aerial covering 150 to 1710kHz: This is the Tecsun PL-368, **Fig. 15**. It is fun to use and takes full advantage of the directional characteristics of the ferrite (*RadioUser*, August 2022: 16-19). **PW**

**Receivers**
- AOR AR7030
- ATS 25 (SI4732) Receiver
- Lowe HF225
- Philips D2999 (Vintage)
- SDRplay RSPduo

**Aerials**
- Grahn Spezialantennen modular magnetic aerial: Control Unit GS2
- Grahn Spezialantennen modular magnetic aerial: Modules: LW2 (50-250kHz) LW3 (75-400kHz) | MW2 (400-1800kHz) | MW3 (850-4,000kHz)
- Moonraker/ Deshibo GA-450 Small Loop
- Reuter RLA3 Crossed-Loop Active Magnetic Indoor Aerial
- Wellbrook ALA1530LN and FLX1530LN Active Magnetic Loop Aerials

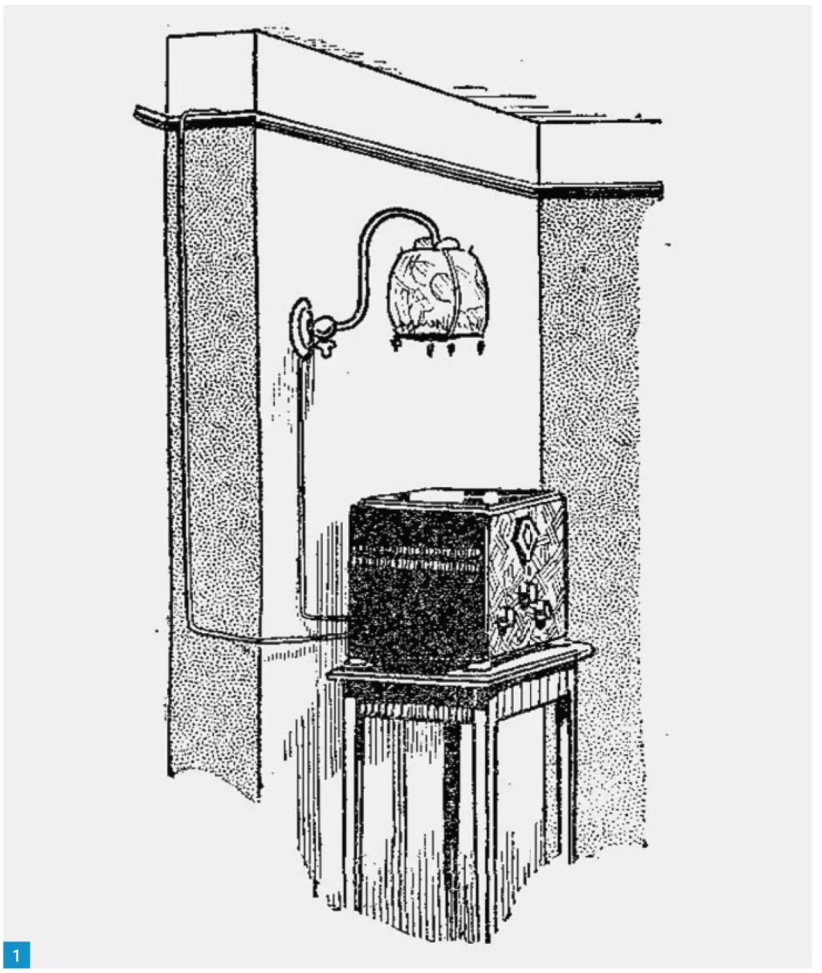
**Other**
- bhi (passive) loudspeaker
- ERA Microreader V.2
- ERA 'BP34' Audio Filter.

**Table 1: Equipment Used**


- *Antennas for the ELF and VLF Bands*: *RadioUser*, January 2022: 51; March 2022: 38 (see also TSM, below).
- *ARRL Antenna Book* (18th ed., 1997 (5-8), 19th ed. 2000 (5-6 to 5-10) (ISBN: 0-87259-817-9) **https://tinyurl.com/5zh7ewrv** **www.arrl.org**
- *BAZ Spezialantennen:* **www.spezialantennen.eu**
- Birchel, R; Red, E T; Schulze, M. (2012): *Breitband-Aktiv und Spezialantennen (Beam-Verlag)*
- Friese, W. (2007) *Außergewöhnliche Empfangsantennen* (Unusual Aerials): (Baden-Baden: vth) (ISN 978-3-88180-836-1)
- Grahn Spezialantennen: **https://tinyurl.com/2efvhkan**
- How a Loop-Stick Antenna Works (Video): **www.youtube.com/watch?v=udLa7dZC0ts**
- Klawitter, G. (1998) *Antennen - Ratgeber für KW- Empfang. Außenantennen*, Aktivantennen und Behelfsantennen (Siebel Verlag)
- Make a Ferrite Rod Antenna: **https://tinyurl.com/3ceuzpes**
- Nussbaum, Hans (2003) *Magnetantennen (Verlag für Technik und Handwerk, vth)* (2020) *Das Neue Magnetantennenbuch* (eBook; in German): **https://tinyurl.com/2p8ztv6k**
- Shielding: **https://tinyurl.com/5c83s94j**
- Wellbrook Communications (2022): Manual: *New ALA1530LN and FLX1530LN Magnetic Active Loop Antenna* **https://tinyurl.com/bdcr6zaa**
- Wiessala, G. (2021), *Antennas for the ELF and VLF Bands* (*The Spectrum Monitor*, October 2021: 21-26) *Time, Measurement and Radio* (Part One): *The Spectrum Monitor*, June 2022: 28 *Time, Measurement and Radio* (Part Two): *The Spectrum Monitor*, July 2022:
- Zierl, R. (2005) *Aktivantennen für Lang-, Mittel- und Kurzwellenempfang* (Siebel Verlag).


**Table 2: References & Further Reading**

**Don Field G3XTT**
practicalwireless@warnersgroup.co.uk



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# Practical Indoor Aerials

This article will interest all readers who for any reason cannot avail themselves of an outdoor aerial. The author describes many novel forms of the indoor type, some of which are not generally known.

Apart from those listeners who object to an outdoor aerial on the score of appearance, there are countless others who are so situated that they are unable to erect one for purely practical reasons. To these the choice of a suitable indoor substitute is of vital importance.

The type chosen will naturally depend on the facilities available: Probably the most efficient type is a replica of an outdoor aerial erected in the loft. However, it is often the case that the listener who has access to a loft can also arrange an outdoor aerial. On the other hand, where an outdoor aerial is out of the question the indoor facilities are also rather limited. For this reason I shall confine remarks to a description of some of the more practical arrangements of the type likely to be available to the flat-dweller and those living under similar conditions.

## Indoor Aerials and Mains Operation

Before going into details of particular types, I want to make a few general remarks. In the first place, most sets nowadays have a small condenser in series with the aerial to increase the selectivity and in some cases to act as a volume control. With an indoor aerial this condenser is usually a disadvantage, since it cuts down signal strength considerably, also the selectivity with a small aerial is already far better than with the longer outdoor type.

First of all, then, "short" this condenser with piece of wire, if possible. This applies to all receivers except those operated from D.C. mains. D.C. sets should have a good condenser of about .01 mfd. in series with the aerial besides the condenser which is already included in the earth lead and is usually incorporated in the mains unit. I say first of all short the aerial condenser for the reasons I have just given, but naturally, if you find that the tuning is not sharp enough, you must include it. If it has too much effect, try one a little larger. If you have a band-pass set alteration of the aerial condenser may necessitate slight readjustment of the first trimmer condenser. Now as to the aerial itself.

## Using the Picture-rail

The piece of wire draped along the picture-rail is so well known as to need no introduction. When properly arranged it is very efficient and costs next to nothing. All that is needed is a length of single bell wire, of a colour to blend with that of the walls, and one or two drawing-pins. Pin the wire at intervals of about four feet in the recess at the top of the rail. Carry it along two sides of the room only, so as to form an "L," as in **Fig. 2**.

With the question of the aerial comes that of the earth. **Fig. 1** shows a neat and effective arrangement where a gas bracket Is handy. The earth is joined to the bracket by scraping the metal clean near the wall and twisting the bared end of the earth wire round it. Soldering the joint is better still. Where no gas bracket is available, there is sometimes a "point" for a gas fire which will work equally well. Failing that, you must resort to a length of wire concealed under the carpet and extending to the bathroom or kitchen water tap. A connection to an iron fireplace or even a brass

**This article appeared in the October 1st 1932 issue of PW and is a fascinating account of aerial understanding at the time. Needless to say, we wouldn't recommend all these approaches nowadays, particularly not using the house mains wiring as an aerial!**


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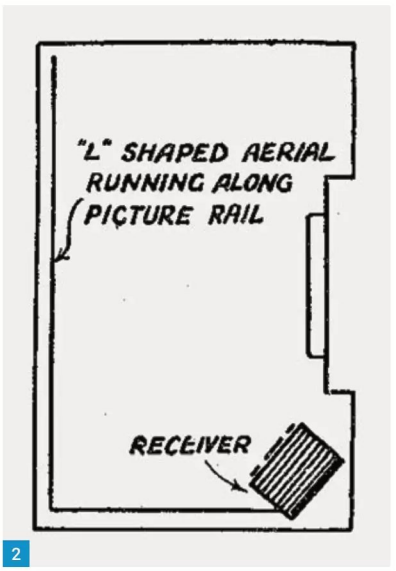

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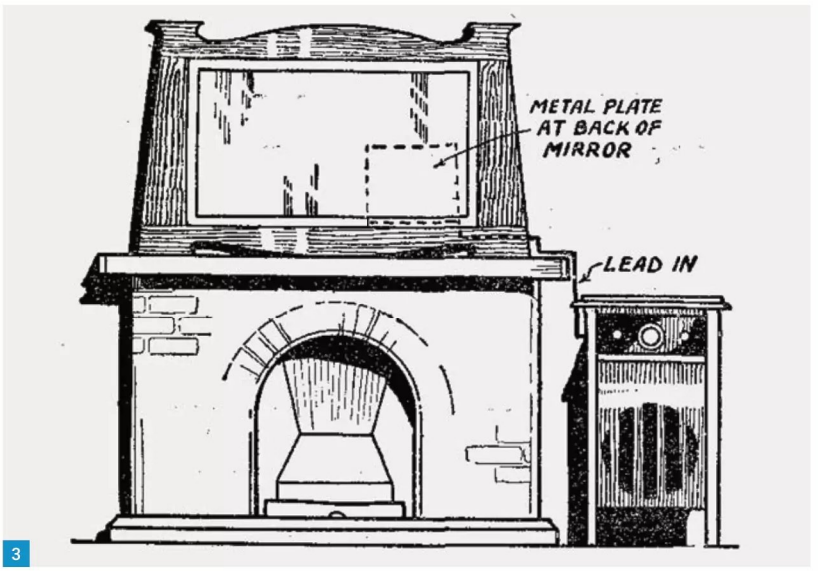

