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# PRACTICAL WIRELESS

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# DEEP DOWN

## How low frequencies are used to communicate underground

## 70 MHz Contest

How to enter our annual readers' competition


## IC-7300 Switch

Building your own automatic antenna switch

**TEST** **Commercially made G5RV antenna**

We review the latest product from MCR Communications

**HOW TO** **Constructing a portable AM HF receiver**

Build a neat Digital Signal Processing receiver based on an Si4825 circuit

## Get Started!

Part two of our 'how to' series

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You tell us what matters in your world

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## NEW! W&S VIDEO CHANNEL

We have launched a new video channel on You Tube - just key in 'WaterSStanton'. It covers a range of topics from transceivers to antennas. It also carries news items, hints and tips.

Presented by myself on a regular basis, its a good way to keep in touch. Alerts to new videos are posted on Facebook and Twitter. Check it out now! You can use Smart phone, tablets or PC's.

Peter Waters G3OJV

ELECRAFT **Brought to you by W&S!**

## Elecraft Portable HF at its best!

### Elecraft KX2

2 Year Warranty

Mic & paddle key are optional extras

**£959.95**

- 12 Watts Out 80m-10m
- Fits into a coat pocket
- Has built-in microphone
- Variable selectivity
- CW audio filter
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**Built: £1349.95 Kit: £1299.95**

There is something very special about the KX3. It out-performs any similar transceiver and almost all of the base stations. You can run it at 100mW or increase to any power up to 15W (a bit less above 20m). You can add 2m or 4m, Add a narrow roofing filter or auto ATU. No other rig can match it.

### SDR-PLAY RSPDX

- Frequencies: 1kHz - 2GHz
- Receive, monitor and record up to 10 MHz of spectrum at a time
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- Software selectable choice of 3 antenna ports
- Enhanced ability to cope with extremely strong signals

**£194.95**

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High Performance Miniature SDR Dongle for All! An affordable high performance receiver for the VHF and UHF bands. The coverage can be extended to the HF bands via the SpyVerter up-converter companion.

- Continuous 24 -1800MHz
- 3.5 dB NF between 42 and 1002 MHz

**£119.99**

### Icom R30

**Digital & Analogue Multi Mode Scanner**

- With dual watch and dual band recording
- Listen to two signals (analogue + analogue or analogue + digital)
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### Icom IC-705

**VHF, UHF, HF, D-Star all mode**
**10W QRP portable transceiver**

- Receiver: 30kHz - 146MHz
- Receive: FM Broadcast & AM Air band included.
- Scope: Live Spectrum and Waterfall
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All-Band Portable

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- Covers: 1.8-430MHz
- RX: 100kHz-30MHz
- Memory Channels: 208
- Dimensions: (W x H x D): 135 x 38 x 165 mm

**£599.95**

HF on a BUDGET

### Yaesu FT-450D

**100W HF/6m Transceiver with ATU**

- Transmit: 160 - 6m (Amateur bands only) 100 Watts (25W, AM carrier)
- Receive: 30 kHz - 56 MHz
- Built-in electronic keyer
- Various scan functions
- Cloning capability

**£649.95**

### UNIDEN Bearcat SDS-200E

**DMR Digital Scanner**

With DMR, NXDN, and ProVoice monitoring modes - visit our web site for more details!

**£779.95**

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**Japanese Quality Audio Specialist**

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- High quality insert
- FM / SSB switched EQ
- PTT with lock
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- Adjustable level
- Uses 2 x AA cells

**£99.95**

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from Japan's Exclusive UK Distributor

**A502HBR** 6m 2 Elements
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**A144S5R** 2m 5 Elements
9dBi Gain Boom 0.95m.....**£49.95**

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11.6dBi Gain Boom 2.13m.....**£79.95**

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40-20-15-10m 1kW SSB Handling
Height 6.52m.....**£189.95**

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80-40-20-15-10m 1kW SSB Handling
Height 6.52m.....**£234.95**

**6BTV**
80-40-30-20-15-10m 1kW SSB Handling
Height 6.52m.....**£269.95**

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**Each of these radios built from the ground up and featuring the very latest SDR technology. Now leading the design trends in Japanese Ham radio.**

### IC-7300

The IC-7300 has quickly become a piece of ham radio history. A marker by which the competition is judged. The fastest selling radio of 2017 and still going strong, replacing all those old radios that many hams gave clung to for years. It's a great performer and great value. 160m - 4m. 100W Max. **£1195.95**

### IC-7610

The new IC-7610 transceiver is now a reality. Few can fail to be impressed with the advanced technical promises. And nobody should be disappointed once their new radio arrives. We have good orders in for this radio and so will be happy to bring your dreams to reality. And if you need any additional items to go with your new radio then we are sure that we can delight you. 160m - 6m. 100W **£2999.95**

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The IC-9700 brings together the three popular VHF bands and puts them into one very high tech. box. The large screen, packed with information, will be a welcome addition and copies their HF range in presentation and flexibility. Top of the feature list is SDR employed on both 2m and 70cms, with all the benefits that go with this. And there is no extra charge for the 23cms down converter which will be the icing on the cake for many. The recent trade demonstration showed us just what a great radio this is. Call us today for a quote. **£1795.95**

**Other Transceivers**

**IC-7100**.....100W All Mode with remote head .....£999.95
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**IC-R30**.....Handy All Mode Digital scanner .....£569.95

## Icom Outdoor Radio

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- Full mode: (SSB, CW, AM, FM, RTTY decode) and D-STAR DV
- Touch screen
- IF DSP features

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### ID-5100E D-Star

Here we have the feature packed mobile that delivers 50W of dual band power. Offering both FM and D-Star with programmable features that enable worldwide communication. **£599.95**

### IC-2730E

This radio is a rugged workhorse. 50W of FM on 2m and 70cm. Keypad mic. and remote head. It has AM and FM receive for out of band reception such as airband and marine. **£299.95**

## AOR AR-8600 MkII

- 100kHz - 3GHz
- SSB, CW, AM, FM, WFM
- Airband 8.33kHz
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- Card Slots
- RS-232 and 10.7MHz output
- Dual VFOs

## Can you monitor all the Bands?

By the time you read this we should have more stocks of the latest version of this most amazing receiver. It covers all the Ham bands that you are ever likely to want to monitor. That in itself is quite an achievement, and at a very competitive price. Add to that all the other services it covers including airband and marine and you have a great package in a very small space. And tuning is easy with steps down to 50MHz so no problem with SSB and CW. Perhaps it is time that you added the capability of monitoring the complete radio spectrum to your radio station. What better than using a model from AOR Japan. **£649.95**

# YAESU Part of our Range

### FT-3DE Digital Handheld

The Yaesu 3D is one of our top sellers. The touch screen makes it so much easier to get up and program. Its a smart phone performance for ham radio!
High resolution screen with bandscope display. Digital and analogue operation on 2m & 70cms. Features wide band receive and has GPS reception. A great travel radio. **£399.95**

### FT-DX3000 HF - 6m 100W + ATU

The FT-DX3000 owes a lot of its features from the FT-DX500, a class leader DXers and Contesters love it - so will you!.....**Call Sales for a deal! £1299.00**

### FT-DX5000MP HF - 6m 200W + ATU

This radio needs little introduction. It's the current Flag Ship of the Yaesu HF range. 200W is 3dB gain on all bands.....**£3299.95**


### FT-991A HF - 70cms 100W max

This is a real top seller. It's the one radio that you can put on the desk and enjoy HF and VHF. Includes ATU. .....**£1239.95**


### Yaesu FT-dx101D

Now top of the Sherwood list for SDR HF Technology. When you buy from us you also get a 3-Year Yaesu UK warranty. The new Yaesu FT-DX101D embraces SDR in an interesting way. You have full SDR technology but they have added a selectable superhet front end to provide optimum dynamic range and front end selectivity. The full colour touch screen offers variable bandwidth up to 1MHz, with clever screen presentation options and a rear panel HDMI output for an external display.

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**Full range of Yaesu products stocked. Call for Quotes**


**Peter Waters G3OJV**, operates the first FT-dx101 to come into the UK.

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**FTdx-101MP**....**£90 CASHBACK**
**FT-991A**.....**£70 CASHBACK**
**FT-818ND**.....**£105 CASHBACK**
**FT-891**.....**£70 CASHBACK**
**Valid until September 30th**

## AOR Receivers Japan

### AR-DV1

Multimode digital demodulation receiver featuring wideband reception, D-STAR, Yaesu Fusion, DMR and much more. **£1199.95**

### AR-5700D

9kHz - 3.7GHz Multi-Mode, Digital Video Out, I/Q Out professional communications receiver that offers a level of versatility and capability, beyond that of any similar receiver. See our website for full spec! **£4,595.00**

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The AR-DV10 is the most advanced digital handheld receiver covering covering 100kHz - 1.3GHz. The latests firmware upgrade now adds comprehensive trunk monitoring. **£939.95**

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In general, all components used in constructing *PW* projects are available from a variety of component suppliers. Where special, or difficult to obtain, components are specified a supplier will be quoted in the article.
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# Keylines





It seems that we are gradually returning to something approaching normality (the new normal?) but on the radio front all is still far from normal, with most events cancelled (the Newark Hamfest being the latest and, in UK terms, the highest profile), DXpeditions pretty much non-existent and portable operations in contests such as the recent IOTA event positively disallowed. The good news is, though, that our hobby remains in good shape. Indeed, remarkably so, with a continuing influx of new and returning amateurs, many clubs managing to keep going through Zoom and similar get-togethers and, of course, person-to-person communication able to continue in a suitably socially-distanced way over the airwaves.

## Getting Started

In this month's *What Next* column, **Colin Redwood G6MXL** gives more tips about getting started in the hobby. In particular, he recommends buying an HF radio in order to have access to international communication. There is an interesting trade-off here in terms of outlay and satisfaction. I recently invested in a couple of VHF/UHF handhelds, partly out of curiosity and partly because they will be handy from time to time, such as at rallies and, indeed, for communicating with fellow team members on our DXpeditions (if I ever get to travel again!).

The first is a Baofeng UV-9R, cheap as chips at £39.98 and with a torch and alarm included. The second is a Yaesu FT-4XE, which set me back £70.90 including postage. Both sets were considerably cheaper than the second-hand Yaesu VX-5 (admittedly a tri-band rig) that I bought from Lowes in Plymouth (that dates me!) more years ago than I care to remember. The Baofeng is far less user friendly than the Yaesu, requiring each channel (or channel pair in the case of repeaters) to be set up and stored, whereas the Yaesu knows about repeater frequencies and shifts from the outset. Presumably this is because the Baofeng is also sold (albeit in a slightly different version) in huge numbers for commercial and other purposes (which will also be how they can manufacture and sell them so cheaply).

But neither rig will be of much use unless there is someone to talk to and even here, in sight of the Mendip repeater, with its widespread coverage, including the Bristol area, there is little enough activity. I have worked folk via the repeater, but they are few and far between (compared with years ago when I would guess it was in constant use).

I'm not entirely sure why this should be, particularly during lockdown, when I would have thought folk would want to talk to locals and share experiences. It may in part be that nowadays there are so many facets to the hobby that other aspects beckon. Digital voice modes on VHF and UHF permit global communication but the entry price is, of course, very much higher. As, indeed, is the price of getting started on HF although it is certainly possible to buy a very competent HF rig second-hand for under £500, which, while it may sound a lot, is probably no more than people would happily spend on other hobbies.

But even on HF there is often a dearth of activity (except during contests), so where is everyone? I would hate to think of them passing the licence exams and quickly losing interest. So, we should certainly commend the RSGB Beyond Exams initiative, which we have some information about in this issue. The snag, it seems to me, is that it requires local clubs to take up the baton and I suspect that many clubs will lack the resources or the will to do so. Only time will tell.

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

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

# Newsdesk

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


## New from Martin Lynch & Sons

**ML&S have told us of three new products that they are stocking:**

- **Nissei NS-2230. The power poles on the NS-1230D have proved so popular, now Nissei is upping the game with the NS-2230D. Listening to feedback they have swapped the power poles to the front and put the large screw-down terminals on the rear. 28A continuous, 30A peak. Priced at £94.95.**
- **MyDEL KC-901V. Do you need a VNA (vector network analyser), spectrum analyser, field strength meter, and an extra low-frequency signal source covering 9kHz – 6.8GHz? Rather than separate units, the KC-901V has it all built in, in one handheld unit. Full specification online on the ML&S website. £1995.95.**
- **ZumSpot Range. New from Zum Radio, the complete ZumSpot range. The most basic ZumSpot-RPi is supplied fully assembled and tested with the very latest version of Pi-Star software (£159.95). Also available is the ZumSpot Dual-band – perfect if you want to make a node on 2m or 70cm (£159.95 – No Raspberry Pi included). The ZumSpot Duplex if you want to make full use of both timeslots on DMR (£149.95 – board only). And the ZumSpot-USB if you simply want to plug into your existing computer and use the BlueDV software (£109.95). All now available from ML&S.**

**And in related news, ML&S have recently reopened their showroom. Their announcement says that after four months of temporary closure, Martin Lynch & Sons have finally reopened for visiting customers.** ***"It's been tough seeing all the work and effort spent designing and building our huge showroom to be without customers actually in it"*** **said Martin Lynch G4HKS.** ***"We reacted to the market and had to close our doors due to the Covid pandemic and for the safety of our staff. Fortunately, our customers supported us throughout this period and we reorganised the entire space to operate as a pick, pack and despatch area for the increase in demand for our mail-order operation.***


***Customers are still able to call or use the web to discuss purchasing product, but so many like to see that new shiny radio before buying. I can't blame them either"*** **said Martin.**

***"We are working to safe distancing practices set out by the government including the mandatory requirement of visitors wearing masks. Hand sanitiser is available before entry", said Dan Lynch, Martin's eldest son and Operations Director of the company. "Despite the enormous area our showroom covers, we can only allow a maximum of five customers in store at any one time. We're confident our customers will respect and appreciate there may be others waiting that have also travelled a distance to do the same. We may work to an appointment system if it proves a problem but hopefully not"*** **said Dan.**

**hamradio.co.uk**

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


## New from Moonraker

Two new items from Moonraker are the Opek AT-401K RF Adaptor kit and the Senhaix 8600 handheld dual-band transceiver. The Adaptor kit sells for £129.95, the transceiver for £89.95. The transceiver specification includes Dual Frequency Waiting, Power switching, Voice control function, Voice control delay, Channel encryption, 1750 relay, Power saving mode, Voltage display, Scan function, FM radio, PTT ID and Automatic backlight.

**www.moonraker.eu**

## New from Nevada Radio

Nevada are pleased to announce the release of a new antenna from Vibroplex USA.

The HF-ALBAND-KW end fed Multi band wire antenna has been built to the highest standards, even using a commercial vent to prevent moisture build up in the Balun. Covering all bands from 80 through to 10 metres without the need for an external ATU, the antenna will handle up to 1kW of SSB and around 350W data. The antenna is approximately 130ft long and may be set up in many ways from inverted L, inverted V or straight wire configuration, with little effect on the SWR.

The Vibroplex HF-ALL BAND KW antenna sells for £169.95 and is available from exclusive UK distributors, Nevada Radio and Waters & Stanton.

Nevada are also now stocking the entire mAT-Tuner automatic tuner range supplied factory direct from the manufacturer in China.

The range consists of six tuners for all situations and compatible with Kenwood, Icom and Yaesu transceivers.

The MAT-125E is a general-purpose external Auto ATU for use with any transceiver. It is RF sensing and so does not require an external control cable. It will handle from 0.1W to 120W from 1.8 to 54MHz. with a 5 – 1500Ω matching range.

The tuner is truly portable using a pair of 18650 lithium ion batteries (supplied) that will last a long time due to the low power consumption of the tuner. A charger is also included should they need a top up at some point.

The MAT-125E sells for £189.95

The complete range of mAT-Tuners is available from both Nevada and Waters & Stanton.

**www.nevadaradio.co.uk**

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# 'Introducing the IC-705 QRP SDR transceiver'

With the release of the much-anticipated IC-705 QRP SDR transceiver just around the corner, Icom UK have managed to get hold of a pre-production sample and give to **Bob McCreadie G0FGX** of *TX Films* to put it through its paces. He produced a video with his thoughts and reactions.

In the video Bob:

- Goes through a rundown of the IC-705's many features and picks up on how simple and intuitive the IC-705 is to use.
- Demonstrates the compact and lightweight body of the IC-705 and the flexibility of its power supply.
- Shows the multiband capability of the radio… literally a 'shack in a box'.
- Highlights its impressive, bright and intuitive 4.3in colour touchscreen display as used on other Icom SDR radios such as the IC-7300 and IC-9700 models.
- Gives us a sneak peek of the LC-192 Backpack designed especially for this radio looks like.

To view this film, click on:

**https://tinyurl.com/y48h992v**

For more details about the IC-705 visit the 'IC-705 Product Page'.

**https://tinyurl.com/yc4hhay3**

For more information about TX Films and their regular programme dedicated to the great hobby of Amateur Radio visit

**www.txfactor.co.uk**

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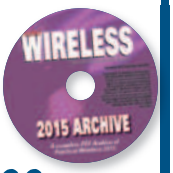


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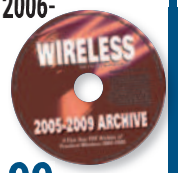


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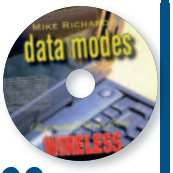


Mike Richards G4WNC has explained the many data modes using a computer with your radio.

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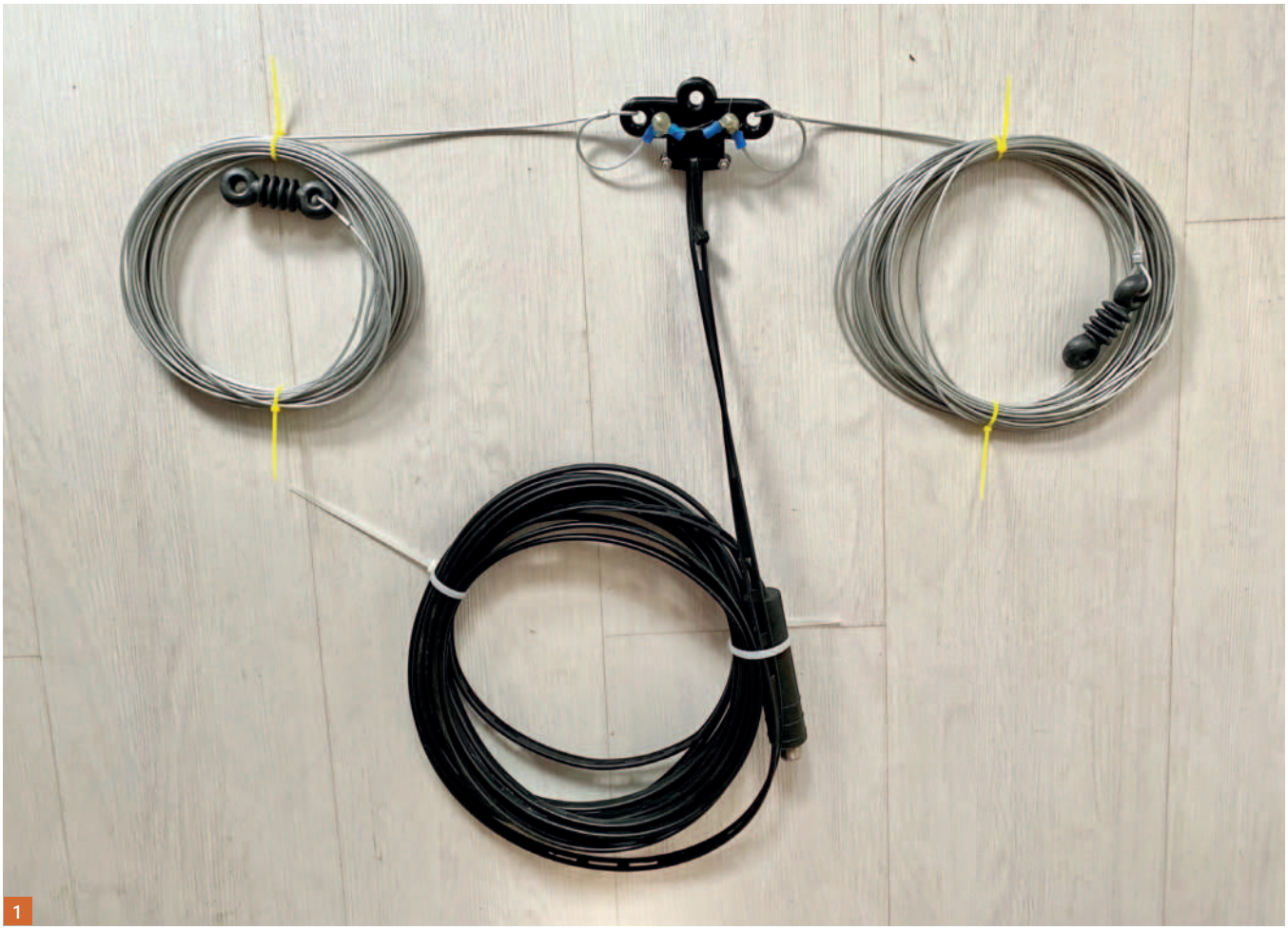


1

# The ‘MCR Communications’ G5RV Antenna

**Vince Lear G3TKN** takes a look at a commercially made G5RV antenna.

**Vince Lear G3TKN/ZL1VL**
g3tkn@tesco.net

In the past I have normally soldered together various wire antennas from odd bits out of the ‘junk box’. However, on this occasion I decided I wanted a nicely made G5RV antenna that I could keep for taking away on holidays or using from the main station as a general purpose antenna.

When I priced up all the individual pieces necessary to make up a G5RV, I soon realised that some of the commercially made ones actually offered good value for money.

After looking at various advertisers online, I came across MCR Communications (website below) in Pontefract, Yorkshire, run by **Mark Raynor M0ZIM**. I carefully inspected the pictures of the G5RV on his website and it certainly seemed very well made. At a price of £34.95, I felt that I probably would not save that much by making one myself.

https://mcr666.com

## Inspection of the Antenna

The antenna arrived just a few days after ordering and was packaged well. The photo, **Fig. 1**, shows it complete with feeder.

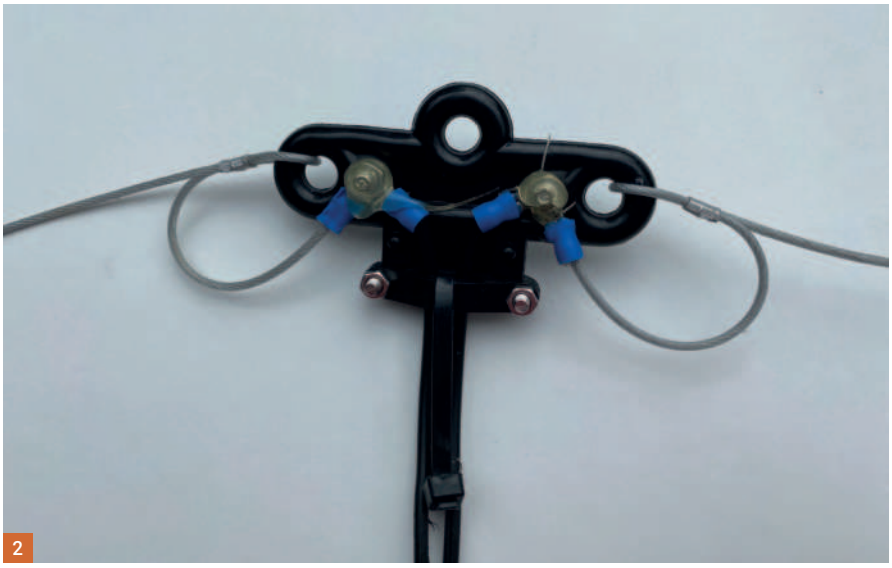
The centre ‘T’ piece can be seen in **Fig. 2**. Although the ‘T’ piece does have a normal clamp on it to secure the 300Ω ladder line, Mark has added additional strain relief in the form of a heavy-duty cable tie.

The ends of the Flexweave wire and the 300Ω ladder line are each terminated in solder spade connections, which are clamped to the fixing bolts (one on top of the other) to make sure of a good connection. Although this may seem obvious, I noted that another manufacturer put the antenna wire and the ladder line connections on opposite sides of the nut and bolt on the ‘T’ piece, which meant that conduction relied solely on the bolt itself.

The other end of the 300Ω ladder line is terminated in an SO239 connector block so that coax terminated with a PL259 plug can easily be attached to it.

The Flexweave antenna wire is secured very neatly to the insulator, **Fig. 3**, using

**Fig. 1: The complete antenna with feeder.**
**Fig. 2: Centre T-piece.**




ferrules. Not only does this provide a robust mechanical joint but it also looks very professional and neat.

I also checked the tightness of the nuts and bolts securing the wires on the 'T' piece. All were very tight.

Before I erected the G5RV, I carefully measured out the two legs of the antenna and also the 300Ω ladder line. Each leg of the antenna was exactly 15.54m long while the ladder line measured 9.3m in length. These are in line with the standard G5RV design measurements. However, it is important to remember that the actual length of the 300Ω ladder line (or balanced feeder) will depend on its velocity factor. Louis Varney designed the antenna so that the balanced feeder/ladder line should always be an electrical half wavelength long on 14.15MHz. The total length of the G5RV is designed to be three half waves on 20m, so the electrical half wavelength of balanced line simply reflects the resistive impedance seen at the centre of the three half-wavelength top to the point where 50Ω coax is connected.

## A Useful Idea

In the past I have used plastic covered stranded copper wire for antennas. Over a period of time I have found that water ingress through capillary action causes tarnishing of the wire near to its end. This tarnishing may with time slowly travel down the wire. However, I have found that by applying hot glue from a glue gun to the ends of the wire this can be prevented.

I therefore decided to do this to the ends of the Flexweave wire on the G5RV.

In addition, I applied a small amount of hot glue to the nuts and bolts securing the Flexweave and ladder line feeder on the 'T' piece. This should prevent the nuts from working loose at any point in the future. It may well be a little 'overkill' because the nuts and bolts were very securely fixed, but I felt it wouldn't do any harm.

Hot glue can also be applied to the top of the SO239 connector block where the 300Ω ladder line enters it via two small holes. If hanging down vertically, it is possible that some ingress of water may enter the block. Alternatively, self-amalgamating tape could be used to weatherproof the assembly.

## The G5RV Design

The G5RV is a very well documented antenna. I have included some links to various websites at the end of this article that discuss it in more detail. It is probably true to say that the G5RV is one of the most popular multiband antennas in use today.

However, it is important to realise that the G5RV does not offer a perfect match to 50Ω on any one frequency and in fact on some it is not even resonant at all.

Louis Varney designed the antenna to be resonant as a three half-wavelength doublet around 14.15MHz. This is the reason why the balanced line section is an electrical half wavelength at this frequency because this gives a resistive impedance being reflected to the bottom of the balanced stub where the coax is connected to it. However, the feed impedance of a three half-wavelength wire is in the region of 90 to 100Ω, depending on the height and configuration of the antenna. Although Louis Varney appears to have optimised his antenna for 20m, the SWR produced on this band is unlikely to be much better than somewhere in the region of 2:1 since the impedance is nearly double 50Ω.

When used on 40m and 80m, the match will not be perfect and will be somewhat reactive.

It is important to say from the outset that the G5RV really does need to be operated with an ATU at the transmit end so that the transmitter 'sees' a 1:1 SWR. On the other hand, the transceiver's own internal ATU may be sufficient to produce a workable SWR inasmuch as the PA 'sees' so that fold back of power does not occur.

It is worth remembering that when Louis Varney devised his antenna, transmitter PA stages were using valves with a pi-tank coupler circuit at their output. This meant that they were generally able to match a wide range of impedances without the need for an ATU.

## Measured Resonances

The comments below could be for any G5RV made to the dimensions of this commercially made one using ladder line of similar velocity factor.

I erected the antenna so that its apex was about 11m high on a tree with one leg going to a pole at 8m in height while the other end was supported such that its end was about 10m high.

I used a RigExpert AA55Zoom analyser (connected via a 1:1 choke balun at the base of the 300Ω ladder line) and did a Frequency vs SWR/Impedance sweep.

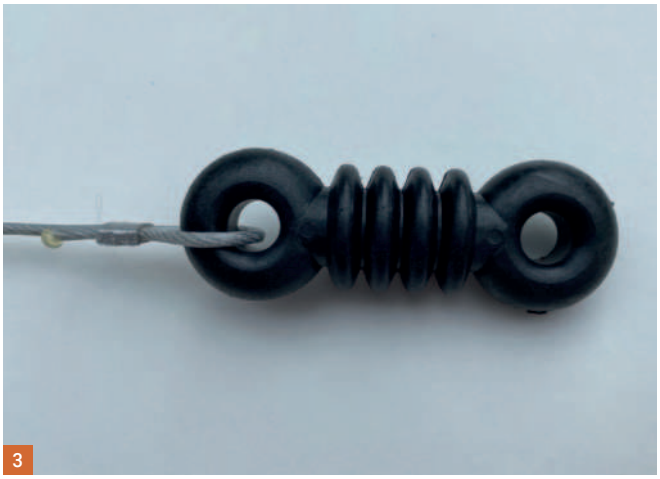
The graph in **Fig. 4** shows the resonances and SWR, while **Table 1** shows the impedances measured at spot frequencies in the amateur bands between 80m and 10m.

The 20m resonance was a little lower than expected at 13.72MHz but it is likely that if the antenna had been erected with a sharper apex angle this may have moved its frequency a little higher into the 20m band.

On 80m, the resonance was near to mid-band at 3.62MHz while on 40m it was some 20kHz outside the 40m band at 6.98MHz. Other resonances occurred at 18.9; 23.6; 30.6 and 51.36MHz.

It must be remembered that these readings will vary somewhat depending on both the height and general layout of the antenna. They are only quoted here as an example as to what I obtained with my own installation.

When I connected up 68ft of 50Ω Ecoflex 10 coax between the base of the matching stub and the transceiver, I found that the in-



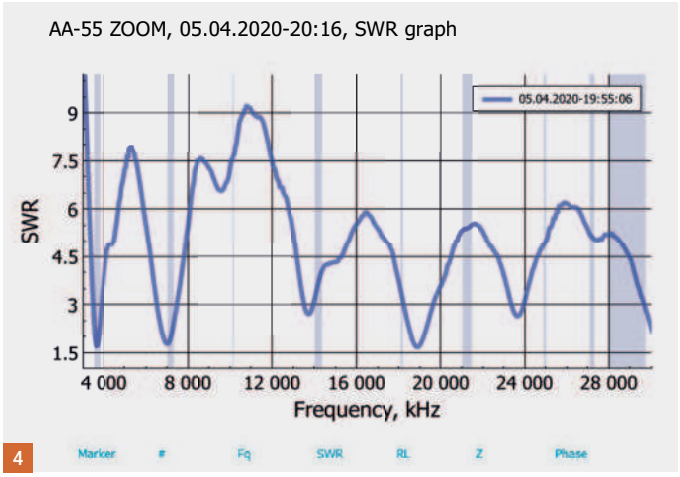



**Fig. 3: End insulator.**
**Fig. 4: SWR/impedance curve vs frequency 3 to 30MHz taken at base of matching stub.**

ternal ATU on my transceiver would match it quite easily on 80, 40, 20 and 15m without any issues and allowed the transceiver to give out the full 100W. However, it is important to remember that the ATU (whether the internal ATU or an external ATU used immediately after the transceiver) is only allowing the PA stage to 'see' a 50Ω ohm resistive load and hence stop the PA stage from folding back the power.

The use of the ATU in this situation does not minimise mismatched line loss on the coax running from the transceiver to the base of the G5RV matching stub.

If I used my DU1500T T-match ATU after the transceiver, I found that it was capable of allowing the transceiver to output the full 100W on every single band between 80m and 10m.

## A More Efficient Option

A more efficient option for all band operation would be to add additional ladder line and bring it into the shack where it can then be matched by a balanced ATU. Louis Varney G5RV did actually discuss this approach in his early description of the antenna.

The impedance presented to an ATU would then depend on the length of the ladder line.

Another option that could be considered would be for the ladder line to be taken to a 1:1 choke balun immediately outside the shack and a short length of coax connected from the choke balun into the shack. The losses on a very short length (say less than 10ft of RG213/UR67)) coax would be negligible. This would certainly offer a better solution than trying to route balanced line into the shack.

## Mismatched Line Loss on Coax Feed

In Table 1 I have listed the impedances (R±jX) at a number of spot frequencies in the amateur bands measured at the base of the matching stub.

