www.radioenthusiast.co.uk

PRACTICAL WIRELESS

NOVEMBER 2020 THE UK'S NUMBER ONE AMATEUR RADIO MAGAZINE SINCE 1932

ANTENNA PROJECTS | Simplified directional 40m, and 40ft fibreglass mast

STARTING WITH MICROWAVES

Everything you need to know to get operational

Latest products

First look at new gear from the UK's top dealers

Cave dwellers!

Part two of our series on sub-surface communication

The rise and fall of America's Drake

Why their radios are still sought after 50 years on

SDR Looking at a new approach to operating

How BBRF103 open-source software is now being utilised more widely

Get Started!

Part four of our 'how-to' series

Readers' letters

You tell us what matters in your world

WARNERS
£4.50
Display until 12th November 2020

WATERS & STANTON
EUROPE'S HAM STORE

Europe's HAM RADIO STORE

Video Channel

We now have a regular YouTube TV Channel with technical features and equipment reviews. Just type in 'watersstan-ton' into the YouTube search band to watch the latest editions. We are approaching 6,000 subscribers so it is worth taking a look regularly. if you press the free 'Subscriber' button, you will be alerted to every new video. Keep in touch.

Peter Waters G3OJV

ELECRAFT — Brought to you by W&S!

GO HF PORTABLE with the BEST!

Elecraft KX2 Portable HF Transceiver

2 Year Warranty

Mic & paddle key are optional extras

Elecraft's KX2 'stealth' transceiver can go wherever your imagination takes you! A rear tilt-foot angles the KX2 for use on any surface, from desktop to park bench to rock.

- 12W Out 80m-10m
- Fits into a coat pocket
- Built-in microphone
- Variable selectivity
- CW audio filter
- On screen data decode
- Very low current drain
- PSK31 and RTTY send
- Backlight can be turned off
- Internal ATU option
- 2 Channel SSB Recorder
- 3 Channel CW Data Recorder
- 2.8"H x 5.8"W x 1.5"D
- Weight: 13 oz (less options)

£959.95

Elecraft KX3 160 - 6m, 15W

Mic & paddle key are optional extras

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.

- All modes
- 3.4"H x 7.4"W x 1.7"D
- 18 oz (less options)
- Rear tilt feet fold up for transport
- Custom high-contrast LCD
- Current drain as low as 150 mA in receive mode

Built: **£1349.95** Kit: **£1299.95**

Add a 100W Amplifier
to: KX2, KX3, FT-817/8 and IC-705

This amplifier is great for use with the above radios and has a switched input selectivity for 5W or 10W drive. That enables you to turn your QRP portable station into a 100W base station. Works with any QRP radio. Just needs RF input and PTT input. Band-switching is RF sensed.

- 100W Output
- 160m - 6mV
- 11V - 15V
- Solid state T/R
- Fast QSK
- 'Silent' Heat Sink
- MOSFET Output
- Compact size
- Auto ATU option

SELF BUILD
Why not self-build? Elecraft kits are designed to be easily built at home. No soldering is involved and there is no complicated alignment. The manuals offer step by step instructions with illustrations. A screw driver and several cups of coffee (not included!) will get the job done.

KXPA100 100W Amplifier ....Kit: **£899.95**
KXPA100 100W Amplifier ....Built: **£949.95**
Optional Internal Auto

Be HEARD above the crowd

An HF Amplifier can make a big signal difference. Connected to a 100W transceiver you can achieve nearly as much gain as a three element Yagi - even on 160m and 80m! But you want a design that's tried and tested and one that has been used on many DXpeditions. What better choice than the KPA500. Fully protected and can be used with any modern HF transceiver. Just connect RF and a PTT line. And if you wish, you can even have the satisfaction of building it yourself.

KPA500 Solid State Amplifier 160m-6m

- 160m-6m FET Amp
- 600W ouput
- RF Sensed Band Switch
- Fully Protected
- Fast & Silent QSK
- Low noise internal PSU
- Same compact size as K3
- Use with any transceiver brand
- Instant switch-on operation
- Only 35W drive needed
- 12kg desktop design

2 Year Portsmouth UK Warranty

Available as kit or ready built and tested
Built: £2849.95 Self Build: £2649.95

PX3 Panoramic KX3 Display

A great companion for the KX3. Similar spec. to the P3 above
Kit: £659.95
Built: £699.95

T1-A QRP (20W) Auto

Ideal for FT-817/8. 160m - 6m. Handles coax and most end fed wires!
Built: £169.95

Adonis AM-UD1 *in stock now!*

- Unidirectional eletret condenser desk microphone
- NORMAL/LOW-CUT sound quality selector switch
- Adjustable output volume (microphone sensitivity)
- UP/DOWN switch and transmission indication lamp (LED)
- Output jack (8-pin) mic connector
- Power supply voltage – AA batteries x 2 (DC3v) or microphone conversion code supply (DC 5 to 9v)
- Output impedance : 500Ω to 100 Ω
- Output voltage : 0-30mv (rms)

£119.95

Vibroplex End Fed Wire HF-Allband-kW

- Covers 80 - 10 M
- Power 1kW
- Length approx. 130ft
- Stainless steel hardware
- NO counterpoise needed although Grounding recommended

Manufactured in the USA by Vibroplex, these antennas are pre-tuned and easy to install. The 10m-80m model includes the WARC bands. We now have the 40m-10m 4-band model at £159.95 and soon will have the half-size 80m-10m model.

£169.95

call: **01702 204965** email: **sales@wsplc.com**

Waters & Stanton Ltd • Unit 1 • Fitzherbert Spur • Farlington • Portsmouth • PO6 1TT

@wsplc blog.hamradiostore.co.uk facebook.com/WatersandStanton YouTube Waters and Stanton

Contents

PRACTICAL WIRELESS

November 2020 Vol. 96 No 11
On sale: 8 October 2020
Next issue on sale: 12 November 2020

ISSN 0141-0857

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

Editor
Don Field G3XTT
practicalwireless@warnersgroup.co.uk
Designer
Mike Edwards
mike.edwards@warnersgroup.co.uk
Advertisement Manager
Kristina Green
01778 392096
kristina.green@warnersgroup.co.uk
Production Manager
Nicola Lock
nicola.lock@warnersgroup.co.uk
Production Assistant
Charlotte Bamford
Charlotte.bamford@warnersgroup.co.uk
Marketing Manager
Katherine Brown
katherine.brown@warnersgroup.co.uk
Marketing Executive
Luke Hider
luke.hider@warnersgroup.co.uk
Publisher
Rob McDonnell
robm@warnersgroup.co.uk
Subscriptions
Subscriptions are available as little as £11. Turn to our subscriptions page for full details.
Subscription Administration
Practical Wireless Subscriptions,
Warners Group Publications plc
The Maltings, West Street
Bourne, Lincs PE10 9PH
Tel: 01778 395 161
subscriptions@warnersgroup.co.uk

Components for PW projects
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.

Photocopies & Back Issues
We can supply back issues, but we only keep them for one year. If you are looking for an article or review that you missed first time around, we can still help. If we don't have the actual issue we can always supply a photocopy or PDF file of the article.

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

WARNERS GROUP PUBLICATIONS PLC


54


62

Sign up to our FREE email newsletter at www.radioenthusiast.co.uk

Keylines

My only on-air activity recently has been an effort in the RSGB Autumn Series contests on 80m but I did enjoy that, having linked up with the Bristol Contest Group so that at least my score is helping out a local club, something I had missed since leaving Reading.

The 'fun' activity recently, though, was being interviewed by BBC Radio Somerset and BBC Points West (TV) with my 10-year old granddaughter, as we report in this month's *News* pages. I do hope that we were able to give a good impression of the hobby. Even if it doesn't result in new recruits, at least we may have gone some way to showing that amateur radio isn't all a bunch of oldies! The interviews were organised by the RSGB under the 'Get on the air to care' banner, an initiative that seems to have been pretty successful and is still going strong.

It's great, of course, that so many newcomers have joined the hobby in recent months, giving them an interest during lockdown and beyond. I see, though, that OFCOM are disappointed at the take-up by women – just 9.9% of the total. I guess that UK amateur radio remains, largely, the preserve of white, middle class middle-aged (and beyond) men, which is a great pity. I know that the RSGB and others do their best to spread the word and try to bring in a more eclectic mix of enthusiasts but it does seem to be tough. Is it the clubs that are putting people off? Is it the folk that they hear on the air? Or is it simply that hobbies don't appeal so much to other age groups, to ladies, to ethnic minorities?

DXpeditions?

International travel is still a lottery unfortunately. A number of DXpeditions scheduled for earlier this year promptly issued press releases to the effect that, as a result of lockdown, they would delay until autumn. That, of course, has proved illusory in most cases. The big international contests (CQ WW Phone at the end of October and CQ WW CW at the end of November) are going to feel quite different this year, with far fewer DX entities active, although some (HH and PJ4 are a couple of examples) are host to stations that can be operated remotely (usually from the USA).

It does seem that planning for DX trips will have to wait – just today I saw that one UK amateur, wanting to travel to the Caribbean for the Commonwealth Contest next March, has been sent a long list of 'dos and don'ts' regarding his travel and accommodation, enough to make him think twice.

On the other hand, I feel sure that amateurs who do live in the more remote parts of the world are appreciating the link that their hobby offers to the outside world. I personally find it frustrating because I have been a regular traveller for amateur radio purposes, so the current situation feels distinctly odd. But it's strange times indeed when even a major airline such as QANTAS (Australia) isn't operating international flights (other than for repatriation purposes) until at least next March. I guess we will just have to content ourselves with some SOTA or other domestic activity, which, indeed, can be just as much fun.

144MHz Contest Results

Finally, I must apologise to any of you who were expecting the 144MHz Contest Results in this issue, as we usually do. Colin G6MXL, has indeed prepared the results and sent them to me but space was at a premium and I wanted to run some of the feature articles that I have been sitting on. Rest assured, the Contest Results article will appear next month.

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**

Ailunce HS2 from Moonraker

The Ailunce HS2 is an ultra-portable full frequency full mode SDR transceiver, featuring a built-in Bluetooth module and built-in sound card. Receive frequency coverage is 300kHz to 1.6GHz. The built-in network port supports remote operation and remote firmware upgrade. The HAM-BOX mobile app (for the Android system) allows the mobile phone to easily control and play radio stations (the app is still under development, any progress will be posted on the Ailunce website). HS2 adopts a full keyboard design, with serial communication port module. Full support for currently popular radio control software and logging software. The provisional price, from Moonraker, is £700.

www.moonraker.eu/ailunce-hs2-hf-vhf-uhf-sdr-transceiver

InnovAntennas invest in Ansys

InnovAntennas have invested in Ansys HFSS 2020 R2, a fully three-dimensional mesh-based simulation package to help in the design and production of the new OWL and LFA Ultra range of lightweight Yagis.

HFSS allows for extremely accurate simulation of the complete antenna, including booms, insulators, coax cable and so on. This removes a lot of manual confirmation time and uncertainty above the final results.

Ansys HFSS gives InnovAntennas the ability to not to have to use or apply any correction as each antenna is modelled and finalised with the boom and insulators in place. Once completed, the antenna can be built to the final software suggested sizes and without adjustment.

The Ansys electronics suite is used to simulate accurately many of today's problems. Be it antenna placement results on aircraft, or motor vehicles, to airflow/wind tunnel simulations for the motor industry. HFSS is even used to simulate radiation patterns of mobile/Cell phones when placed within a human hand.

In addition to the standard line of products, InnovAntennas offer customer antennas and systems, including EME (Earth moon Earth), Radio Astronomy and OHR (Over the Horizon Radar).

The photo shows OE5KE's 20-element 144MHz X-pol Yagis. For more information, contact

sales@innovantennas.com
www.innovantennas.com
www.ansys.com

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

Wouxun KG-UV8H 4m + 2m Handie

Wouxun have just introduced the new KG-UV8H 70MHz & 145MHz Dual-band Handie, with 7.5W output on 70MHz and 9.5W on 144MHz. Wouxun are distributed in the UK by ML&S and Martin G4HKS its owner approached Wouxun after Icom announced they had dropped 4m from the IC-705.

"A lot of people were disappointed that Icom didn't go ahead with 70MHz on their new portable QRP rig so I approached Wouxun and asked them to do a 4+2m variant of their 2/70 version. In record time I had two samples shipped to me and after testing put in an order to start production", said **Martin Lynch**. *"Wouxun are very quick to react as they were ten years ago modifying their 10/6/2/70 mobile at our request."*

The KG-UV8H is supplied with Li-Ion battery, base charger, 4+2m whip, belt clip & lanyard. Available from stock at ML&S at an introductory price of £99.95. incl VAT. For more information see:
www.HamRadio.co.uk/KGUV8H

Keeping it in the Family

Warm congratulations from the whole team at Icom UK to Callum Stockley as he becomes one of the latest students to pass his amateur radio Foundation course during the lockdown.

Callum (Commercial Sales Specialist) follows his Dad Andy G8ELP and his Grandad and founder of Icom UK, Dave Stockley G4ELP into the hobby with the callsign of M7ELP.

Callum was very much a cohort of a new era having to study remotely and then taking the examination after home education. Luckily, there is a huge amount of resource on the web to aid learning in the build-up to a test, plus a wealth of knowledge from his amateur colleagues at Icom UK.

The 'ELP' callsign is very special and has been in the Stockley family for over 50 years. On gaining his Foundation Licence, Callum said, *"I was looking forward to telling my Grandad, who was overjoyed at hearing the news. I am hoping to take the next steps to gain my Intermediate and then Full licence soon."*

Dave said, *"I am very pleased that Callum has achieved his first step in amateur radio. I am even more pleased he has secured the callsign M7ELP. My son Andy took on my old call sign of G8ELP so it's nice that another generation of our family has followed in our footsteps with the same ELP tag. Very well-done Callum".*

Radio News

MORE CANCELLED RALLIES: The Bishop Auckland Rally (November 22nd) has had to be cancelled this year as has the Holsworthy Radio Rally due to take place on November 1st.

G-QRP CLUB VIRTUAL CONVENTION: A suggestion by Chairman Steve G0FUW for a Zoom chat turned into something much bigger, an online Convention with over 500 attendees. Talks included Hans G0UPL of QRP Labs, talking about his kits, Heather M0HMO discussing antenna analysers and Dom M1KTA talking about organising a QRP DXpedition. Next was HF Propagation predictions from Steve G0KYA, Mark MM0DQM speaking about his experiments with magnetic loops and Steve G0FUW with a beginner's guide to QRP.

One of the highlights was Pete N6QW spreading the word about his homebrew SSB transceivers. John VE3IPS discussed T2FD dipoles, Gil F4WBY shared his knowledge of QRP SDR radios, Callum M0MCX talked about vertical antennas, Bill G4ERV about battery technology and John G8SEQ about omnidirectional antennas. Anthony K8ZT gave a live demonstration of FT8 and FT4 while Nick M0NTV described his homebrew 'rig in a bread bin'. Les G0NMD described his inexpensive shack on a pole and Alan W2AEW talked about vector network analysers. All in all, a great success.

U3A AND AMATEUR RADIO: Mike Meadows G4GUG is involved with U3A (University of the Third Age) as well as being an active radio amateur. He has been promoting the hobby through the U3A magazine and invites other radio amateurs involved with U3A to contact Janine Aldridge on janine.aldridge@u3a.org.uk or Mike himself at g4gug161@gmail.com

TELONIC
TEST INSTRUMENTS & POWER SUPPLIES
Trusted in Test & Measurement for 50 Years
0118 978 6911 - TELONIC.CO.UK
MORE CHOICE! MORE STOCK! MORE SAVINGS!
Rigol DS1000Z Oscilloscopes
DS1054Z 50MHz 4 Ch
DS1074Z/-S Plus 70MHz 4 Ch
DS1104Z/-S Plus 100MHz 4 Ch
DS1202Z-E 200MHz 2 Ch
From: £272 +VAT
Siglent SDS1000X-E Oscilloscopes
SDS1104X-E 100MHz 4 Ch
SDS1202X-E 200MHz 2 Ch
SDS1204X-E 200MHz 4 Ch
From: £300 +VAT
Micsig STO1000C Plus Oscilloscopes
STO1102C 100MHz 2 Ch
STO1104C 100MHz 4 Ch
STO1152C 200MHz 2 Ch
Battery powered
From: £379 +VAT
Siglent SDS2000X Plus Oscilloscopes
SDS2102X plus 100MHz 2 Ch
SDS2104X Plus 100MHz 4 Ch
SDS2204X Plus 200MHz 4 Ch
SDS2354X Plus 350MHz 4 Ch
From: £788 +VAT
Rigol MSO5000 Oscilloscopes
MSO5072/4 70MHz 2/4 Ch
MSO5102/4 100MHz 2/4 Ch
MSO5204 200MHz 4 Ch
MSO5354 350MHz 4 Ch
From: £732 +VAT
Siglent SSA3000X Spectrum Analysers
Series Frequency Range Resolution Bandwidth
SSA3021X 9kHz~2.1GHz 1Hz to 1MHz
SSA3032X 9kHz~3.2GHz 1Hz to 1MHz
From: £1,158 +VAT
Rigol DSA800 Spectrum Analysers
Series Freq. Range Resolution BW
DSA815 9kHz~1.5GHz 10Hz to 1MHz
DSA832 9kHz~3.2GHz 10Hz to 1MHz
DSA875 9kHz~7.5GHz 10Hz to 1MHz
From: £826 +VAT
Brymen Handheld Meters
Clamp-On Multimeters
Handheld Multimeters
Insulation Multimeters
From: £66 +VAT
Microtest 6360 Series LCR Meters
6 models, up to 1MHz test frequency
- Basic accuracy up to ±0.05%
- Synchronous test with four parameters settings
- List mode function up to 8 sets
- USB Host can storage testing screen and data
- PC Connection data analysis software is available
From: £1,276 +VAT
Kikusui PCR-MA Series AC Power Supplies
PCR500MA 5A/2.5A
PCR1000MA 10A/5A
PCR2000MA 20A/10A
PCR4000MA 40A/20A
1V TO 155V 2V TO 310V (2 ranges)
From: £1,895 +VAT
Siglent SDG1000X Waveform Generators
SDG1032X 30MHz 2 Ch
SDG1062X 60MHz 2 Ch
Siglent SDG2000X Waveform Generators
SDG2042X 40MHz 2 Ch
SDG2082X 80MHz 2 Ch
SDG2122X 120MHz 2 Ch
From: £231 +VAT
Rigol DG800 Waveform Generators
DG811 10MHz 1 Ch
DG812 10MHz 2 Ch
DG821 25MHz 1 Ch
DG822 25MHz 2 Ch
DG831 35MHz 1 Ch
DG832 35MHz 2 Ch
From: £179 +VAT
JBC Soldering Irons
JBC CD-2BQE General Purpose Soldering Station (Bundle Kit)
Includes:
- Soldering Station
- Soldering iron
- 2x Tip Cartridges
£310 +VAT
Siglent SDM3000 Multimeters
Series Resolution
SDM3045X 4.5 Digits
SDM3055 5.5 Digits
SDM3065X 6.5 Digits
From: £330 +VAT
Rigol DP800/DP700 Power Supplies
DP700 Series Up to 50V Up to 5A
DP800 Series Up to 60V Up to 10A
From: £267 +VAT
Siglent SPD1000X/SPD3000X PSU's
SPD1000X Series Up to 30V Up to 8A
SPD3000X Series Up to 32V Up to 3.2A
From: £207 +VAT
PCBite
£57
£65
PCBite kit Small (A5) & Large (A4)
£83
PCBite kit with 2x SP10 probes for DMM
£114
PCBite kit with 4x PCBite probes and test wires
£132
PCBite kit with 2x SP100 100Mhz handsfree oscilloscope probes
RIGOL WWW.RIGOL-UK.CO.UK
SIGLENT SIGLENT.CO.UK
Micsig
BRYMEN BRIGHT PEOPLE'S CHOICE
KIKUSUI
MICROTEST
JBC

Starting on Microwaves

Bernard Nock G4BXD
military1944@aol.com

How to operate while cooking your tea, or a beginner's guide to microwaves.

Having been playing amateur radio for 50 years I was very content with operating from 160m, or Topband as we used to call it, and up to 70cm or 432MHz. This included the local ragchew bands, 160, 80 and 40m, and the DX bands, those where you could end up speaking to someone with a foreign accent in far-away places like Timbuktu or Bora Bora if you were lucky, the 20 15 and 10m bands. Of course, somewhere along the timeline we were given 30, 17 and 12m to play with as well.

Then there were the 4m, 2m and 70cm bands. These were usually local chat bands but occasionally when the cloud and wind Gods got angry the heavens would open and allow long distances to be worked, causing great delight to those with small antennas (by the way, we used to call them aerials back then). Again, along the timeline a band we used to have but which was taken away and then was given back to us, 6m or 50MHz. This was an odd band, though. Not many Japanese-made radios covered the band so lots of old PMR and taxi radios were used, the same with 4m. Not now though, every HF radio seems to have 6m on it.

And so it was that I muddled my way through the world of amateur radio until in 2019 a new spark was ignited. The launch of a Geostationary satellite carrying amateur radio, Oscar-100, also launched a whole new world of amateur radio for me to play with. This new field, to me at least, was Microwaves.

My only other experience of microwaves, like most people's I guess, was in warming up last night's leftovers for breakfast. Great machine, open the door, put in cold food, close and set timer, ping, open door to hot food.

After getting operational on the Oscar-100 satellite my interest was aroused into what other bands might be available in that region of the electromagnetic spectrum. I was amazed to find we have, wait for it, 1.3, 2.3, 3.4, 5.7, 10, 24, 47, 76, 122, 134 and 248GHz bands. The size of the bands can be staggering. For example, the 134GHz band is from 134 to 136Ghz, that's 2GHz bandwidth, as primary user and 136 to 141GHz as a secondary user (see URL below). We also have allocations above that, into the THz region but that's sci-fi as far as I'm concerned.

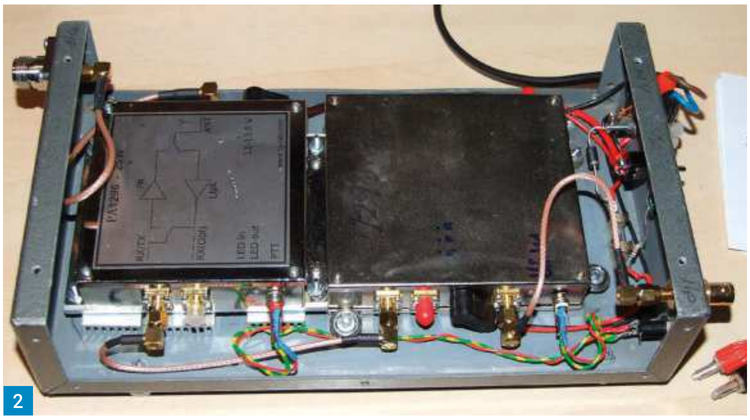
1

https://tinyurl.com/y5b4ne96

New Fields

So, having been made aware of a whole new aspect to the hobby I pressed ahead to see just what it would take to get operational on some of the bands. After some 18 months of acquiring suitable test equipment, microwave power meters, spectrum analysers, receivers, transmitter, bags full of miniature connectors, leads, plugs, sockets, adapters, attenuators, wire, copper, dish antennas, Yagis and a whole host of bits I have come to the conclusion there are two main ways of getting operational on these bands.

These are A: the hard way and B: the easy way. Method A had the least attraction for me. Those choosing method


2

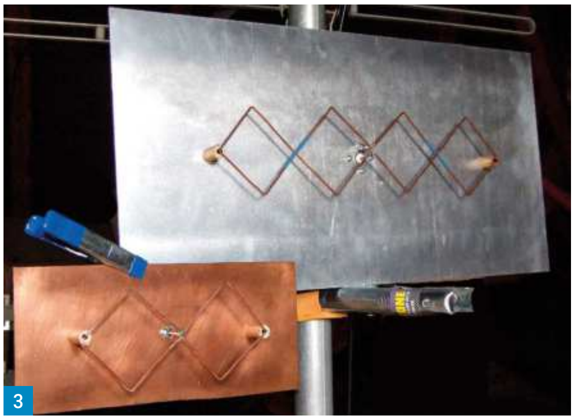

3

Fig. 1: The dish garden continues to grow. Fig. 2: The 23cm station. Fig. 3: The Bi-Quad and Double Bi-Quad antennas. Fig. 4: The 13cm station. Fig. 5: The 9cm station breadboarded on the dish with home-made horn. Fig. 6: The 3cm station in breadboard form, horn on top.

A usually come from or have a mechanical engineering interest, have a large selection of engineering equipment such as CNC millers and lathes and no doubt own one or more digital micrometers.

They are the sort happy to measure to the quintillionth of a mm, something I with my 10m Stanley steel tape am unable to match. They are also happy to solder the tiniest of Surface Mounted Components to the tiniest of PCBs using laboratory grade microscopes.

Method B on the other hand did appeal to me. This is the plug-and-play method, a concept known to many of us, usually in the form of a USB lead, which when plugged into the PC somehow magically tells the PC what it is and results in the PC popping up a message saying *"Your device is connected and ready to use"*.

The plug-and-play method means you simply buy all the ready-made bits and connect them up. There can be a bit of light engineering required, buying suitable diecast boxes and drilling a few holes, a bit of wiring, switches, fuses, lights, etc but nothing too complicated.

I think it's fair to say the lower microwave bands, certainly the 1.3, 2.3, 3.4 and 10GHz bands, are well served by manufacturers in the form of transverters, amplifiers and antennas. Some of the items can be a bit pricey to say the least but if you're expecting someone else to do the hard work of making the stuff, then you have to pay the piper as they say.

My Solutions

Having firstly acquired the SG Labs 13cm transverter to use on Oscar-100 that job has now been taken over by a dedicated system, which freed up the transverter to be used on the 2.3GHz band. Being pleased with the build quality and ease of use of the SG Labs gear, I have gone on to buy their 23 and 9cm transverters along with their 23 and 13cm power amplifiers with built-in LNA or low noise pre-amps. There are other manufacturers out there. Kuhne in Germany for one make some very nice but costly equipment

The 23cm system comprises at the moment an FT-817 as the driver set. This has had its output turned down to the lowest setting, about 400mW on my radio, which is fed into the 23cm transverter. This then drives the 25W amplifier, all of this running off a 13V supply.

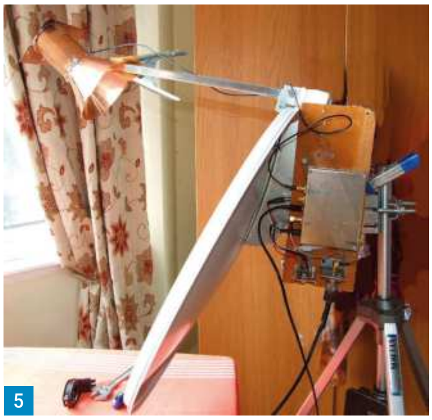
For antennas I first built a thing called a Bi-Quad, lots of information about it on the web (see URL below), very easy and which worked very well. I then added to it by building a double Bi-Quad (see second URL below), which is even better. I have now progressed to a 16-element Yagi. There are various suppliers for these, both in the UK and in Europe. Certain situations with the buildings here mean it's hard for me get a tower or such, which could carry bigger antennas.

https://martybugs.net/wireless/biquad
https://tinyurl.com/yybt2zjo

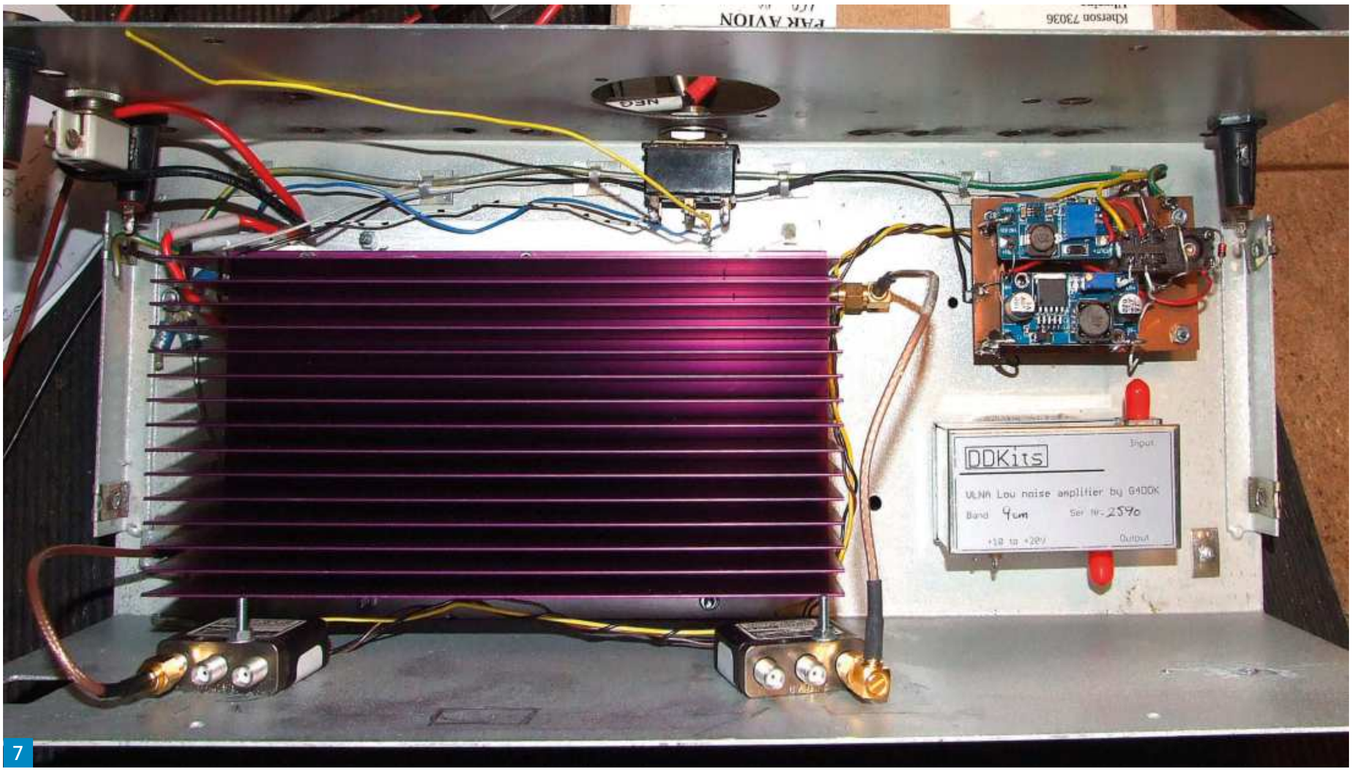
For 13cm I also use the FT-817, which drives the previously mentioned 2.3GHz SG Labs transverter. This feeds their 20W PA unit, which has an LNA in it as well. The PA does require a 28V supply but there are little modules on the web, DC-to-DC converters, that are small and work well. For this band I acquired a 40-element Yagi made by Wimo. At these frequencies a 40-element Yagi is only about 1.5m long so very manageable.

For all these frequencies a most critical thing is cable, coax cable. You have to use the best you can afford because the losses


4


5


6



7

Fig. 7: The 9cm PA and LNA being boxed.

in coax start getting appreciable as the frequency rises. The likes of RG213 are not suitable. I have used LMR400 and Westflex 103 with good results but the purists, or those with long runs up to the top of their towers, use a cable called Heliax, very good, very expensive and hard to fit connectors to.

I then decided to look at the 9cm band, 3.4GHz, and as before SG Labs now make a transverter for that band. Again, there are other suppliers. Kuhne, as mentioned before, do a very nice if costly range. The SG Labs unit is quoted as being 3W output but when I measured mine there were nearly 4W coming out. I did adjust the level, though, in the interests of heat and longevity, to the 3W peak setting.

At these sort of frequencies antenna selection is getting to the point where parabolic dishes are used, offset or prime focus types. Usually with a dish of either sort you need a feed, a device that launches the RF towards the dish. This then gets concentrated and reflected back towards the stations you want to work. The feed unit is the heart of the system and there are many designs for feeds of various types on the web (below). The gain from a dish is considerable, 30dB with ease, something that is a great help at these frequencies.

www.w1ghz.org/antbook/contents.htm

While I pondered on the type of feed to try and build I built a simple Horn-type antenna scaled from dimensions found on the web for a 2.4GHz horn designed for wi-fi. The horn consists of a 67mm copper tube about 104mm long, an N-type socket fitted at a certain location with a small probe antenna inside of a desired length. The end of the horn has a flared skirt around it and even this simple design, constructed with basic hand tools, offers a decent amount of gain.

Using the FT-817, transverter and the horn antenna on its own my first attempt in a 9cm contest resulted in six QSOs, four of which were over 100km distant with 153km being the best so far. Apparently, conditions are not very good at the moment so range should improve with better conditions. The next stage will be to add a 20W Stealth amplifier and a G4DDK LNA preamp to make what should be a quite potent station. When added to a dish antenna I think things will really begin to rock.