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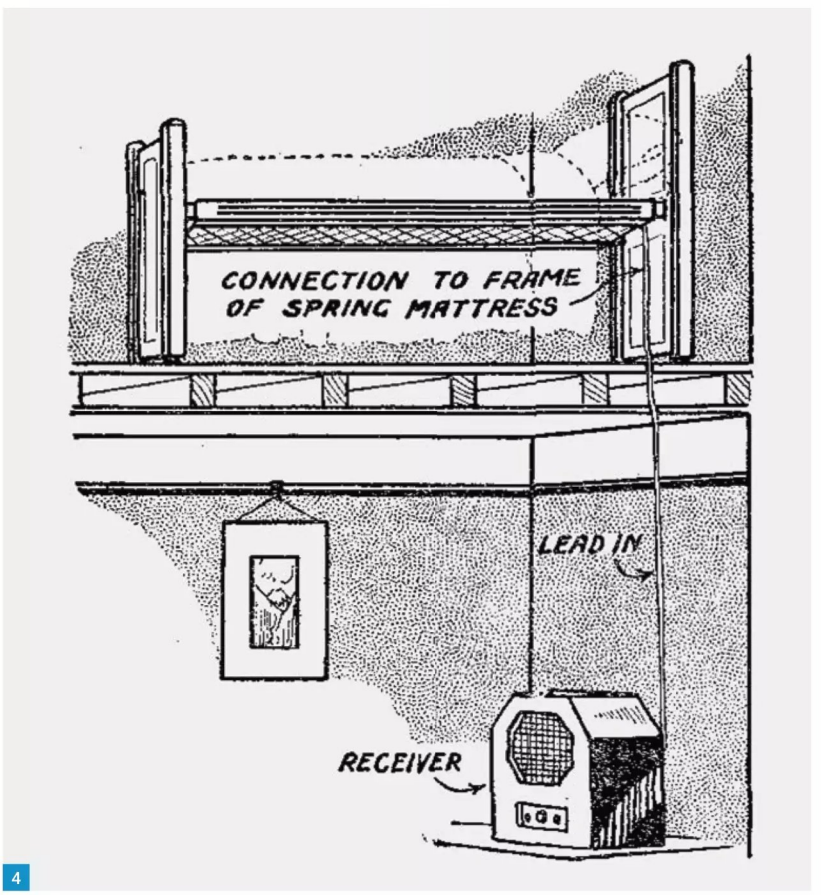

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**Fig. 1: Using the gas bracket as an earth connection. Fig. 2: A picture rail aerial. Fig. 3: The metal backing of an ordinary mirror as an aerial. Fig. 4: The mattress of a bed makes an ideal aerial. Fig. 5: A picture frame can be easily adapted to accommodate an aerial. Fig. 6: A radiogram cabinet containing aerial and earth plates. Fig. 7: Utilising the electric light wires as an aerial. Fig. 8: An aerial erected in the loft.**

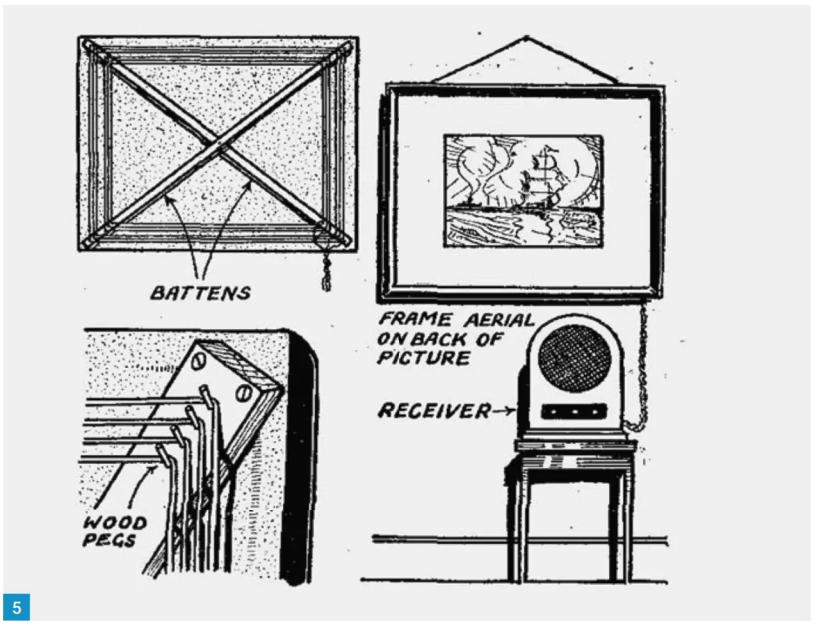
fender is better than no earth at all, but in this case the aerial should be a good one to make up for the poor earth, otherwise results are likely to be disappointing. While on the subject of "earths," here is a tip worth trying. Change over the connections to the "aerial" and "earth" terminals of your set – that is, join the aerial to the earth terminal and the earth to the aerial terminal. You may get better results!

## The Use of Mirrors

It was during a thunderstorm that the idea of using a mirror as a "pick up" of radio energy first occurred to me. I was thinking what a nice large surface of metal there was in a mirror opposite to me, and wondering if it had a sufficient charge on it to make a spark to earth if I connected a wire to it, and also what sort of mess would result if a chunk of lightning chose a path to earth that way. Well, after the storm was over, I tried out the looking glass as an aerial by making careful connection to the quicksilver at the back. It certainly worked, and brought in the radio with the inevitable atmospherics. The only difficulty was in the method of connection, which was too uncertain for universal use, so I did away with direct connection and placed a sheet of copper foil against the back of the mirror itself and replaced the wooden back. The mirror and the foil formed a condenser, and connection to the set was made via a wire soldered to the foil. The arrangement is shown in **Fig. 3** if you care to try it. It is quite simple, and zinc or aluminium may be used in place of copper.

## The Bedstead Aerial

Here is an arrangement that is so old that it has been almost forgotten. I don't quite know why it should be, unless it is because constructors nowadays do not have their sets in their bedrooms, as did some of the amateurs in the old days, when they sat up all night listening-in while their fond mamas thought they were fast asleep. Anyway, a spring mattress forms quite a good indoor aerial,



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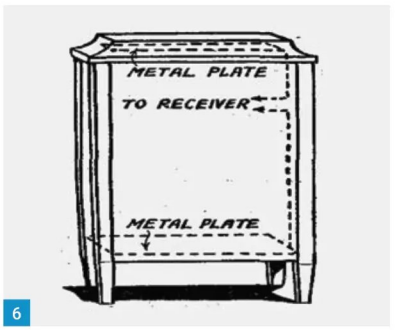

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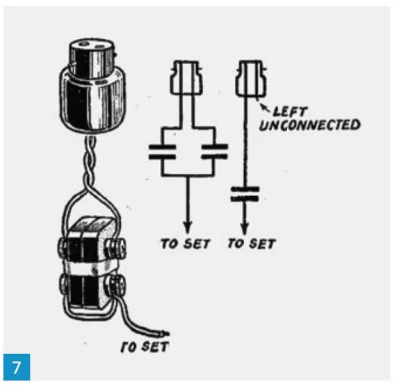

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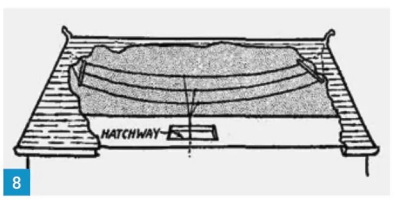

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and you will see how to fix it from **Fig. 4**. Of course, if the set is in the room below, you will have to take the lead-in through the ceiling. That is perhaps why it is not very popular, as it means a small hole in the plaster, and it is difficult to conceal the wire. With the receiver in the bedroom the job is simple enough.

## A Picture-frame Aerial

Quite an effective frame aerial can be wound on the back of a large picture. Details are given in **Fig. 5**. Of course, it has no advantage over the orthodox type apart from the appearance, but, as with most of these schemes, it is intended to make the aerial as inconspicuous as possible, and that is its recommendation. If the wooden cross-pieces are no thicker than ¼in and do not extend quite to the corners of the picture, they will not cause it to stick out from the wall. The little pegs on which the wire is wound are short pieces of matchstick stuck in at an angle. The number of turns of wire must be found by experiment. About two turns of 28 gauge D.C.C. wire will be suitable for the medium waves with a picture 3ft. by 2ft. As with all frame aerials, the receiver must be placed immediately underneath, as long leads reduce the efficiency. There is one drawback with the picture frame aerial, and that is that it is strongly directional. If most stations lie east and west of you, it should hang on a wall running east and west, but if you depend chiefly on programmes coming from a northerly or southerly direction, then hang the picture on a wall at right angles to the first.

## A Radio-gram Aerial

When constructing a radio-gram, the arrangement shown in **Fig. 6** is worth trying if there is no room for a frame aerial. It consists of a metal plate in the lid and another in the floor of the cabinet. They are connected respectively to the aerial and earth terminals of the set. **Fig. 7** shows how to make an adapter to plug into a lamp socket, and so use the mains wiring as an aerial. Two small condensers are held together with a rubber band and connected as shown. Various values round about 0.1 mfd. may be tried. An alternative arrangement with one condenser is also shown. With this pattern the plug should be inserted first one way round end then the other to ascertain which way it works best. With both patterns it is also best to try them with the lightning switch first in the "On" and then in the "Off" position.

Only good condensers which will stand the voltage of the mains should be used. Needless to say, no current is consumed. When the adaptor is completed, wind it round with insulation tape to protect the terminals from accidental short-circuiting.

## Convenience Considered

Finally, let me repeat that the various forms of aerial given here are designed with a view to convenience and inconspicuousness before everything else. They are not all equally efficient, but each has certain merits relative to the circumstances governing its use. If efficiency comes before convenience, then the loft aerial shown in **Fig, 8** needs a lot of beating. If the loft is long, then one wire will be sufficient, but if it is very small then two or three wires are better. A small insulator should be used at each end.

