www.mymagazinesub.co.uk/practical-wireless

PRACTICAL WIRELESS

INCORPORATING RadioUser

MAY 2026

THE UK'S NUMBER ONE AMATEUR RADIO MAGAZINE

RADIO PIONEER

Exploring the work of the trailblazing radio astronomer, Ruby Payne-Scott

LIKE CLOCKWORK

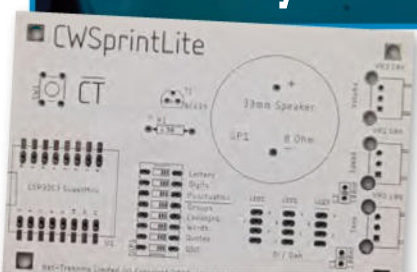
The first of a new series of articles looking at how to service your Freeplay self-powered receiver

The Back Pack Shack

A guide to going portable with a Tatonka Lastenkraxe carrier

The birth of transistors

The work of William Shockley, a pioneer of modern electronics



REVIEW An innovative browser-based trainer

Get to grips with Morse with this inexpensive self-assembly kit

PRACTICAL Making a simple portable power pack

How to repurpose a handy DIY power supply for your outdoor radio needs

THE LATEST NEWS

Radio products & news from around the world

YOUR SAY

Letters from our readers

05
9 770141 085167
WARNERS GROUP PUBLICATIONS
£5.99
Display until 14th May 2026

PRACTICAL WIRELESS
Incorporating RadioUser

May 2026 Vol. 102 No. 5
On sale: 9th April 2026
Next issue on sale: 14th May 2026

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

Advertising Sales
Alex Lyon **Tel: 07350 360313**
alex.lyon@warnersgroup.co.uk

Advertising Production
Kristina Green **Tel: 01778 392096**
kristina.green@warnersgroup.co.uk

Marketing Executive
Rebecca Abbott
rebecca.abbott@warnersgroup.co.uk

Marketing Assistant
Kirsty Westran
kirsty.westran@warnersgroup.co.uk

Publisher
Claire Ingram
claire.ingram@warnersgroup.co.uk

Photocopies & Back Issues
We can supply back issues, but we only keep them for three months. 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.

This publication is printed by Warners Midlands PLC Telephone: 01778 391000

Keylines

I'm completing this *Keylines* from Uganda, where I travelled for the RSGB Commonwealth Contest (still referred to by many enthusiasts as BERU although the Empire is long gone!). I was able to run some FT8 before and after the contest using a very compromise doublet antenna on the roof of the apartment block but struggled during the contest as my KPA500 amplifier failed before the contest started and Uganda is a long way from anywhere!

I did attend a talk in early March by **Larry Bennett G4HLN** (at the Taunton Club) about the Marconi beam stations of Somerset, a topic that has been covered in a couple of recent articles here in *PW* and about which Larry has written a book, which we have reviewed previously. It was a great evening and also a welcome opportunity to catch up with *PW* columnist **Daimon Tilley G4USI**.

3Y0K

Before heading off I was chasing the 3Y0K DXpedition to Bouvet Island in the South Atlantic, a desolate spot if ever there was and one that has stymied several recent would-be expeditions. This one, fortunately, came off OK albeit at great expense as the team, quite rightly, ensured they had the right ship and a helicopter to take supplies ashore. More on the expedition in **Steve G4JVG's** HF column in this issue, but a little more about my own chase. As it happens, I only needed this one on the 12m band, having worked previous expeditions (many years ago) on every other HF band. A few days into the trip I saw they were on 12m but couldn't hear them well enough to make it worth calling. However, the following day they had two signals on the band, one on SSB and one on FT8 (thanks, presumably to good station separation and excellent filters). The FT8 pile-up was enormous and I decided to wait that one out but when I tried SSB I managed a QSO in a little over 5 minutes of calling. Presumably a sign of the times – FT8 is the preferred mode for many nowadays but can, as in this case, be self-defeating.

Having said that, the very next day, they were back and I left the rig calling on FT8 while I worked on something else and kept an eye on things. They had clearly got a bit more organised because they were running four simultaneous streams, and therefore getting through the pile-up much faster than the day before. It still took me the best part of a couple of hours but eventually they were in my log (and I in theirs!). I could head off on my African trip satisfied.

FT2

But that brings me to another topic. You will read in this month's *News* pages about a new variant of the WSJT-X software – FT2. It is twice as fast as FT4 which, itself, is twice as fast as FT8, albeit at the cost of reduced sensitivity.

But, I have to ask myself, what exactly is the point? Do we really need to work stations that much more quicky in order, presumably, to put many more routine QSOs in the log. Indeed, are they really QSOs at all – very little information is exchanged. And, as I mentioned above, for expedition purposes, the use of the MSHV software or the WSJT-X Fox and Hounds allows multiple simultaneous contacts, so the QSO rate is maximised in any case. Indeed, although these programs limit the number of streams to four, I believe the recent Desecheo Island expedition used their own version which allowed five streams.

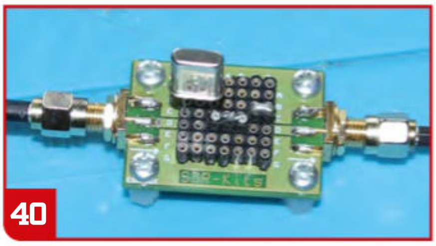
What next? FT1? So fast that the contact is over before it's even started? Certainly we are at the point where the programs are pretty much too fast for operator intervention, so maybe our bands will fill with fully automated contacts taking place 24/7 while the radio amateur fraternity spend time with a pint and a pipe while reading *Practical Wireless*! Or maybe there will be a welcome return to ragchewing (unlikely in these days of free WhatsApp and the like) or, at least, community support activities such as marshalling for sponsored walks, rallies or whatever.

More on FT2, by the way, in both **Tim GW4VXE's** VHF and **Steve G4JVG's** HF columns this month.

Don Field G3XTT
Editor, *Practical Wireless* Magazine

Contents

22



40

Newsdesk

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

IOTA HONOUR ROLL: The 2026 Honour Roll and Annual Listings have been posted on the IOTA (Islands on the Air) website:
https://iota-world.org
Click on PERFORMANCE LISTINGS in the dropdown menu under PROGRAMME INFORMATION. They show the position as of 31 January 2026. The Honour Roll lists the stations with a checked score equalling or exceeding 50% of the total of numbered IOTA groups, excluding those with provisional numbers at the time of preparation. The Annual Listing lists the stations with a checked score of 100 or more IOTA groups but less than the qualifying threshold for entry into the Honour Roll. IOTA rules limit inclusion in the listings to those participants who have updated their scores at least once in the preceding five years and have opted to have their scores published.

THAILAND'S KNACKSAT-2 CUBESAT DEPLOYED FROM THE ISS: Thailand's KNACKSAT-2 satellite is in orbit and operational following deployment from the ISS. The mission continues Thailand's university-led CubeSat development program following the earlier KNACKSAT-1 mission. The project is led by King Mongkut's University of Technology North Bangkok in Thailand, working with domestic and international partners to advance satellite engineering, payload integration, and on-orbit operations.
KNACKSAT-2 was transported to the ISS in late 2025 and is a 3U CubeSat designed to host multiple payloads. The satellite expands on KNACKSAT-1, which demonstrated Thailand's ability to design and build a satellite domestically. Development and testing were conducted in cooperation with NBSPACE and other academic and research partners. The mission is intended to help Thailand develop multi-payload CubeSat platforms and prepare for future ride-share launch opportunities. The satellite carries both educational and research payloads. Non-amateur missions include an Earth imaging camera, a store-and-forward IoT data collection system for remote sensors, ultraviolet radiation measurement instrumentation, and in-orbit evaluation of space-qualified components. These payloads are part of broader national workforce development programs coordinated through the Thai Space Consortium and academic partner networks. The satellite will be operated by ground stations located in Thailand.
KNACKSAT-2 also supports amateur radio operations through an APRS digipeater payload developed in cooperation with the Radio Amateur Society of Thailand. The amateur payload operates using coordinated frequencies through the International Amateur Radio Union (IARU) satellite frequency coordination process. The APRS digipeater system uses 145.825MHz for uplink and downlink using FSK modulation at 9600bps with AX.25 framing. The amateur satellite callsign assigned to the mission is HS0K.
In addition to amateur payloads, the spacecraft transmits engineering telemetry on 400.630MHz using FSK at 9600bps with AX.25 framing and a one-minute beacon interval. Project coordinators have requested assistance from the monitoring community to receive, decode, and submit telemetry reports from the 400.630MHz downlink, which is outside the amateur radio allocation. Many satellite observers actively search for newly deployed spacecraft and contribute reception reports, helping mission teams verify spacecraft health and early on-orbit performance. The satellite is expected to rotate in orbit, and ground stations are recommended to use circular polarisation, with RHCP preferred, to improve reception reliability.

CLUB LOG ADDS VOLUNTEERS: Club Log, a popular database used by DXers, is getting two new volunteers to help with the growing website. **Tony Rider G6GLP** and **Colin Wilson G3VCQ** have joined the project to help support its expanding worldwide user base. Club Log is an online service for amateur radio operators providing log analysis, DXCC tracking, DXpedition support tools, and online QSL requests. Currently, more than 132,000 callsigns are registered in the system, contributing an extraordinary 1.3 billion QSOs for analysis. Every day, thousands of new logs are uploaded, reflecting constant activity from operators across every continent. Tony and Colin are joining a dedicated volunteer group that includes **Alan Jubb 5B4AHJ**, who maintains Club Log's highly detailed DXCC database; **Marios Nicolaou 5B4WN**, author of the expedition tools and OQRS system used by DXpeditions worldwide; and helpdesk volunteer **Dick Hattaway W4PID**.
"Club Log has always been built by volunteers, and its success comes directly from people who care about helping the amateur radio community," said founder **Michael Wells G7VJR**. *"With such a large global audience of users, support is more important than ever. It's fantastic to welcome Tony and Colin to the team, as I know their friendly and helpful style will be so appreciated by our users. I'm immensely grateful for their willingness to contribute their time and expertise."*

New from ML&S


1


3


2

The **STAMPFL X One (1)** is a compact, wideband receive-only active dipole aimed squarely at serious shortwave listeners and monitoring enthusiasts. Covering 90kHz to 150MHz, it is designed to provide clean, low-noise reception across LF, MF, HF and into VHF, all from a physically modest antenna.

At the heart of the X One is an active front end engineered for excellent common-mode rejection and strong immunity to non-linear distortion, helping maintain clarity even in electrically noisy environments or strong HF fields. This makes it particularly attractive for urban listeners or those with limited antenna space. The antenna measures around 900mm in length and weighs approximately 0.9kg, making it easy to mount on a modest mast. Power is supplied via 12–14V DC at about 270mA, and the unit uses an N-type connector (with BNC adapter supplied).

Installation is straightforward: the antenna is supplied partially assembled, requiring only the dipole elements and end capacitors to be fitted. A mounting diameter of 40–60mm is recommended, with best results achieved when installed around 5m above ground and clear of nearby structures. An optional FM broadcast band block (88–108MHz) can be enabled to prevent overload from strong local stations. Currently £452.99.

The latest **Geochron Atlas 4K Pro (2)** is a high-performance digital world display system designed to provide real-time global visualisation on any suitable 4K screen. Supplied as a compact commercial-grade mini-computer, it connects via HDMI to deliver a continuously updating view of the Earth with precise day/night shading and accurate global timekeeping. The Pro version features significantly enhanced processing power, offering up to 300% faster rendering and increased memory compared with earlier Atlas models, enabling smooth display of multiple animated data layers simultaneously.

Users can purchase a wide range of live overlays, including a dedicated amateur radio data, weather systems, satellite tracking, and aviation activity data, creating an informative and visually striking shack or office display, in stunning 4K. Up to 85 live layers (including 35 weather layers) are available, with custom location pins, simultaneous local and UTC time readout, and automatic night dimming among the many configurable features. An internet connection is required for real-time data services.

A working unit is currently installed and on demonstration at the ML&S showroom. The price is £849.95.

A trio of compact handheld direction-finding antennas from **Deepace** and **MEASALL** provides practical solutions for locating signals across a wide VHF and UHF spectrum. Designed for use with spectrum analysers, receivers and DF applications, all three models focus on portability, low weight and clear directional response. The **Deepace R200** (£144.95) covers 20–200MHz, offering a lightweight passive design suited to general VHF direction-finding tasks. With linear vertical polarisation and a compact handheld form factor, it is intended for quick field deployment and reliable bearing determination. Stepping higher in frequency, the **Deepace R300** (£93.95) operates across 200–350MHz, targeting applications such as aviation, broadcast and other VHF services. The aluminium and carbon-fibre construction keeps weight low while maintaining a typical front-to-back ratio of around 10dB for effective signal hunting.

Completing the line-up, the **MEASALL KC980C (3)** (£144.95) hybrid loop covers a broader 50–500MHz range and is part of the KC980X handheld series. These antennas are commonly used for transmitter detection, EMI troubleshooting and general radio direction finding, combining wide bandwidth with robust portable construction.

Together, the three models provide flexible coverage from low VHF through to UHF, giving users options depending on their monitoring requirements and frequency of interest.

https://www.hamradio.co.uk

WQ2XDM - NEW US EXPERIMENTAL CALLSIGN FOR RADIO PROPAGATION TESTS AT 40MHZ & 70MHZ: **John K9JMS** recently received permission from the FCC to carry out propagation tests at 40MHz (8m) and 70MHz (4m) and was granted the callsign WQ2XDM for a period of two years.

Note that this is NOT an amateur radio licence and no two-way communications are allowed. Its purpose is strictly for *"scientific and engineering-based propagation research"*. The 40MHz and 70MHz bands are NOT amateur radio bands in the United States and this is a case of someone getting a permit to make narrow band digital transmissions and seeing if the signals are heard.

John describes it as follows... *"WQ2XDM Propagation Research - Florida-based experimental station studying low-VHF propagation on the 4 meter (70MHz) and 8 meter (40MHz) bands using weak-signal digital modes including WSPR and FT8."*

The licence has the following conditions attached:

- 8m band - 40.660 to 40.700MHz - 10-watts ERP max (FT8 & WSPR)
- 4m band - 70.000 to 70.200MHz - 25-watts ERP max (FT8 & WSPR)
- 40.660 to 40.700MHz is the 40MHz ISM (Industrial, Scientific & Medical) band.
- 70 MHz in the United States was used in the past for analogue TV broadcasts.

RADIO HISTORY EVENTS: ONLINE MUSEUM TOURS/TALKS: ***Did you know...*** you don't need to travel the world to visit and enjoy many of the most impressive museums related to amateur radio and radio communications?

Below are links to online museum tours across the globe which are either:

- Self-guided (click and move/view), or
- Facilitated via video.

When available, this page also displays interactive/live learning events which you might choose to attend - just don't forget to register in advance, if needed. Enjoy!

https://tinyurl.com/5n7e7wy3

Sign up to our FREE email newsletter at www.mymagazinesub.co.uk/practical-wireless

Royal Signals Museum unveils major new exhibition

A brand new, immersive and interactive exhibition: *The Cold War, in the Shadow of the Bomb is now open at* Royal Signals Museum in Blandford Forum. In 1945, Wo rld War II came to an end. What followed, however, was not peace, but the beginning of a new and dangerous global confrontation.

The Soviet occupation of East Germany marked the start of a political and ideological struggle between Communism and the Western Allies – a conflict that would come to define the second half of the 20th century.

It was a time of profound uncertainty and fear. An arms race for nuclear weapons and escalating rhetoric between Soviet and American leaders, combined to create a doctrine grimly known as Mutually Assured Destruction.

In response, large formations of armoured divisions faced each other in a chess like game of movement and counter movement across the European hills and plains, and mass peace demonstrations urged governments to invest in 'Bread not Bombs'.

Royal Signals Museum Director, **Fritha Costain**, said, *"Cold War themes have been brought vividly to life through personal testimonies from soldiers who served on the front line, and anti-nuclear activists who opposed the US air base at Greenham Common.*

"The displays highlight the crucial and often unseen role of the Royal Corps of Signals, whose communications expertise was vital in an age when seconds could mean the difference between peace and nuclear war. The exhibition offers visitors a compelling insight into a tense and transformative period of modern history – and the people who lived it."

The exhibition was opened for invited guests by **Kate Adie**, former Chief News Correspondent for BBC News, and **Dick Strawbridge**, a retired Lieutenant Colonel in the Royal Signals known for presenting Channel 4's Escape to the Chateau.

Kate Adie said, "The Cold War, in the Shadow of the Bomb brings back powerful memories of living in this turbulent period. The displays are poignant and thought-provoking with an exciting immersive quality. I strongly encourage people to visit and experience the exhibition for themselves."

Dick Strawbridge said, "Despite there being no direct engagement between the superpowers, the Cold War consumed vast resources and was conducted between two fiercely opposed ideologies, and under the threat of Mutually Assured Destruction. With both sides looking for any advantage, the Cold War period was defined by extraordinary technological progress. The Museum has managed to capture both the anxiety and the ambition that defined the age."

The exhibition has been generously sponsored by BAE Systems Digital Intelligence. Fritha Costain, said, "We're extremely grateful for the support of our sponsor, without which this new exhibition would not have been possible."

1

2

3

Kate Aidie (Fig. 2) opened the Royal Signals new exhibition, *The Cold War, in the Shadow of the Bomb,* that shows everything from East German Trabants (Fig. 1) to Greenham Common protestors' flamboyant clothing (Fig. 3).

The Royal Signals Museum is located in Blandford Camp, Blandford, Dorset, DT11 8BJ. Opening times: Monday to Friday 10am-4:30pm (last entry 3.30pm), Saturdays 11am to 4pm (last entry 3:30pm). Open Bank Holidays, except Christmas, Boxing & New Year's Days.

• **Adults 16+ must bring a valid Photo ID**
• Admission Adult - £12.00, Concession £10.00, Children under 5 Free, Carers Free when accompanying a disabled visitor.

www.royalsignalsmuseum.co.uk

Georg Wiessala
wiessala@hotmail.com

1

The Secret Life of Ruby Payne-Scott

Georg Wiessala reappraises pioneering Australian radio astronomer Ruby Violet Payne-Scott (1912-1981), whose achievements reflected both the technical progress and the socio-political prejudice of her time.

More than 80 years ago, a little-known Australian physicist and radar specialist laid the foundations of an entire new branch of radio science, using little more than a bent coat hanger and a few odds and ends of sticky tape, plugs and switches. Her name was **Ruby Violet Payne-Scott, Fig. 1**.

She was one of the world's first radio astronomers and a technical pioneer, not only in radio astronomy. But more than that, she has been described as an early advocate of women's rights, too.

However, very few people remember Ruby Payne-Scott today. Compared to some arguably more famous female radio astronomy scientists, such as **Elisabeth Alexander** (1908-19958; Caldwell, 2021), her scientific star has – pardon the pun – been somewhat on the wane for a time.

What is more, she often gets confused with **Cecilia Payne-Gaposhkin** (1900-1979), a Cambridge radio astronomer, who discovered that the Sun is mostly composed of Hydrogen (H) and Helium (He), which was, by the way, a radical scientific discovery at the time (Greene, 2016: 46; Judge, 2021: 12/13; 42).

Science, fame and Google-Doodles

Maybe it is quite fitting that we celebrate Ruby Payne-Scott this month, as she passed away in the month of May, 45 years ago, in 1981. When I read her obituary, I felt certain that I had heard of her before, in connection with radio and propagation science; and yes, this amazing Australian scientist had come to my attention in the shape of a *Google Doodle* – of all things – in May 2012, celebrating the 100th anniversary of her birth:

https://tinyurl.com/5dujt6uk

The *Doodle,* **Fig. 2**, encapsulated very well what RPS was famous for. It showed some of the ground-breaking radio astronomy equipment she developed, such as the S-Band noise tube, and illustrated the types of solar radio bursts (I and III) she discovered (Goss, 2013: 9). And yet, Ruby Payne-Scott, it seems, had always been a bit of a trailblazer 'under the radar', to quote one of her biographers. There was a reason for this, as we shall see shortly.

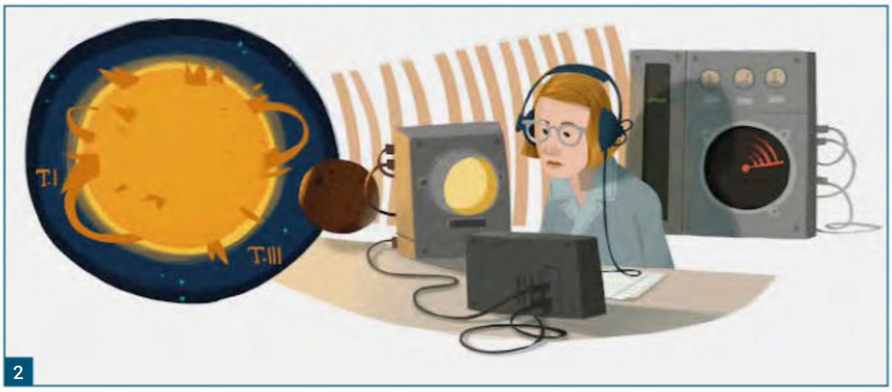
Early life and World War II

Ruby Payne-Scott was born in South Grafton (NSW) in 1912. With historical family roots in Devon and educated in Sydney, the young Ruby became a physicist with a strong aptitude for mathematics. World War II (1939-1945) entailed a shortage of male scientists in STEM subjects (Science, Technology, Engineering and Mathematics) at the time, and Ruby Payne-Scott boldly stepped into that breach.

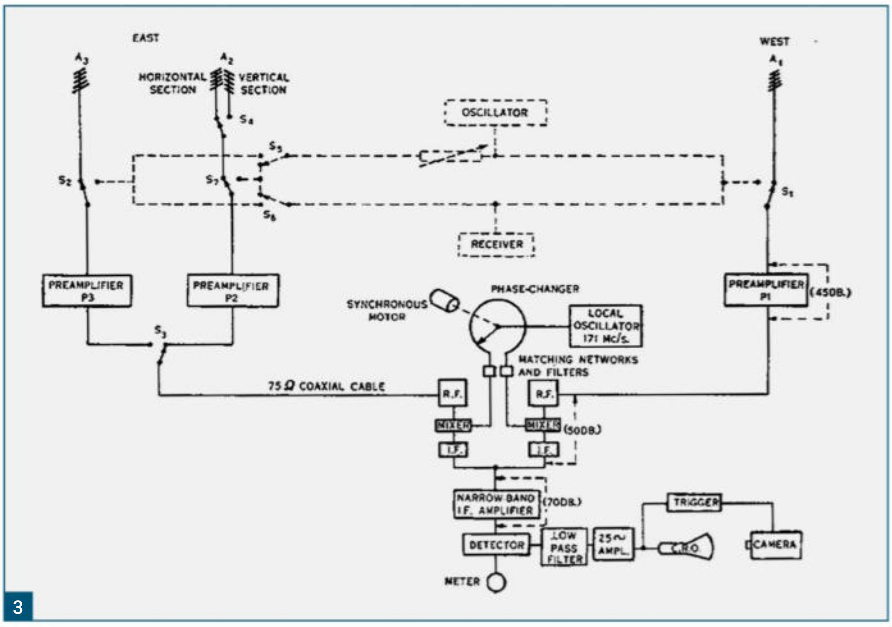
She began her career working for Sydney University Cancer Research Institute and Australian Wireless Amalgamated (AWA), an electronics manufacturer and operator of radio communications infrastructure in Australia. During that time, Ruby Payne-Scott spent much of her time calibrating and testing the Radar (RAdio Detection And Ranging) equipment.

These first projects benefited from her unmistakable interest and skill in electrical engineering. It pointed to what was to come. As was the case in many other countries, Britain included, wartime Radar technology was often the 'midwife' to the emerging discipline of radio astronomy after the War. The plethora of pre-existing Radar facilities, laboratories, equipment and other apparatus left over from the global conflict were simply adapted to the purposes of radio-assisted observation. **Gerrit Verschuur** points out (2015: 20) that the intrusion of World War II may, in fact, have accelerated developments, because of the intense research into Radar techniques in both Britain and Australia.

Fig. 1: Ruby Payne-Scott, radio astronomer, mother and activist (1912-1981) **Fig. 2: The brilliant Ruby Payne-Scott 'Google-Doodle' of May 2012** **Fig. 3: A block-diagram for a *Swept-Lobe Interferometer* (after Payne-Scott, 1951)** **Fig. 4: The two key biographies of Ruby Payne-Scott in 2026.**



2



3

4

This led to the rapid development of precisely those types of radio antennas and receivers that successive generations of radio astronomers were to urgently require for their work. In the UK, for example, such preeminent astronomers as **Martin Ryle** (1918-1984) and **Bernard Lovell** (1913-2012) worked with leftover technology in this field. In Australia, as elsewhere, some key research unfolded at institutions such as Sydney University, and this involved both employment and collaboration opportunities for female scientists.

One of them was Ruby Payne-Scott, who was extremely busy at the time, becoming an expert in PPI (Plan Position Indicator) radar displays and developing some lightweight radar equipment that could be flown out and used at posts across the Pacific Islands (CSIRO, 2026).

World war, radar and astronomy

Consequently, during World War II, Ruby Payne-Scott was engaged in some top-secret work investigating radar, and she soon grew into Australia's foremost expert on the detection of aircraft using PPI (plan Position Indicator) displays. Her research conducted from Australia's East Coast was vital to detecting Japanese fighter planes, and she became an expert in distinguishing those from other sources of radio static, such as lighthouses, buildings and cliffs. Her work eventually helped to drive the Japanese out of the Pacific war theatre altogether (NAA, 2026).

After the war, she was part of one of only two teams of scientists on a global scale who investigated 'radio noise' and 'cosmic static' emanating from nebulae, the Sun and other celestial bodies. Ruby Payne-Scott became, in the words of her biographer, the first female Australian radio astronomy scientist; she was: *"a driving force in radio astronomy in Australia"* (Goss, 2013: 3).

She subsequently worked in conjunction with other 'mothers' and 'fathers' of Australian radio astronomy. For example, **Joan Maie Freeman** (1918-1998), **Joseph Lade Pawsey** (1908-1962), **Lindsay Leslie McCreadie** (1910-19765), and a nebular cluster of other prominent Australian scientists helped to make Australia a world leader in the (long-wavelength) radio astronomy science of this period (cf: *Women in STEMM Australia*).

In addition to her practical work, Ruby Payne-Scott built up a prolific record of publications while working for the Sydney Radiophysics Laboratory (RPL), the Australian Council for Industrial and Scientific Research (CSIR; later: CSIRO) and elsewhere. This was to stand her in good stead. For example, after the War, in February 1946, she co-authored a paper in *Nature*, which was at the forefront of scientific endeavours of the era. It explained the links between sunspots and the measured, increased radio emissions from our Star.

Solar bursts and interferometry

Moving into Solar Physics, Ruby Payne-Scott's main claim to fame was the discovery, in the same year as her *Nature* paper, of Type I and III Solar Radio Emissions ('Solar Bursts'). Type III ('fast-drift') bursts are linked to 'impulse' (or 'eruptive') flares on the Sun. They represent two of the five categories of transient radio phenomena from the Sun's corona. The bursts are generated by acceleration of electrons along magnetic field lines into the corona and can drift from high to low frequencies (Lashley, 2010: 7-10; Arnold, 2021: 19).

These phenomena, with their origins in the corona, dissipate via long (decimetre) wavelengths. It was, perhaps, serendipitous that in 1946, when one of the most massive sunspot groups of the 20th Century had appeared on our Star, Ruby Payne-Scott had started observing the Sun. Her radio interferometry observation at sunrise on 26 January 1946 is said to be the first observation of this nature in the history of astronomy. Many later discoveries in this field by others were directly based on Ruby Payne-Scott's fieldwork.

Just as well then that she was there. From that time onwards, using her mathematical brain, she quickly made the connection between sunspots and the appearance of Aurorae on Earth, through her calculations on the magnetic fields involved. But this was not enough for her.

Re-tooling and expanding horizons

Ruby Payne-Scott was keen to have more than one scientific leg to stand on, as it were. She also established a name for herself in Fourier Synthesis for radio astronomy. Her discoveries have paved the way to what we know today as aperture synthesis. She made further headway in the areas of solar noise research, the thermodynamics of radio frequency noise and imaging techniques, as well as through the development and improvement of the very hardware and techniques needed for radio astronomy. **Goss** has coined a very apt, modern-sounding description when he states that, *"Ruby re-tooled her knowledge set through independent study of astronomy techniques"*. This would surely be on her *LinkedIn* profile today!

One result of her systematic endeavours, and a fruit of her specific research, was the conduct of the first-ever radio astronomy measurements with an interferometer. An interferometer solves the problem of being able to distinguish between large and small angular diameter radio sources, separating, for example, focused sunspot radiation from the more diffuse radio corona (Graham-Smith, 2013: 24, and p. 27 for the setup in Australia) In this context, Ruby Payne-Scott helped to construct an instrument called a 'swept-lobe interferometer', which could rapidly map solar radio emission-strength and polarisation, **Fig. 3**.

Fig. 5: Fiona Hall, the daughter of Ruby Payne-Scott and Academy Fellow Professor Nalini Joshi (left), at the launch of a new Sydney Harbour Ferry named after Ruby Payne-Scott.
Fig. 6: A 'Forgotten Star of Radio Astronomy', as seen by *Scientific American*, on 8 February 2024.

Flying under the radar – in shorts

The development of this instrument by Ruby Payne-Scott, among her other achievements, was instrumental in Martin Ryle eventually sharing the *1974 Nobel Prize for Physics*. However, recognition of her *own work and contributions*, and praise for *her* ideas, were all too often afforded to others, as the authors of some more recent biographies of this remarkable scientist point out repeatedly, **Fig. 4**.

Closely linked to the then Communist Party of Australia (CPA), Ruby Payne-Scott helped to found a Trades Union at her workplace, to fight for such fundamental issues as equal pay for women. She was *"a feminist, atheist, environmental conservationist and communist"* (*Skulls in the Stars*, 2020; **https://tinyurl.com/ytffwfe**). And, worst of all, she would wear *shorts* when skirts were then the officially prescribed work uniform for women in the science workplace. Sadly, her career was affected by malicious name-calling ('Red-Ruby'), deep-running suspicion and outright hostility. At the time, the Australian Security Intelligence Organisation (ASIO) collated an extensive file on her activities from 1948-1959, containing, as it turned out, numerous inaccuracies and misrepresentations. For instance, it never officially established her CPA membership.

A necessary deception and off-the-radar discrimination

Like many professional women of her time, especially in STEM areas, Ruby concealed her 1944 marriage to fellow scientist **William Hall** (1911-1999) from her then employers (Arnold, 2021: 19). Australian Public Service (APS) regulations at the time *forced* women scientists to *resign upon marriage*. Married women like Ruby Payne-Scott were thus pushed into temporary positions with lesser career prospects and no pension rights or other entitlements. At the time, an always-outspoken Ruby Payne-Scott commented on this in February 1950: *"Personally, I feel no legal or moral obligation to have taken any other action than I have in making my marriage known ... the present procedure with regard to married women ... seems to go far beyond the simple statement in the Act ... [it] is ridiculous and can lead to ridiculous results"*. (NAA, 2026).

But her position came to light via a routine departmental staff survey a few years after her marriage. As a result, she lost her permanent post, chances of promotion and superannuation benefits. Her promising career ended at the age of 39. A necessary deception that lasted for six years had cost her dearly. The letters from both her and her employers, now preserved in the Australian National Archives, make for sobering reading.

However, she still made occasional appearances among her former colleagues. In 1952, for instance, one year after she had quit her job, she took part in the *10th International Union of Radio Science General Assembly* at the University of Sydney. It must have been a bittersweet experience!

She also later changed her name to **Ruby Hall**, taking her husband's surname.

Shockingly, the bar on the employment of married women in the Commonwealth Public Service was only abrogated in November 1966, by means of the *Amendment to the Public Services Act*. This was 15 years after Ruby Payne-Scott was forced out. Paid maternity leave was not introduced in Australia until 1973.

Last but not least, Ruby Payne-Scott's children became famous Australians in their own right: **Peter Gavin Hall** (1951-2016) was a world-renowned mathematician and statistician, and **Fiona Margaret Hall** (b. 1953) is an eminent artist. When her children had grown up, Ruby Payne-Scott took up a post as science research staff at *Danebank Anglican School* for Girls.

Conclusion: a bright supernova, dimmed

Ruby Payne-Scott had become the most valued Australian solar observer for at least half a decade following the end of World War II, and beyond. She had forged a career, tragically cut short by the prejudice of her era.

She never returned to radio astronomy in the same way as before. Instead, she focused on being a committed schoolteacher at *Danebank*, from 1963-1974, and on bringing up her own children. Sadly, she also struggled with a serious neurodegenerative condition in old age. Ruby Payne-Scott passed away at the age of 68 on 25 May 1981.

I think that her legacy is probably twofold.

First, as a scientist, she was a pioneer of the (then) new discipline of radio astronomy, with a very significant portfolio of observations, discoveries and research papers to match. She helped discover how the Sun emits bursts of radio energy and developed instruments that could, as it were, 'film' solar explosions in real time. There is no doubt that radio enthusiasts, DXers and amateur radio operators today rely on knowledge of wave propagation and solar activity, which was uncovered by Ruby Payne-Scott. Every space weather prediction relies on the foundations she laid.

Second, in addition to her scientific profile, she has also been called a *"crusader for the rights of women in the scientific workplace in Australia"* (Goss, 2013: 7). While the choice of these words may be debatable, there is, perhaps, a kernel of truth in them. Maybe girls' STEM education today is indebted to her.

Nevertheless, the acknowledgement of her wider global reputation came late, perhaps too late. Today, parts of her legacy are reflected in the *CSIRO Ruby Payne-Scott Award (2008)*, annual lectures at *Danebank* School, as well as scholarships and academic programmes endowed in her honour.

Plus, since 2025, there is now a rather snazzy ferry in Sydney Harbour named after her, **Fig. 5**. The first Australian woman to listen to the heavens founded a discipline which also brings to mind names such as **Karl Jansky** (1905-1950) and **Grote Reber** (1911-2002) who were among the early pioneers of radio astronomy and solar physics in the 1930s and 1940s.