R is the resistive component of the impedance while –jX indicates additional capacitive reactance and +jX additional inductive reactance.

I plugged these values into **Dean Straw N6BV's** *Transmission Line for Windows* program to see what the total loss would be (matched and mismatched line loss) when the 300Ω ladder line stub was fed with 15m of RG213/UR76 coax. The total loss on the coax is shown in the Table.

The total loss (matched and mismatched) will be proportional to the frequency, length of coax, type of coax and the load impedance it is connected to.

It is interesting to note the improvement if 15m of LMR600 high quality coax is substituted for the RG213/UR67. This is particularly noticeable on 30, 15, 12 and 10m.

## Balun or no Balun!

I am almost reluctant to get involved in this discussion as the subject of baluns can certainly get 'heated' – no pun intended!

When going from a balanced feed to coax it is generally good practice to use a choke balun so as to suppress common mode current flow on the outer of the outer braid of the coax.

However, if the coax is an odd multiple of physical quarter waves, the outer of the outer of the coax should be at a high impedance (where it connects to the load) assuming the other end of the coax is earthed or at low impedance due to its connection to the transceiver in the shack. If the coax is a physical number of equal quarter waves, then it will show low

| Freq (MHz) | Impedance (R±jX) | RG213/UR67 (loss dB) | LMR600 (Loss dB) |
|---|---|---|---|
| 3.65 | (32.9 + j16.3) | 0.16 | 0.06 |
| 5.27 | (33.3 - j136.7) | 1.55 | 0.71 |
| 7.1 | (29.2 + j19.1) | 0.34 | 0.11 |
| 10.1 | (24.3 - j183.8) | 3.6 | 1.4 |
| 14.15 | (41.3 - j92.3) | 1.07 | 0.47 |
| 18.1 | (10.9 - j19.2) | 1.1 | 0.44 |
| 21.15 | (10.5 - j73.6) | 2.8 | 1.27 |
| 24.9 | (6.74 - j49.4) | 2.9 | 1.22 |
| 28.5 | (3.75 - j19.9) | 3.2 | 1.45 |

**Table 1: Attenuation on coax with 15m of RG213 and 15m LMR600 at different spot frequencies within the amateur bands.**

impedance on the outer of the coax where it connects to the balanced line. This can offer an alternate path to the RF current, such that some may flow down the outer of the outer of the coax. This can result in common mode current flow on the coax.

Common mode current flow on coax can result in EMC issues, RF feedback and increased noise on receive.

In Louis Varney's July 1984 RSGB *RadCom* article titled *The G5RV Multiband Antenna – Up to Date*, he stated that he did tests with and without a balun at the interface of the coax feed and balanced line stub. He found that even without a balun, the currents in both legs of the balanced line were equal except for some unbalance at 28MHz.

I tried the G5RV with both direct feed (plugging the coax directly into the SO239 connector block at the end of the ladder line) and also using a number of different choke baluns, both commercial and homemade. I had no EMC issues, RF feedback or increase in noise in either

**Continued on page 50**

**Heather Parsons**
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# How the RSGB is helping Radio Amateurs to build their experience

**Heather Parsons** provides an update on the latest initiatives to help new and existing amateurs progress in the hobby.

The amateur radio community is diverse and draws together people who enjoy different aspects of this fascinating technical pastime. Its numbers have been boosted significantly in recent months as a result of the Society's 'Get on the air to care' (GOTA2C) campaign, including the introduction of remote invigilation exams. More than a thousand people have passed their Foundation licence and others have been inspired to return to amateur radio after seeing the high-profile coverage of 'Get on the air to care' in the national mainstream media.

All of this is good news and demonstrates that amateur radio is still very much relevant and of interest in our modern world. However, it also means that now, more than ever, the RSGB needs to provide the information, resources and support to enable people to take their next steps in amateur radio. So, what is the Society doing?

## Tonight @ 8

These webinars cover a range of topics and are live-streamed, allowing you to watch the presentations and ask questions online. Topics so far have included: 'Raspberry Pi' by well-known expert **Mike Richards G4WNC**; 'Antennas for small gardens' by RSGB PSC Chair **Steve Nichols G0KYA**; and a very topical explanation of 'How to check for VDSL RFI' by RSGB Board Director and EMC Committee Chair, **John Rogers M0JAV**. The webinars have been watched by people across the world and have been well-received by both new and experienced amateurs, with requests for the initial series to be continued over the coming months:
www.rsgb.org/webinars

## Mentoring new Foundation Licensees

With the Foundation exam practical waived until further notice and interaction with clubs restricted due to Covid-19 regulations, we're aware that the hundreds of people joining amateur radio via remote invigilation exams don't have access to the same local support as previously. We're setting up a group to provide advice and information to new Foundation licensees as well as those returning to amateur radio after a number of years, which will provide a safe environment in which they can ask questions without fear of being ridiculed – no question will be thought too basic or too obvious! As well as being a source of help from a small group of experienced mentors, we hope it will also be a way that these licensees can get to know other radio amateurs while restrictions are still in place.

## Videos

The RSGB *YouTube* channel is a rich and varied source of information for radio amateurs. From RSGB Annual Convention presentations to taster videos about different aspects of amateur radio; vlogs and videos from events and campaigns like YOTA (Youngsters on the Air) events or 'Get on the air to care' to archive footage from amateur radio in past times, there is something for everyone.

Our videos received over 15,000 views last month alone and the Society regularly receives requests from amateur radio societies in other countries to dub our videos into their language. We're also planning some new short videos, so look out for those.

## Awards

The RSGB offers a number of awards for radio amateurs with a range of experience. We also launched a new Youth Award recently that provides a way for young radio amateurs either to gain experience or discover different aspects of the hobby:
www.rsgb.org/awards

## Beyond Exams (BE)

Beyond Exams is a group of resources brought together by the RSGB Learning Team with the aim of encouraging participation and highlighting the diversity of amateur radio. It was launched nationally at the end of April 2020 after a successful pilot of the Club Scheme in Region 13 at the end of 2019, led by RSGB Regional Representative **Mark Burrows 2E0SBM**.

Whether you are just starting out in amateur radio, returning after a break or are an experienced radio amateur looking for a new challenge, the Beyond Exams resources can help you learn about the latest technology or guide you through trying something for the first time:

- **Getting started:** from training and licensing, to setting up and operating your equipment for the first time, it's all covered in our step-by-step online guide
- ***RadCom Basics*:** a bi-monthly digital publication that explores key aspects of amateur radio in a straightforward and accessible way
- **BE Club Scheme:** this is a way to build experience with the help of your local club. As you go through the scheme and complete activities successfully, you will receive certificates to reward your progress
- **BE Individual Scheme:** building experience on your own, this scheme is all about personal development and higher-level awards as you complete activities and gain experience



**Fig. 1: A map showing the locations of clubs accredited for the Beyond Exams scheme.**
**Fig. 2: Front cover of the April RadCom Basics.**

## BE Club Scheme: Building Experience with the help of your Club

The Club Scheme is run through accredited clubs that help you to complete a series of 23 activities, based around five themes. They don't need to be done in order and you can dip your toe in and out as you want.

The themes are: 'Having a go' – using different modes and bands; 'Getting involved'– in other award schemes, contests and special event stations; 'Taking part' – in club activities; 'Making' – something for your shack; and 'Promoting amateur radio' – introduce possible newcomers to your local club.

As you complete activities, the club will provide Bronze (three activities), Silver (five activities), Gold (ten activities), Platinum (15 activities) and Diamond (23 activities) awards.

Each of the five categories has interesting tasks to try, which range from the simple to the more challenging. More experienced club members can give advice and it is a great way of sharing knowledge or trying something together – for example, why not try a kit as a club construction project as an activity within the 'Making' theme?

All RSGB-affiliated clubs are invited to become a BE Accredited Club as a benefit of affiliation. The registration process has been made as easy as possible and there is no charge.

The club needs to commit to delivering a varying programme of events and activities. It will also need to choose a Club Champion who can collate and monitor each participant's progress, give out certificates and be the contact for the BE team: www.rsgb.org/be-club-scheme

## BE Individual Scheme: building experience independently

The RSGB Individual Scheme was designed to encourage further experimentation and exploration. It is primarily aimed at those already established in the hobby but it can also be used by groups of radio amateurs who prefer to work together and share their knowledge among friends, or even by clubs to add new structure to meetings and projects.

The Individual Scheme has 150 activities based around nine themes, but they are different from those in the Club Scheme. Some of these activities might be more involved or take a little longer to accomplish, but the emphasis is to always have fun.

The areas covered include general operating; using digital, image and satellite modes; collecting awards; contesting and radio sport (e.g. ARDF); non-contest activities; promoting amateur radio; making; tinkering and experimenting through to research.

One example of the Individual Scheme tasks is to operate Maritime Mobile – this can only be achieved by Full licensees, but to encourage a Foundation licence holder there is an option to operate from an inland waterway.

To achieve the latter, a small group could hire a boat on the local canal and have a day playing radio with the skipper's permission.

Awards (Basic through to Gold) are self-managed using a downloadable spreadsheet that automatically tracks achievements. There aren't any time limits for the completion of the scheme and it is free of charge to take part: www.rsgb.org/be-individual-scheme

The Society is grateful to **Derek Hughes G7LFC** for the current details of the Club Scheme and to **Alan Messenger G0TLK** for those in the Individual Scheme. Both have kindly given the schemes to the RSGB to use and develop over the coming months and years.

If you have any questions contact the RSGB Beyond Exams Coordinator **Chris Colclough G1VDP**: be.coordinator@rsgb.org.uk

## Fulfilling the Society's Strategy

This is just a taste of what the RSGB is doing to fulfil its strategic goal to have an active and thriving amateur radio community by 2022 – the end of its current five-year strategy. The Society's values and priorities include supporting and encouraging active participation in amateur radio as well as enabling people to enjoy learning about and using wireless communications.

All of the activities above support these values and priorities and we hope that, whether you're a new radio amateur, you're returning to it, or you're simply looking to try something new within this diverse pastime, there is something for you.

Our website holds more details about these and our other activities so take a look and discover something new… www.rsgb.org

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

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## AnyTone


Qixiang Electron Science Technology Co.Ltd. is a high-tech company with more than 25 years built-up experience of research, production and sales in the wireless communication equipment industry. There main products include Digital and Analog Portable Radio/Mobile Radio/Repeater and System, 3G/4G POC Radio and System, CB Radios, Marine Radios, GSM/CDMA/DCS/PCS/3G Repeater and other wireless communication devices and industry application solutions.

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## VGC


Vero Global Communications compant is a science and technology enterprise in Fujian Province, specializing in R&D, production and sales of electronic products and accessories such as radio communication equipment, alarms, radio frequency smart cards, and GPS equipment.

### Mobile Transceiver

**VR-N7500** is a brand new 50 watt VHF 40 watt UHF Headless mobile transceiver with a solid build quality. It is very different in design compared to any other radio used mobile or base The VR-N7500 uses a smartphone as a control panel and the body is installed in the boot or similar with the mobile phone connected to the body through Bluetooth. The cars hands-free intercom can be utilised through the vehicle Bluetooth and PTT is by th esupplied Bluetooth PTT ..... **£189.95**

## BAOFENG


Started in 2001,Baofeng has always been aiming at creating user value and innovating products. From the first small factory of more than 30 people, Baofeng has deveoped into a high-tech enterprise specializing in R&D, production,sales and after-sales service of handheld wireless walkie-talkies as well as accessories.

### NEW JUST IN

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## SenHaiX


SenHaiX was estabished in 2012 and is in located in the located in the hometown of two way radio Quanzhou city, Fujian Province, China. The company is a high-tech enterprise specialising in radio communications R&D, manufacture of two way communications and accessories.

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## Inrico

Inrico Electronics is a high-tech enterprise which focuses on the design, construction, production and sales of radio communication equipment.

### Mobile POC Network Radio

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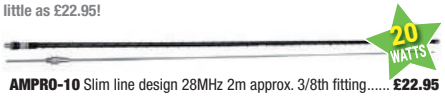


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# Icom Automatic Antenna Switch

**Peter Edwards GW8ARR** describes an automatic antenna switch for an IC-7300 but which can be modified to work with other transceivers too.

**Peter Edwards GW8ARR**
GW8ARR@msn.com

On some Icom transceivers such as the IC-7300 there is only one antenna socket yet the transceiver covers HF and VHF bands. Therefore, to utilise all bands it is desirable to have different antennas for HF and VHF.

The option then is as follows:

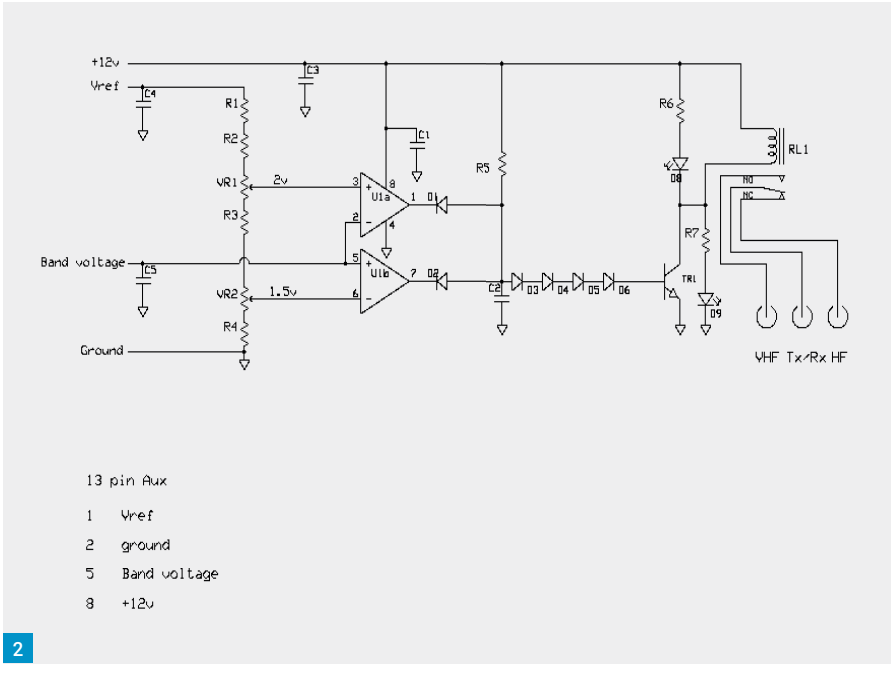
1. Switch the antennas using a manual co-axial switch.
2. Unplug the HF antenna cable and plug in the VHF antenna.

Either solution is not very satisfactory as it is possible to connect the wrong antenna or no antenna at all!

## Solution

An easy solution is available by using the auxiliary output socket. This is a 13-pin DIN socket in the cases of the IC-7300 and IC-706. The following description refers to the pin connections on the IC-7300 and IC-706.

The socket has a pin that changes dependent upon what frequency band is selected. Also available is a reference voltage and conveniently a 12V pin. On other Icom models there are two auxiliary sockets but the principle remains the same and it would be necessary to refer to the model's manual for the pin outs.

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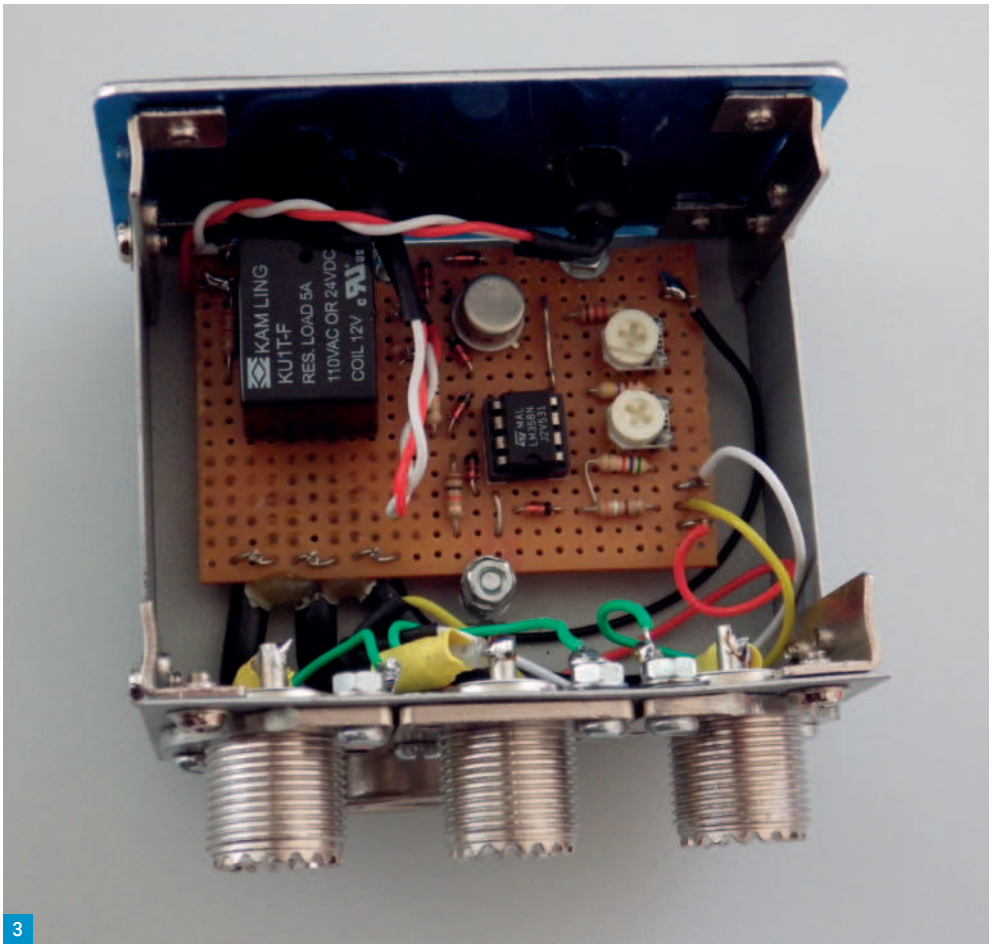


3

| Band | Voltage |
|---|---|
| 160 | 7.38 |
| 80 | 6.05 |
| 60 | 5.05 |
| 40 | 5.05 |
| 30 | 0.03 |
| 20 | 4.05 |
| 17 | 3.17 |
| 15 | 3.17 |
| 12 | 2.21 |
| 10 | 2.21 |
| 6 | 1.87 |
| 4 | 1.87 |

**Band voltage Auxiliary Socket Pin 5**

T1

| | |
|---|---|
| C1-5 | 0.1µF |
| D1-6 | 1N4148 |
| D8 | red LED |
| D9 | green LED |
| R1 | 270Ω |
| R2 | 5.6kΩ |
| R3 | 470Ω |
| R4 | 1.2kΩ |
| R5 | 10kΩ |
| R6 | 4.7kΩ |
| R7 | 2.7kΩ |
| RL1 | |
| TR1 | 2N3053 |
| U1 | LM358 |
| VR1 | 500Ω |
| VR2 | 500Ω |

T2

In the case of the IC-7300/706 they are:
- Pin 1 8V regulated
- Pin 5 Band voltage (varies with band selected) 0-8V
- Pin 8 13.4V

The reference voltage on the auxiliary socket (Pin 1) was measured as 7.9V.

IMPORTANT: It should be noted that the maximum current the regulated output pin 1 can supply is 10mA, therefore the resistor divider chain should be much greater than 800Ω. In the author's case a total resistance of 8.5kΩ was used, therefore only drawing 0.9mA from the reference supply. Very little current is required at the inputs to the comparators; therefore the resistor chain should be of a high value so as not to draw much current from pin 1.

The Band Selection voltage (pin 5) was measured and is shown in **Table 1**.

To select a VHF antenna it is necessary to detect a voltage between 1.87-2.21V and operate a relay for antenna switching. Other limited band antennas can be selected using different voltages as is explained later.

A voltage comparator operating over a 'window' of voltages is used and the range selected to be 1.5-2.0V.

The selection of 6 or 4m will send a voltage of 1.87V, which is within the 'window' and will operate the relay and connect a suitable VHF antenna to the transceiver.

Selecting any of the HF bands will send a voltage out of the range of the window comparator and will disable the relay, therefore connecting the HF antenna to the transceiver.

The window comparator detects input voltage levels that are within a specific band or window of voltages.

One voltage level triggers an op-amp comparator on detection of an upper voltage threshold, and one which triggers an op-amp comparator on detection of a lower voltage threshold level. The voltage levels between these two upper and lower reference voltages is called the 'window', hence its name.

The circuit presented here, **Fig. 2**, is not meant to be followed exactly and is shown to represent one solution. All components, listed in **Table 2**, were from the junk box. The IC used was a LM358 dual op-amp but any op-amp(s) could be used dependent upon what is available.

Transistor TR1 used was a 2N3053 because that was available and the only constraint is it should be capable of switching the relay coil current. Overall, the components are non-critical and this is the principle that the author wishes to impart.

## Circuit Description

Resistors R1-4 and VR1 & 2 form a resistor divider chain and have been scaled to allow VR1 & 2 to select the required voltage for a VHF antenna.

The lower comparator is set to 1.5V at pin 6 and the upper comparator set to 2V at pin 3.

This becomes the 'window' and will switch to HIGH between the voltages (1.5-2V). Setting the voltages on pins 3 & 6 is the only setup required.

D1 & D2 form an AND gate with the truth table shown in **Table 3**.

**Fig. 1: The completed unit.**
**Fig. 2: Circuit diagram.**
**Fig. 3: An inside view.**
**Table 1: Measured voltages by band (IC-7300).**
**Table 2: Icom Automatic Antenna Switch component list.**

**Fig. 4: Seen from a different angle.**
**Fig. 5: Block diagram of an alternative approach.**
**Fig. 6: Breakout box wiring.**
**Fig. 7: The author's completed breakout box.**
**Table 3: Truth Table**

In the 'real' world the output does not go down to 0V due to the forward voltage on the diodes and the output transistors within the chip. The voltage drops to ~2.8V, which would not be enough to switch TR1 off at any state. The inclusion of diodes D3-6 'loses' that voltage due to a 0.7V forward voltage drop across each diode.

When TR1 switches, relay RL1 operates switching the antenna to the VHF position. LED D8 illuminates indicating the VHF antenna has been selected with current supplied through R6 and TR1. Any other band would switch TR1 off and the relay switches back to the HF antenna position. LED D9 illuminates with current supplied through RL1 coil and R7.

Some views of my completed box can be seen at **Figs. 1**, **3** and **4**.

## Further Expansion

The principle can be expanded into selecting any range of antennas available. Many people have dedicated antennas for 20-10m and others for the lower bands.

The block diagram, **Fig. 5**, shows another version (not built by the author) but could be used to select dedicated LF/HF & VHF antennas.

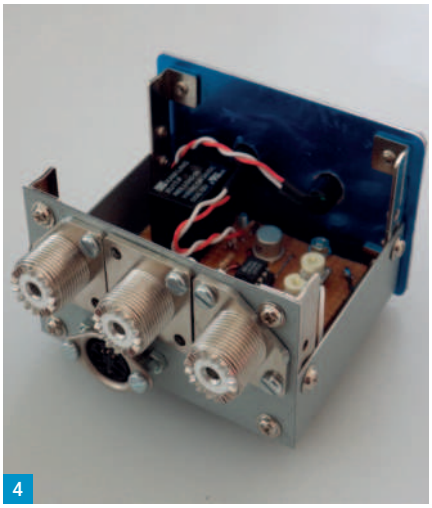
## Auxiliary Socket Expansion Box

Some of the Icom transceivers have a 13-pin DIN socket while others have two auxiliary sockets. The 13-pin DIN plugs are becoming difficult to obtain and very difficult to connect.

With the idea of making the automatic antenna switch it occurred to the author that a breakout box with access to all pins on the auxiliary would be useful. By doing so full access is easy to all the operational functions, **Fig. 6**. So, for example:

Pin

1. a reference voltage (10mA max) for use on the automatic antenna switch
3. foot switch operation of the PTT
5. band change voltage also used in the antenna switch
8. +12V (1A max) for use on external items
11. modulator input from digital mode interface to transceiver
12. fixed audio output for digital mode interface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7

| A | B | Output |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 1 | 1 |

T3

In the author's case, the wires from the 13-pin DIN plug were extended and run into a terminal strip within the box. Wires connect from the terminal strip to RCA phono sockets.

The box allows easy access to all functions.

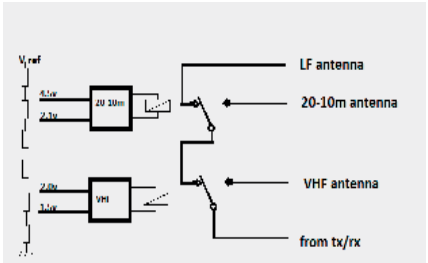
Decoupling capacitors were applied to all phone sockets (0.1µF).

Fuses were inserted in pins 1 & 8.

Pin 1 contained a 20mA fuse although the maximum output current is rated at 10mA only but the author inserted the lowest rating fuse available. This should be better than no protection at all.

Pin 8 a 250mA fuse was fitted as many extras only require low currents therefore a 250mA fuse should be more than adequate.

My completed breakout box is shown at **Fig. 7**.



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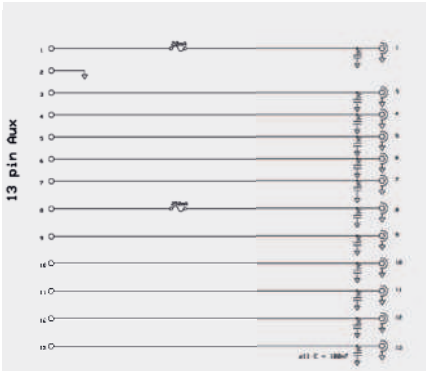

6

## Window Comparator Circuit

When VIN is below the lower voltage level, the output will be LOW. When VIN exceeds the lower voltage level, the first op-amp comparator detects this and switches the output HIGH to Vcc.

As VIN continues to increase it passes the upper voltage level, the second op-amp comparator detects this and switches the output back LOW. Then the difference between VREF(UPPER) and VREF(LOWER) creates the switching window for the positive going signal.

As VIN decreases it passes the upper voltage level VREF(UPPER) of the second op-amp comparator, which switches the output HIGH. As VIN continues to decrease it passes the lower voltage level, VREF(LOWER) of the first op-amp comparator once again switching the output LOW.

Then the difference between VREF(UPPER) and VREF(LOWER) creates the window for the negative going signal. So, we can see that as VIN passes above or passes below the upper and lower reference levels set by the two op-amp comparators, the output signal VOUT will be HIGH or LOW.

As a result, the window width can be customised for a given application.

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# Data Mode Basics

**Mike Richards G4WNC**
practicalwireless@warnersgroup.co.uk

**Mike Richards G4WNC** goes back to basics, with a 'from the ground-up' explanation of data modes.

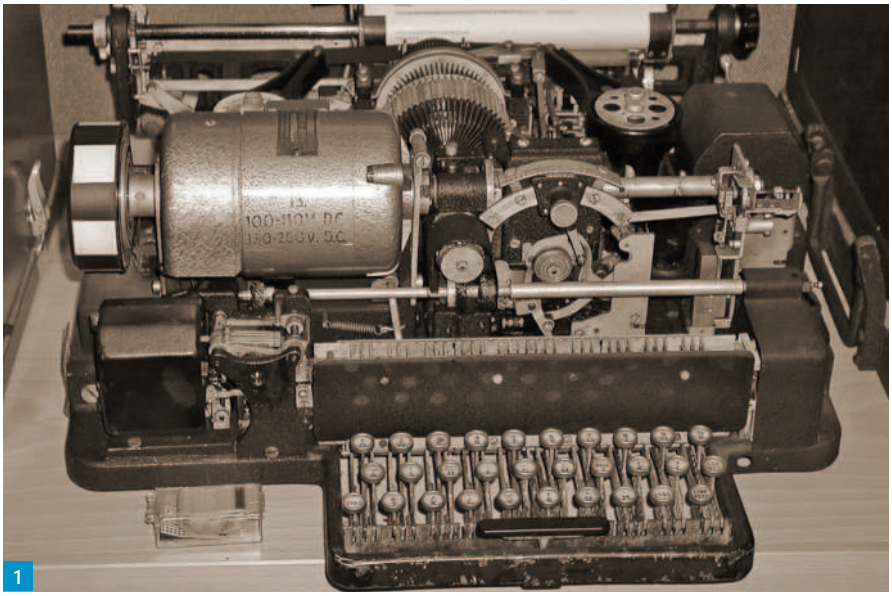
During the Covid-19 lockdown the number of radio enthusiasts taking the amateur radio licence exam has increased dramatically and over 1000 new licences have been granted. As a result, I think it's appropriate to revisit some of the basics of Data Modes operation to encourage new licensees to have a go with data.

## Data Modes: What are They?

That's probably the first question from those that are new to the hobby. Quite simply, the data modes are non-voice communications. That can range from keyboard-to-keyboard contact, through to packet radio-based e-mail and position reporting to digital slow scan television. That covers a very wide range, but one common exclusion is Morse code. While some operators use computer programs to help send and receive Morse, the bulk of operators rely on hand-sent Morse and reception through their ear-brain combination. This makes Morse something of an artform and there are some highly skilled operators out there. Watching an expert Morse operator at work is extraordinary because the translation process from dots and dashes to plain text becomes instinctive – a bit like driving a car. Because Morse is very much based around operator skills, it is not usually considered to be a data mode.

## Simple Data Modes

I'll start by looking at some of the origins of data mode radio signals as this will help you better understand the terms and techniques employed with the current data modes systems. The most popular early data mode was Radio TeleTYpe, which is abbreviated to RTTY. Early implementations of this mode used electromechanical teleprinters, **Fig. 1**. These were large and noisy typewriter-like machines, that converted each typed character into a series of electrical pulses that swung between ±80 volts. In commercial systems, such as the UK Telex network, these signals were passed over telephone lines to the distant terminal. For the system to achieve widespread use, a standard code was required that defined the sequence of pulses to be sent for each typed character. In data modes systems, these code tables are known as alphabets and most RTTY networks used the International Telegraph Alphabet No.



1

2 (ITA-2). In this system, each keyboard character has a unique 5-pulse (also called or 5-bit) code assigned to it. I've shown an example of the letter A in **Fig. 2** and, in **Table 1**, I've shown a selection of letters.

Those of you familiar with binary numbering will have spotted that a 5-unit code only has 32 unique combinations available, **Fig. 3**. While that comfortably covers the 26 letters of the alphabet, it doesn't leave enough codes to handle numbers, punctuation, new lines, etc. The solution was to employ a shift key. Much like the shift key on your computer, it lets you reuse the same keys (or codes) for a different set of characters. The two shift states are known as figures and letters (often abbreviated to Figs and Lets). The shift key acts as a toggle to switch between the two states, i.e. press shift once to switch to Figs and press shift again to switch back to Lets. While the shift character was essential to allow the use of a full range of characters, it also introduced a weakness. When using RTTY over poor quality links, the loss of a shift character would turn the remaining message into gibberish. This is because the keyboard would be temporarily stuck in Figs or Lets mode. In later, computer-based systems, a common fix was to use what's known

| | Bits | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| A= | 1 | 1 | 0 | 0 | 0 |

2

| | Decimal weighting | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 4 | 8 | 16 |
| 0 = | 0 | 0 | 0 | 0 | 0 |
| 31 = | 1 | 1 | 1 | 1 | 1 |

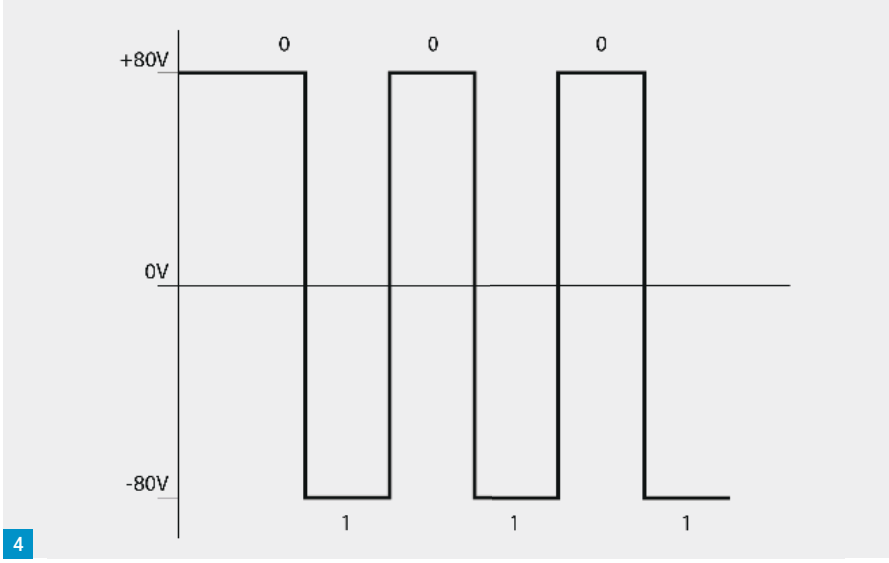
3

as 'unshift on space (USOS)'. When USOS is activated, the computer automatically reverts to letter shift after a space has been received. While not perfect, it does provide a useful solution that works well for plain text messages.