There are of course, certain important details which must be attended to where efficiency is the main consideration. As with an outdoor aerial, the wire should be kept as far from earthed bodies as possible, a good rule to observe being that no part of the indoor aerial should be allowed to run closer than 12ins. to walls, ceilings, etc. Attention should also be paid to the disposition of electric light wires, as an aerial running parallel with such wires may result in hum, which is incurable by all ordinary methods. Apart from the types of home-made aerial above mentioned, there are, of course, already on the market various types of commercial aerials. There is the wellknown spring-type, which has to be expanded and attached to opposite walls; the small "cage-type" aerial, consisting of about a dozen strands of thin wire attached to cardboard discs; and the sheet metal aerials which are intended for attaching to the outer walls, chimney-stacks, etc.

## Super-het Aerial

Those readers who own, or intend to make a super-heterodyne receiver, should remember that it is very desirable to use an indoor aerial in connection with them, and as short an indoor aerial as possible, too; otherwise much of the selectivity associated with this type of receiver will be lost. Another point is that on an outdoor aerial, considerable interference with neighbouring reception is likely to accrue. Best results may be obtained when the super-het is used with a frame aerial. **PW**

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# Early Loudspeakers, Amplifiers & Microphones

This month, **Keith Hamer and Garry Smith** continue to investigate the early days of the BBC and the difficulties that engineers faced with calibrating microphones and loudspeakers. Other topics include Marconi's connection with Bournemouth, experimental short-wave transmissions to the British Empire, the secret BBC studios near Bristol, television pioneer Vladimir Zworykin, and the Swiss Beromünster transmitter. There is also a vintage equipment advertisement from 1927.

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Garry405625.gs@gmail.com

In the early days of BBC wireless, the broadcasting operations were divided into a sequence of three main physical processes: the conversion from sound waves into electrical vibrations; the electrical transformations involved in transmission and reception; the re-conversion into sound at the loudspeaker.

Regarding the three processes, the first serious problem encountered by engineers involved taking accurate measurements. In those days, it was difficult to measure the characteristics of a microphone, to find out how it would deal with the various musical frequencies in the conversion from sound into electrical energy. It was very difficult to obtain any definite information on the effect of the surrounding environment inside the studio or concert hall during the broadcast of a music programme.

The problem was further complicated by the fact that it involved the art of 'broadcast listening'. In the early days of radio, results were judged mainly by ear without any adequate scientific perception of what they actually represented. However, by the mid-1920s, methods of microphone calibration had improved. A study of studio and concert hall characteristics was made, which enabled new studios to be designed and built with greatly improved results.

Apart from the question of the environment, the whole broadcasting system had to be capable of dealing faithfully with, and reproducing correctly, whatever was put into it. This meant not only that the complete system had to respond equally throughout the whole scale of musical frequencies, but also that each component part had to be responsive. The main obstacle was in the loudspeaker.

In the early 1920s, the design of loudspeakers prevented equal pressure output for all frequencies. The microphones used by the BBC gave a remarkably even response for equal sound pressure waves of all frequencies. The microphone amplifiers were even better in this respect, being very little short of perfection. BBC engineers began to investigate the shortcomings of loudspeaker design in a scientific manner.

## BBC Short-Wave & The British Empire

By the mid-1920s, there was a rapid increase in the popularity of wireless in the United Kingdom and elsewhere. The achievements made by amateur enthusiasts and commercial enterprises in establishing reciprocal contact over continents and oceans highlighted the potential of broadcasting to the British Empire.

As early as 1923, the BBC began experiments


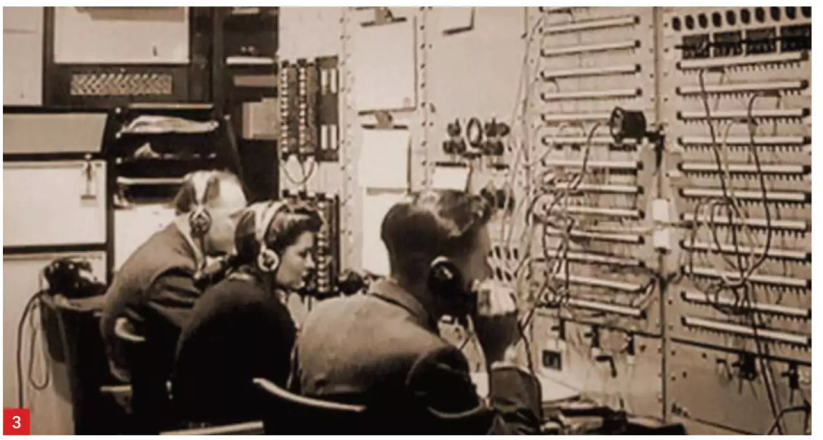


**Fig. 1: The *Marconi Model 22 (2-Valve) Receiving Set*, advertised in 1927. (Photo: The Keith Hamer+Garry Smith Archive Collection.) Fig. 2: The Blue Plaque outside the *Court Royal Convalescent Home for South Wales Miners*, Bournemouth, commemorating Marconi's achievements. (Photo: Keith Hamer and Garry Smith.) Fig. 3: The Control Room at the secret BBC studios located deep inside the former *Clifton Rocks Railway*, near Bristol. (Photo: The Keith Hamer+Garry Smith Archive Collection.) Fig. 4: The Swiss *Landessender Beromünster* radio station, which opened on 1 May 1931. (Photo: Keith Hamer and Garry Smith.) Fig. 5: The Beromünster transmitter, located at Gunzwil in Kanton Luzern. (Photo: Keith Hamer and Garry Smith.) Fig. 6: 'Live' broadcasts were induced into this remote loudspeaker from the high-power Beromünster transmitter. (Photo: Keith Hamer and Garry Smith.)**

that ultimately culminated in what was termed *Empire Broadcasting*. On the transmission side, considerable progress had been made by taking full advantage of successful experiments elsewhere. On the reception side, progress was not so rapid and a lot of research was still necessary. The practical result of work done between 1923 and 1927, including experiments carried out in The Netherlands, the USA and elsewhere, indicated that, at spurious times of the day, it was possible in almost any part of the World to pick up somewhat distorted music and speech transmitted by a short-wave station. Reception was only classed as 'reasonably good' on relatively rare occasions. Despite poor-quality reception, but as a result of the work done and the experience gained, BBC engineers were very optimistic and pressed ahead with more experiments.

By the end of 1927, an experimental short-wave station was established in conjunction with the *Radio Corporation of America* and the *Marconi Company*, whose experience in short-wave work was unique. While the engineers worked on the technical side, problems associated with programmes and expenditure were major considerations.

An important implication of broadcasting to the Empire was that there had to be transmissions throughout the 24-hour period. Active co-operation of the broadcasting authorities overseas was indispensable. Effective Empire broadcasting could only be possible via relays through the broadcasting systems of the 'Dominions' and 'Colonies', as they were termed, within the British Empire. The quality of reception in far-off countries had to support reasonable clarity, similar to that enjoyed by the average listener in Great Britain. Intelligibility, continuity and quality were essential conditions and prerequisite to successful broadcasting of this nature.

## Vintage Wireless Equipment

This month's saunter through vintage copies of forlorn newspapers and magazines has unearthed the *Marconi Model 22 (2-Valve) Receiving Set*. This was, according to the advertisement, the 'Triumph of the Master Mind', **Fig. 1**. It even boasted a 'sterling 'baby' loudspeaker'.

The text has been left in its original format to reflect the spelling, grammar and punctuation of the time.

This is the full description of the equipment originally featured in an advertisement, dated 1927: *"The Marconiphone - The Triumph of the Master Mind.*

*The outcome of close concentration on the fundamental principles of radio reception by the Marconi Company's Engineers.*

*Marconiphone Model 22 (Two Valve) Receiving Set with Sterling "Baby" Loud Speaker.*

*Each type of Marconiphone, from a single valve to an eight valve, instrument represents the highest efficiency in its particular class for simplicity of operation, perfectly pure and natural reproduction of music and speech and above all consistent reliability.*

*Most of the new models of Marconiphone Receivers are adaptable for operation entirely from A.C. mains, D.C. mains or batteries, thus giving a choice of power supplies unobtainable with any other instruments of their type.*

*Marconiphone Apparatus can be purchased on Deferred Payment Terms.*

*Descriptive literature on Marconiphone Wireless Equipment is obtainable from all responsible Radio dealers or on application to*
*THE MARCONIPHONE COMPANY, LTD.*
*210 -212 TOTTENHAM COURT ROAD,*
*LONDON, W.1*
*Registered Office: MARCONI HOUSE STRAND, W.C.2"*

If a two-valve receiver could perform like that, just think what one of their eight-valve sets could do, with or without a 'Sterling 'Baby' Loud Speaker'!

## Marconi In Bournemouth—Part 2

On 28 February 1900, the four-funnel 14,349 gross-ton German transatlantic liner, *SS Kaiser Wilhelm der Große*, probably the most famous liner of her day, sailed from Bremerhaven with Marconi's assistant, **George Kemp**, on board. This was the first liner to be fitted with wireless. Once in the English Channel, the ship's wireless operator made contact with Marconi's stations at the *Royal Needles Hotel* on the Isle of Wight, and the *Haven Hotel* at Sandbanks, not far from Bournemouth. Even before the ship was out of range of the Isle of Wight, many of her passengers had taken the opportunity to try out Marconi's new communication system.

In later years, **Marconi** became a Captain in the Italian Naval Reserve. He often remarked about feeling more at home on the sea than on dry land. Indeed, while in England, he had a yacht that he used as a floating laboratory. It was often seen in Poole Harbour lying just off Brownsea Island. He carried out many experiments in long-range communication on this vessel, receiving signals transmitted from the Marconi Company Wireless Station at Dorchester. This station was built in 1927 and was known as the 'Beam Station' due to the way the radio signal was transmitted.

The *Marconi Beam System* produced a reliable

telegraph service by using reflectors to beam the transmitted waves in the desired direction, and to concentrate the signals at the receiving station onto the aerial. The mechanical size of the reflector had to be large in comparison with the wavelength. For this reason, it was not commercially possible to employ such reflectors on a long wavelength.

Following further experiments conducted by Marconi and **C S Franklin**, a modified Beam System was introduced. Commercial services operated direct from London to Australia, Canada, South Africa and India.

Much earlier, in 1888, **Heinrich Rudolf Hertz** used reflectors and showed that ether waves could be concentrated into a beam, thus obeying the laws governing the transmission of light as predicted by **Clerk Maxwell** in 1864. In 1927, a system by *Empire Wireless Telegraphy* made particular use of these principles.

A wireless telephone service between England and America was opened in 1926, by which it was possible to make direct calls from any subscriber's telephone in England to anyone in the United States.

A valve transmitter of considerable power was used on a wavelength in the order of 3,000 metres, and a method known as 'single side-band' telephony. The system was pioneered by the *Western Electric Company* in conjunction with the *General Post Office*.