Looking to get on the 3cm band, 10GHz, I was lucky enough to be offered an unused Kuhne transverter at a very reasonable price along with a very well made G4DGU round feed for use on an offset dish. On its own the feed has a 10dB gain and when used with a 60cm or such dish you're looking at over 30dB of gain for a very small footprint.

I have managed a relatively short QSO of 56km with the 300mW or so out of the transverter into the feed horn poked out the window so am hoping for great things when it's fitted to a dish and I'm out portable on a high hill. The next stage will be to obtain a PA of some sort, though Watts at these frequencies usually means serious money, and get the system ready for hilltop activation and the DX.

All in all, it's been a fairly easy path to getting operational on several of the lower microwave bands – ease of obtaining equipment, plenty of help from fellow microwavers and the added enthusiasm a new venture instils. It has to be noted though that should I think of going beyond 10GHz to 24, 122, 248GHz etc, then things will get a lot harder. Much of the equipment will need to be built, entailing the aforementioned engineering abilities and machinery.

With the present HF conditions and the ever increasing noise on the shortwave bands, my expedition into the microwave bands has in the main been very enjoyable. There have been frustrating times. Half-way through boxing something you find you're missing a certain plug, or fuse holder or such and you have to wait while the online order gets delivered. You connect up several units only to find no output due to a silly dry solder joint, which takes you days to find. There is, though, I feel, considerable joy to be had on the microwave bands so give it a go.

YAESU
The radio

High Visibility and Operation with a High-Resolution Full Colour TFT & Touch Screen Display
Superior Performance in a Compact C4FM Digital Transceiver

- System Fusion II Compatible
- Compact & Reliable 5W RF Power Output
- 700mW of C4FM Exceptional Quality Audio
- Dual band Simultaneous Receive
- High Visibility Full-Colour TFT touch panel Display
- Built-in High Precision GPS Receiver
- Easy Hands-Free Operation with Built-in Bluetooth® unit
- High-Resolution and High-Speed 79 channel Band scope
- CAM (Club channel Activity Monitor) Function
- FM Friendly Digital by AMS (Automatic Mode Select)
- WIRES-X Portable Digital Node Function

《Actual Size》

C4FM/FM 144/430MHz DUAL BAND DIGITAL TRANSCEIVER

FT3DE

Bluetooth®
micro SD Card
C4FM Digital Clear Voice
Clear and Crisp Voice Technology
AMS Automatic Mode Select
66 ch GPS

YAESU
The radio

YAESU UK Ltd
Unit 12 Sun Valley Business Park, Winnall Close
Winchester, Hampshire SO23 0LB

For the latest Yaesu News , visit us on the internet at www.yaesu.co.uk

Morse Practice Oscillators

Tony Jones G7ETW
charles.jones125@yahoo.co.uk

Tony Jones G7ETW presents several solutions to the need for a Morse practice oscillator.

Simple, useful construction projects taking an evening or less to complete have always been popular in *Practical Wireless*, and one of our 'hardy perennials' is a CW practice oscillator. I expect most radio amateurs have made one at some time, but a request in the *Letters* page in the November 2019 issue gave me a good excuse to revisit this.

I offer you six options. I can take no credit for the circuits by the way; I found them all on the internet.

NE555 Astable Oscillator

This is by far the commonest circuit to be found when Googling 'morse practice oscillator'. **Fig. 1** shows a common circuit.

An NE555 oscillator requires few components and is easy to configure. It produces a loud tone, easily made variable in pitch and volume, but the output is a square wave and the NE555 cannot drive a low-impedance loudspeaker.

In this case the whole oscillator is switched but sometimes the oscillator runs constantly and the key switches in the loudspeaker. This makes no difference; this is a reliable circuit that works well.

(If it doesn't work, check that the capacitor to ground from pin 5 has not been omitted.)

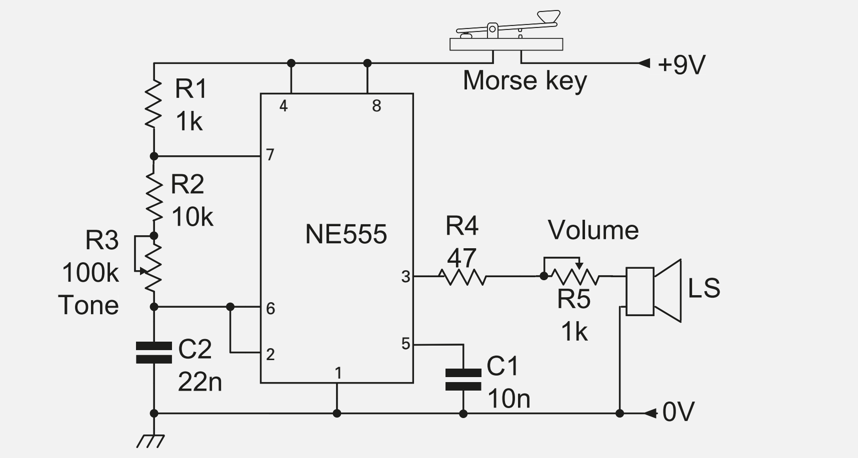
R2 and R3 (call this Rv) in series vary the charging current for C1, and the charge-discharge cycle controls the frequency.

Frequency = 1.44 ÷ (C1 × (R1 + 2×Rv))

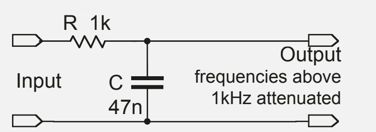
These values give a frequency range from 300Hz to 3kHz depending on where R3's wiper is set.

Using an 8Ω loudspeaker would limit the current draw to something the NE555 can handle, but these are hard to come by. Hence the 47Ω resistor in series with the 8Ω loudspeaker. A pair of modern headphones wired in series would give a 64Ω load, but I think it would be uncomfortably loud.

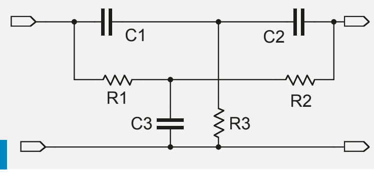
The only real downside is the sound, which is a square wave and harsh to the ear. A square wave consists of an infinite number of sine waves, summed. Adding a low pass filter to suppress all frequencies above the fundamental would give a sinewave output.



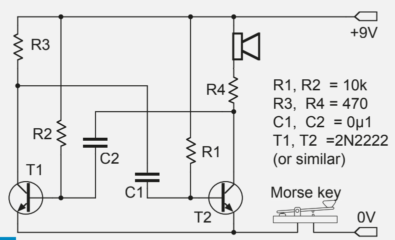
1



2



4



3

Fig. 2 shows an RC filter with a cut off of 1kHz – this should give a nice sound at frequencies up to around 600Hz.

Cut-off frequency = 1 ÷ (2 × π × R × C)

For 1kHz, 3.3kΩ and 47nF are very convenient values.

Two-transistor Astable Oscillator

I first used this circuit to make an LED flasher for my wife's choir's Christmas concert, and I offer it as a lovely example of what astability really is. I had two DMMs monitoring voltages on the capacitors and transistor bases and this entertained me for hours!

Fig. 3 shows one of these oscillators, also called a relaxation oscillator, set up for audio frequencies. There are two outputs, opposite in state and constantly changing, controlled by an RC network. The output is a square wave.

In the femtoseconds after switch-on all bets are off, but a few milliseconds later let's say TR1 is switched on and TR2 is off. Tr1's collector will be nearly at ground, and Tr2's will be at 9V. C1 starts charging via R2 and after a certain time 0.6V appears on the base of Tr2, switching that transistor on.

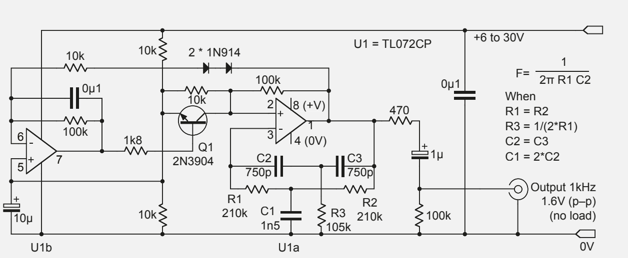
Tr1's base voltage drops, and the transistor is switched off. C2 now starts to charge, and in time the other side of the circuit does the same thing.

This repeats. The loudspeaker experiences a pulsing waveform, at a fixed frequency.

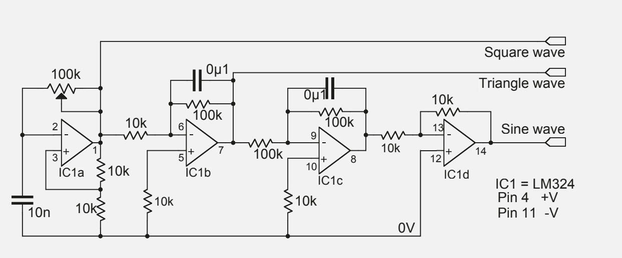
For this circuit to work, R1 and R2 must be of equal value (call this R) and C1 and C2 must also be of equal value (call this C).

Frequency = 1 ÷ (1.38 × R × C) With the suggested values, that is about 800Hz.

To make this a variable oscillator, the

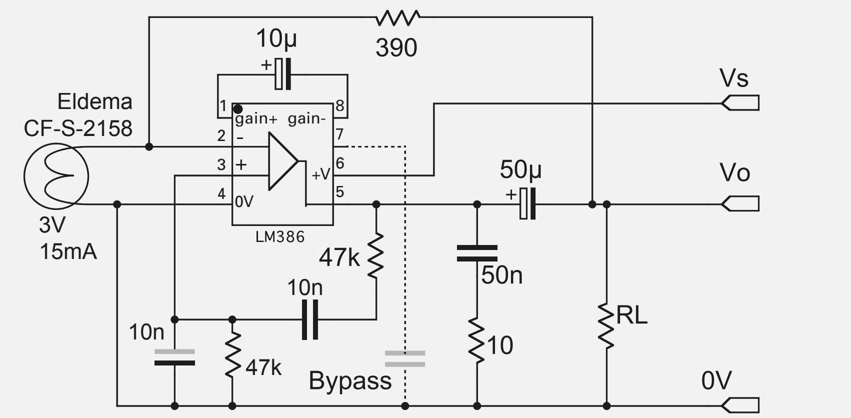


5



6

Fig. 1: Astable oscillator. Fig. 2: RC filter.
Fig. 3: Two transistor astable oscillator.
Fig. 4: Twin-tee band stop filter.
Fig. 5: Op-amp twin-tee oscillator.
Fig. 6: LM324-based function generator.
Fig. 7: An LM386-derived oscillator.



7

capacitor or resistor pairs need to be made variable. Variable capacitors are a fearsome price nowadays – use a twin-gang stereo potentiometer for R1 and R2.

Twin-Tee Oscillators

We have to start with a band-stop notch filter, **Fig. 4**. There is an RCR circuit and a CRC circuit, wired in parallel. The values are related.

The RCR circuit is R1 and R2 (the same value; call this R) and C3. This acts as a low-pass filter.

The CRC circuit is R3 and C1 and C2 (the same value; call this C). This acts a high-pass filter.

C3 in the RCR circuit = 2 × C in the CRC circuit.

R3 in the CRC circuit = R ÷ 2 in the RCR circuit.

To properly analyse how a Twin-Tee notch filter works would require a determination of each section's frequency response, then combining the results, and can't that be done without some pretty gruesome maths. Fortunately, it all boils down to something quite simple:

Frequency = 1 ÷ (2 × π × R × C)

When a Twin-Tee filter is incorporated into an amplifier, the amplifier becomes an oscillator. This is because the filter is in the feedback circuit, and only one frequency (well, a narrow range of them) can get through.

Twin-Tee oscillators can obviously be implemented with discrete components, and only one transistor is needed, but see **Fig. 5** for a Twin-Tee, on about 600Hz, using a quad-amp LM324.

Build a Function Generator

The AD9850 IC is a complete DDS Synthesiser that offers square and sine wave outputs (two of each) at frequencies varying from 1Hz to 60MHz. For a Morse practice oscillator this is total overkill, obviously, but AD9850 chips are cheap and experience gained on a simple project like this is directly transferable to RF-based oscillators as used in SDR designs. Google 'Arduino AD9850' to find some nice examples of a complete DDS with a nice display.

But for a simpler implementation, there is no need to buy a 'proper' function generator chip.

A quad op-amp, using all four amplifiers, can do the same job. See **Fig. 6** for one based on the LM324.

Stage 1 is a comparator circuit in which the capacitor C1 charges and discharges alternately with a frequency given by 1 ÷ 2 RC. This outputs a square wave.

Stage 2 is an integrator circuit, which converts the square wave into a triangular wave of the same frequency.

Stages 3 and 4 remove the triangular wave's sharp edges and produce a sinewave, still at the same frequency. Add a trusty LM386 amplifier via a DC blocking AC-coupling capacitor and a key and we get a Morse oscillator.

Other ideas

LM386 chips also oscillate – like all high-gain amplifiers, sometimes when you don't want them to! But this chip can be used as an oscillator intentionally. **Fig. 7** is taken straight off the LM386 data sheet.

Again, the frequency is given by f = 1 ÷ (2 × π × R × C)

Arduino DDS

I don't mean an Arduino driving a DDS shield, I mean why not get the Arduino do the whole job? True, it's not the fastest computer in the world – it's not even technically a computer, lacking an Operating system – but there is a pleasure in using these.

An Arduino has a 5V 10-bit D-to-A, and can execute loops. So, it should be possible to store some values for a sine wave (or indeed any other kind of wave) and realise these as analogue values using a timed loop. Like the NE555, an Arduino can't drive an 8Ω loudspeaker, but an external amplifier is the easy part.

And the values that need to be stored – there's no need to store a whole cycle of course.

Each quarter cycle has the same values, and all that changes is the direction of passing through them and which side of a nominal zero line we're at. The code gets more complex, but I can almost see it in my head now...

This is well worth a try. Aside from the audio possibilities, people have made RF DDSs as well. That's taken me a long way from an NE555 oscillator, but then my articles are apt to do that!

Mobile Antenna Mounts

MOONRAKER

TRIMAG-S Triple magnetic mount with SO239 antenna fitting with 4m RG58 and PL259 fitted – ideal for those larger antennas........**just £39.95**
TURBO-S single 170mm magnetic mount with SO239 antenna fitting with 4m RG58 and PL259 fitted – will suit most antennas upto 5ft. **£19.95**
HKITHD-SO Heavy duty hatch back mount with SO239 antenna fitting with 4m RG58 and PL259 fitted **£32.95**
HKITM-S Mini hatch back mount with SO239 antenna fitting with 4m RG58 and PL259 fitted...**£32.95**

MOONRAKER

Multiband Mobile

Why buy loads of different antennas when Moonraker has one to cover all! SPX series has a unique fly lead and socket for quick band changing

SPX-100 9 Band plug n' go portable, 6/10/12/15/17/20/30/40/80m, Length 165cm retracted just 0.5m, Power 50W complete with 38th PL259 or BNC fitting to suit all applications, mobile portable or base - brilliant! **£44.95**
SPX-200S 6 Band plug n' go mobile, 6/10/15/20/40/80m, Length 130cm, Power 120W, PL259 fitting............................. **£44.95**
SPX-300S 9 Band plug n' go mobile, 6/10/12/15/17/20/30/40/80m, Length 165cm, High Power 200W,PL259 fitting **£59.95**

MOONRAKER

VHF/UHF Mobiles

GF151 Glass Mount 2/70cm, Gain 2.9/4.3dBd, Length 78cm complete with 4m cable and PL259 .... **£29.95**
MRM-100 MICRO MAG 2/70cm, Gain 0.5/3.0dBd, Length 55cm, 1" magnetic base with 4m coax and BNC **£19.95**
MR700 2/70cm, Gain 0/3.0dBd, Length 50cm, 3/8 fitting..................................**£9.95**
MR777 2/70cm, Gain 2.8/4.8dBd, Length 150cm, 3/8 fitting............................ **£19.95**
MRQ525 2/70cm, Gain 0.5/3.2dBd, Length 43cm, PL259 fitting (high quality)... **£19.95**
MRQ500 2/70cm, Gain 3.2/5.8dBd, Length 95cm, PL259 fitting (high quality)... **£26.95**
MRQ750 2/70cm, Gain 5.5/8.0dBd, Length 150cm, PL259 fitting (high quality). **£36.95**
MRQ800 6/2/70cm Gain 3.0dBi/5.0/7.5dBdBd, Length 150cm, PL259 fitting (high quality) **£39.95**
MRQ273 2/70/23cm Gain 3.5/5.5/7.5dBdBd, Length 85cm, PL259 fitting (high quality) **£49.95**
MRQ900 10/6/2/70cm Gain 10m (2.15dB) 6m(2.5dB) 2m (2.8dB) 70cm (5.5dB) Length:

MOONRAKER

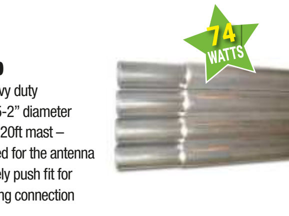
Coax Cable Drums

Save money buying in bulk – handy 50m as well as 100m drums at discounted prices

RG58-DRUM-50 standard RG58 6mm 50m reel...**£19.99**
RG58-DRUM-100 standard RG58 6mm 100m reel..**£29.99**
RG58M-DRUM-50 military spec RG58 6mm 50m reel **£24.95**
RG58M-DRUM-100 military spec RG58 6mm 100m reel..................................**£44.95**
MINI8-DRUM-50 military spec MINI-8 7mm 50m reel **£34.99**
MINI8-DRUM-100 military spec MINI-8 7mm 100m reel **£64.99**
RG213-DRUM-50 military spec RG213 9mm 50m reel **£64.99**
RG213-DRUM-100 military spec RG213 9mm 100m reel **£119.99**
WESTFLEX-DRUM-100 military speck Westflex 103 10mm 100m reel..........**£159.99**
RG174-DRUM-100 military spec RG174 2.8mm 100m reel..............................**£59.95**
FORMULA-ZERO 100m super low loss cable 10mm **£139.99**
FORMULA-ZERO 50m super low loss cable 10mm **£74.99**

MOONRAKER

Masts – Push Up



Lightweight medium and heavy duty swaged masts sets from 1.25-2" diameter 5ft sections to create a lovely 20ft mast – choose the correct size needed for the antenna installation. Masts have a lovely push fit for easy of use and to give a strong connection

MSP-125 20ft Medium Duty (set of 4 poles) 32mm dia 1.6mm gauge..... **£44.99**
MSP-150 20ft Medium Duty (set of 4 poles) 38mm dia 1.6mm gauge..... **£49.99**
MSP-175 20ft Medium Duty (set of 4 poles) 44mm dia 1.6mm gauge..... **£59.99**
MSP-200 20ft Medium Duty (set of 4 poles) 51mm dia 1.6mm gauge..... **£69.95**
MSPX-150 20ft Heavy Duty (set of 4 poles) 38mm dia 2.65mm gauge....... **£69.95**
MSPX-200 20ft Heavy Duty (set of 4 poles) 51mm dia 2.65mm gauge....... **£89.95**

MOONRAKER

GRP Fibreglass Base Antennas Diamond quality – Moonraker pricing

These high gain antennas have been pre-tuned for your convenience, easy to use, easy to install, and a choice of connection … look no further

SQBM100P 2/70cm 3.00/6.00dBd, RX 25-2000MHz, Length 100cm SO239.. ~~£49.95~~ **SPECIAL OFFER £39.95**
SQBM200P 2/70cm, Gain 4.5/7.5dBd, RX 25-2000MHz, Length 155cm, SO239............................ ~~£54.95~~ **SPECIAL OFFER £44.95**
SQBM500P 2/70cm, Gain 6.8/9.2dBd, RX 25-2000MHz, Length 250cm, SO239............................ ~~£74.95~~ **SPECIAL OFFER £69.95**
SQBM1000P 6/2/70cm, Gain 3.0/6.2/8.4dBd, RX 25-2000MHz, Length 250cm, SO239.. **£84.95**
SQBM223N 2/70/23cm, Gain 4.5/7.5/12.5dBd, RX 25-2000MHz, Length 155cm, N-Type **£79.95**
SQBM3000N Triband 2/70/23cm, Gain 4.5/8.3/10.7dBd Length 1.55m **£79.99**
SQBM3500N Triband 2/70/23cm, Gain 6.8/9.2/11.8dBd Length 2.70m **£119.99**

MOONRAKER

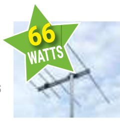
HF Wire Antennas

Our HF wire antennas are made with complete waterproof potted baluns and high quality "original" flexweave antenna wire.

MDHF-80 3.5MHz balun matched mono dipole, length 40m..........**£59.95**
MDHF-40 7.0MHz balun matched mono dipole, length 20m..........**£44.95**
MDHF-20 14MHz balun matched mono dipole, length 10m...........**£39.95**
OSHF-80 3.5-30MHz balun matched off set dipole, length 40m **£59.95**
OSHF-40 7.0-30MHz balun matched off set dipole, length 22m **£44.95**
OSHF-20 14-30MHz balun matched off set dipole, length 11m **£39.95**
LWHF-160 1.8-50MHz unun match end fed antenna, length 42m ...**£49.95**
LWHF-80 3.5-50MHz unun match end fed antenna, length 20m ...**£44.95**
LWHF-40 7.0-50MHz unun match end fed antenna, length 10m ...**£39.95**

MOONRAKER

Yagi Antennas



All Yagis have high quality gamma match fittings with stainless steel fixings!

YG27-35 Dual band 3/5 element 3.5/12.5 dBd gain with one feed! **£79.95**

MOONRAKER

Masts GRP Fibreglass

Ideal heavy duty fibreglass masts for those antennas that need to be insulated from metal hardware or pole – convenient 2m lengths in a light grey

GRP-150 2m 37mm OD..**£29.95**
GRP-200 2m 51.7mm OD..**£39.99**

MOONRAKER

Masts Telescopic

We offer both aluminium and GRP fibreglass push up masts ranging from 20-50ft to suit your needs. The aluminium versions are for portable/occasional use and the fibreglass versions can also be used for fixed installation

LMA-M 26ft open 5.5ft closed 50-25mm aluminium mast **£109.99**
LMA-L 33ft open 7.2ft closed 50-25mm aluminium mast....................**£119.99**
TMF-1 20ft open 5.6ft closed 50-30mm high quality GRP mast...........**£199.99**
TMF-1.5 30ft open 7.5ft closed 57-30mm high quality GRP mast.........**£299.99**
TMF-2 40ft open 9ft closed 57-30mm high quality GRP mast **£349.99**
TMF-3 50ft open 8ft closed 65-23mm high quality GRP mast **£399.99**

Sharman X-510 2/70cm 5.2m Super Gainer at a Super Price Just £99.95

NEW IN

MOONRAKER

QRP Antennas

The Moonraker Whizz range are great for getting on HF in a neat compact and totally portable way

Whizz Whip HF/VHF/UHF portable antenna with telescopic whip - ideal for any situation where a long wore or vertical antenna is just not an option - get on air today for **just £99.95**

Whizz Loop 20-60m compact loop is ideal for QRP Transceivers when space is limited or using portable with a Yaesu FT-817ND or similar. Can be used indoors with surprising results and handy for travelling due to its "pocket" size antenna ideal for indoor or out and can be packed away and all for just **£69.95**

Whizz Loop V2 (right) same as above but with a frequency range from 40-10m............................**£79.95**

MOONRAKER

Base Antennas

Simple plug and play HF antennas radial free and at a great price

GP2500 All Band 80-6M Vertical TX 80-6M RX 2-90MHz, Power 250W Length 7.13M **£199.95**
GPA-80 budget version of GP2500 80-6M Length 6.0M **£99.95**
GPA-80F fibreglass version of GPA-80 ....**£129.95**

MOONRAKER

HF Mobiles

Get great results with the Moonraker range of HF mobiles! From as little as £22.95!

AMPRO-10 Slim line design 28MHz 2m approx. 3/8th fitting...... **£22.95**
AMPRO-11 Slim line design 27MHz 2m approx. 3/8th fitting...... **£22.95**
AMPRO-12 Slim line design 24MHz 2m approx. 3/8th fitting...... **£22.95**
AMPRO-15 Slim line design 21MHz 2m approx. 3/8th fitting...... **£22.95**
AMPRO-17 Slim line design 18MHz 2m approx. 3/8th fitting...... **£22.95**
AMPRO-20 Slim line design 14MHz 2m approx. 3/8th fitting...... **£22.95**
AMPRO-30 Slim line design 10MHz 2m approx. 3/8th fitting...... **£22.95**
AMPRO-40 Slim line design 7MHz 2m approx. 3/8th fitting........ **£22.95**
AMPRO-60 Slim line design 5MHz 2m approx. 3/8th fitting........ **£24.95**
AMPRO-80 Slim line design 3.5MHz 2m approx. 3/8th fitting..... **£27.95**
AMPRO-160 Slim line design 1.8MHz 2m approx. 3/8th fitting... **£59.95**

Other frequencies available. Call or see online for more details.

Make Your Own? Wire, insulators & bits

Have fun but making your own antenna system and see how it works against the commercial designs

SCW-50 Enamelled copper wire, 1.6mm, 50m length **£24.95**
HCW-50 Hard drawn copper wire, 1.6mm, 50m length **£29.95**
FWPVC-50 high quality flexweave with PVC coating 4mm, 50m **£44.95**
300-20 Ribbon feeder 300 ohm high quality slotted, 20m.....................**£17.95**
450-20 Ribbon feeder 450 ohm high quality slotted, 20m **£19.95**
DPC-W Wire dipole centre with securing clamps **£5.95**
DPC-S Wire dipole centre with SO239 socket for PL259 ....**£6.95**
DPC-38 Dipole centre for 2 x 3/8th whips antennas to make dipole **£6.95**
DOGBONE-S small plastic insulator **£1.00**

Hardware

We offer all type of mounting hardware to help get you rigged up at home – if you cant see it listed chances are we have it. Check www.moonraker.eu or just give us a call

TRIPOD-HDA heavy duty collapsible tripod to suit base mats up to 67mm **£149.95**
TK-24 wall bracket offers 18" clearance **£29.95**
TK-12 wall bracket offers 12" clearance **£19.95**
BB2 mast base plate to suit up to 2" masts/pole **£22.99**
JOIN-200 clamp 2" poles back to back **£17.95**
PTP-20 2" to 2" mast clamp **£5.95**

Join the best loyalty programme

and start earning WATTS now!

All registered retail customers can now earn and redeem free product credits known as WATTS. It's simple the more you spend the more WATTS you receive. You will also receive bonus WATTS when you refer a 'New Customer', 'Write a Product Review', 'Share' a product' or 'Refer a Friend'

Don't miss out – Register now and start enjoying free WATTS

Tim Kirby
longworthtim@gmail.com

More Transatlantic Propagation on 2m

Tim Kirby GW4VXE has a full column, with news of some excellent 2m transatlantic QSOs and the new repeater on the ISS.

Perhaps inspired by the exploits of the D4VHF group making 2m/70cm QSOs from Cape Verde, across the Atlantic to the Caribbean, it is exciting to be able to report that more transatlantic QSOs have been made on 2m.

On August 27th, **Cesar Regalado Leon EA8CXN** in the Canary Islands made some remarkable contacts on 2m FT8, working NP4BM, WP3DN, WP4G, J69DS, FM5CS and FG8OJ. **Miguel Hernandez EA8DEC** was also heard across the Atlantic, by NP4BM. Next day on the 28th the path was still open with EA8CXN working or being heard by NP4BM, KP4EIT, WP4JCF, WP3DN, WP4G, FG5GH and FG8OJ. EA8DEC was heard by KP4EIT and FG8OJ. **Fernando Borges Dominguez EA8TX** also made it across the Atlantic, being heard or worked by NP4BM, KP4EIT, WP3DN and WP4G. Perhaps even more interestingly for us, **Alex EB1DJ** had a single decode from KP4EIT. This may be the first time that 2m tropo signals from North America have been received in mainland Europe.

It was good to see **Tim Fern G4LOH** (Helston) and **Dave Edwards G7RAU** (The Lizard) testing the path to the north-eastern US and Canada in early September. The propagation maps had looked promising and Tim and Dave were both seen testing with NY2NY and VE1SKY. Sadly, no signals were exchanged on this occasion, but it is surely only a matter of time and effort.

A Crossband Repeater on the International Space Station

It was good to see a recent press release from the Amateur Radio on the International Space Station organisation (ARISS): "*The ARISS team is pleased to announce that set up and installation of the first element of our next generation radio system was completed and amateur radio operations with it are now underway. This first element, dubbed the InterOperable Radio System (IORS), was installed in the International Space Station Columbus module. The IORS replaces the Ericsson radio system and packet module that were originally certified for spaceflight on July 26th, 2000.*

"Initial operation of the new radio system is in FM cross band repeater mode using an uplink frequency of 145.990MHz with an access tone [CTCSS] of 67Hz and a downlink frequency of 437.800MHz. System activation was first observed at 0102UTC on September 2nd. Special operations will continue to be announced.

"The IORS was launched from Kennedy Space Center on March 6th, 2020 on board the SpaceX CRS-20 resupply mission. It consists of a special, space-modified JVC Kenwood D710GA transceiver, an ARISS developed multi-voltage power supply and interconnecting cables. The design, development, fabrication, testing, and launch of the first IORS was an incredible five-year engineering achievement accomplished by the ARISS hardware volunteer team. It will enable new, exciting capabilities for ham radio operators, students, and the general public. Capabilities include a higher power radio, voice repeater, digital packet radio (APRS) capabilities and a Kenwood VC-H1 slow scan television (SSTV) system.

"A second IORS undergoes flight certification and will be launched later for installation in the Russian Service module. This second system enables dual, simultaneous operations, (e.g. voice repeater and APRS packet), providing diverse opportunities for radio amateurs. It also provides on-orbit redundancy to ensure continuous operations in the event of an IORS component failure.

"Next-gen development efforts continue. For the IORS, parts are being procured and a total of ten systems are being fabricated to support flight, additional flight spares, ground testing and astronaut training. Follow-on next generation radio system elements include an L-band repeater uplink capability, currently in development, and a flight Raspberry-Pi, dubbed ARISS-Pi, that is just beginning the design phase. The ARISS-Pi promises operations autonomy and enhanced SSTV operations.

"ARISS is run almost entirely by volunteers, and with the help of generous contributions from ARISS sponsors and individuals. Donations to the ARISS program for next generation hardware developments, operations, education, and administration are welcome – please go to this website to contribute to these efforts": www.ariss.org/donate.html

I saw the press release on the evening of September 2nd and immediately checked

Photo 1: A screenshot of the DATV reception of G4FRE's 24GHz signal from Graham G3VKV.
Photo 2: You don't always need the latest rig! This 1980s Trio TR-9000 has been in use here at GW4VXE. It works well. Send me your pictures of your 'vintage' VHF/UHF rigs still in use!
Photo 3: Patrick WD9EWK's portable station all set up for the ISS crossband repeater.

2

to see when the next pass of the space station would be! The passes were mostly overnight, but I spotted a low pass to the west on the morning of the September 3rd. The pass was very busy with lots of stations trying to use the new repeater, but I was very glad to be able to have a quick QSO with **James Preece M0JFP** (Chertsey) and heard many other stations.

Signals on 437.800MHz (plus or minus Doppler) are very strong and you should easily be able to hear the downlink on a mobile or handheld. Remember that the downlink could be up to 10kHz higher or lower, depending where the ISS is in relation to you. The uplink frequency of 145.990MHz is much less affected by Doppler shift, so you should not have to adjust this, but don't forget to set your 67Hz CTCSS tone.

Duplicate QSOs and Transmit/Receive Periods

Tony Collett G4NBS (Cambridge) sent an interesting e-mail with some thoughts about 'duplicate QSOs' in digital data modes operating and also on the vexed question of transmit/receive periods. Tony writes, "*Firstly, I also have the same 'rule' as **Malcolm** in that while I am more than happy to work anybody, I generally only call a station on 6m FT8 once in a calendar year. It is nice to keep a record of DXCC/Locators worked on a yearly basis to see how years compare but there are several that refuse duplicates from when I returned to 6m in 2017. At one point I thought I had a Tx issue as I failed with so many until I realised they were 'No Dupe' stations!!*

"Then there are others that only ever call CQ DX, refusing to work 'local' countries. But if they never work local countries, it is hardly surprising that they attract attention!

"I'm not sure I fully agree with your thoughts on VHF/UHF openings though. If the path is short lived (as in Es or marginal tropo), then is it better to let somebody else try if you have previously managed a QSO? Yes, if you see them call CQ with no responses, then it is good to probe the path but I wouldn't say I'd treat each day as a separate event. Difficult one!