Ruby Payne-Scott – largely forgotten but recently rediscovered, **Fig. 6** – anticipated many of the most significant developments in radio astronomy in later decades. Her research led to the discovery of deep-space phenomena such as Black Holes and Pulsars (1967) by other female pioneers like **Dame Susan Jocelyn Bell Burnell** (b. 1943). Remarkably, the very techniques Ruby Payne-Scott discovered are still underpinning the use of many contemporary radio telescopes such as the Square-Kilometre Array (SKA **https://www.skao.int/en**)

And, while she was instrumental in mapping the sky and exploring Space with radio waves, the map of her own life was too often marred by the systemic institutional discrimination of her time.

In an *ABC Science Show Special* programme, **Caroline Little** arguably paid the most fitting tribute to Ruby Payne-Scott: *"Ruby's life was like a supernova – a great, brilliant, explosion, that, tragically, died out very quickly"*. There is a fascinating podcast about Ruby Payne-Scott at the URL below ('365 Days of Astronomy'; Source: Arnold, 2021: 19).

Table 1 offers a few more resources for further research on this fascinating personality. **PW**

- Arnold, S. (2021) *Radio and Radar Astronomy Projects for Beginners* (Springer)
- Australian Dictionary of Biography: **https://tinyurl.com/54c6efx6**
- Caldwell, S. (2021) 'Good Weather for Monkeys – and the Norfolk Island Effect' (*RadioUser*, April 2021: 40-42)
- Church, J. (2019) 'The Secret Life of Miss Ruby Payne-Scott' National Archives of Australia: **https://tinyurl.com/v779hvfv**
- CSIRO: 'Wavelengths Ahead: Ruby Payne-Scott's Astronomical Legacy': **https://tinyurl.com/3kattcjs**
- DeBakcsy, D. (2023) A History of Women in Astronomy and Space Exploration: Exploring the Trailblazers of STEM (Pen and Sword)
- Freeman, J. (1991) *A Passion for Physics* (CRC Press)
- Goss, W. M. (2013) *Making Waves: The Story of Ruby Payne-Scott, Australian Pioneer Radio Astronomer* (Springer)
- Goss, W. M. and McGee, R. X. (2009): *Under the Radar: The First Woman in Radio Astronomy* (Springer)
- Graham-Smith, F. (2013) *Unseen Cosmos – The Universe in Radio* (Oxford: OUP)
- Great Australians you should know: Ruby Payne-Scott: **https://tinyurl.com/ybk7c7yf**
- Greene, L (2016) *15 Million Degrees. A Journey to the Centre of the Sun* (Viking/ Penguin).
- Halleck, R. (2018) 'Overlooked No More [...]' (New York Times, 29 August 2018) **https://tinyurl.com/46vdna27**
- History of Scientific Women/ Wikipedia: **https://tinyurl.com/43exjc3j**
- Hooker, C. (2004): *Irresistible Forces: Australian Women in Science* (Melbourne: University of Melbourne Press)
- Judge, P. (2020) *The Sun – A Very Short Introduction* (Oxford: OUP)
- Lashley, J. (2010) *The Radio Sky and How to Observe It* (Springer)
- Making Waves (Book Review): **https://tinyurl.com/2d9d88wf**

New York Times (Obituary, 2018): **https://tinyurl.com/2bt3krcp**

Orchiston, W.; Robertson, P. et al. (2021) *Golden Years of Australian Radio Astronomy: An Illustrated History* (Springer)

Schoolcraft, L. (2018) 'Ten Facts to Know About Ruby Payne-Scott: the Feminist that the World Forgot' **https://tinyurl.com/y5d4j547**

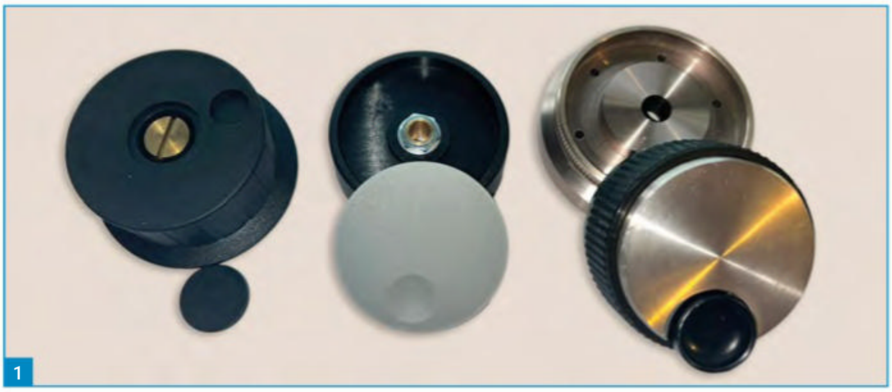
Scientific American: 'The Forgotten Star of Radio Astronomy': **https://tinyurl.com/bd357wbs**

Skulls in the Stars: Ruby Payne-Scott and the Mystery of Sunspots: **https://tinyurl.com/ytffwfe**

The Science Show (Special, 2004): 'Ruby Payne-Scott, Radio Astronomer' (Australian Broadcasting Commission, ABC)

Verschuur, G. (2015) *The Invisible Universe - The Story of Radio Astronomy* (Springer)

Table 1: Further Reading and Resources



1

Tuning with Feeling

Samuel EI9FZB tackles the challenge of decent tuning knobs with a smooth feel.

Dr Samuel Ritchie EI9FZB
practicalwireless@warnersgroup.co.uk

Since I started building equipment I have seldom been satisfied with the feel of the tuning knobs I have used and have wanted the same feel I experience with many of the amateur and professional receivers I have used. When first touching the knob I want a bit of resistance, enough to stop inadvertent tuning but not enough resistance to need so much force to overcome the inertia, that suddenly I turn the knob too far. Turning the knob must be smooth and effortless and giving the knob a hard spin should result in 3 to 5 complete revolutions.

With the advent of microprocessor control of direct digital synthesisers, the tuning knob is usually connected directly to a rotary encoder. While tinkering at my desk I favour a cheaper mechanical rotary encoder as it gets clamped in a vice, dragged across the desk and even knocked off the desk to the floor when I step on the dangling cables. I like the Alps Alpine 24 pulse incremental mechanical rotary encoder with model number EC12E2460802 from Radionics under RS 729-585 which costs €3.60. When rotating the shaft you feel a slight stop (called a detent) every 15 degrees of rotation and pushing on the shaft activates a switch.

However, on the finished item I favour an optical rotary encoder such as the Bourns model ENS1J-B20-L00128L, available from Mouser at about €42. This encoder has no detent, no switch function, provides 128 pulses per rotation and has a ball bearing on the shaft to ensure smooth rotation. Its bushing size (the part that goes through the panel and has a nut keeping it attached to the panel) is 3/8 inch thick and the shaft (onto which you attach a knob) is ¼ inch diameter and 5/8 inch long. For a longer shaft try the Bourns model ENS1J-B28-L00128L on which the shaft is 7/8 inch long.

This article looks at using a range of knobs on that Bourns rotary encoder and I endeavour to make this project repeatable by anyone with a few hand tools and a drill (preferably in a drill press).

Choice of knob

The Alps Alpine mechanical encoder has a 6mm shaft whereas the Bourns encoder has a ¼ inch shaft and this is another frustration. I would also like to use knobs that are made for 6mm shafts but am thwarted by the ¼ inch diameter shaft on these rotary encoders.

Fig. 1 shows three different styles of knob. On the left in dark grey is a knob that comes from JabDog Electronic Components who sell new Racal tuning knobs, I believe as used on the RA1776 communications receivers. These knobs are made to fit a ¼ inch shaft. In the middle is a modern knob made by OKW, purchased from tme.eu. If one examines the OKW catalogue, then you will be spoilt for choice. This particular style of knob is made for a 6mm shaft and comes with or without pointers, with or without dials, the bodies available in grey or black and a range of pastel and other colours for the cap. The cap can have the finger depression or just be flat. The 50mm knob comes with a 6mm or 8mm borehole and I have selected the 6mm version. At €7.40 for the body and €1.60 for the cap they are good value and attractive.

I have noticed on eBay that there seems to be a market for older amateur equipment but instead of selling the complete rig, rather the rig is stripped and sold as spare parts. Either the rigs could not be fixed or more likely there is greater value in stripping and selling the pieces rather than selling the whole, especially when you are located in a low labour cost country. On the right of Fig. 1 is a Yaesu FT-102 knob off eBay and this came with the aluminium skirt which attaches to the panel with the knob rotating inside the skirt, again made for a 6mm shaft.

Introducing the mechanism

The final fully assembled design is shown in **Fig. 2**. I am going to describe the assembly by looking at the back plate on which the rotary encoder is attached and most things directly attached to the back plate, then the front plate and then everything in between the two plates. This version is called the M3 metal design as the pillars are M3 Hex and aluminium plates are used.

One might ask what the use of the mechanism is if the rotary encoder already has a ¼ inch diameter shaft and the knob is a direct fit. The coupling and the brass shaft I add gives a little weight, which gives the slight resistance to turning and then added momentum when turning.

The back plate

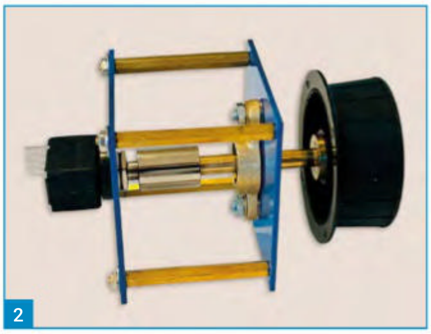
The mechanical drawing for the back plate in given in **Fig. 3**. The back plate is 60mm × 60mm × 2mm and needs five holes drilled in it. To overcome having to find and cut the plate I used an aluminium plate I found from a supplier on AliExpress. This determined the size of the plate that I used. Four holes with a 3mm diameter are needed, one in each corner, for the separation bars that hold the front and back plate apart and a 3/8 inch hole in the centre for the rotary encoder. I printed the drilling template as shown on the left-hand side of **Fig. 4** on a 1:1 scale and then glued this to one of the aluminium plates. Centre punched the middle of each hole on that plate, clamped both plates together and drilled one corner hole through both plates. Then using a M3 machine screw and nut clamped the plates together and drilled the opposite corner. Another screw and nut kept both plates tightly together and I drilled the two remaining corner holes and the centre hole. This ensured that even if I was slightly off in my drilling that everything would still align perfectly.

To limit the amount of bushing that comes through the back plate, in order to maximise the space between the plates, I used a flat washer. This not so flat washer is used with M10 machine screws, is 5mm thick, and fits snugly against the encoder body and not the bushing, all ensuring a tight fit.

In Fig. 3 the circles with a letter inside match up to the parts list on which I show what exactly I used. **Fig. 5** contains a partial list as an example and the full parts list with the source of each part and links to where I sourced them from can be found on my website.

The front plate

The mechanical drawing for the front plate is shown in **Fig. 6** and if you followed what I did in section 3, then this part already has five holes in it. The four corner holes need to be countersunk on the front side so that the M3 machine screws are flush with the plate. This is necessary if you are going to mount the assembly directly onto a front panel. This time an 8mm hole is required in the centre to give enough space for the ¼ inch shaft and then two holes for the ball bearing pillow block using the



2

template as shown in Fig. 4. I use a pillow block that comes with a ball bearing that has been press fitted into the block. I did try flange couplings into which you insert your own ball bearings but struggled to get everything to align and gave up on it.

This particular pillow block contains a ball bearing that accepts a ¼ inch copper bar. You need the ball bearing on the front panel to support the weight of the coupling and extended shaft. The pillow block uses M4 screws, which also need to be countersunk so that they are flush with the plate.

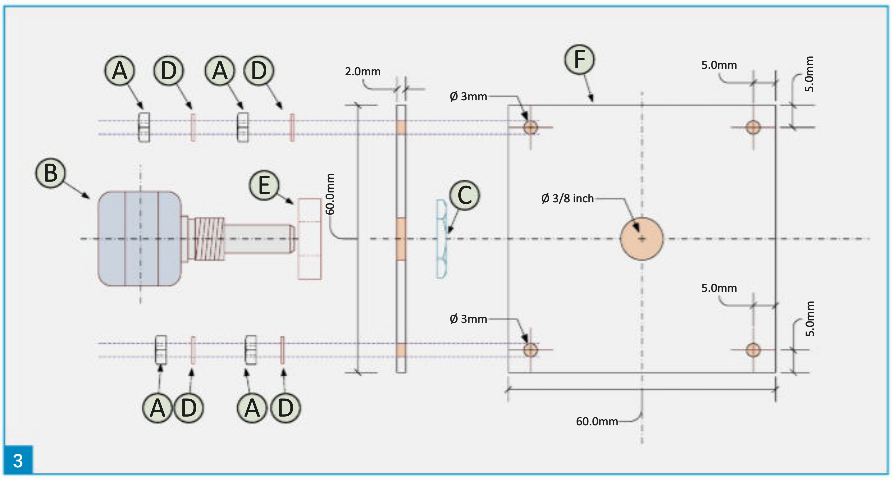
Fig. 7 shows a rear view of the front plate with the pillow block installed and the copper rod through the ball bearing. It is a tight fit as both parts have good tolerances and I found it necessary to clean the brass rod well. I used 800 grit waterproof emery paper to clean the rod. Using the two flat washers between the pillow block and the front plate is necessary so that you don't squeeze the ball bearing against the front plate and stop it rotating.

What is needed in the middle

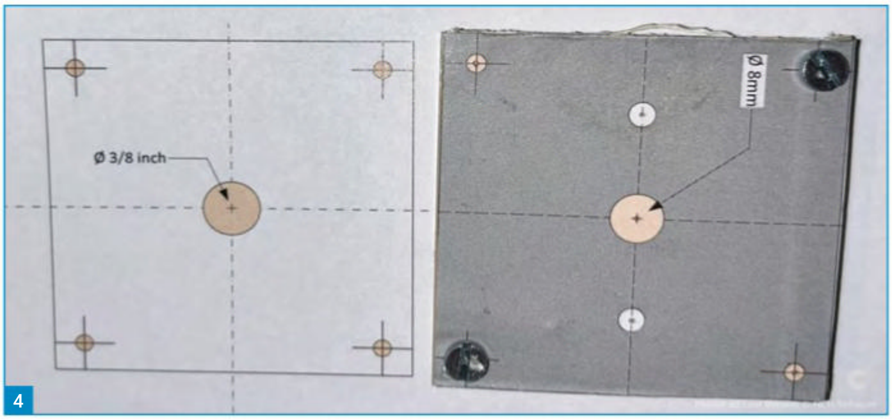
The pieces that need to be assembled in between the plates are shown in the mechanical drawing in **Fig. 8**.

We extend the shaft of the encoder using a coupler. Thanks to 3D printers and CNC machines these couplers have become available in a range of sizes. In this case it is a ¼ inch to ¼ inch coupler that connects to the shaft of the rotary encoder and to the ¼ inch brass round bar which I left at 70mm length for trimming once installed on a front panel.

There are four brass hex pillars that are used to pull the two plates together. Each of these pillars is 50mm long and tapped at one end for a M3 machine screw, with a length of M3 thread at the other end. The threaded part of the pillar goes through the back plate and a M3 flat washer and a M3 nut (A and D) is used at each corner. On the front plate a countersunk M3 machine screw (L) is needed, the ones I used came with a Pozidriv head.



3



4

TUNING KNOB PARTS LIST - M3 METAL

Identifier	Part description	Source
A	M3 x 5.5mm nut	RS Stock No. 560-293
B	Bourns Optical encoder ENS1J-B28-L00064L	Mouser: 652-ENS1J-B28L00064L
C	Rotary encoder nut	Comes with Part B
D	Plain Washer, M3	RS Stock No.: 287-4015
E	3/8" Flat washer for M10 screw, 10mm ID x 18mm OD x 5mm long	Amazon: https://www.amazon.ie/dp/B0F7LK793B
F, H	Plate 60 ◊ 60 ◊ 2 mm aluminium	AliExpress: HomeDIYer store under the heading: Aluminum Plate Solides Thickness 0.3mm-2mm Aluminum Alloy Square Plate Polished Plate Sheet 50x50mm/600x600mm
G	Not used	
I	M4 nut	RS Stock No: 122-4401
J	Plain Washer, M4	RS Stock No.: 287-4032
K	Pillow Block Bearing for 6.35 mm Diameter Shaft	AliExpress: JUGETEK Official Store under the heading 2pcs/lot, Pillow Block Bearing for 5/6/6.35/ 7/8/10/12.7mm Diameter Shaft
L	M3 (3mm x 6mm) Pozi Countersunk Machine Screws	Amazon: https://www.amazon.ie/dp/ B08W8LDCZG
M	Not used	
N	Pozi M4x12mm Countersunk Machine Screw	RS Stock No: 553-425
	Racal Finger Indent Tuning Knob collet fix onto 1/4" 6.35mm Shaft	eBay: https://www.ebay.ie/itm/141366270095

5

Fig. 1: Three different tuning knob options. Fig. 2: The M3 metal design. Fig. 3: Back plate assembly drawing. Fig. 4: Drilling template. Fig. 5: Example of the parts list.

Final assembly

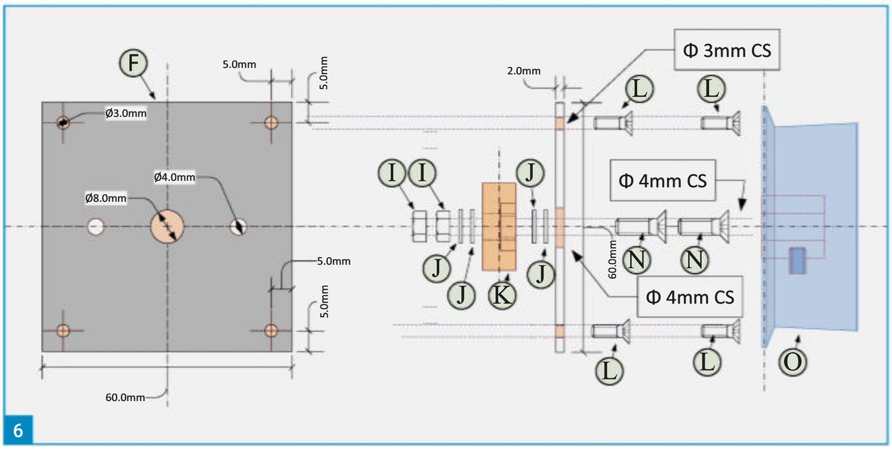
This is the sequence I followed having partially assembled the back and front plates as shown in Fig. 7 and **Fig. 9** but keep the screws on the pillow case loose at this stage. Connect the coupler to the rotary encoder shaft and tighten the grub screws. Feed the brass rod into the coupler and tighten the grub screws. Using four M3 countersunk machine screws attach the front plate to the four hex pillars and tighten. Lastly tighten the two M4 screws that affix the pillow block to the front panel making sure the shaft if aligned and turns freely.

Using knobs with other borehole sizes

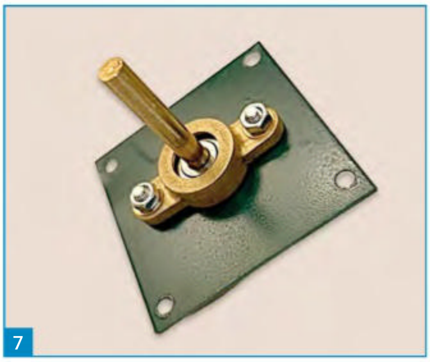
The knob from OKW has a 6mm mounting hole and for this I use a different coupler that converts from ¼ inch to 6mm and to use a 6mm brass rod. This also means you need to change the ball bearing, which is done by changing the pillow block for one that has the right sized ball bearing press fitted.

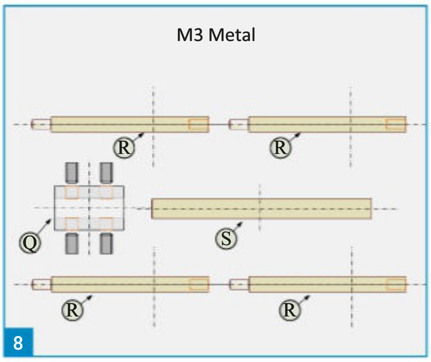
Fig. 10 shows my assembly using a ¼ inch to 6mm coupler, a 6mm brass rod and a different ball bearing pillow.

Fig. 6. Front plate exploded assembly drawing. Fig. 7: Ball bearing in its pillow block and copper shaft on the front plate. Fig. 8: Parts for the middle. Fig. 9: Mounting the pillars on the back plate. Fig. 10: M4 metal assembly with OKW knob and 6mm shaft. Fig. 11: The three mechanisms awaiting projects.

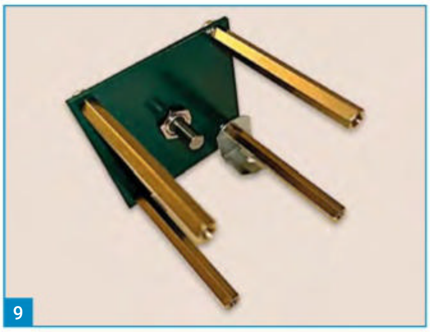


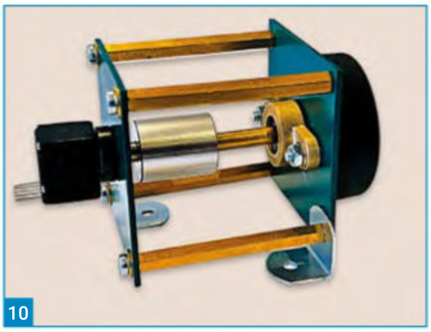
6


7



8


9


10


11

This particular design is called the M4 metal design as it uses M4 hex pillars and aluminium panels. Unlike the M3 hex pillars the M4 hex pillars do not have an external thread on the one end so the back panel uses M4 cheese head screws instead of nuts. I experimented with using two L-brackets to attach the mechanism to the chassis with only the brass rod protruding through the front panel so have mounted two L-brackets on two of the corners. Instead of drilling the corner holes with a 3mm diameter drill a 4mm diameter drill is used. The assembly drawings for this mechanism are also on my website.

The third version was made to utilise the FT-102 skirt and knob. Shown on the left in **Fig. 11** this model is called the M4 Perspex version. Once again it uses M4 pillars but instead of aluminium it uses 3mm Perspex. I cut the Perspex using a mitre saw with a toothless blade and as long as you are quick, the Perspex does not melt or soften. I found that drilling and countersinking the Perspex was as easy as, if not easier than, the aluminium.

The silver metal skirt attaches to the front panel and the knob rotates within the skirt. I can see it will be critical to get the skirt carefully aligned with the brass rod to ensure the knob does not touch the sides of the skirt. The thick block of wood, which mimics the panel, just happened to match the length of brass rod I had on hand.

Endnote

You are not limited to aluminium or Perspex and appropriately thick PCB, polycarbonate or steel plate could be used. You are also not limited to plates that are 60mm × 60mm and smaller sizes could be used, I chose 60mm × 60mm as they were available. It is also possible to use shorter pillars and further reduce the footprint needed by the mechanism.

For those in or near the UK I have used the website below, who can supply plates cut to your size as long as they are longer than 50mm. You can get plates in aluminium, mild steel and stainless steel.

www.metals4u.co.uk

If you want to reduce the amount of drilling, I suggest looking at buying Perspex or polycarbonate from McMordie (website below) in Belfast or a similar supplier. Not only can you get smaller plates but the corner and centre holes can be drilled at M4 for you. For both plates you could then use a stepped cutter to enlarge the centre hole and use the drilling template to cut the two holes to fit the pillow block on the front plate.

www.mcmordiebros.co.uk

While my focus is normally on electronic design I did enjoy the elements of mechanical work and getting to use all those skills I learned as a young apprentice.

Have a look at my website (below) where there are higher resolution pictures, exploded assembly diagrams and the complete part lists for each design. There is also the Visio® file if you want to play around with or modify the design I came up with.

www.samuelritchie.com

I have no financial interest in any of the suppliers or online platforms mentioned in this article. **PW**

1

Bernard Nock G4BXD
military1944@aol.com

The Eddystone 910

Bernard Nock G4BXD waxes lyrical about an Eddystone treasure.

Here at the Military Wireless Museum we have several rare or rare'ish Eddystone sets. Though most were not exactly military in use there are one or two that were indeed used by the military. The 358 receiver was used by the Royal Navy as the B34 while the Army used Eddystone's S440 series as a VHF point-to-point relay system. Receivers such as the 730 were used to monitor HF communications, usually from Russia, in various European and UK locations.

The interest in collecting Eddystone sets stems from firstly it being a major British manufacturer of the day, not something easily found these days, and that most of them are just so nice to use, super smooth tuning, good specifications, for the time, and that they just look so good.

The rarer examples in the collection include a 730 receiver with serial number 00001, a nice example of the All Wave 4, 1930, the All World 4, 1934, and a very smart All World 2, 1936. There is a nice example of the 659 Tea Planters special with matching speaker plinth and an S.850, used for marine and submarine communication and surveillance. There is the 909A, a set made for the Scandinavian market so very few found in the UK, the BBC special 930 and a rare EC10 Seaguide, one of only two known.

The main reference for Eddystone sets, the bible so to speak, is the *QRG* or *Quick Reference Guide*, which can be downloaded from the Eddystone User Group website and details nearly all of the known models. The *QRG* also has a section giving the codes shown on the sets data plates enabling one to find the date of manufacture.

It seems the 910 was the prototype, 1957, with the 910/1 being the version which was to be produced. A run of pre-production sets were built, this is serial number PPBL0006, and the BL in this serial number indicates Feb 1960 production. It's believed between 1961-2 around 200 sets produced in the end.

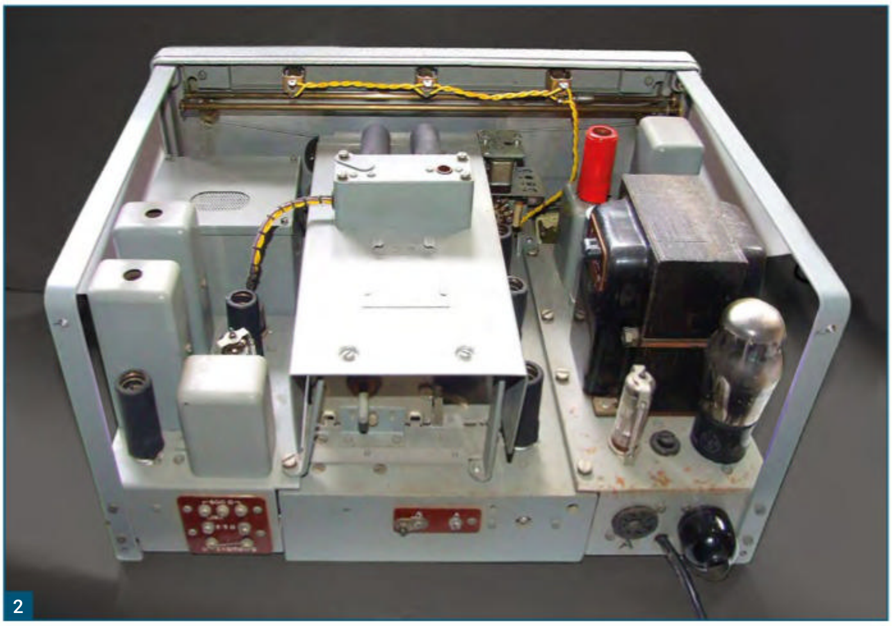
This latest set was spotted being offered for sale and it seemed odd that it had not been snapped up. An enquiry was made, yes, it was still available and snap, the trap sprung. A short trip to the wilds of the far west country, with a two night stopover in a quaint inn, returned the treasure to the museum.

Description

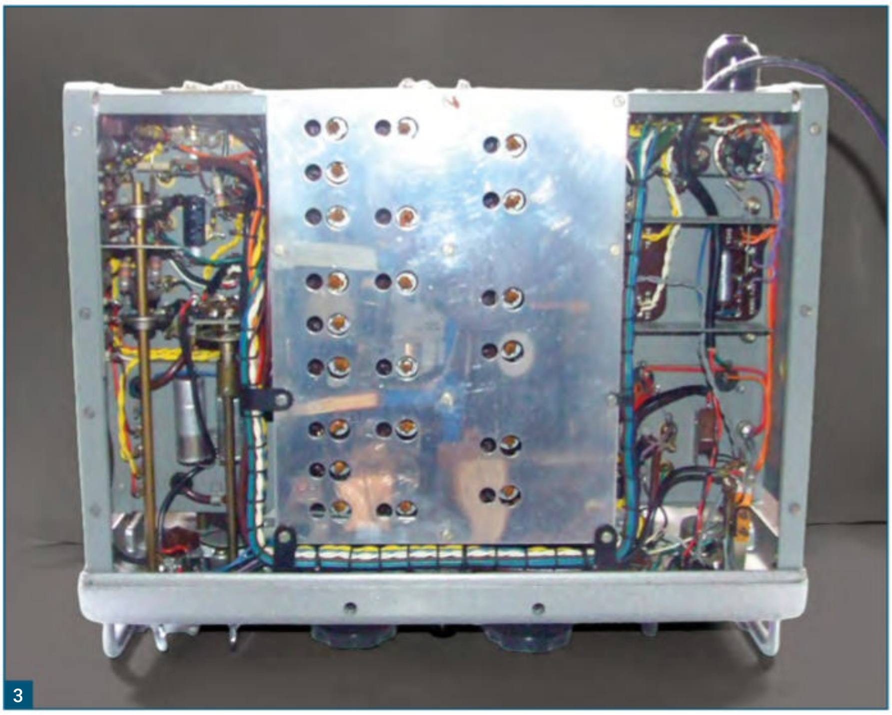
The Eddystone 910/1 is a general coverage HF radio, 1.5 to 30MHz, with the addition of the marine band, 375-525kHz. There is no coverage of long wave or medium wave. The set is a double conversion superhet, first IF is 1400kHz with tuning 50kHz either side and a second fixed IF of 85kHz. The first local oscillator has provision for four crystal-controlled settings for high stability single channel reception.

The receiver resolves AM, SSB and CW with a

Fig. 1: The 910/1 with S meter and speaker. Fig. 2: Internal, IF/audio on left, RF/osc in centre, PSU/BFO on right. Fig. 3: The underside of the 910.



2



3

BFO and has a continuous variable selectivity control on the 85kHz stages from 1 to 6kHz. RF and IF gain controls are fitted and switchable fast, slow or off AGC and Noise Limiter options are offered.

While the set has a mains power supply built in, it can also be operated from an external 6V vibrator unit, type 687/1 using an octal connector on the rear wall of the chassis.

Another octal socket next to it allows the use of the Eddystone external S Meter unit, type 669. A 500kHz crystal calibrator is fitted with a push switch on the front, which de-senses the RF stage and puts volts on the calibrator when used. There is a small thumb adjuster at the top right of the cabinet which will move the scale pointer a small amount.

Circuit design

The RF stage uses a 6AK5 as amplifier with manual RF gain and AGC when selected. Provision is fitted to de-sense the set when used with a transmitter, the two terminals on the rear wall are shorted together when this function is not needed.

A 6BE6 is used as the first mixer with a 6C4 as the local oscillator, running on the high side of the RF on all bands. The oscillator has a four-position crystal bank for use on specific channels. The crystal frequency is the wanted receive frequency plus 1400kHz in a HC-6U housing.

The first 1400kHz IF feeds into the second mixer, a 6AK5, which is mixed with the output of the second local oscillator, a 6C4 triode, and tunes 1265 to 1365kHz centred on 1315kHz. This tunable second IF has two advantages. Firstly, a constant calibrated band-spread is available over any 100kHz portion of the received spectrum allowing a high degree of accuracy and on the higher ranges, the incremental tuning allows a tuning rate comparable to the lower ranges.

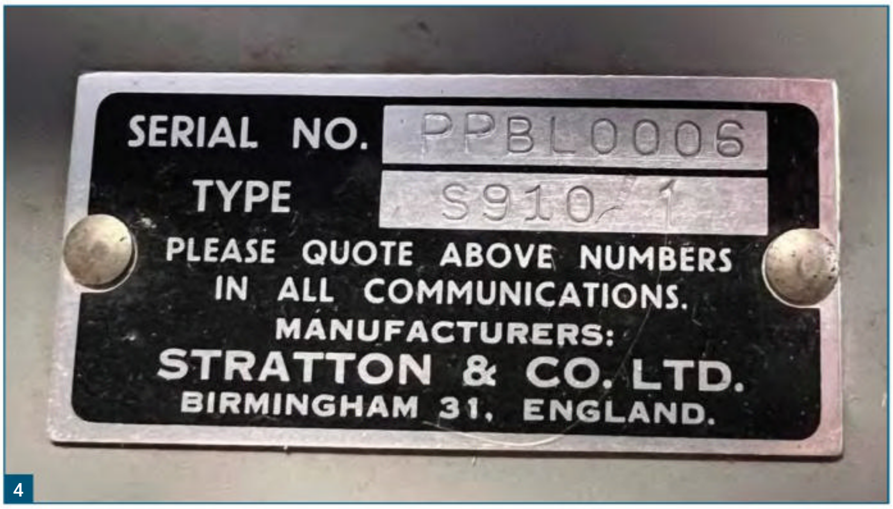
Secondly, when using crystal control, the actual crystal frequency may be anywhere in the range fs + 1350kHz to fs + 1450kHz so reducing the number of crystals required for control over a wide range of frequencies. A PEAK RF control is provided and this allows compensation for misalignment of the signal frequency circuits when tuning signals on the Incremental control. The PEAK RF control takes the form of two ganged capacitors of relatively low capacity wired in parallel with the RF and first Mixer sections of the main tuning gang. The receiver is aligned with the PEAK RF capacitors at 'half-capacity' so permitting both positive and negative tracking correction when the first IF is detuned from its centre frequency of 1400kHz.

Output from the second Mixer is taken via T1 to the grid of the 85kHz IF Amplifier V5. This stage utilizes a 6BA6 operating with automatic and/or manual gain control (RV2). The cathode of V5 (like that of the RF Stage V1) is returned to chassis via the desensitising terminals to further reduce the overall gain when desensitising is in use. Variable selectivity is provided by physical movement of the primary winding in T1 and also in T2, which feeds the two detectors.