The first successful radio re-broadcasts of American programmes to be heard in the UK were radiated on 28 and 29 December 1923. The actual re-transmission was also picked up and heard very distinctly in South Africa.

Guglielmo Giovanni Marconi was born into Italian nobility on 25 April 1874. He received many awards in recognition of his achievements. In 1909, for his pioneering work in the development of wireless telegraphy, he shared the Nobel Prize for Physics with the German physicist and inventor of the cathode-ray tube, **Karl Ferdinand Braun**. Incidentally, Braun was also noted for conducting electrical experiments on crystals of galena (lead sulphide). While probing his crystals with wires connected to an electrical circuit, he discovered that the current flowed more readily in one direction rather than the other. By repositioning the wires, he could force the current to flow only in a single direction, a phenomenon which later became known as 'rectification'.

Returning to Marconi, in 1929, he was made a nobleman and appointed to the Italian senate. On 12 February 1931, he personally announced the first radio broadcast from the Vatican.

He died in Rome on 20 July 1937. This was reported in a Bournemouth newspaper, commenting that local residents should take *"special pride"* in the fact that Senator, the Marchese Marconi, conducted his first commercial experiments in the town. Unfortunately, in 2023, the only public acknowledgements to Marconi's historic endeavours in Bournemouth appear to be a framed newspaper cutting in a pub and a Blue Plaque outside the original *Madeira Hotel*, which became the *Court Royal Convalescent Home for South Wales Miners* in 1947, **Fig. 2**.

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## Secret BBC Studios—Part 2

In January's column, we mentioned that some production staff and engineers, as well as performers, were moved away from Broadcasting House in London during World War II to the relative safety of secret underground studios deep inside the disused *Clifton Rocks Railway* system near Bristol. This was due to potential enemy attacks, which had already damaged several BBC premises in the Midlands and Wales.

The original railway linked Clifton at the top to Hotwells and Bristol Harbour at the bottom of the Avon Gorge via a tunnel cut through the limestone cliffs.

The BBC's secret hideaway accommodated various transmitters, the largest of which was an American RCA 'H' group operating on 1474kHz (203.3m), broadcasting the Home Service. The equipment was on loan from America and had been acquired during the early days of the War. An aerial was strung between the tunnel entrance and the Grand Spa Hotel.

Two additional transmitters consisted of a Harvey McNamara short-wave set, and an ex-RAF medium-wave transmitter for maintaining or restoring communication between the other main provincial and metropolitan broadcasting stations in case the GPO (General Post Office) telephone lines were damaged by an attack.

A small studio that could accommodate a dozen or so actors was located lower down the tunnel. The studio was equipped with various essentials such as a piano, a gramophone and other facilities for producing music, drama, and schools' programmes. Poor acoustics were overcome by installing a combination of heavy carpets and quilting.

Recording facilities comprised a Philips-Miller machine, which used a 7mm-wide gelatin-coated celluloid film onto which recordings were cut by means of a sapphire stylus. The room also contained sufficient pre-recorded material, which would allow many weeks of broadcasting if required.

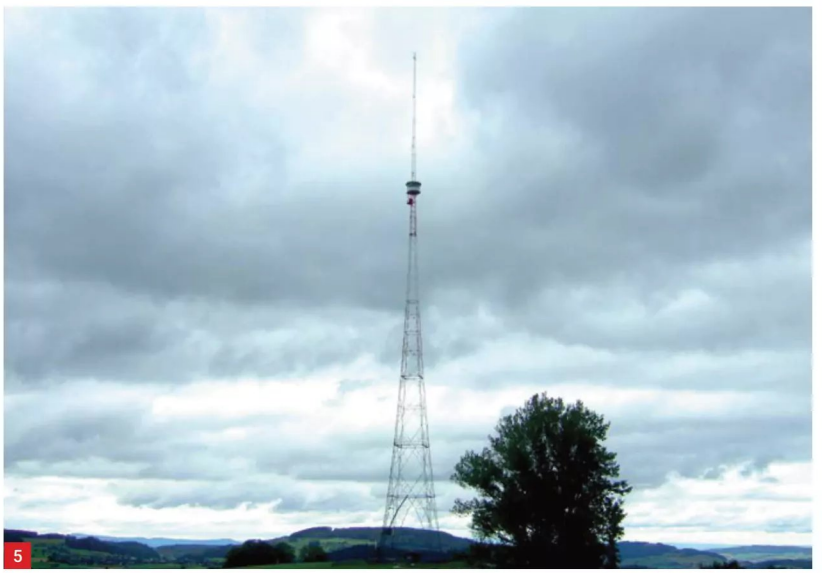
Further down the tunnel was a Control Room, which accommodated BBC engineers and switching gear for no fewer than 80 landlines leading to outside stations, **Fig. 3**. The GPO routed these using diversification techniques to minimise the risk of damage that could have been caused by a single bomb if only one cable system had been installed.

The Control Room was continuously operational day and night, delivering thousands of programmes in many different languages to various transmitters.

Three ground-level rooms housed emergency generators and a special ventilation plant in which full precautions were taken against possible enemy gas attacks. There was also a canteen stocked with sufficient food and water to last for several weeks. All the main entrances and windows were sealed, and ventilation ducts were installed.

## Swiss Beromünster Transmitter: 90th Anniversary—Part 2

Over the years, Beromünster became a household name for listeners whose main language was *Schwyzerdütsch* (Swiss-German). Known as the



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*Landessender Beromünster*, the station opened on 1 May 1931, **Fig. 4**. The station's callsign was *Schweizer Radio DRS*. Programmes broadcast by DRS (*Radio der Deutschen und Rätoromanischen Schweiz*) are an integral part of Switzerland's radio history. The station appears on virtually any vintage European radio tuning scale together with other great names such as Lyons, Allouis, Stuttgart, Vienna, RIAS Berlin, Monte Ceneri (southern Switzerland), AFN München, Budapest and, of course, BBC London.

With the relentless advance of technology to VHF and, much later, DAB, the transmitter's days were numbered and the decision was made to pull the plug on the 531kHz broadcasts. Despite protests by many listeners, the transmitter was finally switched off at midnight on Sunday 28 December 2008.

'Beromünster' is something of a misnomer because it is not actually located in the district of the same name but in neighbouring Gunzwil. At the beginning, the radio transmitter was considered by proprietors of daily newspapers to pose unfair competition. Following heated discussions, it was agreed that the station would broadcast only two news bulletins per day.

During the Second World War, there were weekly commentaries on the situation from well-known radio reporters. Everyone kept up to date by listening to transmissions from Beromünster rather than by television. The station was respected as the only independent German-language broadcaster, and not just in Switzerland. After the war, Beromünster was as popular as ever. The programmes were not just about national events and music, but also general entertainment. However, some younger Swiss listeners discovered *Radio Luxembourg* with a totally different style of music. Beromünster listening figures began to decline.

In later years, the station was operated by *Swisscom Broadcasts* and radiated *SRF Musikwelle* with a blend of unique traditional Swiss music (known as *Örgelimusig*), pop songs and news bulletins. This station, mainly in the Schwyzerdütsch language, is still available via the internet. News bulletins are in German.

Shortly before Beromünster finally closed, the authors visited the transmitter, together with Swiss guide, **Marco Holer**, **Fig. 5**. It still looked very impressive and quite unique. One of the fascinating features that visitors were able to try was hearing 'live' broadcasts via a loudspeaker located in a field approximately 1km from the station, **Fig. 6**. The speaker wasn't connected in any way to the tower; signals were simply induced from the high-power transmitter. Unfortunately, all that is now history.

## Early Television Pioneers: Vladimir Zworykin – Part 2

In 1924, **Vladimir Zworykin** began constructing a television system based on his patent. The following year, he demonstrated an all-electronic system to several Westinghouse executives. Unfortunately, they were all decidedly unimpressed! He later wrote: *"I was terribly excited and proud, but after a few days I was informed, very politely, that my demonstration had been extremely interesting, but that it might be better if I were to spend my time on something 'a little more useful'."*

Westinghouse re-assigned Zworykin to work on photoelectric cells. In 1926, he had obtained a doctorate from the University of Pittsburgh. In 1929, he joined the *Radio Corporation of America* (RCA) and registered his first patent for colour television.

In the previous year, he had been despatched to Europe to examine television research being conducted in partnership with Westinghouse and RCA. He was particularly impressed by the cathode-ray tube designed by **Fernand Holweck** and **Pierre Chevallier** at the Paris laboratory of the French inventor **Édouard Belin**. The Holweck-Chevallier tube used electrostatic fields to focus the beam of electrons. Zworykin's re-energised enthusiasm for the new tube and electronic television was not shared by most Westinghouse executives, but vice-president **Sam Kintner** suggested that he should meet the RCA vice-president, **David Sarnoff**. At their meeting in January 1929, Zworykin was asked how much it would take to bring electronic television to fruition. He replied: *"Two years and $100,000."* This turned out to be a huge under-estimate. In fact, it took Zworykin and RCA ten years and $50 million to perfect the system!

Fortunately, Sarnoff persuaded Westinghouse to give Zworykin the necessary resources. By the end of the year, he had perfected his cathode-ray receiver, which was known as the *kinescope*. This system gave a bright, large picture suitable for home viewing. However, his television system still used a mechanical device, a spinning mirror, as part of the transmission apparatus. Six kinescopes were manufactured and Zworykin had one at his home so that he could monitor the experimental late-night television broadcasts radiated from Westinghouse's radio station, KDKA, located in Pittsburgh.

## Stay Tuned!

Please send archive photographs, information or suggestions for future topics via the email addresses shown at the top of this column. **PW**

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# 8m – A Future Amateur Band?

**Roger Lapthorn G3XBM** updates readers on progress with the 8m (40MHz) allocation.

Since early April, a Test and Innovation licence from OFCOM that costs £50 annually has been held covering 40-42MHz, digital only, with 5W allowed (in practice I use 2.5W). The rig is a modified FT-817ND, **Fig. 1**, with a low wire dipole, **Fig. 2**. Mostly FT8 is used as this only needs a transmit bandwidth of about 50Hz. The software (WSJT-X) is free. It is not uncommon on other bands to see 25 stations, or more, co-existing in the narrow FT8 slots. If activity on SSB on other bands looks quiet, then try the FT8 segment!

## Progress in 2022

So far, the 2.5W FT8 signal has been spotted in 16 countries and 3 continents with the furthermost being Florida in the USA. With a higher ERP, some have reached much further. As a keen QRPer, the interest here, as it is for most others on 8m, is purely radio science. Two-way communication is not important. The aim here is to see how far is possible on 8m with a very modest station.