"My main gripe is regarding periods though! It's well publicised that we follow the European MS procedure on 50.313MHz and last year 50.323MHz was used for QSOs outside of our Continent with all Eu Tx on 1st period to work either Stateside or Asia. This year it was apparent that 313 had become the only frequency of choice and in the mornings it was full of the big UK stations transmitting 1st period but beaming East. Not being in the right place to hear JA at the time it became a gamble if you heard an Eu station in the 1st period – is he beaming our way as the previous recommendation or does he only want to work Asia? Do you dare call CQ in the 2nd period looking for single hop Es to Eu or are you going to be ostracised on KST for doing something wrong?

"On 2m FT8 the periods seem to be better understood and honoured thankfully but then along came the recent Perseids with MSK144 on 144.360MHz. OK, once again confusion as to 15 secs or 30 secs. Worse though was that instead of treating 360 as a 'calling frequency' the vast majority were using it as a working frequency. It has long been normal on FSK in big showers to call CQ with a working QRG".

Martin Cox M0GQB wrote too regarding 'duplicate QSOs' and says, "*I have to agree with your comments about duplicate QSOs. In my opinion, the only time 'No Dupe' should be set is during contests and the running of special event stations. Apart from the fact that propagation – especially at VHF/UHF – is an ever-changing phenomenon, each station in the (potential) QSO has no idea whether the set-up at the other station has changed. As an example, in the past few weeks and because I have no permanently-erected antennas, I have used three different antennas. The only way for me to assess their relative performance*

3

is to get reports from the same station over several days to try to average out the effect of changing propagation conditions. Because of the limited exchange of information using FT8, the other station doesn't know that I have changed antennas and might even be using a vertical in place of a horizontal. So, please, don't set 'No Dupe' on!"

The 6m Band

Peter Taylor G8BCG (Liskeard) just missed the last column but worked some nice DX during during July and August including a very nice EME QSO with ZL7DX on Peter's moonset on July 20th. July 25th saw some nice signals from Columbia, Ecuador and Venezuela in the late evening. Next day saw a good opening in the afternoon to the US East Coast and Mid-West. Peter was heard in VE7 but didn't have the chance to make a contact. Peter took part in the UK Six Metre Group's Summer Marathon. His totals were a little down on last year with 2273 QSOs, 702 squares, best DX 19068km (EME). Peter's DXCC count for the year on the band is 129 with three all-time new ones.

Tony G4NBS has a high noise level on the band but despite the challenges has worked some nice DX. He says that his best day was July 13th when he just called anyone that was interesting and was amazed to find at the end of the day he had made 133 QSOs in 91 locators and 25 DXCC! Tony caught an unusual and interesting evening opening to Japan working JA8WKE (QN02) at 2241 with another five stations worked with the last, JA7QVI (QM08), at 2328. Other nice DX was UN7LAP, UN9L (MO13) and UN3M (LO61) on July 25th with UN3GX (MN83) on July 28th.

Jef Van Raepenbusch ON8NT (Aalter) had a busy month with the highlights being TA1D/3 (KM39), Z30A (KN11), SV3SPD (KM08), EA8JK (IL18) and 4O5JD (JN92), all on FT8. Jef runs 10W to a V-2000.

Kevin Hewitt ZB2GI had another good month with over 90 QSOs made on FT8 using an IC-7300 and whip antenna and counterpoise stuck out of the window!

Phil Oakley G0BVD (Great Torrington) lists plenty of contacts despite a slightly quieter month, highlights being OD5KU and T77C

The 4m Band

Jef ON8NT worked G8HGN (JO01) on 4m FT8 on August 2nd.

The 2m Band

Tony G4NBS sent an interesting log, which I've had to edit a little for reasons of space! The Low Power contest on August 1st enabled Tony to work F8FKJ/P (JN28) and F4VPC (IN87) on SSB. During the FT8 activity on August 5th, Tony worked 33 QSOs in 14 locators. The best DX was DB9VE (JN39). Other highlights through the month on FT8 were DK3EE (JO41), OZ1CX (JO45), OZ2ND (JO46), GW1JFV (IO71), F8ZW (JN38), EA1SA (IN83), LA9AKA (JP20), DJ9MS (JO54), DL3TW (JO44), GM0HTT (IO89), OV3T, OZ4TT, OZ2LIN (JO46), OZ5AGJ (JO47), LA3BO (JO59), LA3YNA (JO48), SK6QA (JO58), SM6MUY (JO67), GM0HLV (IO88), EI6GF (IO62) and DG4KLK (JO41). CW and SSB weren't neglected with GM4ODA/P (IO99) worked on CW and GM4YXI and GM0HTT on SSB. Tony says that MS wasn't very good for him owing to the noise level to the east so he concentrated to the south with some nice contacts into EA/CT. CT1CAK (IN50) was a new DXCC with CT1HIX (IN52) and CT7ABA (IN60) also worked.

Tony caught the tropo in early September with the best day being September 11th, and the best DX being EC1A (IN73) with EA1SA (IN83), SF6F (JO67), SM7DIT (JO65) and DF5VAE (JO64) also worked.

Highlights of Jef ON8NT's log were EI3KD (IO51), G4ALY (IO70), F6GLQ (IN98) and G0RQL (IO70). Jef runs 25W to a 5-element log periodic.

Keith Watkins G8IXN (Redruth) and I can always work each other on 2m FT8 over a 200+km path. Keith suggested we try a simplex D-STAR contact on 2m. We both used verticals. Keith used his IC-9700 at around 25W and I used my IC-E92 handheld at 5W. My signal broke up somewhat to Keith, but he was a very solid signal here. We wonder who else has tried simplex D-STAR over a fair distance?

Pete Walker G4RRM (Crewe) caught the tropo on September 11th and was delighted to work EA2XR (IN83) on FT8. Pete was running 20W or so to a V-2000 vertical.

Phil G0BVD caught some activity during the September 2m contest on September 5/6th with the highlights being GD8EXI, GM3S, GM3HAM/P and GD0TFG/P. GM0HBK (IO77) and G1GEY (IO94) were worked on September 10th when conditions were good to the North. Phil also enjoyed contacts with MW6BWA/P who was activating SOTA summits.

The 70cm Band

Tony G4NBS has some nice QSOs in his log, mostly on FT8. Highlights include OZ7MHZ (JO44), OZ1AXL, OZ1MJN & OZ2ND (JO46), OZ1IEP (JO55), OZ1SKY (JO56), OZ9AEG (JO57), SM6CEN (JO67) OZ1IEP, OZ7MHZ, LA3FV (JO59) and SK6QA (JO58). Tony used the ON4KST chat to arrange a QSO with LA0BY (JO59) for a rather marginal QSO taking 15 minutes to complete – at 1083kms for the best of the month. GM4ODA/P (IO99) was a new square for Tony on SSB.

On September 11th, Tony saw decodes from LY2WR (KO14) and SP1MVG (JO74) while he was away from the radio. Happily, he was able to work SP1NEN later in the evening. DL7APV (JO62) was seen with an incredible signal for long periods.

Jef ON8NT found some good activity during the August UK Activity contest with highlights being G4CLA (IO92), G0XDI (IO91) and G3TBK/P (IO93).

Satellites

Kevin ZB2GI and John King ZB2JK operated ZB2LGT (Europa Point Lighthouse) on August 22/23. John operated on AO-91 and AO-92, working EA5WA (IM99), EA3AGB (JN00), EA1PA (IN71), DL6IAN (JN49), EB7A (IM87) and DG9MA (JN58).

Simon Evans G6AHX (Twyning) writes, "*I have been playing with the satellite function on my IC-9700 with the 2m & 70cm beams. On Sept 7th I did a pass of SO-50 working EI3FW, G0ABI, SA2KNG and* ***Peter 2M0SQL*** *who recognised me and welcomed me back to the satellites. The software on the IC-9700 turns out to be great for working the FM satellites with its AFC function. Now I have to master the SSB satellites with it. So far I have worked EI3FW through RS44 but there's a lot more to learn and do!*""

Graham Jones G3VKV (Cheltenham) tried the ISS crossband repeater on September 5th and worked EB1AO. Graham said that he needed to get on early when the satellite was low on the horizon before it became too busy over mainland Europe. He says it should be possible to work Newfoundland on a suitable pass.

Patrick Stoddard WD9EWK (Phoenix) writes and starts with some interesting details regarding the new installation on the ISS, "*The TM-D710G on the ISS has been engineered to avoid overheating. For the crossband voice repeater, the radio will transmit at 5W. The radio also has a packet/APRS digipeater mode, and will transmit at 10W in that mode. For two-way contacts it will operate at 25W.*

"Another new TM-D710G and power supply is planned for the Russian ISS segment.

"In recent weeks, the AO-92 satellite has been slipping into safe mode. It appears that its batteries are not holding enough voltage to keep the FM repeater operational, and the satellite has not been able to stay in L/V mode for more than a couple of hours. AMSAT's Fox-1 satellites will switch to safe mode when the battery voltage drops below 3.6V. If there are no other issues while in safe mode, the FM repeater resumes operation once the satellite sees the battery voltage above that threshold – usually when it is back in sunlight. We hope that things will improve as we move into Fall and winter in the Northern Hemisphere, and that the satellite doesn't suffer an early demise".

DATV

Graham G3VKV says that he has now completed TV reception on all eight bands between 145MHz and 24GHz with **Dave G4FRE**. From 145MHz to 10GHz they were able to exchange pictures between their home stations in Cheltenham and Malvern respectively. 24GHz did require Dave to go portable into open ground though! Graham used a 450mm dish pointing through the shack window on the 1.2cm band.

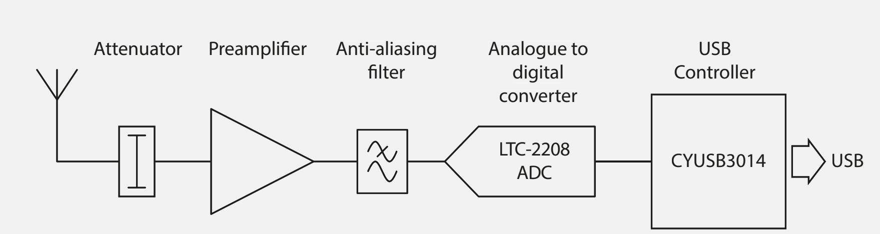
That's it for this month. Thank you for all the varied input and please keep it coming.


LAMCO WANTS
YOUR
QUALITY USED GEAR
TRADE IN FOR CASH
OR PART EXCHANGE
01226 361700
WWW.HAMRADIO-SHOP.CO.UK
5 DONCASTER ROAD, BARNSLEY, SOUTH YORKSHIRE, S70 1TH

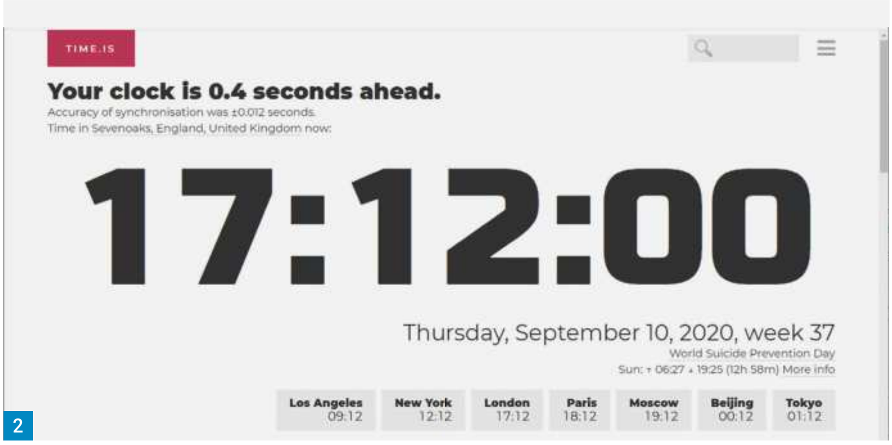
Mike Richards G4WNC
practicalwireless@warnersgroup.co.uk

SDR: The next phase has arrived!

Mike Richards G4WNC reports on a new approach to SDR and starts a tutorial on FT8 operation.



1



2

High-end SDRs almost universally use 16-bit sampling ADCs (Analogue-to-Digital Converters) located as close to the antenna as possible. Most of the popular models directly sample the entire HF and low VHF (50MHz) bandwidth. Sampling such a wide bandwidth at 16-bits creates extremely high data rates. For example, using a common sample rate of 122.8Msps and 16-bit depth gives a serial data rate of 122.800000 x 16 = 1.965Gb/s. That was considered way too fast to pass directly to a computer, so it has become standard practice to use an FPGA (Field Programmable Gate Array) to down-sample the data to a more manageable rate.

The FPGA device contains extremely fast logic and is able to parallel process the data. The FPGA's role in an SDR can be likened to the first mixer in an analogue communications receiver, where it translates the incoming RF to a more manageable standard sample rate, or intermediate frequency in the case of an analogue receiver. However, the FPGA introduces two problems. The first is the specialist and expensive programming skills required to write and maintain the FPGA code and the second is the cost of the FPGA itself.

So, what's the next phase SDR I hear you ask? The past few years have seen a dramatic change in the serial port technology used in popular PCs and the latest PCs with USB3.1, 3.2, USB4 or Thunderbolt 3 can handle bus speeds of up to 40Gb/s! That gives SDR designers the option to ditch the FPGA and process the raw data stream from the ADC using software on the main PC. Not only does this cut the costs associated with the FPGA, but it brings tremendous flexibility. The front-end hardware effectively becomes a spectrum capture device. In addition to the fast serial ports, modern PCs have processors with multiple cores and graphics cards with powerful GPUs (Graphics Processing Units) that can process SDR data.

The reason I raise this now is the availability of the first capture hardware at reasonable prices (circa £150-200). There are several variants out there, but they are all based on the BBRF103 open source design by **Oscar IK1XPV**. Oscar's design uses the LTC-2208 ADC combined with a Cypress FX3 USB controller and a clock generator. I've shown a block diagram in **Fig. 1**. The two main variants out there are the Dragonfly 666 and the SDR-888. Of these, the RX888 is the one to go for as it is based on a later design and includes a pre-amp ahead of the ADC. Without the preamp, the Dragonfly is likely to be a bit deaf. The design also includes an RT820T tuner to extend coverage to 1.8GHz but it's the 32MHz HF direct sampling that's the highlight.

As with all SDR hardware, its usefulness depends entirely on software availability. So far, these receivers have been very well supported as there's modified HDSDR software and **Simon Brown G4ELI** is including support in SDR Console v3. At the time of writing, the RX888 is available on eBay for just under £150. One important point to note is that these units should be treated as development boards and, as such, you shouldn't expect much in the way of customer support from the suppliers.

Data Modes Introduction: Continued

Having spent the past couple of issues introducing some of the fundamentals of data modes operation, this month I'll dive straight into the most popular mode, FT8.

FT8

FT8 and its sibling FT4, form part of the WSJT-X suite of weak signal programs. The name WSJT comes from the primary author's name (Weak Signals **Joe Taylor**) and the operating procedures have their origins in the techniques developed for EME (Earth Moon Earth). When working EME, the exchange required for a completed QSO comprises the callsign, report and other information such as the location. In addition to a fixed format for the messages, EME operators use timed transmit and receive slots to improve their chances of success. FT8 follows similar principles by using 15 second timeslots and structured messages.

Fig. 1: Simplified block diagram of the HF section of the RX888 SDR Receiver.
Fig. 2: Screenshot of the useful time.is website.
Fig. 3: WSJT-X station entry screen.
Fig. 4: WSJT-X soundcard selection screen.
Fig. 5: WSJT-X Wide Graph.
Fig. 6: WSJT-X Main screen following a call with SP9QMP.

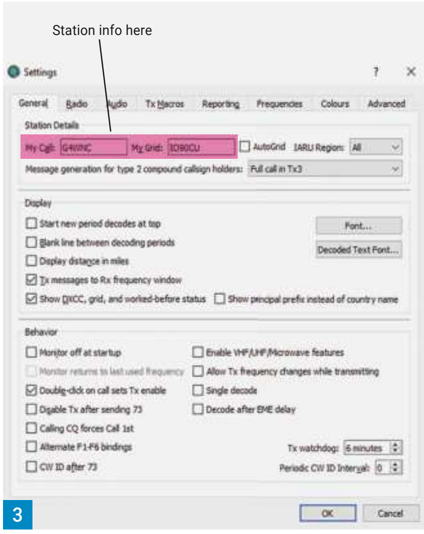
Other than a 13 character (including spaces) final message, there is no facility in FT8 for free text messages. I've shown the structured message format used for a typical FT8 QSO in **Table 1**. Here you will see that the location is restricted to the first four characters of the Maidenhead locator and the signal report is given in dB (−21 and −19 in Table 1). Rather than use the usual RST report, the FT8 software automatically calculates the signal to noise ratio based on a 2.5kHz bandwidth. This is far more helpful than the dubious 599 exchanges that are all too common!

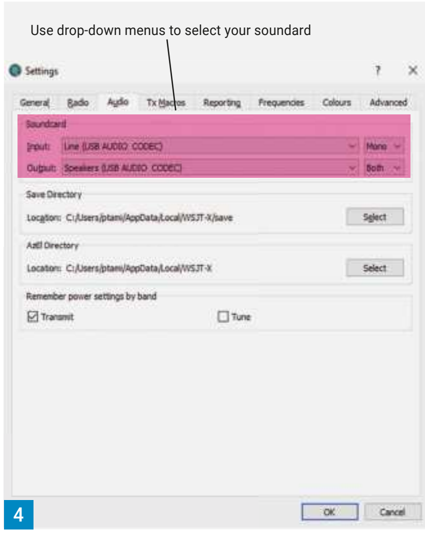
FT8 Modulation

FT8 transmissions are generated using audio tones, as described last month. In the case of FT8, eight-tone Gaussian Frequency Shift Keying (8-FSK) is used with a slow baud rate of just 6.25 bauds. This modulation systems employs eight, closely spaced, frequencies and the gaussian filtering ensures a smooth transition between tones and reduces the key-clicks that would otherwise be generated by abrupt frequency changes. By using such a slow baud rate, FT8 signals occupy a very narrow bandwidth of just 50Hz. The use of such a narrow bandwidth means the entire FT8 activity for each band can normally be accommodated in a single 2.5kHz speech channel.

Starting with FT8

Before starting to use any new radio system, it's important to set aside some time to monitor and note how the mode is being used. With today's software-based data modes, it's all too easy to load the software and dive straight into operating. However, you will get much better results if you familiarise yourself and take time to learn the basics before you start transmitting. As with most data modes, the FT8 software is available as a free download and there are packages available for PCs, Macs and Linux machines, including the Raspberry Pi. The entire WSJT suite of programs is available via a single download that you will find here:





https://tinyurl.com/yaytakyp

Windows installation is particularly easy as you simply run the downloaded .exe file. If you're planning to use Linux or macOS, you find links to the installation instructions on the download page.

Before starting to use any of the WSJT-X modes it's worth making sure that your PC clock is being accurately updated. A simple way to check the accuracy is to visit **http://time.is** In **Fig. 2**, I've shown a screenshot of time.is site, where it displays the current time along with details of your PC clock.

An accuracy of half a second or better is generally fine for FT8. If you want to improve your clock accuracy, you will need to install a time synchronisation program and a popular choice is the free Meinberg NTP software that can be downloaded from here:

https://tinyurl.com/lfqoj2v

Configuring WSJT-X for FT8

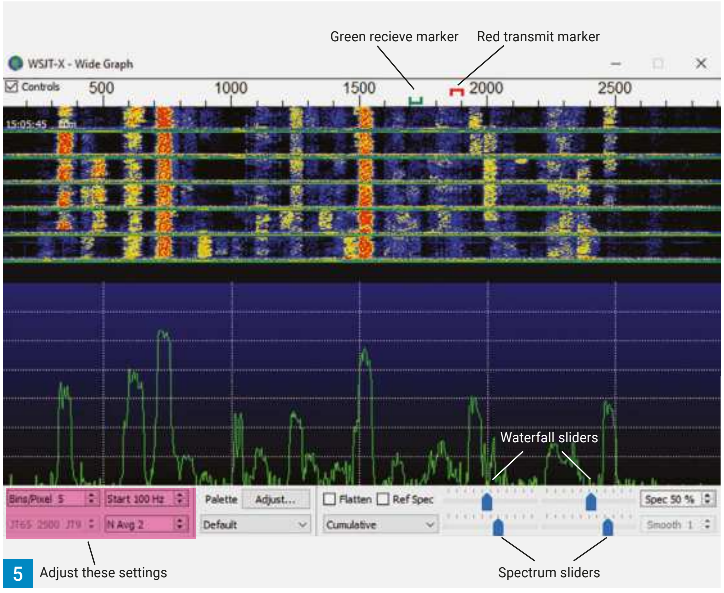
If you're new to data modes, I suggest you start by using VOX for transmit/receive switching rather than full CAT control. This makes the configuration simpler and you can add CAT control later. Assuming you now have WSJT-X installed, the first task is to enter your station details as follows:

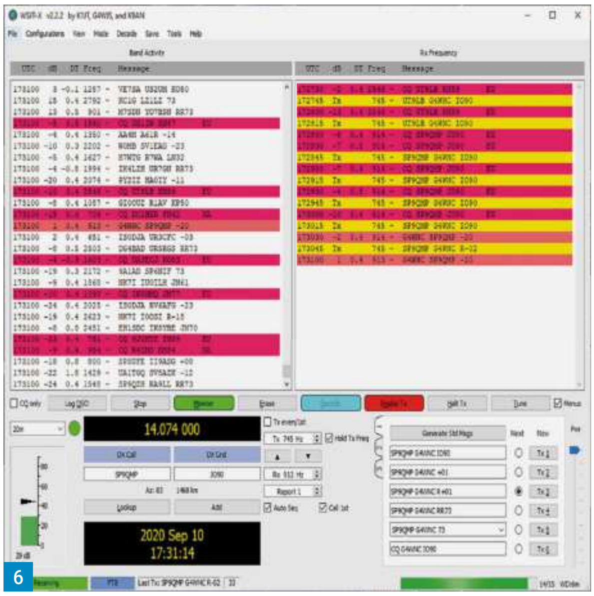
- Run WSJT-X
- Select File – Settings and then the General tab
- Enter your callsign and Maidenhead locator, **Fig. 3**
- Select the Radio tab and make sure the Rig is set to None and PTT set to VOX
- Select the Audio tab and choose the soundcard you will be using for the audio input and output from your rig, **Fig. 4**
- Click OK to finish and save the configuration

When WSJT-X started you will have noticed that two windows opened, one of which was the Wide Graph, **Fig. 5**. This displays the audio spectrum currently being received via the selected soundcard. In addition to providing a view of band activity, we can use the spectrum controls to set our transmit and receive frequencies. However, to get the best display for FT8 operations we need to make some minor adjustments as follows:

- Connect-up your audio link between the rig and computer
- Tune your rig to the 14MHz band and select USB or Data.
- Start WSJT-X and set the mode to FT8.
- If all is well, you should see signs of life in the Wide Graph and the level meter in the bottom left of the main screen.
- Tune your rig to an empty RF channel somewhere around 14.1MHz
- Adjust the audio input level to the computer to get a reading of approximately −30dB in WSJT-X
- Retune to the main FT8 frequency of 14.074MHz
- You should see some FT8 activity as this band is rarely quiet
- Make sure the input level bargraph remains green
- With the receive sensitivity configured, we need to adjust the Wide Graph parameters to optimise the view for FT8 as follows:
- Select the Wide Graph window
- Set the Bins/Pixels to 5, Start to 100Hz and N Avg to 2

The next step is to adjust the waterfall and spectrum sensitivity sliders. These are located on the lower-right of the Wide Graph and the top two sliders adjust the waterfall while the lower set deal with the spectrum display. The waterfall is





Transmission	Notes
CQ G4WNC IO90	This is my CQ call and includes the first four digits of my locator
G4WNC G0ZYZ IO91	Here G0ZYZ answers my call and includes the station locator
G0ZYZ G4WNC -19	My reply with the signal report (-19) for G0ZYZ
G4WNC G0ZYZ R -21	G0ZYZ confirms receipt of the signal report by sending R and adds my report (-21)
G4ZYZ G4WNC RRR	I send RRR to confirm that I've received G4ZYZ's messages
G4WNC G0ZYZ 73	G0ZYZ sends '73'

Green = my transmissions, Red = G0ZYZ transmissions

Table 1 - A typical FT8 QSO

generally the most useful display and you should adjust the sliders for a display similar to that shown in Fig. 5.

Having completed the receive setup, we can move on to the transmit configuration. You should be expecting to run low power most of the time and a few watts is usually sufficient. One common failing is to overdrive the audio stages of the transmitter. This results in the transmission of multiple distorted artefacts of your signal, so you won't be popular!

To configure the transmit path, begin with a dummy load connected in place of the antenna. You can then click the Tune button in WSJT-X to generate a transmit audio tone. In the bottom right of the WSJT-X main panel you will find the transmit drive slider.

This slider adjusts the level of the transmit tone and I suggest starting with this set to about 75%.Now you can move to your rig and adjust the mic audio gain, VOX sensitivity and the PA drive to reach the target output power. I suggest starting with around 5 watts. If you have a digital scope to hand, you could put it in spectrum analyser mode and use a tap of the transmit output to check the spectrum quality. When you start making QSOs, you use the transmit slider in WSJT-X to trim the power output.

That completes the basic setup.

Tuning FT8

Because FT8 signals use such a low data rate, the decoding process requires very little processing power from your PC. FT8 software takes advantage of this and can comfortably decode a large number FT8 signals in each 15 second time slot. As a result, it is standard practice to confine FT8 operations to a single, SSB width, channel in each band. This greatly simplifies operating because you can tune your rig to a single SSB frequency and monitor and communicate with any active station without touching the rig's tuning.

Another important characteristic of FT8 operation is the use of split transmit and receive frequencies.

As the decoder can handle all the signals in the 2.5kHz bandwidth, you can reply to a station using any clear frequency.

The first task before making a call is to select a clear transmit frequency. You can find a suitable frequency by watching a few 15 second FT8 cycles on the Wide Graph display. Once you've identified a clear frequency, use the mouse to shift-click on the left-hand edge of the chosen frequency.

You will see the red, transmit frequency, marker move to that location. When you've set the transmit frequency, make sure you tick the Hold Tx Freq box in the lower centre. This will lock the transmitter on that frequency, leaving you free to move the Rx frequency to the station you want to work.

WSJT-X does a particularly good job of simplifying FT8 operation. The operational heart of the software is the two main panels. The left panel shows all the decoded activity, while the right-hand panel shows the activity on the currently selected receive frequency (green marker on Wide Graph).

CQ calls will be highlighted in the band activity panel and you can respond to a CQ by double-clicking on that station's entry. This will populate the call and locator fields and set the transmitter to start on the opposite cycle to that of the wanted station.

Once the link has been established, the software will automatically step through the structured messages and complete the QSO.

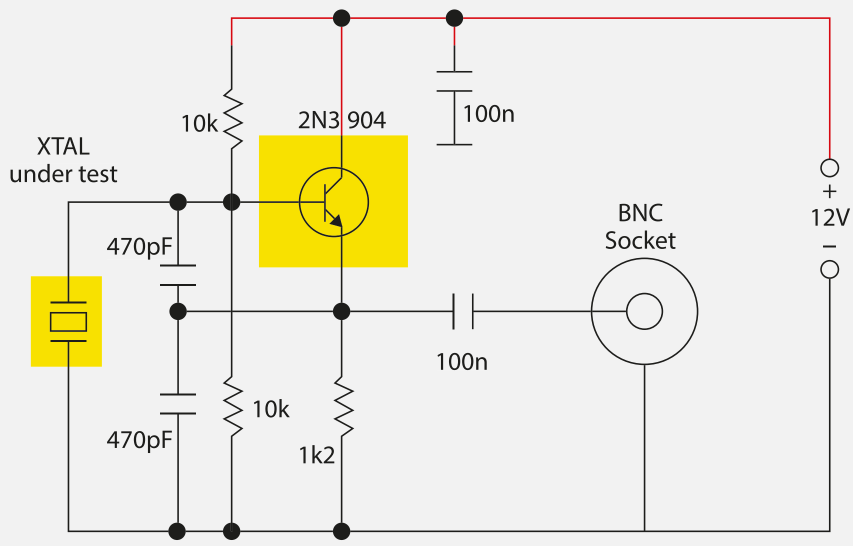
Summary

I've squeezed a lot into this month's column so next month I'll spend a bit more time on some techniques to improve your FT8 success.

Matching Crystals

Eric Edwards GW8LJJ describes an easy way to match crystals for ladder filters.

Eric Edwards GW8LJJ
ericgw8ljj@outlook.com



1

This project uses a Colpitts oscillator and a novel circuit to 'see' the offset frequencies of the crystal (xtal) that has been selected as the nearest to the wanted frequency for use in a ladder IF filter. It came about after talks with a friend of mine, **Ray G7BHQ**. We were discussing IF filters and I mentioned that I have always used ready-made ones. He said that good results can be achieved with ladder filters but is time consuming in matching the crystals using an oscillator and frequency counter (meter).

I thought there must be an easier way to check for matched crystals than by observing the individual results on a frequency counter. I remembered a unit I had built up here some time ago to monitor my VFO frequency when using the home-brewed valve AM transmitter. It is called 'Netometer11' and the purpose of it was to monitor easily either with LEDs or a meter if the transmitter VFO had drifted high or low frequency without connecting to a frequency counter to see the change in frequency. Netometer11 does not measure the VFO frequency but it shows whether the VFO has drifted high or low in frequency.

Netometer11

The Netometer11 is a design by **Dave GW4GTE** and has been made a kit in its own right. (See reference section). It was produced for monitoring the VFO of AM transmitters and has four memory positions. Selecting any of these allow storage of the station's most frequently used AM frequencies. Once the frequency is stored, which is a very simple operation using toggle switches, the transmitted carrier can be seen if any change is made with the transmitter's VFO. There are two sensitivity settings with a low setting used for the AM transmitter VFO and the higher sensitivity that has much narrower frequency spacings of tens of Hertz, which makes it ideal for monitoring the difference in frequency of the crystal plugged into the test oscillator unit. It is this sensitivity mode of the Netometer that is used for crystal matching.

The Crystal Oscillator

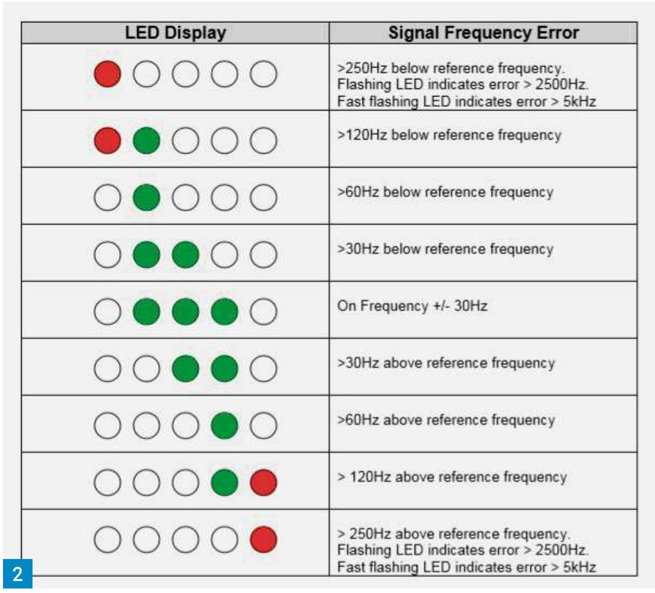
The circuit used, Fig. 1, is a very well-known Colpitts type and is easy to build with or without a PCB. The circuit is basic and while suitable for crystal testing, when used for an oscillator such as a VFO, the output should be buffered with an emitter follower. The crystal is plugged into either the larger socket for the older HC6/U types or an 8-way (DIL) socket for the more common HC49 series. The circuit comprises a 2N3904 transistor with 10kΩ resistors to create the base bias. One of these resistors is connected from the base to the 12V rail and the other from the base connection to ground (0V).

In conjunction with the added crystal, oscillations are set up by the two capacitors (470pF), one connected to the base with the other end connected to the emitter of the transistor. The other capacitor is also connected to the emitter with the other end to ground. A bypass resistor (2.2kΩ) is also connected from the emitter to ground. The output of the oscillator is via a PCB type BNC socket. This allows for easy connection to the monitor (Netometer11) or a frequency counter (meter).