Connections are taken from the screen grid and cathode of V5 and are terminated at the rear wall SOCKET 'A' for operation of the external carrier level, S meter (Cat. No. 669). The cathode connection is taken via the diode V6A, which provides protection for the meter when the IF Gain control is turned down. (Extreme unbalance in bridge circuit.)

One diode of V7 (6AT6 double-diode-triode) serves as the AM Detector. V6B is incorporated in this circuit and functions as a series type noise limiter when S3a is open. Closing S3a short circuits the diode V6B taking the limiter out of circuit. The limiter is of the self-adjusting type and audio output is taken from the cathode to the AM side of the Signal Mode switch S4a.

Also fed from the secondary of T2 (via C72) is the CW/SSB Detector V11. This is a product type detector using a 6BE6 pentagrid with the



4

screen fed from the HT2 line in the interest of greater oscillator stability. The screen supply is removed when switched to AM (S4b). The complete detector is housed in a small screening can and extensive decoupling is employed to reduce spurious signals due to harmonics of the beat oscillator. C113 permits adjustment of the beat frequency over the range 85kHz ± 6kHz. Audio output is taken from the anode via the filter comprising R62, C115 and C116 to the CW/SSB side of the Signal Mode switch (S4a).

The remaining diode in V7 functions as the AGC Rectifier and is fed direct from the anode of V5 via C66. AGC is delayed by the bias across R37 and is applied to V1, V2, V4 and V5. Two AGC time constants and AGC 'OFF' are available at S3b.

The audio section and power supply

Audio output from either the AM or CW/SSB Detector is selected by means of S4a and taken to the AF Gain control (RV3), which feeds the grid of the triode portion of V7. This stage is resistance-capacity coupled to the Audio Output Stage which employs a 5763 beam tetrode. The output transformer T3 is provided with two secondary windings of 2.5 and 600Ω impedance for connection to speaker and lines while telephones are tapped across a voltage divider (R48/49) fed direct from the anode through C79. The circuit is arranged so that insertion of the telephones automatically disconnects the speaker but does not interrupt the line output. The 600Ω output can be attenuated should that be required.

The power supply circuitry is quite conventional, employing the usual full wave 5Z4G rectifier, capacity input smoothing filter and 150V stabiliser V12. The unusual heater connection of V6 is necessary to avoid the introduction of hum in the noise limiter circuit. The heater is maintained at some 10V above ground by the potential divider R56/R67 and this obviates the need for selection of the 6AL5 for use in the noise limiter position.

Both LT supplies are taken via links in the octal plug which mates with rear mounted SOCKET 'B'. Removing the shorting plug disconnects the transformer heater windings from the heater circuits and facilitates connection of the external LT supply when the receiver is used with the Vibrator Unit Type 687/1.

Calibrator

V9 (6BA6) functions as a 500kc/s crystal oscillator to provide calibration markers at half-megacycle intervals throughout the entire coverage. The calibrator HT is applied through S2B while S2A desensitises the RF stage to prevent interference from external signals while calibrating. The calibrator output is capacity coupled to the grid of the first Mixer and scale correction is achieved by means of an adjustable cursor.

EDDYSTONE TYPE S.910, 1957, communications receiver. No details other than the factory blueprint (BP) register, which lists the model. It does not seem to have passed the prototype stage but was undoubtedly the forerunner of the 910/1. A very blurred photograph of it shows it to have 5 wavebands. This was used (presumably in error) in an American Marconi advert for the HR101 in 1962 (see below).

EDDYSTONE TYPE S.910/1, c.1961/2 marine communications Rx. I believe this set to have been sold only badged as the Marconi HR101. Double superhet with interpolation tuning of first IF stage. Very similar in operation to the 830-series *(ibid.)* but in general appearance much like the 730-series *(ibid.)* No picture is to hand. 16 valves, 6 bands; coverage 1.5-30Mc/s and 375-525kc/s. First IF 1350-1450kc/s; second IF 85 kc/s. Production run 200. Very rare ♠

5

Other exceptions to the rule are the prefixes 'DD' and 'PP', which refer to the set being a development or pre-production model. The serial will always be very low (like PP0002).

These sets were not sold but raffled off to employees. They may or may not be something like the final product! But they do turn up.

Dating Code for Eddystones (see text)

A – 1923	A – 1949	A – Jan
B – 1924	B – 1950	B – Feb
C – 1925	C – 1951	C – Mar
D – 1926	D – 1952	D – Apr
E – 1927	E – 1953	E – May
F – 1928	F – 1954	F – Jun
G – 1929	G – 1955	G – July
H – 1930	H – 1956	H – Aug
I – 1931	I – 1957	I – Sept
J – 1932	J – 1958	J – Oct
K – 1933	K – 1959	K – Nov
L – 1934	L – 1960	L – Dec
M – 1935	M – 1961	
N – 1936	N – 1962	
O – 1937	O – 1963	
P – 1938	P – 1964	
Q – 1939	Q – 1965	
R – 1940	R – 1966	♠
S – 1941	S – 1967	
T – 1942	T – 1968	
U – 1943	U – 1969	
V – 1944	V – 1970	
W – 1945	W – 1971	
X – 1946	X – 1972	
Y – 1947	Y – 1973	
Z – 1948	Z – 1974	

6

Fig. 4: Data plate, no 6 of the pre-production run. Fig. 5: The QRG entry for the 910. Fig. 6: The QRG dating chart.

User friendly

Unlike modern sets there are no menus, no multi presses of a button to get to a function, each of the functions on this receiver has its own knob or switch.

Tuning around the bands with the smooth flywheel driven knob is a joy, the ease of mode selection, filter width, BFO, AGC etc make for a really enjoyable experience, maybe lost on today's techo equipment.

Obviously, sensitivity, selectivity and stability have improved in leaps and bounds since this set was produced but, even so, this is quite a lot of set in one box and, as with nearly all of Eddystone's output, was a marvel of its time that can still provide hours of fun even today. **PW**

Steve Telenius-Lowe G4JVG
teleniuslowe@gmail.com

1

A Month of Expeditions

This month, as **Steve G4JVG** reports, has seen a lot of DXpedition activity from several continents.

After two years off the air following our return to the UK in March 2024, **Eva M9TEL** and I are now active once again. We moved into a top-floor flat with very limited possibilities for antennas so initially, at least, most of our activity is on FT8, **Fig. 1**. Like it or loathe it, FT8 does allow flat-dwelling amateurs such as us to make DX contacts (see 'Band highlights' below) using low power and literally bits of wire thrown out of the window!

FT2: a new data mode

First came FT8, in June 2017, as part of the WSJT suite of datamode programs by **Joe Taylor K1JT** and **Steve Franke K9AN** and amateur radio operating was revolutionised overnight. Two years later FT4 was released, allowing for contacts to be made twice as quickly as FT8, making it more suitable for contesting, albeit with a 4.5dB loss of sensitivity.

Now an experimental new mode, FT2, which is twice as fast again, has been developed by a team led by **Martino Merola IU8LMC**. With 3.8-second transmit / receive cycles, a contact can be completed in 11 seconds, four times faster than FT8. The first FT2 contacts were made by the Italian developers on 16 February.

The protocol is the same as that of FT8 / FT4, so if you already have those set up on your computer you should be able to download FT2 and start using it straight away. Version 3.1.0 of 'WSJT-X Improved', released on 26 February, and later versions, include FT2. It can also be downloaded directly from the Italian developers' page and there is also much more information on the new mode there:

www.ft2.it

The spotless sun

On 22 February, the Space Weather website showed a large picture of a totally spotless sun, the first time this has occurred since 2022. However, as the site commented, the blank sun *"does not mean Solar Minimum has arrived. On the contrary, it is still years away. However, it does tell us that Solar Cycle 25 is waning. Sunspots will be back – probably tomorrow – but today is a preview of things to come."* Space Weather added that at *"Solar Minimum whole months can go by without a single sunspot, racking up dozens of spotless days in a row. Between 2018 – 2020 (the last Solar Minimum) there were more than 700 spotless days!"*

The sun remained spotless on the 23rd, 24th and 25th; two sunspot groups eventually re-appeared on the 26th.

QSL from yesteryear

With Iran very much in the news at the moment, I thought it a good opportunity to look at an old QSL from that country. I worked **Hassan Zohourian EP2HZ** in Tehran, **Fig. 2**, 38 years ago this month, on 11 May 1988 on 14MHz SSB. Hassan's callsign is still listed on QRZ.com, although he doesn't seem to be active any longer. Iran is, and always was, a 'semi-rare' country, with a relatively small number of licensed amateurs who are active from time to time. In the month before the recent breakout of hostilities EP2CPB, EP4HR, EP5APP, EP5AQQ, EP5MMS and EP5YAS had all been spotted on the DX Cluster, all on either SSB or FT8, though there seems to be little CW activity from Iran these days.

Iran is a country that has long fascinated me, if only because I was lucky enough to work there back in 1978 for what should have been a two-year posting. But then the Islamic Revolution came along and after only 10 months I was evacuated by the RAF in February 1979, shortly after the return of **Ayatollah Khomeini** to the country. After waiting five months for my licence to be issued, I became active as EP2SL (**Fig. 3**), using a second-hand KW-2000B to a Hustler 4BTV vertical and an 80m dipole. As a 22-year old I couldn't afford a new transceiver: in 1978 the brand-new Icom IC-701 cost around £700, the equivalent of over £5000 today!

Most of the amateurs in pre-revolutionary Iran were American and British expats; those who I got to know well included **Roger EP2IA (G3SXW)**, **Alf EP2TW (GI3PGG)**, **John EP2WR (G3LZQ)** and **Harry EP2BQ (ZL2SQ)**, all now sadly Silent Keys.

The month on the air

The 3Y0K DXpedition team arrived at Bouvet Island after the long journey from Cape Town and started making contacts in early March. They expect to remain on the island between two and three weeks.

The KP5/NP3VI Desecheo Island DXpedition closed down on 3 March after a 50-day long operation, making nearly 110,000 contacts. This activity was low power and entirely solar powered, using two 'Remote Deployment Units' in a couple of Pelican cases.

desecheo2026.com

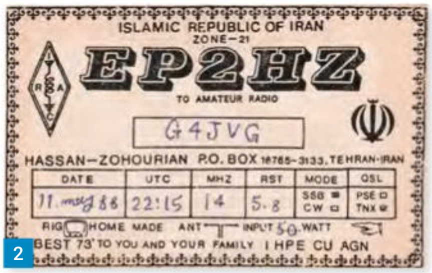
Five German operators were active as J51A from Bubaque Island (IOTA AF-020) in Guinea-Bissau from 23 February until a scheduled close date of 15 March. By 11 March they had made 216,830 QSOs, setting a new record number of contacts made by a single DXpedition and beating the previous record set by the UK's Five Star DXers Association T32C operation in 2011.

Three Polish operators have been active from Anguilla as VP2EWE, VP2EAD and VP2ELX from 3 March and are scheduled to remain on the island until the 20th. Their operations were mainly on FT8 and SSB.

What to look for in April-May

Take JG8NQJ/JD1 has been on Minami Torishima, **Fig. 4**, since February and expects to stay until the middle of May. He operates CW and FT8. Minami Torishima is the easternmost point of Japan and is around 1850km east of Tokyo. The 411m high LORAN-C mast shown in the photo (dating from 1987) has since been dismantled.

Further to the item in last month's *HF Highlights*, a new announcement on I2YSB's website says that his group's Ghana expedition will begin in the first half of April. On 20 February the *425 DX News* bulletin reported that the team will be active on 160 to 6m as 9G5RR on CW, SSB and RTTY



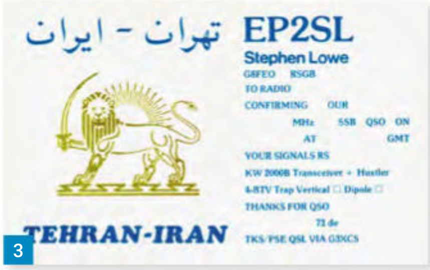


Fig. 1: Your columnist in his new 'shack'.
Fig. 2: A 1988 QSL card from EP2HZ in Tehran.
Fig. 3: The 48-year old QSL from your columnist.
Fig. 4: Japan's easternmost island, Minami Torishima, in the Pacific Ocean. Fig. 5: The 'Mad Dog Coil' vertical antenna used by Carl M8HPI/P. Fig. 6: Mark VK4EMP (left), with Marty VK4KC, the owner of Mad Dog Coils (right).

and as 9G5CC on FT8 from a beachside location on the mainland. Operation from Abokwa Island (IOTA AF-084) will depend on the weather and sea conditions: activity will be as 9G5ZP on 15m CW, SSB and FT8 from morning to evening only.

i2ysb.com/joomla5

It was good to hear from a new contributor, **David FitzGerald EI7BR**, who wrote to say that he and **Roger Greengrass EI8KN** will be active from St Kitts from 13 to 21 May. They will use the callsigns V4/EI7BR and V4/EI8KN, while Roger has also been issued with the contest callsign V49B. David wrote that their QTH *"will be the fully-equipped holiday home of **John W5JON** in Calypso Bay, located 200 feet from the Caribbean Sea. Activity will be on 160 to 6 metres (including 60m) using SSB and FT8. Equipment is a Yaesu FT-3000D and an Elecraft KPA500 amplifier. Antennas are a Mosley Mini32A 10/15/20m, 33ft vertical 10-40m, 35ft top-loaded 80m vertical, 160m vertical and 6m 5-element Yagi."*

Readers' news

Congratulations to regular contributor **Carl Gorse M8HPI** who is getting married to **Lindsay** on 20 March and, as a result, has had little time for portable operating, being involved with wedding organisation. However, he did have one session on 21MHz SSB from POTA reference GB-5639 in Hartlepool using a Yaesu FT-891 to a Mad Dog Coil vertical antenna, **Fig. 5**.

Mad Dog Coil antennas were one of the traders at the Gold Coast Hamfest in Queensland, Australia, which **Martin Burch VK4CG** recently visited. In **Fig. 6**, **Marty Nelson VK4KC**, the owner of Mad Dog Coils, is seen with **Mark Perry VK4EMP**, the Parks On The Air (POTA) representative for Queensland (Marty is also a keen POTA activator). Martin says that events like the Gold Coast Hamfest *"have a loyal following here, allowing VKs to get together and have a chat as well as pick up a bargain."*

In the March column, I wrote that **Etienne Vrebos OS8D** was an 'evangelist' for portable operating, and he takes up the same theme this month: *"I really forget my age (76) when going to activate some park, getting everything ready and start CQing. Thanks for your kind words about being an evangelist. But it doesn't help: no increase in activators, only chasers. A good question would be: what keeps him / her inside and what good reason he/she has not to activate... There is no pleasure like being outside in the nature with wild people, animals (and wild authorities not understanding what you're doing!)"* The photo in **Fig. 7** shows Etienne activating another park with his motorbike during some sunny weather on 25 February.

Owen Williams G0PHY reported *"Activity levels were high again this month with the ARRL SSB DX contest and a couple of DXpeditions to chase. The ARRL DX contest is a chance to try some QRP operating as the exchange is a signal report and the power that you are using. It's a good test of how good my operating skills are and how good the US and Canadian participants are in picking up low-powered stations. The best low-power contacts, using 20 watts, were: 7MHz NA8V in Michigan, 14MHz W3LPL in Maryland, 21MHz VA5AA in Saskatchewan. Using 200W I managed QSOs with stations in Texas, New Mexico and British Columbia. During the contest I made an interesting discovery: I inadvertently used the quarter-wave inverted-L I use for 7MHz on 21MHz, although I shouldn't have been surprised as 21MHz is the third harmonic of 7MHz (it's a long time since I took my RAE so I'm a bit rusty on the theory). Anyway, the SWR as per the meter on the rig was better using the vertical than the 21MHz dipole. Using the vertical on 21MHz I managed to work VE9XX in New Brunswick using 20W. Outside the contest the team at J51A in Guinea-Bissau were loud over all*

Fig. 7: **Etienne OS8D/P operating portable on 25 February.** Fig. 8: **The G0PHY antennas: dipoles and a Spiderbeam pole.**

bands except 7MHz and the three Polish operators on Anguilla provided some new band slots." Owen added that he had heard both the 3Y0K Bouvet and T8OK Palau DXpeditions: *"I take that as a good result as I thought I would be unable to hear them at all. However, working them will be quite a challenge!"* Owen's antennas are shown in **Fig. 8**.

Tim Kirby GW4VXE, operating on CW as **GW4MM**, says *"it seems to have been all about expeditions"*. Tim was pleased to end up with six bands from KP5/NP3VI. *"Although they were difficult to work for some, particularly SSB operators, they did an amazing job, making over 100,000 contacts on a solar-powered station running limited power. Having the contacts confirmed on LoTW within an hour or so of making the contact was great too – quite a contrast to some expeditions who do anything to squeeze a donation out of you!"* Tim also commented that J51A have been everywhere and have been very easy to work. He was particularly pleased to work them on 80m FT8. *"And then of course, there's Bouvet! The pile-ups have been intense, but I'm pleased to have worked them on three bands so far: 12, 15 and 17m, all on FT8. I would like a CW QSO, but each time I listen to one of their CW pile-ups, I change my mind!"*

28MHz beacons

The 28MHz beacon report for the period 1 to 28 February was compiled by **Neil Clarke G0CAS**, who commented: *"Well it had to happen: the number of days when Sporadic E took place during February deceased substantially. In fact only six openings were detected."* ZB2TEN 28168 was heard on the 1st, 12th and 22nd on its new frequency of 28168. Several beacons from Italy were logged on the 9th, 15th and 28th, including IZ0EGC 28175, IW3FZQ 28228 and IZ0CWW 28295. Also, OY6BEC 28235 was heard on the 4th.

Now for F-layer propagation. 5B4CY 28169 and YM7TEN 28225 were logged on 27 and 21 days receptively, while on 28200 4X4TU was logged on 24 days. Paths to North America were good most days, with 4U1UN 28200 heard on 22 days. Beacons in W call areas 4 and 5 were logged on 24 and 23 days respectively, while call areas 1 to 3 were logged between 16 and 20 days. From Canada, VA3XCD 28170 and VE3TEN 28175 were logged on 11 and 20 days respectively. Down now to Central and South America where two recently new beacons are providing an excellent service. They are PY2BBM 28198 and XE1JAL 28276 and were logged on 25 and 22 days respectively.

Across to South Africa, where ZS1TEN 28220 was heard on seven days and ZS6DN and 5Z4B, both on 28200, were logged on nine and six days. Finally, now to Australia, and on 28200 ZL6B was only heard on the 4th while VK6RBP fared better and was heard on ten days. VK8VF 28268 was logged on nine days and VK4RST 28264 was only logged on the 9th.

Band highlights

Key: Q = <20W, M = 20 – 100W, H = >100W, S = Single-element antenna, B = Beam (see January *HF Highlights* for a more detailed explanation).

Eva M9TEL (MS): 21MHz FT8: FJ/DK6AS, FR4OM, HI3K. **24MHz FT8:** 9Y4DG, CO2XK. **28MHz FT8:** HC1MD/2, OX3LX, P4/WE9V, PJ4GR, PJ7/TF1OL, TI2JJP, V31DL, WP4PNT, XE1KK.

Steve G4JVG (MS): 21MHz FT8: FJ/DK6AS, HI3A, J51A, KP4Z, P4/WE9V, VP2MAA. **24MHz FT8:** 9Y4DG, EK/RX3DPK, J51A, PJ7/FT1OL. **28MHz FT8:** D2UY, J51A, OX3LX, PJ4NX.

Carl M8HPI/P (MS): 21MHz SSB: AC3NQ, AB4WS, HI8AM, KC2QVD, KJ5GCH, N0TAR, PY2MHC, W1WCM.

Martin VK4CG (MS): 7MHz SSB: OH7WP. **14MHz SSB:** N3AD. **21MHz SSB:** JL1MWY, WD6T, ZL1LU. **28MHz SSB:** K3EST, KW7MM, VE7BC, W5HL.

Etienne OS8D (HB): 14MHz SSB: 4UNR (UN Vienna). **18MHz SSB:** J51A. **21MHz SSB:** 4K3ZX, 8R1WA, BI1XJT, HP1GDS, JY6SC, KP4YAT, PJ2/K8LG, ZV4MG. **24MHz SSB:** CX4RT. **28MHz SSB:** 8P5AA, 8R1WA, AP2HA, CA3HHE, CB7C, KP5/NP3VI, LU1ANG/0, PJ2/DF8ZH, V4/WA7RAR, VP8TM/P, ZV5PR.

Owen G0PHY (MS / HS): 7MHz SSB: CF3A, FY5KE, NA8V, VP2ELX. **14MHz SSB:** J51A, VA7OM, VP2EAD, ZV6BA. **18MHz SSB:** J51A, VP2EAD. **21MHz SSB:** FY5KE, J51A, PJ4/G4PVM, VP2ELX, ZV4MG. **24MHz SSB:** J51A. **28MHz SSB:** J51A.

Tim GW4VXE / GW4MM: (MS): 3.5MHz FT8: J51A. **7MHz CW:** KP5/NP3VI, ZD7AQH. **14MHz CW:** KP5/NP3VI. **14MHz FT8:** 8Q7ZW, T8OK. **18MHz CW:** KP5/NP3VI. **18MHz FT8:** 3D2USU. **21MHz CW:** KP5/NP3VI. **21MHz FT8:** 8Q7ZW, KP5/NP3VI. **24MHz FT8:** KP5/NP3VI. **28MHz FT8:** KP5/NP3VI.

Signing off

Thanks to all contributors: please send all input for this column to teleniuslowe@gmail.com and note that for the July issue the deadline is **9 May**, a couple of days earlier than usual. 73, Steve G4JVG. **PW**

Buy back issues and archive CDs at www.mymagazinesub.co.uk/practical-wireless

Broadcasting history

Keith and **Garry** invite you for another leisurely jog through their archives.

Keith Hamer
Keith405625.kh1@gmail.com
Garry Smith
Garry405625.gs@gmail.com

BBC Broadcasting House, London: Part IX

In 1933, complaints were lodged in the *House of Commons* regarding a certain statue placed in a purpose-built niche above the front entrance of *Broadcasting House* depicting *Prospero and Ariel* (two characters from *The Tempest*, the last play written by **William Shakespeare**). The sculptured group, by **Eric Gill**, depicts Prospero, Ariel's master, sending the "*invisible spirit of the air out into the World*", **Fig. 2**. The BBC commissioned the work "*as the personification of broadcasting*". Unfortunately, when the statue was unveiled in 1933, it seemed more like the personification of vulgarity, according to some MPs who said it was *"an offence to public morals*". The BBC's *Director-General*, **John Reith**, took one look at it and immediately ordered certain parts of Ariel's anatomy to be re-worked and made, shall we say, of more *"decent proportions*". Mr. Gill wasn't impressed and is reported to have shouted down to passers-by a rather obscene comment relating to Ariel's original dimensions, which we won't repeat here!

On 12 January 2022, the iconic statue was vandalised by a man wielding a hammer. The *Metropolitan Police* sent officers to the BBC's headquarters following reports that someone was attacking the 10ft (3m) sculpture. After about four hours, a fire crew using a 'cherry picker' brought the man down. Following recent repairs, the statue is now enclosed behind a protective transparent screen.

Vintage Chakophone aerial tuning unit advertisement

This month's trawl through vintage copies of desolate newspapers and magazines has uncovered an advertisement by *Eagle Engineering Co., Ltd.*, for their *Chakophone Universal Aerial Tuning Unit*, **Fig. 1**. The advertisement dates from 24 September 1932. The text has been left in its original format to reflect the spelling, grammar and punctuation of the time.

The length of aerials used for early domestic *TRF* (*Tuned Radio Frequency*) wireless receivers was normally restricted to approximately 100ft. This was because *reaction coils*, referred to in the advertisement, were used to improve gain and selectivity. The coils were frequently poorly adjusted and susceptible to re-radiating a carrier which could cause interference to neighbouring receivers. Limiting aerial length was a compromise between permitting reception of distant stations and restricting the area of interference from an oscillating RF stage.

100 years ago: May 1926

This series acknowledges some of the events, technical achievements and personalities associated with the world of broadcasting from exactly 100 years ago this month.

Due to the *General Strike* in the UK between 4 and 12 May 1926, no national newspapers were published. From the beginning of the strike, the *British Broadcasting Company* broadcast five news bulletins each day. This caused unrest with members of various unions resulting in the Daventry transmitter having to be guarded by 12 plain-clothes policemen. A total of 27 special news bulletins were broadcast. This number does not include other bulletins dealing with emergency railway arrangements.

The first radio broadcast of a complete opera, *I dispettosi amanti (The Mischievous Lover)* by **Attilio Parelli**, was transmitted on 6 May. It was performed by the Milan station of the *Unione Radiofonica Italiana* (*URI*).

The British broadcaster, **David Jacobs**, was born on 19 May. Perhaps he was best known for presenting *Juke Box Jury* on BBC-tv. The first edition aired on 1 June 1959. David died on 2 September 2013.

On 15 May the *American Telephone & Telegraph* company established the *Broadcasting Company of America* which incorporated *WCAP* in Washington, DC, *WEAF* in New York, and the small communications network between both stations.

Also on 15 May, *Radio Zagreb*, the first radio station in south-eastern Europe, began broadcasting.

The British disc-jockey and actor, **Desmond Carrington**, was born on 23 May.

The first broadcast from the House of Peers was on 26 May with coverage of the *International Parliamentary Commercial Conference* banquet featuring speeches by the **Prince of Wales** and the **Rt. Hon. Winston Churchill**.

The Finnish national broadcasting company, *Yleisradio* (*YLE*), was formed on 29 May. On the same day, the *Vrijzinnig Protestantse Radio Omroep* (*VPRO*) was established in the Netherlands.

The Chakophone Regd.
UNIVERSAL AERIAL TUNING UNIT
2 MODELS NOW AVAILABLE
HERE is a Tuning Unit which brings in stations all around the dial. It is fitted with an oxydised panel ready for mounting on the set. It embodies a reaction coil which dispenses with a condenser. It is suitable for a two or three-valve set. It is made in two models, Standard and Selective. The two used together make an excellent combination should you desire to construct a Screen Grid Circuit.
Price 10s. 6d. each.
A wiring diagram is supplied with every coil.
Ask for one at your dealers or send to us.
• entirely British made
EAGLE ENGINEERING CO., LTD., WARWICK.

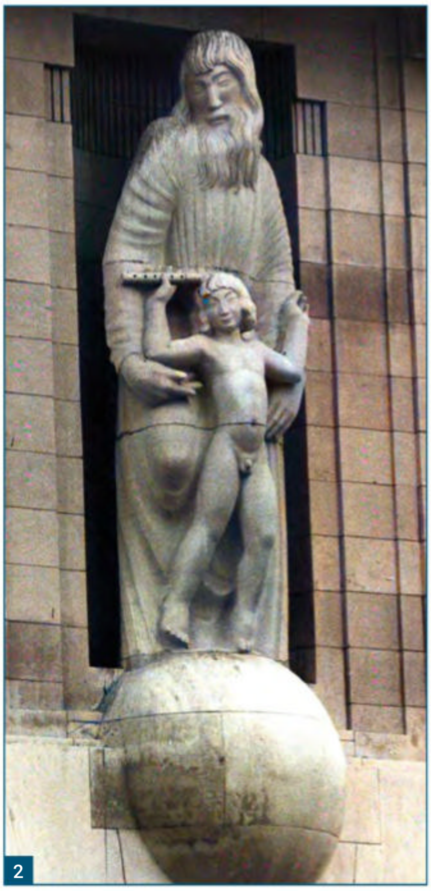
1

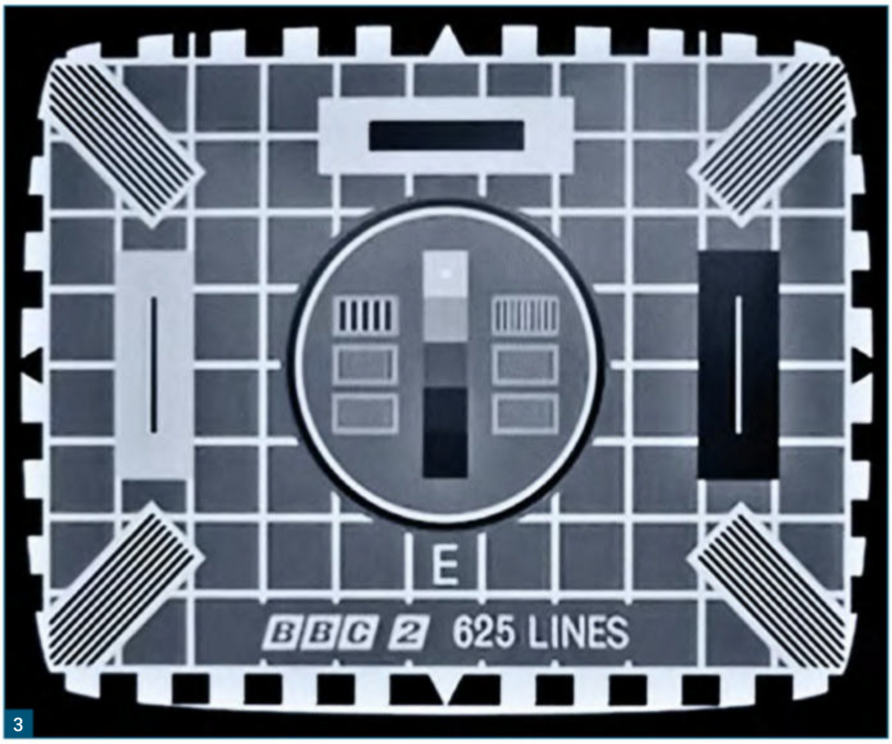
The Italian-born actress, writer, radio announcer and television personality, **Katie Boyle**, also known as **Lady Saunders**, was born in Florence on 29 May. Her actual Italian name was **Caterina Irene Elena Maria Boyle**. Katie was perhaps best known for hosting the *Eurovision Song Contest* on a record number of occasions: in 1960, 1963 and 1968, 'live' from London, and in 1974 when the competition was held in Brighton. The event on 16 May 2026, 'live' from Vienna, celebrated the 70th anniversary of the first festival which was held in Montreux, Switzerland.

In focus: The BBC Crystal Palace transmitter – Part II

Most radio and television transmitting installations in the UK are of the straight, steel, open-lattice 'mast' variety. The *Alexandra Palace* and *Crystal Palace* structures are officially classed by the BBC as 'towers'.

The Crystal Palace tower was designed and erected for the BBC by *British Insulated Callender's Cables Co., Ltd.*, (*BICC*). The company was formed in 1890. A 16mm film of the construction was produced by BICC. It was entitled *The Phoenix Tower - The Story of the Crystal Palace Television Tower,* which may be


2



3

Fig. 1: **An advertisement by *Eagle Engineering Co., Ltd.*, for their *Chakophone Universal Aerial Tuning Unit*, dating from 24 September 1932. Fig. 2: Prospero, Ariel's master at Broadcasting House in 1933, sending the *"invisible spirit of the air out into the World"*, as well as sending shock waves of disgust to MPs in the House of Commons! Fig. 3: The BBC-2 Test Card "E", used for a relatively short time from 20 April 1964.**

available on loan from the *BICC Film Library*.

All the steelwork for the tower was fabricated by *Painter Brothers Ltd*., of Hereford.

The tower was erected using two masts acting as derricks; one was 230ft (70m) high and the other 125ft (38m). The masts were used in conjunction with a winch. From the outset, the installation was required to transmit television programmes with good reception over a wide area of London and parts of the surrounding Home Counties.

The current height of the tower is approximately 719ft (219m). It is located atop a 358ft (109m) hill in *Crystal Palace Park.* The installation is operated by the television and transmission company, *Arqiva*.

60 years of BBC-2: Part XXVI

In preparation for the start of BBC-2, special test transmissions were aired from January 1964. There were often at least 70 demonstration films shown each week. The films included *Diavolezza*, *Hook, Line, and Sinker* and *Skyhook*. These particular films were also shown during *Trade Test Transmissions* for colour television which began in 1967. One film which wasn't used for colour was grandly entitled *Cubism and After: Figures in Space*. No doubt that one made people rush out to buy a BBC-2 set!

Cinema feature films were also shown from January 1964, including the 1938 *RKO Radio Pictures* production of *Bringing Up Baby* (starring **Katharine Hepburn**, **Cary Grant** and **Baby**, the latter being played by a trained leopard whose real name was **Nissa**!) and the 1941 **Alfred Hitchcock** thriller, *Suspicion*, with Cary Grant and **Joan Fontaine**.

Trade Test Transmissions on BBC-2 began at 9.00am with the Test Card (accompanied by either some wonderful music or the 440Hz/1kHz *Test Tone*) and continued until approximately 8.00pm, at which time, BBC-2 closed down. Those were the days!

Test Card 'E' was first transmitted on 20 April 1964, when BBC-2 was planned to officially open, but was later replaced by a modified 625-line version of Test Card 'C'. This was due to inherent technical problems with the design of frequency gratings used for Test Card 'E', **Fig. 3**. Test Card 'C' (first transmitted in January 1948 and featured in the July 2025 column) incorporated frequency bars produced by a square-wave generator.

Test Card 'D' (BBC-1, 405 lines) and Test Card 'E' were the first to employ sine-wave cross-section frequency bars. Although Test Card 'D' was perfectly satisfactory for the VHF 405-line service, Test Card 'E' presented difficulties on the higher definition UHF 625-line standard; the sine-wave bars appeared 'soft' and indistinct. This apparent softness was accentuated on Test Card 'E' because the frequency bars were positioned on a lower-toned grey surround compared with the background grey used for Test Card 'D'.

Service information, Iceland: Part V

When the national television service, *Ríkisútvarpið Sjónvarp (RÚV)*, eventually arrived in 1966, television performers and producers in the USA believed that the *American Forces Radio & Television Service (AFRTS)* should pay similar fees to those paid by *RÚV* for the broadcast of purchased American programmes.