## Serial Data

The development of RTTY has shown the value of a standard telegraph alphabet to allow widespread adoption of a data mode. The other fundamental principle that comes from the early RTTY and Morse communication systems is the use of serial data. While the telegraph alphabets

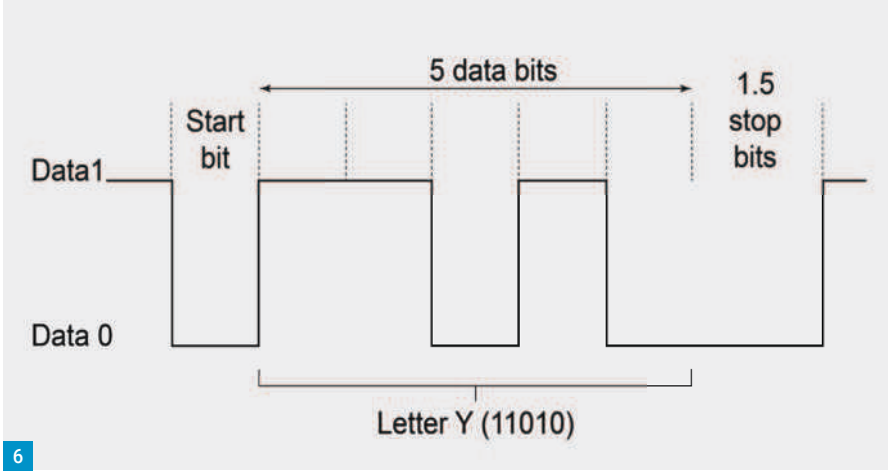
**Fig. 1: Photo of an old teleprinter (Courtesy of RSGB). Fig. 2 - Illustration of the translation of the letter A into data bits. Fig. 3: Simple table to illustrate the range of combinations available from a 5-bit code. Fig. 4: How ±80 volts was used to send teleprinter signals.**




give us the vital codes for each character, how are we to send them over a phone line or radio link? The answer is one pulse at a time, much the same as Morse code is sent one element at a time. This technique of sending signals is commonly known as serial data and is used for virtually all data modes signals. In fact, serial data is just about the most common way to send digital information and is used to handle most of today's communications systems from mobile phones to the internet!

Let's look a little more closely at the serial data used for RTTY as this will illustrate some important characteristics of serial data. Telegraph alphabets and all other codes utilise binary numbers. This is common to all digital systems and comes from the fact that most electronic systems have just two states, on or off. Much in the same way that the Morse signal turns the transmitter on or off. Going back to our teleprinter example, when used for landline links, the teleprinters used ±80 volts for signalling where −80V represented a 1 or on and +80V was used for 0 or off, **Fig. 4**. You may wonder why they used opposite polarity instead of a disconnection to represent 0 or off. The + voltage was used to provide a clear indication of 0 or off, whereas relying on no signal became ambiguous on long routes when the signals were very weak. Using ±80 volts gave a significant increase in usable range. There was also a safety factor involved because using higher voltages would have put phone company staff at risk of electrocution while working on the lines. Having worked on the UK Telex network in my early days with BT, I can tell you that a


5




6

**Fig. 5: Frequency shift keying as used for amateur RTTY. Fig. 6: Construction of a RTTY character complete with start and stop bits.**

pulsing ±80V shock was unpleasant but survivable whereas holding on to a steady 160V DC can kill!

While we can see how DC signalling would work with landlines, what about radio links? The solution here was to use two closely spaced radio frequencies to represent 1 and 0 respectively, **Fig. 5**. Typical spacings for commercial signals would be 400Hz or 850Hz, while amateur radio operators settled on 170Hz as the standard. This type of modulation is classified as Frequency Shift Keying or FSK and is still in widespread use today.

## Data Synchronisation

Having seen how a keypress can be turned into a digital code that can be sent bit by bit using serial data, we need to look at transmission speed and the way each keypress is prepared for transmission.

One of the problems facing all digital communications systems is how to keep the receiving and transmitting equipment in synchronisation. In the case of a RTTY link, if we sent a string of 5-bit characters one after the other, the receiving station would be fine initially, but what if there was a short break in the transmission? The receiver would immediately lose synchronisation and could easily start receiving again part-way through a character.

This is because the receiving station would have no way of knowing where one character finished and the next began. The result could be garbage for the rest of the transmission, which would be unacceptable.

The solution developed for RTTY was to wrap each character inside some additional control characters, **Fig. 6**. The first is known as a start bit and this is a single bit added to the front of each character. This is matched by another pulse which is 1.5 bits long that marks the end of a character. By wrapping each character using this technique, the receive teleprinter can re-synchronise by looking out for the sequence 1 start bit, 5 data bits and 1.5 stop bits.

Once the sequence has been identified the teleprinter can be confident that what follows is the start of a new character. This fast synchronisation is one of the reasons that RTTY survives to this day as a popular contest mode. This type of, character-based, synchronisation is known as asynchronous transmission and works well for hand-typed situations where there are variable gaps between the sending of each character. However, the technique of adding a unique synchronisation pattern within the data is also used in many modern digital systems.

## Data Speed

The final characteristic of our teleprinter signal is the transmission speed, i.e. the rate at which the individual bits are sent. The first point to note is that all data modes need an agreed set of standard speeds. If you've been paying attention, you will note that each RTTY character requires the transmission of 7.5 pulses of which 5 are the character data and 2.5 are extra elements that were added to aid synchronisation.

The additional 2.5 data bits are known as redundant bits because they don't carry any useful information but are required to support the RTTY protocol. Most modern data systems include some form of redundancy.

When we look at the speed of a RTTY signal we are concerned with the time allocated for each pulse or data bit, including the start and stop bits. These individual elements of a data signal are called symbols. In the UK Telex network, the time allocated to each data bit or symbol was 20ms which resulted in a symbol rate of 50 per second, which is more commonly known as 50 baud. The naming comes from **Emile Baudot**, a French telegraph engineer and inventor. It was Emile that developed and patented the first 5-bit code, Baudot code, for telegraphy back in 1874. In the US, the individual data bit time was 22ms, which works out as 45.45 baud rate. Due to their being many more active RTTY operators in the US, 45.45 baud has been adopted as the international standard for amateur RTTY.

| Letters | Figures | ITA2 5-bit code |
|---|---|---|
| A | - | 11000 |
| B | ? | 10011 |
| C | : | 01110 |
| D | $ | 10010 |
| E | 3 | 10000 |
| F | ! | 10110 |
| G | & | 01011 |
| H | # | 00101 |

**Table 1: Sample of ITA No 2 codes.**

## Summary

This first part of my explanation of data modes has introduced you to a few terms that apply to most of the data modes that I'll go on to explore next month.

Here's a quick summary:

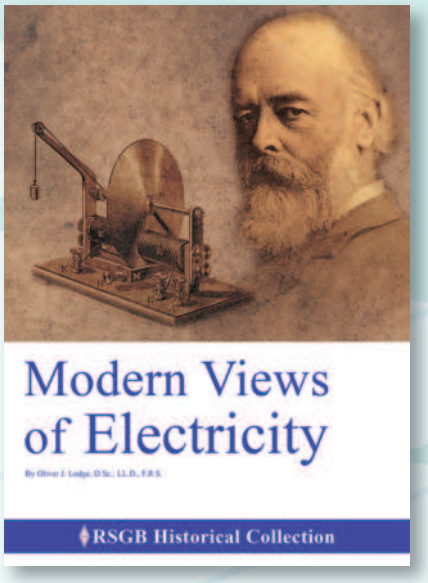
- Telegraph Alphabets – Tables used to convert a letter or keypress into a digital code.
- Serial Data – Sending digital information one bit at a time.
- Redundancy – Additional bits added to the serial data to provide protection or synchronisation.
- Baud rate – The number of symbols per second, including the redundancy bits.

# RSGB BOOKSHOP

**Always the best Amateur Radio books and more**

## Modern Views of Electricity

By Oliver J. Lodge, D.Sc., LL.D., F.R.S.




When Oliver Lodge started working with electricity, he was following in the footsteps of Heinrich Hertz who had produced and detected electric waves. He identified electromagnetic radiation independent of Hertz's proof and, demonstrated an early radio wave detector he named the "coherer". This great British physicist and writer was involved in the development of, and holder of key patents for, radio. In 1925 he also became the President of the Radio Society of Great Britain (RSGB).

This 1889 book, originally published by MacMillan, was authored when the understanding of electricity was still evolving, and had not yet begun to be explained in the terms that are well established today. Republished today by the RSGB it provides a unique insight into the world of electricity as it was seen in the Victorian age. Broken into four sections and fifteen chapters you will find Lodge's 19th century views of Electrostatics, Conduction, Magnetism and Radiation. There is discussion of how they were producing currents, thoughts on the conduction of gases, the structure of magnetic fields, the relation of magnetism to electricity and even the relation of ether to electricity.

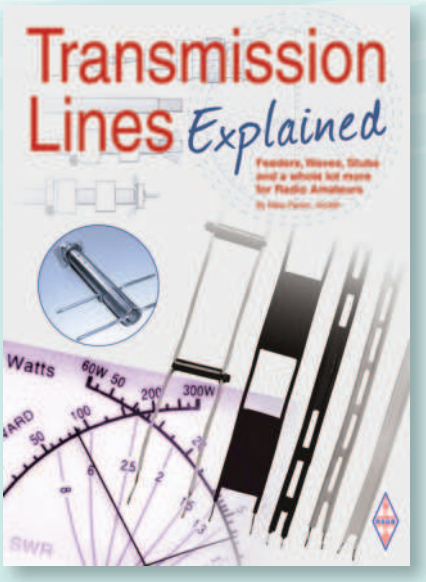
Published as part of the RSGB Historical book collection, *Modern Views of Electricity* provides a fascinating look back at the developing years of electricity and radio as it was perceived over a century ago.

**Size: 174x240mm, 256 pages. ISBN: 9781 9101 9388 4**
**Price £12.99**

## Transmission Lines Explained

*Feeders, Waves, Stubs and a whole lot more for Radio Amateurs*

By Mike Parkin, G0JMI




Getting the signal from your radio to the antenna is a vital component of any radio setup but few understand the full impact their feeder is having. This is where *Transmission Lines Explained* steps in providing through descriptions and techniques rather than mathematics the theory involved.

The aim of this book has been to provide an understanding of the theory, operation and use of transmission lines where twin-line cable or coaxial cables are used, not only as antenna feeder cables, but also as a basis for the matching arrangement between a line and its load. Broken down into logical sections *Transmission Lines Explained* covers twin-line and coaxial cable transmission line types, including examples of how transmission lines can be constructed to suit particular applications. Techniques are included to summarise how coaxial cables can be fitted with connectors, including BNC, N and PL259 types. There is a section covering the use of the Smith Chart where the effect of a mismatched load on a transmission line is described through several practical examples.

*Transmission Lines Explained* is the ideal compilation of techniques, descriptions and examples, giving an understanding of the concepts associated with transmission lines.

**Size: 174x240mm, 136 pages. ISBN: 9781 9101 9387 7**
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E&OE (All prices displayed plus p&p)

**Tim Kirby**
longworthtim@gmail.com

# More news from Cape Verde

**Tim Kirby G4VXE** reflects on making duplicate QSOs and has more exciting news about D4VHF.

The D4VHF group, not content with setting record-breaking contacts on 144 and 432MHz have been looking at improving their 50 and 70MHz setups. A recent tweet from the team (**@d4c_Team**) shows a picture of a dual-band amplifier made by Italab for both 6 and 4m ready for installation at the site.

## FT8 and Duplicate QSOs

**Malcolm Appleby G3ZNU** wrote, *"I started wondering how soon after a rubber-stamp FT8 contact should I consider working the same station again? I had JTAlert set up to let me know if they were in my log and when the last QSO was so I could make a judgement before calling. The rule of thumb that I then adopted was that if I'd not worked a station this year, it was fair game to call them again. Despite this I did get one station that I called reply with* "DO NO DUPE" *(I won't say the callsign). I looked back in the log and found I had worked the station in May 2019, hardly recently! What do you think is fair game for a repeat QSO – outside a contest of course?"*

It's a good question. Like Malcolm, I have noticed some stations, particularly on 6m, that have configured their FT8 programs not to work duplicates. On the face of it, we'd probably all agree that you shouldn't call a DX station each time you hear them, on the basis that you might be preventing someone else, who's not yet worked the DX, from making contact. You can hardly argue with that.

Sometimes, though, you might hear a station you've worked before, calling CQ with no-one going back to them. My reaction would be to give them a call, off their frequency, which, if someone else calls, they can easily ignore, but if no-one else calls, they will know the band is open still and in what direction. FT8 QSOs hardly take long to complete, so why wouldn't you make that QSO?

Another scenario presented itself at **GW4VXE** the other evening. A few weeks back, I had a scratchy QSO with a DX station in South America. It was just about complete but not the cleanest of contacts. Then, a few days ago, I heard the station again, very strongly and I thought – I can have a nice quick fire QSO with them. Despite the station hearing me well (I know, through the PSK Reporter website) they refused to work a duplicate. Well, I suppose at least I found out that they considered the previous QSO complete!

In answer to Malcolm's question – I'm not in favour of 'No Dupe' settings on FT8. On VHF/UHF, I tend to feel that each opening is a separate event. If I have one or many QSOs in the log with a particular station and I see them working a pile-up, I'd leave them to it. But if things slacken for them – why not log a contact quickly? On 2m and up, I'd be even more liberal, feeling that each day is a separate event as far as propagation is concerned.

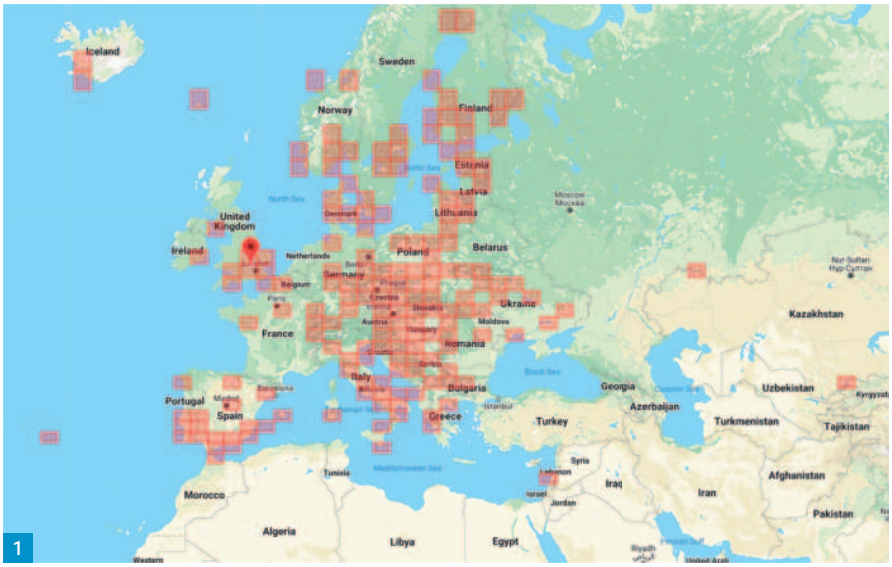


**Fig. 1: Plot of squares worked during June on 6m from Malcolm G3ZNU.**

## The 6m Band

A very welcome e-mail from **Steve PJ4D**X who wrote, *"I put up an antenna for 6m and started on the band for the first time ever at the beginning of May. Up it went on a 20ft scaffold pole attached to a fence post by loose cable ties to allow for Armstrong rotation.*

*"I have an Acom 1500 amp, which gives me 1kW output on 6m. The first day I put the antenna up I had S9+20dB each way QSOs with several stations in northern Brazil. After a day or two the band was dead to everywhere so I realised I just got lucky when I first put up the antenna. I managed to work a few more semi-local stations around the Caribbean and into the eastern US states but on many days, I was just listening to white noise.*

*"Then, on May 29th, the band opened into Europe. I'd like to thank my neighbour* ***Bert PJ4KY****, who alerted me to the opening. I worked ON, EI, EA, OK, G, LY, S5, HB9, I, DL, F and EA8. The one and only UK station was* ***Martin M0BCT*** *in Suffolk and best DX was LY3W at over 9000km. At one point I heard 'Five Bravo Four...' and investigation revealed this was almost certainly* ***Norman 5B4AIF*** *at over 10,200km though no QSO resulted. Not bad going with a 2-element at 20 feet! So far, I have worked 32 DXCC entities on 6m. All of those are on SSB. I do not use FT8 or any other data mode.*

*"There are two other stations in Bonaire active on 6m:* ***Peter PJ4NX*** *and* ***Gerard PJ4GR.*** *Both run 100W to verticals; both have worked into Europe several times this season using FT8.*

*"Since that big opening on May 29th 6m has been largely dead for me: There was one exception: I did hear* ***Peter G8BCG*** *calling CQ on 50.110 SSB one day, though rather weak. I called him with 100W to no avail and during the three minutes it takes for the linear to warm up either we lost propagation or Peter QSYed!"*

**Pete Walker G4RRM** (Crewe) had an amazing QSO on July 2nd, when he worked PV8DX (FJ92) on FT8, using 50W to a V-2000 vertical! In an e-mail to Pete from **Paulo PV8DX**, Paulo said that in 20 years on the band he could not remember such a strong opening into Europe.

**Dave Hobro G4IDF** (Worcester) wrote, "*a short dabble in the 6m Trophy contest produced two new countries and three new squares. IZ7ECL (JN81) for a new square and E7TT (JN92) and Z3A (KN11) both new countries and squares'.*

**Kevin Hewitt ZB2GI** (Gibraltar) says that lockdown has been easing and it is now possible to operate portable from the top of the rock again. Kev has been very active on 6m and has been heard often and at good strength at GW4VXE! Over the month, Kevin has made over 300 QSOs on FT8. He caught an excellent opening into the USA on June 8th, working around 30 stations in the US and Canada. Next day on the 9th, Kev worked another 30 or so US/Canadian stations.

On June 13th, Kev found another good opening, working N5RP (EM57) as well as many other North Americans. Kev was running an FT-450 into a whip antenna – so these are stunning results! From the top of the Rock running 60W to a 3 element Yagi, Kev worked many more contacts, including 9K2OD. He did not neglect SSB and was able to make 28 QSOs on the mode from the top of the Rock.

**Jef VanRaepenbusch ON8NT** (Aalter) listed some nice DX on the band, including EA8ACW (IL28), WP4G (FK68), EA9ACB(IM75), ZB2GI (IM76), CN8LI (IM63), 7X2KF (JM06) and EA8JK (IL18)

**Phil Oakley G0BVD** (Great Torrington) has had a great month on the band and says he's worked his best ever DX on 6m, five new countries, seven new US states, four new US counties and 12 new squares. Phil uses a 2-element Hexbeam at 24ft. Highlights of Phil's log include W5IF (EM14), ZA/IZ7PMQ, FG8OJ (FK96), J69DS (FK94), JH8HQA (QN03), JA5EXW (PM63), HI3T (FK49) and KP4TG (FK68).

**John Hemming G0UYT** enjoyed the July 2nd opening, working PV8DX (FJ92) on FT8 and both WP2B (FK77) and PZ5RA (GJ25) on FT4. John runs 75W to an HB9CV.

**Peter Taylor G8BCG** (Liskeard) sent a quick report and says that the highlights of the month were working two new DXCC entities on the band: 3W1T (#259) and RD9D #260), both on June 13th. Peter saw a decode from a KL7 station on June 21st – but only a single period. On July 1st, Peter mentions that **Nigel G3TXF** worked VK8AW. On July 3rd, Peter worked KG6DX (Guam) and says that JA openings continue almost daily as do those to North America and the Caribbean. Peter says that he tries not to neglect the SSB and CW portions of the band – some North American openings have seen plenty of SSB activity but very little on CW. Peter also mentions that **Paul Pasquet G4RRA** left his gear monitoring in the early morning of July 10th and noticed an opening to Japan and Korea around 0300UTC.

Malcolm G3ZNU writes, "*Our local club, Chesham & District Amateur Radio Society (CDARS) has just started an 'Air Miles' challenge. Members are asked to send in their logs each month and they're compiled to see the total distances worked, numbers of QSOs, average distance of QSO, by band and by mode. Contest QSOs were excluded. As June started, with the Es season well underway I decided to stick to 6m and 10m*

*"By the end of June, I'd worked 347 stations in 176 squares on 6m,* **Fig. 1***, virtually all on FT8. Not bad for one month's operating. Nothing particularly exotic due to my modest setup, and it was frustrating to hear many UK stations working into the USA over my head. I had several decodes from the US and worked one, but there were clearly many stronger signals than mine, and I probably missed the really big openings. I was pleased to work two stations in Kazakhstan, six during an opening to Iceland, and two in Gibraltar, including Kevin ZB2GI".*

**Colin Fawcett G8YIG** (Stalybridge) took part in the RSGB 50MHz contest on July 9th and worked 14 stations with the highlights being G3TXF (IO71), and GW4SHF (IO82). Colin uses a homebrew rotary dipole for 4/6m.

## The 4m Band

**Jim Edgar GM4FVM** (Eyemouth) sent a very interesting e-mail about some of the 70MHz openings that he found in June. Jim writes, *'Over four days (May 29 to June 1) I worked 62 stations in 51 squares in 23 countries. Best DX was EA8DBM in IL18 at 3278km. I also worked the Azores for the first time in seven years on 4m when I contacted CU3AC on May 28th. A new country and a new continent on 4m for me was worked when I reached 4X1TI on May 18th. KM71JG is 3956km and a new personal record for me on 4m. Soon after came Norman 5B4AIE using his club call 5B60AIF in Cyprus (KM64), a bit closer at 3512km but another new country for me.*

*"On June 6th I worked UN7MBH (LO51), another new one for me on 4m. The distance, 3478km would have amazed me before May 18th".*

Jef ON8NT had a good month and listed some nice DX on the band, including OH1MLZ (KP23), LA9AKA (JP20), OH7TE (KP30), GM4VVX (IO78), OH2BVJ (KP10), OH3CT (KP21), OH4MVH (KP32), EA5/G3XGS (IM98), OM5KM (JN98), OH3AWW (KP11), OH3NE (KP11), EA7M (IM76), EA6SX (JM19), EA6SA (JM19), OH1KH (KP01), YO9IE (KN34), YO9HP (KN35), G3SHK (IO90) and EA8DBM (IL18). Jef runs 10W from an IC-7300 to a halo.

**Gordon Smith GW6TEO** (Castlemartin) caught a number of openings in late June, working S59F (JN65), YO5TP (KN16), OM5KM (JN98) and EA8DBM (IL18). On July 9th, Gordon worked HA3GR (JN86), 9A1Z (JN86) and YU7EF (KN04). Gordon says that Serbia was only given access to the 70MHz band on July 9th!

**Dave Thorpe G4FKI** (Ampthill) says that anyone looking for 4m FM reports can try GB2RS on Sundays. In the London area, M0XTA's transmission is well heard as is G4OXY's in Bedfordshire. Times and frequencies can be found on the GB2RS website. Dave has made some nice QSOs via Es and lists HG2DX (KN06) and EA8DBM (IL18) on June 21st and an opening to Finland on June 29th when he worked six stations, followed by 9H1TX on July 1st. All QSOs on FT8.

## The 2m Band

Jim GM4FVM writes, "*There was Es on four days on 2m here between May 29th and June 1st. I worked 37 stations in 30 squares in 12 countries. These included France, Spain, Portugal, Italy, Ukraine, Germany and Switzerland. Best DX was UR5FLN (KN56) at 2509km".*

**Steve PJ4DX** kindly forwarded the following from one of his HF correspondents, **Victor Brand G3JNB**. Victor writes, "*On June 20th, for a G3 'Old Timer', an all-time new experience occurred. At 1322UTC, I walked into the shack and heard American voices chatting on the speaker while monitoring the local Cambridge 2m repeater GB3PI. From Orlando, Florida,* ***Kent K3NTH*** *was strolling out while using a handie for his own repeater, to work through to* ***Frank KK6LKT****, parking his big truck right over in Long Beach California. As they closed, I called in and we three had a faultless, 25 minute QSO on topical matters in the UK and USA. When I paused for breakers, we were joined by* ***Steven M7OPL*** *sitting in his Cambridge garden, also on a tiny handie. Amazingly, that was actually Steven's very first call as brand new licensee.*" One of the things I really like about internet linking of repeaters is the way that QSOs like this can catch people's imagination.

2


3

**Fig. 2: The microwave corner in Bernard G4BXD's shack. Fig. 3: WD9EWK's neat portable setup for both linear and FM satellites.**

Gordon GW6TEO caught the marine ducting event on June 23rd, working D4VHF (HK76) and 4 EA stations in IN73 and IN83.

Simon Evans G6AHX (Twyning) took part in the 144MHz UK Activity Contest on July 7th, with the best DX being GI4SNA (IO64).

## The 70cm Band

Jef ON8NT worked G4CLA (IO92) on SSB and G3XDY (JO02) on CW running 25W to a 5-element log periodic.

Simon G6AHX took part in the 70cm section of Lockdown VHF NFD, making 21 contacts in four countries and 11 squares. Best DX was OR6T (JO20) at 501km.

## Microwaves

Simon G6AHX says that he bought a 36-element Dual antenna for 23cm. It comes in two sections, which are easily assembled together. Simon writes, *"Previously I had tested a 19-el Tonna for 23cm on a pole in the garden, which only produced a weak signal from GB3MHZ. With the Dual antenna and a preamp at 10m AGL I have heard GB3MCB, GB3USK, G8MBU, GB3MHZ, GB3DUN and the Clee Hill radar".*

**Bernard Nock G4BXD** writes, *"Having started on 23cm I now have stations on 13cm, 9cm and most recently 3cm or 10GHz. Using just a simple horn-feed antenna and the 250mW from a Kuhne transverter, I worked my first stations on 3cm in a recent contest with my best QSO at 153km. I have just received a 2.5W PA and need to box this with the transverter and I am working on getting a 46cm ex-radar dish antenna in use, so the range and contacts should increase".* Bernard kindly included a picture, **Fig. 2**, of the microwave corner of his shack, which looks very interesting.

## Satellites

**Patrick Stoddard WD9EWK** (Phoenix), **Fig. 3**, sent his usual interesting e-mail, which this month unfortunately, I have had to truncate rather, particularly Patrick's experiences of ARRL Field Day.

*"Satellite operators over here are setting out and operating from many different locations once again. Those in the northern and eastern parts of the continental USA, along with eastern Canada, are looking to AO-7 and RS-44 to work stations across the Atlantic.* ***Hector W5CBF*** *in Louisiana worked DL4EA in Germany via RS-44 in late May, setting the current distance record on that satellite at 8357km. When AO-7 remains in mode B (U/V), transatlantic contacts are commonly heard on that satellite. For those closer to the north-eastern USA and eastern Canada, FM satellites are also being used to cross the Atlantic.*

*"The Chinese CAS-6 satellite, also known as TO-108, is now in operation. Well, sort of – its transponder appears to quickly switch on and off. It is possible to make SSB contacts through the transponder, but that requires operators to speak quickly to time the transmissions when the transponder is on. Others have taken to using digital modes like MSK144 to make quick transmissions through the satellite. Once operators get the rhythm of the transponder's on and off times, it is easier to complete QSOs.*

*"AO-27 has returned from the dead. After several years of silence, command station operator* ***Michael N3UC*** *has rewritten and uploaded the satellite's operating system. Since late May, with the exception for the last weekend in June, AO-27 has been back in operation. For now, the FM repeater is operational for four minutes (exactly!) on passes over the Northern Hemisphere, and packet bursts are heard around the morning activations. In the past, AO-27's repeater would only be operational on afternoon or evening passes for seven minutes at a time, also only over the Northern Hemisphere. More information on AO-27 since its return to service is available at* ***http://ao27.net*** *and* ***Chris K7TAB*** *has developed an Excel spreadsheet that can be used to calculate when AO-27's repeater will be active. Look for @K7TABravo on Twitter to find the spreadsheet, or in a web browser at the website below for those who don't use Twitter".*

**http://twitter.com/K7TABravo**

Simon G6AHX says that he has been introduced to a site streaming DATV activity from QO-100 as well has giving you the chance to see what you might have just missed!

**www2.qo100.net**

Another busy month! Thank you for all your input and please keep it coming. See you next time.

# TOP SUMMER CHOICES!

## With a HUGE range of Radios & Accessories

***...& Fast, friendly service - with a smile!***



DUE SOON!

### Icom IC-705
**VHF, UHF, HF, D-Star all mode**
**10W QRP portable transceiver**

- Large bright touch screen
- Rx: 30kHz-146MHz
- Bluetooth, GPS, SD card slot + lots

**£1299.99**

- Optional Carrying Case **£156.00**


SEE WEB FOR OFFERS!

### Icom 9700
**Latest Technology**

- 2/70/23cms Transceiver
- All Mode
- Direct sampling
- D star
- 100/75/10W
- Touch screen control

GENEROUS Part X CALL NOW!
**£1795.95**


SEE WEB FOR OFFERS!

### Icom 7300
**Top selling HF/50/70MHz**
**100W SDR Transceiver**

- Touchscreen TFT display
- Auto ATU
- All Mode

GENEROUS Part X CALL NOW!
**£1195.95**

## YAESU


NEW!

### Yaesu FTM300DE
**Dual Band Digital/FM Transceiver**

- 50W High Power, C4FM/FM
- Detachable remote head
- Plus lots of features!

**£399.95**

## YAESU

£90 YAESU CASHBACK

### Yaesu FTdx-101D
**SDR HF/50/70MHz 100W**
Price after cashback ~~£3149.95~~ **£3059.95**

### Yaesu FTdx-101MP New 200W version
Price after cashback ~~£4199.95~~ **£4109.95**

Cashbacks valid until 30 September

## YAESU


£70 YAESU CASHBACK

### Yaesu FT-991A
**Full coverage HF/VHF/UHF Transceiver**

- 100W HF/6m, 50W 2m & 70cms
- Touch screen colour display
- Modes: SSB/CW/FM/AM/RTTY/PSK/C4FM
- 160-6 meter Built-in Autotuner

Price after cashback ~~£1239.95~~ **£1169.95**

Cashbacks valid until 30 September

## YAESU

£105 YAESU CASHBACK

### Yaesu FT-818ND
**Portable Multi-Band**
New version with 6W output and larger battery

- Covers: 1.8-54MHz
- RX: 100kHz-30MHz
- Memory Channels: 208

Price after cashback ~~£599.95~~ **£494.95**

Cashbacks valid until 30 September

## YAESU

### Yaesu FTdx-3000
**100W Classic HF/50MHz Transceiver**

- DSP noise reduction
- Built-in keyer
- Auto Tuner

GENEROUS Part X CALL NOW!
**£1399.95**

## ICOM

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### Icom 7610
**SDR HF+6m 100W transceiver**

- Widescreen Display
- Dual receiver
- Auto Tuner

**PRICE PLEDGE**
**Seen it cheaper – let us know!**

GENEROUS Part X CALL NOW!
**£2999.95**

## ICOM

### Icom IC-R8600
**Wideband Communications Receiver**

- Ultra-wide frequency coverage (10kHz-3GHz) with RSSI
- Decodes multiple digital protocols, including D-STAR, NXDN, dPMR and APCO P25
- Colour touch screen display

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**£2,499.99**

## YAESU

£70 YAESU CASHBACK

### Yaesu FT-891
**HF+6m Mobile Base Radio**

- 100W (25W AM)
- RX: 30kHz-56MHz
- Ideal summer radio!