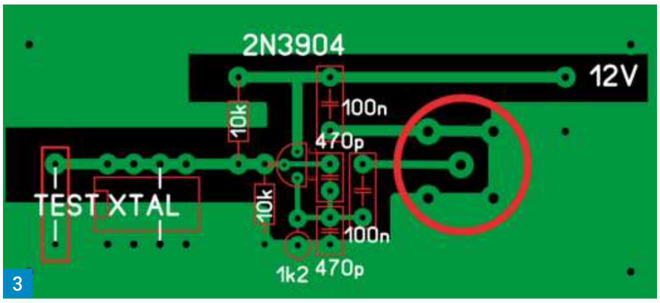
In Use

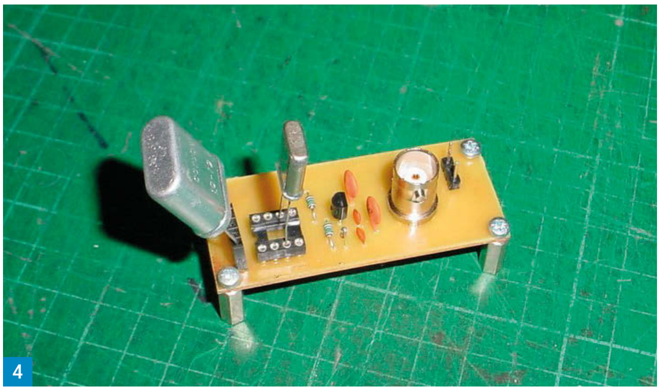
The 12V power supply is connected to the Netometer11 and to the '+' pin on the crystal tester. The ground (0V) is also connected to both units. A BNC lead is connected between the crystal checker and Netometer11. A crystal is selected that is to be the reference frequency and this will have been measured on a frequency counter. Crystals are not all 'spot-on' frequency so a compromise has to be made by selecting a crystal that is as close to the wanted frequency as possible. This will be the reference frequency and the other crystals will be 'matched' to it.

Plug the reference crystal into the tester and switch on the 12V. The toggle switches on the Netometer11 can be set to any of the 0 or 1 positions. These represent the memory locations and are set using the bi-



LED Display	Signal Frequency Error
Red, Off, Off, Off, Off	>250Hz below reference frequency. Flashing LED indicates error > 2500Hz. Fast flashing LED indicates error > 5kHz
Red, Green, Off, Off, Off	>120Hz below reference frequency
Off, Green, Off, Off, Off	>60Hz below reference frequency
Off, Green, Green, Off, Off	>30Hz below reference frequency
Off, Green, Green, Green, Off	On Frequency +/- 30Hz
Off, Off, Green, Green, Off	>30Hz above reference frequency
Off, Off, Off, Green, Off	>60Hz above reference frequency
Off, Off, Off, Green, Red	> 120Hz above reference frequency
Off, Off, Off, Off, Red	> 250Hz above reference frequency. Flashing LED indicates error > 2500Hz. Fast flashing LED indicates error > 5kHz





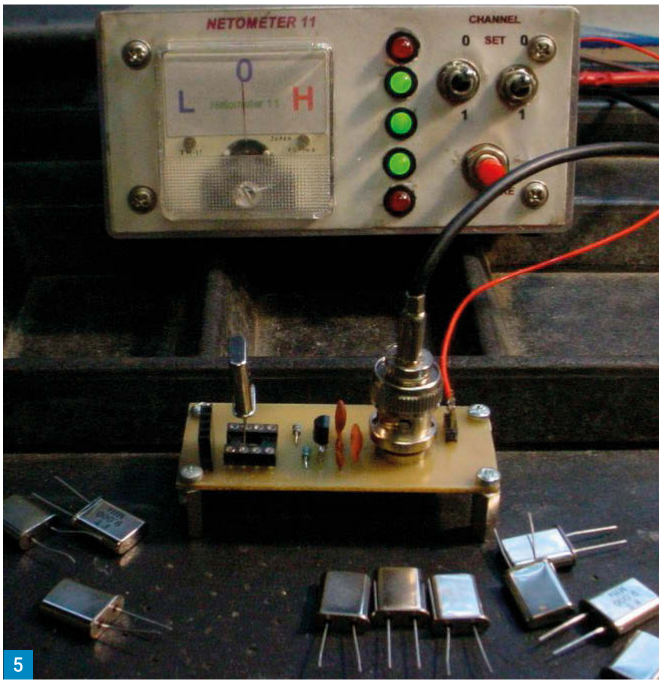


Fig. 1: Circuit diagram. Fig. 2: Frequency difference as shown by the LED display. Fig. 3: PCB layout. Fig. 4: The populated PCB. Fig. 5: The Netometer in action.

nary notation. Placing both the switches in the 0 position can be called memory 1. Following the binary code, one switch in the '0' position and the other in the '1' position has changed the memory location to two. A combination of 0 and 1 will provide four memory locations. This will be useful for checking up to four crystal frequencies without re-entering the frequency every time it is used. The memory is retained after switch-off and is ready for use the next time it is switched on.

The Netometer11, when used for the first time at switch-on and the crystal tester connected with a reference crystal, will show a flashing end (red) LED (if the coloured LEDs are as used as in the construction taken from the manual. See reference section). Push the button and the centre LED (green) will illuminate. Release the button and the centre along with one of the green LEDs either side will also illuminate. The frequency of the reference crystal has now been set. Remove the crystal with the 12V still connected and the centre LED will be flashing slowly, indicating that it is waiting for a crystal to be tested. Plug in another crystal and the lit LEDs will show any frequency differences, **Fig. 2**. Selecting a range of crystals it can be seen at a glance if they are within the limits required either above or below the reference frequency without working out the differences seen on a frequency counter.

PCB

The PCB, **Fig. 3**, is of a simple design and is made on a single-sided FR4 board with a ground plane on the copper track side. There is only one transistor as mentioned in the oscillator paragraph and that is sufficient for this application. There are two crystal plug-in inputs to allow for the usual HC49 and HC6/U types. The larger crystal is plugged into a PCB header seen on the far left of the PCB and the smaller crystals are plugged into an eight-pin DIL socket. The output is a PCB fitted BNC connector and a BNC lead can be conveniently connected from that socket to the Netometer11 or frequency meter. The power supply is 12V and is connected to a pair of PCB pins. A completed PCB is shown at **Fig. 4** and the working Netometer in use at **Fig. 5**.

Is there a kit

I can supply the PCB and all parts for the oscillator as shown on my usual 'picking list' available by contacting me at my e-mail address.

Netometer11 is available as a complete kit as shown in the reference section and a complete manual is available from the same source. I am grateful to Dave GW4GTE for permission to use Netometer11 in this project.

References

- Netometer11: (Dave GW4GTE S9kits) www.s9plus.com
- Ladder filter design: Dishal2052
- PCB and picking list: Eric GW8LJJ ericgw8ljj@outlook.com
- Ray G7BHQ for the conversations and help during this project

Radio News

CAITLIN ON RADIO AND TV: Caitlin Field M6XTT, granddaughter of PW editor Don G3XTT, featured recently on BBC Radio Somerset and BBC Points West (TV). The interviews focused on the fact that she had trained during lockdown, using the Essex Ham online course with assistance, via Zoom, from her grandad. Also, that she becomes part of a three-generation amateur radio family, M6XTT having been the Foundation call of her dad, Ed, who is now 2E0WWF. The interviews were arranged by the RSGB as part of their 'Get on the air to care' initiative. Right: **Don, Jane (mum)** and **Caitlin** in front of the FT-847, used for a demo QSO (with thanks to **Alison G0ALI** at the other end).

BURNHAM BEECHES NEWS: BBRC usually has three weekend meetings a year, often coinciding with a contest or two.
This year they had two such meetings, the first at the end of July to coincide with the IOTA contest and the recent meeting covered the RSGB SSB Field Day and the RSGB 144MHz Trophy contest. Various members attended the venue near Maidenhead during the weekend and a hard core stayed overnight. Members attending all used their own equipment to stay safe.
Trevor entered the 2m Trophy contest using one of the club's callsigns M0DX/P and made 188 contacts with a fair number into Holland, Belgium, France and Germany. Hauke, Ash and Andy (and others) spent time on HF using a DX Commander, SOTABEAMS Linked Dipole and a G5RV antenna respectively.
Everyone enjoyed excellent cuisine courtesy of Trevor's portable BBQ. It was not all radio as much model aircraft and drone flying was also done. The whole site was powered by Andy's 7.5kW diesel generator.
The photo shows: Standing from left to right: **Graham Price 2E0DQF**, **Andy Birch M0YGB**, **Ashish Bhakoo M0KBA**, **Charlie Mitchell G0SKA**, **Hauke Gruen 2E0HBX**, **John Ratcliffe M7JHA**, Kneeling **Trevor Clapp M0TDZ**. Antennas: Left Clark 13m mounted on Trevor M0TDZ's Landrover with stacked 9-ele 2m beams and on the right one of three DX Commander multiband vertical antennas used.

SPECIAL EVENT STATION: Over the next six years, GB5ST will celebrate 54 years of the Star Trek TV show, spinoffs, and movies. This event will take place until the series' 60th anniversary in 2026. QSL direct or via the RSGB bureau.

SES FACEBOOK GROUP: There is a Facebook group promoting Special Event Stations within the UK. It already has over 1000 members. Any radio amateur or SWL with an interest in organising, operating or working special event stations is welcome. The group is run by **Mark G1PIE**, **Martyn MM0XXW** and **Pam 2E1HQY**:
www.facebook.com/groups/SESUk

OTN135: OTN 135 (Old Timer News issue 135) is now available and on schedule despite the ongoing virus situation. OTN consists mainly of articles written by RAOTA members. Articles in this issue include:
• My quest for a decent low-band antenna (final part) by G3ZST • Patch Leads by G3ZPF (RAOTA President) • Further 'goings on' in the Antenna System by G0RGB • My Callsign and the History Behind it by G2ARY • Learning from our Hidden History using Amateur Radio Sources by M0EDU • This issue also carries our annual reports.
Enquiries about membership of RAOTA should be sent to membership secretary George Miles G3VBE QTHR or memsec@RAOTA.org and there is more information at:
www.RAOTA.org

Colin Redwood G6MXL
practicalwireless@warnersgroup.co.uk

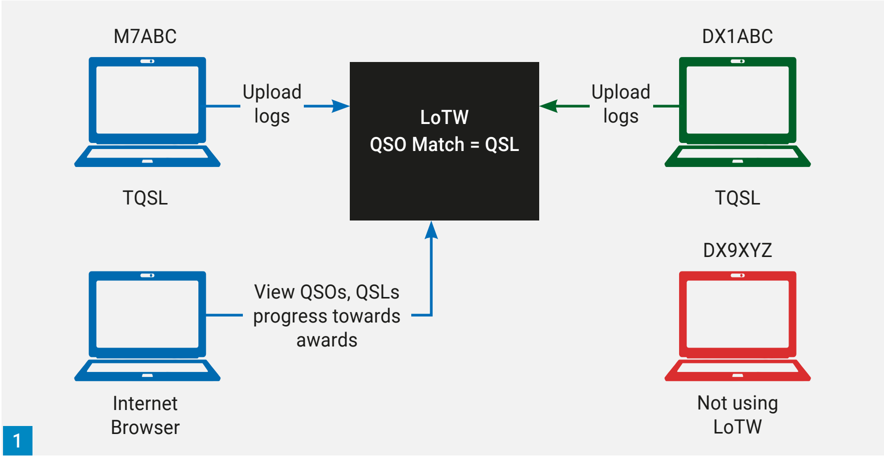
Getting Started (Part IV)

Colin Redwood G6MXL explains Logbook of The World.

This month I'm looking at Logbook of The World (LoTW) – an electronic alternative to sending and receiving QSL cards, whose popularity is certainly increasing among newcomers and old-hands alike.

Logbook of the World

LoTW is an online logbook matching system. It tries to match contacts (QSOs) in your electronic log with logs uploaded to it from other stations. Where it finds matches, it marks those contacts as confirmed (like an invisible QSL card), **Fig. 1**. These confirmed contacts can be used to apply for a number of awards, including DXCC for confirmed contacts with 100 entities (≈ countries) without the need for paper QSL cards.



1

Getting Started

Getting set up with LoTW entails a five-step process, which I have summarised in the flow chart, **Fig. 2**. There's a more detailed explanation on the LoTW website (below), together with an extensive Frequently Asked Questions section. By the way, you don't need to be a member of ARRL to make full use LoTW.

www.arrl.org/logbook-of-the-world

Download and Install Software

1. The Trusted QSL (TQSL) software needed for LoTW can be downloaded from the ARRL website. There are versions of TQSL for Windows, Linux and Macintosh. TQSL is the program that is used initially to set up your personal and station data and subsequently to submit logs to LoTW.

www.arrl.org/tqsl-download

Request a Callsign Certificate

2. LoTW uses private-key public-key encryption. The purpose of this is to provide confidence that any log you upload has come from you and no one else. The encryption key is made up of two electronic halves, the TQ5 and TQ6 files. You start by entering some basic data into the TQSL program, which produces a TQ5 file that you then upload to the LoTW website. On receipt, the ARRL will process the TQ5 file and send an e-mail confirming that it has been processed and requesting authentication of your location.

Authentication

3. For amateurs outside the USA, authentication requires a copy of the first page of your amateur radio licence and a copy of some suitable official photographic ID (driving licence or photo page of your passport) to be e-mailed or posted to ARRL. While waiting for the ARRL to process this, you can start preparing your log file(s) for uploading.

Receive Your Certificate

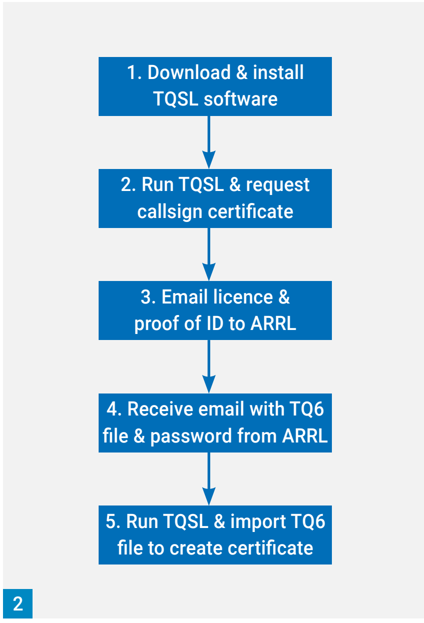
4. Once your documentation has been processed by the ARRL, they will e-mail your TQ6 file. The e-mail from ARRL will also include a password that you will need to use when logging into LoTW using an internet browser to view you logs, confirmations and progress towards awards.

Import Your TQ6 file

5. When you import your TQ6 file from the ARRL, TQSL combines it with the TQ5 file to complete your encryption key.

Create Your Station Location

The TQSL program will prompt you to add further information about your location, such as your ITU Zone (27 for the British Isles), CQ Zone (14 for the British Isles), Locator Square (IO90JO, for example) and IOTA reference (EU-005 for mainland Britain, for example). If at any time you have operated from other locations using exactly the same callsign (perhaps when you change from home to university address), then you'll need to set each of the locations up before submitting logs for those operations. Although some of this data is not mandatory, it is helpful for some location-based awards. The ease of doing this is a particular strength of LoTW in my opinion.



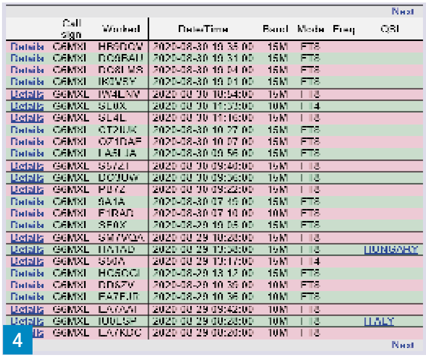
2

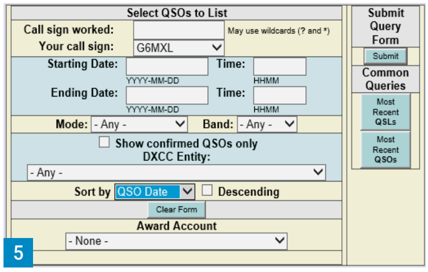
Preparing Log Files

You'll need to have your log file in ADIF (.adi) or Cabrillo (.cbr) format to upload it to LoTW using TQSL. Most computer logging programs (both station logging and contest logging varieties) will generate an ADIF file as an export option. The Cabrillo format is used for HF contest logs. Many data mode programs such as WSJT-X (used for FT8) and those used for PSK31 and RTTY, can also export .adi files

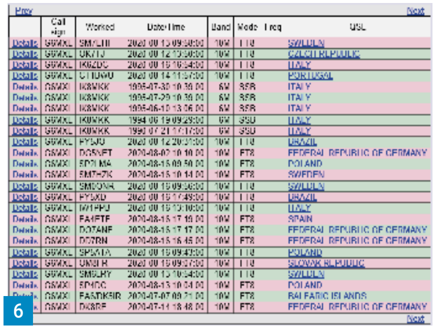
Fig. 1: LoTW Overview. Fig. 2: The 5-step process to getting set up on LoTW. Fig. 3: The simple TQSL log entry screen. Fig. 4: The most recent QSOs button is a good way to see your uploaded log. Fig. 5: The LoTW log searching facility is quite comprehensive. Fig. 6: The most recent QSLs button shows your recent QSLs. Fig. 7: Some of the awards that can be applied for directly through LoTW.

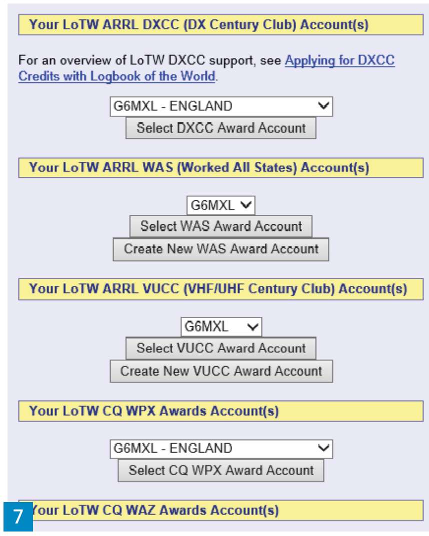
3


4



5


6



7

Satellite Contacts

If you've made contacts through amateur radio satellites, you'll need to make sure that your ADIF file includes the propagation mode SAT and the name of the satellite. Without this, your contacts will not be credited as being satellite contacts for either party to the QSO – an important consideration for those wishing to apply for Satellite awards.

No Logging Program

If you don't have a suitable logging program to generate ADIF files, all is not lost because the TQSL program has a basic data entry screen to enter contacts, **Fig. 3**. Until you've got the hang of this facility, I'd suggest uploading just a handful of QSOs. You can check your log on the LoTW website, **Fig. 4**.

Alternatively, you can use a tool such as DF3CB's excellent Fast Log Entry software, to create a suitable ADIF file. This can be a good way to 'convert' paper logs to ADIF logs with the minimum of typing – especially if you have many contacts on the same day, band and mode.

www.df3cb.com/fle

If you have your log in an Excel spreadsheet, then the 'essential' fields can be converted to ADIF using the spreadsheet at:

https://tinyurl.com/yd5nkn52

Uploading Log Files

Before uploading your ADIF file, you will be asked to select the callsign you used and the location from which you made the QSOs. You'll also need to select the log file to be uploaded. Each subsequent file you come to load will need to be given a different file name. If the format of ADIF file is incorrect (unlikely if you have exported it from an established logging program), you will get appropriate error messages. Behind the scenes, the TQSL program will use your certificate to electronically 'sign' and encrypt your log file to produce what is known as a TQ8 file. It is the TQ8 file that is actually uploaded to the LoTW server.

There is no need to upload your whole log at one go. You can do multiple uploads and you don't even need to worry about duplication of QSO data. LoTW spots exact duplicate QSOs and ignores them.

Matching

Once your log has been uploaded, it joins a queue of logs for LoTW to process. This usually takes a few minutes, although it can take longer, depending on how many other logs are waiting to be processed. A match (and hence marking a QSO as QSL'd) is based on the same date (UTC), time (UTC), band, callsign and mode, but not reports. There is a tolerance on the time, so don't worry if your time is out by a few minutes. This all assumes that the other station uploads their logs to LoTW (as DX1ABC has done in Fig. 1). If the other station hasn't uploaded their logs (such as DX9XYZ in the diagram), then no match will happen and your QSO will not be marked as QSL'd until such time as DX9XYZ uploads their log (if ever). Note that unlike eQSL, LoTW does not produce QSL cards in any form.

Viewing Your Contacts

To view your contacts in LoTW, you simply use any internet browser to log onto LoTW by entering your callsign and password. You'll be able to search your contacts by a variety of search criteria including your callsign, the other station's callsign, date ranges, bands and modes, **Fig. 5**. I find the most recent QSOs button, **Fig. 4**, and most recent QSL button very helpful, **Fig. 6**.

Awards Covered

The range of awards covered by LoTW, **Fig. 7**, includes many awards issued by the American Radio Relay League (ARRL – the American equivalent of the RSGB) such as DXCC and VUCC. A number of the Worked Prefix (WPX) awards issued by CQ Magazine of the USA can also be claimed from within LoTW.

A range of RSGB and DARC (the German National Society) awards can also be claimed with LoTW data but via the relevant organisation's website.

Costs

While there are no costs involved in using LoTW, there are often costs involved in claiming awards, just as there are if you were claiming them with paper QSL cards. At least you're saving the costs of posting paper cards to and from the checker as

	2014	2020
Total QSOs stored in LoTW	600 Million	1,225 Million
Confirmed Contacts in LoTW	92 Million	246 Million
Users	69 Thousand	135 Thousand
Confirmed Ratio (QSLs)	15%	20%

Table 1: There are vast numbers of QSOs already uploaded to LoTW. Perhaps some of them are for contacts with your station?

well as the cost of printing and sending the cards in the first place!

Popular

There's no doubt that LoTW has become a very popular way for all operators to store log data with a view to applying for various awards. There are well over 400 Foundation Licence callsigns registered on LoTW. I find the statistics in **Table 1** very impressive. Notice in particular that the confirmed ratio is increasing as a growing number of stations worldwide make use of LoTW. Perhaps some of the QSOs are awaiting matching with QSOs in logs from your station?

These days I find roughly 30% of my HF contacts are confirmed on LoTW within a few weeks, although I'm still getting confirmations coming through from older contacts – some up to 30 years ago, Fig. 6 again. I suspect some stations have used the recent lockdown period to convert older paper logs to electronic logs and upload them to LoTW.

Old Paper Logs

There is no need to have your entire log in electronic format to start using LoTW. However, there are lots of benefits to be gained by getting your historical logs into electronic form, if only so that you can easily find previous QSOs with a specific station next time you work them.

If you have old paper logs, then I'd start by just uploading your new QSOs from your electronic log, and then over time, re-key your paper logs, starting with the most recent. You can upload your re-keyed logs to LoTW in batches as big or small as you choose.

Other Callsigns

You'll need to make sure that the callsign used to upload contacts to LoTW is exactly the same (including any suffixes such as /P or /A) as you used on-air. If you've used other callsigns for some of your contacts (e.g. M7ABC/P, MW7ABC, MM7ABC/M), you'll need to request additional TQ6 files through the TQSL program. You'll also need to do this for previous callsigns or if you get a new one. Likewise, if you operate from other DXCC entities or use a special event callsign under a Notice of Variation from Ofcom. You don't need to send your identity information to ARRL as you've already provided it.

You can request additional certificates at any point before you upload contacts made using those other callsigns. Allow about a week for additional TQ6 files to arrive. You'll need to import the additional TQ6 file using TQSL and add location(s), just as you did for your main callsign. You don't need to do any of this immediately. By all means wait until you are happy with using LoTW for your main callsign.

Other Locations

If you have made contacts from more than one location (perhaps a favourite hilltop used for VHF contests), then you will need to ensure that your log is split into separate files for each location and callsign. For example, you'd need separate log files for each of the following: M7ABC/P operating from IO90AR, M7ABC/P operating from IO81WD, MJ7ABC/P operating from IN89WF.

Keep Those Log Files

Make sure you keep the log files that you have used for uploading to LoTW because they can also be used to upload to other online facilities such as eQSL and Club Log, which I'll look at in future months.

Corrections

LoTW does not provide a facility to make corrections or delete log entries in LoTW. Incorrect data simply won't match with other stations uploads and thus will not result in a match. All you can do is to load the correct data and forget the incorrect data. I'd suggest starting with just a few log entries to make sure you get everything correct.

LoTW Users

As a final note, it can be helpful to know who uploads their logs regularly to LoTW because this can be handy if you need a particular confirmation for an award. HB9BZA maintains such a list, which you can find on his website.

www.hb9bza.net/lotw-users-list

Radio Round-up

G8SRS/100: The club callsign G8SRS was used by members of Stockport Radio Society for the month of June with the suffix /100 to celebrate the centenary anniversary of the club. The callsign was operated from several members' home stations as well as portable. A special QSL card was designed for the occasion, featuring photographs that document the history of the club. These have been received by members that worked the station, as well as sent to other stations by request.

In total there were 18 operators of the callsign over the 19 days that it was used. Most operators used their home stations, some operated portable stations as part of the Summits-on-the-Air (SOTA) programme, some sought high ground to take advantage of the good take-off, and a number of other operators also operated portable or 'garden-portable'.

FCC PROPOSES TO INSTITUTE AMATEUR RADIO APPLICATION FEES: Amateur radio licensees would pay a $50 fee for each amateur radio license application if the FCC adopts rules it proposed recently. Included in the FCC's fee proposal are applications for new licences, renewals and upgrades to existing licences, and vanity callsign requests. Excluded are applications for administrative updates, such as changes of address, and annual regulatory fees.

145 ALIVE 2M ACTIVITY DAY : Lockdown has proved to be a major challenge, however one positive aspect has been the boom in interest in amateur radio and in particular the increase in new M7 licences since April, thanks to the exam being available online. 2m and 70cm have often been the first port of call for many newcomers to the hobby and Tim G5TM, along with some like-minded amateurs, decided it would be great to encourage activity on the 2m band for all licence levels, including M7 callsigns. The aim was to encourage people to join a series of frequencies during one afternoon and to help them fill their logbook with new contacts and to show just how much 2m FM can be used to have an enjoyable time on air.

Making the best use of Time

Steve White G3ZVW takes a look at radio systems that require extremely accurate timing.

Steve White G3ZVW
practicalwireless@warnersgroup.co.uk

Collectively, such radio systems are known as Time of Arrival (ToA). They rely on really accurate timing, to perform a function that would not otherwise be possible. I am going to detail two such systems; one which a lot of people know about and one which not a lot of people know about.

First though, a few nuggets of information about the Global Positioning System (GPS). This American system works by transmitting extremely accurate time signals from a constellation of satellites orbiting Earth at a height of 20,200km. This height is known as Medium Earth Orbit (MEO), as opposed to Low Earth Orbit (LEO) or Geostationary (Geo). The accuracy of the time signals is crucial to the accuracy of the system as a whole – and in the case of GPS is to within 10 nanoseconds. Currently there are 24 GPS satellites in use, plus spares, all of them in orbit. There are other satellite navigational systems that work in a very similar way, e.g. Glonass (Russian) and Galileo (European).

Blitzortung

There are various live lightning sites on the internet, perhaps the best known of them being Blitzortung (German for Lightning Location). A not-for-profit 'community', it works by people buying its kits, assembling them and connecting them to the internet. A kit will contain a very low frequency (VLF) radio receiver, a GPS receiver and a good bit of logic. Purchasers are expected to provide their own antenna, a magnetic loop being popular.

A lightning strike is an electrical discharge and when one occurs it results in a wideband pulse of radio frequency energy. On a radio the pulse will sound like a brief crunching sound. They are often known as static crashes. Normally the crashes would be heard over the station you might be listening to, but if you tuned a receiver to a frequency on which there was no activity you would just hear the crashes. A Blitzortung receiver detects the exact time it hears every static crash, then sends it and the receiver's exact coordinates (derived from the GPS receiver) to a central server. The central server uses all the incoming reports to build up a picture of lightning activity, which it superimposes on maps and then makes available on the internet. It requires a minimum of four receivers for the server to determine the location of a lightning strike, but more reports from more receivers makes for a more accurate fix. Blitzortung's maps contain two hours of historical data too, so you can easily see in which direction lightning activity is moving. The whole collection and distribution process takes only a few seconds. Blitzortung works worldwide, but there is no meaningful coverage in some parts of the world because very few Blitzortung receivers are there. Europe, the Far East and North America are all well covered. Arctic regions, Africa and South America aren't.

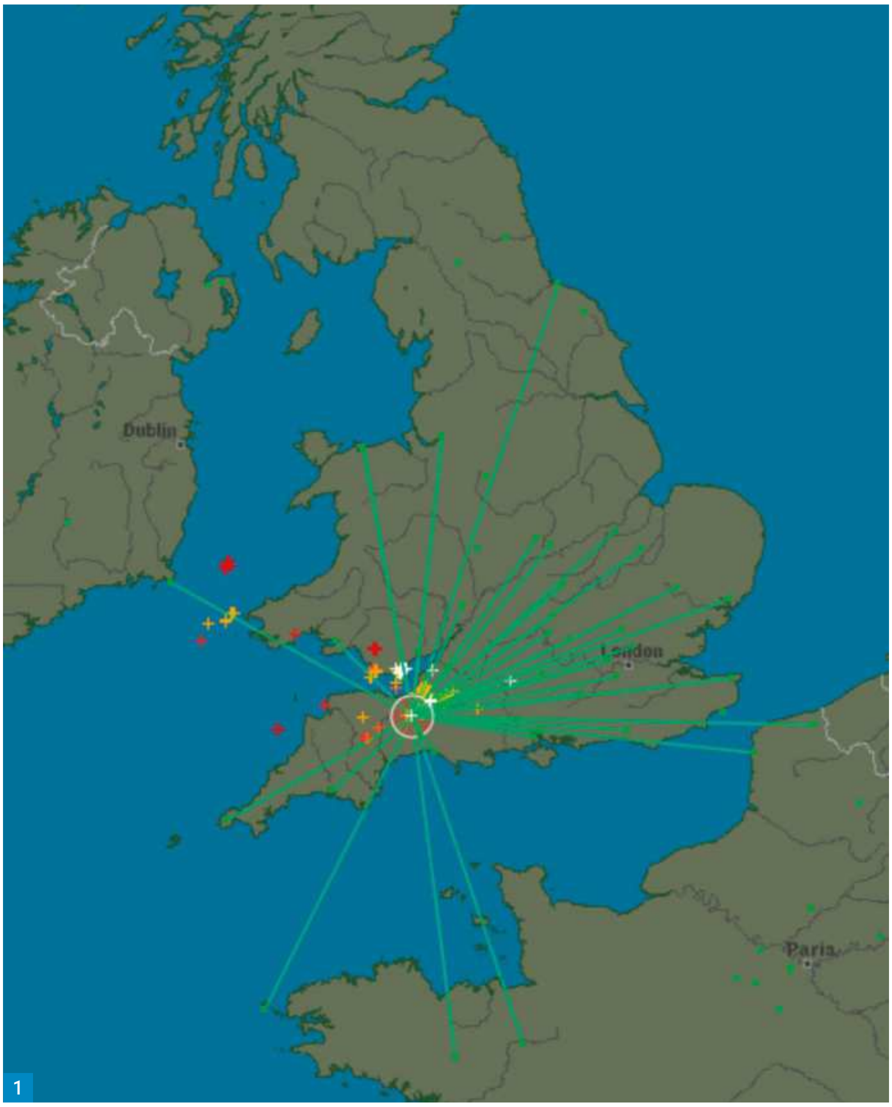


Fig. 1: Blitzortung map of lightning strikes from a thunderstorm in Somerset. Fig. 2: Listening spots around London and driving times to a transmitter in South East London. Fig. 3: Times taken for radio signals to reach the ToA listening sites.

So how accurate is Blitzortung? In theory it should be able to pin down a lightning strike to three metres, but in reality the accuracy is less because some receivers will hear a static crash via ground wave propagation and some will hear it via sky wave. Sky wave signals – signals that have gone up to the ionosphere and been refracted back to Earth – take a longer path than ground wave signals, so are received slightly later than they would otherwise be. Blitzortung tries to overcome this by using a VLF receiver, because signals at VLF travel very long distances by ground wave. The worst case accuracy might be a couple of hundred metres. Blitzortung certainly puts you in the picture if a storm is coming your way, **Fig. 1**.

Security

The 2012 Olympics Games took place in London. Suppose someone with a VHF transceiver decided to deliberately interfere with one of the frequencies used by security guards at the main site of the Games in Stratford, East London. Let's compare traditional and ToA methods of locating the illicit user.

Traditional

You could certainly use traditional direction-finding techniques to locate the illicit transmitter. In theory it could be done by one person, but to save a lot of time you would use a team of people experienced in direction finding, each of them in a vehicle. Say you had five of them, located at the yellow stars in **Fig. 2**. Each member of the team would need to use a receiver and a directional antenna. They would need to wait for a transmission to take place and be certain that it was not legitimate, then plot bearings on maps and liaise with one another to come to a consensus on where the transmitter was. Taking bearings is never precise, so there is never going to be complete agreement on where the illicit transmitter is.