## Where 8m is in the Spectrum

The 8m band is at a very interesting part of the spectrum, midway between 10m and 6m. Just occasionally, the maximum usable frequency (MUF) with F2 will get to 8m allowing long distances to be spanned via F2 propagation. Sporadic-E propagation, especially in the spring and summer, allows propagation across Europe and similar distances on other continents. Trans-equatorial propagation (TEP) has allowed stations in South Africa to be spotted on FT8 on several occasions with just the dipole. While others have been spotted in South Africa, my 2.5W QRP signal has not. The ERP is probably too low. There are other modes too that have not been characterised properly.

## The Future

There is a very strong case for a small amateur allocation at 8m. These are the minimum proposals:

- 5kHz wide only
- Narrow digital modes only (e.g. WSPR, FT8, QRSS, CW, but no speech)
- Somewhere in the ISM allocation (ideally 40.680 to 40.685MHz)
- By NoV only (by application only)
- Strictly non-interference (secondary status)
- Perhaps limited power.

Narrow digital modes only such as WSPR, FT8, QRSS and CW would easily fit in just 5kHz of band. Clearly more would be better, but free access for serious experimenters is important. With no speech allowed and a very narrow band, the allocation would only attract serious experimenters, especially as there is no commercial amateur gear for 8m, without special modification. Also, this would allow traceability. With a T&I permit, one can transmit without a callsign or giving the location allowing no traceability at all!

The amateur radio hobby is meant to be about self-training, yet we have to pay annually to do this at 8m, whereas 2MHz (2000kHz!) has been allocated at VHF for DATV experiments by NoV. This is fine, but surely just 5kHz can be found for serious research?

No, radio science and self-training at VHF should be free for radio amateurs, especially at a time when good RF engineers are in short supply in the UK. The case for a tiny 8m amateur band is overwhelming. A great deal can be found out. If this was widely available to radio amateurs, so much self-training and research would occur.

## ISM Bands

The indications from OFCOM are that operation without a licence is allowed in the 8m ISM band from 40.66-40.70MHz for beaconing as long as the technical requirements and IR 2030 are met. This also means the power has to be less than 10mW ERP in the UK. This differs in different countries. Please ensure the rules for your country are always followed.

## Conclusions

8m could be a most interesting, if tiny, amateur band in the future. It is at a very interesting part of the radio spectrum where amateurs could greatly contribute to radio science.

## References

WSJT-X: **https://tinyurl.com/28k4njzh**
OFCOM: **www.ofcom.org.uk/home**
RSGB: **https://rsgb.org**
G3XBM: **www.g3xbm.co.uk**

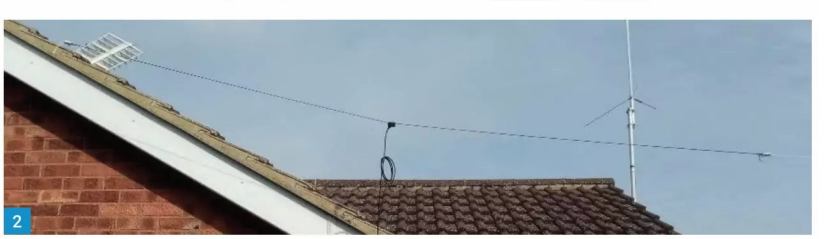
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**Fig. 1: The author's FT-817 on 40MHz. Fig. 2: The low dipole.**

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Email: kristina.green@warnersgroup.co.uk

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# Bargain Basement

## Wanted

**NATIONAL PANASONIC RF3100L DR31** SW/MW/LW/FM Radio in very good condition. **Dick: 07963 319751** DORSET

**OLD HALF INCH FERRITE RODS.** Must be half inch 12.7mm in diameter and be six inches long or more will pay good money for the old rods. **Peter Tankard 0114 2316321 or email: peter.tankard@gmail.com** SHEFFIELD

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**RADIOSPARES (RS) CATALOGUE** First half of 1970s. **Godfrey G4GLM: (020) 8958 5113 or email: cgmm2@btinternet.com**

**TO ADVERTISE IN**
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Contact Kristina Green
Telephone: 01778 392096

# Bargain Basement adverts cost just £5.00

**BY EMAIL** Firstly email your advert's wording to **kristina.green@warnersgroup.co.uk** and then call **01778 392096** to make your payment. **BY POST** Send your advert to: **Bargain Basement, Practical Wireless, Warners Group Publications plc, West Street, Bourne, Lincs. PE10 9PH** Please write your advert in BLOCK CAPITALS up to 30 words, plus 12 words for your contact details and send it together with your payment of £5 (subscribers can place their advert free of charge as long as they provide their subs number or mailing label). Cheques should be made payable to Warners Group Publications plc, credit card payments also accepted. Advertisements from traders or for equipment that it is illegal to possess, use or which cannot be licensed in the UK, will not be accepted. No responsibility will be taken for errors and no correspondence will be entered into on any decision taken on any of these conditions. The Publishers of Practical Wireless also wish to point out that it is the responsibility of the buyer to ascertain the suitability of goods offered for purchase.

# Rallies & Events

All information published here reflects the situation up to and including **19th December 2022**. Readers are advised to check with the organisers of any rally or event before setting out for a visit. The Radio Enthusiast website **www.radioenthusiast.co.uk** has the latest updates, please check it regularly. To get your event on this list, e-mail the full details as early as possible: **wiessala@hotmail.com**

**29 January**
**LINCOLN SHORTWAVE CLUB WINTER RADIO RALLY:** The Festival Hall, Caistor Road, Market Rasen, LN8 3HT. Doors open at 10 am with disabled visitors gaining access at 9.30 am. Indoor event. Refreshments will be available on-site. Entry £2 Talk In is on 145.375MHz.
**contact@m1dhv.co.uk**
**Steve G6TVP/M5ZZZ**
**07777 699 069**
**m5zzz@outlook.com**

**5 February**
**CANVEY RALLY (SOUTH ESSEX AMATEUR RADIO SOCIETY (SEARS)):** Cornelius Vermuyden School, Dinant Avenue, Canvey, Essex, SS8 9QS. Open 10am, entrance fee is £4 The rally is expected to be the usual hive of activity (CBS [Indoors] | CR | TS).
**sears.enquiries@gmail.com**
**07748 432026**

**12 February**
**RADIOACTIVE FAIR 2023 (MID CHESHIRE ARS):** Nantwich Civic Hall, Market Street, Nantwich, Cheshire, CW5 5DG. 100 Traders and Exhibitors Stands. Public transport is onsite, Doors open at 10 am, and admission is £5. A wide variety of trader stalls covering every aspect of the radio hobby, new and old radios, computers and electronics.
(CR | BB | D | FP | RF | RSGB)
**http://radioactivefair.co.uk**
**https://midcars.org**

**26 February**
**RED ROSE RALLY:** St. Joseph's Hall, Leigh WN7 2PJ (CR | FP | RF).
**www.wmrc.co.uk/rally.htm**

**5 March**
**EXETER RADIO & ELECTRONICS RALLY:** The 2023 Exeter Radio & Electronic Rally will be held at America Hall, De la Rue Way, Pinhoe, Exeter EX4 8PW. The doors will open at 10.30 am (10.15 for disabled visitors). Admission is £3.00 (under 16's free). (BB [book in from 10.15 am] | TS). Details: Pete G3ZVI
**07714 198374**
**g3zvi@yahoo.co.uk**

**11 March**
**SOUTH KESTEVEN ARS, JUNK SALE:** Railway Club, Grantham, NG31 7AU. Doors are open for traders at 8 am (bring your own table), and to the public between 9.30 am and 1 pm. Admission for traders is £5 and for the public £1. The maximum table length is 2m. Please book in advance to avoid disappointment (CR).
**s.mason@skars.co.uk**
**https://tinyurl.com/53bc9b44**

**12 March**
**HAMZILLA RADIO FEST (DOVER ARC):** Julie Rose Stadium in Ashford, Kent TN24 9QX. Early bird tickets are available; open from 9:30 am; general admission from 10 am. Local and national traders are welcome.
Join SDR Play, Ceecom Antennas, Icom, and ICQ Podcast. Book your ticket and/or table online (BA | BB | CR | FP | D).
TBC: (RSGB | L | RF | Wi-Fi).
**www.Hamzilla.uk**
**club@darconline**
**Twitter: @HamzillaRally**
**Facebook: www.hamzilla.uk**

**26 – 28 March**
**RADIODAYS EUROPE 2023:** In the Finale of Radiodays Europe 2022, it was announced that Prague would be the host city for this now three-day event, in 2023, 26 – 28 March.
**https://www.radiodayseurope.com**

**11 June**
**JUNCTION 28 RALLY:** Alfreton Leisure Centre Bowls Hall, Church St. Alfreton, DE55 7BD. From January 2023, trader booking forms for the J28 Radio Rally, hosted by South Normanton, Alfreton & Dist. ARC, will be available on the club website, or by contacting the club secretary.
**www.snadarc.com**
**secretary@snadarc.com**

**30 July**
**THE NEW BLACK COUNTRY RADIO RALLY:** Bloxwich Active Living Centre, High Street, Bloxwich, Walsall, WS3 2DA; Doors will be open from 10 am to 4 pm. There is a large car park available and catering on site.
Entry is £3 each or £5 for two. See the website below for details of the traders and clubs attending.
**www.theradioclub.co.uk**

**15 October**
**HORNSEA ARC RALLY:** Driffield Showground, YO25 9DW. Organiser: Les, 2E0LBJ.
**01377 252 393**
**lbjpinkney1@hotmail.co.uk**

## LOOKING AHEAD

- **April** International DX Convention
  **http://www.dxconvention.com**
- **April** NAB Show Broadcast Engineering and IT Conference
  **https://tinyurl.com/y783mzb8**
- **April** NARSA 2023
  **https://narsa.org.uk**
- **May** NDB 2023
  **https://nrbconvention.org**
- **May** ARIAS 2023 (Radio Academy)
- **May** Critical Communications World 2023, Helsinki
  **https://tinyurl.com/4tb4wsp3**
- **May** International Broadcasting Convention (IBC), Amsterdam
  **https://tinyurl.com/2n8cruj6**
- **July** International Journalism and Mass Communication, Austria
  **https://tinyurl.com/9zknsmfu**
- **August** IEEE International Symposium: Radio Frequency Integration, Australia
  **https://tinyurl.com/mrxk6695**
- **September** European DX Council Conference, France

## WEB UPDATES

**https://tinyurl.com/ytnnym3h**
**http://www.g4rga.org.uk/All.html**
**https://tinyurl.com/3ezb68d3**
**https://rsgb.org/main/news/rallies**
**www.radioenthusiast.co.uk**

**BA** Buildathon **BB** Bring-and-Buy **CBS** Car Boot Sale **CR** Catering / Refreshments **D** Disabled visitors **FM** Flea Market **FP** Free Parking **LB** Licensed Bar **L** Lectures **MS** Meeting Spaces **RF** Raffle **RSGB** (RSGB) Book Stall **RU/PW** RadioUser/ PW in attendance **SIG** Special-Interest Groups **TI** Talk-In (Channel) **TS** Trade Stalls **Wi-Fi** (Free) Wi-Fi

# Your Letters

**Send your letters to:** Practical Wireless Letters, Warners Group Publications plc West Street, Bourne, Lincs PE10 9PH
**E-mail:** practicalwireless@warnersgroup.co.uk

## ★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**

### Learning Morse

**Dear Don,**
I refer to the article by G3UGF (November 2022 *Practical Wireless*) and the reply made by **Ray Howes G4OWY** in the subsequent December edition. Both advocate *"writing it down comes last"* when learning Morse code.