Price after cashback ~~£659.95~~ **£589.95**

Cashbacks valid until 30 September

## YAESU

### Yaesu FT-450D
**100W HF/6m Transceiver with ATU**

- 100 Watts of output power on SSB, CW and FM (25 Watts AM)
- Built-in electronic keyer
- Various scan functions
- Cloning capability

**£649.95**

## MORE RADIOS

Icom IC-7100

### Icom Radios

| | | |
|---|---|---|
| **IC-8600** | Pro Comms Receiver | **£2499.95** |
| **IC-7100** | HF/VHF/UHF 4m Trsvr | **£999.95** |
| **IC-2730E** | 145/433MHz | **£299.95** |
| **ID51E Plus 2** | Dual Band H/H D-Star | **£379.95** |
| **ID5100E** | Dual Band D-Star | **£574.95** |

### Icom Accessories

| | | |
|---|---|---|
| **AH-4** | Auto ATU 120W | **£334.95** |
| **SM50** | Desktop microphone | **£199.95** |
| **SM30** | Desktop microphone | **£114.95** |
| **SP23** | Filtered speaker | **£229.95** |
| **SP38** | Speaker IC7300/9700 | **£149.95** |
| **SP34** | Speaker 7800/7700 etc | **£239.95** |

### Yaesu FTdx-5000MP
HF/50MHz 200W with ATU
Performance still hard to beat! ..... **£3299.95**

### Yaesu Radios

| | | |
|---|---|---|
| **FT857D** | HF/VHF/UHF Mobile | **£739.95** |

### Digital Transceivers

| | | |
|---|---|---|
| **FT3DE** | C4FM/FM Dual Band | **£399.95** |
| **FT2DE** | C4FM/FM Dual Band | **£289.95** |
| **FT70DE** | C4FM/FM Dual Band | **£169.95** |
| **FTM3200DE** | C4FM/FM 2m Mobile | **£189.95** |
| **FTM400XDE** | C4FM/FM Dual Band | **£369.95** |

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**Acom 1200S**
1.2kW Solid State Amplifier
- Covers 1.8-54 MHz
- RF sensing for auto band changing or CAT interface for full rig control.
- Interfaces with AT-04 Auto tuner/Antenna switch

**£2799.95**

NEW

**Acom 700S**
700W Solid State Amplifier
- Covers 1,8-54MHz

**£2499.95**

**Acom Valve Amplifiers**
**1500**..1.5kW PEP (1.8-54)MHz.....**£2999.95**
**1000**..1kW PEP (1.8-50)MHz..~~£2299.95~~ **£2199.95**
**1010**..700W PEP (1.8-54)MHz.....**£1599.95**
**Acom Antenna Switch**
**AT-04**.1.5kW auto ATU 4 way ant switch.**£999.95**

## ALINCO

SPECIAL OFFER!

**Alinco DX-R8E**
Communications receiver
- 150 kHz-34.99 MHz
- 600 memories
- IQ output for PC decode
- Removable Front Panel (requires optional EDS17 remote kit)

**£469.95**

**Alinco DM-330MW MkII**
Communications Grade 30A Supply

**£129.95**

**DM-330FXE**..30A standard filtered supply..**£119.95**
**DM-30E**.....30A (peak) digital display .....**£89.95**

## AOR

NEW!

**AOR AR5700D**
Digital Communications Receiver for the professional user!
- Frequency range: 9 kHz - 3.7GHz
- Analog modes: FM, AM, SSB, CW, FM video, analogue I/Q
- Huge range of digital modes - full details on our web

**£4595.00**

**AOR AR DV-1**
Advanced Scanning Receiver
- 100 kHz - 1,300 MHz
- Decodes virtually all popular Digital modes

**£1199.95**

## BEKO

**HLV-1000**
144 MHz Solid State 1kW Amplifier
**German engineered high spectral purity**
- Input: 20W output max. 1050W
- 100% duty cycle for WJST modes

Price ~~£2895~~ **SPECIAL £2595**

**Palstar AT-2K**
- Covers 6-160m
- Output: 2000W PEP
- Optional 4:1 Balun for balanced wire feeders

**£669.95**

## MIDLAND

**CT-3000 - Ideal Novice radio**
- 10W/25W Dual Band Mobile
- IP54 rated • Colour display
- Customisable control buttons

**PRG-3000**
Optional software ....**£26.95**

**£149.95**

## MIDLAND

**CT-990** High Power 10W Dual Band
- 2m/70cms colour
- IP67 Rated - fully featured
- Colour LCD display
- Fully featured
- Affordable price!

**£99.95**

## MetroVna Network Antenna Analysers

NEW

**Metropwr FX-700**
Portable Vector Network Analyser
- Covers 100kHz-700MHz
- Touch screen Colour display
- Measures R, Z, X (sign), SWR, Phase, Return Loss, TDR, L, C
- Smith chart, TDR, Cable length
- SD card for data storage

**£349.95**

**MetroVna Deluxe Model**
- Frequency: 1-250MHz
- SWR, R, Z, X, phase, filters, return Loss & more!

**£274.95**

**MetroVna Pro Mode** .....1-180MHz .....**£259.95**

## DAIWA METERS

NEW

**CN-901G**
UHF SWR/Power Meter
900 MHz-1.3GHz

**£249.95**

**CN-103LN**....140-525MHz 20/200W N type.....**£99.95**
**CN-501H**.....1.8-150MHz 15/150/1.5kW.....**£109.95**
**CN-501H2** ...1.8-150MHz 20/200/2kW..... **£119.95**
**CN-501VN**...140-525MHz 20/200W N type.....**£99.95**
**CN-901HP** ...1.8-200MHz 20/200/2kW.....**£149.95**
**CN-901HP3** .140-525MHz 20/200/3kW N type ..**£179.95**
**CN-901VN**...140-525MHz, 20/200W N type....**£119.95**
**High Quality Switches**
**CS-201A** .....2 Way 600MHz, 1kW SO239.....**£24.95**
**CS201G11** ...2 Way 1.3GHz, 1.5kW HF N type ..**£39.95**

## ROTATORS

### YAESU

**G-2800DXC**...Extra heavy duty .....**£929.95**
**G-5500**.....Azimuth/Elevation....**£654.95**
**G-1000DCX**...Heavy duty.....**£499.95**
**G-450C**.....Standard duty .....**£339.95**

**We carry a full range of Yaesu Rotators and Accessories**

### SPID

Double Worm drive with almost zero backlash. PC control & near silent operation.

**SPID RAU**.....medium duty .....**£545.95**
**SPID RAK**.....medium to heavy duty.**£595.00**
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**SPID RAS-HR**.Az/elevation, hi-res.....**£1795**
**More on our web site!**

### CREATE

High Quality Japanese manufacture
Using a worm gear for higher Torque

**RC5-B** Heavy Duty
- Rotating torque 22 kg/m
- Brake torque 250 kg/m
- Mast dia. 48-63mm
- Vertical load 700 kg
- Horizontal load 1,000 kg
- Controller w/preset

**£1289.95**

**RC5-A3**
Heavy Duty with pre-set
- Rotating torque 16 kg/m
- Brake torque 200 kg/m
- Mast dia. 48-63 mm,
- Vertical load 700 kg
- Horizontal load 1000 kg
- Variable speed 75-110

**£899.95**

**Medium Duty models**
**RC5-3**.....Medium/HD w/pre-set.....**£679.95**
**RC5-1**.....Medium duty .....**£569.95**

## ULTRA LOW LOSS COAX

**Seatex 10**
**New!**
**Outdoor cable**

**Resistant to UV, oils & moisture!**
**Install on ships, marinas, oil rigs, Amateur Radio**

Freq: up to 8GHz, Dia: 10.2mm , VF: 0.85
Loss @ 500MHz per 10m = 0.96 dB
per metre.....£4.65 price per 102m drum .....**£440**

**Ecoflex 15**
per metre.....£7.99 price per 102m drum .....**£759**
**Ecoflex 15 plus**
per metre.....£7.99 price per 102m drum .....**£759**
PL259 connector (Part: 7350).....**£8.95**
N type connector (Part: 7395).....**£9.95**
**Ecoflex 10**
per metre.....£3.79 price per 102m drum .....**£359**
**Ecoflex 10 Plus**
per metre.....£3.79 price per 102m drum .....**£359**
PL259 connector (part: 7378).....**£5.95**
N type connector (part: 7367 .....**£6.50**
**Aircell 7**
per metre.....£2.99 price per 102m drum .....**£269**
PL259 connector (part: 7390).....**£2.65**
N type connector (part: 7392) .....**£5.25**
**Aircell 5**
per metre.....£2.75 price per 102m drum .....**£259**
**Other 100M Coax Drums**
Westflex 103 ..Semi Air-spaced low loss .....**£179.95**
RG-213 (Cabnex).....Low loss good quality .....**£99.95**
RG-Mini 8.....Super XX.....**£69.95**
RG58/CU.....Mil spec .....**£39.95**
**Twin Feeders**
450 Ohm.....Twin feeder .....**£89.00**
300 Ohm.....Twin feeder .....**£76.50**
**Nevada Antenna Wire**
Coated flex weave Antenna wire.....**£59.95**
**Nevada KEVLAR – green ultra-strong wire!**
Nevada 28.....2.8mm 2kW.....per metre .....**£0.99**
Nevada 32.....3.2mm 5kW.....per metre.....**£1.20**

## NEVADA

**PS-40M**
Linear
- 40A (max) with meter
- 1.5-15V DC
- Cigar adaptor output

**£129.95**

**Quality Power Supplies 2 YEAR WARRANTY!**
**PS-08** .....Linear 8A (max) 13.8V DC .....**£34.95**
**PS-30M**.....Linear 30A (max) 3-15V DC.....**£99.95**
**PSW-50**.....Switch mode 50A (max) 9-15V DC..**£129.95**
**PSW-30**.....Switch mode 30A (max) 9-15V DC....**£79.95**
**PSW-30H**.....Switch mode 30A (max) 9-15V DC....**£69.95**
**PS23-SW1** ...Switch mode 23A (max) 13.8V DC ...**£59.95**
**PSW-07**.....Switch mode 7A (max) 13.8V DC .....**£29.95**
**PSW-04**.....Switch mode 5A (max) 13.8V DC .....**£24.95**

## MASTRANT

### Quality Guy Ropes & Accessories

**Full range in stock!**

**P type** Ideal for general guying

**P2**.....2mm 100kg B/s.....**£14.95**
**P3**.....3mm 200kg B/s.....**£21.95**
**P4**.....4mm 400kg B/s.....**£29.95**
**P5**.....5mm 500kg B/s .....**£46.95**
**P6**.....6mm 850kg B/s.....**£79.95**
**P8**.....8mm 1,300kg B/s.....**£89.95**

**M type** Thinner higher performance

**M2**.....2mm 240kg B/s.....**£31.95**
**M3**.....3mm 100m 390kg .....**£49.95**
**M4**.....4mm 900kg B/s.....**£119.95**
**M5**.....5mm 1150kg B/s.....**£189.95**
**M6**.....6mm 1850kg B/s.....**£237.95**
**M8**.....8mm 2600kg B/s.....**£336.95**

**Full range of fittings in stock**

## INRAD

**INRAD W-1**
Competition Headset
Ham radio never sounded so good!
- Super comfortable & great audio
- Headband tilt-back feature like pro broadcast headsets
- Large high response speakers
- Boom mic with great transmit audio

**£179.95**

Requires optional adaptor
select Icom, Yaesu, Kenwood .....**£22.95**

## AIRSPY

NEW

**Airspy HF+ Discovery**
- HF - 0.5 kHz, 31MHz
- VHF - 60, 260MHz
- Pre-selectors

**£199.95**

**AIRSPY R2**
- 24MHz-1,800MHz
- 10MHz spectrum
- Tracking RF filters

**£199.95**

**AIRSPY Mini**
- SDR Dongle
- 24 – 1,800MHz

**£119.95**

## SDRplay

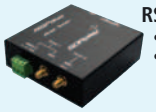
NEW

**RSPdx** SDR in metal case
Covers: 1 kHz - 2GHz
Now with Improved:
- Performance below 2MHz
- Plus more!

**£194.95**

**RSP 1A** Wideband Budget SDR
- Covers: 1 kHz - 2GHz
- Software upgradable
- Good dynamic range

**£99.95**



**RSP DUO** Dual Tuner SDR
- Covers: 1 kHz - 2GHz
- Software upgradable

**£239.95**

## SSB

**SSB Masthead Preamplifiers**

**SUPER AMP - SERIES**
Super-low-noise, large-signal handling, protective circuit. High quality Helix filters, Vox control, remote & T bias DC feed.

**MHP-200R**.....1.5kW 2m Preamplifier (T-Bias) .**£599.95**
**HP70** .....70 cm, 0.7 NF. 20dB, 100/500W.....**£320**
**HP-200**.....144MHz 0.5 NF. 20dB 100/750W...**£320**
**DCW-2004B**...Sequencer 6/2/70cm .....**£279.95**

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NEW

# Vibroplex End Fed Wire
## HF-ALLBAND-kW

- Covers 80 - 10 M
- Power 1kW
- Length approx. 130ft

**£169.95**

## HIGH PERFORMANCE BEAMS

### DUAL Antennas by YU1CF

**High Performance Beams using Professional 3D EM modelling**

**6M Yagis**

| | | |
|---|---|---|
| PA-50-4-3B | 4 el. 9.2 dBi 2.92m boom | £139.95 |
| PA-50-6-6BG | 6 el. 11.5dBi 5.84m boom | £245.00 |
| PA-50-7-9BGP | 7 el.12.7 dBi…8.68m boom | £299.95 |

**Dual Band 6/4**

| | | |
|---|---|---|
| PA5070-7-3 | 6m 3el 4m 4 element 3m boom | £199.95 |
| PA5070-11-6 BG | 6m 5el 4m 6 element 6m boom | £259.95 |

**4M Yagis**

| | | |
|---|---|---|
| PA70-5-3 | 4m 5 element Yagi 3m boom | £199.95 |
| PA70-6-4 | 4m 6 element Yagi 6m boom | £219.95 |

**Dual Band 2/70cms**

| | | |
|---|---|---|
| PA144-432-37-7-2CBGB | 2m 12 el 70cms 25 el 2 connectors | £289.95 |
| PA144-432-13-1.5-2CB | 2m 5 el 70cms 9 el 2 connectors | £134.95 |
| PA144-432-17-2 | 2m 6 element 70cms 12 element | £149.95 |
| PA144-432-19-3-2C | 2m 7 element 70cms 12 element | £199.95 |
| PA144-432-21-3B | 2m 7 element 70cms 14 element | £199.95 |
| PA144-432-13-1.5A | 2m 5 el. 70cms 9 el 1.5m boom | £134.95 |
| PA144-432-34-6-2CBG | 2m 11el, 70cm 23 el. 2 conn | £249.95 |
| PA144-432-38-6BG | 2m 11 el. 70cms 28 element | £225.95 |

**2M Yagis**

| | | |
|---|---|---|
| PA144-5-1.5 | 2m 5 element Yagi 1.5m boom | £94.95 |
| PA144-6-2 | 2m 6 element Yagi 2m boom | £119.95 |
| PA144-8-3 | 2m 8 element Yagi 3m boom | £135.95 |
| PA144-9-5A | 2m 9 element portable 4.67m | £174.95 |
| PA144-11-6BG | 2m 11 element guyed 5.72m | £199.95 |
| PA144-12-7BGP | 2m 12 element Yagi | £259.95 |

**70cms Yagis**

| | | |
|---|---|---|
| PA432-8-1.2R | 70cms 8 element Yagi 1.2m boom | £89.95 |
| PA432-14-3 | 70cms 14 element Yagi 3m boom | £145.95 |
| PA432-23-6 | 70cms 23 element Yagi 6m boom | £199.95 |
| PA432-30-8BG | 70cms 30 element Yagi 8m boom | £269.95 |

**23cms Yagis**

| | | |
|---|---|---|
| PA1296-13-1R | 23cms 13 element 1m rear mount | £99.95 |
| PA1296-18-1.5AR | 23cms 18 el1.5m rear mount | £139.95 |
| PA1296-36-3BRG | 23cms 36 element 3m RG Balun | £169.95 |
| PA1296-36-3BUT | 23cms 36 el 3m Teflon Balun | £189.95 |
| PA1296-70-6RG | 23cms 70 element 6m RG Balun | £225.95 |

**Power Dividers**

| | | |
|---|---|---|
| PD1024 144MHz | 2 way power divider, 1.5kW | £79.95 |

## CREATE - ANTENNAS

**As used by the 'Professionals'**

### CLP-5130-1N
21 Element Log Periodic Beam
- 50-1300MHz
- 500W
- Gain: 10-12dBi

**£379.95**

### CLP-5130-2N
17 Element Log Periodic Beam
- 105-1300MHz
- 500W

**£299.95**

## SPIDERBEAM

**Telescopic Masts and Poles**

**Fibreglass Telescopic Poles**

| | |
|---|---|
| 12mtr Heavy Duty | £99.95 |
| 18mtr Standard | £199.95 |
| 22m 'Long John' NEW | £399.95 |
| 26mtr Standard | £499.95 |
| Base Plate for Fibreglass Poles | £28.95 |

**Aluminium Telescopic masts** *German engineered!*

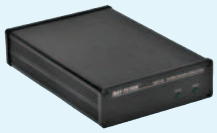
| | |
|---|---|
| 10 metre Standard (1.35m retracted) | £339.95 |
| 10 metre Heavy Duty (1.7m retracted) | £359.95 |
| 12.5 metre (1.65m retracted) | £399.95 |
| 14.5 metre Heavy Duty (2m retracted) | £499.95 |
| 15 metre Standard (2m retracted) | £459.95 |

## MAT -Tuners – factory direct!

### MAT-40
Outdoor Auto-tuner
- Freq: 1.8-54MHz
- Power: 0.1-120W
- Tunes from 10ft + wires

**£259.95**

Requires adaptor cable for your rig
Request when ordering, Icom, Yaesu, Kenwood



### MAT-30
For Yaesu radios
- Freq: 1.8-54MHz
- Power: 0.1-120W
- Interface cable supplied

**£189.95**

### MAT-125E
General purpose Auto Tuner
With internal battery
- Freq: 1.8-54MHz
- Power: 0.1-120W

**£189.95**

### MAT-180H
For modern Icom & Kenwood radios (Supplied with Icom interface lead)
Allows manual tuning also
- Freq: 1.8-54MHz
- Power: 0.1-120W

**£174.95**

### MAT-10
'One touch' tuner for Yaesu FT-818/817
Can also be used with any QRP transceiver
- Freq: 1.8-54MHz
- Power: 30W

**£229.95**

### MAT-K100
For Icom & Kenwood radios (Kenwood lead included)
- Freq: 1.8-54 MHz
- Power: 0.1-120W

**£189.95**

## SIRIO ANTENNAS

**Quality Antennas from Italy!**

### SY400-10N
- 70cms 10 element
- Wideband 400-470MHz
- Boom: 2m, Gain: 14 dBi

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| CWA-1000 | Multi Band dipole 3.5/7/14/21/28MHz | 124.95 |
| AB1230H | Handheld Airband Antenna - RX only | 29.95 |
| AB380 | Civil/Military Base Antenna -RX only | 89.95 |

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| GP-1M | 144/430MHz length 1.2m (SO239) | 49.95 |
| GP-3M | 144/430MHz, SO-239 Lgth 1.78m (SO239) | 69.95 |
| GP-6M | 144/430MHz, SO-239 Lgth 3.07m (SO239) | 99.95 |
| GP-93N | 144/430/1200MHz, Length 1.78m N Type | 99.99 |
| GP-9M | 144/430MHz SO-239 Lgth 5.15m (SO239) | 149.95 |
| GP285 | VHF 5/8 Collinear 135 - 175MHz 3.34m | 89.95 |

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| CF-530C | 1.3-90/125-470MHz, SO239 2 x PL259 lead | 49.95 |
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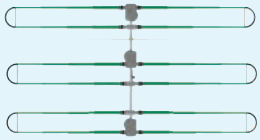

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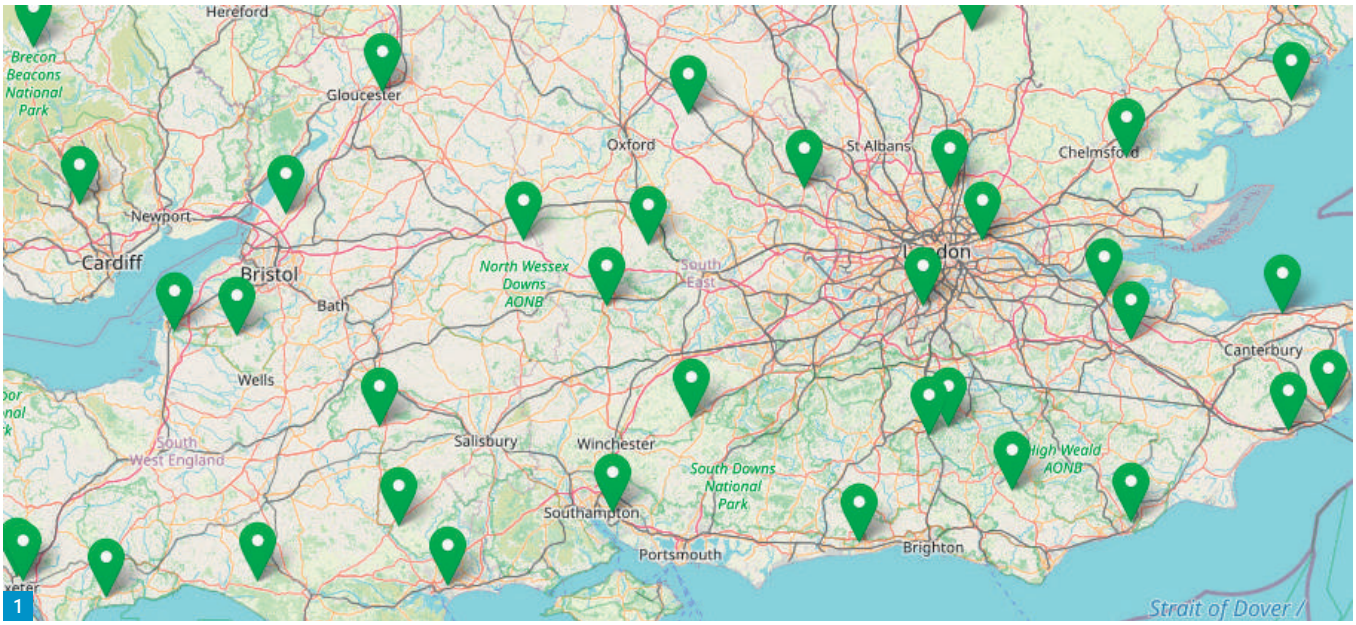


**Colin Redwood G6MXL**
practicalwireless@warnersgroup.co.uk

# Getting Started (Part II)

**Colin Redwood G6MXL** continues his advice on the best way to start out in the hobby.

Last month I provided an overview of the steps from training for a Foundation exam to making your first contact. This month I am going to cover the choice of equipment in more depth, as last time space didn't permit anything other than the barest essentials.

## Setting Expectations

So, you've passed your Foundation Exam, got your new M7 callsign and want to get on the air. What equipment do you buy to get started? There are hundreds of new amateurs in this situation at present, and the answer will not be the same for all. Over the decades ahead, your interests in the hobby are likely to evolve. For example, the space you have for antennas may change as you move house over the years. What is 'right' for you now may not be suitable for you in 10 or 20 years. In most cases there will be constraints such as interests, space and budget. These are all likely to change with time, so you're not going to get the 'ultimate' amateur radio station the week after you get your licence. Likewise, you're not going to do every aspect of amateur radio in the first year – you'll be lucky to do so in a lifetime! To use a car analogy, you're not looking for a Rolls Royce or Ferrari as your first car after you pass your driving test, nor are you looking to become a Formula 1 Champion or complete a round-the-world rally in the first year.

To get started, I think you should aim for sufficient equipment to keep you interested in the hobby – which to my mind means making contacts. I'd suggest trying to establish a station that can transmit and receive reasonably well on a single band. You'll then have something with which you can hone your operating skills and make comparisons with as you explore other bands and modes later on.

I'd certainly get in touch with a local amateur radio club. This may be by phone, e-mail, Zoom, Skype, social media or face-to-face if circumstances permit, etc. Pick the brains of several of the members to establish the level of activity locally to you on the 2m and 70cm bands. Be aware that the various members are each likely to have their own views and recommendations. If you'd asked them about cars, they wouldn't all recommend the same make and model!

## 2m and 70cm

Unless you can be certain that you will get plenty of contacts locally (for example if you live in a really large conurbation or city or on top of a hill nearby), you'll probably not make many contacts on the 2m and 70cm bands, even if there is an analogue repeater locally. The only exception is if there is a Digital Voice repeater within range, in which case you may be able to make contacts further afield using internet links associated with some of these repeaters. If you are considering this, then please make sure you understand which Digital Voice mode(s), if any, are supported by your local repeaters, and make sure that any transceiver you buy is compatible. If you buy a DMR transceiver, it won't work with a Fusion repeater for example.

If you decide to go down the digital voice route, you'll need to get advice from a local amateur who has done this before because you'll need to configure your transceiver and for some digital voice modes you'll need to be registered with the repeater group.

## Local Repeaters

To find out what repeaters are local to you, visit the UK repeaters list on the RSGB website. You can search by band, type, etc. I think the map option is probably the easiest to use, **Fig. 1**, but don't forget to zoom in so that you can see the individual repeaters:
**https://ukrepeater.net/repeaterlist.htm**

## VHF/UHF DX

If you are considering making longer distance contacts on the VHF or UHF bands, then you'll need a transceiver that has SSB and CW modes. You'll also need a good horizontally-polarised directional

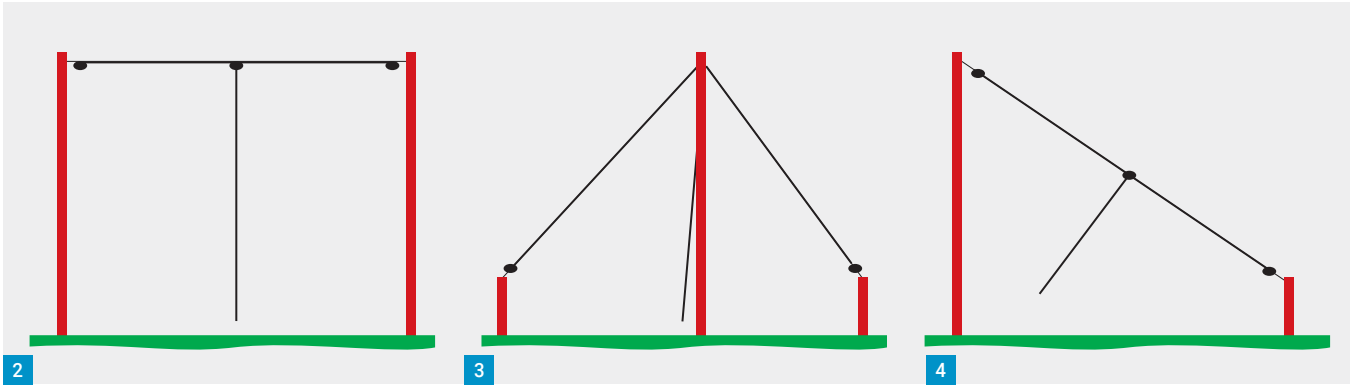



**Fig. 1: Part of one of the repeater maps from the RSGB website (courtesy RSGB).**
**Fig. 2: A horizontal half-wave dipole.**
**Fig. 3: A half-wave dipole in an inverted-V configuration. Fig. 4: A half-wave dipole in a sloper configuration. Fig. 5: A small, lightweight switched-mode power supply unit. The double knob on the right can adjust the voltage (centre), and the frequency of the main oscillator (outer).**

antenna (a Yagi) mounted high up in the clear with a means to rotate it and fed with low loss feeder. If you are not located in a favourable location, you are unlikely to make frequent contacts.

## HF Antenna

If you want reasonable certainty of making contacts outside the British Isles, then you'll need to look at the HF bands. Choosing equipment with which to get started is probably the most difficult aspect for most newcomers. Try not to get too ambitious at the start and be realistic. With a 10 Watt power limit on most bands, you're going to need an effective antenna. As I suggested last month, I'd start with a dipole resonant on the 20m band and just operate on 20m. By choosing a resonant antenna, you can avoid the expense of an ATU and SWR meter – you can always add these later when funds permit. You can either buy or make a half-wave dipole antenna (usually just called a dipole). Either way, try to get it as high up (ideally at least 5m above the ground) as you safely can. If you can't get all of it high up, then try to get the centre high up, but don't worry if you can't, there are a number of ways to configure a dipole, each of which work well – horizontal, **Fig. 2**, inverted V, **Fig. 3**, and sloper, **Fig. 4.**

You may be wondering why I suggest the 20m band. We are currently at the bottom of the 11-year sunspot cycle, which means that propagation on the higher HF bands is not too good. At present the 20m (14MHz) band is about as high in frequency as you can reliably make low power contacts on most days. The 20m bandplan has parts of the band for all popular HF modes, including upper sideband (USB), Morse (CW), various data modes (e.g. RTTY, PSK31/63 and FT8) and slow scan television (SSTV).

If you move down in frequency to the 30m (10MHz) band, not only will you need a longer antenna, but you'll be limited to Morse (CW) and data-mode contacts (no voice contacts). If you have space for a 40m (7MHz) half-wave dipole antenna, then this would be a good alternative to 20m, particularly if you can only operate in the evenings and overnight, although daytime propagation on 40m generally permits contacts around the British Isles. On 40m you can use all the modes that you can on 20m except it's lower sideband (LSB) rather than USB on 20m. You might consider the 17m (18MHz) band, but at sunspot minimum this band doesn't open as often as 20m. If over time you decide you don't want to continue with the 20m dipole at home, you can keep it for portable use in the future or reduce its length to operate on a higher band such as 17m or 15m.

In choosing your first band, you'll need to be aware that almost every weekend there are contests on many HF bands, including 20m and 40m. If you really cannot stand contests, then I'd suggest 17m or 30m, as they are both 'WARC' bands, with no contests permitted.

If you are fortunate to have enough space for a 40m dipole, then you could start with 40m dipole for weekday evenings and perhaps swap to a 20m dipole at weekends.

## HF Transceivers

Choosing an HF transceiver is probably the most difficult area on which to provide advice as there are so many new and used models on the market. In practice if you buy almost any new transceiver from the major manufacturers (Alinco, Elecraft, Icom, Kenwood, Yaesu), you won't go far wrong. Most transceivers deliver 100 Watts of RF output power but provide a control to reduce the power down to 10 Watts or less. This will future-proof your purchase in case you go for an Intermediate or Full licence in the future.

You should also be fine if you buy a second-hand transceiver from a reputable dealer that was made by one of the major manufacturers over the last 5 to 10 years, provided you get at least a 3-month guarantee. Spares for older equipment can be difficult or impossible to obtain – hence my suggested limit of 10 years old.

Make sure that the knobs and other controls are sufficiently big and well-labelled


Fig. 6: A Czech Morse key, often found on eBay.

for your needs and that the transceiver comes with the relevant instruction manual. Don't be afraid to ask the dealer for help in getting set up before you leave the shop.

## Power Supplies

These days few transceivers come with a built-in mains supply unit, so unless you are going for a portable transceiver (in which case you'll need a rechargeable battery and a charger), you'll need a mains power supply unit (PSU). Broadly speaking there are two main types of PSU. The first is a linear PSU. A quality linear PSU is heavy and big. The advantage of a linear power supply is that it generates no spurious radio frequency signals. The second type of power supply is the switch-mode power supply, **Fig. 5**, which are generally much smaller and lighter than their linear equivalents. Switch-mode power supplies have a reputation for generating unwanted radio frequency signals, but which most amateurs find they can live with, in some cases by means of control. Whichever you choose, make sure that you choose a PSU that will comfortably deliver at least 20 Amps, so that when you get an Intermediate or Full licence it will deliver enough current to fully power a 100 Watt transceiver. If money is tight, then I'd suggest choosing a switch-mode PSU, which you can also use for activity away from home, rather than lug a heavy linear PSU around.

I don't see any advantage of a power supply with variable output voltage over one with a fixed 13.8V DC output voltage – quite the contrary – just about every piece of current amateur equipment needs a 13.8 Volts DC supply. Being able to vary the voltage means that you can potentially set it too low (risking weak and/or distorted transmissions) or too high (risking damage to your transceiver)! Some power supplies with variable voltage have a detent at 13.8 Volts so that it needs a little effort to rotate the knob away from the 13.8 Volt position.

If you have a spare car battery, you could use this to power your station, saving the cost of a PSU. Remember that car batteries can be very heavy. Make sure that you don't short out the terminals, and that there is a suitable fuse in the supply lead. You'll also need a suitable battery charger, be sure to provide adequate ventilation and disconnect your transceiver while charging the battery.

No matter what power source you use, make sure that the connecting wire can handle the current that will be drawn when transmitting. The lead supplied with most transceivers is sufficient. Make sure that connections are tight so that there is no voltage drop when you draw current as you transmit and remember the red lead is positive and black is negative.

## Microphone

If you want to operate using voice modes (SSB, AM or FM), then you'll need a microphone. Most new transceivers come with a basic hand-held microphone, which is perfectly adequate to start with. As time moves on you may wish to migrate to a desk microphone, or headphones with a boom microphone attached.