By this time, AFRTS signals in Iceland were reaching a much larger audience than originally intended. Consequently, the commander of the American base requested permission from the Icelandic government to allow the AFRTS to significantly reduce the transmitter power so that reception was only possible on the American base and its immediate surroundings, as the operating costs of the station would inevitably rise significantly to pay for the increased broadcasting fees.

Stay tuned!

The photos are once again from Keith and Garry's collection. Please send archive photographs, information or suggestions for future topics via the email addresses shown at the top of this column. **PW**

Phil Harris G4SPZ
practicalwireless@warnersgroup.co.uk

1

Servicing BayGen/ Freeplay spring-driven radios (Pt I)

Phil Harris G4SPZ starts a two-part feature on how to service the once-popular Freeplay wind-up radios.

The self-powered radio receiver, dubbed the 'clockwork radio', was conceived in the early 1990s and patented in 1991 by British inventor **Trevor Baylis, Fig. 1**, but it took five years till 1995 to bring the concept to reality. The first three generations of sets used powerful springs to store energy mechanically, and to drive a dynamo to power the receiver. In less than ten years and after many millions of sets had been manufactured, the hand-cranked spring-driven radio had been superseded, by a hand-cranked alternator as the power source and a rechargeable battery for energy storage.

Background

Trevor Baylis's invention of the wind-up radio is quite well-known. He first thought of the idea in 1991, and coupled a clockwork motor to drive a small dynamo and mechanically generate enough power to run a small transistor radio. The principle was sound, but the traditional clockwork motor springs used in the first prototypes delivered a constantly-decreasing amount of power as the spring unwound, and failed to provide more than a few minutes of playing time before re-winding became necessary. The real breakthrough came when Trevor discovered the constant-force spring as used in motor car seat belt tensioners, and its close relative, the constant-torque spring motor. The arrangement is shown in **Fig. 4** where item 14 is the storage drum, 15 is the torque drum and 16 is the output shaft leading to the gearbox.

The detailed design and perfection of the spring-driven power source took nearly four more years of dogged persistence, effort and collaboration until June 1995 when the purpose-built BayGen factory in Cape Town, South Africa, was ultimately open and producing clockwork radios. BBC1 television featured the story in its programme *QED* on 8 August 1995, still available to view at the time of writing. The obituary article about Trevor Baylis which appeared in *The Independent* newspaper could still be found online at the time of writing.

BayGen/Freeplay spring technology

The carbon steel spring – about which an important safety warning will appear later - at the heart of the power generator is 5m long, 50mm wide and 0.2mm thick, and is arranged on two spools known as the storage drum and the output or torque drum, sometimes referred to as a 'B-motor' arrangement. When unwound, i.e. 'relaxed', the spring resides on the storage drum. As it is wound up or 'charged', the spring is pulled from the storage drum and rolls back on itself onto the torque drum; once fully wound - 60 turns of the winding handle – the spring returns to the storage drum, turning the torque drum via a one-way ratchet mechanism. The crucial advantage of the constant-torque spring motor over a conventional clockwork spring is that its output torque remains substantially constant throughout its unwinding cycle, dropping by no more than 22% from start to finish, and generating a steady power output.

Linked to the torque drum is a 1,000-to-1 ratio step-up gearbox which drives a Mabuchi dynamo, the final stage being by a 1.2mm square section rubber drive belt. It is interesting that the original patent gives two alternative final stages for the gearbox; one where the dynamo is gear-driven throughout, much being claimed in the patent for the gear mesh depth adjustment provided to ensure quiet running; and an alternative final stage using pulleys and a rubber drive belt. It apparently proved impossible to obtain sufficiently quiet running in prototypes using the all-gear drive train, so the drive belt was adopted from the beginning of volume production. The rubber drive belt was far quieter, but immediately introduced an age-related point of failure.

While on the subject of the springs, the specification for these calls for a minimum of 10,000 charge-discharge cycles before performance begins to deteriorate, which equates to roughly 5,000 hours of playing time, or three hours per day for five years. An interesting bit of research I undertook was to measure and calculate the amount of mechanical work required to wind up the spring (197mWh) and compare it with the total electrical output from the dynamo (52mWh),

Fig. 1: The late Trevor Baylis.
Fig. 2: The FPR1 radio.
Fig. 3: The power control circuit.
Fig. 4: Spring mechanism (from patent).

so the overall energy conversion efficiency turned out to be just 26%!

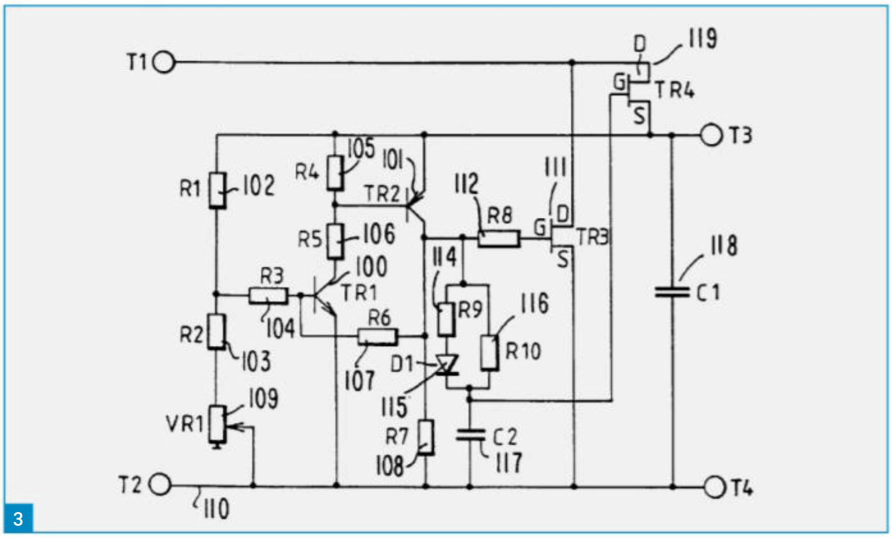
The original BayGen 'Freeplay' radio

The first generation model, known as the BayGen 'Freeplay' and designated the model FPR1, **Fig. 2**, was deliberately styled to appeal to African tastes – big, relatively heavy at over 2kg and robust-looking. The set covers medium waves (500-1,700kHz) and short waves (5.5-18MHz) plus VHF-FM (88-108MHz). The single-conversion superhet receiver circuit is sensitive and selective, and the mechanical fine-tuning feature enables short-wave stations to be resolved with ease and without any backlash. Despite only delivering about 100mW of audio power, the sound quality is surprisingly clear and volume is perfectly adequate, no doubt helped by the 5-watt 4in speaker and spacious cabinet. The receiver is based around the Temic (Telefunken Microelectronics) U-2510B 'single-chip radio' IC and the circuit operates from a little over 2.3 volts.

The dynamo spins at around 2,000 RPM and produces about 3V DC at 30-35mA, thus the spring unwinds at nominally 2 RPM. A full 'charge' of 60 turns of the winding handle therefore provides 30 minutes of playing time, irrespective of volume. The generator output voltage is clamped at around 3V by a TL431AC 'programmable Zener' chip. The set can also be powered by an external DC supply of between 3-9V.

The FPR1 remained popular in developing countries where it was distributed widely by aid agencies and charitable organisations, and it continued in production till around 2003 or 2004.

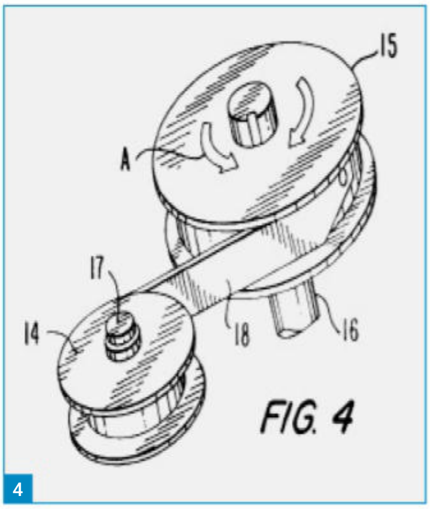
2



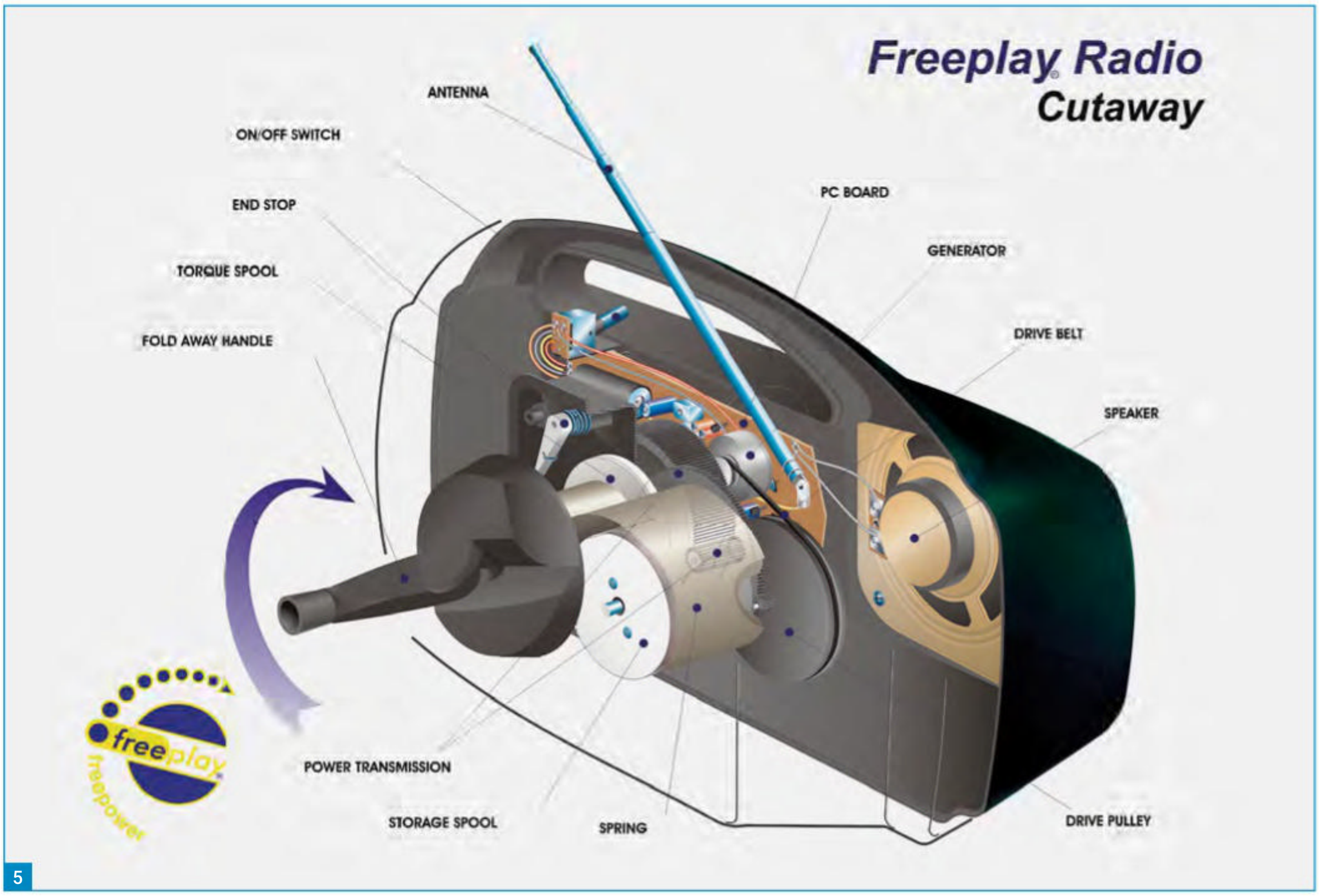
3

Smaller, more modern and with a solar panel – the Freeplay FPR2

The second generation model was launched in 1997, and featured more modern and compact styling designed to appeal to Western tastes. Trevor Baylis is holding a blue FPR2S in Fig. 1. It covered just medium waves and VHF, used the same Temic U2510B receiver chip and 50mm wide spring, but incorporated an improved hysteresis voltage control circuit which electronically brakes the unwinding of the spring when the current demands of the receiver circuit permit. This patented power controller, **Fig. 3**, effectively monitors the voltage across a 22,000μF reservoir capacitor (changed in later FPR2S models to a parallel pair of 6,800μF capacitors) connected across the Vcc supply to the receiver PCB. A MOSFET (TR3) shunted across the dynamo is alternately turned 'on' and 'off', applying a 'shunt brake' and slowing the dynamo to a crawl when the supply voltage reaches an upper threshold of around 3.5V, and releasing it again when the voltage has dropped to about 2.8V. The visible result is that, at low volume levels, the spring unwinds alternately quickly, then slowly, then quickly, then slowly... The hysteresis controller consequently increases the run time from a fully-charged spring from 30 minutes to at least 45 minutes, and at low volumes the FPR2 will play for nearly an hour. Incidentally, switching the set 'off' places a short-circuit across the dynamo, allowing the



4



5

spring to continue to unwind at a very slow but controlled rate.

Early model FPR2 sets appeared in solid-coloured plastic cases in black, olive green, grey and silver and featured a moulded speaker grille, but in around 1999 an updated model designated FPR2S superseded it, the 'S' indicating the presence of a solar panel which is capable of running the radio on its own in bright sunlight. Later FPR2S models were released in transparent polycarbonate cases in green, red, blue and clear colours which made the rotating parts visible as the radio played, and had a black perforated metal speaker grille. The FPR2 is still a fairly heavy radio at 1.9kg, and its moderately chunky styling made it popular in Europe and the USA, particularly among those keen on emergency preparedness. The cutaway, **Fig. 5**, shows the more compact construction. The radio can also be powered from an external 3-12V DC supply.

The third and final 'clockwork' radio

The Freeplay FPR3 or the 'S360' model, **Fig. 6**, was launched in around 2000 and was in many ways a major departure from the previous designs, being much more compact, having a smaller spring only 25mm wide (but still requiring 60 turns of the crank handle for a full wind) and incorporating for the first time a 2.4V rechargeable NiMH battery pack, together with a small solar panel. In bright sunlight, even here in the UK, the solar panel will run the radio and trickle-charge the battery pack.

Due to the mass of the spring and mechanical components, the set is surprisingly heavy for its size at 1kg. The S360 uses a different and more powerful model of Mabuchi dynamo and the spring unwinds fully in a matter of ten minutes, charging the NiMH battery at a rate of about 230mA (560mW) and powering the receiver as it does so. No voltage control circuit is necessary, as the NiMH battery clamps the dynamo's output at a nominal 2.5V.

The battery can also be charged from an external 4.5V or 5V DC supply, and the continuous playing time with a fully-charged battery is of the order of 30 hours.

A very short production run of a rare solid-colour model 'S3' preceded the main release of the S360 radios, in translucent blue, purple, clear, and solid black cases. All have a perforated metal speaker grille. The one-chip receiver IC had by now changed to the Sony CXA1691BS [**4**], which receives MW and VHF bands and will operate down to just above 2V, hence making more use of the full capacity of the two-cell 2/3AA NiMH battery pack. Incidentally, a single full winding of the spring will power an S360 for up to an hour, depending on volume.

Fig. 5: **FPR2 cutaway.** **Fig. 6:** **S360 blue.** **Fig. 7:** **The warning label.** **Fig. 8:** **FPR2 gearbox.**

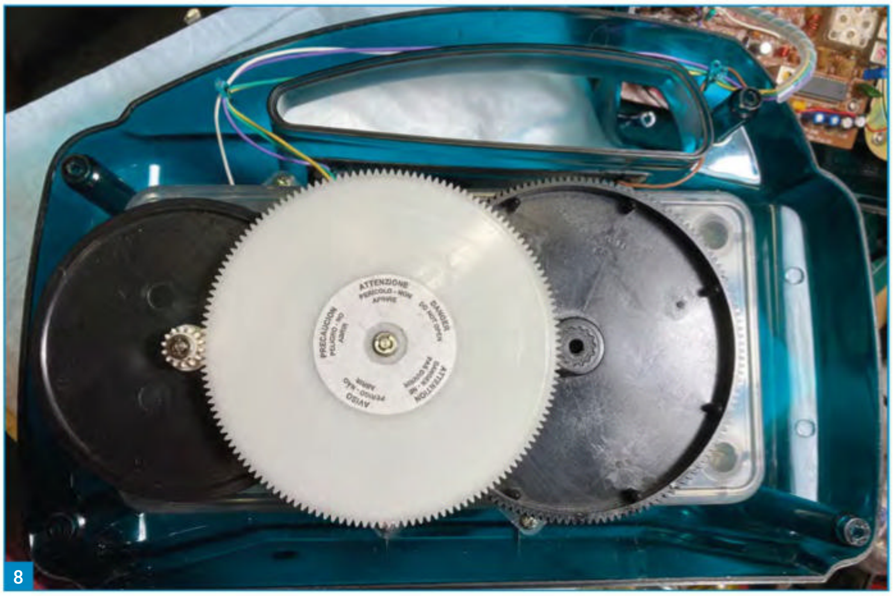
Servicing Freeplay radios

First, a safety warning. The springs inside all Freeplay sets of this era can be extremely dangerous. When fully charged, the large 50mm wide spring is storing over 700 Joules of potential energy. Putting that into electrical terms, it's equivalent to a 1,200μF capacitor charged to 1kV, something that we'd all treat with a great deal of respect and handle with extreme care. Another comparison is that a typical medical defibrillator delivers a shock of 600 Joules. The last thing you would want to do is to release all that stored energy instantaneously, which under certain fault conditions can actually happen with Freeplay springs. I have seen one YouTube video of someone clumsily dismantling a fully-wound FPR1, and to say he received a surprise is putting it mildly!

As long as the spring is completely relaxed, however, and remains fully wound onto its

6

7


8

storage drum, it can be considered quite tame and can be handled with care. As an amateur horologist, I have some experience of safely dealing with powerful springs, and at the very minimum, eye/face protection and protective gloves are strongly advised. However, the servicing procedures that I will outline in Part 2 of this article do not generally involve accessing the spring, although removing the PCB and solar panel of the Model S360 radio may require the spring and its spools to be manoeuvred out of the radio. Details will be provided in Part 2.

The writer and *PW* cannot accept responsibility for any injury sustained to any person – Freeplay placed prominent and multilingual warning notices inside their devices for very good reason! (**Fig. 7**)

Notwithstanding the foregoing safety warnings, repairing the majority of faults found in Freeplay radios is relatively straightforward. By now, every set of this type is 25-30 years old, the rubber drive belt will have stretched and/or perished, and the internal NiMH batteries, where fitted, will need replacing. Failure of the final drive belt will result in the un-braked rapid and potentially catastrophic unwinding of the spring, which can be quite alarming, not to mention damaging to the gear train!

To avoid this risk, it is not advisable to wind up a Freeplay radio fully unless you have first replaced the drive belt. Standard 1.2mm square section cassette drive belts serve perfectly well as replacements, the FPR1 and FPR2 taking an 80mm belt and the S360 a 57mm size.

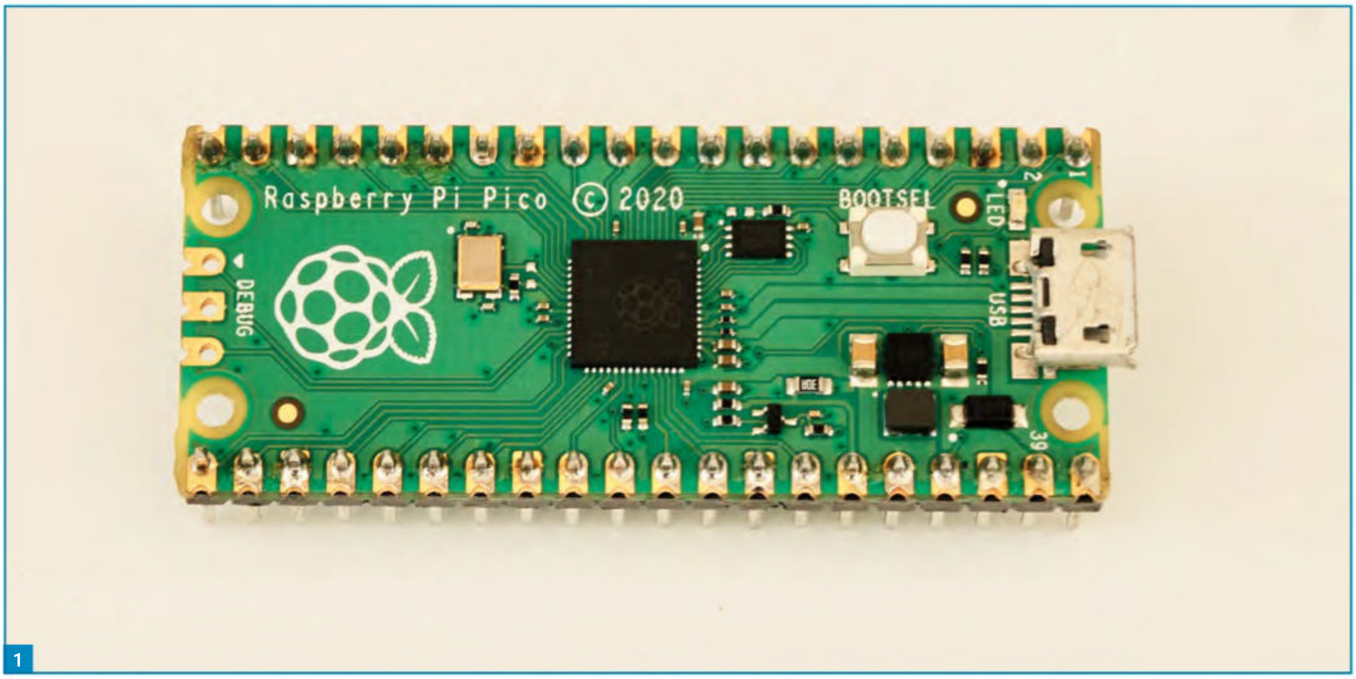
Dismantling

As previously stated, dismantling the radios should only be undertaken if the spring is fully relaxed, i.e. wound back onto the storage drum. A long, slim cross-point screwdriver is needed to reach the case securing screws at the bottom of long tubes in the case back. These screws are often very tight, and care is needed to avoid damaging the heads. I apply a small quantity of grease to the threads on reassembly to facilitate subsequent removal. The fifth case screw on the model S360 is concealed beneath a warning label, which needs to be peeled back or cut away to enable access to it.

There is normally adequate lead length to enable the two halves of the case to be carefully laid aside, giving access to the 1000:1 step-up gear train, **Fig. 8**. The black pulley on the left is the final stage which drives the dynamo via the rubber belt, both concealed behind the white centre wheel. The black gearwheel on the right is splined directly onto the storage drum output shaft, item 16 in Fig. 4. The spring itself resides safely behind the internal sub-chassis which holds the axles for the gear wheels.

(Images in Figs 1, 2, 5 and 6 courtesy of Freeplay Inductries Ltd) **PW**

In Part 2, Phil will describe some of the mechanical and electronic faults commonly encountered with Freeplay radios and will expand on repair and restoration techniques.



1

A Cheap WSPR Beacon

Mike Richards G4WNC
practicalwireless@warnersgroup.co.uk

Mike G4WNC describes how to build a low-cost WSPR beacon that you can maybe send to a friend abroad.

Last month, I raised the thought that we might be missing unusual band openings. This is because many data modes operators understandably use the available technology to follow activity. This results in predictable movement of activity between bands and encourages others to follow the same pattern, since that's where you'll find the most contacts. However, while RF propagation does follow clear patterns mainly driven by the Sun, other anomalies can occur, producing unexpected openings. My thought is that, with current data modes and operating practices, we may be missing some of these.

So how do we fix this? What we need is a system with transmitters operating on supposedly closed bands, paired with monitors that listen for an opening. Other than routinely calling CQ on quiet bands, one solution would be to make more use of WSPR's excellent propagation-probing capabilities. The availability of wideband SDR receivers such as the Web-888 and the RX-888 MkII, combined with software such as WebSDR and UberSDR, has led to an increase in the number of all-band 24/7 monitoring stations (I have two running here). This is great news and provides an excellent monitoring resource. These receivers are mainly located in Europe and the US, which is fine. However, I've noticed that the number of WSPR transmitters has been declining in recent years. This is especially true for parts of the world we in Europe would call DX. That's not so easy to fix, but it's not impossible.

One solution would be for UK amateurs to use their contacts and friendships abroad and supply them with simple WSPR beacons that can run 24/7 at very low cost. The designs for these beacons already exist thanks to the high-altitude balloon community. Balloon aviators regularly use WSPR beacons to track their high-altitude balloons during their global flights. For this application, the beacons need to be extremely light and have low power consumption. This also fits well with our requirements.

Pico beacon

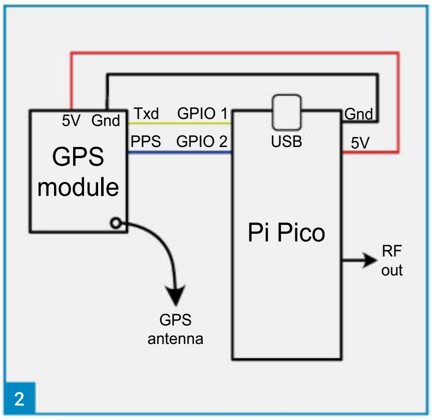
After looking at several designs, I settled on the WSPRer by KC3LBR. This uses the Raspberry Pi Pico microcontroller board, **Fig. 1,** a low-cost GPS unit, and very little else. The GPS provides a 1PPS (Pulse Per Second) output, along with serial data containing detailed time and positional information. This data is used to control the frequency, accuracy and stability of the Pico transmitter. Interestingly, the Pico software also calculates the Maidenhead locator from the GPS position, so we don't need to enter that manually.

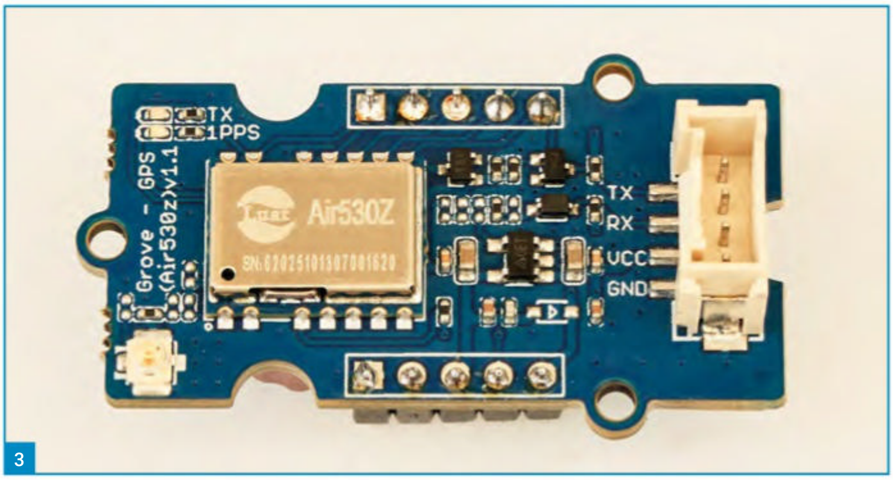
The original Pi Pico-based WSPR transmitters produced a digital output that required significant filtering before reaching the antenna. However, this design uses a later technique to create a pseudo-fractional PLL, resulting in a cleaner output. This simplifies the filtering and reduces the number of components. The WSPRer software also includes simple programming options that let you set the callsign, operating band, protocol, and more by connecting to the Pi Pico via USB. Overall, this makes for a very flexible and attractive solution. Let's look at the design in a bit more detail.

There are only two components in the basic tracker: a Raspberry Pi Pico (original version) and a GPS breakout board. You can use a variety of GPS boards, the only requirements are:
1) Standard NMEA 0183 output at 9600 baud and
2) a 1 PPS pulse output.

The connections are very simple, as shown in **Fig. 2**. I experimented with several cheap GPS breakout boards, and the best I found was the Grove – GPS (Air350Z), shown in **Fig. 3**. This is available from several suppliers, but Pi Hut has stock and sells them for £10.60 plus postage. There are a few things I particularly like about this board.

To begin with, it's very nicely built and has all the signals we need brought out to 0.1in spaced solder points on the board edge. This makes it very easy to add pins, allowing you to mount the board securely on a breadboard for testing or on a matrix board for the final build. The Grove GPS also includes a battery backup option for fast recovery after a power supply break. This uses a 1220-size 3V lithium battery with the holder on the underside of the board. There is also a very clear 1PPS LED that provides a useful





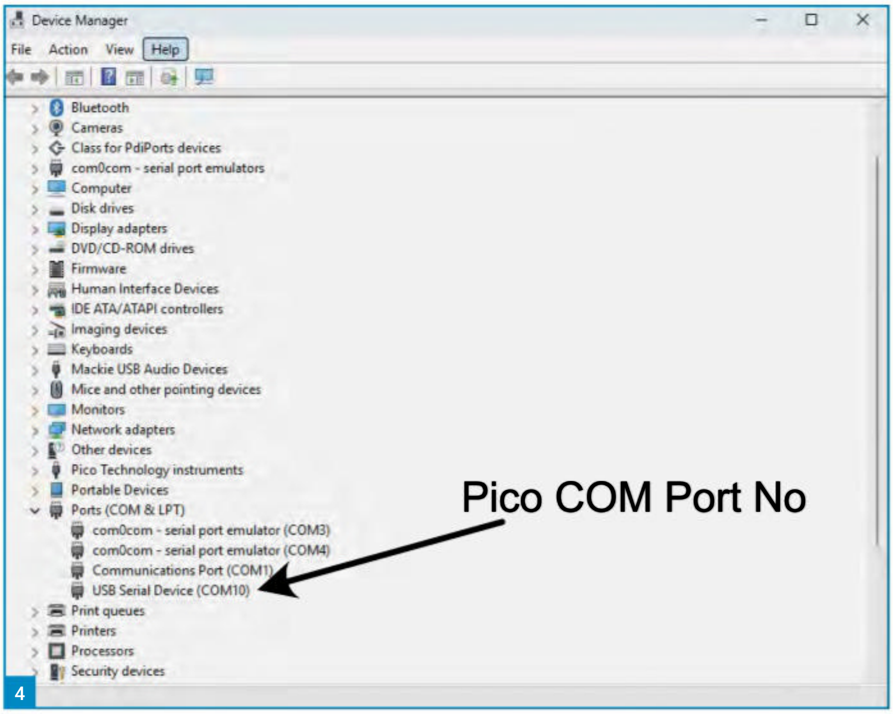


Fig. 1: Rapsberry Pi Pico microcontroller board. Fig. 2: WSPRer beacon connections. Fig. 3: Grove GPS receiver. Fig. 4: Device Manager COM ports.

indication that the board has achieved a solid fix. The supplied patch antenna also appears to work well. In my case, it reliably found at least six satellites from the workbench inside the shack!

The next stage is to install the software on the Pi Pico. This is a simple process because the author has kindly provided a pre-compiled binary file that we can download from their GitHub site. One of the many attractions of the Pi Pico is its simple programming system. To load a program onto the Pico, you first put it into programming mode by connecting the power while pressing and holding the BOOTSEL button. When you do this, the Pico appears on the connected PC as an external hard drive called RPI-RP2. To complete the process, you drag the downloaded UF2 file onto the Pico. Once the transfer is complete, the Pico will disconnect and start running the software.

For our tracker, you can download the uf2 file from here:

https://tinyurl.com/3wmyy942

Here's a step-by-step guide to installing the software:

1. Remove the USB plug from the Pico and reconnect it while pressing and holding the Boot/Sel button. This puts the Pico into programming mode, and it should appear in File Manager as an external drive, usually with a name similar to RPI-RP2.
2. Open and unzip the WSPR Beacon software you downloaded.
3. Now drag and drop the extracted .uf2 file onto the RPI-RP2 drive.
4. Once the software has downloaded, the Pi Pico will disconnect, and the software will start running automatically.

Initial testing

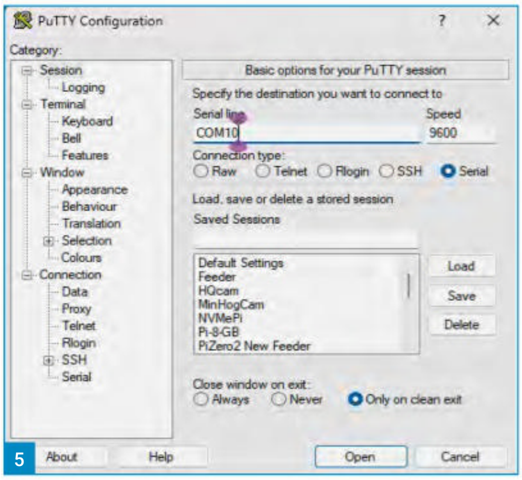
To perform initial testing, you can use a breadboard to connect the GPS unit to the Pi Pico. While testing, the Pi is best powered via the USB socket, and the GPS unit's 5V power can be taken from the 5v and Gnd pins of the Pico. The only other connections are the Tx data from the GPS, which goes to GPIO 1 and the 1PPS pulse, which connects to GPIO 2. The raw RF output appears on GPIO 21 of the Pico so you could connect this via an attenuator to a spectrum analyser. Alternatively, you could attach a short patch wire and use your rig to monitor the output.