I am intrigued by this statement as it is the opposite of the method I was taught some 49 years ago when studying to be a radio officer in the merchant navy. On day one of our three year course (we were studying for the Marine General Radio Certificate, City and Guilds Telecommunication Final Technicians Certificate and for Radar Maintenance Certificates) our group of about 17 young men and one girl were sat down in a Morse room. As instructed, we put headphones on and as each of the first three letters of the alphabet was introduced we wrote them down. For example, the letter 'A' would be sent numerous times and each time we wrote down 'A'. 'B' was then introduced and after a while 'A' 'B' were intermingled. After that, 'C' would be introduced. The same technique was used to introduce and learn the rest of the alphabet, figures and accented letters. Writing it down was therefore instilled in us from the very start.

Competency in Morse was then a process of practice, practice, practice to increase speed. Natural humps (ie finding it difficult to move beyond 12 words per minute) were always overcome by peer support and practice. We used to challenge each other to push ourselves by increasing the speed of the Creed tape sender or by one of the (new-fangled) electronic Morse machines! As competency developed the typing lessons we also had were put to good use as we transcribed CW straight to the keyboard. This ability was especially valuable at sea. The skill of reading Morse in your head developed as competency increased until, eventually, most of us at sea would hold complete conversations over the key with no copying of traffic onto paper.

On leaving the sea I started my next career teaching future radio officers. Alongside electronics and telecommunications that included Morse code. The same method was used by the college where I taught as had been used on me in Plymouth and it brought the right results. I have also used the technique when teaching radio amateurs.

In conclusion then, I professionally challenge 'Writing it down comes last'. Over the years I have read of various techniques to ease the learning of CW but at the end of the day practice and association of sound with the appropriate written word develops competency. It must work as 48 years after getting my amateur call I have only ever had one SSB QSO and am active on HF about every other day.
**Dr Tim Strickland G4EOA**
**East Sussex**

*(**Editor's comment**: Thanks Tim, a different perspective and from long experience too. I can't comment personally as, after all these years, I forget how I learned Morse! But there is certainly a difference in what professional operators need to be able to do – i.e. copy to paper, so there is a written record – and what amateurs need, which is generally just to copy name, QTH, etc, at least to start with. I'd welcome other feedback from both professional and amateur operators.)*

### Conversational Digital Modes

**Dear Don,**
I feel I must respond to letter from **G4LMN**. I think that **Ron** has missed the point of **G4WNC's** comments. **Mike** was not inferring that digital modes should only be used for conversational contacts but there has been a shift in program development to modes ideally suited to DX and 'contact only' QSOs. This has sidelined other modes, which are more suited to conversation.

Along with that there is a trend nowadays to feel we must have the latest mode and if it is new, it must be better. This applies to many things in our modern society but that is another discussion. Many 'older' modes remain available but are often overlooked with the shift towards FT8, WSJT modes etc. Modes such as PSK31 are simple to use and offer exceptional DX capabilities.

I am a 99% digital mode operator but mostly use chat modes, that is my preference, but do accept 'horses for courses' in that I am happy to know that others feel very differently.

The mode I use almost daily is another overlooked mode, FSQ, which has had almost no recognition since its inception several years ago. FSQ could be considered as 'Skype over the radio', offering typing speed conversations, multiple stations in a net, beacon mode for propagation experiments and the ability to transmit images almost like SSTV. It was originally designed for NVIS on 80, 60 and 40m.

A small program with minimal requirements and not reliant upon computer timing. Therefore, very simple and ideal for the initial entry into digital modes.

Amateur radio has many sides and all options should be explored which makes for an interesting world.
**Peter Edwards GW8ARR**
**Knighton, Powys**

*(**Editor's comment**: Thanks Peter. I must admit to being ignorant of FSQ, at least until you enlightened me! Google ZL2AFP and you can read all about it.)*

### Thank You!

**Dear Don,**
Please accept you a big Thank You for producing such a great radio magazine!

I've been a subscriber for a couple of years and find the magazine more useful overall than *QST* and CQ, which I also subscribe to. *PW* is more 'down to earth' for the average ham that uses 100W or less with wire antennas.

Carry on and enjoy!
**Dave Newman WB1EVP**
**Kingston, Massachusetts, USA**

*(**Editor's comment**: Thanks for the plaudit Dave. Unfortunately, many amateur radio magazines have gone by the wayside in recent years – the good news is that since we launched an online version of PW, it's much easier to subscribe from outside the UK.)*

### Blazing Fast Morse etc

**Dear Don,**
Imagine that: copying CW at *"75.2 words per minute"* (January 2023)! Beggars belief. But of course, it was all true. Mind you, if we wanted to, we can all do that now, courtesy of computing technology. But that's cheating, isn't it? So is driving an automatic gear change car, as my partner constantly reminds me. No, I'd much rather sit back and let the car mechanics shift the gears for me. So much easier. I'm awaiting the day (if I get there) when I

haven't got to do anything in a car, except listen to music and await my destination. There again, perhaps I should be careful for what I wish for, it might have unintended consequences.

Enjoyed reading yet more adventures of the famous amateurs still among us. This time, **Dave Roundtree M0IEG**. I once got to know Lord Rix briefly. Aka, **Brian Rix G2DQU**. However, I suspect that many younger *PW* readers won't have heard of him (I think he was in his nineties when he died). And whoever would have thought that 'Superman's' father was a radio amateur, **Marlon Brando**? And the bloke who played a chimney sweep in *Mary Poppins*, **Dick Van Dyke W4CAR**. Apparently, **Sir Cliff Richard** has a US callsign **W2JOF**? Yet more, **Howard Hughes W5CY**, **Yuri Gagarin UA1LO**, **Donnie Osmond WD4SKT/KA7EVD**. The list goes on.

That would be a coup, to get Cliff Richard waxing lyrical about his amateur radio adventures (if he actually has/had a US callsign, that is). Ditto, Donny Osmond. Or how about **Chris Tarrant G0KRH**, of *Who Wants to be a Millionaire* (who doesn't?) fame? Perhaps **Fergal Sharkey G0OAN**, ex-pop singer (The Undertones), would care to step up to the rostrum and dish out his amateur radio exploits? It seems we've only skimmed the surface so far as famous amateur radio operators' stories are concerned. Let's put the bait out.

**Ray Howes G4OWY/G6AUW**
**Weymouth**

*(**Editor's comment**: Indeed Ray, although the intention with this series isn't purely to feature 'famous' radio amateurs. But, rest assured, there are plenty still to come! I'm not convinced about Sir Cliff but maybe other readers would know? In the past, of course, in addition to those you mention, we have had King Hussein JY1, King Juan Carlos EA0JC and many others. As for Marlon Brando, one of my Californian amateur radio friends once got an all-expenses paid trip to French Polynesia to install equipment and antennas at his island getaway – nice work if you can get it! As for self-driving cars, I recently had the opportunity to try out a Tesla in self-driving mode, albeit only for a short distance, and was deeply uncomfortable!)*

## Supporting Magazines

**Dear Don,**

When we had an amateur radio shop 30 years ago we sold a few magazines, and a common complaint was that *"There are too many adverts in them"*.

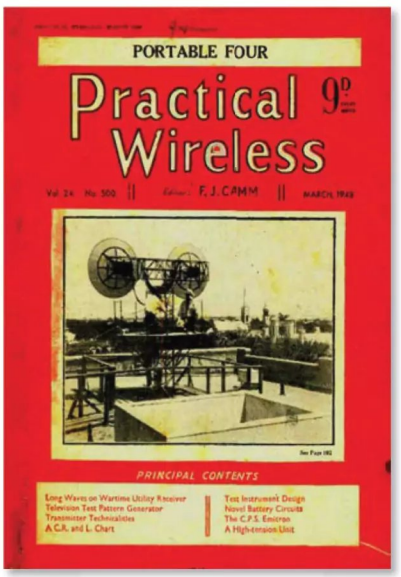
What these customers did not realise was that if it was not for the income from advertisers, many magazines would not be commercially viable.

I always appreciated it when customers contacted my business and said something like *"I noticed your advert in ***** as this gave me an idea where to spend my advertising budget."*

Giving a little feedback to dealers will cost you nothing, but it may help to keep the shop and the magazine in business.

**Harry Leeming G3LLL**
**Huddersfield**

*(**Editor's comment**: So true Harry. That applies to this magazine as much as any other – although advertising is but a fraction of what it was back in the 60s, for example. So, yes, do please mention, when buying gear, that you saw it advertised in* PW*!)*




## Spelling Error?

**Dear Don,**

The 800th edition of *PW* (October 1973) has a copy of the 500th edition and mentions a flagrant spelling error. After 49 years I have never solved the puzzle of the spelling error, would someone at *PW* care to enlighten me?