## Morse Key

If you want to operate using Morse code, then you'll need a Morse key. You can spend a lot of money on a Morse key. If you are just starting out, I'd suggest talking to other Morse operators at your local club, and if circumstances permit, trying out some of their Morse keys. Remember that until you can read Morse code, you don't really need a key. There are numerous keys listed on eBay, including many ex-military ones from eastern Europe, **Fig. 6**.

## Filters

There are filters for several purposes in amateur radio. To start with, you probably don't need any. If you are a keen Morse operator, then you may wish to purchase a narrow CW filter, if it is an optional extra for your transceiver – this will help eliminate signals either side of the signal you will be trying to listen to. But this could be something you add subsequently.

## EMC

Using 10 Watts of RF power, it is unlikely you'll get any EMC issues. In the event that you do have problems, then you may need to look for a filter for the particular problem you have. From time to time you may also need to have access to a dummy load. Initially, I'd suggest trying to borrow one on the fairly rare occasions that you need one.

# Radio Round-up

**NEW RIGS?:** Early days yet but we are seeing details online of the Andromeda 100W SDR transceiver from Apache Labs. ANDROMEDA integrates all of the elements of an HF software defined radio. The PC, display, DSP and RF elements are all integrated into a single unit giving true standalone operation. The front panel is fully integrated to the THETIS software providing leading edge DSP with 'conventional radio' usability. The front panel features a high resolution VFO encoder, six dual encoders for a range of settings and 29 pushbuttons. All the encoders and pushbuttons are programmable allowing the user to re-allocate them to other functions from a menu within THETIS. A 7in touchscreen display is provided for the THETIS PC display.

A configurable 'softkey' menu button bar at the bottom of the screen can be used to make most of the user settings needed to operate THETIS; others are accessed through setup menus.

A set of pushbuttons below the touchscreen can be used to operate the softkey buttons, or could be user reprogrammed to other functions.

The radio is expected to ship in Late September/Early October, 2020. Price in the USA looks like being around the $4400 mark.

https://tinyurl.com/yxqj5epn

Another interesting new one is the Lab599 Discovery TX-500. This is a QRP all-modes 160 through 6m ultra-compact SDR transceiver specifically designed for outdoor operation. Despite the size, it includes a 48kHz built-in hi-speed panadpter.

The US price appears to be around the $790 mark. You can find several YouTube videos extolling its virtues.

https://lab599.com

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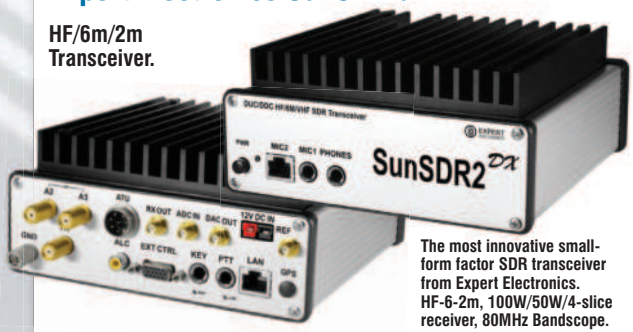


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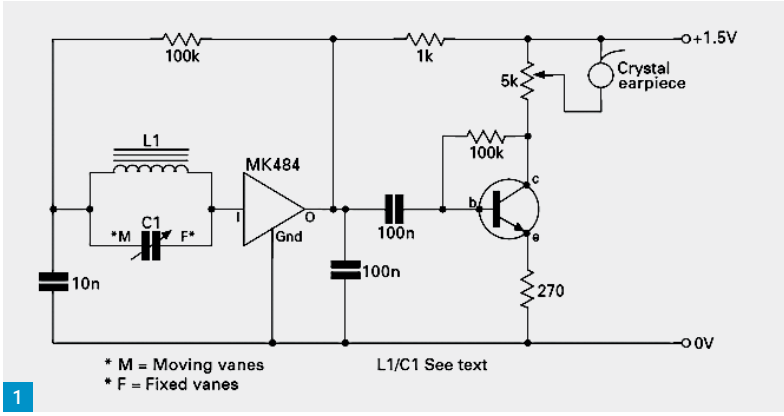

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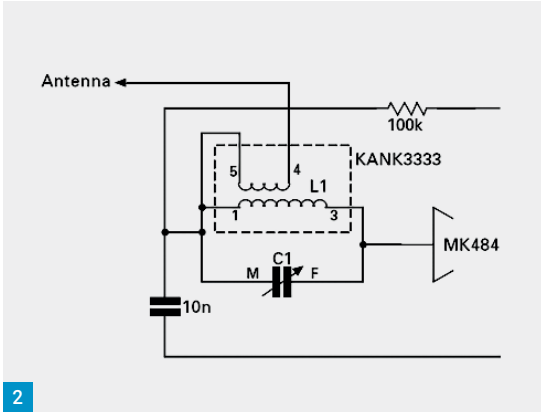

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# A Simple One to Build...

**Lee Aldridge G4EJB** revisits an MK484 TRF receiver from George's archives.

**Lee Aldridge G4EJB**
leeG4EJB@outlook.com

Among a number of other projects being built and wrestled with, I thought I'd take on an easy one of **George Dobbs G3RJV's** projects from his epic *PW* series. I'd bought an equivalent to the MK484 IC – the TA-7642 – ages back and thought it about time I made use of it. The IC only has three legs, what could be simpler?

Here's what George had to say about the tuned radio frequency (TRF) receiver in his *PW* Jan 2002 article, *"Several years ago I introduced some schoolchildren to radio construction using the ZN414 radio chip. This complete tuned radio frequency (TRF) receiver on one chip proved to a good way to quickly build a radio, which yielded reasonable results. The original Ferranti ZN414 has now been replaced by the MK484.*

*"This article is about how quickly and simply a short wave receiver might be built using that chip but does not exhaust the possibilities using this remarkable little IC. The diagram, **Fig. 1**, shows the basic circuit of a receiver using the MK484. It's based on the circuit that came with the chip".*

Now yet again, I had a cunning plan and that would require the LM386 audio amplifier built on breadboard for the 7MHz DC receiver from another of George's projects a few months back. It didn't take many moments to alter to a single input amplifier (similar to the VK6FH circuit mentioned later).

In George's article he suggested using a Toko 3333 coil for SW coverage, see **Fig. 2**. Mine had a couple of windings open circuit. I've taken these Toko coils apart a few times before so I have a repair method. I tease open the metal casing, without breaking any more windings, take out the core and replace it with a bolt and then gently push the former out of the casing... eventually. I use very fine gauge wire and loop onto the existing end of the wire, solder then wrap the fine wire back around the pillar and solder to the pillar. Making sure the solder joint and wire are routed away from the metal case. Dedication or what? (I know, the 'or what'). So, there's the one hour construction time for the TRF receiver gone already.

The TA-7642 circuitry was built on perforated fibre board very much as George described in his article, keeping as many of the leads as short as possible. See photo, **Fig. 4**.

A 1.5V supply (with some adjustment), **Fig, 5**, was derived from the 9V DC supply on the LM386 amplifier board, having followed George's comments and found the old application notes at:
https://tinyurl.com/y2qeq86u

With the basic RF stage built, it was connected up to the audio amplifier with a bit of screened cable. The volume control, a 100kΩ potentiometer, was fitted on the perf board. You see, the cunning plan was based on an interesting idea that I'd found on **Frank Hughes VK6FH's** website at:
www.vk6fh.com/vk6fh/mk484radios.htm

(The circuit appears to originate from **Jack Donio**). Anyway, before getting too far in front of myself, I wanted to see how George's suggestion worked.

However simple a circuit is, I always like to check my handiwork (I only had one IC so I couldn't afford to get it wrong). I will mention, set the variable supply to give minimum voltage to the IC and then adjust upwards with care – because I didn't.

I switched on the DC supply that provided 9V for the audio amplifier and DC input for the RF stage. I measured the DC voltage on the board – in my case 1.8V – and quickly adjusted it down to 1.45V. Thankfully no smoke. I connected a bit of wire to the input winding of the coil that was (at that point) wired as shown in George's suggested circuit. So, there's DC on the input coil winding – it may be a good idea to fit a capacitor.

Sadly, there was so much noise generated within my shed I couldn't hear anything else. I tried with my counterpoise wires from the W3EDP antenna system, still just noise. Then the W3EDP wire was put on, lots of breakthrough, obviously the poor little IC was being overloaded. With a little ingenuity and a bit of coax, I connected my Z-match inline, hoping it would help. The Z-match could be made to filter and fine tune the little receiver! Not quite what I was expecting but with a little practice I could hear what I thought was 40m and occasionally a CW signal could be made out. It appeared that the little IC was performing to some degree and there was plenty of audio output to the LM386 amplifier.

But could I make this TRF work any better with my limited resources?

## The Partly Hartley Bit

Originally, I had planned on removing the Toko coil and fitting a toroid as George had described in his article if a Toko coil wasn't available although these days there's a 45.0μH coil available from Spectrum Communications. Well laziness had set in. I'd looked at the tickler circuit and mulled

over what to do next. If I'd replaced the Toko coil with the toroid, I was going to add a few turns to the toroidal core to provide the positive feedback. I had an idea, could I use the tapping (pin 2) on the Toko coil as in a Hartley oscillator to provide the feedback? I had to go and have a lie down after that one.

After further wrestling with the idea, I realised the emitter of the BC547 would require a DC path. See circuit in **Fig. 3**. Note the Toko coil input winding goes to the 0V rail. The capacitor $C_{fb}$ value is discussed in the text.

I would love to tell you the circuit worked a treat first time but, someone had wired the BC547 round the wrong way – remember that 'checking your handiwork' bit? Well, to cut a long story short and with another transistor fitted, the tickler circuit kind of worked. My first step was to add the emitter resistor (with a decoupling capacitor) shown in Fig. 5 to increase the BC547 collector voltage range when adjusted with the tickler pot – I thought it might help. I'm not sure if it did but I left it in.

To test the receiver on-air, I found by trial and error it was happiest with the 14ft counterpoise as the antenna (well it is at about 5ft around the perimeter of the shed) but not directly connected. The counterpoise was terminated with a 4mm plug that conveniently fitted the SO239 connector on my VSWR meter. Then a piece of coax was connected from the meter to the input of the receiver. The screen of the coax had to be earthed otherwise the little receiver was awash with noise. There was a little breakthrough from MW stations but with the aid of my old Howes crystal calibrator, I eventually worked out coverage – with the very large value variable capacitor fitted – was most of MW through to just above 3.6MHz. (I'd tried adding a 100pF capacitor to the antenna input link but that just increased the amount of breakthrough). By advancing the tickler pot I could hear the gain of the receiver increase – in other words signals became louder and selectivity increased - but at the onset of oscillation, it didn't seem to help resolve the CW stations I could hear on 80m. So the capacitor $C_{fb}$ was changed from 10pF to 40pF (that is 30pF added in parallel) to increase the feedback at the coil tapping point. It was a good guess but, the value was probably too much as the oscillation would noticeably swamp the receiver.

I thought it would be sensible to check the control of receiver gain throughout its frequency range. So, I used the method of turning the tickler pot back and then advancing it just to the point of oscillation at a number of different frequencies. It's tricky with a standard pot but it did confirm the little receiver was working well beyond its original intention. As the point of oscillation changes with frequency, the tickler pot has to be re-adjusted and it would be far better with a 10-turn pot. But I did find a method to properly demodulate CW signals by going past the point of oscillation then winding the tickler pot back a little.

Frequency stability was acceptable enough to copy a number of CW signals on 80m, considering the total lash-up of the tickler circuit on the back of the perf board. I'm sure with better construction techniques and shorter component leads, the tickler circuit could be made to work well with the IC, particularly with further adjustment of capacitor $C_{fb}$.

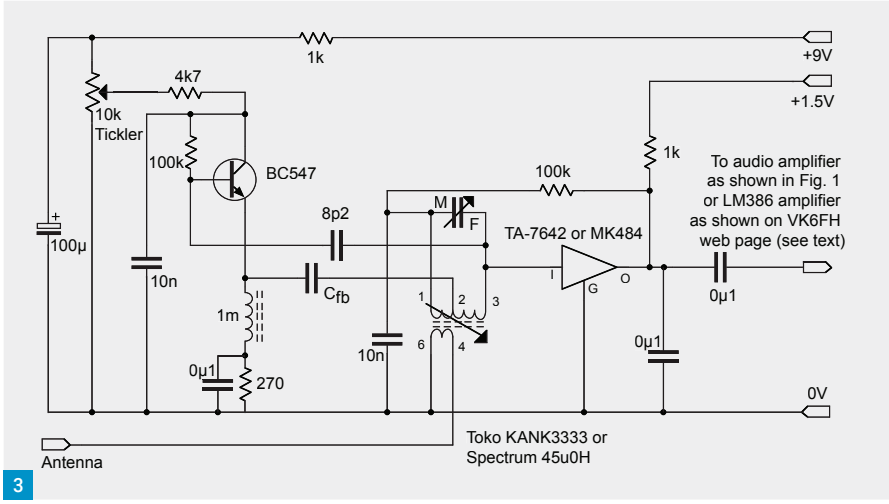
So what I have learnt? A great deal about a simple receiver, techniques that have been around for almost 100 years and that eventually, I made a variation of an idea work with a little three-legged radio IC. The fitting of the transistor the wrong way round in the tickler circuit really threw me for quite a while because I was able – by fiddling with capacitor values – to make the receiver work, albeit with slightly less frequency coverage. I'm still scratching my head on that one.

I also learnt that George had built a MK484 based receiver on breadboard and while trawling through the *Carrying on the Practical Way* CD index at the website below there was George's Hartley regenerative receiver article in PW Nov 2007. Humbled or what?

www.m0czp.uk/copw.php

As far as the simple broadcast receiver is concerned, the final words from George *"So there it is...a simple short wave broadcast receiver you can build in less than an hour to amaze the children... you could also present them with a hobby to last a lifetime!"*

And for regenerative receivers, *"Like all regenerative receivers this project does require careful driving. The regenerative control is set just below the point of oscillation for amplitude modulation (AM) signals and just above oscillation for CW (Morse) and single sideband (SSB) signals"*.



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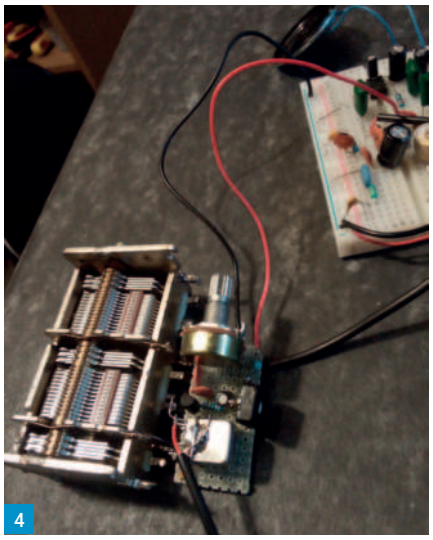
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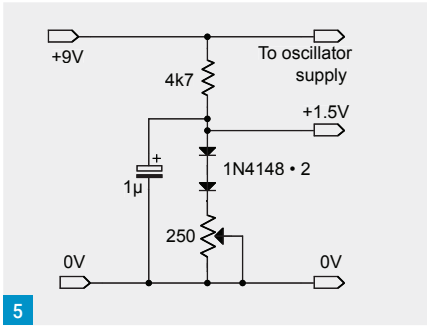
**Fig 1. George's AM receiver using MK484 (TA-7642). Fig 2. George's suggestion for SW coverage using a Toko coil. Fig. 3: Modified Tickler circuit. Fig. 4: TA-7642 with 1.5V supply circuitry on perforated board.**
**Fig. 5: Variable 1.5V supply used with IC.**



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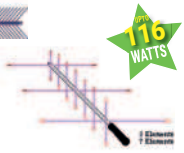


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MFJ Cobweb puts your call back on the map!

This six-band (20, 17, 15, 12, 10, 6 Meters) full half-wave Cobweb Antenna is perfect for restricted space or portable operation. Sky-gray fiberglass spreaders and nearly invisible wire elements (flat 9x9x1/2 feet square. 8 pounds), blend in with your surroundings while standing tough against nasty weather. Outstanding performance! Horizontally polarized for less local noise pickup plus solid gain over verticals will allow you to work DX easily -- even on QRP. Omni-directional. No radials needed! Works great at low heights. Low SWR is due to MFJ's exclusive Spider-MatchTM broadband network

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**Tony Smith G4FAI**
g4fai@btinternet.com

# Wartime Civilian Receivers

**Tony Smith G4FAI** tells the tale of a little-known period of domestic receiver design and manufacture.

Before WW2 the British radio industry produced 1,125,000 domestic wireless sets a year. Production virtually ceased in 1939 as the industry began to produce equipment for the armed forces. By the end of 1943, many households in Britain did not have a wireless set and many existing sets were in need of repair.

The war situation was about to turn more hopeful. The invasion of Europe was expected soon and the government was anxious that as many people as possible should be able to receive the BBC's regular news bulletins to keep them informed of progress, to receive public announcements, and to boost public morale.

## New UK Produced Receivers

In February 1944, *Practical Wireless* reported a statement by the Radio Manufacturers Association (RMA) about a new supply of new radio receivers, which had been approved by the Board of Trade. Authority had been given to complete the sets left partly finished when the industry changed over to war production. As at the previous September 30th, 75,000 of these sets still required completion and would be made available as soon as possible.

This number, however, was inadequate to meet demand so 10,000 American sets had also been obtained for domestic users. These sets were intended for those without means of listening, and owners of existing sets were urged to keep them in good working order.

## Testing in Hand

In May 1944, an editorial in *Practical Wireless* reported an announcement by the Board of Trade that a small number of the domestic sets bought on government account in the USA would shortly be placed on the market, reaching the public by normal trade channels.

They were of widely varying types and the work of repairing and testing where necessary to ensure suitability for the British market was in hand. The sets had been classified into four groups with maximum prices fixed by Government Order, as follows:

Group I, £11.14.2d (£11.71p); Group II, £13.10.0d (£13.50p); Group III, £15.5.10d (£15.29p); Group IV, £17.1.8d (£17.08p).

A statement by the Radio Manufacturers Association, in the same issue, announced that the first 10,000 American sets would be available by May 1944 and a further 20,000 in the following three months.

## Criticism by PW

Noting that although each set was be tested on arrival here and that they were to be sold without guarantee, a *PW* editorial asked, *"Why, therefore, waste time testing them?"*

*"We hope that these American sets will be adjusted to eliminate the troubles which have been experienced with the American sets hitherto sold to the British public.*

*"All American sets are made to suit the American standard voltage of 110 volts and the usual method of converting these is to use a resistance cord between the mains and the set. This is by no means satisfactory. They overheat, the resistance does not remain constant, with the result that the valves become overloaded and soon blow. There are other and more satisfactory means of making 200/250 volt mains suitable for 110-volt receivers.*

*"It is also to be hoped that replacements will be imported so that receivers which become damaged can be serviced. We hope that they will be accompanied by adequate service instructions for dealers. There have been many complaints about the ignorance of dealers when dealing with American receivers."*

It hasn't proved possible to find further news of the American sets. As far as can be seen, they were not advertised in the media and it has not proved possible to identify their specific brands or makers. As they were to be sold through normal trade channels, they were probably bought straightaway as they arrived in the shops and there was no need to advertise them.

## The Wartime Civilian Receiver

In the same issue of *PW* (May 1944) it was reported that the American sets would be followed later in the year by a number of civilian wartime receiving sets that were being made to a standard design by British radio manufacturers with the approval of the government. The new sets were designed by **Dr GD Reynolds** of Murphy Radio. Designated 'The Wartime Civilian Receiver' and popularly known as the 'Utility' set, production had been authorised by the Board of Trade subject to the sets being produced with the minimum of raw materials and labour. They were to be sold through normal trade channels with preference given to areas where they were most scarce.

## Governmental Control

*PW*, September 1944, confirmed that the new Utility receivers were intended for members of the public without means of listening. It reported that as from 1st July 1944, the Wireless Receiving Sets (Control of Supply) Order 1944, controlled the sale, hire purchase and renting of wireless sets marked with the words 'Wartime Civilian Receiver'. The mains sets were to be sold at the following maximum prices. Battery sets could not be rented:

**AC mains sets.**

- Price to wholesalers, £5.13.4d. (£5.67p).
- Price to retailers, £6.13.4d. (£6.67p).
- Price to retail customer, £12.3.4d. (£12.17p).

**Battery set, exclusive of battery and accumulator.**

- Price to wholesalers, £5.2.0d. (£5.10p).
- Price to retailers, £6.0.0d. (£6).
- Price to retail customers, £10.19.0d. (£12.95p).

This Order remained in force until it was revoked in July 1947. In a further restriction, the Musical Instruments and Wireless Order 1944 made it unlawful for any person to remove the words 'Wartime Civilian Receiver' from any set on which they had been marked, or to mark those words on any set except by licence of the Board of Trade.

## Standard Design

The cabinet was to be of plain light colour wood, possibly pine, but one version, painted olive green and bearing an Army Stores No. ZA 30255, suggests that the set was also issued for army recreational use.

*Radio Marketing Service Engineer,* August 1944, stated that while the circuit, cabinet and general design were standard, individual manufacturers were free to use their own available components and to make minor alterations to the layout to suit their manufacturing arrangements.

The makers included Bush, Cossor, Decca, GEC, Kolster-Brandes, McMichael, Murphy, Philips, Portadyne, Pye, RGD, Roberts, & Ultra – some 42 manufacturers in all – but the sets could not be sold under their individual trade names.

The chassis was stamped with a code indicating the manufacturer to enable dealers and service engineers to obtain spares. The sets were otherwise unbranded, and the buying public were not able to identify which manufacturer made a particular set. Typical manufacturers codes were U1 – Bush Radio, U9 – Pye Ltd, and U33 – Roberts Radio Ltd.

Valves were also coded with the final figure of the code number indicating their manufacturer, e.g. 1 – Cossor; 4 – GEC; and 7 – Standard Telephones.

## Specification of the Wartime Civilian Receiver Mains Set

The following is the specification of the set:

- Circuit: Superhet; IF 460kc/s.
- Valves: BVA 273 frequency changer; BVA 243 IF amplifier; BVA 211 Westector metal detector; and BVA 264 pentode AF output stage.
- Frequency coverage: MW (medium wave) only.
- Tuning dial: Only two stations were marked on the dial, the 'Home' and 'Forces' Programmes.
- Tone control: No tone control.
- Aerial: External, wire. Two aerial input sockets, one for general use and one for the reception of strong local transmissions, which would otherwise overload the circuit.
- Audio output: Internal permanent magnet speaker.
- Power supply: AC mains, 200-250V, 50 cycles.
- Release date: June 1944.

## "Smacks of State Control"

*Practical Wireless* welcomed the production of the wartime receivers but did not favour their marketing on a 'government imposed pool system', commenting: *"It smacks too much of the people's set as in Germany. It smacks of state control, which this country does not want, and after the war will not have"*. The German Volksempfänger (people's receiver) mentioned was an inexpensive radio made available in Nazi Germany to ensure widespread reception of government propaganda. It was promoted with the slogan, *"All of Germany hears the Führer with the People's Receiver"*.

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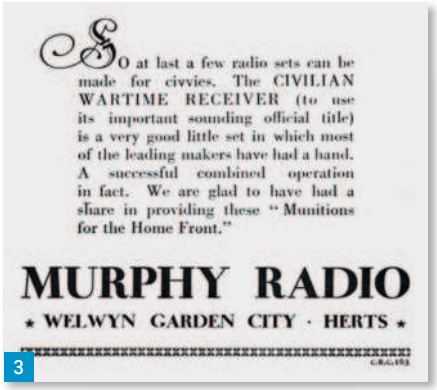
*PW* continued, *"We think the RMA should have insisted that manufacturers should be allowed to complete their receivers on their own individual lines... Members of the public would not be able to distinguish one manufacturer's product from another."*

As with the American sets, it has not been possible to find direct advertisements for the Utility set after its launch apart from a statement by Murphy Radio. Without claiming credit for its design, it simply referred to the company's involvement in the combined manufacturing operation, describing the receiver as 'Munitions for the Home Front' and 'a very good little set'.

## Modifications

After the war, some users modified their sets to obtain long wave (LW) reception, particularly in areas where the Light programme could not be heard on MW after dark. Bush Radio issued an instruction sheet, and *Practical Wireless*, March 1948,



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carried an article covering the conversion.

Readers were advised that it could be carried out for the sum of sixteen shillings (80p), and that *"apart from being able always to receive the Light Programme (on LW) without fading, the transmissions from Luxembourg are now very entertaining"*.

The BBC's National programme on LW, on 1500m (200kHz), had closed down at the outbreak of war. LW transmissions had recommenced in July 1945 with the launch of the BBC's Light Programme, which replaced the wartime General Forces programme.

Radio Luxembourg, on LW 1293m (231kHz), the commercial 'Station of the Stars', had also closed down at the beginning of the war. Its popular English language broadcasts had resumed on its original LW frequency in 1946 and were well received in the UK.

A later modification for the Wartime Civilian Receiver converted it to all-wave working: Short 15 – 52m; Medium 200 – 290m; and Long 800 – 2000m, but this was probably only carried out by more technically minded radio enthusiasts such as the readers of *PW*.

## Poor Take Up?

**Chas E Miller**, in his book *The Radiophile Book of the Wartime Civilian Receivers* commented *"Considering the extreme shortage of new radio receivers at the time the Utility set might have been expected to receive a warm if not rapturous reception but the reality was somewhat different"*.

He suggested that take up from the public was poor. Apart from the high price, the timing was bad. Europe had been invaded, the end of the war was in sight and normal domestic radio production could soon recommence. A wider choice of sets would be available and LW broadcasting would be returning.

Nevertheless, despite the combination of urgency and the need for economy, the design specifications from the RMA were extremely detailed and stringent and, he commented, this was the one British domestic radio whose performance could be checked against standard criteria.

## End of the War

The war was over less than a year later. By 1950 more attractive sets with more features and better performance were available. Demand was becoming greater for such sets as the number of broadcast receiving licences increased. In October 1945, for instance, 9,884,000 licences were on issue; and by November 1950 this number had increased to 12,334,000.

**Fig. 1: Wartime Civilian Receiver, mains model. Fig. 2: Wartime Civilian Receiver, battery model. Fig. 3: Murphy Radio advertisement. Fig. 4: Government surplus advertisement, June 1950. Fig. 5: The German Volksempfänger (people's receiver).**

The Wartime Civilian Receiver had now lost its attraction and was available from government surplus stores at the much-reduced price of £3.19.6d (£3.97½p). Today, surviving models in reasonable condition can still be obtained in the collectibles market, but at a somewhat higher price!

It was an interesting experience with government control overruling normal commercial practice, but it was certainly not popular with the manufacturers who, on this occasion, lost their individual identities.

It was a good basic receiver but with no special features. It served its purpose for a limited time and made a contribution to the war effort on the home front. In the history of the development of radio, however, it has no great significance apart from the story of why and how it was conceived. Or, as Murphy Radio claimed, it was simply *"a very good little set"*.

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# Are Conditions going to get Better?

**Steve Telenius-Lowe PJ4DX** reports on a recent publication that foretells a great sunspot cycle to come!

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Welcome to the September *HF Highlights*. Other than the big '*CQ*' contests (WPX in the spring and CQ World Wide in the autumn), one of my favourite contests of the year is the Scandinavian Activity Contest ('SAC'). This could be because I am married to a Swedish-born lady, I lived in Stockholm in the 1980s, and because I know many of the Scandinavian contest operators – but it's also because there is a lot of activity from Scandinavia in SAC, so operating in Search and Pounce ('S&P') mode is quite effective. (Operating from Bonaire, if I call *"CQ contest, only Scandinavia, Scandinavia ONLY"* I nevertheless still get called by many American, Italian, Spanish etc stations, so S&P mode is the only way to go in such contests!)

Last year I found conditions to be particularly poor from here to Scandinavia, so I was surprised to receive a metallic plaque, **Fig. 1**, in the post for being the highest-scoring station in South America. Propagation is naturally much easier between the UK and Scandinavia so this is a fun contest to operate from the UK, with good operators, typically strong signals and plenty of activity. This year the SAC CW contest is on September 19/20th and the SSB event on October 10/11th, from 1200UTC on the Saturday for 24 hours. See the SAC website for the full rules: sactest.net

Talking of contests, as this issue of *HF Highlights* is being put to bed, I have been taking part in the IARU HF Championship over the weekend of July 11th and 12th. I found conditions to be generally rather poor although there was a marginal opening to Europe on 28MHz during which I worked a few of the IARU HQ stations. I was also pleased to work the RSGB HQ station GR2HQ on 3.8 to 21MHz (though not on 1.8 or 28MHz). Almost all my contacts were with North America and Europe, with a few from South America,

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but there was little propagation from here to Asia or Oceania. One exception was a great early morning greyline contact with **Benny YG9WKB** on Biak Island off the north coast of New Guinea (IOTA OC-147) on 7MHz SSB. I think he was as surprised as I was by the QSO because he e-mailed me after the contact to say that he had only been running 30 watts to a rotary dipole and that I was 59+15dB with him. Despite his low power Benny was a good 58 with me: quite astonishing over a distance of 19,400km and considering that neither of us were using beams. It certainly made it worthwhile getting out of bed at dawn!

## Time to Prepare for Great Conditions?

We may still be bumping along at the bottom of the current solar cycle as it transitions from cycle 24 to 25 but you can be sure that, eventually, HF propagation conditions will improve. The only question really is just how good will propagation get by the peak of cycle 25? Almost all forecasts predict that cycle 25 will be another weak one, similar in magnitude to that of cycle 24 which peaked in 2014. But an interesting post by **Adrian McGonigle G0KOM** on the CDXC Reflector pointed out the publication of a new paper by five American and British scientists entitled *Overlapping Magnetic Activity Cycles and the Sunspot Number: Forecasting Sunspot Cycle 25 Amplitude*, which turns most predictions on their head. The paper is quite 'scientific' but its conclusion is crystal clear: *"we deduce that sunspot cycle 25 will have a magnitude that rivals the top few since records began. This outcome would be in stark contrast to the community consensus estimate of sunspot cycle 25 magnitude"*.

There should be a marginal improvement in HF propagation by the end of next year or in 2022 but we will still have to wait until about 2025 to see whether or not this new paper is correct. In the meantime we can but hope! If you want to read the full paper it is published on the internet at: arxiv.org/pdf/2006.15263.pdf

## Armed Forces Day SES

**Steph Foster G4XKH** wrote that the Riviera ARC recently operated special event station GB8AFD for Armed Forces Day from Torquay in South Devon, **Fig. 2**. *"We ran phone, FM, CW and data modes. In use was an off-centre fed dipole and a Flex 6400M SDR radio,"* she reported. GB8AFD made over 300 contacts worldwide.

## Readers' News

For the first few days of June and after the excitement of May's WPX CW contest with DX bands packed with signals, the best 'station of interest' that **Victor Brand G3JNB**, **Fig. 3**, could find was 4U2STAYHOME on 20m CW from the United Nations in Vienna. *"Similarly, **Eugene RU9CK** located in Yekaterinburg, Asiatic Russia, was calling for DX long after he should have been 'abed' but replied to my call, as did RG9A and OJ0JR on Market Reef. Sadly, scant pickings prevailed for days. Late on Sunday 14th, I could barely hear **Didier FY5FY**, French Guiana, on 30m at nowhere near his regular strength. Through the pile-up came 'G3?' and it took multiple calls to get across my suffix. Up band, CX2CC Uruguay could be heard weakly under serious DQRM. None of my calls succeeded so I tried a CQ at the band edge. No response, but the RBN revealed 14 spots from around EU plus a post from W3LPL confirming my aerial was still connected! Odd conditions prevailed although on 18th D2EB Angola appeared to come back to me on 40m but I was not sure and, on 30m, watery signals from both VR2XAN Hong Kong and ZZ60CRASMO*

**Fig. 1: Scandinavian Activity Contest plaque. Fig. 2: Ian G6TEQ operating GB8AFD in Torquay on Armed Forces Day in June. Fig. 3: G3JNB's traditional 'Top Band to Two' station keeps it simple and does the business. Fig. 4: John King ZB2JK being 'assisted' with the 10m 2-element Yagi. Fig. 5: New Hustler 6BTV vertical antenna at QTH of Carl 2E0HPI. Fig. 6: The EA5/G4VZV pedestrian mobile setup used by Ken Churms.**


*(!) Brazil faded out as dusk approached. However,* ***Luis CE2ML*** *Chile heard my 20m CW call late one evening despite deep QSB that had him copy me as G3JND. I had to up power to 100W to correct his log. Good to work HB0/OT4K working from Liechtenstein on 20m and also CJ3A Ontario who cleared up his pile-up before working me. Finally, I was heartened by the news that rig sales have soared during lockdown as operators returned to the hobby after many years of absence. However, wondering why I was not hearing them on air, I asking a DX friend why? 'Ah', said he, 'perhaps they are still reading the manuals?'."*

**Kevin Hewitt ZB2GI** reports that in the coronavirus crisis Gibraltar went from Phase 3 to Phase 5 of six in June, allowing free movement and gatherings in small groups. Portable operation from the Rock was therefore possible once again so he and **John King ZB2JK** put up the 10m two-element Yagi at the top of the rock, **Fig. 4** – only to find the band was dead!