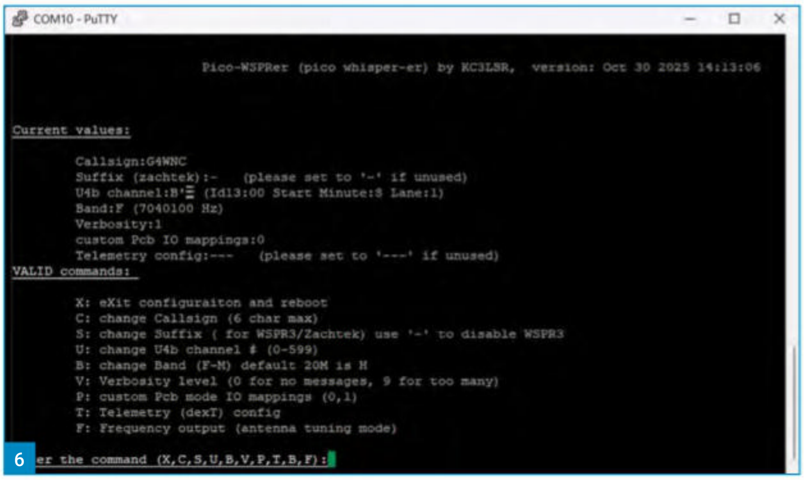
The WSPRer's default settings have it transmitting on the 20m WSPR band with no callsign set, so we need to configure the beacon so that any escaping signal is legal. Configuration is completed via the USB port using a terminal emulator program. My favourite program is PuTTY, which is available for most operating systems, including Windows. You can download it from here:

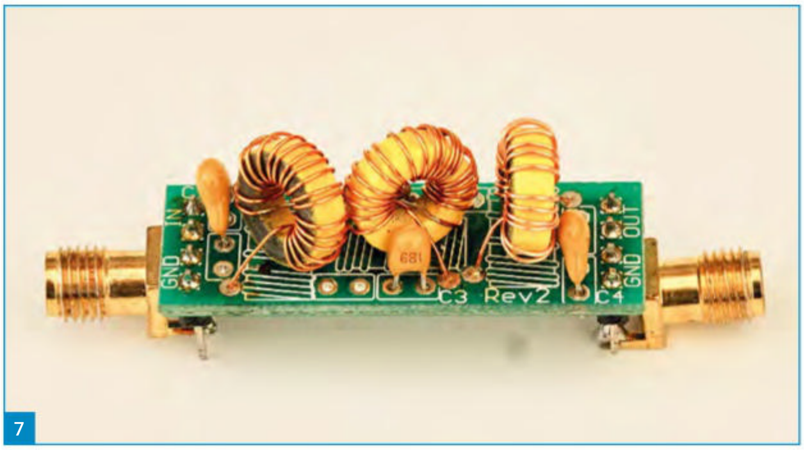
https://putty.org/index.html

Before running PuTTY and connecting to your Pico, you need to know which COM port it's on. To find this, open Windows Device Manager and expand the Ports (COM & LPT) entry, **Fig. 4**. You should see a list of the active COM ports, The Pico will show as a USB Serial Device (COMxx). The nn is the COM port number; make a note of it. Next, open PuTTY (**Fig. 5**). In the Connection type panel, select Serial. In the Serial line box, enter your COM port number and set the baud rate to 9600. To save time in the future, it's worth saving this configuration. To do that, enter a name in Saved Sessions and click the Save button. You can now click Open to start the session.

If all is well, you should see a line of text appearing regularly. To enter configuration, just hit Enter on your keyboard. You will see a message followed by a prompt to press any key. When you press a key, you should see the main menu (**Fig. 6**). The top section lists the current settings, while the bottom section shows







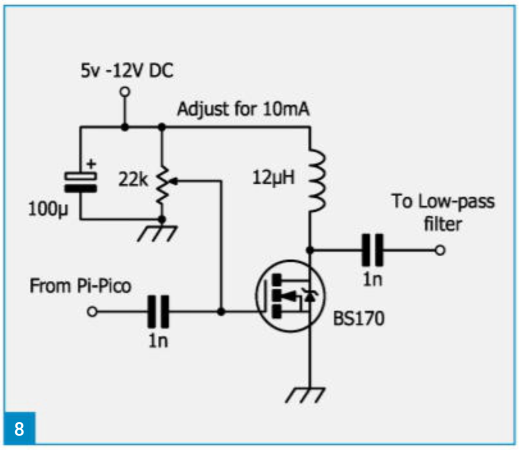


Fig. 5: PuTTY main menu. Fig. 6: WSPR Beacon menu. Fig. 7: QRP-Labs low-pass filter. Fig. 8: Simple BS170 PA.

the available options. This beacon includes an option to add additional information, but we're not using it. Press 'S' followed by '-' to stop the suffix, then 'T' followed by '---' to stop the telemetry.

Now you can enter C followed by your callsign, then B followed by the band letter (F to M) to set the operating band. Here's the band index: F = 40m, G = 30m, H = 20m, I = 17m, J = 15m, K = 12m, L = 10m and M = 6m.

NB: The beacon will not transmit until it receives a 3D fix from the GPS unit. A flashing blue 1PPS LED on the GPS unit confirms a 3D fix. This limitation is necessary because, without the lock, the generated RF is both inaccurate and prone to drift. When first connecting the GPS, it may take quite a while to achieve a good fix. Make sure you have a good GPS signal and give it time.

To force the unit into transmit mode, enter 'F' followed by a frequency in MHz. This command is a bit flaky, but it should allow you to check the output. You will also need a low-pass filter to clean up the output signal; there are plenty of simple designs available online. If you want neat kit solutions, SOTA Beams offer single-band-pass kits for £5.25 each. They also offer dual- and 3-band filters. Alternatively, QRP-Labs offers plug-in kits for $4.60 each, **Fig. 7**, but shipping will likely be more expensive than with SOTA Beams. Unless you're connecting to a very good antenna, you will probably need to add a simple PA. The most popular solution for this application is to use a cheap BS170 FET between the Pico output and the low-pass filter. I've shown a schematic in **Fig. 8**.

Alternative beacon

The beacon I've suggested here is intended for those who enjoy some home construction and are happy to configure the final construction and housing to suit what they have available. If you'd like a more complete solution, I can thoroughly recommend the Ultimate 3S kit from QRP Labs. Their basic, uncased, single-band kit costs just $36, which is excellent value. The Ultimate 3S is extremely versatile and can be set to transmit QRSS, Hell, Opera, PI4, and WSPR slow-signal modes on any band from 2200m to 2m. As with many QRP-Labs products, several upgrades can be added to the kit. One of the most important for WSPR operation is the QLG2 GPS receiver. This adds $25 to the cost but provides a very accurate timing source to keep the transmit frequency spot-on, ensuring accurate transmit timing, making it a worthwhile addition, especially as WSPR is such a time-critical narrow-band mode. One extra benefit of including the GPS receiver is automatic Maidenhead locator calculation. The Ultimate 3S software uses the GPS positional data to calculate the Maidenhead locator. This could be particularly useful if you're sending the beacon to a friend in a distant land. All you need to program is their callsign, and the Ultimate will calculate everything else, based on where it finds itself.

If you would prefer a multi-band beacon system, QRP-Labs can supply a deluxe version of the Ultimate 3S. In addition to the Ultimate 3S, this kit includes the following modules:

- 6-band relay-switched low-pass filter extension kit
- 6 low-pass filters of your choosing (10, 15, 20, 30 & 40m included as standard)
- QLG2 – GPS receiver
- 2 spare BS170 PA FETs so you can increase the RF power
- Drilled and printed alloy enclosure

This multi-band kit is called the Deluxe 6-band U3S set and currently costs £136.99 plus shipping. I currently have one on order, so I should be able to give you more info and some photos next month. **PW**

ML&S Web: www.HamRadio.co.uk Tel: 0345 2300 599

Trustpilot — HamRadio Reviews. Like our service? Why not leave a review? https://uk.trustpilot.com/review/www.hamradio.co.uk

Choose ML&S for the 'Big 3' and so much more!

YAESU

ML&S Officially the only Direct Factory Appointed Distributor & Repair Workshop for Yaesu Musen Products

This month's STAR PERFORMER
Yaesu FTX-1F
ALL BAND ALL MODE PORTABLE

Another Dream Radio from Yaesu.
Taking over from where the best-selling FT-818 left off.

FTX-1F (Field version): £1459.00
Comes with free SPG-1 protection guard & SCF-1 fan.

- 6W/10W on any band
- 160-70cm incl 4m
- Twin RX with any mode on either receiver
- SDR Technology and 3DSS
- 5670mAh high-capacity Li-ion battery pack
- Dual Loudspeakers
- USB ports support CAT operation, audio input/output and TX control

Yaesu FTX-1 Optima. 100W HF/6M 50W 4M/2M/70cm SDR Transceiver. £1950.00. Comes with a free backpack.

HamRadio.co.uk/FTX1F

NEW Yaesu FTM-510DE ASP Dual Band Mobile Transceiver
C4FM Digital/FM 55W Dual-Band Mobile Transceiver
The New Flagship Mobile with Super-DX & ASP for Enhanced Coverage
Latest high-performance C4FM Digital/FM Dual-Band Mobile Transceiver, offering 55W VHF / 50W UHF output power and packed with cutting-edge features for superior communication. Designed to replace upon the successful FTM-500DE. **£569.95**

Yaesu FTM-150 ASP 55/50W 144/430MHz FM Dual Band Mobile Transceiver. Versatile dual-band mobile transceiver offering 55W on VHF and 50W on UHF. **£349.99**

Yaesu FT-3185 ASP 85W 144MHz VHF FM Mobile Transceiver. Powerful 2m mobile transceiver, delivering an impressive 85W of reliable transmit power, selectable at 85W, 50W, 20W or 5W **£189.95**

Yaesu FT-3165 ASP - 65W 144MHz FM Mobile Transceiver. Robust, compact 2m mobile transceiver designed to deliver powerful performance and reliability for ham radio enthusiasts. With a 65W output, users can select from three power levels (65W/30W/5W) to suit various needs. .... **Limited Offer £156.00**

Yaesu FTM-310DE ASP
(Without ASP) 144/430MHz 55W/50W C4FM Digital / FM Mobile Transceiver
Now in Stock **£375.00**

ONE OF OUR BEST SELLING UNITS

FT-710 AESS HF/6/4m All Mode Compact Transceiver. Perfectly sized & simple to use **£999.95**
FT-710 Field (no speaker) **£949.00**
Both with a FREE Yaesu hat!

FTdx101D
100W HF/6m Transceiver **£3099.95**
FTdx101MP **£4099.99**
Yaesu FTdx10 Narrow band SDR and Direct Sampling **£1299.00**
Yaesu FT-891 HF/6m Base/Mobile **£649.00**
20% Discount off FC-50 when bought together
Yaesu FT-991A All-Mode Transceiver **£1249.00**
Yaesu FT-5DE IPX7 Dual C4FM RX Handie **£379.00**
Yaesu FT-70DE
C4FM/FM 144-430MHz Dual Band Handie **£167.95**
Yaesu DR-2XE C4FM Repeater **£1279.00**
Yaesu FT-65E VHF/UHF 2m/70cm Dual Band FM Handie **£84.95**

Yaesu FT-4XE
5W VHF/UHF FM Portable Transceiver **£64.99**

Yaesu M-70 Desktop Microphone **£129.95**

WANT THE QUICKEST WAY TO OUR WEBSITE? TURN ON YOUR CAMERA ON YOUR PHONE AND POINT HERE >>>
OR CALL THE TEAM ON 0345 2300 599

KENWOOD

ML&S Officially Appointed UK Sole Distributor & Repair Workshop for Kenwood's Ham Radio Products

This month's Featured Kenwood
Kenwood TS-890SE2
HF/6m Transceiver

BACK IN STOCK!
Probably the best HF/6m Transceiver Kenwood have ever made.
Peter Hart was astounded by the receiver performance & general build quality. **This month's deal includes a FREE MC-43 microphone**. **MLS Price: £4049.95**

New! Dual Band remote TM-D750E. First shown at Tokyo Ham Fair 2024. Coming Soon!

Kenwood TH-D75e 144/430MHz Handie
Priced at £778.99 with FREE UK mainland shipping, use code RC75.
The new TH-D75E is the logical evolution of Kenwood's popular TH-D74E duo bander. 5W on 2/70. FM & D-Star, Built-in Digipeater, APRS, Wide-band all mode receive, IF Shift function, USB-C charging port & IP54/55 approved.

ICOM

ML&S Stock the Full Range of New Icom Products

This month's Featured Icom
Icom IC-7300Mk2

You asked and Icom Japan listened!
An upgraded Mk2 version of the best-selling radio.
Final price £1359.60 – Now in stock.
See HamRadio.co.uk/IC7300mk2

IC-R9500
High-end professional communications receiver for wideband monitoring. Special build direct from Icom Japan. The only available NEW units in the world! .... **Last one remaining! £12999**

Icom IC-7300 Best selling 100 Watt - HF/50/70MHz Transceiver with SSB / CW / RTTY / AM / FM .... **with free PSU £975.00**

Icom ID-5100
Latest 2/70 D-Star Touch Screen Transceiver **£639.95**

Icom ID-5200 144/430MHz Dual-Band Transceiver.
Versatile dual-band transceiver supporting both FM and DV (Digital Voice) modes, with the ability to perform simultaneous dual reception of FM-FM, FM-DV and DV-DV signals. **Price and Delivery Date TBC. Place a £50 Deposit to secure yours NOW.**

Icom IC-7760 200W HF/6m 50MHz Remote head transceiver **£5074.99**
RC-7760 Remote head accessory for the Icom IC-7760 .... **£1679.00**

Icom IC-718 .... **£730.00**
100W HF/6W Base Transceiver.

IC-PW2 HF/50MHz 1kW Linear Amplifier
A high-performance, multi-function linear amplifier is one of the key pieces of equipment for keen competition in DX hunting and contesting. Increased Linearity & Clean Transmission with the Digital Pre-Distortion (DPD) Technology (with the IC-7760) **£5069.95**

Icom IC-905 VHF/UHF/SHF D-Star Transceiver
The IC-905 is a versatile all-mode transceiver that covers 144-5600MHz and includes a 10GHz transverter option, providing access to VHF/UHF and SHF frequencies.
£2949.95 or CALL for bundle deal!
Icom CX-10G 10GHz Transverter **£1450.00**
Or buy together with IC-905. Call for package price!
The Icom CX-10G 10GHz Transverter is a high-performance radio frequency (RF) converter designed for amateur radio enthusiasts and radio experimenters.
ID-52E PLUS Dual Band D STAR Digital Transceiver .... **SPECIAL PRICE £539.95**
Icom IC-7100 HF/6m/4m/2m/70cm Base & Mobile Transceiver including D-Star with remote control head unit
NEW LOW PRICE £975.00 and Free PS-30 Power Supply
Icom IC-R6E 0.100–1309.995MHz Handheld receiver .... **PRICE DROP £220.00 ML&S £199.00**
Icom IC-7610 SDR HF/50MHz Transceiver
With Free SM-30 Mic & Free SP-41 Speaker **£3199.99**
Icom IC-705 The worlds best selling All-Band All Mode Transportable 160m-70cm. **PRICE REDUCTION £1194.95**
Icom AH-705 Automatic antenna tuner for IC-705. **£284.95**
PTRX-7300 High quality RF interface module for the IC-7300 .... **£220.00**
PTRX-9700 .... **£309.95**
Icom IC-9700 With FREE SP-38 speaker worth £156
Base Station 2/70/23 all mode including D-Star. **£1899.95**
Icom IC-R8600 New 100kHz-3GHz Receiver with SDR technology from IC-7300 .... **SPECIAL PRICE £2449.99**
Icom AH-730 100W Remote Auto-ATU **£525.00**

MARTIN LYNCH & SONS LTD
THE WORLD FAMOUS HAM RADIO STORE
OUTSIDE THE ULEZ ZONE! Wessex House, Drake Avenue, Staines, Middlesex TW18 2AP UK
Tel: 0345 2300 599. International Tel: +44 1932 567 333. E-mail: sales@hamradio.co.uk
Opening Hours: Mon - Fri: 8.30am to 5pm. Sat: 9am to 4.30pm
SAFE ONLINE SHOPPING www.HamRadio.co.uk
E&OE

SOMETHING FOR THE WEEKEND SIR? Tune in every Friday to www.MLandS.tv https://www.youtube.com/@Martin_Lynch/videos
Keep up with our latest **USED EQUIPMENT, SPECIAL OFFERS & NEW PRODUCTS** YouTube

MARTIN LYNCH & SONS LTD

THE WORLD FAMOUS HAM RADIO STORE

OUTSIDE THE ULEZ ZONE! Wessex House, Drake Avenue, Staines, Middlesex TW18 2AP UK
Tel: 0345 2300 599. International Tel: +44 1932 567 333. E-mail: sales@hamradio.co.uk
Opening Hours: Mon - Fri: 8.30am to 5pm. Sat: 9am to 4.30pm

SAFE ONLINE SHOPPING www.HamRadio.co.uk

E&OE

HamRadio.co.uk/CREDIT

- Buy stuff (any stuff) via our website & get 1% CREDIT back on the money you spent after VAT
- You can use the CREDIT the next time you order via our website, or you can save your CREDIT for future purchases
- The CREDIT won't expire for a whole 12 months so you will have more than enough time to use it
- It's simple and it's FREE. You spend money with us via our website and we give you money back to spend on our website on a purchases.

FlexRadio

Aurora AU-510M & AU-520M. Due early 2026

FlexRadio Aurora AU-510M 500W Integrated SDR Transceiver (With Screen). The World's First Fully Integrated 500W SDR Transceiver.
Introducing the Aurora AU-510M from FlexRadio – a revolutionary SDR transceiver delivering a true 500W of RF output in a compact, all-in-one design. Built for modern amateur radio operators, the AU-510 redefines station architecture by integrating the transceiver, amplifier, automatic tuner, and power supply into a single chassis................. **£7349.00**
FlexRadio Aurora AU-510 (Without Screen) £6199.00

FlexRadio AU-520M Dual SCU 500W Integrated SDR Transceiver (With Screen) The Next Evolution in High-Power SDR.
The AU-520M is part of FlexRadio's revolutionary Aurora™ Series—a new class of HF/6m transceivers that combines the transceiver, 500W amplifier, automatic tuner, and power supply into a single, compact system. Designed for operators who demand high performance and modern convenience, the AU-520 offers unmatched efficiency, integration, and flexibility.. **£9599.00**
FlexRadio AU-520 (Without Screen) £8599.00

Flex Maestro Control Console
The Maestro™ is an intuitive, plug-and-play control console that directs the operation of any Flex-6000 or 8000 Signature Series transceiver without the need for a traditional PC. Connect Maestro directly or through your local area network (LAN) to any Flex-6000 or 8000 series transceiver and you are ready to operate........................**£1599.00**

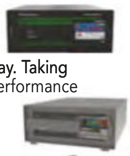
FlexRadio 8000 Series

The FLEX 8000 Series revolutionise your view of the bands with up to two 7MHz spectrum waterfall displays and independent receivers. These dual receivers can simultaneously operate on any band and mode with instant QSY between VFOs, perfect for digital mode and remote operations.

Flex-8600M With screen Free Shackmaster PSU **£5599.99**
Flex-8600 Without screen Free FlexControl **£4599.00**
Flex-8400M With screen Free FlexControl...................**£3599.99**
Flex-8400 Without screen **£2449.99**

ML&S Exclusive FLEX Distributor for UK

Power Genius Amplifiers



There's power - and then there is POWER!
You can never have too much power - which is where Power Genius amplifiers come into play. Taking your perfectly good radio and amplifying its performance exponentially.
1x3: £5299.96. New SO2R version: £6299.95

KiwiSDR2

An ultra-high performance HF 0-30MHz SDR Receiver – from New Zealand!
No PC required, simply connect via your Ethernet cable to your router and attach an HF antenna.Once set-up, your HF receiver will be accessible from anywhere in the world via the internet. **It's that simple!**

In stock now at £409.99

Kiwi Protection Circuit For Any SDR
We have seen a number of KiwiSDR radios recently that have suffered serious damage! **Protect yours for only £27.95**

Elad SDR products available at ML&S

ELAD

Elad FDM-DUO

5W - Multi use SDR Transceiver for only £899.00
The FDM-DUO is a game-changer - a top-end SDR with dials and knobs! This transceiver has a 5W output that can operate as a stand-alone unit, without a PC! Connected to a PC, FDM-DUO is a very modern SDR receiver and transmitter with capabilities which are usually available in very large large radios only.

Elad TM-2

Console for SDR Radio for only £269.95
TMate2 allows the control of main functions of SDR software as FDM-SW2, PowerSDR and Perseus. Intended mainly to allow the use of SDR software without the need to watch the screen of the PC, or when the screen of the PC is crowded by various programs such as LOG or software for DIGITAL operations or CONTEST.

HAVE YOU SEEN WHAT YOU MISSED ON OUR YOUTUBE CHANNEL THE LAST FEW WEEKS!

Best HF Radios Ever Made? FTDX9000MP & IC-7850

Visit our YouTube Channel at MLandS.TV

Apache Labs SDR products available at ML&S

ANAN-G1

100W HF & 6M SDR Transceiver
Sstate-of-the-art SDR transceiver designed for amateur radio enthusiasts and professionals alike. 100W output power, covering HF and 6M bands with exceptional performance.
Final Price & Delivery TBC. £50 Deposit secures yours.

ANAN-10E In Stock now!

NEW

Reintroducing the ANAN-10E HF & 6m SDR Transceiver. £874.99

Xiegu products available at ML&S

NEW

Xiegu GPA100

100W Solid State HF Linear Amplifier. £489.95
Compact 100W solid-state HF/6m linear amplifier designed for portable and home station use. It features smart cooling, built-in protection circuits and full coverage from 1.8–54MHz. Seamless integration with current Xiegu transceivers, including the X6200, X6100, G90, and G106.

Xiegu G90

HF 20W SDR Transceiver. £379.96
Portable 20W HF amateur radio transceiver with an SDR architecture and built-in automatic antenna tuner.

Xiegu X6100

Ultra Portable Shortwave Transceiver Radio. £489.95
Adopting SDR software radio platform architecture with excellent performance, which carries powerful baseband and RF, bringing a brand-new recognition and experience on amateur radio.

Xiegu X6200

HF/50MHz Compact-type Intergrated & Portable Amateur Radio Transceiver. Only £659.95
X6200 inherits the compact and high performance characteristics of the X6 series combining excellent performance with advanced features.

Ham Radio Guide Book 2025. £24.00

The **Ham Radio Guide Book 2025** is a comprehensive printed guide aimed squarely at amateur radio enthusiasts. It consolidates essential information in a full-colour, magazine-style format–covering frequency allocations, band plans, licensing tips, operational best practices, and handy reference tables. It's your year-round companion, packed with clear diagrams, FAQs, and updates relevant to the 2025 amateur radio landscape.

NEW

Topbytes Morse Trainer

New Version 2 with Battery Indicator & USB Cable.

EXCLUSIVE TO ML&S! Only £99.95

The Topbytes Morse Trainer is a **compact, self-contained CW practice unit** with a feature set designed to make learning Morse code accessible, adaptable, and engaging. Housed in a durable enclosure with a **colour touchscreen display**, it enables easy navigation through practice modes, settings, and even built-in games.
Its **USB-C rechargeable battery**, onboard speaker, and **3.5 mm key input** mean it's ready to go right out of the box–whether you're practising at the desk, outdoors, or between QSOs at a club night.

The **Topbytes Morse Trainer** is a thoughtfully designed CW learning aid that blends traditional practice with modern convenience. Its feature set supports a wide range of users, from absolute beginners to those chasing 30+ WPM. The addition of Wi-Fi, games, and a vibrant touchscreen makes it stand out from many of the more spartan alternatives on the market.
With its portability, ease of use, and real-world keying options, this is a trainer that doesn't just teach Morse–it encourages you to enjoy it.

See: www.HamRadio.co.uk/topbytes

DXSpotter

WiFi DX Cluster Spot Display for Amateur Radio

ML&S! Only £59.95

The TopBytes DXSpotter is a compact, WiFi enabled DX cluster display that brings real time spot information straight into your shack – without needing a PC, laptop or tablet running all day.

See: www.hamradio.co.uk/dxspotter

As the UK's Ham Radio Distributor of British made and designed SDRplay products, we have all models available ex-stock for immediate shipping.

SDRplay

SDRplay RSP1B - 14-bit SDR Receiver
Enhanced version of the popular RSP1A, offering a powerful wideband 14-bit SDR receiver that covers the RF spectrum from 1kHz to 2GHz.............................. **£126.95**

NEW! SDRplay RSPdx-R2
Providing up to 10MHz Spectrum Display anywhere between 1kHz to 2GHz..**£225.00**

SDRplay RSPduo
The ultimate Plug-in SDR. Dual Tuner 14bt SDR.. **£239.95**

USB A-B Cable for SDR Play RSP ...£2.65

SDRplay Limited nRSP-ST
All-in-one, Plug-and-play Networked SDR Receiver
This exciting product addresses the needs of radio enthusiasts who want a 'plug-and-play' solution for remote reception.

The nRSP-ST is a networked general coverage radio receiver for frequencies from 1kHz to 2GHz with up to 10MHz of spectrum visibility. The nRSP-ST is your own personal remotely accessible SDR which can also be shared with a small number of trusted friends or colleagues. **£409.00**

FOLLOW US ON X (Twitter) AND FACEBOOK HamRadioUK Watch our YouTube Channel on www.MLandS.TV

Looking for the latest releases at ML&S?
Click: www.HamRadio.co.uk/new-release

We need new sales and workshop staff.

Interested? Call 0345 2300 599 or drop in & see Martin or Dan TODAY. Alternatively, you can email in the strictest confidence to recruitment@MLandS.co.uk. **We look forward to hearing from you!**

We are now the UK Distributor for VGC

VGC VR-N76 APRS Handheld Radio 2m/70cm
The VGC VR-N76 is a VHF and UHF handheld radio, equipped with advanced features. With 5 watts of transmission power, app-based control, integrated Bluetooth, GPS and a built-in compass. It certainly is a feature packed analogy radio. Enjoy a range of exciting and practical functions that were once exclusive to digital radios, without the steep learning curve. **Now with full KISS functionality via new firmware Via the downloadable App. Only £119.95**

VGC VERO VR-N7600 50W Dual Band Mobile Radio With APP Programming
The Vero VR-N7500 and VERO VR-N7600 are advanced dual band mobile radios designed for seamless communication and enhanced functionality. Both models offer robust performance and are ideal for amateur radio enthusiasts and professionals alike. **Only £224.95**

NEW RANGE OF POTA PRODUCTS

MICRO POTA EFHW 49:1 Kit with 25m of dipoflex available in SO and BNC
Discover the versatility and efficiency of the POTA EFHW 49:1 Kit, designed for amateur radio enthusiasts seeking reliable performance. This comprehensive kit includes a MICRO with two connector options, ensuring seamless connectivity and ease of use in various setups. With 25 metres of high-quality dipoflex cable, this kit provides excellent flexibility and durability for outdoor operations.This kit will allow you to make a 20m EFHW.......... **£69.95**

Portable Ham Radio Backpack with Wheels – Fits Yaesu FTX-1, IC-705, FT-710 Field, Xiegu X6200
ML&S Portable Ham Radio Trolley Backpack. **£99.95**

Chameleon 34ft (10.5m) Portable Carbon Fibre Mast
Lightweight. Stealthy. Self-supporting. Built for the field. **£169.96**

Chelegance JMount-01
1/4" Tripod Antenna Bracket with SO239 Mast Clamp. **£28.96**

Windcamp Pota/Sota Radio Case
Designed specifically for portable operations, this case ensures that your radio gear is safeguarded against the elements while remaining lightweight and easy to carry. **£65.99**

CHA FSR — Faraday Strip Radial System
Designed for serious operators, the CHA FSR delivers superior performance while remaining compact and easy to transport. **£138.95**

HackRF Pro SDR Platform

A Next-Gen Open-Source Transceiver
Delivers impressive performance in a compact package. Covering **100kHz to 6GHz** with transmit and receive capability, it is a versatile and open-source platform designed for serious radio experimentation.
Only £349.95. See HamRadio.co.uk/hackrfpro

ML&S RANGE OF LINEAR AMPLIFIERS

Acom 1400S

Solid-State 1.8-54MHz Linear Amplifier £3339.95
State-of-the-art amplifier covering all amateur bands from 1.8 to 54MHz. It comes with a new compact Touch-Screen Remote Control Unit. The proven ACOM 06AT tuner is the optimal option for use with ACOM 1400S. Both devices share the same front panel design and will look magnificent in your shack. ACOM 1400S amplifier is based on the latest LDMOS transistor technology. The final PA stage uses a rugged 65 V LDMOS transistor for heavy operation modes. The amplifier as standard is equipped with an Ethernet interface and thus can be remotely controlled via the Internet through the integrated Web interface.

Acom 500S

500W 160m-4m 500W Linear Amplifier IN STOCK
The ACOM 500S is a state-of-the art linear power amplifier that covers all amateur bands from 1.8 through 70.5MHz and provides 500W rated output power (PEP or digital) **£2449.95**

New Acom 1003 HF + 6m Linear Amplifier **£2799.00**
Acom 2100 1.8-54MHz Linear Amplifier **£3599.05**
Acom 1010 160-10m Linear Amplifier **£2089.99**
Acom 1000 1kW 1kW PEP/CW 1.8-55MHz.......... **£2699.95**
Acom 2000A 1500-2kW output auto with 2x4CX800A **£5609.95**
Acom 700S 700 Watts PEP or Carrier output **£2649.95**
Acom 1200S Same as 700S but with 1kW output **£2895.00**
Acom 1500 HF+6m Linear Amplifier **£3199.95**
Acom 06AT Automatic Antenna Tuner & Switch **£1079.95**

SPE Expert Linear Amplifiers

1.5K-FA Taurus Solid-state linear amplifier providing a solid 1.5kW of output with exceptional linearity, efficiency, and robustness. Integrated with a built-in power supply and a highly capable automatic antenna tuner. **£4699.95**

SPE Expert 1.3K-FA with ATU **£3799.95**
SPE Expert 1.3K-FA without ATU **£2849.95**

Hiberling Ultra-premium HF/VHF Transceiver

Hiberling PT-8000A HF/VHF Transceiver handcrafted in Germany to the highest engineering standards **£12999**

Hiberling HPA-8000B

1kW Power Amplifier. 160/80/40/30/20/17/15/12/10/6/4m bands. All-mode: AM/FM/SSB/CW. Internal power supply: 200-260V **£5499.00**

TYT Mobile & Handheld Transceivers

TYT TH-8600
Compact, IP67 rated waterproof dual band mobile transceiver **£99.95**

TYT TM-D70W
High power VHF and UHF mobile transceiver **£185.95**

TYT UVL-15W
High power 2 metre and 70 centimetre handheld transceiver **£109.95**

Anytone Mobile Transceivers

AT-5555N MKII
60W SSB High Power 10m Mobile Transceiver......... **£179.95**
AT-588 4m Transceiver 70MHz **£149.99**
AT-6666Pro 10m Mobile Transceiver. AM FM SSB 10m Radio 28-29.700MHz 80W .... **Special Price £204.95**

OM Power Amplifiers now in stock!

OM Power OM2000A+
Automatic linear amplifier for all short wave amateur bands from 1.8 to 29MHz (including WARC) + 50MHz and all modes. .. **£5294.00**

OM Power OM2501A
Automatic linear amplifier for all short wave amateur bands from 1.8 to 29MHz (including WARC) and all modes.......... **£5449.00**

OM Power OM2501HF
This linear amplifier is a manual tune designed for all short wave amateur bands from 1.8 till 29MHz (including WARC) and all modes.......... **£4299.00**

Hear those weak signals with bhi DSP Noise Cancelling Products

British made and designed!

NES10-2MK4
New NES10-2MK4 amplified DSP noise cancelling speaker. **£128.95**
Dual In-Line
Dual channel amplified DSP noise eliminating module. **£189.95**
DESKTOP MKII
Amplified DSP base station speaker – 10 Watts audio. **£239.95**
NEDSP1901-KBD Pre-wired low level retrofit audio DSP noise cancelling module. This module replaces the popular NEDS01061-KBD that many Yaesu FT817/FT-818 users have installed over the last 18 years. ..**£129.95**
Compact In-Line Compact DSP noise cancelling module with improved DSP algorithm giving even better noise elimination. **£170.00**
ParaPro EQ20-DSP 20W Audio Enhancer **£329.95**
ParaPro EQ20B-DSP 20W Audio Enhancer (Bluetooth version)..**£399.95**
BHi NCH Active noise cancelling headphones..........**£29.95**
BHi HP-1 BHi Wired stereo communications headphones..........**£19.99**

ZUMSPOT Mini 2.4" OLED LCD Pi Zero 2

Single band UHF Modem, Raspberry Pi Zero 2 depending on availability), 2 part ZUMcase, SD Card loaded with Pi-Star ready for you to configure, use with your compatible digital radio.
£178.00

Power Supplies

Samlex SEC-1235P-M Desktop Switching Power Supply
The Samlex SEC-1235P-M is destined to become THE premier lightweight 13.8 VDC desktop power supply, offering updated features and upgraded performance and ratings.......... **£179.96**

Samlex SEC-1235G 30 Amp Switch Mode Power Supply

This highly efficient AC-DC power converter provides a highly regulated output DC voltage of 13.8 Volts at 30 Amps with an AC input of 230 Volts, 50Hz. **£127.96**

MyDEL

Two-year warranty on all MyDEL PSUs

MyDEL PS-30SWVI (PS-30)

A high power DC regulated Switch Mode power supply, providing up to 30amp maximum current.Comes with Over Voltage, Current Limiting and Short Circuit Protection. **£79.00**

MyDEL MP-50SWIV
Super Lightweight Metered PSU 48-50 Amp, 9-15V DC power supply **£118.99**

MyDel 30A Linear Power Supply

The **1830SC** is a high-quality 30A linear power supply designed to provide reliable and stable DC power for a variety of radio communication and electronic applications.......... **£109.99**

Pro Audio Engineering Kx33

Low-RFI AC Power Supply for HF Transceivers
Small, light, easily portable high-power DC supply which has low AC input to DC output coupling. This is critical to minimise RFI due to common-mode currents often found with temporary antennas such as end-feds or verticals. **£69.95**

MyDEL Battery for Mobile Operation 12V 50Ah LiFePO4 Lithium Battery **£136.00**
10A Battery charger for above **£64.99**
50% OFF charger when purchased with battery.