**Andrew Redding**
**Sheffield**

*(**Editor's comment**: Well, if you look closely, it says Technicalitles rather than Technicalities. I too have once let through an error on the front cover - I was gutted!)*

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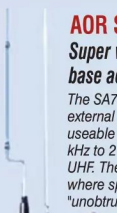

*The SA7000 is an ultra-wide range external receiving aerial with a useable frequency coverage of 30 kHz to 2 GHz - short wave / VHF / UHF. The aerial is designed for areas where space is a problem or when an "unobtrusive" installation is essential.*

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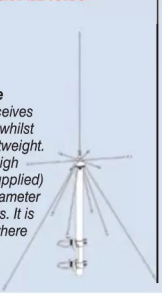

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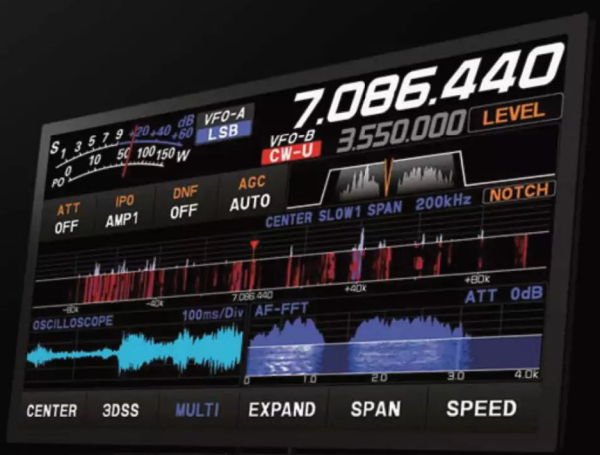


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*Cover image courtesy of acclaimed tank MMO game, World of Tanks (c) Wargaming*





# Welcome

It was a conflict that gradually spread across the world, from border clashes between the Soviet Union and Japan, to the deserts of North Africa, the cities and countryside of Europe, the chilly and vast spaces of the Eastern Front, to the Far East and the Pacific. World War II wasn't just a global conflict that demanded total war from its participants, it saw a new kind of warfare, a fast moving, all arms, mobile style of fighting, spearheaded by legions of armoured vehicles.

Welcome to this special collector's magazine, *Tanks of WWII*, where we take you through the commanders, tanks, battles and collectables associated with the hardware that was developed through six years of fighting. The Famous Tank Commanders section includes those who created successful tank fighting tactics as well as the generals who planned the pivotal battles. In Key Tank Battles there are the clashes at Khalkhin Gol in the Far East, Hannut in Belgium, Brody on the Eastern Front, El Alamein in North Africa, Prokhorovka during the epic clash at Kursk, Arracourt in France and the final roll of the dice for Hitler in the Battle of the Bulge.

The tank features themselves start with the light and cavalry tanks that were adopted and developed by various nations around the world. Here we trace the development of the hardware, in the context of the global conflict, as ever more powerful and heavier tanks took to the battlefield. By the time the Soviet IS-2 was rumbling down the streets of Berlin it was packing a monstrous 122mm main gun that could destroy anything. As well as the American, Soviet and German tanks, there are also the contributions from the British and French, especially at the start of WWII, and the other Axis countries of Italy, Hungary and Japan. Each tank article explains its development, production and use, along with technical specs and blueprints. All the main models are shown, along with action photos and 3D illustrations. The technical specifications panel is for a specific model - either the most important or the most produced in WWII. Measurements are in the units specified by the respective country, so British are imperial, German are in metric, for example, though engine power for all is listed in horsepower (hp) as a common point of reference.

One thing that did become apparent though was that as the war progressed all available materials were used as and when they became available. As such, when a new gun and turret, or a new feature, was introduced, if it could be retrofitted onto an older chassis that was in for repair, then it would be. This can make model identification tricky but where it was done our writers have endeavoured to point it out.

So, I hope you enjoy this special collector's magazine, where you can discover more about the tanks of WWII, how they were designed and the men who fought in them.

**Duncan Evans, Editor**

# TANKS OF WWII

## FAMOUS TANK COMMANDERS

*These are the Generals who revolutionised tank warfare through innovative tactics and the men on the ground wreaking destruction on their opponents.*



## ALLIED TANKS

*Starting with British export tanks that inspired numerous designs, to the workhorse of the Allied nations, the Sherman M4, and the Soviet tanks that crushed the Germans in the East, the T-34 and IS-2. This is your guide to the Allied hardware of WWII with technical specs, blueprints and 3D illustrations.*

### BRITISH TANKS



### AMERICAN TANKS



### FRENCH TANKS



### SOVIET TANKS





## KEY TANK BATTLES

*Whether it was the Soviets routing the Japanese in the Far East or the German blitzkrieg, fast-moving armour with air and infantry support changed the face of warfare in WWII. These are the key battles where the rumble of heavy metal was a significant factor in deciding the outcome.*





## AXIS TANKS

*From the panzers that swept across Europe to the Japanese in the jungles of the Far East and the Italian tankettes of the North African desert, these are the main tanks of the Axis nations, with technical details and blueprints of each one.*



## TANK MEDIA

*To round off your guide to the tanks of WWII it's time to take a look at where you can take your interest further, with museums, games, models and collectable militaria.*



**'Designated M4, the new tank evolved from the existing Grant and Lee medium models incorporating a combined percentage of their best attributes. The Sherman was designed to be the mainstay of the US tank forces.'**

*Read more on page 62*

Words: Mark Wood

# The Battle of Khalkhin Gol

The source of the Khalkh or Halha river lies in the western slopes of the Greater Khingan mountain range of Inner Mongolia, and in part forms the boundary between China and the Mongolian Republic. Between May and September of 1939, the Imperial Japanese Army was locked in combat with the Soviet Red Army as part of a series of territorial disputes that boiled over into outright conflict and the use of armour on the battlefield.

The Japanese maintained sizeable forces both in Korea and east of Mongolia in Manchukuo where the Kwantung Army existed as the power base of the Japanese-imposed puppet government of the former Manchurian state.

During the 1930s Japanese military and political doctrine focused on a strategy known as *Hokushin-Ron* or the road to northern expansion. This concept considered Mongolia, the eastern Soviet maritime ports, and Siberia as Japan's geographical sphere of interest which would create a buffer zone against the Soviets.

The source of the ongoing dispute was the geographical demarcation of the border which the Soviets claimed was located at the village of Nomonhan, 15 miles east of the Halha River. The Japanese considered the river itself to be

▼ T-26 light tanks were superior to the Japanese armour

▼ Soviet fast tanks and light tanks at Khalkhin Gol

the border and small-scale incidents had continued during the 1930s.

Throughout May of 1939 a series of Japanese provocations escalated into fighting and what would become known as the Khalkhin Gol incident to the Soviets and the Nomonhan incident in Japan.

On 14 May, elements of the Japanese 23rd infantry division mobilised, supported by aircraft, with the first indecisive clash occurring over the days of 28 and 29 May 1939. The Japanese reorganised and ground forces were bolstered by additional reserves bringing regional strength to 20,000 troops supported by 112 artillery pieces under the command of Lieutenant General Komatsubara.

It is a measure of the seriousness with which Josef Stalin viewed the situation that he despatched General Georgy Zhukov in early June to take command of Soviet and Mongolian forces at Khalkhin Gol.

The sparse ground cover initiated an immediate struggle to secure air superiority with the Japanese holding a distinct advantage. Deploying the recently introduced Nakajima Ki-27, flown by veterans of the air campaign in China, the Japanese quickly gained the initiative. Although lacking in speed and rate of climb the Ki-27 had extremely low wing loading enabling exceptional turning ability and initially proved superior to its Soviet Polikarpov I-15 and I-16 adversaries.

In an urgent attempt to stem the catastrophic losses, Soviet air command transported six squadrons of upgraded Polikarpov fighters, totalling 100 aircraft, to the East accompanied by additional pilots, veterans of the Spanish Civil War. As the conflict progressed the Red Airforce, equipped with improved aircraft and experienced crews, began to reverse the tide of battle. Combat casualty analysis of the period reveals that while 10% of total Japanese air losses occurred in May, by August that had risen to 50%, causing considerable tension between the Kwantung Army and Japanese high command in Tokyo.

On the ground, Zhukov's most challenging task was the logistical supply of the large Soviet defensive forces along the Chinese border. Organised by the extremely able General Grigori Shtern and transported via the Trans-Siberian Railway to Chita, supplies of food, ammunition, fuel and equipment were trucked over 800 miles south to the combat zone.

Changing Japanese fortunes in the air war provoked a two-pronged ground assault commencing in July. The attack on the southern flank was to be led by Lieutenant General Masaomi Yasuoka, commanding a mechanised brigade which would force the Red Army back while the northern flank would cross the river and attack south behind the retreating Soviets, cutting them off.

While the tactical planning was both bold and ambitious, the supporting organisation was not. The mechanised brigade intended for the southern prong of the assault was still in the process of being formed with only one of the three tank regiments of the prospective brigade being combat ready. The brigade's infantry and artillery units had not yet been integrated and supplies of the new Type 97 medium tank proposed to spearhead the attacks had not materialised

**BATTLE STATS**

| BELLIGERANTS | |
|---|---|
| Soviet Union | Japan |
| Mongolia | Manchukuo |
| **COMMANDERS** | |
| Georgy Zhukov | Masaomi Yasuoka |
| Grigoriy Shtern | Michitaro Komatsubara |
| **FORCES** | |
| Men: 61,860-73,961 | Men: 20,000-30,000 |
| Tanks: 498-55 | Tanks: 73 |
| Armoured cars: 385-450 | Tan |
| Aircraft: 900+ | |
| Artillery: 500 | |
| | |
| So | |

# Georgy Zhukov

**Words:** Duncan Evans

▲ *Stalin's General - Zhukov was featured inside the American magazine Life in 1944*

◀ *Zhukov and Ivan Konev during the Battle of Kursk, in 1943*

Coming from a poor, peasant family in Western Russia, Georgy Zhukov was determined to rise above his station. He completed three years of primary education at home before being apprenticed as a furrier to his uncle in Moscow. While working in a shop all day he managed to fit in classes at night school and undertook reading sessions with his cousin on the topics of mathematics, science, geography, Russian and German languages. As World War I raged he was conscripted into the 10th Dragoon Novgorod Regiment in the Imperial Russian Army, seeing action against German forces at Kharkiv. He was wounded in battle and awarded the Cross of St. George twice, before being promoted as an NCO in 1916. However, it was after the 1917 October Revolution that his star really began to ascend. Zhukov joined the Bolshevik Party and fought in the Civil War, in the Second Cavalry Brigade and 1st Cavalry Army. He completed a training course for officers in 1920 and was duly commissioned.

In the years between the two world wars Zhukov immersed himself in the new tactics of mobile warfare, taking every opportunity for education including graduating from the Frunze Military Academy.

His background of poverty and loyalty to the Party, plus a career in the Cavalry, stood him in good stead during Stalin's Great Terror purge. By 1938 he had risen to become Deputy Cavalry Commander of the Belorussian Military District so when Japan's Kwantung Army escalated a border clash into a full scale war he was the man Stalin turned to. Zhukov was given command of the First Soviet Mongolian Army Group, facing around 80,000 men with 180 tanks and 450 aircraft. Now Zhukov's education in fast-paced, all-arms warfare came to fruition. At the Battle of Khalkhin Gol he organised what looked like a traditional frontal assault, but in reality concealed twin pincer movements of two tank brigades supported by artillery and infantry. The battle was a stunning success, ensuring Japan no longer looked to the north for expansion. It also cemented Zhukov's reputation and he was duly promoted to the rank of General.