It was good to hear from **Bill Ward 2E0BWX** for the first time since I started compiling this column in 2015. He wrote: *"At one time I used to send reports to* ***Carl Mason*** [GW0VSW, my predecessor as *HF Highlights* columnist – ***Ed***] *however, around five years ago I went QRT due to family issues. I returned to the hobby last year and my HF setup is an Icom IC-736 used for SSB and a Kenwood TS-480SAT used for data modes. My antennas are: 1.8 – 30MHz Hamtenna end-fed wire, 2 – 10MHz Prowhip 8 vertical. I have recently started using FT8 at 25 watts."* Bill sent in a list of European stations worked on 7, 14, 18, 24 and 28MHz, the best DX of which was TF5B on 40m. Welcome back to the hobby Bill and we look forward to receiving more reports from you in future now that you are active once again.

**Etienne Vrebos OS8D** and **ON8DN** says his activity was *"very quiet actually, 150 QSOs this month and I really did do my very best. I do give priority to the courageous stations working /P and QRP (whenever they announce it). Last week I bought the new Icom IC-9700, a nice little transceiver for VHF, UHF and SHF... be sure I will not leave HF and your part of* PW*!"* I'm sure **Tim GW4VXE** would be interested to receive reports on your VHF/UHF activity for his *World of VHF* column, Etienne.

**Reg Williams G0OOF** says, *"It looks like I have missed the action on 10 and 6m over this season from the comments I see on the CDXC Reflector... On 10m I have a problem trying to tune the Butternut vertical, which you would think would be the easiest to tune to resonance... I have found the bands available to me fairly poor here on SSB with mainly European stations to work. Once again I have reverted to the FT8 mode to make some DX contacts, which have been reasonably fruitful. It has meant some very late nights and early mornings trying to increase my count for USA States, Counties and DXCC. I hope to continue doing this on SSB when conditions improve. The band I like working in particular is 10MHz, which has turned up some nice contacts even at this time of year. The best contacts for DX during June have been on the 7MHz band with Australia VK7MZ and VK7AC and Mexico XE1KK. 14MHz provided me with China BG0BBB. I have never worked Mexico or China on SSB so was pleased to get them on FT8."*

**Tony Usher G4HZW** says that *"Much of my time was taken up getting to grips with my new camera, a Panasonic Lumix DMC FZ-1000, a present from my XYL to celebrate our 49th wedding anniversary. The basic manual runs to 96 pages! Still there was plenty of time for my favourite band and it's provided some remarkable results once again. Among the 187 contacts during the current period I was delighted to work Japan at last on 10m using FT8, with three contacts on the evening of June 19th (coincidentally bringing up the 100th DXCC entity for 2020 on the band). Other highlights included my first VE6 the previous day and K7RL in Washington state, but I missed out on Alaska with KL7XO and KL7TC, both heard when I was away from the computer. On July 5th at 2005UTC I saw MW0ZZK work NH6Y on the island of Hawaii, an amazing contact considering we're still bumping along the bottom of the sunspot cycle! As conditions improve such events will become commonplace and long-path openings to VK and ZL at night possible once again, such is the power of the FT8 mode."*

**Owen Williams G0PHY** wrote that *"Now the RSGB Hope QSO Parties have finished activity at G0PHY has dropped off. Conditions were poor for the RAC Canada contest and I only managed two VE contacts. As I write this the IARU contest is in full swing and there is the IOTA contest to look forward to, although it will be a*


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*little different this year as the RSGB has stated that the contest is [only] for single operators at Fixed Island or World stations. So far in the IARU contest I've had contacts on 7, 14, 21 and 28MHz, all with European stations apart from four US stations on 21MHz... I'm still practising CW using AA9PW's website and working my way through the alphabet."*

While known best for his /P portable operating, **Carl Gorse 2E0HPI** took the opportunity of being in lockdown to install a Hustler 6BTV in his garden with many radial wires under the lawn, **Fig. 5**. Carl says it is giving him *"excellent results on all bands from 80 to 10m"*. He is now active on FT8 and FT4 using an Icom IC-7300 and recently worked five new DXCC entities – Colombia, Dominican Republic, Ecuador, St Lucia and Kenya – to take his total to 106 DXCC worked.

**Ken Churms EA5/G4VZV/M** (actually Pedestrian Mobile, **Fig. 6**, see also August 2020 *PW* page 38) says he has *"returned to Spain in the past few days... First outing this evening (Thursday July 9th) at the salt lagoons, 20km south of Alicante and working on the 20m band resulted in many UK stations worked including five 'G' stations from my local radio club Denby Dale, near Huddersfield. Later in the evening worked into PY and then in a big pile-up worked VP8LP in the Falklands Islands. The band was opening up well into mid-evening and had it not been for the then low battery power I'd have worked many more DX into South America. A good start for day one!"*


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## Around the Bands

**Kevin ZB2GI: 7MHz FT8:** TM80CDG, ZL3IO. **10MHz FT8:** 9Y4DG, EA8DHH, GB9BLM, GJ0KYZ, K0MLD, NP3DM, TR8CA, W4TTZ, ZL3IO. **14MHz SSB:** 9Z4FE, 9Z4M, AC4BV, FM5DN, K2AR, KK6BT, KP3DR, LU4MBY, N9CQB, VE2AR, VE3FRR, W1GC, WX3G. **14MHz FT8:** J68HZ, ZS1DX. **21MHz FT8:** CE3KL, OD5YA, PU7RJB, PY2XC, PY3WW, WJ0T. **28MHz FT8:** K1RI, PY2KNK, VE1HQ, WN4N.

**Bill 2E0BWX: 7MHz FT8:** TF5B. **28MHz FT8:** EC5WR, HA1RB, IZ5IMB, LA3WAA.

**Carl 2E0HPI: 7MHz FT8:** GX7WAB, TM80CDG. **10MHz FT8:** SV1LIP. **14MHz FT8:** 5Z4/G3AB, 9K2NO, HC1E, HI8RMQ, HK6DOS, J68HZ, PY5JO.

**Etienne OS8D/ON8DN: 14MHz SSB:** 5A0YL, A71VV, AH6U, AT2SH, CE6CGX, EX8VM, EY7AD, UN7QF, VU2VID, VU3WEW. **18MHz SSB:** CQ8F. **28MHz SSB:** OH0BHU.

**Reg G0OOF: 7MHz FT8:** J68HZ, VK7AC, VK7MZ, XE1KK. **10MHz FT8:** CE2SV, CO7DSR, HK3W, WP4J. **14MHz FT8:** 8P6QA, BG0BBB, HC1DAZ, HK2AQ, J68HZ, OD5KU, YV1FM.

**Tony G4HZW: 28MHz FT8:** 8P6ET, 9Y4DG, A75GE, CE2SV, HC1DAZ, HI3CMM, HK4GSO, J68HZ, JE2DZC, JR2LJO, JR7TEQ, LU7ADN, OA9DVK, PT2HL, R8CCC, RA0R, S01WS, UK8IF, UN7IO.

**Owen G0PHY: 14MHz SSB:** VA2UR, VE3KZ. **21MHz SSB:** K5ZD, KC1XX, N1UR, NU1AW.

## Signing Off

Thank you to all contributors. Please send all input for this column to **teleniuslowe@gmail.com** by the 11th of each month – photographs of your station or activity would be particularly welcome. For the November issue the deadline is September 11th. 73, Steve PJ4DX.

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# Portishead Radio

**Don G3XTT** takes a look at a recently-published book about the maritime radio service and, in particular, Portishead Radio.

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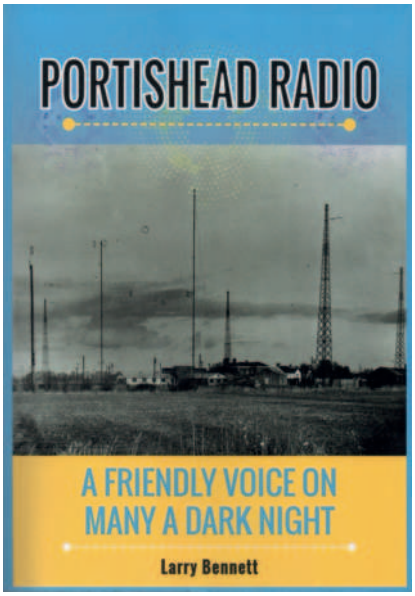
In the April 2020 issue of *PW* we ran an article by **Larry Bennett G4HLN** entitled *100 Years of the UK Long-Range Maritime Radio Service*. Larry has now written and published a book going into the subject in much more detail. Entitled *Portishead Radio*, it focuses on the work of the Portishead Radio station (receiving station at Highbridge, transmitter site at Portishead) from its early days in the 1920s until its closure in 2000.

The book goes into lots of detail regarding life at the station, procedures and, indeed, the ongoing politics as, for example, it was several times faced with closure, only to be given a reprieve. There's not a lot about the actual radio equipment used but the antenna systems are described as they evolved over time to serve the changing requirements of the station.

The chapters basically follow the decades over which the station was active, but with one chapter dedicated specifically to dealing with aircraft, yachts and fixed station while another focuses on daily life at the station over the years.

And although Larry himself was employed at Portishead, he includes short Annexes giving some details about several of the other maritime stations, notably Leafield, Ongar, Dorchester, Criggion, Baldock, Bearley, Somerton and Brent. Perhaps of particular interest to many *PW* readers, though, is the Annex detailing the various Morse keys used over the years at Portishead.

Portishead was one of the busiest (the busiest?) maritime stations in the world for many years, handling both short- and long-distance communications with merchant vessels and, during the war years, with naval vessels too. As an HF enthusiast I was particularly interested to read of direct communication between Portishead and ships in the Pacific – oh for access to their rhombic antennas!




Of course, despite their later efforts to diversify, for example into aeronautical communications and to serve domestic boat owners, the advent of cost-effective satellite communications was always going to signal the end of the seagoing and shore-based radio officers and their awesome skills with Morse code. It's hard to believe the way that in days gone by they were able to sustain long and accurate exchanges with distant ships while listening on, for example, a CR100 receiver. After all, the CR100, while state-of-the-art at the time, would hardly be considered a suitable receiver for day-to-day HF operation nowadays.

While the book, being self-published, has a few typos and editorial problems, it makes for a fascinating read for anyone interested in the history of maritime communications, with lots of photos to complement the text, and the price is very affordable compared with many other historical tomes.

*Portishead Radio* is published by New Generation Publishing, ISBN 978-1-80031-896-0. It costs £9.99 and is available through Amazon or signed/dedicated copies can be obtained through the GKA website (below): www.portisheadradio.co.uk

**Continued from page 12**

case. This included running 400W PEP into the antenna.

Some articles on the G5RV recommend winding the coax into a coil to form an RF choke. There are more than enough of these designs to be found on the internet. However, this type of choke has narrower bandwidth than ones using ferrite material and although they might offer high common mode rejection on some frequencies, they may not offer enough at others.

My advice would be to use a 1:1 RF choke at the base of the ladder line if EMC issues or RF feedback are encountered. Every situation is somewhat different and I may just have been lucky.

An RF choke can also be used at the shack end if necessary.

## General Performance of the G5RV

Like any simple wire antenna, the higher up one can erect it then the better it will perform, especially if out in a straight line.

I have found that my G5RV is a little quieter on 80m reception than my previous 40m long Windom.

It is a very good high angle inter-G and EU antenna for 80m as one would expect. On 40m (using 20W of FT8) I have been logged on PSK Reporter down into VK and SE Asia during the evening. On the same mode and power it easily gets across to the States on 20m and 17m during the day. I have not used it on 15, 12 or 10m as yet.

The antenna offers a multi-lobe pattern on 14MHz and above. It can be expected to show some slight gain in these lobes. More information on the patterns produced by the G5RV is easily obtainable on various internet sites.

## Summary

At £34.95 I feel the MCR Communications-made G5RV is a well manufactured product and offers good value for money. However, it is important to remember that you do need to use an ATU with any G5RV to obtain a good match on all bands.

MCR Communications also plan to offer the double sized (62.18m) G5RV that also covers 160m as well as the 'ZS6BKW' antenna. Other antennas produced by the company can be seen on their website listed at the start of this article.

## References

www.w8ji.com/g5rv facts.htm
https://tinyurl.com/y2bthfzk
https://tinyurl.com/yxhjlwpu

**Steve White G3ZVW**
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# RADAR

**Steve White G3ZVW** takes a look at a form of radio communication that's going on around us all the time but which very few people think about, even though it is very important – RADAR.

The history of RADAR (RAdio Detection And Ranging) and the research which resulted in it goes back a long way. In the 19th Century German physicist **Heinrich Hertz** (the man whose surname is used as the unit of measure for frequency) knew from experiments he conducted that radio waves were reflected by metallic objects. In the early part of the 20th Century another German, inventor **Christian Hülsmeyer**, developed the first practical radar. It was fitted in ships to help them avoid colliding in the fog. Other radar systems were also developed, but they were all fairly short range.

They say that necessity is the mother of invention, and never was that more so than shortly before and during WWII. Numerous technological advances were made during WWII, including longer range radars. Scientists and engineers in several countries were working on lots of different systems to extend the range and accuracy of radars, but Scottish inventor **Sir Robert Watson Watt** (who worked for the General Post Office in London) is widely regarded as having made a very significant contribution. His team developed the Magnetron, a special kind of radio valve. What was special about it was that it could directly produce high output power at microwave frequencies. It was radically different to other powerful valves of the day, which for technical reasons could not work on microwave frequencies. Basically, they were too physically large to work at such short wavelengths.

## Frequency

First, here's a fact. As frequency goes up, the wavelength of a radio signal goes down. There's a very simple relationship between the two. In **Table 1** you can see just a few comparisons of frequency versus wavelength, the relationship being governed by the speed of light.

In the last instalment of *Making Waves* I said that the strength of a radio signal reflected (or scattered) off an aircraft gets stronger as frequency is increased, because the aircraft becomes a larger target in terms of wavelengths. To give you an example, an Airbus A320 has a wingspan of 35.8m. That makes it 35.8 wavelengths long at 300MHz (1m) but 358 wavelengths long at 3000MHz (10cm). It stands to reason that there will be a much stronger reflection at the higher frequency, because as far as radio waves are concerned it appears to be ten times the size. It also stands to reason that because the reflection is stronger at the higher frequency, for any given sensitivity of receiver that forms part of a radar station, an aircraft will be 'visible' further away. Happily, it gets ever easier to engineer a highly directional antenna as frequency increases, which is another reason to use microwave frequencies for radar.

In WWII the race was on to produce higher power radars that were operating at ever higher frequencies. One of the main reasons was indeed to detect aeroplanes (which are small, compared to ships) and detect them further away (which results in them being very small radar targets). Consider this, too. If you can detect smaller objects, you should also be able to see on your radar screen if one aircraft or a squadron of them are in the sky.

We take radars for granted, but developing the technology for radars that could work on a much higher frequency was no mean feat. Really early radars were not like modern radars. They were big, the displays didn't look much like the displays of modern radars and operating them was a skilled job, so yet another race was on to make them smaller and easier to use.

Another problem with early radars was that low flying planes could not be detected. 'Flying under the radar' is a term still in use today. It is exactly why fighter-bombers fly low.

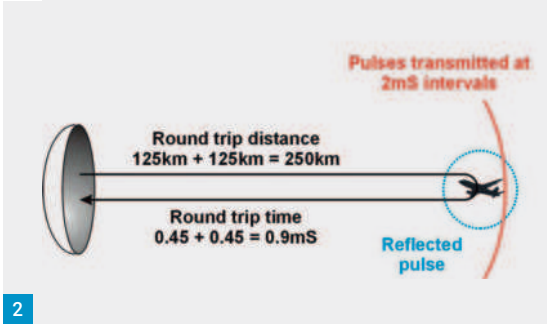
**Fig. 1: The Approach Surveillance Radar (ASR) dish at Exeter Airport. Fig. 2: A radar pulse being reflected by an aircraft. Fig. 3: A radar dish sends out pulses in a circle.**

## How Radar Works

Not all radars work exactly the same, so I am going to give just two examples – a scanning radar and a fixed radar.

A scanning radar, such as you might find at an airport, transmits a regular stream of highly focused pulses of radio frequency energy. No antenna is perfect, so the radiated energy gradually spreads out as it travels away from the antenna, just like the beam of even an expensive torch gradually spreads out as it gets further from you. A lot of scanning radar antennas look like the one shown in **Fig. 1**. Horizontally (i.e. in the direction of rotation) the energy is tightly focused, but vertically (i.e. up and down) it is less so, which enables the radar to detect objects at higher angles. Such an antenna is sometimes tilted back a little, to help it 'see' targets at high angles. Alternatively, a second antenna may be stacked on top of the first.

In my example pulses of energy are transmitted every two milliseconds. This equates to 500 pulses per second. The duration of



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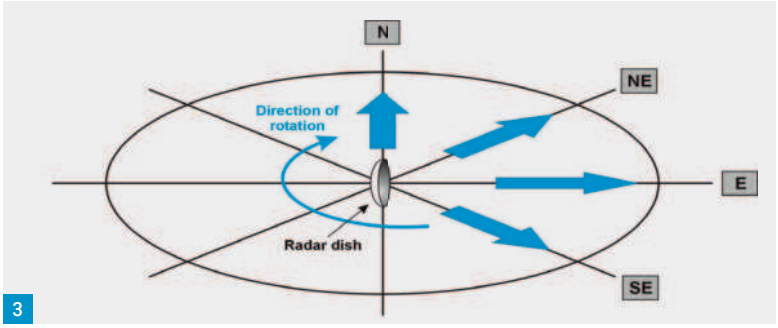

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each pulse is two microseconds, which equates to 1/1000th of the two millisecond period. Put simply, this means that the radar is not transmitting for 99.9% of the time. This is important, but more about it later.

The transmitted pulse travels at the speed of light, so 100 microseconds later it will be 30km away and one millisecond later it will be 300km away. Because of the curvature of the Earth, 300km is approximately the practical limit for detecting an aeroplane from a radar station on the ground, although most radars limit their range to less than that. **Fig. 2** shows a pulse being transmitted and reflected from a plane that is 125km from the radar. The reflected pulses spread out more or less evenly. I am showing just one pulse being reflected, but in reality there will be 500 of them every second. During the 99.9% of the time that the radar is not transmitting it is listening, so reflections make their way back and are received. The total distance to the aircraft and back is 250km, so a pulse is received back 0.9 milliseconds after it is transmitted. This is well inside the 2 milliseconds between transmitted pulses.

In **Fig. 3**, imagine the antenna is pointing North at the start of the process. The first pulse is transmitted North, the second pulse is transmitted North East, the third pulse East, and so on in a circle. The radar display is synchronised to the rotation of the dish. In reality the pulses are transmitted when the antenna has moved a lot less than 45°. Indeed, to give the system accuracy there will be several pulses for every degree that the antenna moves.

Now let's go back to consider the power of a radar transmitter. No transmitter is 100% efficient and powerful transmitters get hot, but if a transmitter is only required to be 'on' for brief periods it has plenty of time to cool down between each period. This is known as 'duty cycle' and it means that you can run a transmitter at much higher power. Add into the equation the fact that the radar antenna has quite a lot of gain, the Effective Radiated Power (ERP) of a radar can be huge. This makes detecting a distant target easier.

It is worth mentioning that the speed of rotation of a radar dish can tell the observer something about what it is used for. A fast rotating dish will be used for shorter range detection, while a slower rotating dish will be used by a system looking for things further away. An Airport Surveillance Radar dish turns about 12-15 times per minute, so its display gets updated every 4-5 seconds.

## Cone of Silence

There's a problem with highly directional radars – and it stems from the antenna itself. The antenna transmits pulses in the general direction of the horizon and because they are highly focused practically no energy goes steeply upwards or straight up. This means that such radars are not good at detecting objects at high angles or overhead. It is known as the cone of silence. It doesn't affect marine radars, but it certainly affects aircraft radars.

## A Problem Averted

Imagine once again the radar I've described above, sending out pulses at two millisecond intervals. An object that happens to be 500km away returns an echo, the total path length for the signal being 1000km. I have given these figures because they are four times as much as before. This means the round-trip time for the signal is also four times as long as before, i.e. 3.6 milliseconds.

Now, here's the problem. The radar transmitted another pulse after two milliseconds and it doesn't know which transmit pulse resulted in the echo. All it detects is an echo 1.6 milliseconds after a transmit pulse, so it will think the echo is from an object 222km away. This is a ghost echo and you can get multiples of them, though they get weaker as distance increases. Incidentally, the only thing that could have been 500km away would be a satellite – which do reflect radar signals. It couldn't be a plane that far away, because the curvature of the earth would mean it was way outside of the atmosphere.

So how is it that radars don't suffer from this problem. The antenna itself is the answer. Radar dishes rotate and are sufficiently directional that by the time ghost echoes return they have moved far enough on not to be pointing in the right direction to receive them.

## Fixed Radars

Now, the fixed radar – the kind of technology used in a roadside speed camera. Perhaps the most common type of speed camera in the UK is the Gatso, but there are several others.

Just like scanning radars, a Gatso transmits a regular stream of pulses at microwave frequency. The transmit power is low because the range over which the system operates is short. Pulses reflected from a vehicle are received back by the Gatso. If a vehicle in view is stationary, the time period between each transmitted pulse and each received pulse will all be the same, but if the vehicle is moving towards the Gatso the delay between the transmit pulses and the received pulses will get ever shorter. Likewise, if the vehicle is moving away from the camera, the delay of the return pulses will get ever longer. Electronics in the camera calculate the speed of the vehicle from the time differences and how far away the vehicle is from the camera by the return delay time.

## The Magnetron Legacy

The magnetron has been superseded and is no longer widely used in radar systems, but that doesn't mean it has disappeared off the face of the planet. These days vacuum valves are regarded by many as being ancient technology, so it might surprise readers to learn that magnetrons are still being made – and in huge numbers. Their widespread use today is as the source of radio frequency energy in microwave ovens.

| Frequency | Wavelength |
|---|---|
| 100MHz | 3m |
| 300MHz | 1m |
| 1000MHz | 30cm |
| 3000MHz | 10cm |
| 10000MHz | 3cm |

**Table 1: Example frequencies/wavelengths.**

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# A Portable AM HF Receiver

**Eric Edwards GW8LJJ** describes a portable receiver for AM reception on 80 through 60m.

This is a portable AM DSP (Digital Signal Processing) broadcast receiver using an Si4825, which is a very useful integrated circuit from SiLabs. This design covers the amateur AM portions of the 80m and 60m bands using DC tuning control. The frequencies normally used on 80m are 3615kHz and 3625kHz with 5317kHz being a popular frequency on the 60m band. There are other frequencies used by UK and continental stations so it may be worth looking around. This receiver, being portable, **Fig. 1**, is ideal for tracking local interference as well as listening for the commercial AM broadcast stations found at the top end of the 60m band.

## The Si4825

The Si4825 integrated circuit, which was introduced to me by **Ray G7BHQ**, is a complete (broadcast) radio receiver from antenna-in to audio-out. It is an FM receiver covering 64 to 109MHz, with medium wave (MW) AM coverage of 504 to 1750kHz and shortwave (AM) 2.3 to 28MHz. The frequency bands are internally programmed by SiLabs and are selected by using an external set of 1% resistors. The FM range has 18 bands, the MW has five bands and the short wave has a selection of 18 wide or narrow band coverage. The wide band tuning covers a wide frequency range, while the narrow band is less than 1MHz. This project uses the 3.2 to 7.6MHz (wide) band but limited to 3.4 to 5.9MHz to make it more useful for tuning the 80m and 60m bands. The narrow band, if selected from the same resistor network selection, is 3.2 to 3.4 MHz, which is not suitable for this project and cannot be made wider. This extensive band coverage allows 59 bands to be employed if all the wide and narrow bands are used.

There are no bandpass filters at the input to the radio chip but if used with a whip antenna or an indoor antenna, it will be possible to receive lots of stations without too much interference from local broadcast stations. If an outside antenna is used, then it would be prudent to use bandpass filters for all the bands in the shortwave section. I initially built it up on breadboard and selected the broadcast FM (VHF) channels. I was very surprised by the reception obtained with about 5cm (2in) of wire for the antenna. The broadcast stations on the MW band also produced similar results. When testing several shortwave bands it was receiving stations on a short length of wire (150cm, 6in) but when connecting it to my half-wave 80m G5RV-type antenna, more stations than it should have were received because of no band filters being employed. To make filters for all the shortwave bands would be quite a challenge involving complex switching and other routing problems so I decided to limit the range to one band. The choice of band was determined by realising that amateur AM activity is mostly on the 80m and 60m bands.

## Bandpass Filter

The bandpass filter is a Butterworth design and is reasonably flat, covering 3.3MHz to 5.9MHz. It is important to use close tolerance components or measure components with other tolerances to ensure the values are as stated on the circuit and component list otherwise it will not provide the desired response. This applies to any filter designs, be it Low Pass, High Pass or Bandpass. This design was based on the 'ELSIE' from TonneSoftware, listed in the Reference section.

## Other Bands

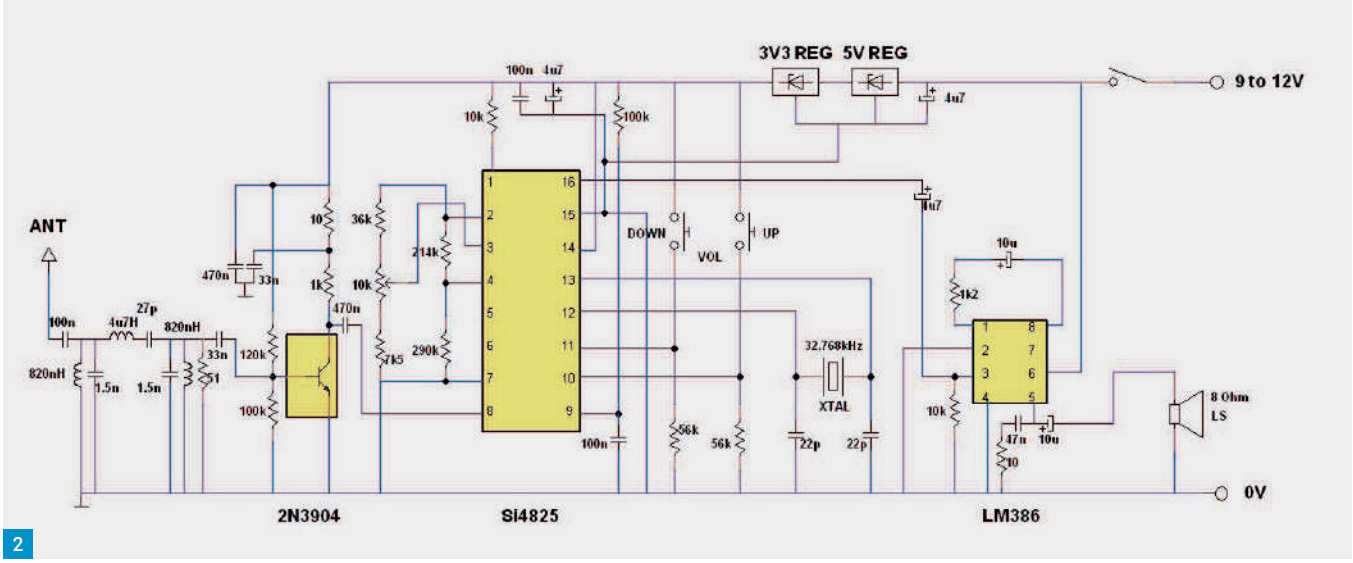
The datasheet (Si4825-A10 PDF) shows a simple setup for a choice of SW, MW or FM band by a selection of a combination of four resistors. The full range band selection is shown in the datasheet Si4825-DEMO PDF. These certainly work but as explained earlier, bandpass filters are needed otherwise lots of unwanted stations will also be received. The FM band (broadcast) makes a very good receiver in its own right and no bandpass filter is needed. Only about 6in of wire was used for the antenna at my location and the audio quality was very good on this band. It is important to keep to the resistor values in the divider chain and is the reason for using 1% tolerance resistor values for all of the bands selected. The tuning control is also critical in resistance value and a 100kΩ ten-turn potentiometer or a 100kΩ standard (linear) type with a slow-motion control fitted should be used here.

1

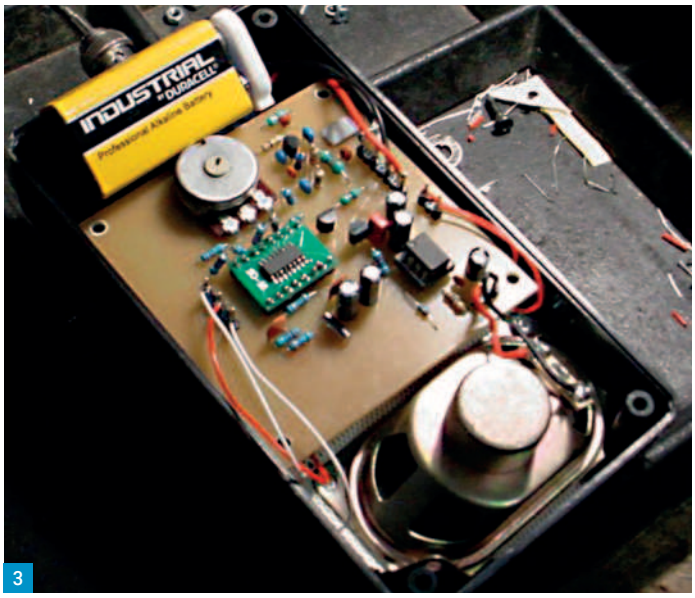
## The Circuit

The circuit is shown at **Fig. 2**. The antenna is connected to a bandpass filter via a 100nF capacitor for isolation. The filter components have been selected for a flat response from 3.3MHz to 5.9MHz, **Fig. 5**. The main reason for the filter is to remove any strong MW broadcast signals. A high pass filter could have been used but it was decided to remove any possible strong continental broadcast signals above 6MHz as well, so a bandpass filter was chosen. The output of the filter goes into a transistor preamplifier to give a little gain and then into pin 8 of the Si4825 integrated circuit.

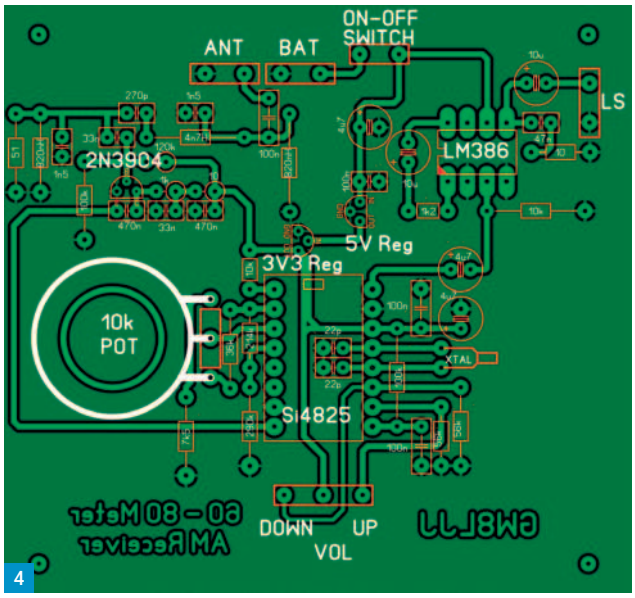
The band is selected with the resistors connected to pins 2 and 4 on the Si4825, and the tuning range is with a ten-turn, or standard linear potentiometer with a slow-motion drive, and the resistors connected at either end of the control. The Si4825



2



3



4

requires a 3.3V supply so a regulator is fitted but as this works with a maximum of 6V input, I have placed a 5V regulator before it. The whole circuit can now work with a 9V battery or the shack 12V (13.8V) power supply. There is a reference crystal used, which is a watch type with the frequency of 32.768kHz. The volume is controlled with a centre biased off two-way toggle switch (or push-button switches can be used) and holding the switch in the up or low positions adjusts the audio level into the LM386audio amplifier. The output drives an 8Ω speaker with loud signals.