Shackmaster Power 600

Rig Expert 13.8V/40A Power Supply.
Compact Desktop Power Supply sets the new standard for high quality..........**£399.00**

Lido In-Car Mounting Kits

Lido Cup Holder Mount. £31.20
This is just one example of the many available in store.
See web for our full selection

Shack Clock

Special Offer £19.99

Red Pitaya SDRlab 122-16 Internal Clock Starter kit

Professional-grade SDR digitiser and processing platform, tailored for serious experimenters, RF engineers, and advanced amateur radio operators.
The SDRlab 122-16 Internal Clock is based on Red Pitaya's high-performance SDRlab platform, modified for use with an external oscillator connected via the E2 extension port. This flexibility allows integration with GPSDOs, rubidium standards, or other precision clock sources required in demanding RF environments. **£695.00**

Nissei Power Meters & PSUs

Nissei PS30SW II 30A Switching Power Supply
This Switching Power Supply is designed for radio amateurs, it is composed of a low ripple switching circuit which can perform like a linear power supply. It is small,light, portable, and efficient. **£98.95**

Nissei NS-1245A 40A Switching Power Supply

40 Amps continuous and 45 amps surge. Illuminated dials showing Amps and Volts. **£154.96**

Nissei DG-103 MAX
Digital Display SWR/Power Meter.This digital SWR & Watt meter is highly accurate for measuring Forward Power,Reflected Power, & VSWR **£129.95**

DG-503Max Digital Power Meter.......... **Only £139.00**
DG-503 Digital Power Meter .... **Only £99.00**
NS-2230D 30Amp PSU, Front Power Pole Connectors....... **£84.95**

MyDEL Nissei Compact in-line meters

RS-50: £65.95. RS-70: £69.00 The RS-50 (120W 2m & 70cm) & 70 (200W 160m-6m) are compact in-line meters that present power and SWR on a digital backlit LCD display.

Heil Sound

ML&S are the official UK importer for Heil Sound headphones and microphones

Pro-Set 7 Headphones	**From £299.95**
Pro-Set 7 IC Headphones	**£319.96**
Pro-Set Elite 6 Headphones	**£179.95**
Pro-Set Elite IC Headphones	**£189.95**
Pro-Set 3 Headphones	**£127.00**
NEW PR-77D Microphone	**From £159.96**
PR-781 Microphone	**From £199.95**
PR-40 Microphone	**From £249.95**

Jonathan Hare G1EXG
jphcreativescience@gmail.com

1

Tatonka Lastenkraxe Carrier Used as a Backpack Shack

Jonathan Hare G1EXG describes how to use a back pack to go portable.

I recently wrote an article in *RadCom* [1] describing trekking backpacks that might be useful for radio amateurs taking equipment into high places. This was based on my experience over many years hiking in the Alps carrying relatively heavy (non-amateur radio) loads of ca. 25-30kg.

Last year, I received some money following the death of my good friend, **Rufus Marsh**. Rufus was a fantastic technician, prop maker, and tireless experimenter. I wanted to use the money to buy something I probably wouldn't have considered without this gift. I also wanted it to be a special project that I knew he would have loved and found interesting.

I bought a Tatonka Lastenkraxe carrier [3] (see **Photo 1**). It's a robust, well-made carrier with proper shoulder straps and an excellent hip support system—features you'd expect from a quality backpack.

Tatonka are a German company [3] that make quality army and civilian hiking equipment. Unlike a standard backpack, this carrier is designed to allow heavy loads (up to 50kg) to be carried safely. Rather than having a bag that can be filled, it has an L-shaped frame made of 24 and 20mm welded aluminium tubes, that can be loaded up.

Adding panels

This rucksack can stand up on its own even on quite rough or rocky surfaces. The L-shape is designed to accommodate packs of gear strapped to it. I decided to mount flat panels on to the back. The idea was that this could now take a set of storage crates or even mount the transceiver and battery directly to the panels.

Part of my day job as a science communicator is building scientific apparatus and demonstrations (see the 'commissions' page of my website [2]) and I often use Perspex in my work. I happened to have a few large offcuts of 6mm transparent Perspex sheets, so I decided to use this to form a solid L-shape storage system. I could have used varnished plywood but decided the transparent Perspex would allow easy viewing of the gear from all sides and would be a good electrical insulator and more weatherproof. Perspex is a little on the heavy side compared to plywood, but I am not intending on taking this gear on trips to the Alps, but rather closer to home so the extra weight is not really an issue for me.

I used two Perspex panels: a small ca. 28 x 32cm base plate drilled and bolted to the bottom of the frame (i.e. horizontal) and a larger ca. 70 x 32cm plate going up the back. This larger plate is held by four 3D printed holders fitted to the tubular frame pipes. A couple of 3D printed pillars or stand-offs, secure the very top of the panel to the top tube. The aluminium tubes of the carrier had to be drilled to take these holders and pillars.

Small spacers hold the Perspex sheets close to the carrier. These had bolt holes through them so that they could be secured to the Perspex and the tubular system of the carrier. Holes had to be drilled into the metal tubes of the carrier. See **Photo 2**.

Storage crates

One option was to build the transceiver on to the back of the carrier, but I wanted to keep the versatility of the L-shaped carrier, so I decided to mount my radio gear into storage crates and load these onto the carrier. It was then just a case of selecting the type of gear for my trip and radio requirements and loading them up on the carrier. I used bungees to secure the crates onto the carrier. The carrier has convenient built-in hooks and loops as well as the tubes to secure too. The crates are splash proof but not waterproof. Running draft excluder tape along the inside of the lids might make them more weatherproof, providing of course the crates don't get cracked or split with use etc.

3D printed side mast

As the carrier is a sturdy device that can stand up, an antenna mast [4] can be an integral part of the design. In principle I wanted a portable solution that would allow me to sit the equipment down and operate with minimal set-up time and I wanted this simplicity to include the antenna mast. For example, in the 23cm station shown in **Photo 3** I don't require guys unless it's very windy.

I made a four-section mast out of a set of ca. 60-70 cm long concentric square cross section aluminium tubes that I happen to have. When

Photo 1: Tatonka Lastenkraxe carrier 2 ca. £160-200. pack frame ca. 2.7kg 78 x 35 x 28cm, loads up to 50kg [3].

2

3

fully extended the mast is about 2.5 m high and when fully retracted is about 70cm long and just protrudes above the top of the pack.

I 3D printed the holders between each section and used butterfly bolts (go pro thumb bolts) to secure each section [**4**], see photos.

Three radio stations

I have built the following setups for portable work: i) 40m station, ii) HF station, iii) a 23 cm station. Each of the portable setups consists of one or two storage crates that fit onto the carrier. With these I am ready to go LF, HF or SHF whenever I want.

40m shack (total packed weight - ca. 20kg)

The 4m shack (**Photo 4**) consists of:

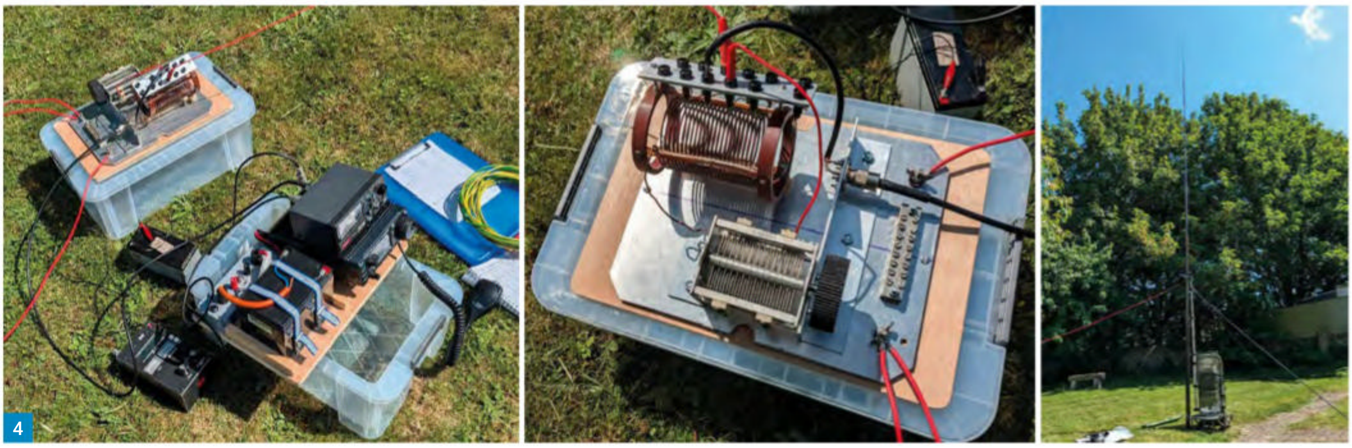
• Tatonka Lastenkraxe carrier 2
• 12V 12VA LiFPO4 battery, IC706 MK II G [5] 100 watt transceiver [**5**]
• 40m homebrew ATU, 2 x splash proof Allstore 15L crate (ca. 47 x 30 x 17cm)
• 10m SOATBEAMS fibre pole mast extensions, guy wires needed

HF shack 10, 12, 15m bands (total packed weight - ca. 18kg)

The HF shack (**Photo 5**) consists of:

• Tatonka Lastenkraxe carrier 2
• 12V 12VA LiFPO4 battery, IC-706 MK II G 100 watt transceiver [**5**]
• 2 x Allstore 15L storage crates
• homemade ca. 2m mast fitted to pack
• half-wave 5m telescopic rod vertical + homemade ATU

I am using my repaired IC-706 MK II G [5] with a 15m, 12m and 10m band halfwave end-fed vertical antenna with homemade tuned matching system and 1m counterpoise radial. It looks like the radio is mounted on the bottom panel, but in fact is on a wooden base that has just been removed from its storage crate.



UHF and 23cm shack (total packed weight - ca. 19 kg)

The 23com shack (**Photo 6**) consists of:

- Tatonka Lastenkraxe carrier
- 12V 12VA LiFPO4 battery, homemade ca. 2m mast fitted to pack
- FT-817 + SG Labs transverter (2 watt at 1296MHz) (using separate Tx and Rx outputs)
- 23cm Down East Microwave Inc. 1296 BPF SAW band pass filter on Rx
- 1 x Allstore 15L crate (ca. 47 x 30 x 17cm)

Shown in use on Hollingbury Hill, Brighton with a basic 2-element PCB Yagi (mast not at full height).

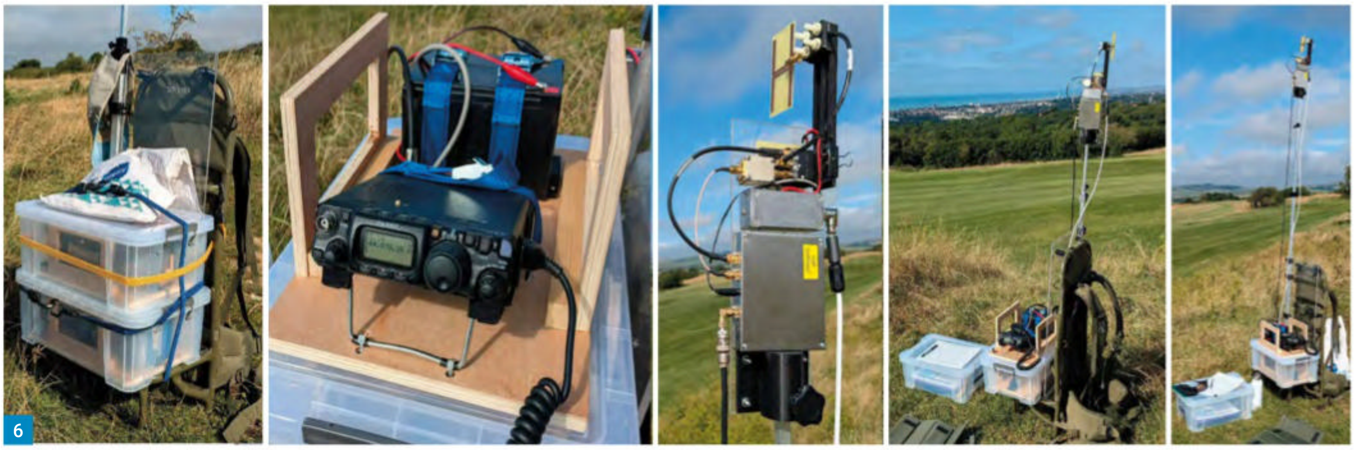
Acknowledgements

This article is dedicated to Rufus Marsh. I would also like to thank his brother **Justin Marsh**, **Sarah Hogben M6GDW**, **Roger M0TJK**, **Graham G8BZL** and **Simon G4EYR** for on-air tests and discussions.

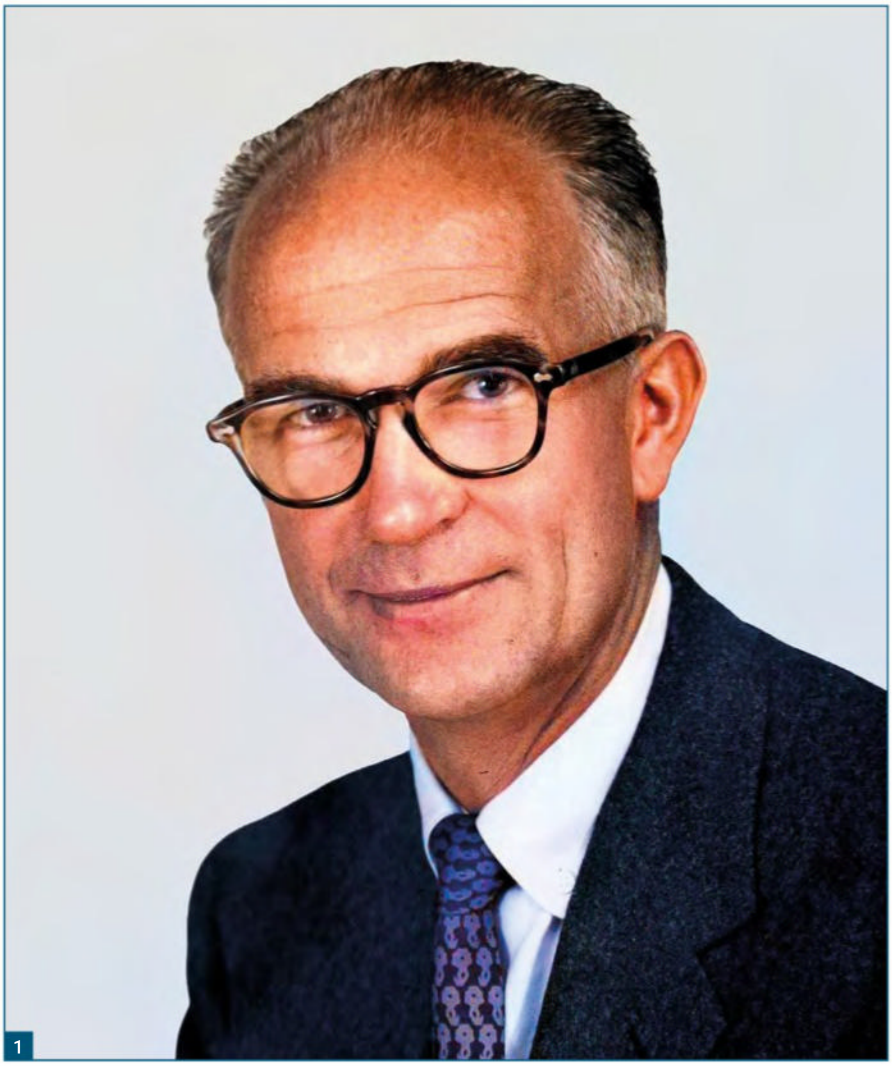
References and links

[1] Backpacks for Radio Mountain Goats, J P Hare, RadCom, March 2024.
[2] **www.zoomscience.co.uk/rufus**
[3] Tatonka website: **www.tatonka.com/en**
[4] CSC 3D page: **https://tinyurl.com/4wxs88mc**
[5] Service history of an IC-706 MK II G, J P Hare, *Practical Wireless* magazine, August 2025. **PW**

Photo 2: Details of the 3D printed brackets and stand-offs used to attach the panels to the carrier can be found on my 3D printing page [4] where you can see the designs and print your own.
Photo 3: The 23cm station. Photo 4: 40m shack. Photo 5: HF shack. Photo 6: 23cm shack.



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



1

William Shockley & the Transistor

Tony Jones G7ETW looks at the early history of the transistor.

The transistor was invented by American **William Shockley**, **Fig. 1**; everyone knows that.

Well, yes and no. For a start, Shockley was British. He was a Londoner, born in 1910, and taken home by his American parents as a three-year old. And he wasn't a one-man-band inventor – he worked for AT&T. But there is one achievement Schockley can take 100% of the credit for. He invented the 'Hole'.

In 1950, three years after AT&T's Bell Laboratories announced the first BJT (bipolar junction transistor), Schockley introduced the hole to electronics in his *On Semi-Conductors* article in the prestigious *Physics Today* magazine. He followed that up the same year with a book called *Electrons and Holes in Semiconductors* (**Fig. 2;** he dropped the hyphen); this was the 'bible' of semiconductor learning for a very long time. I expect some *PW* readers have memories of this.

Chemistry of semiconductors

Before we get to electrons and holes, I need to recap some O level chemistry. **Fig. 3** shows a simplified extract from the periodic table of the elements. Gallium, Germanium and Arsenic are side by side in different vertical 'Groups', named after their 'valency', that is, how many electrons their elements possess 'orbiting' in their 'outer shells', as this was seen in a pre-quantum world.

Germanium in its natural form is a very poor conductor. **Fig. 4** shows some resistivities to put this in context. To make the differences stand out, I expressed resistivity in one measure: nanoOhm metres, the product of resistance and length.

That's not a mistake. nanoOhms *per* metre sounds right, but isn't. Resistivity (symbol **ρ**, named rho and pronounced 'row', as in a boat, is the 17th letter of the Greek alphabet) depends on the overall size of a lump of material under test, and cross-sectional area comes into it.

Gallium and Arsenic, as can be seen, have very similar resistivities, and both are much better conductors than Germanium. Silicon is a noticeably – three orders of magnitude! – worse conductor, which might explain why semiconductor development began with Germanium.

Doping

Doping is the deliberate and precise adulteration of pure elements with suitable elements from neighbouring groups.

Adding Arsenic (tri-valent) to Germanium results in a negative 'n' material which is electron-rich. Penta-valent Gallium doping does the opposite; creating a positive 'p' material rich in positively charged holes.

Unlike the three sub-atomic particles of my youth, the hole is not real. It's classified as a quasi-particle, defined as the *absence* of an electron. When a hole meets an electron, they combine and vanish, leaving neutrally-charged nothing. So, it's anti-matter, right? No, it's just a positively charged electron-shaped space.

I sense you are not entirely satisfied. I can't say I am, but holes have their place in the history of electronics, and are still taught.

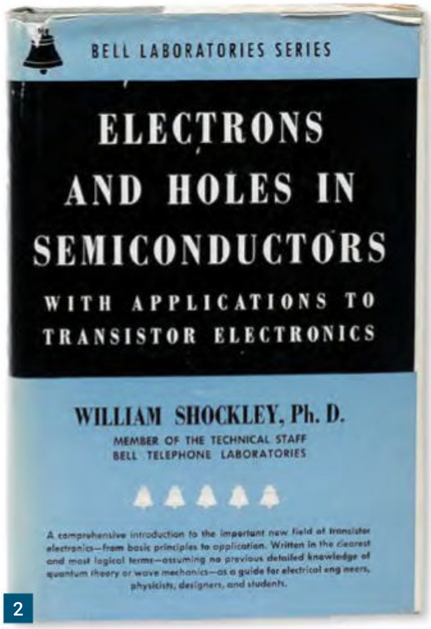
Moving on…

Conductivity effects

This is all to do with 'primary charge carriers.' For n-materials, the primary charge carriers are electrons and the secondary charge carriers are holes. p-materials are the other way round.

In an n-material, dopant-derived electrons are in the 'conduction band', meaning that they are high energy particles, easily able to move through the crystal lattice. Whereas a p-material's holes are in the 'valence' band, and can only move from atom to atom. They are slower and much less mobile.

That's the best I can do without going into quantum physics and I think the chances of me meaningfully venturing there, without introducing errors, are slim. For what I want to illustrate, these n- and p-material explanations will suffice.



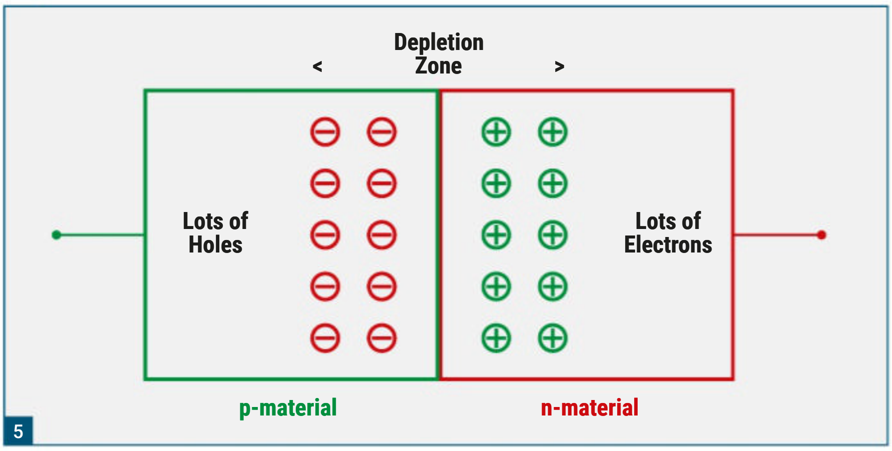
2

Group 13 has three electrons in its outer shell		Group 14 has four electrons in its outer shell		Group 15 has five electrons in its outer shell	
Atomic number	**Element**	**Atomic number**	**Element**	**Atomic number**	**Element**
5	Boron	6	Carbon	7	Nitrogen
13	Aluminium	14	Silicon	15	Phosphorus
31	Gallium	32	Germanium	33	Arsenic
49	Indium	50	Tin	51	Antimony

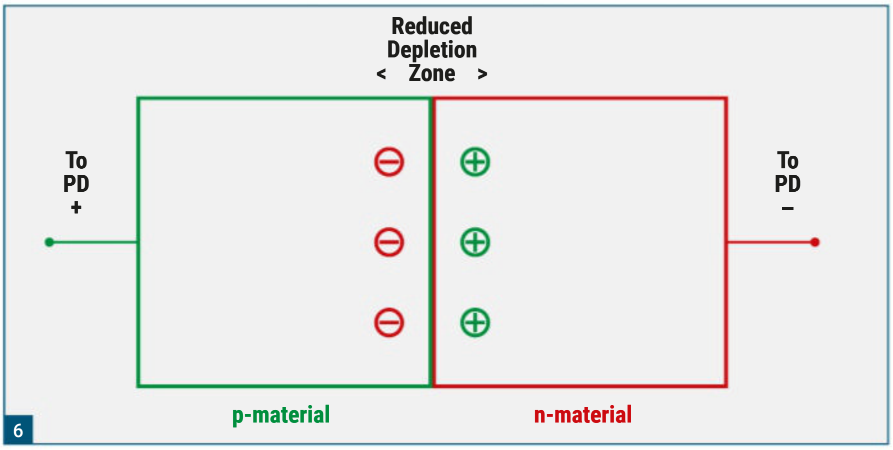
3

	Resistivity in nanoOhm metre at 20 degrees C
Silver	15.9
Copper	16.8
Aluminium	17.2
Gold	22.1
Iron	96.1
Tin	115.0
Lead	208.0
Gallium	270.0
Arsenic	330.0
Silicon	2300000000000.0
Germanium	1000000000.0
Glass	10000000000000000000.0

4



5



6

Fig. 1: William Shockley. Fig. 2: His classic book. Fig. 3: Extract from the periodic table Fig. 4: Some resistivities for comparative purposes. Fig. 5: A basic p-n junction. Fig. 6: The same junction with a potential difference applied.

p-n junction: no potential difference applied

Fig. 5 shows a p-n junction, comprising two slices of doped Germanium, pushed together, each with a wire lead-out. The lead-outs are not connected to anything please note.

n-side electrons close to the 'border' cross it and merge with holes. Both majority charge carriers vanish. The material having lost negative charge, positive ions build up in a strip on the *n-side*.

On the p-side, the opposite (but to a lesser degree because holes cannot move as easily), happens.

Holes cross into the n-material and join with electrons. Pairs of holes and electrons disappear, leaving negative ions on the *p-side*.

A 'no man's land' equilibrium arises around the border, in which primary charge carriers are few. This is Shockley's 'depletion zone'. The oppositely charged ions, like cold-war border guards, face each other across an insulating 'dead zone', giving rise to an electric field. I find it helpful to imagine an internal capacitor, charged in reverse polarity compared to what one might have expected.

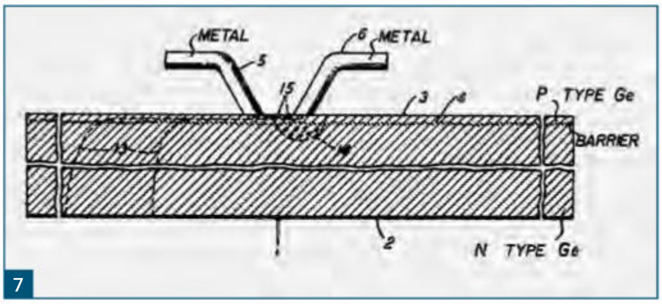
p-n junction: potential difference applied

Fig. 6 shows the effect of applying a potential difference, battery positive to the p-type material.

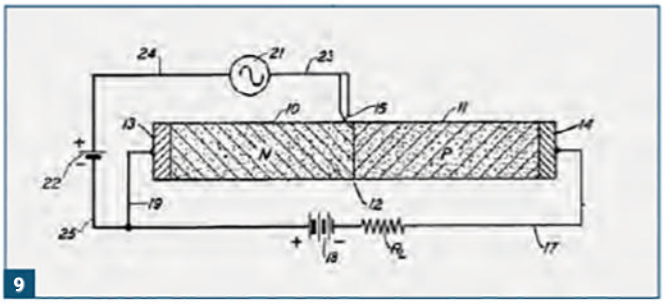
The usual explanation is as follows:

With this DC voltage applied, a negative charge appears on the n-material where the lead out connects. Electrons in the material are energetically repelled towards the junction. On the p-side, the external positive charge pushes holes towards its side of the junction.

Electrons meeting the n-side positive ions merge with them and neutralise them. Holes reaching the negative ions on their side neutralise their 'barrier' ions. The internal electric field, and consequently the depletion zone, is reduced. Above a certain supply voltage, this field and the depletion zone all but vanish, and electrons and holes can meet, destroying themselves and allowing a current to flow.



7



9

8

Fig. 7: Extract from the Bardeen Brattain patent.
Fig. 8: Bardeen (left) Shockley (centre) and Brattain (right), pictured in 1948.
Fig. 9: A diagram from Shockley's patent.

This is a forward biased diode. For a Germanium diode, 300mV is all that's needed for this to occur.

Now reverse the supply. n-side electrons and p-side holes are pulled to the oppositely-charged wires from the battery. (Holes can't leave the material; they don't exist, remember.) The ionised layers get 'deeper' and the depletion zone gets larger.

No current can flow, unless the potential difference is increased to the level that the doped materials destructively break down.

This is a reverse-biased diode.

I said that was the usual explanation. It has never sat well with me, and long have I searched for simple but, to quote **Einstein**, not too simple one that feels less arbitrary. If any readers have one, I'd love to hear it.

npn transistor: potential differences applied at collector and base

This is a little harder to explain, but does follow logically from what came before.

The base to emitter junction is a p-n diode, forward biased. Current can and does flow (if the biasing is right).

The base to collector junction is another p-n diode, with a depletion zone, but this one is reverse biased because the collector is more positive than the base.

The three areas are not equally doped. In an npn transistor, the emitter is most heavily doped, the base is lightly doped, and the collector's doping is somewhere in between. Electrons from the emitter enter the base in large numbers, far more than is required for the tiny base currents that flow. That leaves electrons free to be attracted through the collector towards the positive DC connection.

This explains the names of transistor's legs. The emitter *emits* electrons and the collector *collects* them. Well, nearly all of them. Some leave the transistor through the base.

If that sounds wrong, blame **Benjamin Franklin**, who, in the eighteenth century, decided that current was a flow of positive charge. He'd have liked holes, I'm sure.

Shockley and the invention of the transistor

When we think of transistors, it is BJTs that come to mind, but it was the FET that came first. Austrian born, **Julius Edgar Lilienfeld** first theorised this kind of semiconductor, and was awarded a US patent in 1925. In 1934, **Oscar Heil**, German, was awarded a similar patent in Germany. But neither of these were able to make a FET.

A FET is conceptually different to a BJT, because only one kind of charge carrier is used (electrons for an n-FET, holes for a p-FET) and the conductivity is controlled by an applied electric field.

In 1945 William Shockley was working for Bell Laboratories, joint manager of a group researching into solid state physics. He too wanted to develop the FET, believing that an electric field could control the current in a Germanium wire. This was very similar to the operation of a grid in a thermionic valve, so it must have seemed a good bet.

He and his team, chiefly **John Bardeen** and **Walter Brattain**, both Americans, worked on this, but achieved no success. 'Surface States' was their problem; they did not understand how current flowed in a semiconductor under an electric field.

But along the way, Brattain discovered the 'transistor effect'. He and Bardeen invented 'three electrode circuit element utilizing semiconductor materials', that is, the contact point transistor, in 1947 and in June 1948 filed for a patent. They were issued US Patent 2524035 jointly in October 1950. (After the war, the US Patent Office had a huge backlog of work to do.) **Fig. 7** shows a diagram from their patent application.

Fig. 8 shows Bardeen (left) Shockley (centre) and Brattain (right), pictured in 1948.

This same year **John Shive**, another member of Shockley's team, made the crucial discovery that holes could make their way through the body of a semiconductor, contrary to what was thought. Shockley had been working on similar lines – in secret, say some accounts. In September that year he filed papers for a 'semiconductor amplifier' and in April 1950 he (alone) was awarded US patent 2502488. **Fig. 9** shows a diagram from this patent.

Look at those dates again, and ask yourself two questions. Does Brattain's discovery, plus Shive's, not look a lot like Shockley's? And what must the atmosphere have been like in Shockley's team meetings?

In 1956, the year Shockley, Bardeen and Brattain won the Nobel prize in Electronics for the contact-point transistor. This was Shockley's only Nobel prize.

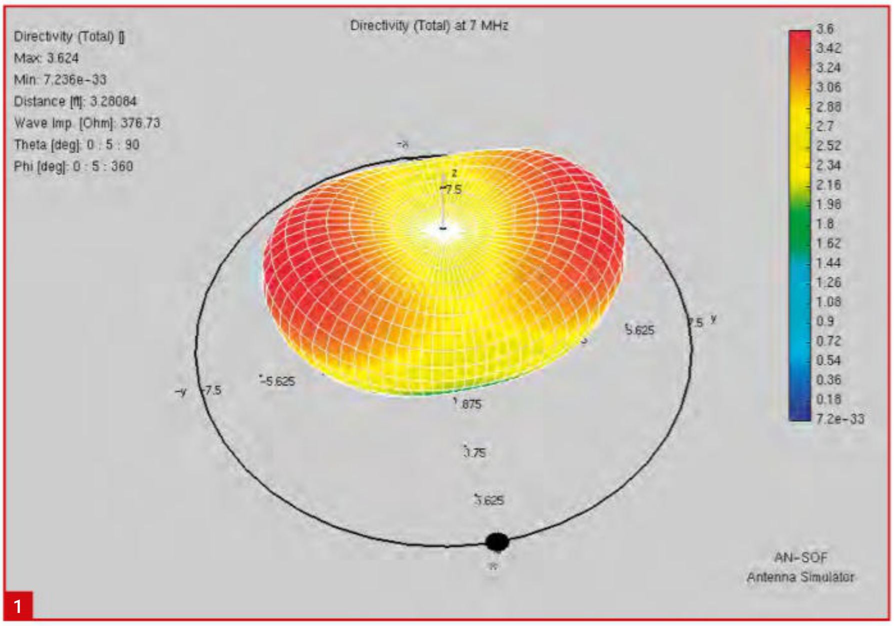
Conclusion

Shockley was a very clever man, and deserved success. But he could have achieved so much more if he'd been more generous, intellectually. A 'people-person', he wasn't. 'He may have been the worst manager in the history of electronics' was how one biographer summed him up.

As an example, in 1956, after a short stint in academia, Shockley founded the Shockley Semiconductors Laboratory as part of Beckman Instruments. But within a year, eight 'traitorous' members of his hand-picked staff left en masse, to start up Fairchild Semiconductors.

By 1970, Shockley's business was gone. But it can be regarded as the cradle of the modern electronics world, with dozens of big electronics names' staff having begun their careers working for Shockley.

Shockley died in 1989, with more than 90 US patents to his name. His contribution to the modern world is not in doubt, but his name is tarnished by his later-life views, which I naturally won't go into, on race, human intelligence and Eugenics. **PW**



1

Circular Loop on Ground

Keith G4MIU discusses a circular alternative to the basic Loop on Ground before reporting on the latest AN-SOF offering and explaining how to use your VNA to measure crystals.

Keith Rawlings G4MIU
keith.g4miu@gmail.com

Hello and welcome to another *Antennas*. In the March issue I revisited the Loop on Ground antenna. Quite a few readers got back to me regarding the LoG. It seems that a lot of you have been using this antenna for quite some while and, in the main, have found it to be effective where local QRM is bad.

Bruce G4EUW emailed me: *"I've just seen your article in latest edition of* PW*. It was about the same time as your original article in 2021 that I first tried a LoG although I didn't read* RadioUser*. I fully concur with everything you write. Mine isn't deployed permanently, only when I am taking part in an 80m or 160m contest as it is on a patch of grass at the front of my property and is virtually invisible so liable to be a trip hazard to dog walkers. An excellent receive aerial. My main aerial is a very bent Doublet and, as you say, all that is heard on that can be heard on the LOG albeit at a lower strength but in the clear usually."*

Bruce also added: *"Another interesting receive-only aerial I tried recently was a Single Loop Near Ground adapted from an article in* RadCom *for a Double Loop Near Ground. Excellent results again. 73 Bruce G4EUW".*

This pretty much sums up other readers' comments about how the antenna performs, although there has been some disappointment in a few cases and it seems many only deploy the antenna when it is needed.

My take from this is that most users that suffer high levels of QRM live in built up areas and often have small back gardens where leaving the loop deployed is inconvenient.

Notably two readers who contacted me live in flats. One living on a third floor deploys a Mag Loop on a tripod located on his balcony when he wants to go 'on air' and a vertical version of a LoG hangs down from the balcony just for receive.