To minimise false bearings, they are best taken from locations that are clear of clutter (buildings, trees, etc). In London the top of a block of flats should be good, but even if a list of buildings was available they would take time to access. Say the direction finders decide that the transmission is coming from where the red star is. They would then need to converge on that location, listen again and take further bearings. They would have to do this several times before they finally homed in on the target. Radio reflections from buildings and structures make for a difficult task, because sometimes the strongest signal might not be taking a direct path.

The average speed of road traffic in London is 12mph, so I show the straight line distances and driving times in Fig. 2. The real-world distances would, of course, be more. Eventually it would be possible to find the source of the transmission, but it would be likely to take hours. The illicit user would probably have stopped and gone away long before the exact location was known, let alone before something was done to put a stop to it.

2

3

Now, if you think things are difficult enough so far, consider how difficult the task becomes if the illicit user is mobile and/or making occasional brief transmissions. And what about if there is more than one illicit user? Essentially it becomes practically impossible.

Where this traditional method of direction finding scores is when a transmission is permanent, not intermittent or occasional, but finding the transmitter will still take time.

Time of Arrival

Although little was spoken or written about it, a commercial Time of Arrival radio monitoring system was deployed for the Olympics Games in London. It was put in place to quickly identify the location of any transmitters causing interference to radio systems being used at the Games. Such a system works in a similar way to the live lightning locating system, but instead of listening for static crashes it can be set to monitor specific frequencies.

How such a system works is that a frequency is identified and sent via a secure radio link or the internet to a network of ToA monitors, each of which are located in an advantageous location. For convenience, in **Fig. 3** I show them at the same locations that were used in Fig. 2. Rather like Blitzortung, multiple monitors are needed to triangulate a transmitter. Three is the minimum requirement, but more work better.

The monitors don't use directional antennas, because they don't know in which direction a transmitter is. When instructed, they all switch to the frequency in question. The instant a transmission starts on that frequency they each report their location (from GPS) and the precise time that the transmission started. Just like the lightning detectors they use GPS clocking, so they know the time that a transmission starts to within ten nanoseconds. That's one hundredth of one millionth of a second. I also show in Fig. 3 how many microseconds (µS) the signal takes to get to each monitor. Collectively, the ToA system can pinpoint every transmission made on the frequency that is being monitored, so someone in a control room can see where everyone using the frequency concerned is, be the transmissions legitimate or illegitimate. In a street you could walk straight up to the building. In a line of cars you could walk straight up to the vehicle. You might want to do a local search or listen when you get close, but it should soon be a case of 'job done'. In traffic, a ToA system enables a vehicle's progress to be plotted.

Because the radio systems at the Olympic Games were largely VHF and UHF, transmissions were pretty-much line-of-sight. This means no ionospheric reflections, which in turn means the accuracy of the system was better than the lightning monitors. That said there will be local reflections, which will diminish the accuracy.

You might imagine that ToA systems don't work well when a transmitter is on all the time, because there is no definable time that a transmission starts. That's not so, because as long as there is modulation present they work by performing timed analysis on it. That said, the accuracy isn't as good.

Where ToA systems don't work is when a transmission is permanent, but with no modulation.

MFJ Enterprises, founded in 1972 by Martin F. Jue, is a manufacturer of a broad range of products for the amateur radio market. They specialise in station accessories, such as antenna tuners and antenna switching equipment. MFJ now manufactures more amateur radio products than any other company in the world

MFJ Automatic Tuners

UPTO 708 WATTS

MFJ-926B remote Mobile ATU 1.6-30MHz 200W........................£399.95
MFJ-929 Compact with Random Wire Option 1.8-30MHz 200W.£329.95
MFJ-991B 1.8-30MHz 150W SSB/100W CW ATU........................£299.95
MFJ-993B 1.8-30MHz 300W SSB/150W CW ATU........................£389.95
MFJ-994B 1.8-30MHz 600W SSB/300W CW ATU........................£449.99
MFJ-998 1.8-30MHz 1.5kW........................£849.95

MFJ Manual Tuners

UPTO 475 WATTS

We stock all the popular tuners to suit your needs and budget

MFJ-902B 3.5-30MHz 150W mini travel tuner........................£139.95
MFJ-901B 1.8-30MHz 200W Versa tuner........................£149.95
MFJ-945E 1.8-54MHz 300W tuner with meter........................£179.95
MFJ-941E 1.8-30MHz 300W Versa tuner 2........................£199.95
MFJ-949E 1.8-30MHz 300W deluxe Versa tuner with DL........................£249.95
MFJ-934 1.8-30MHz 300W tuner complete with artificial GND.....£249.95
MFJ-974B 3.6-54MHz 300W tuner with X-needle SWR/WATT.....£249.95
MFJ-969 1.8-54MHz 300W all band tuner........................£299.95
MFJ-976 1.8-30MHz 1500W balanced line tuner with X-Needle SWR/WATT........................£569.95

MFJ Analysers

UPTO 416 WATTS

MFJ offer the best range of analysers the most popular being the MFJ-259C

MFJ-207 HF 10-160M 1.6-30MHz in 5 bands........................£129.95
MFJ-208 VHF 138-156MHz + external jack for frequency counter........................£119.95
MFJ-223 HF/6M 1-60MHz with colour graphic display........................£399.95
MFJ-225 HF/VHF 1.8-170MHz, two ports, with graphic display....£399.95
MFJ-226 HF/VHF/UHF 1-230MHz expect times analyser with graphic display........................£449.99
MFJ-227 VHF/UHF 88-226-330-500 MHz graphics VNA analyser£449.95
MFJ-249D HF/VHF/UHF 530kHz-230MHz with analogue meter...£379.95
MFJ-259C HF/VHF/UHF 530kHz-230MHz with analogue and LCD screen........................£349.95
MFJ-269D HF/VHF/UHF 530kHz-230/415-470MHz with analogue and LCD screen........................£529.99
MFJ-269 PRO HF/VHF/UHF 530kHz-230/430-520MHz with analogue and LCD screen........................£549.95

MFJ SWR Meters

UPTO 217 WATTS

MFJ have every SWR/Wattmeter you could ever need including the world's largest with a 16cm+ screen

MFJ-869 HF 1.8-60MHz 20/200/2000W with massive 6.5 screen and fully automatic........................£329.99
MFJ-868B HF+6m 1.8-54MHz 20/200/2000W with massive 6.5" screen........................£249.95
MFJ-867 VHF/UHF 144/220/440MHz 20/200/400W with large screen........................£219.95
MFJ-826B HF 1.8-54MHz 1500W digital SWR/Wattmeter with built in frequency counter........................£249.95
MFJ-828 HF 1.8-60MHz 1500W digital SWR/Wattmeter with 3" cross needle screen........................£259.95
MFJ-864 Compact cross needle HF/VHF/UHF 1.8-60/144/430MHz 30/300W........................£139.99
MFJ-862 Compact cross needle VHF/UHF 144/220/430MHz 30/300W........................£84.95
MFJ-860 Compact cross needle HF 1.8-60MHz 30/300W............£69.95
MFJ-849 Digital HF/VHF 1.5-525MHz 200W with large 3.5" LCD display........................£229.95

MFJ Headphones

UPTO 62 WATTS

MFJ-393 are professional grade MFJ Boom-Mic Head-phone set is for contesting, DXing and traffic nets. Comfort designed leatherette padding lets you operate for hours at the rig. Superb inch thick padding on each ear and headband. The MFJ-393 is so super lightweight, you won't even know you are wearing them Available pre wired for ICOM, Kenwood, Yaesu................£79.99
MFJ-392B is perfect for amateur radio and shortwave listening. Great for all modes -- SSB, FM, AM, data, and CW. Each earphone has an individual volume control. Superb padded headband and ear cushioned design makes listening extremely comfortable. High-performance driver unit reproduces enhanced communication sound. Signals never sounded so crystal clear!.............£44.99

MFJ Dummy Loads

UPTO 150 WATTS

Chose between dry and oil filled dummy loads between 15-2500W

MFJ-261 15W (100W peak) DC-500MHz with PL259........................£39.95
MFJ-261N 15W (100W peak) DC-500MHz with N-Type........................£47.95
MFJ-262B 35W (200W peak) DC-1000MHz with PL259........................£79.95
MFJ-262BN 35W (200W peak) DC-1000MHz with N-Type............£99.95
MFJ-260C 25W (300W peak) 30-650MHz with PL259........................£59.95
MFJ-260CN 25W (300W peak) 30-650MHz with N-Type...............£67.99
MFJ-250X 1kW (2kW peak) DC-400MHz with SO239 (need transformer oil)........................£69.95
MFJ-250 1kW (2kW peak) DC-400MHz with SO239 (includes transformer oil)........................£99.95
MFJ-264 100W (1.5kW peak) DC-650MHz with SO239................£99.95
MFJ-264N 100W (1.5kW peak) DC-650MHz with N-Type..........£119.95
MFJ-251 25W (300W peak) DC-60MHz 16.6/25/50/100/150 Ohm selectable........................£179.95

MFJ Antenna Switches

UPTO 108 WATTS

MFJ Rhino antenna switches are tough and durable with gold plated flanges and connector contacts that provide low VSWR and low insertion loss. A rock-solid, sturdy, die-cast design gives up to an excellent 70 dB isolation.

These switches are built like a rhino, tough inside and out! A superior internal design lets them work for you for a long lifespan.

MFJ-2702 SO239 2-Way 0-1000MHz 2kW........................£44.95
MFJ-2702N N-Type 2-Way 0-1000MHz 2kW........................£64.95
MFJ-2703 SO239 3-Way 0-800MHz 2kW........................£79.99
MFJ-2703N N-Type 3-Way 0-1.5GHz 2kW........................£94.95
MFJ-2704 SO239 4-Way 0-900MHz 2kW........................£119.95
MFJ-2704N N-Type 4-Way 0-1.5GHz 2kW........................£129.95

MFJ DC Multi-Outlet Strips

UPTO 104 WATTS

These strips have 5-way binding posts for your transceivers and accessories to keep your power connected neat and tidy and organized.

MFJ-1118 Deluxe Multiple DC Power outlet lets you power two HF and/or VHF transceivers and six or more accessories from your transceivers main 12 VDC supply........................£129.95
MFJ-1117 Multiple DC Power outlet lets you power four HF/VHF radios -- two at 35 Amps each and two at 35 Amps combined -- from your transceivers main 12 VDC supply........................£89.95
MFJ-1116 Multiple DC Power outlet handles 15 Amps total. It has eight pairs of heavy duty, RF bypassed 5-way binding posts that lets you power your accessories. They are protected by a master fuse and have an ON/OFF switch with "ON" LED indicator........................£89.95
MFJ-1112 15 Amp Multiple DC Power outlet lets you power up to six devices from your transceivers main 12 VDC supply........................£54.95

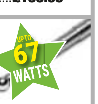
MFJ Morse Keys

UPTO 108 WATTS

Morse keys, readers and tutors starting from just £24.95.

MFJ-550 Budget practice key for beginners........................£24.95
MFJ-553 Deluxe wood telegraph straight key........................£37.99
MFJ-557 Deluxe code practice oscillator with volume adjust.........£59.95
MFJ-566M Micro CW keyer black with metal base........................£44.95
MFJ-566P Micro CW keyer black with plastic base........................£34.99
MFJ-564 Deluxe Lambic paddle with heavy base in chrome.......£134.99
MFJ-564B Deluxe Lambic paddle with heavy base in black........£129.95
MFJ-461 Pocket size Morse code reader........................£129.95
MFJ-418 Pocket size Morse code tutor........................£139.99

MFJ Telescopic Antennas



UPTO 67 WATTS

Premium stainless steel telescopic whips are the perfect choice for building collapsible multi-band dipoles, mobiles, portable and base antennas. They are great for traveling, mini DXpeditions, vacations, etc.

MFJ-1979 17ft Ten section (27" to 16.9ft) 3/8th fitting..................£79.95
MFJ-1977 12ft Seven section (24"to 12ft) 3/8th fitting..................£64.95
MFJ-1976 10ft Seven sections (20" to 10ft) 3/8th fitting................£59.95

MFJ HF Transmitting & Receiving Loop Antennas

UPTO 500 WATTS

Enjoy listening or transmitting on HF with these suburb loops. Ideal for limited space – apartments, motorhomes, attics, mobile homes or small gardens

MFJ-1782X 10-30M TX (inc WARC bands) just 36" diameter......£479.95
MFJ-1786X 10-30M TX (inc WARC bands) just 36" diameter, control box includes VSWR/PWR meter........................£519.95
MFJ-1788X 15-40M TX just 36" diameter, control box includes VSWR/PWR meter........................£649.99
MFJ-1886X 50 KHz-30 MHz RX super low noise receiving loop..£279.95
MFJ-1886TRX 50 KHz-30 MHz RXsuper low noise receiving loop with built-in transmit/receive switch........................£339.95
MFJ-1888 50 KHz-34 MHz high performance loop with adjustable gain and multi-coupler remote control........................£549.95

MFJ Cobweb Antenna

UPTO 291 WATTS

Restricted space spoiling your operating fun? 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

MFJ-1836 300W version........................£349.95
MFJ-1836H 1500W version........................£399.95

MFJ Clocks

UPTO 26 WATTS

MFJ-107B Mounted in a brushed aluminium frame, our 24 Hour LCD Clock features huge, easy-to-read 5/8 inch LCD numerals and a sloped face that makes it easy-to-read across the room £17.99
MFJ-108B Read both UTC and local time at a glance with our dual 12/24 hour LCD clock that displays 12/24 hour time simultaneously! £31.99

MFJ Patch Panel

UPTO 92 WATTS

These panel connect devices with virtually no loss, feed-thru or cross-talk .Provides 8 or 12 Teflon SO239 coax feed thru barrel connectors to patch 8 coax fed devices together with short coax jumpers. This extremely high performance and versatile military/professional patch panel approach has virtually no loss, no feed-thru and no cross-talk

MFJ-4704 4 position........................£99.95
MFJ-4706 6 position........................£109.99

MFJ MFJ-2100 HF Octopus antenna base

UPTO 117 WATTS

Octopus antenna hub turns your ham-sticks into four fully balanced dipoles in minutes! Mix and match any four HF/VHF/UHF bands. Example: screw in 80,40,20 meter hamsticks and a dual band 2M/440 MHz whip (two on each band) on opposite sides. Now you have an automatic band switching 5-band dipole! Rotate it for maximum signal and minimum QRM and noise with a small rotator like Hy-gain AR-500,
Works at any height, low for local NVIS and high for DX. At a fixed height, (say 20-30 feet) use 80-Meters for NVIS and 20-Meters for low-angle Exomoons on any mast up to 1-inch in diameter. Use a fiberglass pole on a tripod and you are on the air! Check out our MFJ-1919EX a perfect mount for the new Octopus Antenna. Perfect for casual portable operation, limited space, HOAs, field day, camping, and ARES. Single coax feed, built-in balun.......£139.95

MFJ-1234 RIGPI BASE JUST £349.95

MENTION PRACTICAL WIRELESS AND GET FREE POSTAGE ON THIS ITEM

Join the best loyalty programme

and start earning WATTS now!

All registered retail customers can now earn and redeem free product credits known as WATTS. It's simple the more WATTS you spend the more WATTS you receive. You will also receive bonus WATTS when you refer a 'New Customer', 'Write a Product Review', 'Share' a product' or 'Refer a Friend'

Don't miss out – Register now and start enjoying free WATTS

Steve Telenius-Lowe PJ4DX
teleniuslowe@gmail.com

IOTA & ILLW

Steve Telenius-Lowe PJ4DX reports on the Islands on the Air contest and on the International Lighthouse and Lightship Weekend.

The RSGB IOTA Contest took place on July 25/26th and, despite receiving nearly 2500 logs, the organisers published the results only a month later, which may be something of a record. (I remember the days when major international contests' results took nearly a year to be published!)

With sparse activity from North or South America, to do well in this contest requires making as many contacts as possible with Europe (and particularly British Isles stations because by definition everyone in the UK and Ireland is an Island station and therefore worth three times as many points as those on the mainland of Europe). Unfortunately, conditions were poor from here to Europe and my claimed score was well down on previous years, so I was pleased to receive a certificate for the highest-scoring station from South America. The organisers report that there was plenty of activity this year from stations in Japan and Indonesia. Although propagation was such that most of those were not heard here, it does bode well for the future of this contest, which in the past has always been very Eurocentric. We just need to increase activity from North and South America and in particular the Caribbean islands.

Full results are at:
tinyurl.com/y6mgy85m

ILLW August 22nd/23rd

For me, one of the highlights of operating in August was participating in the International Lighthouse and Lightship Weekend (ILLW) for the first time. Bonaire has three lighthouses, none of which had ever been activated before, at least not to the knowledge of the organisers of ILLW. During a get-together of Bonaire's amateurs, I suggested that the group should rectify this and put on a station for ILLW. **Peter PJ4NX** suggested that we go to the Spelonk lighthouse, located on the rough windward (eastern) side of Bonaire. It's in a remote part of the island requiring four-wheel drive vehicles for access and, after nearly seven years on Bonaire, I had never been there so I jumped at the opportunity to discover a 'new' part of my island home!

I contacted the ILLW organisers and they issued reference number BQ0001 to the Spelonk lighthouse. However, in the week leading up to the activity weekend, Bonaire experienced several consecutive days of unseasonably wet weather with thunderstorms and localised flooding. The dirt track to Spelonk became impassable, even for four-wheel drive vehicles.

1

'Plan B' was to activate the Willemstoren lighthouse, **Fig. 2**, instead. This is at the southernmost tip of Bonaire and is easily accessible with a paved road right up to the lighthouse building. I explained the situation to the ILLW organisers and they issued BQ0002 to the Willemstoren light in time for the weekend.

We set up an HF station with my Icom IC-7300 powered by a Yamaha 2.5kVA generator owned by **Bert PJ4KY** to Peter's 'DX Commander' multi-band vertical [see the review in the August 2020 *PW* – *Ed*]. **Berry PJ4BZL** provided the all-important barbecue and we all took cold bags with food and drinks. Fortunately, the weather had returned to normal so we were able to operate in the open air; the lighthouse building itself providing much-needed shade, **Fig. 3**.

This was very much a social event rather than a strictly operating event, but that fitted in nicely with the ILLW ethos which, it is emphasised, is not a contest. It was good to contact several other lighthouse stations during the weekend, including PA2TMS at NL048 on Texel Island, VY2PLH at CA051 on Prince Edward Island and KP2AD at VI001 in the Virgin Islands. Best DX by far was a 7MHz SSB greyline contact with **Billy YB6NE** on Sumatra, who called in while Peter PJ4NX was operating. The weekend also provided an opportunity for some of the island's less-active operators to get on the air. **Erwin PJ4EL** received his Bonaire licence just before ILLW so was able to make his first QSOs with the new callsign. We were also visited by **Ish**, a local lady who hopes to become licensed herself before too long.

The event was a real success and we are already planning to activate BQ0001 for ILLW 2021 – weather permitting, of course!

Meanwhile, over in Gibraltar, **Kevin Hewitt ZB2GI** reported that the Gibraltar Amateur Radio Society activated Europa Point Lighthouse ZB2LGT, GI001, **Fig. 4**. Kevin, **John ZB2JK**, **Francis ZB3Y** and **Andy Rainer** all operated SSB with **Derek ZB2CW** operating CW. The station operated on 80m to 10m and comprised a Yaesu FT-450 running 100W into 10m of wire wound on a 9m telescopic fishing pole connected via a 9:1 balun. Kevin also operated on digimodes using a Yaesu FT-897 running 40W. The log included over 700 SSB and 250 FT8 contacts. Kevin commented *"Great to work HFH regular contributor **Etienne OS8D** while I was operating SSB on 20m.The majority of SSB contacts were made into Europe on 20m. The majority of FT8 contacts were made into Europe across all the bands."*

Bill Ward 2E0BWX reports working DL0MFK/LH on 18MHz FT8 during ILLW. This station was active from the Karnin Lighthouse, DE013, on Usedom Island, IOTA EU-129.

There are more reports and full details of the ILLW programme on their website at:
illw.net

Readers' News

Bill 2E0BWX sent in a short report of his activity on FT8 and FT4, including QSOs with special event station OE25DMT, commemorating 25 years of Austria in the EU, as well as DL0MFK/LH during the International Lighthouse/Lightship Weekend.

In addition to his activity as ZB2LGT, this month Kevin ZB2GI also operated portable from the great siege tunnels viewing

Fig. 1: IOTA Contest certificate received by PJ4DX for highest-scoring station from South America. Fig. 2: DX Commander vertical at the Willemstoren Lighthouse, BQ0002, during the ILLW. Fig. 3: Operating ILLW: Peter PJ4NX on the mic with SWL Ish giving him the thumbs up. In the background Bert PJ4KY, Rinse PJ4RF and Gerard PJ4GR. Fig. 4: The Europa Point Lighthouse, Gibraltar, from where ZB2LGT was active. Fig. 5: John ZB2JK operating from the great siege tunnels viewing platform in Gibraltar. Fig. 6: 1995 QSL from Betty Christian VR6YL. Fig. 7: G3JNB/P escaped lockdown with his FT-818, 'Miracle Whip', straight key – and a thermos.


2

platform at the north end of the Rock, **Fig. 5**, using an Icom IC-703 with 5m of wire wound on to a 5m telescopic fishing pole and connected via a 9:1 balun, from the GARS club station using a Hexbeam antenna, from the top of the Rock, and from his home station.

Etienne Vrebos OS8D/ON8DN wrote that he had *"not that many activities this month, even if I called CQ many times direction east"*. Etienne carried out some tests with European stations during which he confirmed that his 40m end-fed wire *"is much better in receiving and transmitting than the Butternut [HF2V vertical]"*. I would have expected that to be the case, but I would also expect the Butternut vertical to outperform the end-fed wire for DX stations on both 40m and 80m. I remember putting up a Butternut HF2V when, as G4JVG, I moved to Stevenage in 1995. Almost the first station I worked on it on 80m SSB was **Betty Christian VR6YL**, **Fig. 6**, wife of the late **Tom Christian MBE, VR6TC**, a direct descendant of **Fletcher Christian** of mutiny on the *Bounty* fame (she called me, so this was definitely a case of being in the right place at the right time!) The Butternut was fairly useless for working around Europe, though!

Etienne also commented: *"You've seen I made a lot of QSOs with Asia* [see 'Around the Bands' below – ***Ed***]... *Japanese people are sometimes very difficult to understand but I love them because they are that polite and patient. That's the fun of making SSB contacts, trying to use other languages, trying to understand and with a little experience make QSOs (short ones) with Russians just by knowing some easy and simple words."*

Tony Usher G4HZW reports that *"28MHz seems to have run out of steam after an excellent summer. It had one last fling in mid-August and on the evening of the 16th South Americans were rolling in with huge signals. I half expected the band to open up to long-path VK and ZL! One of the stations worked was LU1BJW who sent me an e-mail thanking me for the QSO: it was our second, the first being in 1985! The Nordic Radio Amateur Union 28MHz Activity Contest, late on September 3rd, proved entertaining as I was using FT8 in contest mode for the first time. On 7MHz, looking at what others are working, the vertical is OK to the west but leaves a lot to be desired to the east. I think it could be due to the fact that I wasn't able to bury radials on the east side. China and Thailand were new countries for me during the month, so I'm not complaining."*

Owen Williams G0PHY wrote that *"The bulk of the DX I worked this month was in the All Asia phone contest with stations worked in Asiatic Russia, Kazakhstan, Israel, Cyprus, Saudi Arabia, Turkey and Oman. I heard one Japanese station and a couple of Thai stations. Outside the contest I worked into Canada and also had a QSO with 4S7JL/MM off the north-west African coast, he was a very strong signal. It reminded me of a tale my father told me when he had an Artificial Aerial licence and at the time was living in Liverpool. One day he heard an American with a very strong signal. He was a bit disappointed to hear he was a maritime mobile on the Manchester ship canal."*

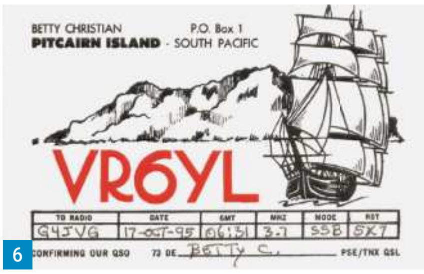
Following the excitement of splendid propagation over the WAE CW contest weekend, **Victor Brand G3JNB** reports *"It went quiet here for several days although I tried* ***Andy 5Z4/G3AB*** *in Nairobi on 20m, making several unsuccessful attempts. He used his new callsign 5Z4VJ, appropriate the day before our 'VJ Day' celebrations. Then, on 17m,* ***Jeff TZ4AM*** *Mali was logged. Routine 20m sessions involved OH0Z, the Åland Islands plus club station OE25XGM and the ever-present 4U1A in Vienna. Raising the 'anti', 2.5 watt CW contacts using an original 'Miracle Whip' antenna and my FT-818 on battery, added a little spice to the lockdown scenario. Several 20m contacts from indoors* *and the garden included LZ3ZX, SP50BNV and YL3JD. Realising I really 'needed to get out more' I took the rig and tiny antenna up the hilltop above my village,* **Fig. 7***. What a difference height above sea level makes: EUs with moderate strengths in the valley were blowing my head off! First call on 20m and* ***Frank OV1CDX*** *came straight back. An enjoyable couple of hours, with RL4F the best DX at 1528 miles. On August 22nd the 15 – 40m bands blossomed. 5Z4VJ was finally logged on 20m. Next day, CX1AA the Radio Club of Uruguay in Montevideo, was worked on both 15m and 40m, plus the Radio Amateurs Club Kourou FY5KE in French Guiana on 17m and D2EB Angola on 17 and 30m. And so it went on. C31US Andorra obliged on 40m, A61Q of UAE on 30m and 9Z4Y Trinidad on 20m. But no JAs, VKs or ZLs.*

"So could it be true? This QRPer climbed the Hill to consult the Old Timer, asking if Cycle 25 really had started? Thoughtfully, he gazed at me and quietly replied 'Patience my son... the Sundancers are still warming up'. Ah!"


3


4


5



6


7

Around the Bands

Bill 2E0BWX: 7MHz FT8: DG5YL. **14MHz FT8:** OE25DMT and other Europeans. **14MHz FT4:** IK1HJS. **18MHz FT8:** DL0MFK/LH. **18MHz FT4:** F6KBF. **28MHz FT8:** EA3GLE.

Etienne OS8D / ON8DN: 14MHz SSB: 5E7PA, 5T5PA, 5Z4VJ, 9V1YC, BD7BM, BD7DT, BG4OP, HS3PIK, JA1OGI, JE1RXJ, JG1OUT, JH1GEX, JH4UYB, JH9URT, JR1GSE, JY5MM, UN7QF, V85T, ZB2LGT.

Kevin ZB2GI: 7MHz FT8: K6JDC. **14MHz SSB:** AJ2I, K1VYU, NL7WA (Florida). **18MHz SSB:** 5T5PA, PY5QW + many Europeans. **18MHz FT8:** 9Y4VF, CT3IQ, FG8OJ, K4AWM, K8CW, W1JX. **28MHz SSB:** M3DDY.

The **ZB2LGT** log included: **3.5MHz FT8:** LU5EPB. **5MHz FT8:** HB0CC, K8MFO, N4UXP, W4CHA, N7GB, N6RW. **7MHz SSB:** JM5CJZ. **7MHz FT8:** 6E6E, BH4QYX, K7KE, KC2ZOR, N7IVV, NR0P, VA3DX, W4DWS, W0VHF. **10MHz FT8:** EA4ESI. **14MHz SSB:** 5B60AIX, 9H1DL (MT0001), 9Z4FE, CR5L (PT025), CX2CB, DL0HGW (DE0123), DQ100SL, HK1NP, II1L (IT177), IQ4RA/LH (IT0028), JG0CUK, LU1PHF/P, LU9DD, N2ED, ON9BD (BE0006), OS8D, PP5SEM, PY1FC, PY2HP, PY7BC. **14MHz CW:** DK0RA/LH (DE0050), DL0HGW/LH (DE0123), GB0PLL (UK0222), OE4XMF/LH (AT0004), W0WP. **14MHz FT8:** M0BSM/LH. **18MHz SSB:** 5B60AIX, AE3CT, W5ZM. **18MHz CW:** ZD7BG. **18MHz FT8:** 9K2OW, CO6HLP, NP4W, PY2EBD, TA2K, W3FOX, W4DR. **21MHz FT8:** 5H1FF, 9H1FL, BG2WRJ, HC2TMZ, PT7AAS, PU1JSV, PU2OOC, PU4LSB, PU5AOA. **24MHz FT8:** PE5I. **28MHz SSB:** EA7AQR. **28MHz FT8:** TK5IH, ZS6BUN, ZS6VLR.

Tony G4HZW: 7MHz FT4: A45XR, HS5XWY, K7BV, N1SNB, NB2P, NF3R, VE2CSI (Zone 2). **7MHz FT8:** BG0BBB, KC1JMF, PT2ADM, VE1BZI, VE9FI. **28MHz FT8:** 5T5PA, A71AE, CE3DOH, CX4CAW, CX7CO, HC1DAZ, HC1HC, LU1BJW, LU2FDA, LU3DI, LU4DTD, LU5FPJ, LU7PB, LU9HPO, LW2EIY, PP2CS, PU1SKS, PU2KRL, PU4TNT, PY1VOY, PY2DPM, RA9LL, RV9CX, UA9WOU, UN7LZ, VO1CH, W1NRB, YV5JLO, ZD7MY.

Owen G0PHY: 7MHz SSB: 4X1DX, UN9L. **14MHz SSB:** 4S7JL/MM, A42K, HZ7C, UN9L, TA4CS, UA9A, VE9FI, VE2CSI. **21MHz SSB:** 5B4AIF.

Signing Off

Thanks to all contributors. Please send all input for this column to teleniuslowe@gmail.com by the 11th of each month. For the January 2021 issue the deadline is November 11th. 73, Steve PJ4DX.

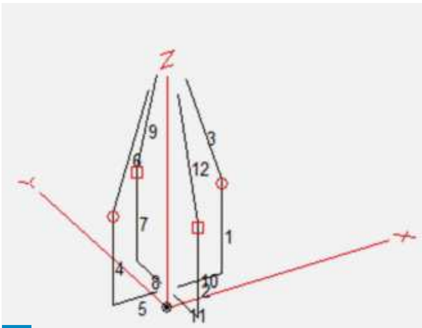
A Simplified Directional 40m Antenna (Part I)

Bob Whelan G3PJT
practicalwireless@warnersgroup.co.uk

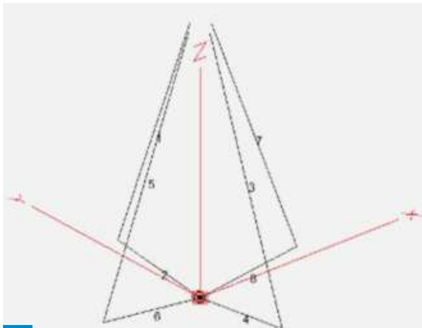
Bob Whelan G3PJT describes a gain antenna for 40m that can be put up in many gardens.

Effective antennas for 40 or 30m present somewhat of a challenge to the DX operator. Gain and directivity can confer big advantages in being able to hear and work DX when competing with other stations, especially those in Western Europe. But antennas with gain and directivity at 40m can involve significant amounts of space and engineering. I have built two types of directional antenna, a four-element parasitic array for 30m [1], **Fig. 1**, and a two- and four-element driven array (4-square) [2]. Both of these antennas were electrically rotatable and both showed good directivity and some gain in the forward direction. Using these antennas, I quickly realised that the major advantage of these antennas over omnidirectional vertical antennas was the significant improvement in received signal-to-noise ratio.

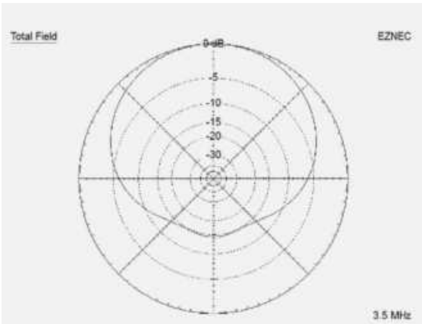
This article covers some experiments undertaken in 2018/9 with the objective of seeing if computer modelling and better measuring equipment might allow some new insights and maybe some design simplifications.