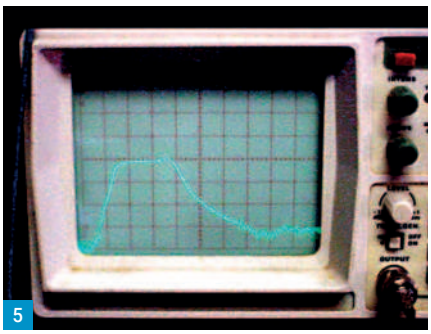
## The PCB

The PCB layout appears at **Fig. 4**. This is single-sided and with a ground plane to keep earth loops to a minimum as is general practice for RF circuits. The tuning potentiometer is a PCB type and is fitted to the PCB with a nut and washer and the pins soldered. Pins are used for all the external connections and are standard PCB types. The Si4825 is a surface mount component that is soldered onto an adaptor board to enable it to be used as a DIL (Dual-in-Line) type component. The two crystal capacitors (22pF) are to be soldered in place before the Si4825 is fitted because they are underneath the adaptor board. The finished board is shown at **Fig. 3**.

**Fig. 1: The finished receiver. Fig. 2: The circuit diagram. Fig. 3: Inside the receiver, showing the assembled PCB. Fig. 4: PCB layout (not to scale). Fig. 5: The bandpass filter response.**

## Is there a Kit?

I am offering my usual PCB and picking list where there is a choice of all the parts that are to be fitted on the PCB.


5

## References

PCB and parts list
ericgw8ljj@outlook.com
Si4825 data sheet: Si4825-A10 from SiLabs
Si4825 extra data:
AN738 and Si4825-DEMO Users Guide
Filter Design
www.TonneSoftware.com

# The Twelfth Practical Wireless 70MHz Contest

**Colin Redwood G6MXL** invites readers to participate in the Practical Wireless 70MHz Contest.

The 12th Annual *Practical Wireless* 70MHz Contest takes place on Sunday September 27th 2020 from 1300 to 1600UTC.

The contest is split into two sections. The low-power section with a power output limit of 10W enables Foundation Licence holders to compete on an equal basis with other low power stations. The high-power section allows stations to run up to the full power permitted by their licence.

You may operate from a fixed location **or portable subject to complying with the spirit and letter of prevailing government coronavirus regulations and guidelines.**

For those new to the 4m band, the *PW* 70MHz contest is a great introduction to the friendly nature of contesting found on the band.

## Equipment

The choice of equipment at 70MHz (4m) continues to improve.

For SSB and CW operation, Kenwood's TS-890, Icom's IC-7100 and IC-7300 transceivers and the Yaesu FTdx101 all offer the 4m band in addition to the traditional HF and 6m bands.

Less well known is the Noble NR-4SC, a dedicated 4m SSB/CW (but not FM) transceiver, which was reviewed in the March 2015 issue of *PW*. The UK version of the older Yaesu FT-847 also covers 4m and can often be found second-hand.

Transverters are still used by some 4m operators and are available from a number of sources. Most use an intermediate frequency (IF) of either 28MHz or 144MHz, taking the 28MHz output from an HF or 144MHz transceiver and mixing with a local oscillator to give 70MHz for transmit and vice versa on receive. Transverters usually require drive levels much lower than the full output power of most HF and VHF transceivers, sometimes as little as a few milliwatts. You may need an attenuator unless your main transceiver has a low-power output to suit your transverter.

A number of FM transceivers for 4m are available such as the Wouxuns's KG-UDV1P/L 4m and 2m dual–band and KG-699E 4m handhelds, the Wouxun KG-UV950PL mobile and the Mydel ML-5189 mobile.

## Antennas

Many stations will perhaps be using nothing more than a simple dipole or quarter-wave vertical. Stations with Yagi antennas are likely to have fewer than six elements. A number of suppliers now offer commercial 4m Yagis.

Vertically polarised antennas are generally used for FM and AM operation. For SSB and CW, most stations use horizontally polarised antennas. For those who like building antennas, there are a number of designs for the 4m band on the *PW Antenna Collection Archive Disc*.

## Operating

I'd suggest spending some time on FM and AM in addition to SSB and CW. If you are unfamiliar with the 4m band, you could be surprised at just how many stations are using these modes.

In recent years there has been increasing activity from the continent in addition to activity from almost all parts of the British Isles, including a number of EI stations. It is easy to miss out on contacts simply by not rotating directional antennas in all directions. Don't forget that slow QSB (fading) is a common occurrence on the 4m band, so you may miss a station altogether if you don't rotate a directional antenna a number of times during the contest. The QSB can cause stations to disappear for a minute or two and then re-appear.

## Entries

Don't forget to submit your entry after the contest. Although electronic entries via e-mail are preferred and make the task of the adjudicator much easier, legible paper entries continue to be welcome. The e-mail address for logs is

**entries@pwcontest.org.uk**

Do make a note in your diary now. The 12th *Practical Wireless* 70MHz Contest takes place on **Sunday September 27th 2020**. If you plan to use batteries, don't forget to charge them a day or two before and put a reminder in your diary to submit your entry to be received by **Tuesday October 13th**. Let's hope for some good weather and propagation on the day so that we can all have a really enjoyable time.

## The 12th Practical Wireless 70MHz Contest Rules

**www.pwcontest.org.uk**

## The 2020 Rules

**1. General:** The contest is open to all licensed radio amateurs, fixed stations or portable, using SSB, CW, AM or FM in the 4m (70MHz) band. Entries may be from individuals or from groups, clubs and similar organisations, provided that **all operation is in accordance with the spirit and letter of prevailing government coronavirus regulations and guidelines.** The duration will be from 1300 to 1600UTC on September 27th 2020.

All stations must operate within the terms of their licence and only transmit within the 4m licensed allocation. Stations using transverters are reminded to be careful not to transmit out of band.

Subject to licence conditions, split frequency operation is permitted for the purpose of working stations in countries with different 4m allocations. Cross-band contacts where either station is not operating between 69.0 and 71.0MHz will not count for points.

Entrants must observe the bandplan for their country and keep clear of normal calling frequencies such as 70.200MHz. Entrants must avoid using any frequency that is obviously in use for non-contest purposes. **The 4m band is not an exclusive amateur band in many countries. Contest stations must allow all other users (including non-amateur users) of the band to carry out their activities without hindrance.**

The station must use the same callsign throughout the contest and may not change its location. Entrants not operating as a fixed station must use the /P callsign suffix.

**2. Contacts**: Contacts will consist of the exchange of the following minimum information:

(i) callsigns of both stations (**including any /P suffix**)
(ii) signal report, standard RS(T) system
(iii) serial number: a 3-digit number incremented by one for each contact and starting at 001 for the first contact
(iv) locator (i.e. full 6-character IARU Universal Location for the location of the station).

Information must be sent to and received from each station individually and contacts may not be established with more than one station at a time. Simultaneous transmission on more than one frequency is not permitted.

If a non-competing station is worked and is un-

able to send his full universal locator, his location may be logged instead. However, for a square to count as a multiplier (see rule 4), a full 6-character locator must have been received in at least one contact with a station in the square.

Contacts via repeaters or satellites or using any digital voice modes (including D-STAR, Fusion and DMR) and data modes or machine generated modes, such as FT4, FT8, JT65, PSK31 and RTTY, are not permitted. The use of the DXCluster, ON4KST chat or similar is limited to setting up contacts and not for requesting or passing reports, serial numbers or locators, which must only be exchanged on the 70MHz band.

**3. Power**: In the low-power section, the output power of the **transmitter** or **transverter** final stage must not exceed 10W PEP. If the equipment in use is capable of a higher power, the power shall be reduced and measured by satisfactory means. Stations cannot rely on feeder loss to meet the 10W power limit. In the high-power (Open) section, stations may use whatever power they are permitted to use by their licence conditions.

**4. Scoring**: Each contact will score one point. The total number of points gained during the contest will then be multiplied by the number of different locator squares in which contacts were made (a square here is the area defined by the first four characters of the universal locator).

Example: 52 stations worked in IO81, IO90, IO91, IO92 and JO01 squares; final score = 52 × 5 = 260.

Only one contact with a given station will count as a scoring contact, even if it has changed its location, e.g. gone /M or /P. If a duplicate contact is inadvertently made, it must still be recorded in the log and clearly marked as a duplicate (not necessary in computer logs submitted by e-mail).

**5. The Log**: Logs may be submitted by e-mail or by post. In either case the log must contain the following information for each contact:

(i) time (**UTC – NOT BST**)
(ii) callsign of the station worked (**including any /P suffix**)
(iii) report sent
(iv) serial number sent
(v) report received
(vi) serial number received
(vii) locator received (or location).

The preferred form of a log is a computer file sent by e-mail. This may be generated by contest logging software such as MINOS or EI5DI's SDV, or a file in any other suitable format (plain text is fine) provided each of the items above is separated by a separating character such as a comma or tab (please don't mix separators). Give the file a name, including the station callsign (e.g. g6mxl-p.log), and send as a standard e-mail attachment to: **entries@pwcontest.org.uk**

The REG1TEST, .log, .edi and .adi formats or the spreadsheet available on the contest website are preferred. If there is any problem with your entry, you will be contacted by e-mail.

Log sheets and covering information sheets for paper-based entries are available for downloading from the contest website: **www.pwcontest.org.uk**

**6. Entries**: The covering information listed below must be provided with each entry. The preferred method of submitting this is by the use of the online facility on the website. Alternatively, the information may be written in the e-mail message to which the log file is attached. For entries sent by post, it should be written on a separate sheet of A4-sized paper. The information required for every entry is:

(i) name of the entrant (or of a club etc. in a group entry) as it is to appear in the results table and on the certificate
(ii) callsign used during the contest **including any /P suffix** (e.g. G6MXL/P)
(iii) name and address for correspondence
(iv) location of the station during the contest
(v) full 6-character locator as sent during the contest
(vi) whether single or multi-operator (a single-operator is an individual who received no assistance from any person in operating the station, which is either his/her permanent home station or a portable station established solely by him/her); if multi-operator, include a list of operators' names and callsigns
(vii) a full description of the equipment used, including transmitted PEP output power
(viii) if you are entering the low-power section and the transmitting equipment (including any transverter employed) is capable of more than 10W PEP output, a description of the methods used (a) to **reduce** and (b) **measure** the output power
(ix) antenna used and the approximate station height in metres above sea level (ASL)
(x) if you receive or send a report of poor-quality signals (e.g. wide/splattering), full details of the complaint, including time, callsign, nature of complaint and actions taken **during** the contest to investigate and resolve
(xi) the following declaration must be included in the e-mail text or written and signed by the entrant: *"I confirm that the station was operated within the rules and spirit of the event and that the information provided is correct"*.

Failure to supply the required information may lead to loss of points or disqualification.

Entries by e-mail must be sent to **entries@pwcontest.org.uk**

Paper entries should be sent to: Practical Wireless Contest, c/o Colin Redwood G6MXL, 53 Woodpecker Drive, Poole BH17 7SB.

**Entries must be received not later than Tuesday October 13th 2020. Late entries will be disallowed.**

Any other general comments about the station, the contest and conditions during it are welcome. Photographs relating to the operation may also be sent by e-mail.

They may be used for publication in *Practical Wireless* or on the contest website. If these are not available by the time the entry is submitted, they may be sent later **to arrive by October 22nd 2020**.

You will be asked, with your entry, to agree to the holding and processing of your log and to the publication of the results. Warners Group Publications data policy can be seen at: **www.radioenthusiast.co.uk/privacy-policy**

**7. Miscellaneous**: When operating portable, obtain permission from the owner of the land before using the site. In particular observe any restrictions on access. Always leave the site clean and tidy, removing all litter. Observe the Country Code.

**8. Poor Signals:** Make sure that your transmitting equipment is properly adjusted and is not radiating a broad or poor-quality signal, e.g. by over-driving, excessive speech compression or low voltage supply. On the other hand, be aware that your receiver may experience problems due to the numerous strong signals it will have to handle and that this may lead you to believe that another station is radiating a poor signal. Before reaching this conclusion, try heavy attenuation at the received input. The use of a high-gain RF pre-amplifier is likely to worsen strong-signal problems so if you do use one, it is best to be able to switch it off when necessary.

If, after making the checks above, you are certain that another station participating in the *PW* 70MHz contest is radiating poor quality signals, please call the station, giving your callsign, and tell them about the problem. You cannot expect a station with a poor signal to do something about it if they are unaware!

If you receive or send a report of poor-quality signals (e.g. wide/splattering), you must record on the cover sheet full details of the complaint including time, callsigns of stations involved, nature of complaint and actions taken **during** the contest to investigate and resolve.

**9. Adjudication**: Points will be deducted for errors in the information sent or received as shown by the logs. Unmarked duplicate contacts in paper-based logs will carry a heavy points penalty. Failure to supply the complete information required in rule 6 may also lead to deduction of points.

A breach of these rules may lead to disqualification. In the case of any dispute, the decision of the adjudicator will be final.

# Then the Rain Came

**Joe Chester M1MWD**
m1mwd@gmx.com

**Joe Chester M1MWD** ponders the vagaries of propagation and the effects of rain.

1

Are electrons soluble in water? Or, more correctly, do 'photons' of RF energy dissolve in the rain? It certainly seems like that. For a start, that D-layer is definitely a wet blanket during daylight hours on the LF bands. It's a bit like a wet rag soaking up whatever we radio operators throw at it. I've definitely heard stories from operators who say that the rain affects their transmissions by changing the SWR. But surely this is just the 'wet ground' effect, caused by the soaking of their under-lawn field of radials. But could there be something else going on?

Following on from last month's relative successes, please don't imagine that all the work of the past few weeks has generated endless QSOs every day. Some days are good, some bad, and some completely bonkers. After a reasonable week of fine weather, call-ins on several nets on 80m, and a few 20m contacts in the afternoon, it rained and put me off the air. Now I really have no idea what happened. Hence my water absorption theory. But maybe you can explain it better. Stay with me, please.

It's been an interesting few weeks in 'lockdown', and being able to focus on improving my little station. I started with an Icom IC-7300, and a fan dipole for 10, 20 and 40, in the attic, and an Elecraft KX3/PX3 on my office desk, now sitting on its new stand (from **Paul W4KLY**, and with clear covers by **Dave W8KGU** – see image, **Fig. 1**). Other than the accessories, the major recent work has added an Inverted-L (all bands except 40m), and I've also hunted down some of the minor losses. I'd like to report that these additions have produced a significant improvement in my performance – but it's too soon to say that.

I'm surprised at how well the fan dipole in the attic works. This is a small space, so the 20m dipole droops at both ends, and the 40m one zig-zags back and forth from one side of the roof space to the other. I'm sure there is a bit of attenuation due to the roof tiles, and these antennas are only up about 5m at most. But I can work from Russia in the East to North America in the West relatively easily, especially when the 'big guns' come out to play. But I thought I needed to try out a couple of different antenna ideas, to see if I could do better. The inverted-L was the result, and there is also half a vertical lying on the ground awaiting completion (more on this another time).

## The Low Bands

One of the specific difficulties I had was low band work – 80m (and hopefully 160m in future), where ground losses, even for large antennas, quickly mount up. I could probably say that it took a year of experiments of one sort or another to convince me of this. I put up an inverted-L and tried working on 80m with my 100 watts. I made a few contacts, but when the 'lockdown' nets started up, my poor signal really made life very difficult. But I persevered, and finally got the QSOs for which I was hoping (*PW* August).

## System Crash

Then my system 'crashed' during the morning nets – the SWR went through the roof (if anyone on the NRL net that day is reading this, my apologies – I must have popped up briefly, as I heard someone giving me a report, but then silence!). I immediately blamed it on the heavy rain – hail really – so I switched everything off. I had a few other matters to attend to that morning, so I only got back to the issue in the afternoon.

## Mysteries on 20

To start with, and in order to get a few signal reports, I tuned around the 20m band with the IC-7300 on the inverted-L to find a strong station. **Toly RA3RCL**, 400km south of Moscow was a good 59 with me on 14.260kHz. I briefly check that the system was OK, and putting out 100W, and answered his QRZ? No reply. I tried several times. He was answering stations all over Europe, including several UK ones. But he wasn't hearing me. I moved off frequency a bit and keyed up to see if there was something wrong – SWR less than 2:1, all switches in the right place. OK, no obvious problem; try someone else. Next up was AM7WARD, and then CT1EHI – all failures. In desperation, I switched to the attic dipole, which is connected directly to my KX3. I answered IT3BTY on 14.253kHz and got a 59 report, with just 10 watts from my KX3! Then back to the ones I missed.

**Fig. 1: The stand for KX3 and panadapter.**
**Fig. 2: Listening to the morning net on on the KX3 with Hack Green on the PC.**


And worked them all with just 10 watts, plus IK4LHZ for luck. So, what was that all about?

Was it just the rain on the wire of the inverted-L shorting something? Or was something else wrong? To this day, I just don't know for sure what happened. I have a bit of a theory about the 20m QSOs, but this might just be pure speculation. So, let's start by going back to my wet rag idea – the D-layer absorption of LF radio energy. Well that at least is a proven fact. My work with the 80m nets proved that – abysmal conditions in the mornings, but when the net controller kindly shifted to late afternoon work, there were 59+ signals both ways – the veritable armchair copy. I should point out, in the interest of strict scientific accuracy, that it's not the water vapour in the D-layer that's doing the absorbing, but rather ionised air molecules. Still, 'wet rag' certainly describes the effect of the D-layer as a party pooper! But this doesn't explain why the SWR went up when it rained, forcing me to shut down operations.

And then there are the tests I did in the afternoon on 20m. Nothing to do with D-layer absorption, that result. Is there some subtle difference in the performance of the two antennas, for which the theory doesn't quite account? Assuming these stations are not hearing me on ground wave, then it has to be the skip. So, is the skip angle generated by these two antennas likely to be dramatically different?

We do know that the radiation from the inverted-L has both horizontal and vertical components, and that the proportions of these vary with frequency. Could it be that the major part of the radiation from the inverted-L at 20m was the vertical component, whereas for the dipole, of course, the horizontal component dominated? And on that day, the horizontally polarised component was the dominant mode of propagation. I think this is why we call this a scientific hobby!!

## Back to 80

But back to 80m. Exasperation might be the right word. Frustration is also a good one. After my initial success, days went by, turning into weeks, with signal levels so low that it's just a waste of everyone's time if I try to call into the morning nets. Early in the month I was hearing the calls clearly, then silence. Hack Green, **Fig. 2**, kindly provides some comfort, but it's not the same as sending a few signal reports, an update on the weather, and having a chat about a diverse range of topics. I am beginning to believe that 120 miles is just too far for daylight propagation on 80m in the middle of May. But then a station popped up on one of the evening nets and told us what we all knew but had just forgotten. The D-layer gets more and more active as we approach midsummer's day, and after that its activity starts to decline. Sorted!

The heavy rain of a week or so ago is now gone. And, of course, there is a corresponding silver lining – a few days of the most extraordinary propagation on 6m, 10m and even on 12m and 17m. Don't get me wrong. I'm not saying that the recent Welsh sunshine caused the fabulous trans-European propagation on these bands. The reception issues on 80m are clearly the responsibility of the aforementioned wet rag. But, amazingly, with this sunshine, I'm also hearing the NRC net again – I'm getting very generous signal reports too, so many thanks. One of the most eagerly discussed topics of recent weeks was pole dancing – don't panic! Rather, the fine art of designing and mounting exotic poles to support antennas, with the consequential ladder gymnastics. Everyone was at it!

So, to summarise. I don't know why the SWR suddenly jumped while I was transmitting on 80m. That gremlin hasn't reappeared since, and my little station seems to be working. Apart from the impact of the 'wet rag', getting on the 80m nets needs a few basic things. First, as my old friend Ray told me 40 years ago, 'get as much wire up in the air as you can'. And he also added a second requirement: 'get it up as high as you can'. These two basics are echoed in lengthy articles by antenna guru **LB Cebik W4NRL** (SK), and by advice in the current edition of the *ARRL Antenna Book* (p. 9-26, Section 9.3.5). Both of these eminent sources say exactly the same thing. The guys on the net added impedance matching to this list, with which I would, of course, agree. And a good RF ground, or elevated tuned counterpoise (I use the latter). If you've done all of that, then that's the best you can do.

Cebik has shown that the differences between particular antenna designs is rather minimal – sloper, dipole, doublet, inverted-L, G5RV, OCFD, or a random wire up in a tree. There are minor improvements to be made, to eliminate small losses, and some configurations have a bit of directionality (for example, the inverted-L has about a 1dB gain broadside to the vertical part, in the direction opposite to that of the horizontal part). My inverted-L is set up for multi band operation, but, as **David G4HMC** kindly suggested (by e-mail), it might make sense to concentrate on tweaking this specifically for 80m. At 19.8m long, this is nearly a quarter wave on 80m. So, I could probably eliminate the unun, and its losses, and run ladder line back to the shack. This work is on the list for the next available work slot. And a longer wire, even if I have to fold it somewhat.

But, once all this is done, you have the best simple wire antenna system you can build at your location. The rest is down to propagation. Try this – I get a 52 from one operator, and a 58/59 from another 30 miles away from the first one, but both of them are 120 miles away from me in the same direction. Conditions? Everyone knows that – don't they?

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# S-Meter versus Time Display for the 21st Century

**Ian Dilworth G3WRT** makes the case for an alternative approach to an S-meter, one for the 21st century?

I have long thought the S meter supplied by a conventional transceiver is rather primitive and not that useful, presenting just an instantaneous indication of received signal strength. I present here a cost-effective colour XY display, consisting of a dedicated DC-coupled oscilloscope and small colour display S-meter capable of displaying the history of signal strength over a period of 5mS – 6000 seconds (1 hour 40 minutes). It is based on the digital storage oscilloscope kit described in last month's *Practical Wireless*:
JYE tech Ltd. Jyetech.com

This has proven useful to monitor radio propagation conditions, for example by continuously observing HF/VHF/microwave beacons up to 1 hour 40 minutes. It is possible to 'hold' the display. So, in principle it could be made into a quasi-continuous chart recording (albeit by taking a picture since there is no provision to store the data, yet the hardware appears capable of output to a PC but that has not been implemented in the version presented here).

It has proven useful for monitoring repeater use and for giving more detailed reports when in QSO over the air so long as the contact is like my typical G3WRT ragchew QSO. Or simply to tell the station how much their signal has varied during their over. This is especially useful on HF. One other feature is useful. If you have two or more antennas, it is clear which one is better at any instance by switching – the display shows the difference immediately and graphically. It also gives a clear indication during fading conditions. So, all in all, it adds another dimension to listening.

## In Use

To illustrate the idea plots are shown in the following figures. The first in **Fig. 1** is a snapshot of a typical 160m VOX SSB QSO with a timebase of two seconds per division, thus the total display spans 24 seconds. The noise floor at the time was S7 and there are three stations transmitting over the 24 seconds all at different strengths – the strongest is S9+. In **Fig. 2** a broadcast station of S9++ on 40m illustrating rolling QSB over one minute or 5s/div. **Fig. 3** shows a broadcast station over about an hour just before it ceases transmission. Notice the fading signal enhancement. Illustrating that broadcasters know how to time their transmissions to suit the propagation. The five-minute switch-off was my intervention. The right hand S8 level was due to other broadcasters underneath this one.

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Monitoring my local repeater activity over an hour has proven useful to examine later. My local 1296MHz beacon, which is mainly via diffracted propagation at my QTH, provides an interesting comparison between summer and winter and foliage and by automatically switching antenna polarisation and obtaining the statistics of cross-polarisation due to diffraction. In short, this facility provides many possibilities that a simple S-meter does not.

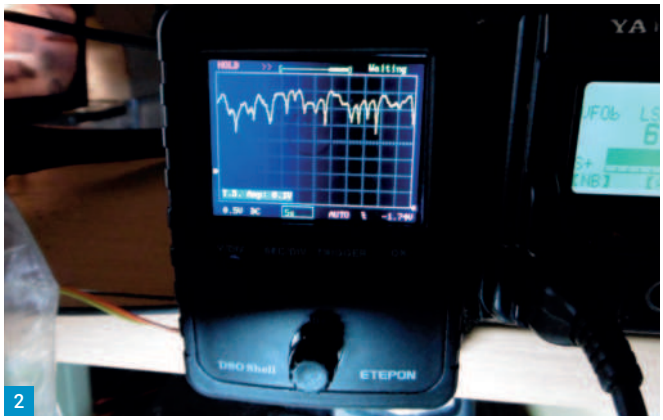
## Details

A very convenient input is provided by the meter output fitted to an FT-897, this is the AGC derived voltage. This goes from approximately 0 to +2.5V corresponding to S zero to S9+. It is linear enough to be practically useful. I could not find the circuit details even by searching the circuit diagrams. Given the socket's bizarre location underneath the front panel one assumes it was an afterthought. I have not experienced a similar facility, which I understand exists on an Icom IC-7610 and according to the specification this has a maximum output of zero to +8V and an impedance of 10kΩ.

All that is required is to adjust the display vertical volts per division, the DC offset of the vertical trace and the seconds per division required in the horizontal axis. Setting the trigger on Auto then produces a continuous scrolling, to the left, chart recorder-like trace in yellow.

I have found a two seconds per division speed to be about right for monitoring SSB. However, during a QSO I find that a slower sweep speed is useful to show the variation in signal strength with time. I am still experimenting. The AGC is what is displayed and there is a choice about the time constant (fast or slow) employed on the FT-897. I have found slow to be my default choice for SSB and CW but sometimes a fast response is more useful. I have not found it necessary or attempted to slow the response down further but, of course, a series resistor and then a capacitor across the output will achieve that if desired. The figures showing SSB indicate the decay of the AGC time constant in slow mode.

The power required is 9V at120mA (1W). I have a ubiquitous 13.8V PSU in the shack and use a voltage regulator fed from that to provide 9V. A suitable, cost effective, dedi-



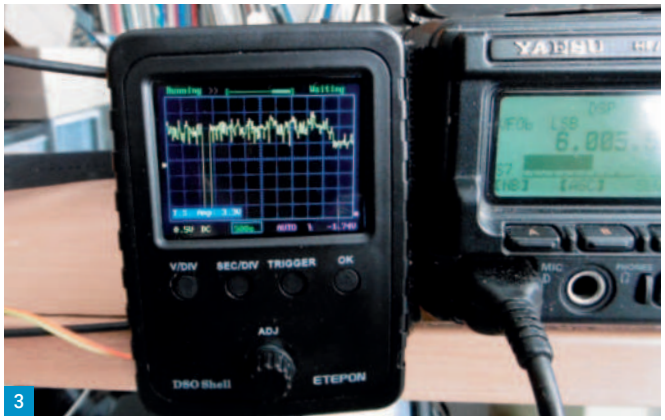
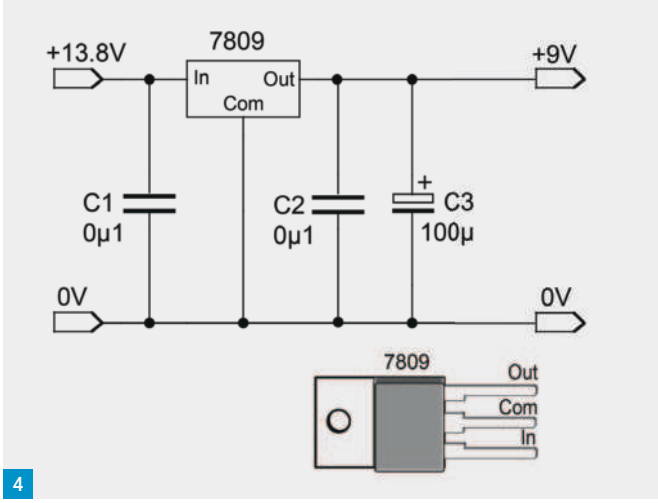




**Fig. 1: SSB VOX operation, three stations shown, one very quickly transmits – the strongest. Note the right-hand slope when transmission stops are the time constant of the AGC action, in this case slow. The time base is 2s per division. S7 residual noise level!**
**Fig 2: Rolling QSB over one minute.**
**Fig. 3: A broadcast station over an hour.**
**Fig. 4: A suitable 13.8V to 9V regulator.**
**Fig. 5: An attenuator suitable for calibrating the vertical scale. All values rounded up. It can be seen the 6dB attenuator is convenient component wise since little dB difference between using 47Ω and 50Ω resistors.**




cated regulated circuit is shown in **Fig. 4**. This dissipates about 0.5W and the 7809 is capable of 1.5A so there is plenty of capacity for other 9V requirements.

It is only necessary to find a convenient AGC point, on any receiver/transceiver, and route this out, to use this device. However, given the fixed selectable vertical V/div it may be necessary to change the amplitude range of the AGC voltage and to DC shift it to fit in with the existing shift facility. A suitable outline circuit is available (URL below) along with how to calculate the resistor values required. I have modified my IC-7300 and it is simple to do. I see the same is also true for the IC-9700.

https://tinyurl.com/y8nfp9d3

## Calibration

Essentially this display shows relative signal levels. However, the AGC voltage increases linearly with increasing signal strength over a good range. It can be calibrated in dB or S points and it is a good idea to have a mental picture of what a vertical division represents. Remember 3dB represents a doubling of the transmitted power and 6dB four times the power.

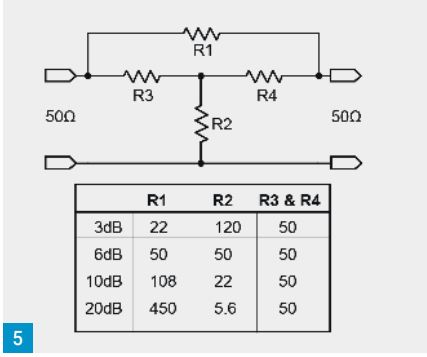
Most S-meters are calibrated for 3dB or 6dB per S-point (Some are known to be 4dB per S-point although my FT-897 is around 3dB per S-point), meaning that an S9 signal will be 27dB or 54dB respectively above the noise floor without an antenna connected. S9+20dB represents 47dB or 74dB above the noise floor. This is the range over which it can usually be displayed over eight vertical graticules, i.e. approximately 10dB per division assuming 74dB displayed range.

The vertical display available is divided into eight lined levels on the screen as can be seen in the photos. To establish what one of these divisions represents, a simple way is to externally apply a stable signal from a signal generator or a crystal oscillator and to insert a 6dB attenuator. Assuming a 50Ω source, a suitable attenuator circuit is shown in **Fig. 5** – this will be adequate at HF frequencies.

## Conclusions

I have found it fun and useful to have this S-meter facility added to my operating, mainly for observing radio propagation. I would not be without it now; it really does add another dimension to listening.

All of this could be done, of course, with a typical oscilloscope, apart from the unusually long timebase this device provides and its digital rolling data storage and display. The main attraction is the low cost, the small size, the build quality and the convenience of a dedicated long-term rolling S-meter. Its cost is much less than the dedicated external mechanical meters advertised and is far more useful.




| | R1 | R2 | R3 & R4 |
|---|---|---|---|
| 3dB | 22 | 120 | 50 |
| 6dB | 50 | 50 | 50 |
| 10dB | 108 | 22 | 50 |
| 20dB | 450 | 5.6 | 50 |

The kit is fun to put together and the colour display is superb. I have modified my unit so as to avoid the inconvenient and clunky BNC and 2.1mm power connectors supplied (the advantage of a kit is that you can do that in the course of construction) and to make it more conformal to my operating position right next to the transceiver using adhesive Velcro, as illustrated. I expect to add other facilities (e.g. PC connection to download the data) once I have studied and understood the circuit, although note it is software driven. It may not be perfectly adapted to the task, but I think it is nevertheless a useful tool/gadget. I wonder if manufacturers will, in future, adopt an S-meter like this, fit for the 21st century?

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# Radio at Depth (Part I)

**Mike Bedford G4AEE** investigates how low frequencies can be used to communicate with cavers underground, and how amateurs have contributed to this fascinating application of radio technology.

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*"Cave rescues are fortunately a fairly infrequent event, but when accidents occur deep below the surface, communications can become a major issue. Typically, a casualty will need to be medically stabilised before any attempt is made to bring them to the surface. Safely negotiating narrow passages and vertical pitches with a casualty in a stretcher is a slow process and can take many hours. In some situations the cave passage may even have to be widened to allow the stretcher to pass through. During the course of such a rescue there is therefore a need to exchange multiple messages with the surface, typically relating to requests for medical equipment, specialist hardware, additional personnel, etc. In a recent rescue at Ogof Daren Cilau, a particularly challenging cave in South Wales with flat out crawls and tight meandering passage, the South and Mid Wales Cave Rescue Team had to extract a diabetic caver who had become unwell deep within the cave and was unable to continue. The rescue team anticipated a lengthy recovery and therefore deployed their cave radio system to allow communications between the surface and underground teams throughout the course of the rescue. The casualty was safely brought to the surface in the early hours of the next morning."*

This description by **Tony Haigh GW6UMU**, Communications Officer of the British Cave Rescue Council, will surely have resonated with many a reader because providing a public service is so much a part of the amateur radio ethos. Unusually, though, he also made an intriguing reference to something called a cave radio. This is a device that allows communication, wirelessly, through solid rock and, unlikely as that might sound, it's the theme of this article.