The second reader, an SWL, lives on the ground floor and deploys his LoG permanently on a patch of grass outside a window and it is his only HF antenna.

While I revisited the LoG in the March issue I made an experiment with the loop in a circular configuration (CLoG) as well. Unfortunately, I was unable to directly compare it side by side with the conventional LoG so can't give an apples v apples comparison but overall I could not discern too much difference in performance. Where there was a station with a known stable signal, for me this was limited to Radio 4 on 198kHz, Radio 5 Live on 909kHz and Talk Sport on 1089kHz, I was able to compare notes and found little difference in the recorded signal levels except on 909kHz where there was almost a 5dB reduction in level.

The predicted 3D antenna directivity pattern of a CLoG at 7MHz may be seen in **Fig. 1** and in **Fig. 2** the plot at 3.5MHz

The AN-SOF simulator calculates that this antenna still has a directional pattern. In Figs 1 and 2 it can be seen that the pattern is at right angles to the feedpoint (the feedpoint being represented by the black dot on the loop element).

Incidentally, I am limited on how many plots I can squeeze into the column due to space restrictions and the need to show other images but if any reader would like to see any of the AN-SOF predicted plots at other frequencies that I show, please email me and let me know. I will run the requested plots and email them to you.

For comparison I have included the VSWR plot for the CLoG in **Fig. 3**. The measurement was taken using my FA-VA6 vector antenna analyser with the result stored into internal memory, the file is then loaded into the VNWA software to produce the image shown here. It is very similar to the square LoG from the March column with a poor match below 80m and the same blip in impedance around 4MHz.

This experiment shows that if for some reason a square loop is not possible (I personally can't think of one!), then a circular format should work just as well.

AN-SOF

While mentioning AN-SOF, they have recently sent me some news updates on the software. Version 10.8 is now the current version. At the user level there are no massive UI changes compared to when 10.5 was released. However, there are improvements to the example models and there have been refinements in the related documentation.

There is also some news on **AN-SOF DX** which is a lower cost product aimed at radio amateurs. The price is now USD 279 and includes 500 segments (wire segments + junctions + ground connections). The limitations of 50 frequencies per sweep and the 5° radiation pattern resolution have been removed so the only remaining difference from the PRO version is the maximum number of segments supported.

The DX price includes a lifetime licence with one year of updates and support. The software will continue to function after the support plan expires, and activation keys are provided for at least three years following any potential discontinuation. This offer is exclusive to licensed radio amateurs.

For comparison, the professional and enterprise plans start at USD 999, so AN-SOF see the DX plan as being well-suited for the amateur radio budget.

I've noticed on the website there is a recently updated Knowledge Base article regarding the comparisons of AN-SOF and NEC to clarify that AN-SOF does include the Sommerfeld-Norton 'high-accuracy' ground model. However, in use,

Fig. 1: Circular LoG 3D Polar Plot at 7MHz.
Fig. 2: Circular LoG Polar Plot at 3.5MHz.
Fig. 3: VSWR of the circular LoG.
Fig. 4: Comparison of Ground models.

the Sommerfeld-Wait model is recommended, as it allows wire connections to ground, it is faster, and aligns well with measured data. See **Fig. 4**.

More details on this can be found here: **https://tinyurl.com/mr6z9vkr**

The AN-SOF team are keen to point out that the strongest argument for the purchase of AN-SOF over NEC is that their product is actively supported and improved by a live team. The authors of NEC and developers of legacy interfaces like EZNEC have passed away or retired. They consider it is only a matter of time before a Windows update renders those legacy applications unusable.

This latter point is true, but like most things Windows based we are all at the mercy of the operating system developers; I have a number of costly software packages, all paid for, that I can no longer run.

Indeed, I have still not paid out and upgraded my Win 10 PC to a new one that supports Win11, but rather, I am using the Win10 extended limited support for the time being. No doubt this PC will eventually sit next to my old Win XP machines that are still perfectly serviceable but more or less useless. Any new PC will likely not have PCI slots so I doubt I will be able to continue using my WinRadio G313i and associated plug-ins either.

However, I get what AN-SOF are saying, they will support their product through further operating system changes so the AN-SOF package should have a considerable lifespan.

Crystal clear

While not directly antenna related I thought I would discuss another use of the NanoVNA and that is to measure the resonant frequency of crystals. We can measure the Series and Parallel Resonant frequencies of a crystal using an S21 series sweep on the NanoVNA

Setup

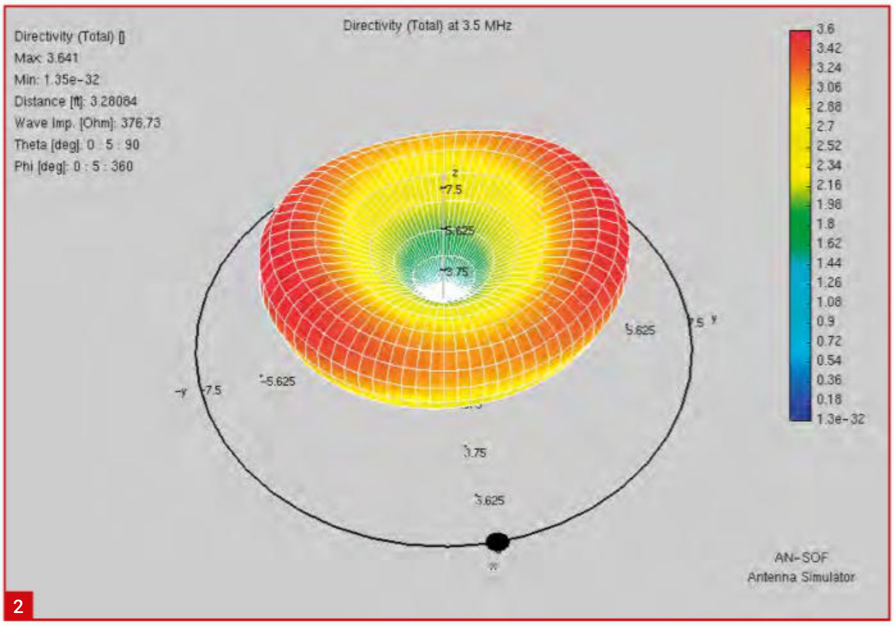
For this example the crystal is held in a VNA test board, **Fig. 5**.

Testing a crystal using a Nano can be tricky. Crystals are high-*Q* devices and consequently the response on the VNA trace will be quite narrow. With the sweep points on some models being as low as 101 a wide frequency sweep may miss the returned response entirely.

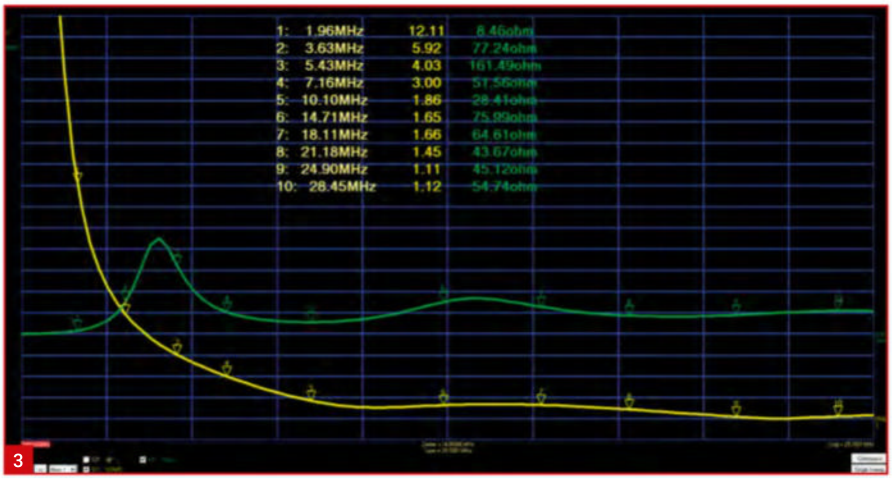
If the frequency of the crystal is known, this isn't too much of a problem as the sweep can be set accordingly. With unknown crystals, instead of sweeping a wide bandwidth in the hope of finding the response I suggest it is better to sweep smaller spans and increment the sweep until the response is found.

This can easily be done with most Nanos by setting the sweep range and changing the centre frequency as you go. The more sweep points of your Nano the wider this sweep may be. Once the response has been found set an appropriate sweep span to display the trace satisfactorily. You may have to juggle the trace Reference Position and Scale too.

Now, I suggest performing a SOLT Calibration. This can be done on the reference plane of the



2



3

Ground Model	AN-SOF	NEC-4/5
Perfect Ground (PEC)	Yes	Yes
Sommerfeld – Norton	Yes	Yes
Sommerfeld – Wait	**Yes**	No
Reflection Coefficients	Yes	Yes
Radial Wire Ground Screen	**Yes (+)**	Yes (-)
Dielectric Substrate	Yes	No

4

Fig. 5: Crystal in the Test board.
Fig. 6: Crystal swept with 1025 sweep points.
Fig. 7: Crystal swept with 101 sweep points.

test board connector and then a port extension/electrical delay added to the point of the crystal or by using a Calibration 'kit' that plugs into the test board. This has been described in previous columns.

For this example, the crystal I have used is a 3.579545MHz crystal that was supplied with a C M Howes 80m CW transmitter kit but never used, so it is new but many years old. The measured response of this crystal may be seen in **Fig. 6**. The Nano is reading the Series frequency as a short as seen in the upper 'spike' at 3.578MHz and Parallel lower spike as an open circuit at 3.584MHz.

In this example the sweep points of the VNA3G VNA I use has been set to 1024 and I have made the sweep deliberately wide to demonstrate the responses seen to the right of the main response.

On researching this I read that the within the NanoVNA there is a second signal generator that is outputting a signal on Port 1 offset 5kHz from the main signal, which is used to heterodyne the detected signal level of the reflected signal back into Port 1 and this is what is causing the responses!

In **Fig. 7** I have set the number of Sweep points to 101 to replicate those Nano's that have only this number of points. As can be seen this trace has lower resolution than that of Fig. 6 but it is still perfectly useable.

As noted crystals have relatively high *Q* and ideally they need time to settle to a new frequency stimulus so it is important to sweep them slowly. With the limited number of sweep points available in most Nano's It is probably advisable to use the Nano under software control using a package like NanoSaver.

Using software, the frequency span may be larger due to the possibility of using increased sweep points and the lower sweep speed will allow the crystal to settle and avoid ringing.

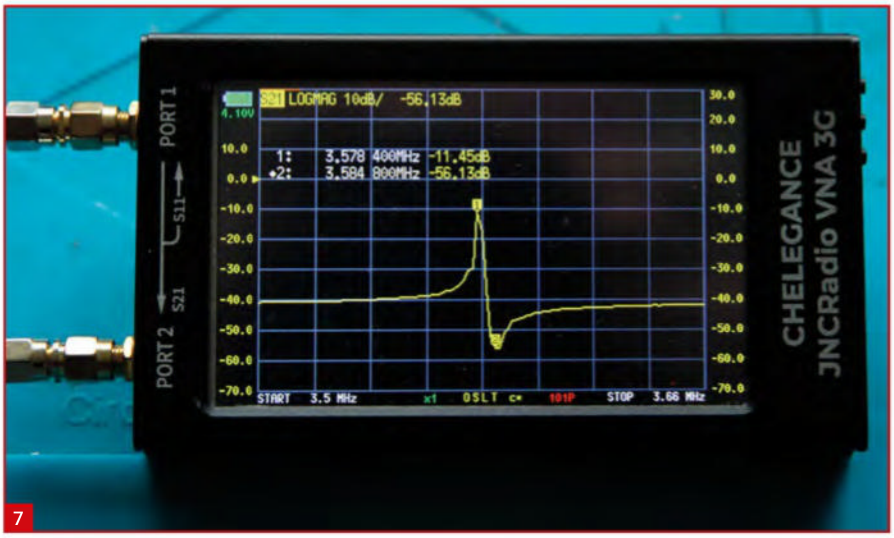
Something to remember is that although you may have found a response from an unknown crystal, it may be the fundamental frequency but that crystal may be intended for overtone working so it may be the latter you are reading. For example, if a crystal oscillates in its fundamental mode at 5MHz, the third overtone oscillates at 15MHz and the fifth overtone oscillates at 25MHz.

Another thing to watch out for is that sometimes the marked frequency is the receive frequency of a particular receiver. The actual crystal frequency will be tied in to the local oscillator frequency of that receiver.

Many of the crystals supplied to the very first scanners were like this. They had a bank of crystals where channels could be 'scanned' by switching the crystal in and out of circuit. Popular channels were usually available by purchasing additional crystals and these were usually marked with the actual receive frequency.

5

6



7

This is just a basic example of crystal measurement. The S21 phase characteristics, insertion transmission coefficient, S11 reflection properties and complex impedance may also be easily characterised.

That's it, see you next month. **PW**

Tim Kirby GW4VXE
gw4vxe@icloud.com

1

FT2: Just what we needed?

Tim GW4VXE starts this month with a discussion on the pros and cons of the new FT2 mode in respect of VHF working.

Over the last few days there was a great deal of fanfare about a new FT mode, FT2. **Martino Merola IU8LMC** released a program called Decodium 3 which includes a digital mode called FT2. Martino says that the mode is four times faster than FT8 and has a 3.8s Transmit/Receive cycle.

Uwe DG2YCB from the WSJT-X development team wrote, *"Apart from whether an FT2 mode alongside FT4 makes sense at all, in my eyes the best answer to the brazen behavior of this Italian group was to simply reverse engineer 'IU8LMC's' FT2 mode and publish it as open source. Just on principle! To take the wind out of the sails (as we say here in DL) of people who obviously have fame and/or money primarily in mind.*

*"You should know that the history of FT2 goes back to experiments by **Joe** and **Steve** in early 2019 (at that time with a TR period of 2.5s). Later it was introduced as FT4, first with 5s TR period, and then with 7.5s because with 5s the success rate of QSOs was not good enough.*

*"IU8LMC introduced 'his' FT2 mode with slightly modified parameters (3.8s TR period). He is free to do so, provided he clearly states what 'his' FT2 mode is ultimately based on, and that he publishes the source code. But he refused. **Such a behavior is not only a violation of GPLv3, it is also the opposite of ham spirit and contradicts Joe's and our open source approach for WSJT-X! Furthermore, it is unfair,** as 'his' Decodium program is nothing more than a (poorly working) fork of our (now obsolete) joint WSJT-X and WSJT-X Improved 3.0.0-rc1 250915 release. This means, that 99.5% of 'his' Decodium software is based on our work. ('His' Decodium program is currently full of bugs, by the way.)*

"Nevertheless, according to PSKReporter statistics, almost 4,000 users are already using FT2 mode (within two weeks). This indicates that there seems to be some interest in the market for such an ultra-fast mode. (Or maybe you are all just bored and urgently needed something new to play with!). Let's see if FT2 proves itself alongside FT4, or if it's just a short-lived hype.

"I haven't decided yet whether I will keep this new mode in WSJT-X Improved, but for the reasons mentioned above, I would like to release a new WSJT-X Improved (beta) version soon, where the FT2 mode is included open-source and in the usual 'WSJT-X Improved quality'".

It's clear that there is some disharmony about the actual ownership of the code, apparently quite reasonably. Although the increased speed seems attractive, this comes at the cost of sensitivity and FT2 will 'only' decode signals down to around -12, compared to -25 or so for FT8. As VHF operators who routinely deal with weak signals, I'd question why we'd want to throw this sensitivity away. The short transmit/receive periods are also likely to be more prone to timing issues and interference, probably leading to repeats. I rarely use FT4, as it is, reluctant to discard the chance of working some weaker signals.

So, although though this is, on the face of it, an interesting development I don't see it as having much practical use at VHF/UHF beyond the novelty value of getting it running and trying a couple of QSOs. Of course, that should not be underestimated – we SHOULD be trying out new things and working out whether they're useful or not.

If you want to grab a copy of WSJT-X Improved with the FT2 code in it, you can find it at:
https://tinyurl.com/3fxwu7ch

and if you want to try IU8LMC's Decodium 3, you can find it at:
https://www.ft2.it


2

I'm aware of plenty of FT2 activity on HF but I don't think there are any agreed frequencies on VHF – so if you decide to experiment you will need to do a little local co-ordination.

A new radio for satellite operators

One of the challenges for FM satellite operators in recent years has been the lack of dual-band handheld radios capable of full duplex operation. The last radio capable of full duplex was the discontinued Kenwood TH-D72. Occasionally people write to me and say that one of the Wouxun radios is capable of full duplex, but I have heard mixed reports about this when people have tried to use it for satellite operation.

From **Patrick Stoddard WD9EWK** comes interesting news. He writes, *"In late 2025, the Chinese radio manufacturer Anytone released a new handheld FM/DMR radio, the AT-D890UV* [**Fig. 1**]. *It looks similar to the earlier Anytone AT-D868UV and AT-D878UV and has improvements like more memory for memory channels, talkgroups, and a larger DMR contact list. It also has more functionality for APRS, along with a dual receiver, and can function as a cross-band repeater. What makes this radio interesting for satellite operators is its ability to work full-duplex, being able to hear satellite downlinks while transmitting on the uplink. This works for satellites with 2m and 70cm uplinks, something not seen in amateur handheld transceivers since Kenwood's discontinued TH-D72. This radio has a built-in satellite tracking and tuning function, something seen in the firmware of other radios and the OpenGD77 firmware compatible with many different radios, but this function doesn't take advantage of the AT-D890UV's full-duplex capability.*

"Working satellites full-duplex with the AT-D890UV is similar to how it is done with other radios, like the TH-D72. Both VFOs are used, one for the uplink and the other for the downlink. This radio uses the same two-prong speaker/mic configuration as other Anytone handheld radios, and Kenwood's handheld radios. When I use the AT-D890UV, I plug an audio splitter into the 2.5mm speaker jack on the side of the radio, feeding downlink audio to an earphone and an small audio recorder. I have a codeplug that has memory channels for FM satellite uplink and downlink frequencies, plus other settings for transmit power ('Turbo', the highest power level) and squelch (maximum squelch for the uplink VFO, and open squelch for the downlink VFO).

"The AT-D890UV is rated to transmit at up to 7W on VHF, and 6W on UHF. Testing my radio with a wattmeter and dummy load, it transmits at 6W on UHF, but is up to almost 10W on VHF. The supplied battery pack has a USB-C socket on the bottom, which can be used for charging (5V only, not USB-PD). The radio also comes with a drop-in charging cradle.

"So far, I have enjoyed working FM satellites (AO-123, SO-50, SO-125, and the ISS cross-band repeater) with my AT-D890UV. Like with many other radios from the Chinese radio brands, it seems easier to set the radio up with the programming software than the front panel. The radio comes with the programming cable, two dual-band antennas (7in, 15in), and a Bluetooth button that can serve as the radio's PTT button. Anytone has also said support for the NXDN digital-voice mode along with DMR will come in a future firmware update (although at least one USA-based importer is already offering an AT-D890UV firmware update with both DMR and NXDN)".

Fig. 1: The Anytone AT-D890UV – a full duplex radio for satellite operating.
Fig. 2: The summit of Knott in the Lake District as activated recently by G7WKX.

'More 144' yielding results

Reading around this morning, with the RSGB's 144/432MHz contest taking place, I was pleased to see on the '145 Alive' group a few comments from people saying that having enjoyed the 'More 144' SSB activity during the last '145 Alive' event they had had a tune around during the contest and made a few contacts. That's good to hear. Even with a simple vertical some surprising contacts will be possible.
If you haven't room for a beam, what about a horizontal dipole, a halo or even a 'big-wheel'? With 'traditional' SSB activity being horizontally polarised, you should find your results improve considerably. But, as I've said before, use whatever antenna you have.

The 6m band

Dave Edwards G7RAU (Lizard, Cornwall) has been copying the J51A expedition to Guinea-Bissau regularly during the afternoons. Dave worked them on FT8 on 26 February and then on the first of March on CW. Dave says he's gradually getting the repairs to the antennas done following the recent storm damage.

Roger Greengrass EI8KN (Co Waterford) worked J51A when they became very strong on 5 March.

Roger Lapthorn G3XBM (Cambridge) says that recently when he has called CQ on FT8 with 10W and his V-2000 vertical he's only been spotted by English stations, a change from when he was being heard more widely across

Fig. 3: Robert PA9RZ in his shack, with his Semcoset Semco-SSB for 2m.

Europe. Roll on the Es season says Roger!

Here at **GW4VXE** (Goodwick, Pembrokeshire) I was pleased to work TZ1CE (IK52) on 18 February. I'd had a sketchy QSO with him a couple of years ago, so it was nice to have a solid QSO. I've seen him again but not as regularly as in previous years. J51A has been seen on a number of occasions too, but so far, when I've been in the shack, signals have been too weak to make a QSO. Aside from that, there was some Es to Southern Spain on 1 March when I worked EA7DHT (IM87).

The 2m band

Jef VanRaepenbusch ON8NT (Aalter) worked G0LTG/P (IO81) on CW on 3 February and G0JCC (IO82) on 25 February on FT8.

Roger EI8KN worked CT9ACF (IM12) on 23 February, with EA2XR (IN83) also worked. I saw CT9ACF here at GW4VXE too, although on the vertical, signals were too weak to have a QSO.

When testing his 2m aerial using FT8, **Phil Oakley G0BVD** (Great Torrington, Devon) was surprised to be heard on the Island of Skye, most likely by aircraft scatter.

Simon Davis-Crane G7WKX (Liverpool) has picked up an old Yaesu FT-290R2, which he's planning to use in the SSB SOTA challenge and perhaps the odd RSGB contest, once he can get it working. Nice radios those – a real solid feel to them. Simon and his partner **Nic** activated Knott (G/LD-023) for SOTA on 7 March, **Fig. 2**. They made one summit to summit contact on 2m with M7GTU/P who was on St Sunday Crag (G/LD-010).

It's really good to hear from **Robert van der Zaal PA9RZ** (Sassenheim) once again. He's been using his Yaesu FTX1F and, although he likes the radio, he's not keen on the menu system on VHF and says that his IC-9700 is not often used these days. During the March 2m/70cm contest Robert has worked DF0MU (JO32), DK0PU (JO31), F8KGU (JN19), G8T (JO01), ON4EI/P (JO20) and PI4AMF/P (JO22) – all done with 10W SSB to a 5-element Yagi at around 15m. Robert has new antennas to go up. In the picture of Robert's shack, **Fig. 3**, he mentioned a rig I haven't seen before, a Semcoset Semco-SSB which is a rig of German manufacture from the 1970s.

The 70cm band

During the tropo to the south on 23 February, Roger EI8KN worked CT9ACF (IM12). It's great to see that Stevo is on 70cm. Roger asked Stevo if he has 23cm and the answer was 'not at the moment'! Roger was also pleased to win the 'Leading Overseas Station' in the Single Operator Fixed section of the RSGB AFS 432MHz Data Contest.

Satellites

Jef ON8NT monitored the ARISS contact on 5 February with a school in Belgium. Jef says that at 1045UTC on the same day, he heard the Russian crew talking to a Russian school. Using the Deepl translation app on his smartphone, he was able to translate the Russian into Dutch. Between the 6th and 9th February, Jef received a number of SSTV pictures from the UMKA1 satellite, celebrating 92 years of LABRE (Brazil). Also on 6 February, Jef worked EA3EA (JN01) and PA3GAN (JO21) using FT4 on the RS-44 satellite.

Dave Ryan 5B4AOB (Paphos) reports that since moving to Cyprus he is up to 75 DXCC entities on satellites.

Patrick WD9EWK (Phoenix) has been out and about while the Arizona weather is not too hot and writes, *"At the end of February, I took a couple of days to attend the Yuma Hamfest in southwestern Arizona. Yuma is next to the Colorado River, very close to California and Mexico, and is a popular destination in winter for those who live in colder climates. Before the hamfest, I went a little further west toward San Diego, so I could operate from the DM12/DM22 grid boundary halfway between the west side of California's Imperial Valley, a few miles north of the Mexico/USA border. A fun place to play radio, even trying an AO-91 pass with maximum elevation of 0.9 degrees. The satellite was on, but nobody else showed up for the pass. A shame.*

"Early the next morning, I worked SO-50 and ISS passes from next to the Yuma Territorial Prison State Historic Park. This was an actual prison in the late 1800s, before Arizona became a state. It is on high ground overlooking the city of Yuma and the Colorado River, a great place for working satellites. After a couple of hours of radio, I went to the hamfest for the rest of the day before driving home.

"The 2026 Yuma Hamfest in Arizona also served as the ARRL Southwestern Division Convention, at the Yuma County Fairgrounds. This hamfest draws people from Arizona, California, Nevada, and the 'snowbirds' visiting from the colder parts of the continental USA and Canada. Hams from nearby Mexico also showed up. Hams were selling their gear outside the vendor hall and around the fairgrounds site. Inside the hall were commercial vendors and radio clubs. Near midday, I went outside and gave an impromptu demonstration of working satellites, as the SO-125 (HADES-ICM) satellite passed over the hamfest. Contacts were made with stations in the western half of the continental USA and western Canada.

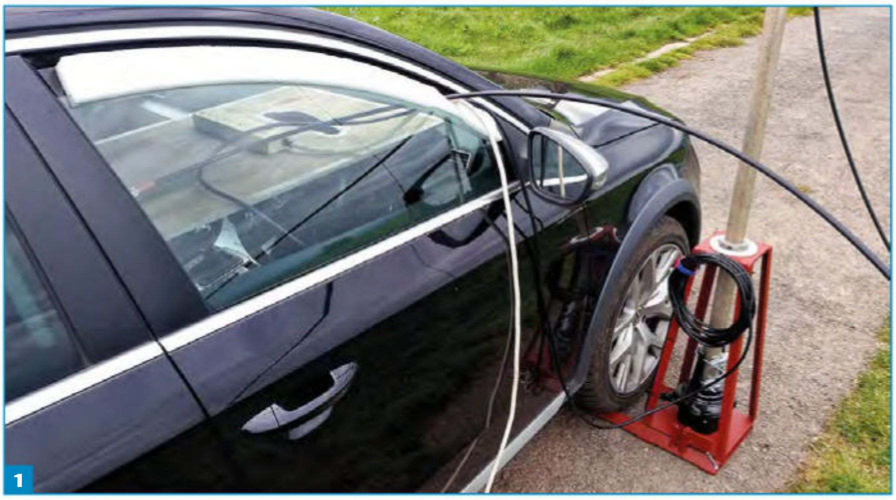
*"**Bernard KG6FBM** caught me working the SO-125 satellite during my demonstration at the hamfest. His video has me working VA7XO in British Columbia near the end of the pass:* **https://youtu.be/LqA6gjquwKc**

"As I write this, SO-125 is nearing the end of its life, as it will reenter the Earth's atmosphere in the next few weeks. Like its twin SO-124 which recently reentered, SO-125 has been a very good satellite supporting both FM and D-STAR communications".

And finally

That's it for this month. By next month, perhaps there will be some signs of the Es season starting up. It will be interesting to see how this season compares with last, which seemed quite disappointing on 6m in particular. Will the declining solar activity help the Es? We shall see – there's always something interesting going on in amateur radio. As usual, many thanks to all the contributors – please keep your news coming. **PW**

Steve Clements G1YBB
steve@g1ybb.uk



1

Improved car portable cable access

Steve Clements G1YBB tackles the challenge of a weatherproof solution for car-portable operation.

As a regular car portable operator, mostly for contesting and very often in poor weather and after dark I try to make the mobile shack as comfortable to sit in as possible, which means having a way of bringing cables in but trying to keep weather and flying critters out. At the very least most of us portable ops have a coax entering and at VHF as thick as we can afford to use really, and some like myself also have a mains cable from the generator and a rotator control cable. A lot of people use things like the split foam pipe lagging and other ideas. I have been using a 1in thick strip of foam with a small slit for the window glass and a notch for the cables since about 2017, **Fig. 1**.

And while this has been OK it has some drawbacks. Once while packing away, it blew away so I am actually using the second incarnation! Also, it forces the cables to the very top of the window by design which for stiffer coax like the LBC400 I use can make it awkward to pass it to the far side of the car for the weekend contests using amp(s). As it's very often very wet and the ground is covered in mud or sheep muck, I have to be careful to wipe the coax off before passing it in or it stains the headlining inside the car above the door. Also, bugs manage to locate the very small gap and attack me as the light is directly above my head in the car. It's very hard to run a pileup with several attack moths bouncing off your glasses, trust me!

Time for a new approach

So, time for a new one. **Clive G8LNR** showed me pics of his, which is a piece of thin ply and a letterbox. The letterbox I thought was a great idea, so I decided to steal that idea. His fits to the rear door of his Discovery so it is quite a simple shape. Mine of course would be a little more awkward.

I wanted to make mine inherently waterproof, so plastic was the obvious choice. I asked my friend **Paul** who ran a plastic injection moulding company the best plastic to use and he recommended polypropylene, so I got some 3mm sheet after measuring the window which was 4mm thick. Some places advertised 3mm and 5mm, some did 3mm and 4.5mm and some did 3mm and 4mm, allegedly. Following my Moulder principle of trust no-one, I ordered 3mm as I wanted to ensure it would fit into the same channels in the door as the glass does. I know that often plastic rod is slightly oversize as a rule so didn't want to risk the material being over thickness. I was able to order some 1000 x 500mm sheet for £11.44 a sheet. This was a standard size. Be warned that on the online plastic sites they will do a custom size, anything you want mostly, but the custom 1000 x 500mm was more than this 'standard' size! Shipping was £10 so I ordered three sheets, both to cover disaster and also in case I want to have a second cable entry on the other side. I'd previously done a rough measurement of the door and window imagining the area I needed contained by a rectangle. Incidentally, if buying polypropylene, the 'natural' colour is translucent to a certain degree which I thought might be good and it is usually cheapest if there is a difference in colour prices. These things are important to radio hams!

The actual letter box I got from the local Screwfix for £9.79, which was a bit top end of budget, but I wanted to crack on and take measurements from it. This is just the sprung flap and brush type you may well have on the inside of your front door. The flap for rain, the brush for bugs.

Checking the dimensions of the letterbox I realised that I needed the maximum opening I could get at the door pillar end of the glass, which is where I like the cables to enter. I started off by scribing the full width window curve onto cardboard, cutting the sides to shape then opening the window to the desired amount and scribing the curve again. I had to make a second cardboard one as the ends were truncated but soon had that test fitted. You can see from the image, **Fig. 2**, it looks wider at one end than the other. That is not camera distortion, unlike my expectation the window does not seem to fall equally both sides. Hence my plan A of scribing one line then copying that same line lower down would have been a fail!

Then it was a case a case of taping that to my sheet of polypropylene to trace with a Sharpie ready for cutting. As seen in the photo, **Fig. 3**, the 1000mm length was only just enough. I could have gone more diagonally but I wanted to use that lower edge of the offcut to cut off another strip to act as a weather seal.

I then cut this out with a jigsaw using a metal cutting blade. After deburring it was time for the moment of truth. To fit it I would have the window down and insert the narrow end by the door pillar then flex it so I could insert it into the opposite channel, then slide it up into the top channel. Then carefully raise the window to pretty much press it into the top channel. Only very slightly though as my car has one of those annoying non optional 'safety' features that if it detects any unexpected resistance, it panics and winds the window fully back down again. Grrr. But I managed to get it just right and fitted nicely, **Figs 4** and **5**.

A bit of wavy line syndrome, both from the cardboard cutting and the jigsaw but more than close enough for this job.

I then used the offcut to cut a thin strip to attach to the outside as a cover for the plastic-to-glass joint to keep water out. A slot was cut out for the letterbox ensuring it was far enough away from the inside door frame and everything drilled and screwed together with some silicon mastic to seal and glue things up. I sealed under the letterbox before fitting and around the top and both sides, **Fig. 6**.

But we are not quite there yet

As by design this is quite flexible so I can flex it to fit into the channels both sides of the door, there is nothing to stop it bowing outwards from the glass at the bottom. It shouldn't much due to being in

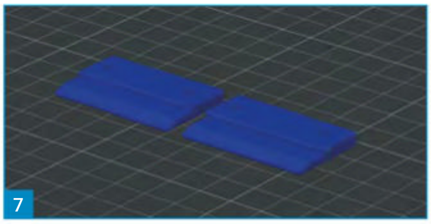


Fig. 1: Old cable entry system. Fig. 2: Cardboard template test fit. Fig. 3: Marking out the polycarbonate. Fig. 4: Polycarbonate test fit inside. Fig. 5: Polycarbonate test fit outside. Fig. 6: Final assembly. Fig. 7: Two clips by 3D printing. Fig. 8: In use seen from inside the car. Fig. 9: In use, seen from outside.

the top window channel but it wouldn't be a G1YBB design if I didn't deal with that.