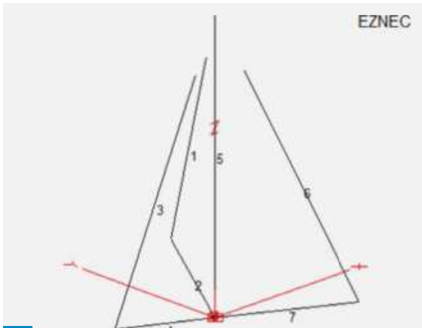
1



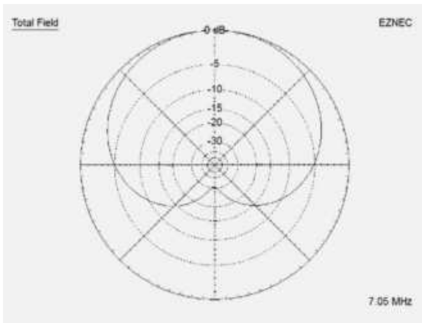
2a



2b



3a



3b

Initial Thoughts

In early 2018 I constructed a three-sloper dipole array [3] suspended from an 18m tower. These slopers were also backed up with reflectors to provide better rejection of signals from Western Europe when beaming to the west. Results were mixed and did not meet expectations. But still in my mind the proven performance of the 4-square was offset by the significant effort required to construct a new one, especially the need for four new ground radial systems! Yes, elevated radial systems represent an option but there is still debate as to their efficacy especially when close to ground.

The antenna described in [1] if scaled for 40m was going to need a new 20m mast – I was sure this would not get past the local planners. This antenna, Fig. 1, had bent dipole elements, each element being centre fed with parasitic tuning using variable capacitors. EZNEC showed it had a rather similar pattern and gain to a 4-square though estimates had to be made of some dimensions as my experimental notes were lost.

The complexity of the 4-square – four matched ground radial systems, the need to drive all four elements, use correct feedlines and construct a switch box system – arises because of the need to feed each element with the correct phase and current amplitudes. Yet HF antennas use parasitic coupling to achieve the correct element currents and there is no reason why the same approach cannot be used on lower frequency antennas too with a potential simplification of the system.

G4DKG [4] described a rather simple way to add directivity to an 80m vertical and more recently VE1ZAC and VE3VN [5] have also described vertical antennas with parasitic elements to add directionality. A 3-element in-line 40m antenna is available from M0MCX in [6], but that antenna is fixed in one direction. Another reference worth consulting is in [7], the section on 80 and 160m antennas especially.

An EZNEC model of the G4DKG antenna, **Fig. 2**, shows that this would have the directional performance of a 2-element antenna even though three parasitic elements are used.

At 20° elevation over average ground the gain is 5.8dBi, about 3-4 dB over a single vertical (1.98dBi). (All models are at 20° elevation). There is ~120° sector in the rear direction where signals are attenuated by 10dB

Fig. 1: EZNEC modelling of the G3PJT 30m array.
Fig. 2: Modelling of the G4DKG 80m array.
Fig. 3: EZNEC modelling of the G3PJT 3-element 40m array described in the text.
Fig. 4: Top of mast showing element connection.

or more. Unusually, this design uses a single ground radial system and the ends of the three parasitic reflectors and the driven element are bought back to a switch and tuning box at the centre of the ground radial system. No feedlines are needed. Thus, by selecting one element from four as the driven element, four directions can be covered.

VE3ZAC used a bent element director as an addition to a simple vertical and he changed direction by moving the director so it 'pointed' in the direction he wanted. VE3VN describes a two-element array with elevated radials, the base of each vertical being at 10m – I judge this to be a significant engineering exercise!

Summarising the conclusions at this point. A simplified parasitic vertical array seemed feasible based on a single radial system and using wire elements. A 10-11m support would be needed and the likely performance would be as good as a 2-element vertical.

Experimental Designs

As a first step the dimensions used by G4DKG were roughly scaled to 40m. Each element looked like a tilted-L with the long leg 8.9m and the short leg 5m. The junction of wires 1 and 2 is at 1m and about 5m from the centre. A single element of this shape has a modelled resonant frequency of around 5.8MHz. According to EZNEC it has a circular azimuthal radiation pattern at 7MHz almost exactly the same as a full-size quarter-wave 40m vertical.

2, 3 and 4 element antennas were modelled and combinations of driven element and parasitic element tried at various orientations around a central support mast. As the parasitic elements were always inductive at 7MHz, they were tuned using a series capacitor. The most interesting arrangement was three elements disposed at 120° as this allowed three directions to be selected and if reversible, a further three, making six directions in all, **Fig. 3(a)**.

In the case of a three-element antenna a number of different arrangements were possible, namely,

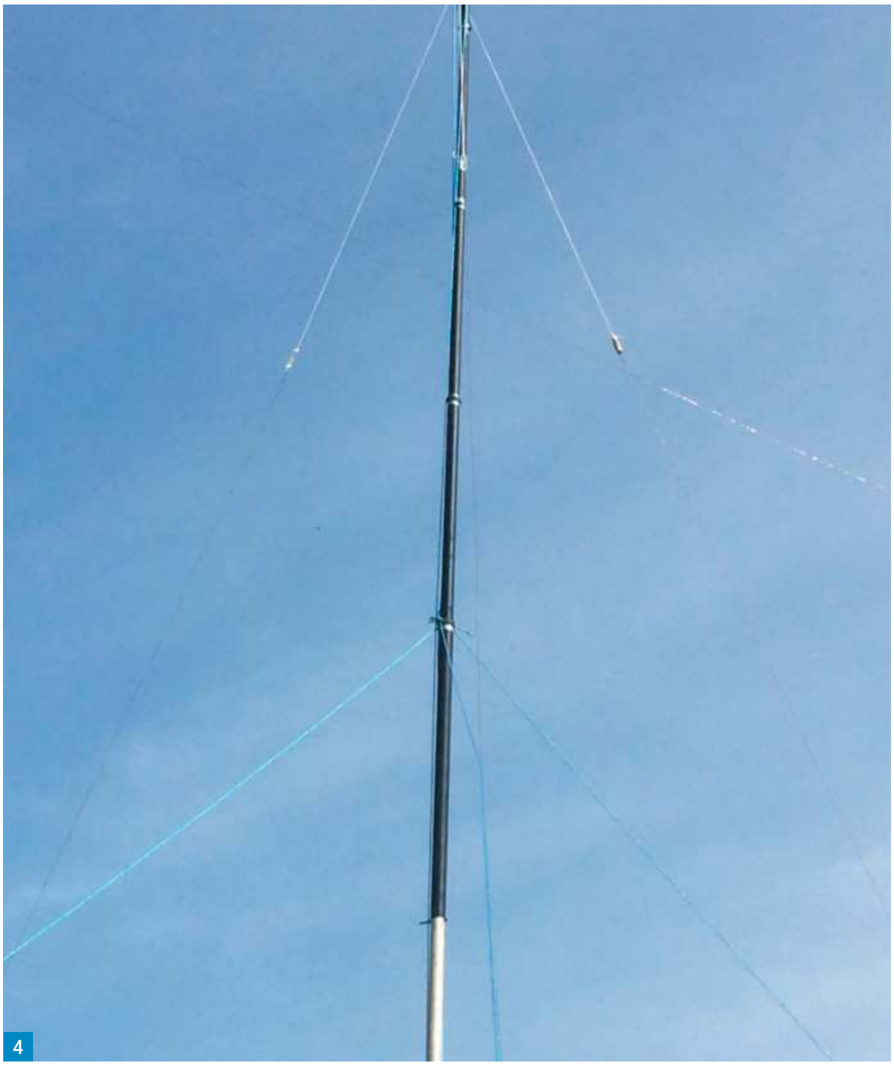
- two driven elements fed in parallel with a single parasitic director or reflector
- one element driven with two parasitic elements in parallel as either directors or reflectors

These two arrangements beam in opposite directions but have very different electrical characteristics and therefore need a more complex switch and tuning box.

- a pair of elements, one driven and one as reflector or director with the third element floating or grounded. As the selected driven and parasitic elements can be reversed easily, this combination allows for six directions and was the arrangement selected for further study. Modelling showed that performance was best if parasitic elements were tuned as reflectors.

A typical azimuthal pattern is shown here, **Fig. 3(b)**, almost identical in shape to the G4DKG design but slightly less tight in the reverse direction. The outer ring is 5.4dBi giving a gain of about 3dB over a simple vertical. The −3dB beamwidth is 143°. By inserting various values of series capacitance into the parasitic element the performance could be optimised for gain and front-to-back ratio.

EZNEC predicted that at the feedpoint the current in the driven and parasitic element would be almost equal and the phase difference would be ~135 to 140°. The parasitic


4

Frequency MHz	Gain dBi	Front to back dBi
7.0	5.7	16
7.05	5.4	25
7.10	5	16
7.15	4.6	12
7.20	4.3	9

Table 1: Gain and front-to-back ratio as a function of frequency.

Resistance ohms	Gain dBi	F/B dB
0	5.8	25
5	4.6	21
10	3.6	15
15	2.6	12
20	2	10
25	1	8

Table 2: Ground loss modelling.

Fig. 5: Fixing to 1m posts. Fig. 6: Close up of radial attachment and status LEDs. Fig. 7: Switch box showing relays and capacitors for tuning.

Element #	Resonant freq MHz	Impedance R	Reactance ±j
1	5.56	19	9
2	5.55	16	11
3	5.56	17	14
EZNEC	5.8	14.4	3

Table 3: Element matching.

element would need a capacitor of −j200Ω, ~100pF, to bring it to the optimum setting at 7MHz. The driven element would be 36+j246Ω and an L-section circuit would be needed to match the driven element to 50Ω. The unused element could be either left open circuit or grounded because very little current flows in it in either case, but probably best to ground it.

Close-spaced antennas inevitably have narrow bandwidth. Modelling shows that this design retains its pattern for about 100kHz or so, **Table 1**.

This design then:

- has gain of 3dB over single-element vertical
- has a rear angle of ~120° where signals are attenuated by >10dB
- requires three wire elements hung from a central 11m mast
- uses a single ground plane
- needs a suitable switch and tuning box

On that basis the decision was made to construct the design as an experiment.

5

Frequency MHz	6.9	6.95	7.0	7.02	7.04	7.05	7.1	7.15
Front/back dB	3	8	15	19	23	23	15.5	11.5
Parasitic I ratio	.84	.926	.975	.98	.976	.97	.924	.853
Phase diff	170	158	145	130	134	131	120	109

Table 4: Current phase and amplitude modelled.

Support Mast

A rigid 11m mast is needed so that the three elements can be held in proper alignment. An aluminium bottom section of about 5m was joined to 6m of bottom sections of a Spiderpole. This made a rigid mast of sufficient strength. This was fastened in a hinged baseplate and supported by four guys at the 9m level, **Fig. 4**. A pulley and halyard were used to facilitate things.

Ground Radial System

For any vertical system the ground radial effectiveness is key and this antenna is no exception. To make some sort of estimate of ground effects a series of EZNEC models was run with various amounts of resistive loading. This is a proxy for ground loss but is quite informative. **Table 2** shows how the forward gain and front-to-back ratio change with resistive loading.

The need then is to get the 'loss' below 10Ω if possible. Otherwise the shape of the azimuthal pattern degrades to a circle and directionality is lost.

The ground radial system comprised 50 radials of insulated thin wire varying in length from 5 to 8m (30 of ~5m would probably have been enough). These were pinned into the grass surface using best bent wire and large paper clips. The radials were terminated at the centre end with crimp terminals and bolted to an aluminium plate with stainless steel set screws, **Fig. 6**. This radial system fitted into a ~12m diameter circle. For comparison my old 40m 4-square took up an area 18m by 30m.

Elements and Support

All three elements were measured as a set to try and ensure they were identical. Each element was marked 8.94m from its upper end insulator. This is the point where they were attached to a 1m post to hold them in position relative to the centre, **Fig. 5**. To fit in with the available area these posts were orientated at 70,190 and 310° to the mast. As the elements are used in pairs and are reversible the azimuthal angles that can be covered are 40, 100, 160, 220, 280 and 340°.

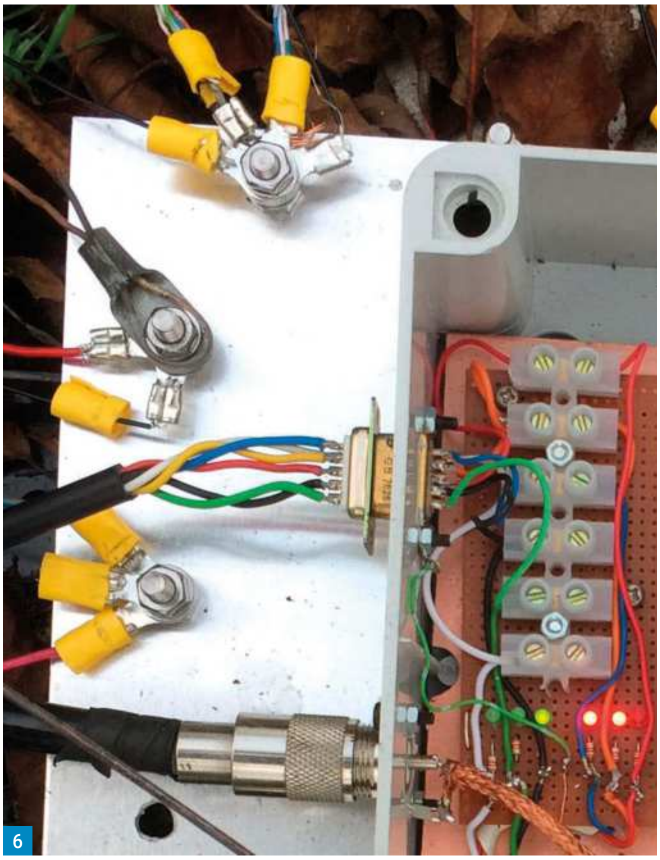
Switch and Tuning Box

The relay arrangement at the base of the antenna allows the selection of elements individually as either driven element, parasitic element or ground, **Fig. 7**. The circuit is shown in **Fig. 8**. Note the use of LEDs, Fig. 5, to indicate the state of each of the six relays. This is invaluable when experimenting with various selections. For relays I used a mixture of 24V vacuum relays and some open frame relays with15A contacts.

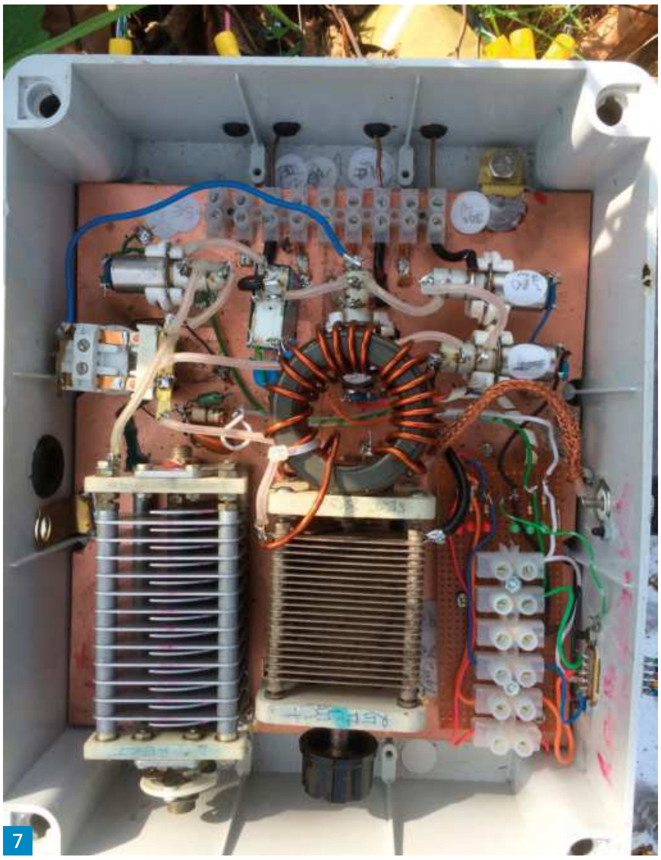
The driven element was matched to 50Ω with a series inductance of 6μH (22 turns on a T200 toroid) and a shunt capacitor of 170pF across the driven element end to ground. These values were not the same as those from EZNEC so were adjusted to give a match to 50Ω.

Control Box

I also constructed a portable, flexible control switch that allowed each element to be configured as either driven element, parasitic element or ground. A step-up voltage converter for 12 to 24V was used for the



6



7

relay supply. A second control switch was constructed for use in the shack on-air using a 6-way, 2-pole, rotary switch and steering diodes to select the six directions in a logical sequence.

Set Up

Elements were measured individually to check they were matched (min. SWR measurement), **Table 3**.

This indicates that the effective loss resistance from the ground radials (30 × 5-8m) was about 3Ω. Adding a further 20 radials did not change these figures. Adding 3Ω loss into the EZNEC model reduces gain by less than 1dB as predicted above.

Setting up this antenna proceeded in three stages: first, a quick on-the-air nulling of signals process, second, by using an oscilloscope to measure and set element currents and third, by setting currents using a digital phase and amplitude meter.

Stage 1

Using a portable receiver it was very easy to null out signals arriving from the back of the antenna while beaming west. DLs (Germany) and other European signals could be nulled by adjusting the capacitor in the parasitic element. A setting of between 50-150pF is a reasonable starting point. The antenna was just flipped back and forth, forward to reverse, setting the capacitor to minimise the signals in the reverse direction. The capacitor was set to ~75pF as a good compromise.

Bearing deg	Test 1 Local RX dB	Test 1 Remote RX dB	Test 2 Local RX dB	Test 2 Remote TX dB	EZNEC dB
40	0	0	0	0	0
100	-1	0	-2	-3	-1.4
160	-8	-5	-8	-13	-8.3
220	-12	-10	-12	-9	-28
280	-17	-15	-8	-13	-13.5
340	-3	-5	0	0	-3

Table 5: Local field strength measurements.

Stage 2

EZNEC suggested that the currents at the base of the driven and parasitic elements would be equal with a phase difference of 135-140°. Two current transformers, one on the driven and one on the parasitic reflector, were connected to a two-channel oscilloscope. This enabled amplitude and phase differences to be measured. Varying the capacitor in the parasitic changed both amplitude and phase difference. As these two parameters are governed by the coupling between the elements, then they should be related, that is at roughly equal currents, the phase relationship should be 135-140, as **Table 4** from EZNEC shows. (Driven element current = 1).

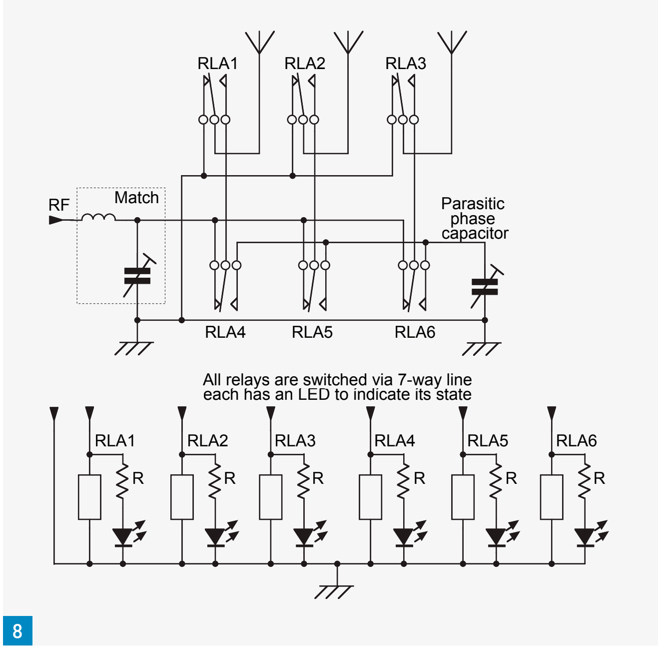
This was the case and suggests a simple set-up procedure of just equalising the currents in the driven and parasitic elements. This needed to be investigated further with better measurement techniques.

Stage 3

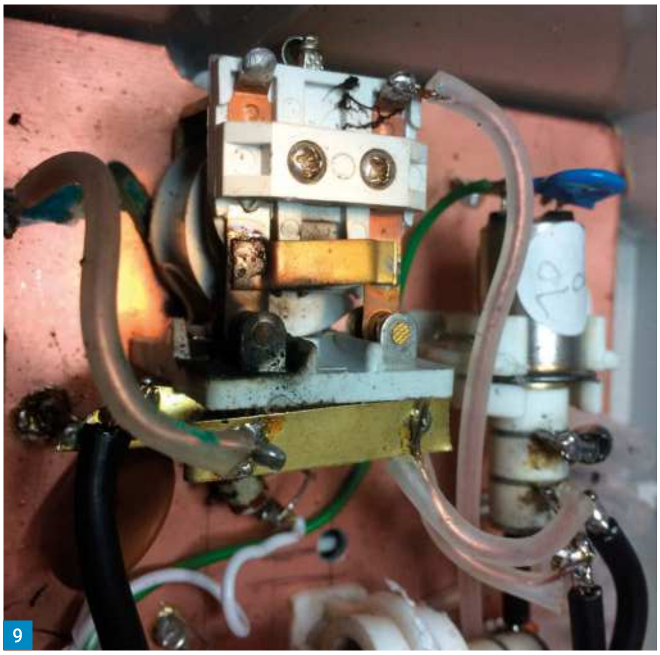
To improve the accuracy of the set-up process a current amplitude and phase detector circuit [8] was constructed.

Taking the parasitic capacitor settings made using the oscilloscope method above the measurements were:

- Freq 7027kHz, amplitude diff = 0, phase difference = 147°.
- Freq 7050kHz, amplitude diff = 0, phase difference = 153°.
- Resetting the parasitic capacitor such that the phase difference at 7050kHz was 138° gave a current amplitude difference of approximately −1dB.



8



9

Fig. 8: Circuit of the switch box.
Fig. 9: Burnt out relay.

- The opportunity was taken to make an on-the-air check by nulling a signal from DL while beaming to the west. This null setting was then remeasured and the phase difference was −129° with some −2dB of amplitude difference.
- Measurements were then made of all six directions. Generally, the reciprocal directions matched and all readings were ~0-1dB difference in amplitude and −130 to −140° in phase difference.

Results: Ground Wave Reception

Two measurements of the strength of ground wave signals were made, one on a bearing of 45° at a distance of three miles and a second with a station at 20 miles on a bearing of 305°. Signal strength was measured at each of the six directions using a calibrated receiver (RX). This measurement was repeated in reverse but only using S-meter readings (TX). The signal strengths were normalised to the same orientation to facilitate comparison, **Table 5**.

These results are in reasonable agreement though probably slightly skewed. As a further test a simple 10m vertical was erected and signals received and transmitted from this antenna were used to 'validate' the above results. Signals received were identical to those using a single element of the three-element antenna. This test confirmed a difference of around 3dB when the antenna was beamed at the remote station.

	EZNEC	Test 1	Test 2	Test 3
Forward gain dB	4.6	6	5	3
Front to back dB	12	13	12	11

Table 6: Twente remote receiver tests summary.

Results: Twente Remote Receiver

A single tone was transmitted from the antenna in Cambridge and received on the remote HF receiver at Twente. This is on a bearing of 85°. Gain was measured relative to a single element, **Table 6**.

Fading effects cause difficulty in interpreting these results so they should only be taken as indicative of some gain and front-to-back. Each test is the average over several test cycles.

On-the-Air Measurements

3-4dB gain doesn't sound very much but it seems to make quite a difference on the air based on a large number of measurements on signals from all directions. As part of the practical work, measurements were also made of my local noise floor. It seems that I have a much lower noise floor to the NW through NE, the direction away from the house line.

As I said in the introduction, the effect of the attenuation of signals off the back makes reception of weaker DX signals much easier. The impact on received signals is much greater than the figures would seem to indicate.

Conclusions

The performance of a new simplified three-element triangular antenna has been modelled, constructed and tested. The test results are broadly in line with the predicted performance. It should be possible to scale this design directly for other frequencies.

A future article will cover the next stage of this project and is concerned with a simplified version of this design.

As an aside, **Fig. 9** shows what happens if you switch directions while transmitting with 400W. Probably best not to try this!

My thanks to G4RKO and G3ZAY for help with the ground wave measurements and the reviewer for helpful comments.

References

- *An electrically steerable parasitic array for 10.1MHz*, RC Whelan. *RadCom* January 1988.
- *Phased Arrays for 40m*, RC Whelan, *RadCom* (71) 5,6 May p.14, June p.58 (1995).
- *ARRL Antenna Book*, Chapter 6, 18th ed., page 6-30.
- *A directional antenna for 3.5MHz*, G Collins G4DKG. *RadCom* Dec 1987.
- www.ve1zac.com/40M%20director.htm https://tinyurl.com/y3rbjkyv
- https://tinyurl.com/y4oc73dh
- *ARRL Antenna Compendium* Vol 4, (1995), page 1-17.
- *An HF phase detector*. G3PJT, *RadCom* April 2019.

The Impact of Covid-19 on an Amateur Radio Station

Joe Chester M1MWD ups sticks for a houseboat but manages to stay QRV.

Joe Chester M1MWD
m1mwd@gmx.com

No, this is not an inquiry into the virus, or an analysis of its effect on radio operators in general. However, the current public health emergency has had a dramatic effect on my station. And no, thankfully, the virus hasn't made an appearance, but this does not mean that it hasn't caused a major rethink. For the past few years, I have put a huge effort into improving my small station. Recently, I appeared to have some positive success from these modifications.

Then, over dinner on a wet Monday, the floor disappeared from under my feet. Apparently, there was a family Zoom, or some such, during which stern instructions were issued. We were informed in no uncertain terms, that we were moving house, to be closer to our children.

Now, if you have been following this column, you will realise that moving house in order to acquire more space for antennas was strictly forbidden. And indeed, my dreams of more space were quickly dashed by a further announcement – we were moving into (onto?) a houseboat, by the River Avon, in Gloucestershire! Details of the whys and wherefores are too boring to recite.

So, the radio challenge starts all over again. But there is good news, so don't panic.

Operating from Boats

Boats, be they yachts, cruisers, or houseboats are, in some respects, ideal locations for radio stations. This goes all the way back to the days of Marconi, and to ship- to-shore services in fine trans-Atlantic liners. I once had a small yacht, in which I used the backstay of the mast as an antenna, and that worked really well. But this houseboat does not have a mast. However, the ubiquitous fishing pole might be pressed into service as a look-alike mast.

So, my first thoughts are to set up as if I was a /P station, to see what happens. First up was my AX1, basically a short base-loaded antenna for 20m, designed to match the Elecraft series of small /P transceivers (see my review *PW* October 2019). My Elecraft radio is a KX3, all mode, 160-10m. It has given good service on many portable outings, so I decided to set it up on what passes for a back porch here.

It's only a few minutes work to set it up on a camera tripod (after I found the various bits, which had travelled in different bags or boxes!). In five minutes I caught **Alex OZ7AM**, quickly followed by **Ger EC1A**, both of them 59 with me, as I was with them. I didn't manage **Pavel RA3OA**, but I was only running 10W. Thank you gentlemen, my first QSOs with my new M1 callsign.

Proof of concept? Well it's a portable setup, so of course it's going to work! There were many other stations showing on the PX3 spectrum display at the time, but unfortunately, we had family round for a socially distanced look about (and lunch), so I had to shut down the radio station.

The new QTH means a certain amount of research needs to be done on the best way forward. Even as I was setting up the KX3/AX1, I was eyeing up the possibilities for the next step. Thankfully, as well as the *ARRL Handbook*, the manual for the SGC-237 ATU has much of value here. I had previously used this ATU with the backstay on the yacht.

The manual describes several ways of mounting antennas on all kinds of

boats. It doesn't specifically mention houseboats, but it does mention camper vans (and even aircraft!). Of course, one of the main suggestions is a tall vertical. Which is where it becomes interesting. With its large metal hull, and the nearby river, the opportunity for a really good antenna ground only depends on bonding the ground wire to the boat's hull.

Wire is the wrong word, but rather

copper foil or a strap is needed. **Callum M0MCX** describes (on his blog) how he once built a narrowboat, on which he had a tilt-over mast installed, which supported such a vertical, with an ATU at the base. So here is a ready-made solution.

But first, an experiment with the aforementioned telescopic pole, using 19.8m of antenna wire, set in an inverted-L configuration. I will start by using a 9:1 unun as the feedpoint and see how it works.

This is basically what I was using in the previous QTH (but with a GRP pole rather than the fishing pole). Again, checking the concept out found me running 100W one afternoon. I was delighted to catch **Geoff GM8OFQ**, from Orkney. on 14.285kHz. We have worked a number of times, usually on 40m but never on 20m. He gave me 59+25, and he was 59+ with me. Where he lives on an island in the Orkneys, only 300 people live there. A really nice QSO! Then in quick succession, I logged RU1M, YT8A, EA7ATX and LY1G. So, all in all, a good result, in less than ideal conditions. But, of course, it worked, and just as well as from the other QTH.

80m

But one of my main interests at the minute is 80m, and with the antenna wire being nearly a quarter wave for 80m, it would make sense to eliminate the unun, and set it up as an 80m ground plane, with a bonding strap going to the hull for the ground connection. Future work. But for now it's time to check on the 80m nets with the inverted-L. I heard **David G4HMC** on 3720kHz in earnest discussion about poles (does every radio net have an obsession with poles?).

Then it was time. As 0930UTC clicked around came the QRZ from NRC net controller **Nigel G4RWI**. Next time round I answered and got a 59+20. GB3RS, being run by Ken G7FTD, gave me a 59 as well, as did **Ed G3ZLX**. David joined the net and was delighted to give me a 59, occasionally 59+.

Needless to say, they were all 59 with me. Thus, we proved at least one more useful rule of thumb for 80m morning operations – you can't beat being a shorter distance away for a better signal report.

Mind you I'm only a few tens of kilometres closer. But 80m is a fickle friend at that time of the day in high Summer, so every little helps. Of course, I didn't get away without yet another challenge being offered. *"Now you need to see if you can get to 59+40"*, said one net denizen. I wasn't quick enough with the PTT, so I'll say it here. *"No, I don't want to rent your spare room, or move in next door hi, hi!"*

Other Bands

Eventually, I will need to think about other bands and other modes. Dipoles might be a challenge, and certainly will be limited in height. And mounting that GRP pole. And a tilt-over arrangement of some sort. It promises to be a long, but interesting journey.

And I should also mention, for completeness, that although a houseboat nearly all the time, it could be persuaded to slip its mooring lines and travel up the river to new locations – a new variation on going mobile! Or would I be /P? Please help. Is a radio station moving along a river away from its 'home' mooring /M or /P? Or something else?

Fibre Mast Vertical Antenna & π-Network ATU

Jonathan Hare G1EXG
jphcreativescience@gmail.com

Jonathan Hare G1EXG describes a fibre mast vertical antenna and π-network ATU for the 20, 18, 15, 12 and 10m bands (and 40 & 80m band helical antennas).

Last year I got a great birthday present of a 15m (40ft) fibreglass mast. It's a lovely thing with good quality compression fixings between each telescopic section and it is also about 3m longer than my previous 'work horse' aluminium mast. Living in a city I only have a small backyard so large horizontal antennas are not on, but I can go up vertically. The lack of horizontal space also means that guy wires are a problem so my masts are secured using a set of TV-type brackets to the bottom 3 or 4 foot of the mast on the yard wall.

The bottom 2m or so of the aluminium mast is also used to support the fibre mast (using two Tufnol sheets, see photos, **Fig. 1a and b**). This means the forces are applied over a larger length of the bottom of the fibre mast than they would if the fibre mast was clamped directly to the TV brackets. Also, with this set-up I do not need to tighten the U-bolts on the fibre mast too much; reducing the risk of cracking etc.

Electrochemistry is always a problem with metal masts, especially when you have aluminium tubes with stainless steel brackets and bolts holding them together – moisture and dissimilar metals cause corrosion. The nice thing, of course, about the fibre mast is that it won't rust or corrode even in the sea air at my location. In principle you can do everything with the fibre mast that you can do with the metal mast, but with the added advantage that being insulating you can also run a wire up its length to quickly and simply create a vertical antenna.

1/2 vs. 5/8 Wave Vertical Antennas

The half-wave end-fed antenna has a lot going for it. The maximum current distribution is half way up the radiator so the radiation is often above much of the nearby surrounding objects. Although the half wave should (in an ideal world) be a resistive feed at resonance, it is quite a high value (depends on the diameter of the wire/tubes etc.), so some impedance transformer is required to match it to 50Ω.

The feed impedance of the 5/8 wave is much lower than the end-fed half wave but it will have some reactance that will need to be accounted for/balanced out. The 5/8 wave vertical also provides slightly better gain than the 1/2 wave, with (hopefully) more power being radiated at lower angles toward the horizon where you want it.

The 5/8 is longer, of course, but with a 15m mast I have length to spare even on 20m. I decided then to build 5/8 wave verticals for 20, 15 and 10m and 'load up' the 20m vertical as a 'compromise' antenna on 40m (more on that below when I discuss the helical antennas).

When putting up the antenna, the wire was taped to the top section of the fibre mast first and as the sections were erected I put more tape at various places to stop the wind blowing it away from the mast. The other end was soldered to a 4mm plug (or solder tag) to go on to the ATU.