## Cave Radio Basics

To put it simply, radio signals tend not to propagate too well through conductive

**Photo 1: Cave radio is an important tool in cave rescue, as evidenced by its use here in a rescue practice at the archaeological Huglith Mine in Staffordshire. (Bartek Biela)**
**Photo 2: LF cave radios provide a service to the UK's cave rescue teams, allowing them to better coordinate operations and, in so doing, save lives. Photo of Fred Rattray G4SPR. (Chris Hunter)**
**Photo 3: Not your regular special event station – Tom Stokes G7NER operating GB4CRO from underground in White Scar Cave. (Mike Bedford)**

media such as rock. So, if you're on a train talking on your phone and you enter a tunnel, you'll probably get cut off. Getting a bit more quantitative – although this is a simplification and we'll elaborate further on this statement in the second and final part of this series next month – we can say that the attenuation of a radio signal increases with both rock conductivity and frequency. This means that the more conductive the media, the lower the frequency that's needed to achieve a given range. Seawater is an extreme case, in being so conductive that submarines have used frequencies as low as 76Hz (yes, really, Hertz). Turning to rock, the conductivity of coal measures is such that VLF (3kHz – 30kHz) or ULF (300Hz – 3kHz) frequencies have to be used to provide a through-the-earth communication link for use in emergencies, while the limestone in which most caves are found is not as conductive, so cave radios can use LF (30kHz – 300kHz).

As LF amateur experimenters are all too acutely aware, such frequencies aren't without their difficulties. The common cave radio frequency of 87kHz has a wavelength of almost three and a half kilometres. Efficient antennas would be huge and, impractical as that might be on the surface, in a cramped cave passage they'd be totally impossible. For this reason, cave radios have conventionally used small loop antennas, commonly a metre in diameter. Needless to say, at such a small proportion of the wavelength, these antennas radiate a negligible signal, although they do generate a magnetic near field. Strictly speaking, therefore, this isn't radio but communication by induction, which poses a major problem. While the field strength of a true radio signal drops off with the square of distance, in the case of magnetic induction, an inverse cube relationship applies. So, to double the range you need eight times the field strength, and to quadruple it you need 64 times the signal. But it gets worse. The field strength is proportional to the current in the loop so, all other things being equal, to double the field strength you'd have to


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double the voltage which implies consuming four times the power. To return to our example of increasing the range by a factor of four, and the consequential requirement for a 64-fold increase in the field strength, the power consumption would need to increase by a factor of over 4,000. The upshot of all this is that the range is severely limited. So, you're not going to be working DX with an LF cave radio, but for its intended purpose a maximum range of a few hundred metres isn't a show-stopper. After all, it's normally only necessary to create a link between an underground party and any point on the surface, and locations in caves are rarely separated by more than a few hundred metres from the closest point on the surface.

While LF cave radios equipped with loop antennas have their limitations, though, an alternate type of antenna, that has mainly replaced loops in recent years, offers improved performance. Referred to as an earth array or a grounded dipole, it takes the form of a pair of wires, running along the ground in opposite directions from the surface cave radio, perhaps totalling only 20m in length, with the far ends being grounded by an earth spike. The underground rig uses a similar antenna although, because it's generally not possible to drive electrodes into the solid floor in caves, the electrodes take the form of lengths of copper braid or electric fence twine, which is trampled into the mud or immersed in water. We can imagine that this


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## The GB2CRO: GB4CRO Story

With radio amateurs having been so instrumental in developing cave radios and researching cave communication techniques over the years, cave radio enthusiasts have been keen to raise awareness of this fascinating subject among the amateur radio community. So, back in 1995, the Central Lancashire Amateur Radio Club established GB4CRO while, over the same weekend, the Mid Glamorgan Amateur Radio Group established GB2CRO, both in conjunction with the BCRA's Cave Radio and Electronics Group. But these were no ordinary special event stations – both stations were underground, GB4CRO in White Scar Cave in the Yorkshire Dales, and GB2CRO in Ogof Ffynnon Dhu in South Wales. Needless to say, the hardware was every bit as unusual as the locations.

Underground at White Scar was a Molefone operating on 87kHz, while above ground was another Molefone, interfaced to an HF rig via a box of tricks dubbed a talk-through box. The underground operator was thereby able to gain access to the 80m and 20m amateur bands. Meanwhile, 300km away at Ogof Ffynnon Dhu was a similar arrangement except, instead of a Molefone, an experimental FM cave radio operating at 27kHz in the VLF band was used.

Between the two stations, over 350 contacts were made with 29 countries on all continents except Antarctica, although not all of these were from underground. One notable QSO from the GB4CRO underground station was with a station operating /MM onboard the QE2 in the mid-Atlantic. However, the most newsworthy event was a contact between GB4CRO and GB2CRO via an LF – HF – VLF link. Almost certainly this was the first ever amateur radio contact between two widely separated underground stations.

**Photo 4: Ian Cooper's Micro HeyPhone is a hybrid cave radio design, featuring both analogue circuitry and a micro-controller. (Ian Cooper)**
**Photo 5: The well-defined magnetic field pattern to a cave radio with a loop antenna is the same as that of a bar magnet and is important in radiolocation. (Mike Bedford)**
**Photo 6: Radiolocation, Step 1: By rotating the surface loop antenna until a null is found, and repeating it from another position, ground zero can be found be triangulation. (Mike Bedford)**
**Photo 7: Radio-location, Step 2: Once ground zero has been found and marked, the depth of the underground station can be found by determining the angle of null, while the loop is facing ground zero. (Mike Bedford)**
**Photo 8: Rob Gill, G8DSU, searching for ground zero on the surface, as part of a radio-location exercise. (Mike Bedford)**

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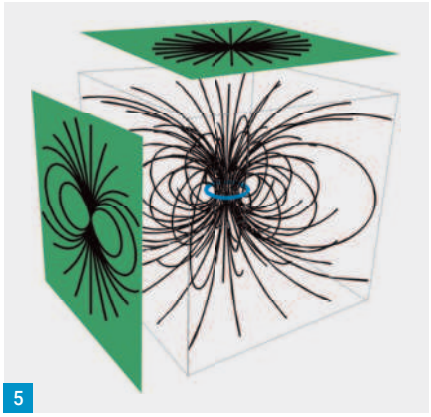
configuration relies on conduction through the earth, and that's probably a contributing factor. However, the operation is more complex than that suggests, as evidenced by the fact that a station with a grounded dipole antenna can interoperate with one equipped with a loop. The bottom line, however, is that earth arrays provide superior performance and improved range compared to loop antennas, despite providing a trip hazard to humans and sheep alike.

## Real-World Cave Radios

Let's now get a bit more practical by looking at some of the real-world cave radio designs that have been used by rescue teams and expedition cavers worldwide. Following experimentation by cavers in the 60s and 70s into the use of baseband, i.e. audio frequency, cave radios, huge loops and all, the first practical cave radio was made available to the UK's rescue teams in about 1980. Called the Molefone, it was developed by caver and Cave Rescue Organisation member **Bob Mackin** at Lancaster University. It was a 10W SSB rig operating on 87kHz, used a one metre square multi-turn loop antennas made from ribbon cable and provided sterling service for many years. Nothing lasts forever, though, and while the Molefone's circuitry was potted to protect it from the rigours of the underworld, this was a mixed blessing, in that it couldn't be repaired. The British Cave Rescue Council (BCRAC), which represents the UK's various cave rescue teams was on the lookout for a replacement which brings us to a fortuitous contact on 80m between yours truly and **John Hey G3TDZ**. The upshot of this was that John learned about cave radio and was inspired to get involved by designing a new cave radio. A few years later, his design was accepted by the BCRA who named it the HeyPhone, and it was rolled out across the country. This design followed a similar path to the Molefone to provide compatibility but departed from the earlier design in being optimised for use with a grounded dipole antenna. But John didn't only design this new radio. Recognising that the UK's rescue teams are charitable organisations, and that the cost of commercial manufacture would be a major drain on their finances, he offered to hand build units for them. A few figures show something of the Herculean nature of this task. No fewer than 66 HeyPhones were assembled, each containing three circuit boards, which were populated with about £7,000 worth of components.

Today the HeyPhone has been joined, and largely replaced by, several alternative cave radios. The System Nicola series of radios was named after the British caver **Nicola Dollimore**, who sadly lost her life in a French cave as a result of a flash flood. This new cave radio had, as its motivation, the provision of a means by which cavers could be warned, by their compatriots on the surface, of severe weather conditions. Designed by British caver and electronics engineer **Graham Naylor**, the Nicola 3 represents the current generation and, unlike previous Nicola iterations, is a software defined radio (SDR) design. It runs in an FPGA (Field Programmable Gate Array), which is one element of a Xilinx Zynq SoC (System on Chip), operating together with an ARM Cortex A9 core, which is used for control functions. Also based on SDR technology is the DSP-based SubPhone by **Ron Taylor G4GXO**, which has been put through its paces by British cavers during expeditions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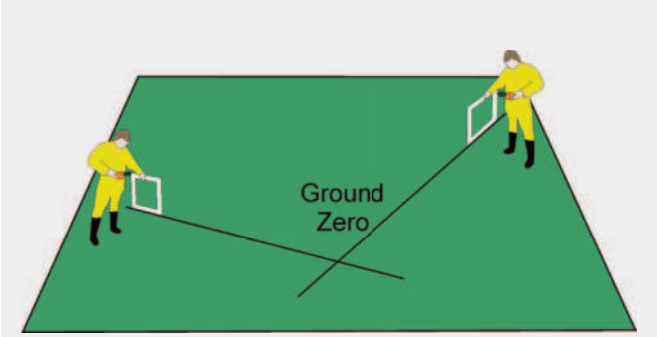
to the Matienzo region of Northern Spain. Next up is Cave-Link which was developed by Swiss cavers **Felix Ziegler HB9CPZ** and **Christian Ebi HB9ZG**. Breaking new ground, it relies on the exchange of textual messages instead of speech. Not surprisingly, range is improved as a result and it's also possible to improve the range further by using multiple Cave-Links to form a mesh network in which messages are transferred from end to end via intermediaries. An unattended Cave-Link on the surface can also be interfaced to a mobile phone, thereby offering communication from underground to anywhere in the world. And finally, named in honour of John Hey who died in 2016, and inspired by his design, caver and electronics designer **Ian Cooper** has released the Micro HeyPhone. As the name suggests, it's compatible with the HeyPhone, but the three boards are reduced to one and, as a result, it's housed in a much smaller enclosure. This has been achieved by replacing the HeyPhone's control circuitry, that was based on 74LS-series discrete logic chips, and its 87kHz IQ signal generator, with an ATmega32 microcontroller.

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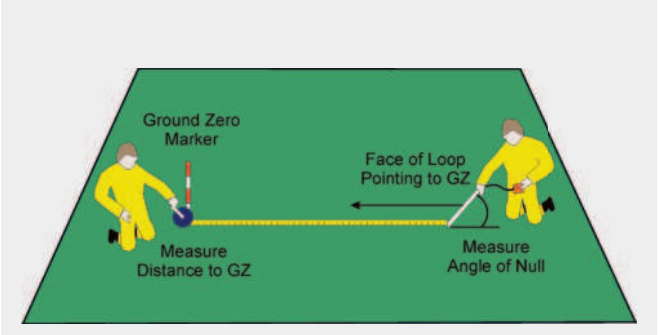


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## Radio-Location

It might seem obvious that the purpose of a cave radio is to enable person-to-person communication but, paradoxically, that's not the only use to which it can be put.

Cave surveyors are denied many one of the most powerful tools in most cartographers' arsenal because the microwave signals, that GPS devices rely on, are very effectively absorbed by rock. So, mapping a cave – a valuable process in cave exploration – involves the iterative techniques that were first used on the surface centuries ago. Starting at a known point, most usually a cave entrance where a GPS fix can be achieved, cave surveying involves taking measurements of the horizontal and vertical angle and distance, from station to station, those stations being separated by the limit of visibility. Instrumentation has progressed from a compass, inclinometer and tape measure to electronic equivalents, but the step by step nature of the process remains, and here lies a problem. Errors build up from station to station and, because cave passages are often very convoluted, there can be lots of stations within just a short distance. The upshot of all this is that the calculated positions for locations furthest from the entrance can be subject to gross errors.

To learn how radiolocation has reaped benefits, we spoke to **Juan Corrin**, coordinator of the Matienzo Caves Project that organises international expeditions to explore the caves around Matienzo in Northern Spain. *"By the end of 2016, surveys showed that passages in the Cueva-Cubío del Llanío cave were close to part of the 59km-long Four Valleys cave system. A link between the two caves would provide more interesting questions and answers about how the caves formed but the route to the possible connection area was arduous, passing through tight passages The survey of Llanío also showed a passage coming close to a main road, apparently only a few metres below the surface, and it was thought that a new entrance here would cut several hours off a round-trip hunting for the Four Valleys connection,"* he told us.

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However, much more precision would be needed to be able to locate that new and probably blocked entrance on the surface with sufficient accuracy, as he went on to explain. *"Pin-point surface and underground positions were required. An inspection showed that the terrain was covered with brambles, gorse, nettles and other vegetation – hiding any prospects. A team soon cleared an area so that a surface cave radio operator employing a portable, large, square aerial could talk to cavers below ground with a SubPhone and small horizontal aerial. A tone emitted from the underground radio enabled a null point to be established on the surface. The underground team were vertically below this and, fortunately, a small limestone feature on the surface lined up with joints in the rock seen underground. This provided encouragement to dig down. By the summer 2017, soil, clay and rock had*

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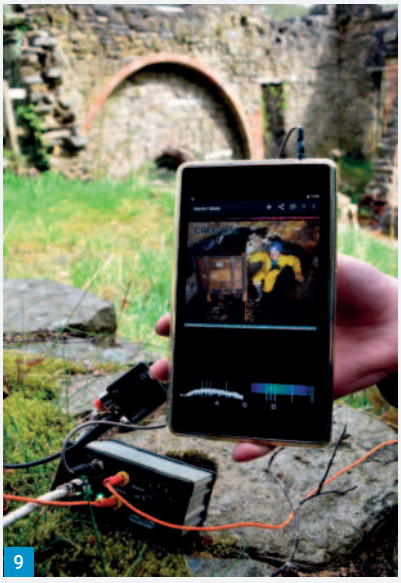
**Photo 9: Using an amateur SSTV app on a smartphone, images can be transmitted from underground to the surface via LF cave radio. (Mike Bedford)**

*been removed and a strong draught from the cave was detected, eventually revealing a narrow entry to the underground SubPhone station some seven metres down. A number of 'pushing trips' deep in the cave soon followed, with a connection between the two caves being achieved through a very muddy dig in July 2019. The length of the Four Valleys System jumped to more than 67km."*

Juan's reference to radiolocation is interesting so let's take a look at how it works. When used with a loop antenna, but not a grounded dipole, a cave radio generates a well-defined magnetic field pattern. In particular, the field lines are the same as those that surround a bar magnet, that we probably learned about in school physics lessons, perhaps by scattering iron filings onto a piece of paper. In reality, however, those field lines surround the magnet in three dimensions. So, if a transmitter is setup underground, with its loop antenna perfectly horizontal, the pattern of the magnetic field lines is entirely predictable, both through the earth and in the air on the surface. Now let's think about a second cave radio, also equipped with a loop antenna, being used as a receiver on the surface. Maximum field strength is received when the field lines intersect the plane of the receiving loop at right angles but, critically, no signal at all is received when the field lines are parallel to the plane of the loop. Having set up a transmitter underground, therefore, ground zero – that's the position on the surface immediately above the underground transmitter – can be found by triangulation, using a loop held vertically and rotating it until a null is found from several locations. Then, having found ground zero, a receiving loop is held facing that position, at a measured distance away, and angled until a null is found. Knowing the distance to ground zero and the null angle, and because the shape of the field lines is mathematically defined, it's possible to calculate the depth of the underground transmitter by trigonometry.

## Next Month

Next month we'll look at some recent work into the use of HF, as opposed to LF, and VLF for through-the-earth cave radio. We'll also delve into the methods of communicating within caves, as opposed to between a cave and the surface. If you fancy the idea of cave radio experimentation, we'll also give you some guidance on how to learn about caving in safety, and how to make contact with like-minded individuals. In the meantime, though, we feel compelled to say that you most certainly shouldn't be tempted to venture into any wild caves – as opposed to tourist show caves – unless you're properly equipped and escorted by experienced cavers.



## Beyond Speech

Most cave radios are used for verbal communication, although the Swiss-designed Cave-Link is an exception in relying on textual exchanges. However, just as in amateur radio, transceivers designed for voice communication can be pressed into service for other forms of communication, often using software running externally on a PC or even a smartphone. And as with amateur radio, there are benefits to be gained from going beyond speech.

Because they are so much more portable and robust than laptops – an essential benefit in a harsh cave environment – smartphones tend to be used with cave radios for use with text and images. It's early days yet but it's anticipated that using low speed text will provide more reliable communication than speech, especially in the presence of interference from the LORAN-C navigation system which, while centred on 100kHz, has wide sidebands that can cause problems to cave radios operating on nearby frequencies. Image exchange might have a different aim – perhaps to allow a doctor on the surface to view the condition of an underground casualty during a rescue – but experiments have demonstrated the value of SSTV for transmitting photos in near real time from underground to the surface.

# Radio Round-up

**RALLIES CANCELLED:** Most readers will now be aware that the Newark Hamfest has been cancelled. We have also been notified of the cancellation of the annual Weston super Mare Radio Rally, scheduled for 20th September and of the Caister Lifeboat Rally.

**GB2VJ:** Members of Essex CW Club will be active using GB2VJ until September, this special event station is to commemorate the 75th anniversary of V-J Day in Europe and the USA. In memory of all that served in the far east during the Burma Campaign 1939 - 1945.

**CDXC SPECIAL AWARD TO THE RSGB HF CONTEST COMMITTEE:** CDXC: The UK DX Foundation is delighted to announce a special Award of Merit presented jointly to the RSGB HF Contest Committee (HFCC) and RSGB Contest Support Committee (CSC) in recognition of their Hope QSO party initiative during the Covid-19 lockdown in April, May and June 2020.

Chris Duckling G3SVL, Chairman of CDXC said, *"This well planned and well executed initiative from the HF contest committee led by **Nick G4FAL** and very efficiently implemented by the RSGB Contest Support Committee created daily on-air activity during a difficult time and encouraged regular involvement in HF contesting by many UK and overseas amateurs. The CDXC committee felt that this deserved special recognition and we are delighted to issue this award".*

More information on CDXC is available at: www.cdxc.org.uk

**CONTACT:** Chris Duckling, G3SVL Chris@G3SVL.com

**OFCOM CONSULTATION RESPONSES PUBLISHED:** Ofcom has published the responses to the EMF consultation on their website. A link can be found on the RSGB's EMF webpage at: http://rsgb.org/emf

The RSGB would like to thank the 255 who took the time to respond either individually or on behalf of your organisation. The majority of all responders were against the proposals. Now that ICNIRP guidelines 2020 have been published, the RSGB is preparing updated guidelines and advice as to how to operate your stations within these guidelines. These will be published on the EMC pages of the website later this year. This guidance is being prepared by a group of experts from the amateur community including the editors of the IEEE Standard for Safety Levels for Human Exposure to EMF fields. RAYNET responses included one from the Technical Team and also Kent County RAYNET.

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ON SALE AT OUR BOOK STORE ON PAGE 9

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### New Amateurs

**Dear Don,**
You may remember a little while ago there was a letter in *PW* from a potential Foundation Licence candidate looking for a club running a course local to him, and that he turned out to be local to our club in Chesham (Bucks). I asked you to forward him my details so he could get in touch.

Thanks to your action, I'm pleased to say that he signed up to study for the exam – just as we went into lockdown! Everything went virtual/online, but in practice this didn't cause a major disruption. Indeed, it turned out that two more candidates made contact with us and started studying as well.

To their credit, the RSGB were quick to make arrangements for remote invigilation of the Foundation Exam and to waive the hands-on practical parts. One of our members also developed a web-based revision guide/test question, and our candidates were all set. I'm pleased to say that all three passed (we had great confidence in them) and are now active on the air. We have another one or two candidates in the pipeline too.

Although we can't quite yet meet face to face with our new members (this may change very soon) it's been very encouraging to see people respond so positively to situations that happen and make the most of it. BTW, I also noticed in the recent *RadCom* just how many new members have joined our national society during this period of lockdown. Definitely a positive sign for the hobby!
**Malcolm Appleby G3ZNU**
**Great Missenden, Bucks.**

*(**Editor's comment**: Thanks for this Malcolm, a very positive outcome. And, as you say, it's good to see so many new or returning folk enjoying the hobby.)*

### Topbander

**Dear Don,**
I have a TW Topbander I'm trying to get working and had to replace the anode tune capacitor as one vane was badly bent and the loading capacitor was shorting to earth at one point in its rotation. The vanes didn't appear to be touching but replacing it seemed logical so I looked for another in my junk box. I had nothing that would fit, they were either too large or too long. As this coronavirus is preventing any radio rallies where I could get another, I wondered whether I could do something with it.

The vanes looked okay but dirty so I thought cleaning the whole thing might be an idea but what to use?

Soap and water might not work too well and something like bleach too harsh then I remembered I had some liquid silver cleaner. For silver it says soak for one minute in the tray. I dipped an old toothbrush in it and worked it round the vanes and it started to foam. Another couple of dips and when I rinsed it the water was black. A good sign. After shaking it and allowing it to dry I tested it for shorts with a multimeter then with a capacitance meter and everything looked fine. The vanes looked nice and shiny where before I could see particles of dirt on them through a magnifying glass. After installing it I applied power and no shorts so it has done the trick.

It smells awful and the instructions say if it gets in your eye to flush with water and contact a physician so wearing goggles would be advised. Perhaps paraffin or switch cleaner could be used instead but I have neither.

Maybe testing on an old capacitor then taking it apart might show how well it worked but looking through a magnifying glass mine looks very clean.
**Bill Kitchen G4GHB**
**Ashton-under-Lyne**

### An Illegal Rig?

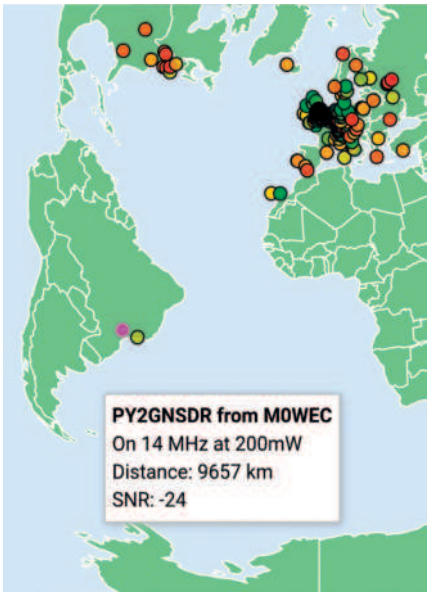
**Dear Don,**
June 2020 *PW* another excellent issue as always, thanks all around.

But the fine review by **Martin Peters G4EFE**, of the QRPGuys DSB digital transceiver has me concerned. By using this transmitter, since we know full well the lower sideband is wasted because it cannot be decoded, are we not deliberately causing interference which is quite illegal?

I e-mailed QRPGuys with this very question. Their response was simply, *"DSB is a legal modulation mode"*. Well that's not the point at all, there are all sorts of ways to transmit illegally using legal modulation modes. One trivial example is simply never IDing. In fact, I wonder if QRPGuys are in violation of type acceptance laws by even selling this radio because it creates intentional interference, no different than, say, selling a transmitter with high levels of harmonics. Moreover, it might be that any distributor reselling this radio would be equally liable as well.

So please, I encourage everyone to think very carefully before reselling, purchasing or using this transmitter. I really think it should be pulled from the market. What do you think?
**Elwood Downey WB0OEW**
**Tucson, Arizona**

*(**Editor's comment**: Thanks for your e-mail Elwood. While DSB certainly takes up more bandwidth than a single sideband, the same is true of AM, which remains a popular mode among many. I have limited knowledge of the US licence situation but DSB certainly isn't illegal in the UK.)*




## WSPR

**Dear Don,**

Using the SOTABEAMS WSPRlite on Tuesday June 23rd at 2128UTC, I was heard in Brazil by PY2GNSDR and PY1EME. Please see attached screen shots.

I enjoy reading *Practical Wireless*.

**Peter Wagstaff M0WEC**
**Dewsbury**

*(**Editor's comment**: Thanks for this Peter, a reminder of how effective WSPR can be at indicating propagation paths)*

## Tiger Radio

**Dear Don,**

Yes, I can remember Tiger Radio (*Letters*, June) but it was nothing to do with amateur radio. In the 1960s I worked for the Jennings/Vox company, producers of electronic equipment for the entertainment industry, including the famous AC30 amplifier.

One of the items we were often asked for was a radio microphone. Unfortunately, the GPO then, had a real 'dog-in-the-manger' attitude in allocating transmitting frequencies.

After much badgering by our Head of Research, **Alan Harding**, they begrudgingly allocated us a frequency of about 175MHz at 5 milliwatts!

As the development was technically out of our remit, we looked for a company that could offer us facilities and we ended up with Tiger Radio.

Bearing in mind, at that time, transistors could barely receive at that frequency, let alone transmit, the original development used hearing aid valves. These worked but battery consumption was a real problem.

For various reasons the product got shelved even though a transistorised version prototype was made with the help of Burndept but I now wonder if there are any ex-employees of Tiger Radio who can remember working on this project?

**Rodney Angell G4CCE**
**Gravesend**

## Do Transistors Wear Out?

**Dear Don,**

I read with interest the letter entitled *'Do Transistors Wear Out'*. As per the Editor's comments, I also am not aware of a 'wear mechanism' in transistors provided they are used within their intended specifications.

However, what caught my eye in the letter was that the transistors are mounted in 'sockets'. It is my opinion that the problem lies with the socket rather than the transistor.

The action of removing the old transistor and inserting a new transistor 'cleans' the socket contacts and fixes the problem. You could probably re-insert the old transistor and it would work fine (you may want to clean the transistor legs first).

Why do I think this? Many, many years ago (when microprocessors were new and expensive), I worked for a manufacturing company. One of our products had a PCB with five Motorola MC6820 devices and a Motorola MC6800 Processor (and lots of other devices). The MC6820 were 40-pin Dual-in-Line devices and they were all mounted in sockets. We manufactured hundreds of these products.

After a few years of product shipments, our service department raised a 'formal' complaint about the Motorola MC6820 device, pointing out that 95% of all faults on the products were fixed by changing one or more of the MC6820s. I was given the job of investigating this issue and recommending a solution.

I asked the service department if they had kept the old MC6820 devices they had removed as I would like to test them. Fortunately, they had kept some of these and gave me 20 to test.

I tested each one and they were all perfect and worked exactly as intended. So, it was not the MC6820!

I then looked at the sockets we were using. These were 'side pin' sockets, which had a springy metal wiper that pushed against the leg of the MC6820 device (it was a 40-pin socket, so there were 40 wipers). It became clear that over the period of a couple of years, the wiper became 'tarnished' and less 'springy', so contact to the device pin was lost.

If you unplugged the MC6820 from the socket and plugged it back in, the product was magically 'fixed'. So, I concluded it was the socket and not the device that was causing the problem.

I recommended that we changed the socket to a 'turned pin' type. These were more expensive (production and purchasing were not happy about that!) but were much more reliable and did not suffer from the 'tarnishing' issue.

From that point on, service never replaced an MC6820.

**Jim Carter G0LHZ**
**Reading**

## A Small World

**Dear Don,**

I had a lovely example the other day, of what radio amateurs have known for a long time, 'It's a small world'.

It all started off on Facebook, where **Paul G4RRA** posted a picture of a shortwave listener card from 1969, sent to G6XA by **Stephen Lowe** of Exmouth. Knowing that **Steve PJ4DX** had grown up in Devon, I dropped Steve an e-mail with an image of the card and yes, of course, Steve had sent it when he was in his teens and was delighted to see it again

The coincidences were about to get a bit more interesting though! My wife Julie had mentioned an **'Uncle Ivor'** in her family who was a radio amateur and who had lived in Exmouth. I e-mailed Steve, wondering if he remembered Uncle Ivor (Howell)?

Not only did Steve remember Ivor, but they had done their Radio Amateur's exams at the same time in 1971, although Steve mentioned that Ivor had to have a couple of goes at the exam.

It was, in those days a written paper and because Ivor had such beautiful copperplate writing he ran out of time on the answers! Ivor retook the examination and passed, as well as taking the Morse test. Steve thinks that Ivor had a G4D series callsign, possibly G4DFW? I wonder if any readers also remember Ivor and what his callsign was?

Steve also remembered visiting Ivor and his wife, **Emmy**, at their house in Roundhouse Lane, Exmouth. Curiously, it must have been around the same time that Julie and her family visited Ivor for a summer holiday.

What a small world!

**Tim Kirby GW4VXE**
**Goodwick, Pembrokeshire**

## Returning to the Hobby

**Dear Don,**

I agree with **Colin Redwood G6MXL** who in his recent very interesting article mentioned that many amateurs are returning to the hobby because of the current situation. The record I have heard so far is after 35 years! I believe that dealers have also been very busy with both newly licensed amateurs and 'returnees' updating. I think also that because of having more free time and maybe being bored, people like a friend of mine who is over 70 and has had an interest for many years are buying the Foundation Licence book and studying for the exam.

I would point out, though, that when he says that the types of digital voice systems are totally incompatible, this is no longer strictly true. As a recent 'returnee' myself having only previously been able to use Echolink, I have discovered the enjoyment to be had from the Hubnet/Allstar systems. As I understand it, Hubnet was introduced as a means to link UK repeaters and, interestingly, during a QSO on Hubnet with a station in New Zealand, I was told that their repeaters are linked as well to promote their use as it was decreasing.

I can only describe the Hubnet/Allstar link as a melting pot of various systems as amateurs can access the world via this link from DMR, Fusion, D-Star, Echolink, a local repeater and others. An example of a particularly interesting topical QSO you might hear/join in with is a conversation I heard between a station in the Shetlands with a British licensee in Hawaii discussing how each place had been affected by Covid-19.

I would also like to thank **Peter G7RPG** and other amateurs who help develop and keep running the various systems that we can enjoy using, including local repeaters.

I realise that for some this is not 'real' radio but particularly for those with antenna restrictions, it is a means to have DX QSOs. After all the hobby is a 'broad church'.

**John Sones M0AAO**
**Suffolk**

## Various

**Dear Don,**

In response to most useful article by **Tom Morgan ZS1AFS/ZT1T** page 54 of August *PW The Magic Box on the Piece of Wire*, here are some more suggested magic lengths of the wire via the link below. Balun Designs quote: *"Longer wire is always more efficient but is usually best kept under 300ft as the characteristics of a Beverage antenna begin to show up beyond this length"* Various suggestions are made along with a few installation tips. In feet so maybe use an online converter.

tinyurl.com/aerialmetres

Subsequent to recent topics of end-fed antennas in *PW* **Norman G8ATO** of Verulam ARC suggested considering using a hot wire RF Current Ammeter inline with the antenna to indicate its efficiency. Apparently, this was quite common in the 1930s along with and/or car headlight bulbs.

So, as I understand it this would mean tuning for maximum efficiency rather than optimum SWR. This information is for interest only because if you have a valve transmitter you may already have an ammeter installed and if using solid-state, best you stick to measuring SWR for fear of damaging your output circuit. Quote: *"RF-current measurements must be conducted with extreme caution"*. Source: *The MFJ-834H RF Ammeter manual*.

A few years ago you kindly promoted my effort to make a HF 9:1 unun. Since then I've seen variations on the internet that include a 100pF 3kV capacitor across the coax input to the unun to improve matching of higher frequencies. I tried a 100pF 40kV capacitor for £3.50 off eBay and it does help the matching. I went for the 40kV for its strength and ruggedness with regard to soldering and insulation. If you source one, it will likely be blue, size of a sweet and marked: 101 40kV.

**Bob Houlston G4PVB**
**St Albans**

*(**Editor's comment**: Thanks as always Bob. Your second point reminds me that in my early days I tuned my antenna with a 19 set variometer and a moving iron RF ammeter. And a great combination that was too!)*

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