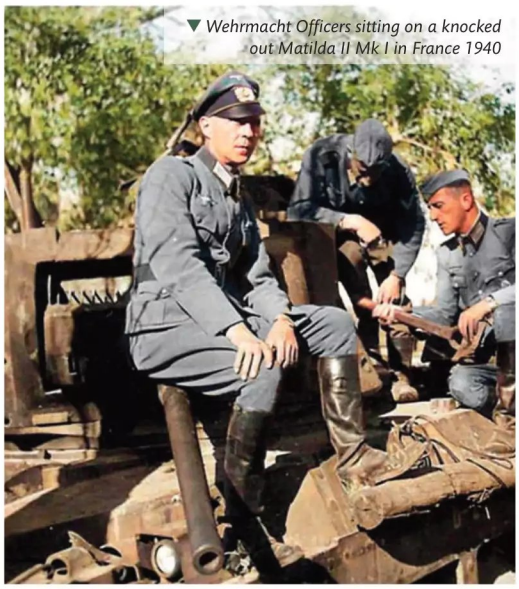
After coming out top in a brace of war games on the new Soviet border, late in 1940, it seemed like Zhukov could do no wrong. In February 1941 he became Chief of the Red Army's General Staff and was elected to the Central Committee of the Communist Party. The following month he became the Deputy People's Commisar for Defence.

In June 1941 the Germans invaded and after clashing with Stalin over tactics he was removed from his Chief of Staff role and sent to the Reserve Front. However, here he oversaw the Yelna Offensive, the first Soviet victory against the Germans, before taking charge of the defences of Leningrad and Moscow. With both cities saved he was dispatched to Stalingrad to take charge of the defence and plan the counteroffensive that destroyed the German Sixth Army. On 18 January Zhukov was promoted to Marshall of the Soviet Union where, together with Aleksandr Vasilevsky, he planned the in-depth defences at Kursk and the massive counteroffensive which finally ended the German threat on the Eastern Front.

With the Soviet Union now on the offensive, Zhukov became commander of the 1st Belorussian Front which crushed the German defences on the Vistula and sealed the end of the Third Reich in the Battle of Berlin. Zhukov was given the honour of personally accepting the German Instrument of Surrender in Berlin on 8 May 1945. ■

| BACKGROUND INFO | |
|---|---|
| **RANK** | Marshal of the Soviet Union |
| **NATIONALITY** | Russian |
| **PERSONAL** | 1/12/1896-18/6/1974 |
| **AWARDS** | Hero of the Soviet Union; Order of Lenin; Cross of Saint George, |
| **MOST FAMOUS FOR** | Battle of Khalkhin Gol; Operation *Uranus*, relief of Stalingrad; Battle of Kursk; Battle of Berlin; accepting Germany's surrender |

▼ *Two Matilda II Mk IIs advancing during Operation Compass in early 1941. Note the Besa MG is missing on the leading tank*



▼ *Wehrmacht Officers sitting on a knocked out Matilda II Mk I in France 1940*

**Words:** Dermot Foley

# Matilda Infantry Support Tank

While the famous British Matilda tank was widely used by the Allies throughout WWII its origins and development can be traced back to mid 1930s, with the A11 (Matilda I) being designed by Vickers Armstrong and the A12 (Matilda II) by the Royal Arsenal at Woolwich separately. Unfortunately, due to financial restraints caused by the 1929 stock market crash, a bad decision was made to manufacture two versions of slow moving battle tanks, the theory being that they could support an infantry attack on enemy defensive lines. This archaic WWI tactic was a mistake, which the British Expeditionary Force would discover to its cost during the Wehrmacht blitzkrieg of 1940.

When the two prototypes were originally designed they were designated the A11 and A12 Infantry Support Tank. The smaller A11 had a two-man crew and it was fitted with one Vickers heavy MG and a Ford V8 engine. Fortunately only 140 Mk I were ever produced. Furthermore, many were either destroyed or left behind in France at Dunkirk and production of the obsolete A11 was completely halted in August 1940.

Although the A12 Infantry Support Tank had a similar visual appearance to the A11 Mk I tank, it was actually derived from another prototype known as the Vickers A7 medium tank which never went into production due to mechanical faults within the design.

In 1936 the first working prototype A11 was delivered for testing, at the same time the A12 Infantry tank was also being developed. It was armed with one, quick firing 2-pounder gun along with a Vickers .303 heavy MG. At the time the idea to fit a two pounder gun was heavily criticised as the tank lacked the capacity to fire an effective high explosive round. Unfortunately, despite the criticism, it was fitted to the tank as standard.

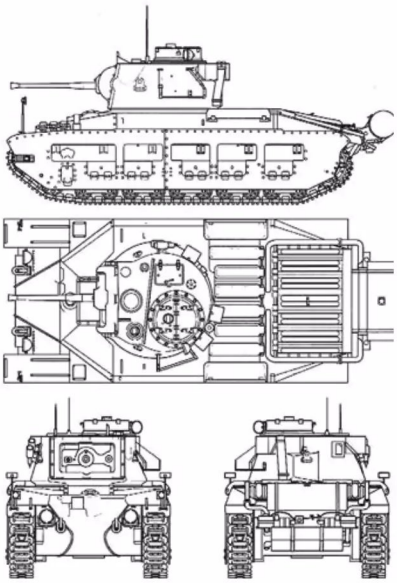
Later in that same year the Vulcan Foundry based at Newton le Willows in Cheshire produced two wooden mock-ups, along with two mild steel prototypes. These were inspected in 1937 and, by April 1938, the first A12E1 Matilda II was delivered for testing. Although the 1,000 mile trial run was satisfactory some improvements were required to the gearbox and suspension.

In 1938 a large order was placed with the Vulcan Foundry. However, it was soon realised that one company would not be able to cope with the amount of tanks required, therefore a number of other factories were also employed throughout the production period, including the well known Harland & Wolff in Belfast. Production was slow and by 1940 a total of 380 Matilda Mk II had been completed. In late 1940 the Matilda II went through a series of improvements to the engine and armament and it was fitted with a 7.92 BESA MG.

At 26t the A12 Matilda was twice as heavy as the earlier A11 Matilda and it required two, linked AEC diesel engines that were used on London buses. It was fitted with the same Bell type suspension as used on the A7 Vickers medium tanks. The Matilda II used a complex Wilson epicyclic six speed gearbox which was powered by compressed air. Steering was provided by Rackham steering clutches, which sent the power to the rear drive sprockets.

The hull of the Matilda and the turret were mainly cast pieces, but two turret top panels were manufactured as separate parts. The cupula was fitted on the right and the loaders hatch on the left. The turret worked using a hydraulic power system. The turret was designed in order to accommodate the main gun and a coaxial machine-gun, along with positions for the gunner, loader and commander. Overall the Matilda was heavily armoured with 78mm at the front and 25mm side-skirts, which was highly effective until the end of 1941.

During the battle for France the RTR deployed 58 Matilda I and 16 Matilda

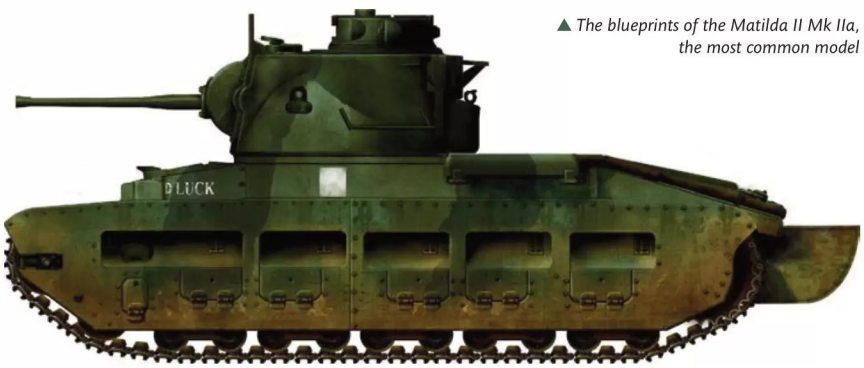


II during the counter-attack at Arras on 21 May 1940. Initially the 7th Panzer Divisions anti-tank guns could not stop them until Rommel turned the infamous 88mm anti-aircraft guns on them and the surviving tanks withdrew from the battlefield.

Matilda II tanks were sent to Egypt in 1940 and they performed well against the Axis tanks during the Western Desert campaign from 1940 until late 1941, where the Matilda became known as the Queen of the Desert. Fortunately, when the Germans were sent to North Africa, in early 1941, the 21st and 15th Panzer divisions were still using early Panzers, all of which had problems penetrating the Matilda's thick armour. Rommel had to use Luftwaffe troops with the highly effective 88mm anti-aircraft gun again to stop the advancing Matildas.

By late 1941 the Matilda was considered obsolete and replaced by the Valentine. However, a special version known as the Scorpion was fitted with a flail to clear enemy minefields during the battle of El Alamein in 1942. Some 900 of the remaining Matilda II were shipped to the Red Army in 1942 and some saw limited use during the battle for Moscow. However, they were deemed unsuitable for frontline use as they were too slow and no match for newer upgraded Panzers.

Despite its known flaws the Matilda II was successfully used in various versions and the Matilda II Mk V Frog version proved to be very useful in the Australian campaign in Asia against the Japanese. ■




▲ *The blueprints of the Matilda II Mk IIa, the most common model*

| SPECIFICATIONS | |
|---|---|
| **MATILDA III MK II A*** | |
| **Crew:** | 4 |
| **Weight:** | 25.5t |
| **Length:** | 18ft 5in |
| **Width:** | 8ft 6in |
| **Height:** | 8ft 3in |
| **Engine:** | Twin Leyland diesel engines 94hp |
| **Top speed:** | 15mph road<br>9mph off-road |
| **Range:** | 160 miles |
| **Front armour:** | 3.14in |
| **Firepower:** | QF 2-pounder gun, 1 x coaxial BESA 7.92 MG |

## MATILDA INFANTRY TANK MODELS

The Matilda series of tanks began with the A11 Matilda I prototype in 1936

◀ ***A11E1 Matilda Mk I:*** *This early prototype tank featured one Ford V8 70bhp petrol engine and a Vickers MG*

◀ ***A12E1 Matilda II Mk I:*** *This A12 prototype featured six mud chutes twin AEC 87bhp engines and a Vickers heavy MG*

◀ ***Matilda II Mk IIA*:*** *The standard version featured the Besa 7.92mm MG and the more powerful 94hp twin Leyland diesel engines*

◀ ***Matilda II Mk IV/V Frog:*** *This Australian conversion was equipped with a flamethrower and was deployed in Borneo in 1945*

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