The insulating property of the fibre mast also means that I can wind a long coil up the length to form a helical antenna, like a giant version of the 'rubber duck' antennas used on handhelds. A quarter wave vertical helical antenna for 80m band can be made by cutting 20m of wire and starting by taping one end to the top section. As you raise each section, you also turn as you go. The result is a long spiral almost the whole length of the mast.

The Simplicity of a Vertical Antenna

The 5/8 wave radiator could not be much easier or more economical – it's simply a copper wire running up the length of the fibre mast. See **Table 1** for ideal lengths. I measured out 13.2m of decent quality copper stranded speaker cable, split the two keeping one strand for the 20m 5/8 wave vertical and cutting down the other length for other bands. Using the ATU (see below) the 10m band 5/8 vertical will also work on the 12m band and the 15m 5/8 will work on 18m band. I therefore made up just three wires: 20m band (13.2m length), 15m band (10.4m) and 10m band (6.6m).

Earths and Radials

It's possible to use both end-fed 1/2 and 5/8 wave vertical antennas with no earth radials but a better performance and lower angle of radiation should result if you do use them. A search on the internet for information about vertical antenna radials (in particular 5/8 verticals) will bring up a lot of interesting articles on the type, size and number of earth radials that might be best.

For longer wavelengths (e.g. 80, 40m say) where the total amount of wire becomes quite long (and so expensive and expansive!), eight x 1/8 radials often seem a better choice than say four x 1/4 radials (even though total amount of copper wire used is the same).

Some authors suggest that quarter-wave radials on the 5/8-wave vertical are not ideal and that 1/8-wave radials provide better low angle radiation and less reactance to match to. As I was trying for a multiband approach, I decided to use four on my test setup: two x 3m and two x 5 m radials so that there was a range that might help cover from 80m to 10m. I understand it's not the best set-up for the longer wavelengths but it will get me on the air.

The radials were simply laid out rather randomly from the base of the mast on the concrete/brick yard so it's not likely that they will actually be 'resonant' at any designed frequency based on their particular lengths. The ATU will tune things up. Again Table 1 shows the ideal lengths of the 5/8 wave wire along with the 1/8 wave radial lengths.

Matching

The antenna needs an antenna tuning circuit to match it to 50Ω coax feeder. I used a homemade π-network (see photo and diagram, **Figs. 2** and **3**). The basic circuit is very simple: two capacitors (C_1 and C_2) and an inductor (L). The variable capacitors are connected to ground and either end of the inductor. It looks a bit like the Greek figure π, hence its name. By carefully varying the values of the three components you can match a wide range

1

1a

Fig. 1: On the right you can see my retracted 12m aluminium mast (r) next to my 15m fibre mast (l). Both masts can be used independently when the other is down. The lower 2m of the aluminium mast supports the fibre mast using two (35 x 35cm) Tufnol panels and 8 U-bolts. The 15m fibre glass mast is shown here with 20m of wire wound around it forming a helix antenna for 80m (see text).

of non-balanced setups. Transmitter output stages often have a π-network to match the relatively low impedance of the output transistor to the ubiquitous 50Ω standard.

Note: there is an inevitable interaction between the capacitors and the inductor, so in practice you select an inductor, adjust C_1, then adjust C_2, and then re-adjust C_1, etc. doing this a few times to work your way to a good match.

An L-type circuit (e.g. just L and C_1 or C_2) is often all that is needed to match a 5/8-wave antenna, so if need be one capacitor can in principle be omitted (or turned to minimum capacitance). However, the extra complexity of the π-network means that it can in principle cope with a wider range of reactances that might be present on experimental antennas (especially on my short 40m antenna). A π-network also acts as a bandpass filter, which is useful to reduce unwanted signal transmission and always useful, of course, on receive.

Junk Box Circuit

I had a few large spaced variable capacitors that I have collected over the years so I decided to use the widest spaced caps I had that were clean and of the correct physical size to go in the box I happened to have. I wanted to use wide-spaced variable capacitors to cope with high voltages that might be present when using 100W from my IC-706 transceiver.

I built the ATU into a standard metal diecast box (ca. 190 x 120 x 76mm). I fitted an SO239 socket on one side for the 50Ω input and used two 4mm sockets and two 4M bolts (with two washers and butterfly nuts) to secure the radials. The antenna was connected via a 4mm plug-socket and also a screw binding post (yellow in photo, **Fig. 4**).

Range of Coils

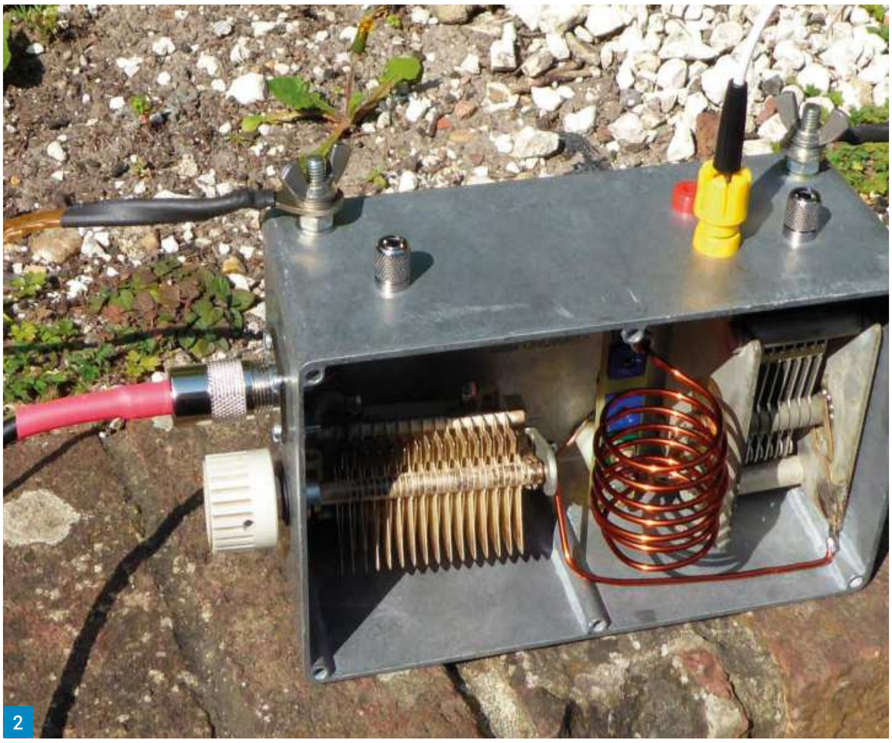
Because of the relatively small capacitance range of my particular capacitors, I chose to make a range of coils to slot into the ATU to provide a good coverage, **Fig. 5**. They are much cheaper than the capacitors and easier to make than tuning capacitors. I simply plug in one I think might work for the band I am using and try a smaller, or larger coil, if that does not manage to tune up correctly.

Band (m)	5/8 wave (m)	1/8 wave (m)
40	26 m	5.2 m
20	13.2	2.6
18	10.4	2.1
15	8.9	1.8
10	6.6	1.3

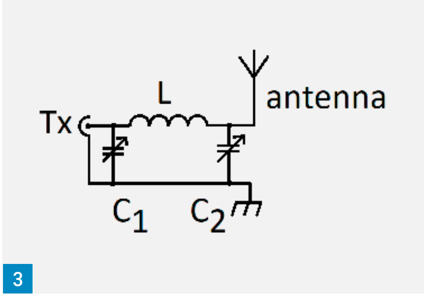
Table 1: The ideal lengths of the 5/8 wave wire along with the 1/8 wave radial lengths.

My first attempts were frustrated with the coils getting in the way of the tuning capacitor vanes so I needed to make sure the coils were held securely and stayed where they were put. I cut a short piece of fibreglass printed circuit board (copper removed) to take four sockets in a line. These were connected in pairs so that a range of coil sizes (lengths) can be accommodated when pushing the coils in from above. Two bolts with support collars supported the socket board.

Each coil had a pair of plugs soldered to them. I had a number of good quality silver plated plugs and sockets in my 'junk box'



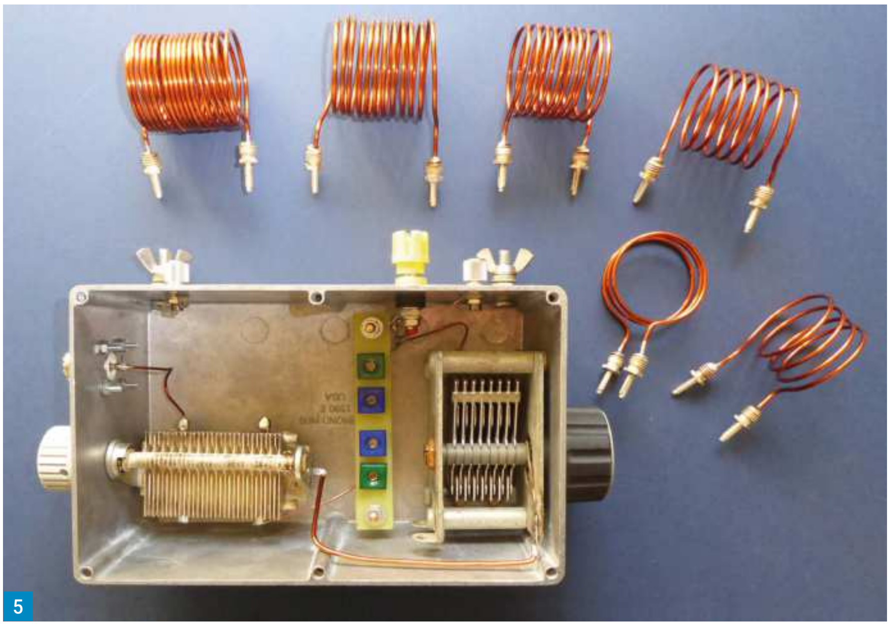
2



3

4

Fig. 2: The π-network ATU: the coax lead on the left goes to transceiver, there are four earth radials in pairs attached to the butterfly nuts, the antenna can be connected to the red 4mm socket or (as shown) pushed (or trapped) in the 4mm yellow screw connector socket. On the left you can see one of the variable capacitor tuning knobs (other cap knob is on the right and out of shot in this view).
Fig. 3: π-network matching
Fig. 4: Close up of the butterfly nut arrangement to connect the earth radials to the ATU, there is also a 4mm socket-thumb screw type connecting post. Both are connected directly to the common earth of the metal box.
Fig. 5: The π-network ATU surrounded by a selection of plug in coils that should allow 80m to 10m band operation. The coil sockets are wired in pairs (top two joined together, bottom two joined together) allowing a range of coil sizes to be accommodated.



5

and found they worked very well. I made up six coils: 3, 4, 6, 11, 14 and 17 turns to cover 10m – 80m bands. They were all about 4cm in diameter, 14SWG copper enamelled wire (wound on a piece of water outlet pipe as a former).

A Note on Variable Capacitors

I haven't suggested you use any particular type of capacitor in this design, partly because they are expensive to buy new and not always easy to get. The idea is to use the simplicity and versatility of the plug-in coils to provide a wide matching and frequency range as they are far easier and cheaper to make. As a consequence, use almost any good quality large spaced variable capacitors you can get (e.g. on eBay, junk sales, etc.).

Waterproofing

Keeping matching circuits and antenna connections water free is a real challenge for all home made outside installations. I only erect my antennas when I want to use them (they are not permanently 'up') so I only need a portable-type installation that can keep out the weather for a relatively short time (i.e. the issue will be rain rather than long-term damp).

The ATU metal box I used could be made water resistant using an o-ring seal (the lid happened to have provision for this) but the capacitor spindles don't have this facility. I didn't want to use the lid because I wanted easy access to change the coil, so I decided to house the diecast ATU unit in a small Tupperware (or Really Useful storage) crate and simply snake the antenna wire out through the lip of the box. I shrink-wrapped the ends of antenna wires and earth radials and shrink-wrapped the solder tags after soldering. Water proofing sealant 'paint' is also very good (eBay).

Tuning-up

It's handy to use an antenna analyser close to the ATU to set everything up and get the best match possible. Once tuned up I connect my main coax lead back to my radio room. If you use your main transceiver to set the SWR, then do these adjustments on low power. Note: once the ATU is set this way, changing the length of the coax run should not affect the SWR greatly – it's a good test to check everything is working properly. If you do get very different SWR readings when you add in a line of coax, check the earth radial connections.

On Air Tests

Initial tests with the 5/8 wave on 20m antenna from the UK to Spain and Finland have been really very encouraging.
I found that the ATU settings were not too sharp and could usually go a few tens of kilohertz either side of lowest SWR (to dodge noise and stations that might pop up on frequency) without having to go outside and re-tune the ATU.
The 40m and 80m band helical antenna seems to load up very well and so far results have been very promising (despite the relatively poor earth system on these bands).

Note: any updates will be posted at: **www.g1exg.co.uk**

The Drama at Drake

A short tale of the rise and fall and rise of Drake Radio.

Ray J. Howes G4OWY/G6AUW
g4owy6@gmail.com

The drama at R L Drake radio was real. A tale of tragedy, engineering excellence and obsession. An American company that would go on to manufacture some of the most famous and beautifully-crafted amateur radio HF rigs ever produced, yet 50 years or so after they were manufactured, still eagerly sought after by radio amateurs worldwide. Many buyers still happy to pay more than they had originally cost when brand new in order to own one. So, the stage was set. The 'actors' were ready to perform their future semi-miraculous transformations of the radio art. But, the embryonic Drake 'magic' first began while America was immersed in the great economic depression of the 1930s, when R L Drake left the University of Cincinnati with an engineering degree gleefully tucked under his arm.

For men like **Robert Lloyd Drake**, and others like him, many of whom would one day be drawn to work for Bob Drake like eager wasps to a jam jar, it was a time of limitless opportunity. A time to help shape the times they lived in. A time to hatch a plan that would, like Collins Radio, bestow on R L Drake the ultimate accolade, that thousands of radio amateurs worldwide still consider its HF transceivers to be some of the best engineered amateur radio products ever manufactured. And some of the most cherished rigs too!

When Bob Drake left university, armed with his electrical engineering knowledge and a smattering of communications technology prowess, it wouldn't take him too long to find employment. Bob Drake's first employer was *Dayton Radio,* known colloquially as *Dayrad.* Drake though, was eager to enter the then cutting edge of electronics, which at that time meant aviation electronics – avionics. He soon found himself working for **Bill Lear** at *Learavia* (he of *LearJet* fame). And like Lear, Drake too, would be an innovator. However, money would never be the prime motivation. Bob Drake was consumed by his passion to think out of the box to bring forth far different engineering outcomes, even if it meant taking financial risks to gain eventual commercial success. But these were to be future times when the likes of Hammarlund, for example, would build huge HF rigs that could probably defy a nuclear explosion. Bob Drake had slightly smaller ideas. He left *Learavia* in1943 and founded R L Drake Co.

1

Early Days

Those smaller ideas had taken place before WWII. Bob Drake had been busily designing and building hand-built bandpass filters. He was selling these to his fellow radio amateurs who were happy to buy them. Back then, nearly all things radio were knocked up in the shack or the kitchen table. Drake saw an opening in the market for equipment that would transform receiver performance. Installing one of his filters into the signal path prior to the high-gain stage in a receiver transformed its signal performance. Hence, the bandpass filters. They were flying out the door like ice-cream on a hot summer's day.

As is a truism of modern warfare, technology and electronics is usually a grand recipient. So, 1943 was, for Bob Drake, a goose that laid a small golden egg moment. The cash began to roll in as R L Drake Co produced and supplied filters designed for the American military equipment market. Drake had also designed and built a jamming device that prevented German Panzer divisions from contacting their command and control chains. Apparently, a filter was demanded (subsequently rejected because of a design anomaly) by the American top brass to remove the jamming characteristics of the filter!

Drake's first entry into the radio receiver business happened as the war ended. The BC-1255-A, a three-valve receiver covering 70-150MHz, was built under licence. The last time I looked for one, the *R. L. Drake Virtual Museum* had an example on show. A strange looking receiver but, in a spooky way, its shape was a prophesy of what the first amateur receiver, the 1-A, from R L Drake would eventually look like.

Post-War

The trouble was, after the war ended, it wasn't all roses around the door for Mr Drake. Finances were tight. And the US economy was in a mild meltdown. Consequently, Drake took in work for other companies in the electronics field, if only to keep his head above water and to ensure a continuation of work for his employees. Although the near future looked ominously precarious, amateur radio was about to rescue Drake from the doldrums. Amateurs began to slide away from Morse code as the only means to communicate. AM (amplitude modulation) was now being embraced enthusiastically.

During the early 1950s, all the major radio manufacturers at the time – HRO, Hallicrafters and so on – were busily churning out receivers and AM transmitters to satisfy a demand for factory-built rigs. Bandpass filters (such as the circa 1940s F15/U) were yesterday's products. In came the Drake *Q*-multipliers and product detectors, which Drake designed for Collins radios, primarily a device to enhance SSB (Single Side Band) reception. Then, during the 1950s, up popped a Drake device (High-Patch), which enabled an amateur transmitter and receiver to be 'patched' to a telephone line. This proved to be popular. People with access to amateur radio equipment could now talk to whoever for free!

(***Ed's note***: *this is a whole other story. Phone patch, illegal in the UK because it would contravene the Post Office's monopoly, was allowed in the US and embraced by radio amateurs who would perform a public service by allowing relatives, friends and neighbours to make long-distance and international phone calls, in the days such calls over the Bell network were expensive and often difficult to set up)*

Success meant a move. In 1953, Bob Drake W8CYE upped sticks and moved into a building in Miamisburg, Ohio. Here, **Milt Sullivan**, a talented electrical design engineer, would join the 'family firm' of R L Drake Co. Milt stayed with Bob's company until Bob Drake sadly passed away in 1975. With a talented collaborator on board, it was time to take more risks. To shake up the status quo that then existed on the amateur radio air-waves, where AM reigned supreme. Where the majority of radio amateurs hated change. But, more importantly, hated the new kid-on-the-block with a vengeance. Namely, SSB.

2

3

Embracing SSB

However, the visionary Bob Drake, embraced SSB. He saw all the positives rather than its negatives. Of course, he would be proven right (as did his contemporary, **Art Collins W0CXX**). Milt and Bob were on course to bring about a sea-change in current attitudes that predominated amateur radio thinking. That SSB was too difficult to understand and to implement, and suchlike. So, confined at home for a while, he busied himself with the design of an SSB-only receiver. It would be called the Drake 1-A. It hit the amateur radio stores during 1957, priced at $259.00.

Unfortunately, its shape did not inspire love at first sight. But its performance did. Much lighter than its competitors' receivers at about 18 pounds, with 11 valves (6BY6s, etc) and Drake's innovative product detector, amazing sensitivity and a few less knobs to twiddle, amateurs wanted one. This product would set R L Drake on the road to being a main manufacturer of amateur radio gear. However, to meet demand another move was imminent.

During 1958, the company again moved to bigger premises. This time, Richard Street, Miamisburg, Ohio. Here, there was plenty of space for a larger production line. This would soon sorely be needed, because Milt Sullivan and Bob Drake would soon amaze the amateur radio world with what is arguably, one of Drake's best-known designs for a valve type SSB/AM receiver, the legendary 2-A. With triple conversion and crystal controlled heterodyne oscillators, it worked a treat. Amateurs and shortwave listeners adored it. This time, though, it didn't buck the then prevailing rig shape. And it cost about the same as a 1-A. The Drake 2-B appeared in 1961. But not without problems. Bob Drake had tried to subcontract out production but with no takers.

Like Hot Cakes

Like the upcoming Drake TR-3 and TR-4 transceivers that would cause a storm of appreciation and wonder, the 2-B sold like hot-cakes. Not surprising really. It was a far better beast of a radio. It had more glamorous gizmos to twiddle with. SSB by then had taken off big time. And most, if not all of Drake's happy customers were looking to Drake to pull yet another rabbit from the hat. But to ensure that R L Drake kept afloat, it meant that Bob Drake was forced to take a back seat in respect of design and engineering. Reluctantly, the role of chief engineer was passed to his bosom buddy and partner in all things engineering-wise to Milt Sullivan. Bob Drake kept his hand in, though.

Another new receiver made its entrance in 1967. The 2-C, designed this time by an engineer called **Ray Midkiff**. Again, its shape and look would be echoed in the next exciting product from the Drake stable. It wasn't popular, due no doubt to the fact that Drake put a transmitter for the Novice licensee on sale at the same time, the 2-NT. It seems that maybe bit of amateur radio snobbery killed it?

But what all avid Drake fans were really waiting for appeared in 1963. Drake's first amateur HF transceiver, the TR-3 (a PSU, the aptly named AC-3 was available). Milt Sullivan had wholeheartedly met Bob Drake's vision for an amateur product that would ensure his company's future. Beautifully engineered and built to withstand the sometimes cruel treatment that some over-zealous owners would throw at it, it was almost bomb-proof. Costing $550, running 300W PEP SSB and about 250W on CW and AM, it used TV sweep valves and covered the HF bands in 600kHz segments. In passing, there is a rumour that Drake manufactured a few TR-3s with a chrome-plated chassis. Not the common bog-standard copper chassis. If you find one, you've happened upon a rare Drake rig that someone might give you a bundle of cash to own.

Come the late 1960s, it dawned on Bob Drake and Milt Sullivan that transistors were the new cutting edge. Valve rigs were heading for their last hurrah. So, again, enter the talented Mr Midkiff, who (Midkiff was instrumental in instigating a new printed circuit board technology, which ultimately would transform its rig production methodology), was charged with replacing the valve VFO with a transistor variant. This he did, overcoming many design and engineering difficulties. He designed an all transistor PTO (Permeably Tuned Oscillator). This unit would be used in all Drake rigs up until the ubiquitous Japanese 'black boxes' took over the US amateur radio market many years later.

Management Style

Perhaps at this juncture I should note that Bob Drake embraced a paternal approach to his workforce, especially, his female employees (several YL operators were used in R L Drake advertising). Not, of course, that his male employees were sidelined. On the contrary, some were given free reign (within limits) to follow their hearts' desire, engineering-wise. At Drake, it was one big family, with Bob, as the surrogate dad.

4

The TR-4 and Successors

The TR-4 took over where the TR-3 left off but with a few more bells and whistles. The Drake rig(s) that really caught the imagination, though, and are still famously and fondly remembered today, are the so called original 'Drake Twins', the T-4X and R-4A. And like the TR-4, which became a TR-4C, TR-4CW and so on, the 'Drake Twins' became the R-4C/T-4XC. They remained outwardly the same looking rigs, instantly recognisable as Drake rigs at a glance and all still beautifully built with loving care. A linear amplifier, the L-4, running 2000 watts PEP, was available for those amateurs who preferred to make themselves heard come what may. An L-4B PA was introduced during the 1970s.

Numerous receivers popped up too. The R4, R4-A, R-4B/C etc. Again, all matching a similar build shape as the transmitters and transceivers. And as I mentioned, amazingly, many of these rigs are still working decades later, still giving on-air joy to many Drake owners worldwide. Built to last but, no doubt, not Bob Drake's original design intention?

Disaster Strikes

Then, in 1975, a thunderbolt struck. Robert Lloyd 'Bob' Drake Sr died. He left behind a wife, three sons and one daughter. All his employees were devastated. Their boss, mentor and friend had gone. However, a brand-new operational epoch was to begin. Risk, hated by Bob Drake Sr, would now be fully embraced by his son, **Peter W Drake**, appointed the new Drake CEO (Chief Executive Officer). Expansion was the goal.

To that end, Peter and **Ron Wysong**, the amateur product chief engineer, began a recruitment drive for electronic engineering talent. Subsequently, **Jim Jaeger** and **Mike Elliot**, who'd worked at Heathkit and Collins Radio, were given the task of plucking yet another rabbit from the proverbial hat. This was to be an all solid-state synthesised HF amateur transceiver, a rig that would knock the socks off the competition. Yes, you've guessed it, the futuristic looking TR-7. Radio amateurs drooled over it. They had to own one, now!

However, blood sweat and tears wouldn't be enough to bring this rig to reality. The big problem for Drake was the total transition from valves to all solid-state. The seemingly eccentric engineer extraordinaire Jim Jaeger and Mike Elliott would eventually crack the problem. They both knew that up-conversion frequencies, sky high IFs, spurious emissions and phase noise were a minefield, but part and parcel of designing a stable synthesiser. Then a transistorised PA had to be tamed and shamed.

Months passed by, the seeming insurmountable engineering problems solved, the TR-7 hit retail amateur radio shops during 1978. Rolling off the production lines at 540 Richard Street and eagerly bought by Drake aficionados worldwide, it was generally perceived as a triumph. But the TR-7's reign didn't last long. The TR-7A and R7A stole its thunder.

Fig. 1: The Drake 2B receiver. Fig. 2: The classic R-4C. Fig. 3: The matching T-4XC. Fig. 4: The L-4B linear amplifier. Fig. 5: The TR-4C transceiver. Fig. 6: The TR-5. Fig. 7: An ad for the TR-7 and R-7.

Although the TR-7 was an awesome rig, it hit a brick wall price-wise. Japanese transceivers were cheaper and almost as good. So why should anyone (other than Drake fans) buy one? Hence, in 1982, out came an improved TR-7 with all the extra bells and whistles, costing a bit more cash. The ploy didn't work. Besides, the amateur radio market had downsized. Unsold TR-s and TR-7A's began to form a mountain of unsold rigs! An amateur radio dealer subsequently bought a big pile of them for a large discount. It was sad times for the RL Drake amateur rig business.

5

6

The TR-5

By way of a last goodbye, Drake advertised a TR-5 HF transceiver during 1983. Basically, a cheaper cut-down version of the TR-7. Unfortunately, although a joy to operate, when it worked, it was beset with internal problems and it didn't sell well. Unlike the TR-7/A's superior internal architecture, the TR-5's similar circuit module connectors, by comparison, were strewn with a myriad of cabling issues, sometimes, even out of the box brand new! These issues were eventually solved but the damage had been done. The TR-5 was tainted. But it was a great radio, if flawed.

Come 1984 (Drake re-entered in 1997, with an esoteric 2m rig, the TR270), Drake pulled out of the amateur radio market. It was a good decision. Anyway, trying to compete with Japanese built rigs would have spelled doom for the whole company. Drake had sensibly entered the booming home style satellite receiver marketplace in the 1970s but, again, that market changed dramatically too.

Drake branched out into the audio-visual sector (then introduced its 1997 *AudioAccent* RF technology and Drake *Digital Transcoder* packages in 2002) and cable TV equipment. Nowadays, Drake is owned by *Blonder Tongue,* a major manufacturer (Franklin, Ohio) of equipment for TV broadcast stations. But the Drake name still shines on brightly.

But Drake Rigs Live On

Bob Drake's company manufactured thousands of amateur rigs, but the astonishing thing is, lots of them are still working and providing communications for those who covet them. One day, even though built like a battleship, these rigs will die and be just a fond memory.

Fortunately, that eventual demise will probably be a long time coming. Mainly because far too many love and own Drake equipment to let it be forgotten! So, until the last Drake rig has finally given up its last part to keep another up and going and on the airwaves, the amateur bands will sing with the sound of a Drake rig some place somewhere.

Finally, in an ironic twist of fate, there was to be a Drake TR-8, a super-duper DSP version of the beautifully proportioned TR-7. An HF transceiver that would propel yet more Drake fun and magic into the 1990s and beyond. Two design engineers, **Steve Koogler** and **Neil LeSaint**, were the people destined to bring the TR-8 to a fruitful launch. However, the whole TR-8 show was shelved.

The prototype was boxed up and given an ignominious send-off. Such were the dreams of thousands of dedicated Drake fans, which were so cruelly crushed that day. But don't fret. Out there in amateur radio land, plenty of pre-loved Drake rigs of various 'flavours' are seeking new owners to perform with. (with thanks to **Ron Baker WB4HFN** for the photos accompanying this article)

7

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

1

Radio at Depth (Part II)

Mike Bedford, G4AEE, continues his examination of sub-surface communication by looking at alternatives to LF for cave radio, and at methods of communicating between underground locations.

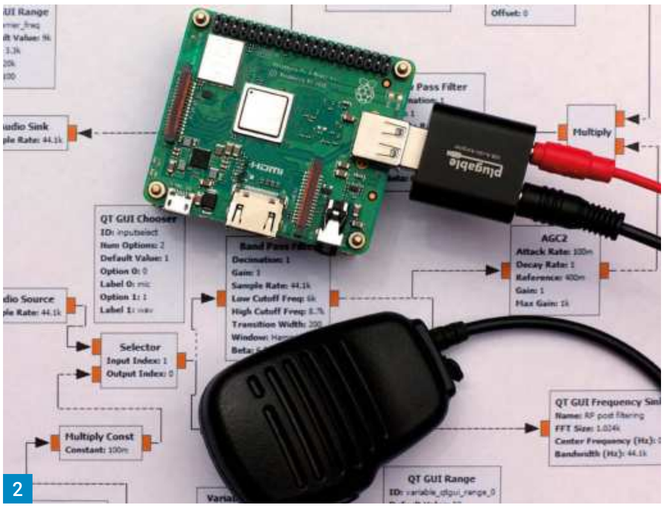
Mike Bedford G4AEE
practicalwireless@warnersgroup.co.uk

Cave radios, operating in the LF portion of the radio spectrum, can communicate to a depth of several hundred metres through limestone. This provides a valuable service for cave rescue teams in their quest to save those who get into difficulty underground, as we discovered in part one of our investigation into sub-surface radio (*PW* September). This month, to conclude our introduction to this unusual and fascinating area of radio communication, we'll address two further subjects. First, we'll look at how different frequency bands offer several potential benefits compared to LF. And second, we'll delve into alternatives to through-the-earth radio for communicating between two underground parties.

VLF Cave Radio and Below

Last time we saw, in passing, how the higher conductivity of coal measures, compared to limestone, means that VLF or ULF is needed, instead of LF, to provide emergency communication in collieries. The negative impact of geology first manifested itself to cave radio enthusiasts following an invitation, by Network Rail, to provide advice on communication in a long-disused railway tunnel for search and rescue operations. While recognising that this area of the Pennines certainly wasn't limestone country, having used LF cave radios successfully in an archaeological copper mine in Cheshire, an old tin mine in Cornwall and a working gypsum mine in Staffordshire, the team was reasonably confident of success at the Standedge Tunnel, despite the different geology. How wrong they were. Using an 87kHz HeyPhone, which was capable of operating through 1,000m of limestone, a surface station tracking an underground station from the East Portal lost contact just a few hundred metres into the 4.75km tunnel, at which point the ground cover was less than 100m. Perusing a geological survey map revealed alternating layers of gritstone and shale, the latter being several orders of magnitude more conductive than limestone. Clearly a considerably lower frequency would be needed.

Prompted, in part, by amateur experimentation at VLF and below, and with the motivation of providing communication where LF fails, cave radio experimenters have recently turned their attention to the bottom-end of the radio spectrum. An LF cave radio can make do with a comparatively small loop antenna but, down at VLF, ULF or SLF, loops would have to be huge to achieve resonance, and this hampered the very early experiments into baseband cave radio. Using a ground-



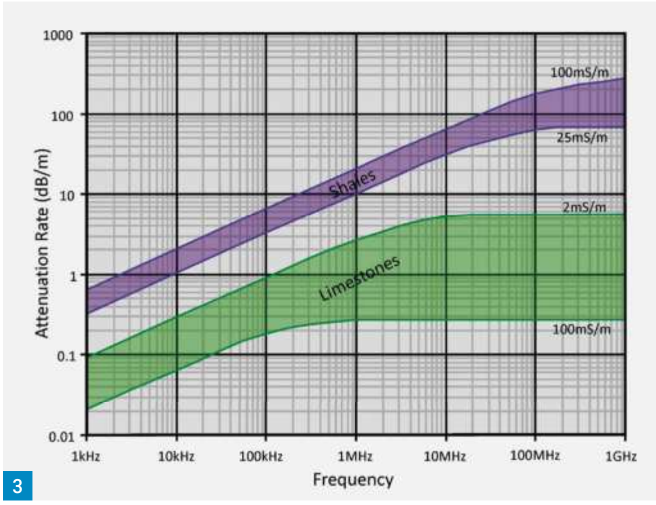


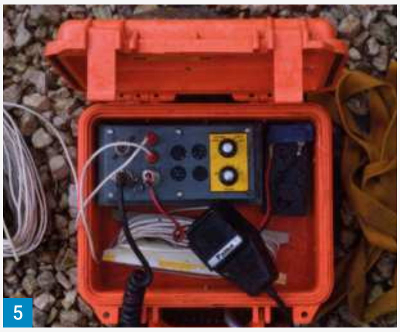
Fig. 1: Yordas Cave isn't typical, in allowing a full-sized 80m inverted-V to be erected, nor is it very far underground, but being able to make a 2 x SSB contact with a station 340km away was remarkable. (Ian Cooper) Fig. 2: Rob Gill G8DS and Robin Gape G8DQX are experimenting with the use of a Raspberry Pi as a software defined SSB radio operating on 9kHz. (Rob Gill) Fig. 3: Attenuation doesn't continue to rise with frequency but starts to flatten off as the rock becomes a poor conductor at higher frequencies. Fig. 4: HF antennas are much shorter than usual underground, because of ground proximity, but they still pose a challenge in confined cave passages. (Gregory Collins)

ed dipole, however, which is now standard procedure at LF, all this changes and a portable rig becomes feasible. Also, very different from the early days of cave radio is the transmitter and receiver circuitry. A software defined radio approach is being pursued and minimal hardware and computing power is needed. In particular, Raspberry Pi hardware is being used and the transmitter and receiver are being implemented using the GNU Radio Companion, which allows the architecture to be defined by wiring up functional blocks on screen. The current prototype is an SSB radio at 9kHz, very different from amateur experimentation at VLF. This is feasible, though, because of the use of magnetic induction instead of true radiation, thereby offering negligible potential for interference to the very narrow bandwidths normally used at VLF.

Going Higher

It has long been believed by cave radio enthusiasts that a frequency in the LF part of the spectrum is needed to achieve adequate signal penetration through the rock. But things aren't quite so simple. While the attenuation increases with conductivity and frequency, it's not correct to believe that the relationship is always one of direct proportionality. Attenuation is only directly proportional to frequency if the rock is considered a good conductor. We're not going to get embroiled in the maths here, but let's just say that rock ceases to be a good conductor as the frequency increases and this causes a graph of attenuation against frequency to start to flatten off. The bottom line is that higher frequencies aren't attenuated as much as the naïve theory predicts, and in limestone this suggests that frequencies as high as a few megahertz could be effective. It certainly won't be true, for example, that a 3.5MHz signal would be subject to 40 times the attenuation of one at 87kHz, as the ratio of those two frequencies might suggest.

With this in mind, radio amateurs have been engaged in HF cave radio experimentation. After all, there are several potential benefits, as well as some unique challenges. A major difference between LF and HF, especially in a constrained cave environment where antenna sizes are severely limited, is that an LF cave radio operates by induction, while at HF true radiation will occur. This, in turn, means that attenuation follows an inverse square relationship, not the inverse cube law that so much limits the range of LF cave radios. But if the purpose of a cave radio is just to provide a link between an underground party and any point on the surface, does an increased range really offer any practical benefits? Actually, we can envisage a couple of advantages. Imagine, if you will, a cave rescue team member given the job of remaining in touch with the underground party, which requires him to spend hours on a windy hillside, at night, in a snowstorm. Now, imag-



5

Cave-Proofing

According to public perception, caves are pretty hazardous to people, but it's probably fair to say that electronic equipment fares much worse in the underground environment. First, caves are wet while electricity and water don't mix. Second, they're muddy with the potential for sockets and pushbuttons to get clogged up with dirt and grit, and third, caves are frequented by cavers. As electronics enthusiasts, many of the people illustrated in this article have taken laptops, amateur radio rigs, smartphones and test equipment into caves without mishap, other than the odd muddy fingerprint or two. But if you're designing equipment that's going to be used by ordinary cavers, things are quite different. After all, if you're abseiling down a vertical shaft, crawling through a tight passage, or traversing along a narrow ledge, the welfare of any kit you're carrying is likely to be well down your list of priorities. The bottom line, therefore, is that knocks, scrapes and drops are to be expected.

So, while recommending that any equipment is always carried into a cave in a protective case such as a Pelicase, and suggesting that it's always put away before moving on, it has to be built to take some punishment. And however much effort you put into this aspect of the design, you have to face the inevitable fact that caving equipment will have a shorter lifetime than equipment that's going to be used in a more benign environment.

6

Fig. 5: If you're building equipment that's going to be used underground, it has to be designed to take some knocks, oh, and a good soaking too. (Mike Bedford) Fig. 6: HF cave radio provides much greater coverage than LF. Red: Stations received from 100m underground. Blue: Reports received for signals transmitted from 20m underground. (Map Data ©2016 Geo-Basis/DE-BKG (©2009), Google Inst. Geogr. Nacional) Fig. 7: Following successful tests at 1.3GHz in Standedge Tunnel, where VHF and UHF had failed, tests with 802.11g WiFi equipment, at 2.4GHz, provided data transfer over the entire 4.75km, compared to 350m above ground. (Mike Bedford) Fig. 8: Juan Corrin with the drone he adapted to explore areas of caves that are otherwise only accessible via a potentially fruitless climb. (Mike Bedford)

ine that same surface operator, this time in a warm vehicle on the closest road. The difference between these two scenarios could well be the difference between using an LF and an HF cave radio. The second benefit of a greater range is to provide cavers with warnings of adverse weather that could result in underground flooding. Some expeditions do indeed remain in contact with underground parties but, realistically, it's just not going to be feasible for cavers to regularly be in contact with a surface party which, at LF, would have to be in the immediate vicinity. At HF, on the other hand, while the regulatory issues would need to be addressed, from a purely technical viewpoint, we can imagine a regional warning broadcast scheme.

So, it appears that there might be benefits, but is through-the-earth radio really feasible at HF? Current experimentation suggests that it most certainly is. Working at 3.5MHz and 7MHz, radio amateurs have been able to replicate the through-rock performance of LF cave radios, but the surface station doesn't have to be rooted to the spot, pretty much vertically above the underground party. In early tests, a team one hundred metres underground was able to remain in voice contact with a mobile surface station as they drove away from the cave to a distance of over five kilometres. Using slow speed data, however, much more impressive results were achieved, especially on the downlink. However, since the purpose of this work is to offer real-world benefits, slow speed Morse at one word per fortnight was dismissed in favour of WSPR for initial tests. Operating on 7MHz in the Valley Entrance of Kingsdale Master Cave in the Yorkshire Dales, a station 100m below the surface was able to receive 17 stations in nine countries, during a period of about 30 minutes, the most distant being in Sweden at a range of 1,327km. No reception of signals transmitted from this location was reported. However, better uplink performance was achieved from another North Yorkshire location, Short Drop Cave, even though there was less rock above the underground station. In particular, reports were received from stations in Liverpool, London and Southampton, the latter being at a distance of 370km. However, the most impressive result, to date, was from another Yorkshire Dales station, this time established in Yordas Cave. To be honest, in being a huge cave chamber, capable of housing a full-sized 80m inverted-V, this cave is by no means typical. It is also easily accessible from the surface, and it's only a few tens of metres underground. However, underground it is, and an SSB contact was made with a station in Ipswich, at a range of 340km.

Along-Passage Communication

As an alternative to through-the-earth radio, other methods are available for communicating between a cave and the surface or between two underground locations.

7

What's more, some of them have rather more in common with ordinary radio. Hang Son Doong in Vietnam is the world's largest known cave. The main passage is over 5km long with parts reaching up to 200m tall and 150m wide. Some of the huge chambers have collapsed roofs, thereby allowing tropical jungle to become established underground. In 2015, Swedish photographer **Martin Edström** led a 50-member expedition to undertake a photographic project on behalf of *National Geographic*. With members of the party who handled the several immensely powerful lights needed to illuminate these vast spaces being several hundred metres from the core photography team, communication was essential. Handheld VHF or UHF radios provided excellent service, with propagation in large cave chambers providing the same line-of-sight performance as in open air. Propagation along cave passages, on the other hand, is entirely different.

You'll recall that through-the-earth LF cave radios failed to work satisfactorily at the Standedge railway tunnel. The request by Network Rail to investigate communication at this location was prompted by their observation that VHF radios had a range of just 300m in the tunnel, and while this increased to 1km with UHF PMR 446 radios, this wasn't nearly sufficient to provide communication throughout the tunnel, even with an operator at both ends. The solution eventually offered by cave radio experimenters was a microwave link, following a demonstration that 23cm (1.3GHz) amateur radio equipment could communicate from end to end through the entire 4.75km of the tunnel. So, with this example of how microwaves can provide communication along a railway tunnel, and with the question of whether the same can be achieved along a cave passage, it's time to take a look at the theory of tunnel communication.

Some Theory

Waveguides are the hollow metal tubes that are used as feeders instead of coax for use with high power microwave transmitters. A key characteristic of a waveguide is its cut-off frequency, which depends on its cross-sectional dimensions, and is a measure of

8

Other Electronics Applications

Although our theme here is cave communication, there's a fair chance that amateur radio enthusiasts have an interest in electronics more generally. And the fact is that electronics in caves goes a lot further than providing communications capabilities.

In cave photography, the only light available is whatever you take with you. So, for artistic effects with multiple flashes, slave units, designed for use in caves, trigger additional flashes when the flash on the camera fires. An interesting development a few years ago was the triggering of multiple flashes in quick succession to simulate a long burn time and so impart a feeling of motion to running water. And recently, there's been interest in triggering a camera plus both visible and ultraviolet light sources to photograph calcite formations normally, while fluorescing, and while phosphorescing.

For cave surveying, cavers have been at the forefront of development of portable electronic aids and software, and have more recently developed laser scanners that can capture a full 3D model of cave chambers and passages at a fraction of the cost of commercial equipment.

In the realm of cave science, there has been considerable interest in rolling out data loggers that can be used to monitor environmental characteristics such as various gas concentrations, temperature, pressures and so much more. And finally, although there's much, much more, turning to a fairly new theme, we've seen quite a lot of work involving the use of drones and other robotic vehicles for cave exploration.

9

Fig. 9: Mike Bedford, G4AEE, uses a spectrum analyser to monitor propagation at 5.7GHz along a low passage in Kingsdale Mater Cave, Valley Entrance. (Mike Bedford)

the lowest frequency that will propagate. Tunnels also behave as waveguides, but with a difference, because their walls are not perfect conductors. In particular, in being imperfect so-called lossy waveguides, the cut-off is not a sharp dividing line but a region over which propagation migrates from the waveguide mode to the evanescent mode in which the signal decays very rapidly with distance.

Cave passages are different from the Standedge Tunnel in three main respects. First, except in the case of a few large caves such as Vietnam's Hang Son Doong, cave, passages are smaller in diameter, sometimes much smaller. The implication of this is that the cut-off frequency is higher, and this has been proven by tests in typical British cave passages where the attenuation in straight passages at 2.3GHz and 5.7GHz was lower than at 1.3GHz. That reference to straight passages is important because it brings us to the second difference. Waveguide attenuation is a line-of-sight effect and, although some signal will propagate around corners, that is via multiple reflections and, as a result, the signal suffers very significant additional attenuation. The upshot of this is that contact will usually be lost after two corners and, because of the convoluted nature of cave passages, this might impose a severe limit on the range. And third, cave passages differ from railway tunnels in that their walls are usually rougher, perhaps due to limestone formations or the effects of water erosion, and this will also contribute to attenuation. Taking all these effects into account, natural propagation along most cave passages will be limited to a few tens of metres in many instances, perhaps to one hundred metres at the most, depending primarily on the presence of bends.

A range measured in tens of metres will usually be of no value in providing communication from a cave entrance to an underground party, although there might just be applications where a short-range link between two underground locations could be of value. In most cases, though, another solution is called for. A leaky feeder is a special type of coaxial cable with periodic slots cut in its foil shield. If a transceiver is connected to one end, a transmitted signal will propagate along the cable, as with ordinary coax, but some will leak out through those gaps, just as some water leaks out of a hosepipe with holes. Similarly, this works in the opposite direction, thereby allowing a station close to the cable to transmit a signal back to the hard-wired transceiver. This is not affected by the presence of bends and has a zero cut-off frequency, even though the physical design of a particular cable will impose restrictions on which frequencies will be effective. Leaky feeders are used in road tunnels and metro systems to provide a mobile phone signal where a signal is usually denied.

For use in cave communication, leaky feeders have some serious disadvantages. To make up for the loss of signal by leakage, in other respects the cables are designed to offer as low a loss as is practical. This means that they have a large diameter, they're heavy, and they're expensive, very expensive. However, Italian caver and radio amateur **Fabrizio Marincola I0HCJ** has discovered that some ordinary low-cost feeders, of the type used for TV antennas, and which you'd never dream of using for your amateur radio antennas, will work as unintentional leaky feeders. Working at VHF, this has provided communication over as far as 600m, and more recent tests have suggested that, for cheap coax with a low coverage braid-only shield, 28MHz might offer even better performance. This solution might be attractive, even for surface to cave communication, where access to the ground immediately above the cave, as required for best through-the-earth performance, is not possible.

Getting Involved

If this introduction to cave radio has inspired you to investigate a new and interesting way to employ your expertise in radio, we have good news, whatever your inclination. If the idea of venturing into the underworld fills you with dread, you'll be interested to learn that many radio amateurs have made important contributions to cave radio without ever venturing underground themselves. However, if you consider yourself an outdoor enthusiast, then experimenting with cave radio could provide you with a technical challenge while, at the same time, allowing you to explore a fascinating world of stalagmites, stalactites and underground waterfalls. Whichever category you fall in, we have advice for you.

Caves are not nearly as dangerous as is commonly believed, although there undoubtedly are risks for the ill-equipped, the inexperienced or, very occasionally, the unlucky. For this reason, if you want to explore caves you should make contact with a local caving club who can introduce you to this sport in safety. To find a club, take a look at:

www.startcaving.co.uk/clubs

If your interest is technical in nature, we also suggest that you contact CREG, the Cave Radio and Electronics Group (website below), which is a special interest group of BCRA, the British Cave Research Association. CREG publishes a technical journal, four times a year, and online annual subscription costs just £4.00. *PW* readers are offered three months free online subscription – contact

creg-editor@bcra.org.uk

The group also organises twice yearly field meetings where you can meet up with like-minded people, see cave technology gear in action, and have the opportunity to conduct experiments yourself.

http://bcra.org.uk/creg

Specialist Dealers

Insurance

South West Broking Ltd
HAM RADIO INSURANCE
Call 01454 806503 or
www.southwestbroking.co.uk
enquiries@southwestbroking.co.uk
Appointed Representative of PSP Insurance and Financial Solutions Ltd
Authorised and Regulated by the Financial Conduct Authority. Number 303461

Mid Glamorgan

SANDPIPER AERIAL TECHNOLOGY
Unit 5, Enterprise House
Cwmbach Industrial Estate, Aberdare
Mid Glamorgan CF44 0AE
Tel: (01685) 870425 Fax:(01685) 876104
A full range of transmitting & receiving antennas available for the amateur commercial market.
www.sandpiperaerials.co.uk
e-mail: sales@sandpiperaerials.co.uk

Scotland

TENNAMAST
General Steel Fabrication
Radio Masts | Masts | Boat Cradles | Trailers
A complete range of Multi purpose Masts
The best of Scottish engineering!
Tel: 01505 503824
www.tennamast.com
sales@tennamast.com

Somerset

LINDARS RADIOS
'A Modern Company With Old Fashioned Values'
USED AMATEUR RADIO EQUIPMENT PURCHASED AND SOLD
www.AmateurRadioSales.co.uk
01935 474265

Suffolk

www.itender.co
Monthly communications tenders!
Ex Police Service
General comms company stock
Contact: 07788 498962

TOP PRICES PAID FOR ALL YOUR VALVES, TUBES, SEMI-CONDUCTORS AND ICS.
Langrex
VINTAGE ELECTRONICS
Unit 4, Daux Road, Billingshurst, West Sussex RH14 9SJ
Tel: 01403 785600 Fax: 01403 785656
www.langrex.co.uk
SCAN HERE TO GO TO OUR WEBSITE
SCAN HERE TO GO TO OUR WEBSITE

Classified Adverts

For Sale

USB CAT, CI-V & Programming cables. Control & program your rig from your PC – logging, satellite tracking etc. SiLabs CP2102 or FTDI chipset for guaranteed reliability. For these and more great items go to **technofix.uk** or **www.technofix.co.uk**

CTCSS ENCODER AND DECODER KITS. DTMF kits and modules. Pic development kits. **https://cstech.co.uk**

Valves

VALVES & ALLIED COMPONENTS in stock Ring for free list. Valves/books/magazines wanted. Geoff Davies (Radio). **Telephone: 01788 574774**

Wanted

VINTAGE FIREWORK COLLECTOR. Do not light the blue touch paper and burn British Heritage, private collector will pay cash and collect from anywhere, licensed explosive storage. **Call Tony on 07956 506300**

Repairs

REPAIRS TO RECEIVERS, TRANSMITTERS ETC. New/old, valve/transistor. **Call 07903 023437 for details. www.kent-rigs.co.uk**

To advertise in Practical Wireless
Contact Kristina Green
Telephone 01778 392096
kristina.green@warnersgroup.co.uk

Bargain Basement

For Sale

A SMALL COLLECTION OF: BC-221, BC-221-AH wooden case, BC-221 Black crackle and PSU, TS-174-U same as above but 20-250 Mc/s with PSU (rare). £100 the lot. R-208 "RX Sputnick Special" and case and P/C H/book. GC. 10-60 Mc/s. £100. **Call Peter, G4VUN: 01677 460302**

Wanted

WILL ONLY SWAP for a superlative condition, unmodified octal valve HRO receiver the R106 or 5T. I have a 1938 Torn Eb receiver. Fine example, untouched, works perfectly. Not for sale. **Please phone 01634 891017**

Wanted

RACAL RA-1795 USER MANUAL required. Will pay a realistic price for an original or a photocopy plus all your costs. **Please email anthony.r.watkiss@gmail.com with details.**

Bargain Basement adverts cost just £5.00

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

DISCLAIMER Some of the products offered for sale in advertisements in this magazine may have been obtained from abroad or from unauthorised sources. Practical Wireless advises readers contemplating mail order to enquire whether the products are suitable for use in the UK and have full after-sales back-up available. The publishers of Practical Wireless wish to point out that it is the responsibility of readers to ascertain the legality or otherwise of items offered for sale by advertisers in this magazine.

To advertise in Practical Wireless
Contact Kristina Green
01778 392096
kristina.green@warnersgroup.co.uk

FREE RADIO ENTHUSIAST NEWSLETTER
Receive our free monthly newsletter with news, reviews, offers & competitions
Sign up for yours today at: bit.ly/radionewsletter2020

Your Letters

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

The Foundation Exam

Dear Don,
I thought I'd respond to a comment in your *Keylines* in the October edition, in particular your comment about a pass mark of 19/26 at Foundation. It actually brings up some wider points that deserve an airing. I should also stress that they are my comments, not wearing any particular hat.

How fair and hard is an exam? At Foundation there are 112 syllabus points. That is more than previously because they have been split out into finer detail. We all have different strengths and weaknesses so logically we should ask a question on all of them to be scrupulously fair to everybody.

How hard it is depends on the pass mark and, crucially, the difficulty of each question. At Foundation the aim is a reasonable all-round ability. That means the individual questions are easier but more of them need to be answered correctly. At Full a degree of specialisation is reasonable. The questions are harder than they might otherwise be but the pass mark is lower. That mirrors, in a way, the style many of us will remember from our school exams, answer any five of the eight questions.

Finally, you suggested it was a number of elderly men who wrote the questions. Far be it for me to comment on others, but I did retire from my day job a few years ago. We would love to have questions from younger authors and from both genders. The Exam Group do write a fair number of the questions. My own view is we should be vetting more and writing less.

Alan Betts G0HIQ
Bromley

Dear Don,
I was interested to see the very good article *Riding the radio waves: amateur broadcasting booms in lockdown* in the 'i' newspaper on August 24th. It quoted the RSGB as helping 1,500 new starters in the past four months pass their Foundation exam. Others have, of course, been helped as well by individuals, 'real' local clubs and societies and 'virtual' clubs like Essex Ham who have been running courses online. Often someone needs to be encouraged to take the first tentative steps and in the article featured, a ten year old boy had been supported by his licensed dad.

During early lockdown I was speaking to a friend who was feeling very bored and had an interest in radio from involvement in CB. I gave him some relevant websites, told him about local clubs and sent him a copy of *PW*. We kept in touch and after working hard, he has just passed the Foundation exam at 73 years of age and will be taking out a *PW* subscription as a birthday present. I am also encouraging another friend of a similar age and interests in the same way to have a go as well.

Where we can, we should all encourage and support anyone in these difficult times who shows an interest whatever their age and help to give them a new pastime while also doing our bit to ensure the future of our hobby.

Jon Sones M0AAO
Ipswich

Dear Don,
I feel I must take issue with your piece concerning the Foundation Licence. While I congratulate your granddaughter for her achievement, which I'm sure brings you both closer and much shared enjoyment, I really do not think we need even more dumbing down of the entry criteria for a transmitting licence, just to enable young children to find it easier to obtain. I have no problem at all with children taking up this hobby, and I acknowledge enthusiastically its place as a learning aid for STEM subjects in education (I am a former teacher).

However, what happened to shortwave listening as the entry route to amateur radio? I realise I'm in the older age group now (63) but I started in the hobby at 14, with no electronics interest or mentoring, just a friend of my dad showing a few of us some of the kit and sitting in on some QSOs. I then spent four years as a listener, avidly logging what I could pull out of the noise on first a Hallicrafters receiver and then a Trio JR500. I learnt about antennas under my own steam, and developed my operating ability through being a receive-only station. I occasionally visited a local club with my dad, and a few of his colleagues who were licensed invited me to join them for operating sessions occasionally (we were a GCHQ family). Why aren't newcomers encouraged to do that now? Why is it necessary to get a transmitting licence to do radio? It was concurrent with this that I started taking *PW*, to build myself ATUs, Preselectors, etc from articles in the magazine. Few ever worked correctly but it was great fun! You don't need to transmit to do amateur radio!

As a general point, there seems to be a modern tendency to let things be easily obtained or achieved, such that the value of achievements is reduced to very little. If you can just buy kit and transmit, where is the sense of achievement? It's easy come, easy go. If you don't need to understand that the word 'mandate' refers to a legal requirement, then how does respect for that law become understood? Having to earn the right to transmit, and subsequently gain additional rights by the expense of effort, is something that should be learned as a child, never mind be understood as an adult.

It is the job of an editor to sometimes generate reaction with controversial statements, so be it. However, I should be terribly disappointed if this were to become a policy promoted by *PW*.

Lindsay Pennell G8PMA
Wellingborough, Northants

*(**Editor's comment**: My thanks to Alan, Jon and Lindsay.* PW *policy will always be to encourage folk into the hobby. But the world has certainly changed and, yes, amateur radio nicely supports STEM – Science, Technology, Engineering and Maths. There is, of course, a good reason to catch children in their early teens, because later they become bogged down with GCSE work, start meeting the opposite*

sex and so on. And the opportunity for self-training is there with the progression through Intermediate and Full. I would argue that Foundation should be exactly that – no more than a start in the hobby, a taster if you like. But many congratulations to the 73-year old joiner too – well done. And Alan, while my comment about the questions being written by a worthy committee of elderly men was somewhat tongue-in-cheek, I do welcome your thought that it would be good to get some younger folk involved in the question setting.)

Wartime Receivers and Mains

Dear Don,

I received my copy of your excellent magazine yesterday and was intrigued in particular by the article by **Tony Smith** and *Wartime Civilian Receivers*.

The importation of some 30,000 American-made receivers, 110V of course, the necessity for each one to be painstakingly converted to operate on the 240V of these islands, suggested an idea for a future article in the magazine.

It would be interesting to read about the evolution of the two rival 110V and 240V systems at the end of the nineteenth century and their continuation into the twenty-first century. Why could not nations, scientists and engineers agree on a worldwide system when electricity was first developed and an AC system agreed? What were the arguments and reasoning proposed by the supporters of the two systems trying to increase their relative spheres of influence? As far as I am aware, the 110V system is now limited to North America and the Caribbean.

I subscribe to your magazine and *RadioUser*, although I rarely listen to broadcast radio and have never been involved as a radio amateur. I pass on my magazines to someone with a more active interest in radio, although I do enjoy reading them each month, hence my subscription.

I wish you all the best for the future and look forward to future editions of both magazines each month.

William Read
Stafford

Dear Don,

Tony Smith's article on wartime radios was very good. I am 85 so have seen a few of these sets. In 1949/50 I was an electrician at Sutton Manor colliery in St Helens. A small group of us were on night shift. We had a workshop radio. Two of us went out to do a job and when we came back the radio was in flames. A very young keen workmate had felt the mains lead, which was quite warm. So, he changed it. That's when we found out it was a USA imported wartime radio designed for 110V and fitted with a mains radio mains dropper mains lead. Years later I was looking at an RS catalogue and came across mains dropper leads for these radios. I wonder if any are still around?

Albert Heyes G3ZHE
Warrington

Morse is Dead?

Dear Don,

Back to the days when Morse was used as a serious and primary means of communication and no commercial operator would use anything other than a straight key or a cootie. The natural rhythms of 'real' Morse a mirror of speech and thought. A joy to send and a joy to read. Long before the metronomic tedium of electronic paddles conquered the world.

But today in an amateur world obsessed with speed and operators naively thinking of paddles as 'perfect' Morse, the airwaves are swamped by anything but. And each new generation of transceiver makes the skill more redundant. Morse sent at the touch of a button, callsigns displayed on a waterfall screen, contest numbers sent automatically.

And so, sadly, Morse is dead. Just another digital mode under computer control in bands swamped by endless contests, which are little more than demonstrations of technology. Yet another human skill killed by computers. *"Oh you Luddite – it's progress!"* I hear you cry. Technological progress – true. But it wounds my human soul to see how low our once great hobby has become. And to see people who never knew the joy of 'real' Morse rejoice in their paddles and bugs and keyboards and computers, unaware of the world they have killed.

It is too late. Each year that lucky band, the few who knew the joy of real Morse, gets smaller and smaller. And when they've gone no-one will remember. All that will remain is a diminished world of keyboards, PF keys, computer decoders, and soulless electronic paddles until finally, one by one, the paddle-jockeys go SK, and all that will remain is another digi-mode.

Like the Aztecs and Incas Morse will fade into legend until even that memory will finally die.

I leave you with a final thought – have you ever wondered why the very best, fastest, and most skilled morse over the last century was sent by operators using nothing more than a polished hack-saw blade set into a piece of wood?

Edward Martin M5UF

*(**Editor's comment**: I think one of the reasons for Morse dying out is that many of the post-war Morse operators learned their trade in the Forces or the Merchant Navy, as indeed I believe you did, neither of which trains Morse operators any more. So, yes, hand-sent Morse probably is on the decline. That said, I happen to think I send pretty good Morse with a paddle! And in the* Portishead Radio *book that I reviewed a couple of months back, it's quite clear that many professional operators were more than happy to use an electronic key. I can understand that – my own 'conversion' to using a paddle came after using a straight key in a 48-hour contest. My wrist ached for the following week! So, I wouldn't have wanted to be a professional operator using a straight key for several hours every day!)*

Bonding to Earth

Dear Don,

The misprint in the *Making a start on the 630m Band* article risks safety and needs correcting. The article states *"... do not link the transmit earth and the house mains safety earth."* This should, of course, have read 'do link' the two earths. The *Full Licence Manual* page 16 (RSGB 2018) states *"...you must take adequate precautions. The most common recommendation is to bond the RF earth to the Main Earth Terminal using cable of at least 10mm^2."* Further literature is referenced.

The danger arises with TN-C-S Protective Multiple Earth (PME) supplies. Everything in the house has to be bonded to create an equipotential like a Faraday cage. An open-circuit neutral, not necessarily on the amateur's own premises, allows this cage to float up to as much as full mains potential. The RF ground is still rooted in 'Mother Earth' so possibly 230V now appears between the mains-earthed case of the transceiver and the RF earth terminal coming into the shack from outside.

Don't be fooled by the reassuring-sounding name of the PME system and don't follow published guidance that applies to different systems installed in other countries.

I'm lucky in my pre-War suburban house to have old-fashioned TN-S where earth is just about, well, earth. At least it was where grounded at the transformer sub-station end and my house earth is connected to the armour sheath of the distribution cable. You can tell if it's PME by the absence of a neutral service link.

Godfrey Manning G4GLM
Edgware

*(**Editor's comment**: It wasn't a misprint Godfrey, but you make a good point, specifically where PME systems are concerned. I checked with **Peter G3RZP**, who wrote an article for* PW *a few years ago on the subject of PME. He says,* "Where you have PME, from a safety viewpoint, the radio system earth MUST be bonded to the mains earth. The danger with that is the common impedance between the two allows noise on the mains earth to be effectively coupled into the antenna circuit. To get around this, the bonding connection (which needs to be a substantial conductor) needs to be threaded through a large chunk of ferrite, especially when considering 475kHz. The TT system, with the mains earth totally separated from the radio earth, and a suitably low earth resistance for the premises safety earth is by far the best.

"As an example, the feed to my house has the neutral earthed at few points, including at the end of the run, to a 4ft earth rod at the base of the overhead feed pole in my garden. The house and radio earths are bonded but the neutral floats at whatever..... A few years back, I was having trouble with the RCBO tripping when putting the kettle on. Different kettle, same problem, plus lights dimmed when putting the kettle on. Called the electricity people at 1400, and a man comes out and measures the mains. Tells me that at 234V it's OK, at which I told him it wasn't because it's usually 239V. Then I put one ring of the electric cooker on and the mains was 180V.... I got him to measure the difference between house earth and neutral with the result that the neutral was 50V above the house earth and that in spite of the earth rod in wet Oxford clay. The man said that *"it needs the overhead gang, and they are on a job the other end of Wiltshire!"* They turned up at 2200 and eventually found a high resistance joint between copper and aluminium conductors in the neutral up a pole... on a cold pitch-black night. The nearest streetlight is five miles away! Still, at least it wasn't raining. Had I had a typical PME installation, the return current would have been through mains cables for the rigs!

"Possibly worth noting that this all applies only to the UK, and other countries have different systems and requirements."

I think, in summary, good advice would be, if you run the earth arrangement as shown in the article, then the whole property you're in should be protected by an RCD. Without an RCD you should bond the RF earth to the local mains earth to ensure safety in the event of certain mains faults. Take advice from a qualified electrician if in doubt.)

Protons and Current

Dear Don,

After reading **Tony G7ETW's** letter in the October edition I thought I would re-read **Eric Edwards'** article to savour his alleged faux pas but, far from finding it, I note that Eric does explicitly state that in a metallic conductor the protons do not move. His reputation surely remains intact?

Also, Tony is confining his attention to metallic conductors but there are numerous instances of protons (aka hydrogen ions) acting as moving charge carriers – aqueous acids e.g. in lead-acid cells are a good example.

However, I cannot let Eric completely off the hook! In his October article, he decodes a colour code of black-brown-black as 0.1Ω. It is, in fact, 1Ω (0.1Ω would be black-brown-gold, gold being the 0.1 multiplier).

Richard Hill G8THE
Hastings

Next Month

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

- **144MHz CONTEST RESULTS:** We bring you the results of the 2020 PW QRP Fun 144MHz Contest.
- **VALVE & VINTAGE:** The story of Barbara Dunn G6YL, the first YL operator in the UK.
- **TECHNICAL FOR THE TERRIFIED:** A look at the fundamentals of using transistors.
- **A SIMPLIFIED DIRECTIONAL 40M ANTENNA, PART 2:** Bob Whelan G3PJT completes his design for a 40m directional antenna system.
- **IN THE SHOP:** Headphones, hearing aids and switching diodes all feature in Harry G3LLL's latest miscellany.
- **A FESTIVE ANTENNA:** We have a fun antenna project and challenge for the run-up to Christmas.

There are all your other regular columns too, including HF Highlights, World of VHF, What Next, Kits & Modules, From a Small Station, the Morse Mode and Data Modes.

The publishers reserve the right to change content according to circumstances.

YAESU
The radio

C4FM/FM 144/430MHz Dual Band Mobile

High Visibility and Resolution QVGA Display with Exceptional Operability
Real Dual Band Operation V+V/U+U/V+U/U+V & Simultaneous C4FM Monitoring
FM Friendly Digital : AMS (Automatic Mode Select)
System Fusion II Compatible
WIRES-X Portable Digital Node Function

- Wide Range RX Coverage : 108 ~ 999.99 MHz
- Easy to Operate II (E2O-II) : New User Interface for Easy Operation
- New Memory Auto Grouping (MAG) Function
- New Multi-Channel Standby (MCS) Function
- High-Speed 61 Channel Band Scope
- Easy Hands-Free Operation with Built-in Bluetooth® Unit

C4FM/FM 144/430 MHz DUAL BAND
50 W DIGITAL MOBILE TRANSCEIVER

FTM-300DE

Bluetooth®
microSD Card
AMS Automatic Mode Select
WIRES-X
C4FM Clear and Crisp Voice Technology

YAESU
The radio

YAESU UK Ltd
Unit 12 Sun Valley Business Park, Winnall Close
Winchester, Hampshire SO23 0LB

For the latest Yaesu News , visit us on the internet at www.yaesu.co.uk