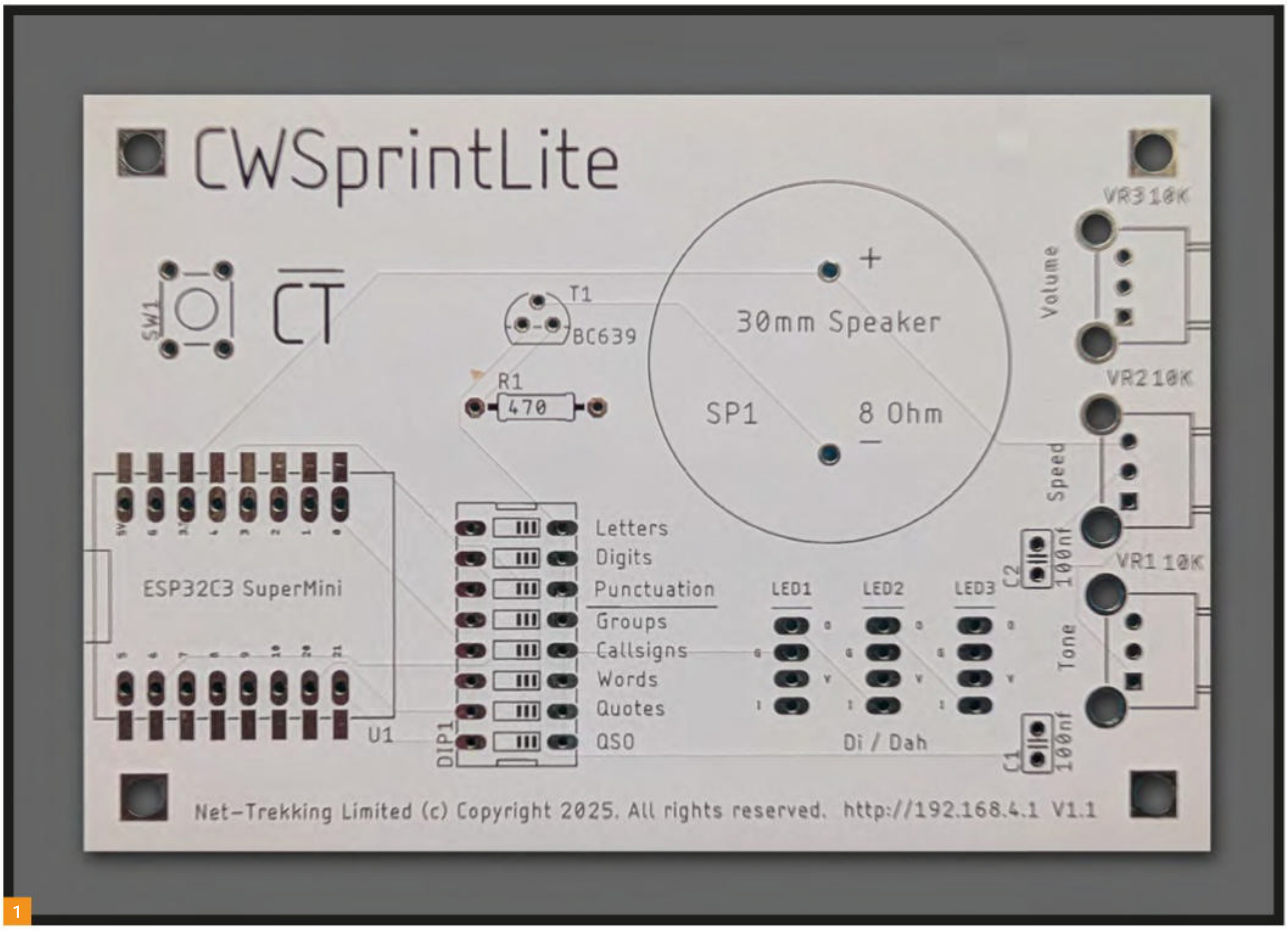
A few minutes in 3D CAD and a few more on the 3D printer and I had two clips to fit to the inside, **Fig. 7**. It has a 1.5mm thick step (3mm polypropylene + 1.5mm > 4mm glass) and a tab to slide the glass past. I printed these in PETG which is more than strong enough for this job. PLA+ would probably be just as successful.

These were fitted then the assembly left over the weekend to give the mastic some time to set.

The next contest was the November RSGB 432MHz UKAC and it was blowing a gale and lashing down with rain. My site has a prevailing wind from the West, so my cable and operator entry is arranged to the East. This night the wind was from the South East blowing right into the car when I got in or out and giving the new cable access an extreme test. It worked a treat with the only problem that despite the spring being quite strong and the flap being very near closed the wind was strong enough to 'cherry knock' me most of the night! The gusts were in the high 50s mph and from a non-usual direction, so I think that won't happen very often. But more importantly, the first test in probably as extreme as it gets for this, was successful. I didn't detect any water ingress at all. There were no crazy critters about to test that on a cold wet November night, but it looks pretty good from the inside to me.

On this inside view you, **Fig. 8**, can see the 3D printed clips in action better. The letterbox is large enough to pass the 4-way end of my AC extension cable through easily. **Fig. 9** shows the outside view of the new system in action.

Hopefully this may inspire others to 'deluxe up' their portable shack and encourage more stations to go out in any weather and maybe come up with even better versions. **PW**



1

Daimon Tilley G4USI
practicalwireless@warnersgroup.co.uk

The CW Sprint Lite Morse Trainer

Daimon Tilley G4USI checks out a newly-launched Morse trainer.

I was recently sent this device, as a kit, to build and test for *PW*. The kit is designed and sold by **Martin Waller G0PJO** from his website (URL below) and costs £35, including post and packing to the UK.

www.net-trekking.co.uk

The kit came with a checklist of the components included, the PCB and a 3d printed stand. It is designed to stand on the desk as a bare PCB without an enclosure and is powered via a USB C power lead, which is included. You will need to supply your own USB mains plug or use your computer as the 5V supply.

A detailed set of instructions are available online and are not included as a paper set. The build is really straightforward so this is not an issue in practice. I had mine built from bare board to working in around 20 minutes and the kit would suit a novice constructor as there is plenty of room in which to work (**Figs 1** & **2**).

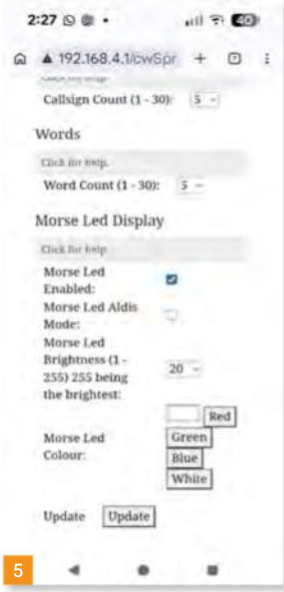
Assembly is straightforward, with the most tricky (but still straightforward) part being placing the four-legged diodes and aligning the three of them nicely. Martin is working on a 3d printed tool to help get those nicely aligned, but I managed well enough to make them look neat. On my first power-up, the red LED on the microprocessor board lit up but nothing else happened. A quick inspection revealed the schoolboy error – I had only soldered two pins of the board to the legs! A quick trip back to the soldering iron soon fixed that and all was well.

How is it designed?

The design is simple and attractive, with the white bare PCB looking quite smart on the shack desk. There are five separate sets of controls, as follows. Three potentiometers control Volume, Tone (pitch) and Speed. Volume can be completely muted at the bottom end, and is quite loud at maximum – enough that you could turn on your HF rig on in the background and practice your CW, with the HF rig providing 'QRM' conditions! Tone range is more than adequate and the speed control gives a range of roughly 8 – 35 words per minute (WPM.)

There are two other controls – a simple stop / start switch (labelled CT) and a red 8-way DIP switch. This latter is designed as a simple yet cheap and effective means of selecting your mode of operation. It is divided into two halves (**Fig. 3**) with the first three positions allowing the choice of Letters, Digits or Punctuation, and the last five a choice of Groups, Callsigns, Words, Quotes and QSO's. Of course, these combinations do not work in all cases – for

Fig. 1: Bare board. Fig. 2: The completed PCB.
Fig. 3: The mode select DIP switch.
Fig. 4: Browser settings mode part a.
Fig. 5: Browser settings mode part b.
Fig. 6: Browser view of Quote mode.



example, if you select DIP position 2 – Digits – then on its own you will get a "?" response, so you would also move position 4 – Groups – to the on position to get groups of digits. Selecting 2 (Digits) and 6 – Words – will give you words instead of digits – so there is a natural logic to what you would choose.

The use of a DIP switch likes this keeps cost and build complexity down, but it is difficult to make changes with my (average sized) fingers. I found it easier to use a retractable ballpoint pen, with the nib retracted, to cover the switch required and move it.

Three multicolour LEDs flash in sync with the Morse, one for 'dits' and all three for 'dahs.' Everything is sent of groups of five, except QSO and Quotes, which are singular. The QSO mode is particularly nice as it sends real callsigns and randomly generated QSO text, in line with the sorts of exchanges you are likely to have for real. Here is an example of part of a random QSO:

"G6FIM/P DE PB4ZIN/P = = MNY TKS FER CALL = NAME IS JOAN JOAN QTH ASSEN ASSEN RST 459 459 QRA JO33GA JO33GA HW? G6FIM/P DE PB4ZIN/P K̄N"

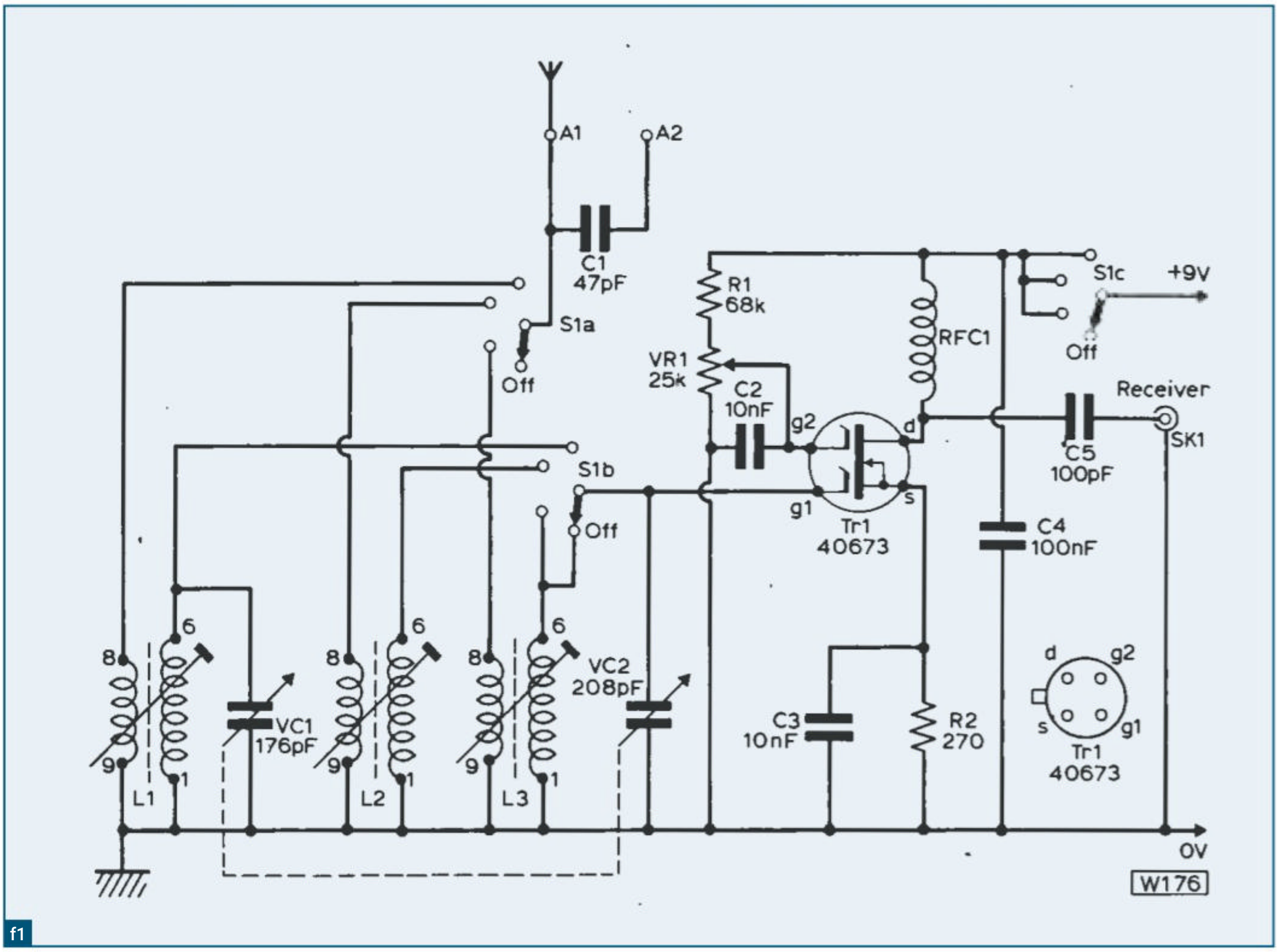
A neat addition is the use of the browser interface. By changing your Wi-Fi settings on your computer, tablet or phone to the Wi-Fi of the device 'CWSprintLite' and entering the web address detailed in the build / operating instructions, you can then see the speed set in WPM and the frequency of the Tone chosen.

By selecting the CW Settings in the web page, it is possible to change a number of settings, such as enabling Farnsworth mode (faster characters but with longer spacing between), the number and length of groups sent, as well as the number of callsigns and words sent. Furthermore, it is possible to change the LED display, and then pressing 'UPDATE' will deliver those changed settings to the device (**Figs 4** & **5**).

One further advantage of using this browser interface is that the characters sent are displayed on screen. However, the full text of what is being sent is displayed on screen before the device starts to send (**Fig. 6**). While this is useful to listen along to, or to check your decoding at the end of a group, it would be nice if a feature was added that displayed each character as it is sent, one at a time, at the same speed as the user has chosen. One other feature that I would like to see, perhaps in a future addition, is the inclusion of a 'Repeat' key. This would allow a user, if they have not fully copied a group, to try again and fill in the blanks. Martin does offer firmware updates, so I have suggested to him that the simple expedient of recognising a 'long press' on the Stop/Go 'CT' button could perhaps allow this in future, as well as considering the suggestion of character display via browser to 'play along' with the sent code at the selected speed. Martin has responded positively to these suggestions and hopes to get more feedback so that he can prioritise any improvements.

In conclusion

This is a neat little device that is fun and easy to build. It is well featured and represents good value for money, and could be an ideal introduction to learning or improving your CW. My thanks to Martin for sending the unit for me to review. **PW**



f1

50 years ago in PW

We feature an article that appeared exactly 50 years ago, an RF amplifier built around the then ubiquitous 40673 dual-gate MOSFET.

Don Field G3XTT
practicalwireless@warnersgroup.co.uk

This tuned RF amplifier will be found to provide quite substantial gain, and is of great help in bringing weak signals up to a level where they can be received properly. Even with a sensitive receiver having two RF amplifiers and a number of IF stages, it can result in the satisfactory reception of signals which are otherwise virtually impossible to copy.

With stronger signals, which would in any case be received satisfactorily, the unit helps to reduce second channel interference, which can be troublesome with some receivers. However, its main use is in improving reception where a poor aerial, or the low signal strength of the wanted transmissions, makes adequate reception otherwise impossible.

Circuit Details

Three coils are used, L1, L2 and L3, **Fig. 1**. Switch S1 selects the required coil. One section of VC2 (208pF) is used for L2 and L3. For the lowest frequency range L, VC1 is also in circuit, giving 384pF in all. As a result, three ranges as follows are obtained:

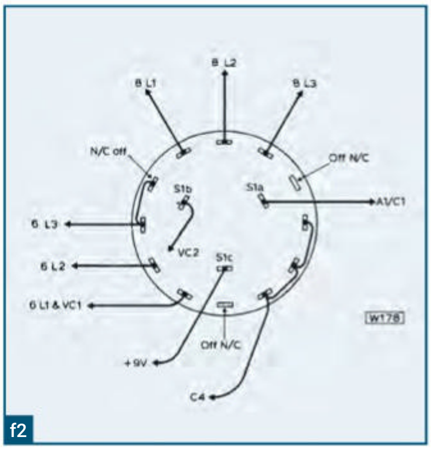
- Range 1-15-32MHz
- Range 2-5.5-15MHz
- Range 3-1 .6-5.5MHz

It is of course not essential to provide tuning in this way. But if a value of about 365pF is used for all bands, Ranges 1 and 2 will overlap considerably; while the use of 200pF or so for each band will curtail the coverage of L3 at the low frequency end.

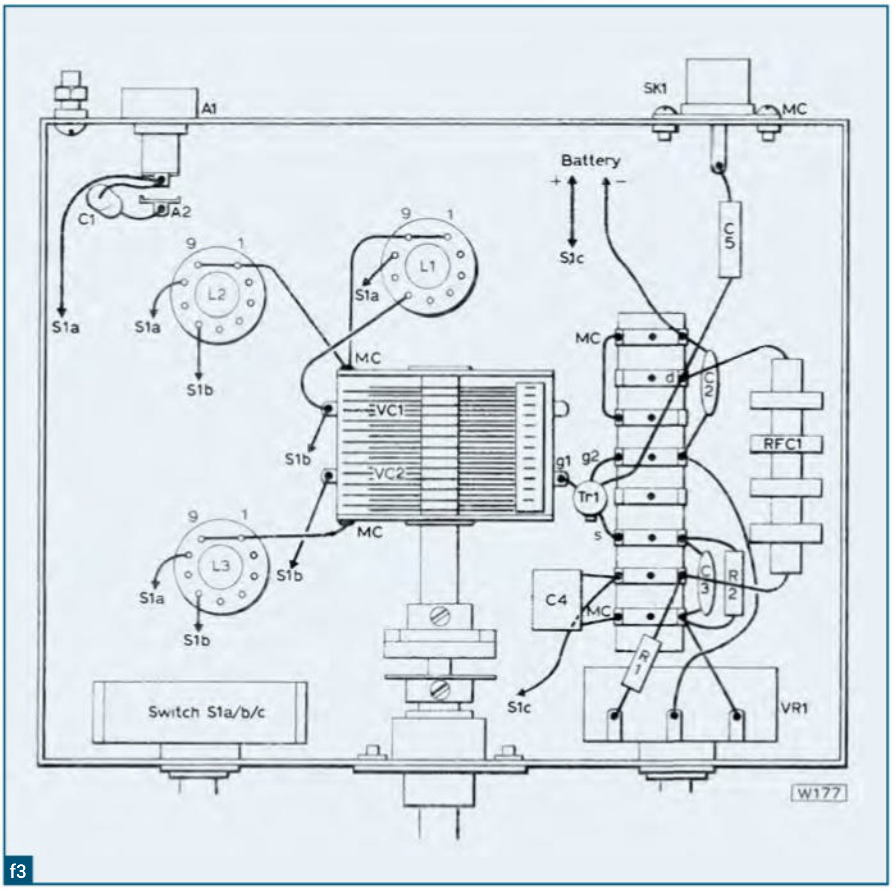
Results would be the same, but it is felt that having three ranges which include all bands from 1.6MHz to 32MHz in this way is probably better.

Switch section S1a/b **Fig. 2** is for coil coupling windings while the third section of the switch, S1c, is for on-off purposes. An alternative aerial socket A2 is fitted for use instead of A1, when the unit is required to tune fairly sharply. Any

50 years ago (May 1976) and RF Rayer G3OGR was still going strong. In that issue he offered a Three band RF mini amplifier.



f2



f3

p1

Fig. 1: Complete circuit diagram of the amplifier, showing the method of switching the coils to obtain a frequency coverage of 1.6MHz to32MHz.
Fig. 2: The three -pole four -way switch S1 is of the rotary type, and front panel mounted.
Fig. 3: The schematic shown here gives the location of all components, and the wiring between components and controls.

end-connected aerial can be used.

Potentiometer VR1 allows amplification to be reduced when strong signals are present, as these might overload the receiver. This control however does not reduce gain to the level where no signals can be received.

Coupling to the receiver is from the RF choke RFC1 and capacitor C5. This will work satisfactorily with receivers having a high nominal aerial input impedance. With receivers having a low impedance, overall gain can be increased by using an impedance matching coil, but this would either have to be tuned in addition to the aerial coils, or be a broadband device. When using the unit with communications type and similar receivers, it was found necessary to employ a screened co-axial lead to the receiver. The power supply is a small internal battery, the drain being only a few milliamps, depending on the setting of VR1.

Cabinet

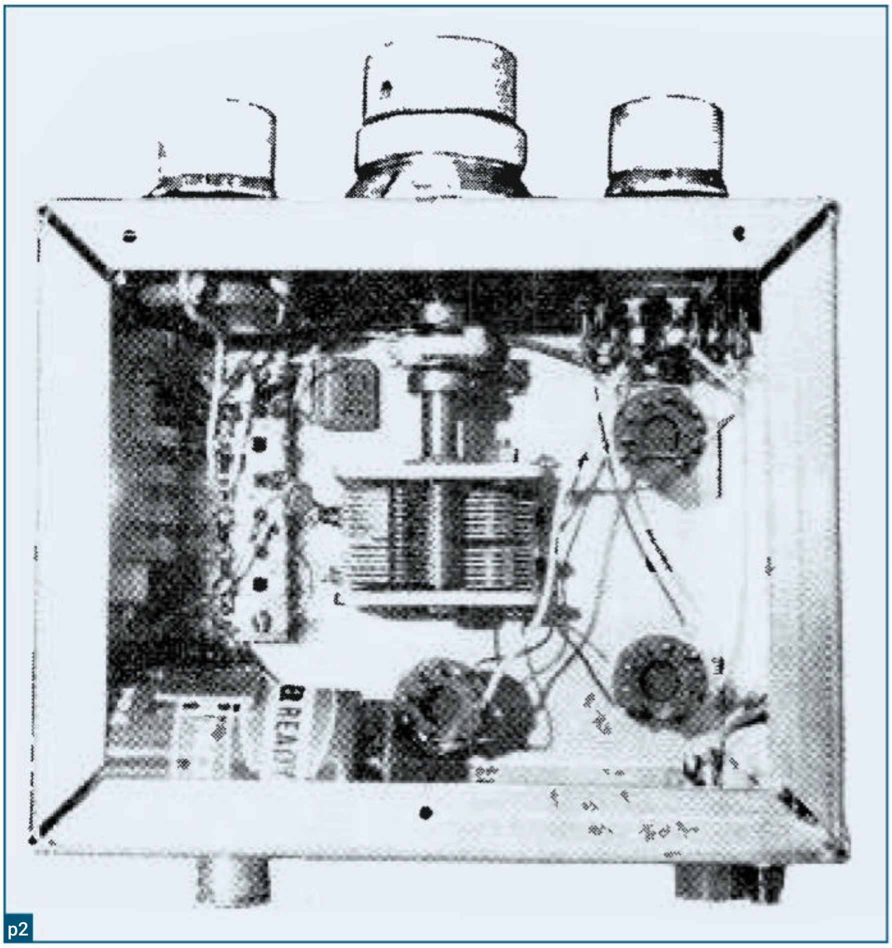
A low-cost and effective screening box and case can be made easily from a 127 x 102 x 51mm ‘universal chassis’ with an extra 127 x 101mm flat plate, which is later attached with self-tapping screws for the top.

As the coil fixing bushes and core-adjusting screws of the coils project through the bottom of the case, four plastic feet are required to raise it about 13mm. First drill one 127 x 51mm member for the front, and fit the switch, VR1, and drive. The bottom 127 x 51mm flat plate is screwed on, and can be drilled to take VC1/2, which is held with one or two 4BA bolts. Washers or other distance pieces are necessary to raise the gang slightly, to get it level with the drive coupling. The capacitor fixing screws must not be too long, or they will short circuit or damage the capacitor. A final lining-up of drive and capacitor is easy if the drive fixing holes are on the large side.

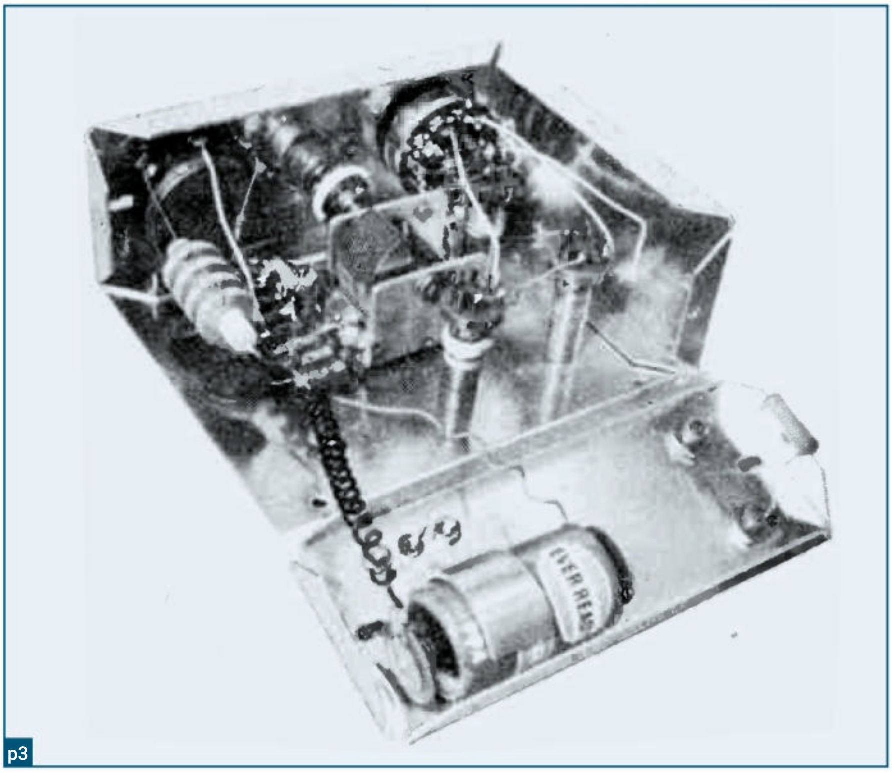
Nearly all wiring is completed before the sides and back of the case are fitted. The back is prepared by drilling it for the aerial sockets and coaxial outlet and a clip is made to hold a PP4 battery. When the back is fitted, one 4BA bolt is used for an earth connection.

Wiring Details

Leads are run approximately as in **Fig. 3**. The tag-strip is raised on 12mm long bolts. As unnecessary coupling between gate 1 and drain circuits is likely to cause instability, G1 is connected directly to VC2. For the same reason, the drain lead is lengthened and taken to the tag holding C5 and the RFC, both adjacent tags being earthed as in Fig. 2. Tr1 is gate-protected, and no special precautions need be taken when



p2



p3

Photo 2: **Plan view of the amplifier with the top plate removed. The ganged capacitor VC1 /2 is driven via reduction gearing to provide precision tuning.** **Photo 3:** **The case is constructed from a single Universal Chassis with an extra plate. Size is approximately 101 x 127 x 51mm.**

Components List

Resistors
- R1 68kΩ
- R2 270Ω
- VR1 25kΩ Lin. potentiometer
- All resistors 1/4W 10%

Capacitors
- C1 47pF
- C2 10nF
- C3 10nF
- C4 100nF
- C5 100pF
- VC1/VC2 Jackson type 00, 176/208pF gang.

Semiconductors
- Tr1 40673

Miscellaneous
- L1, 'Blue' valve type Range 3.
- L2, 'Blue' valve type Range 4.
- L3, 'Blue' valve type Range 5

(All coils Denco miniature dual purpose).
- RFC1, RF choke type Denco RFC5.
- Jackson type 4832 two speed drive with knobs.
- S1a, b, c, 3-pole 4-way rotary switch.
- 127 x 101 x 51mm Universal chassis, with extra 127 x 101mm plate. (Home Radio).
- Four 12mm high rubber feet.
- Two insulated aerial sockets. Coax socket.
- Tag strip comprising 8 tags.
- Battery clip.
- Two matching control knobs.

fitting it, provided the soldering iron is earthed and overheating is avoided.

The coil pins may need scraping, before soldering. Lengthy heating should also be avoided here, or the pins may move. Connections to the switch can be seen from Figs. 2 and 3. All these leads must be reasonably short and direct.

When the sides and back are fitted, connections can be made to A1, A2 and the co-axial socket. The battery is placed with its positive end toward L1.

Earthing is provided by a terminal, or by the co-axial lead to the receiver. Having the latter unnecessarily long may reduce signal strength in some cases. A frequency scale for the tuning need not be provided, as the amplifier is simply tuned to bring about an improvement in signal strength. With the unit switched to the Range needed for the receiver frequency, tuning should be found to peak up signals considerably. This will be most apparent with weak signals, or with the receiver AGC off. If the receiver has a tuning meter, this will show correct tuning. The coil cores are set to give coverage approximately as described. Exact coverage is not important, provided the ranges overlap slightly.

Should whistles accompany reception, especially with VR1 at maximum gain, Tr1 is oscillating. This is most likely when using an unscreened receiver aerial lead, especially if this is near the aerial connection to the unit. Tuning the booster should be found to peak up signals or aerial noise but not cause heterodynes or oscillation. **PW**

Impedance (Part II)

Jeff continues his discussion of impedance.

Chris Murphy M0HLS
practicalwireless@warnersgroup.co.uk

It was mid-morning in the electronics lab and Jeff and Natalie were washing their cups after their mid-morning break. *"After our session on impedance and resistors and inductors in series yesterday, you said that we could cover resistors and capacitors in series today. We've already touched upon it with Archie and Arthur, but I always appreciate the tutorials from you"*. *"Yes, OK"*, Jeff replied. *"We might even have time to look at circuits with resistance, inductance and capacitance in series as well"*.

Lunchtime arrived and Natalie wandered over to Jeff's desk armed with a pad of paper, pen and her trusty calculator. She sat down next to Jeff and waited while he read the last couple of paragraphs in the *RadCom* article that he'd been reading. *"Right, OK"*, said Jeff. *"Resistors and capacitors in series in alternating current circuits. The approach is pretty much the same as for resistors and inductors, but we'll go through it anyway"*. *"OK"*, Natalie replied.

"For a series alternating current circuit containing a resistor and capacitor [**Fig. 1**], *the supply voltage, V_S will be given by the phasor sum of the voltage across the resistor V_R and the voltage across the capacitor V_C. And as we already know for a capacitive circuit, the current will lead the voltage by some angle between zero and ninety degrees depending upon the values of the resistor and capacitor"*. *"Won't the voltage across the resistor be in phase with the current?"* Natalie asked. *"Yes, it will"*, Jeff replied. *"Let's draw the phasor diagram to show the relationships between voltages and current"* [**Fig. 2**].

"The next few steps will follow the approach that we took when discussing a resistor and an inductor in series", Jeff explained. *"Firstly, we can draw a voltage triangle"* [**Fig. 3**]. *"And from Pythagoras theorem we can say that the supply voltage, V_s will be given by the square root of the voltage across the resistor, V_R squared plus the voltage across the capacitor, V_c squared"*:

$$V_S = \sqrt{V_R^2 + V_C^2}$$

"And the phase angle will be given by":

$$\Phi = \tan^{-1} V_C/V_R$$

"Let's do a couple of examples. Let's say that we have a circuit where the voltage across the resistor is fifty volts and the voltage across the capacitor is one hundred and twenty volts. Then the supply voltage will be":

$$V_S = \sqrt{V_R^2 + V_C^2}$$

$$V_S = \sqrt{50^2 + 120^2}$$

$$V_S = \sqrt{16900}$$

$$V_S = 130.00\text{V}$$

$$\Phi = \tan^{-1} V_C/V_R$$

$$\Phi = \tan^{-1} 120/50$$

$$\Phi = 67.38°$$

"Now, let's say that in a circuit consisting of a resistor and capacitor in series with a supply voltage of two hundred volts, the voltage across the resistor is eighty volts. What is the voltage across the capacitor?" *"We'll have to rearrange the formula first to make the capacitor voltage the subject"*, said Natalie. *"Correct"*, Jeff replied. "So":

$$V_C = \sqrt{V_S^2 - V_R^2}$$

$$V_C = \sqrt{200^2 - 80^2}$$

$$V_C = \sqrt{33600}$$

$$V_C = 183.30\text{V}$$

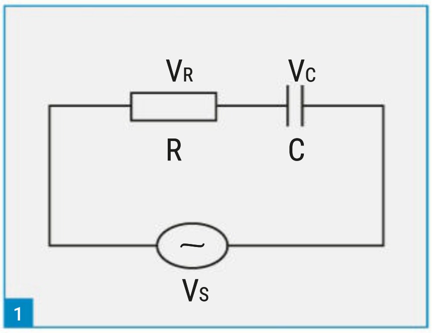
"So", Jeff continued, *"By taking our voltage triangle and dividing through by the current, I, we can construct an impedance triangle"* [**Fig. 4**]. *"And again from Pythagoras theorem we can see that the impedance, Z, is given by the square root of the resistance squared plus the capacitive reactance squared"*:

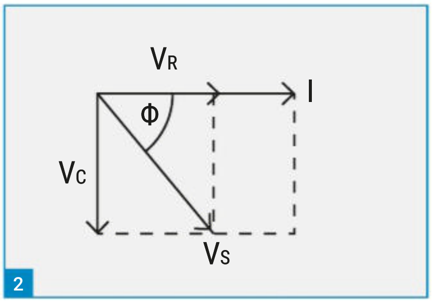
$$Z = \sqrt{R^2 + X_C^2}$$

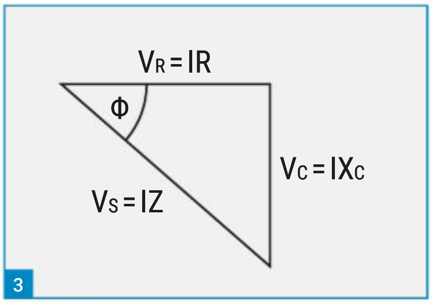
"And the phase angle, Phi, is found by":

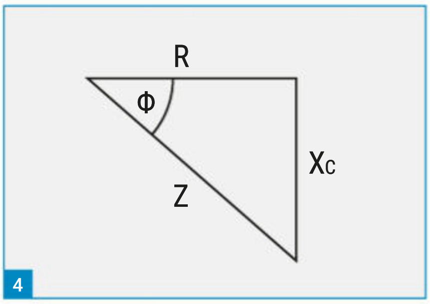
$$\Phi = \tan^{-1} X_C/R$$

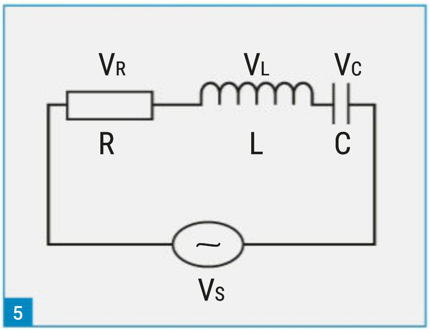
"Let's do a couple of examples", said Jeff. *"Let's say that we have a capacitor with a reactance of five hundred Ohms in series with a one hundred Ohm resistor. We need to find the impedance and the phase angle. So"*:











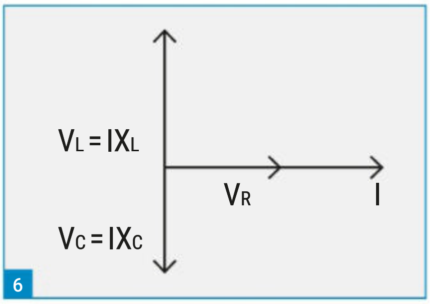
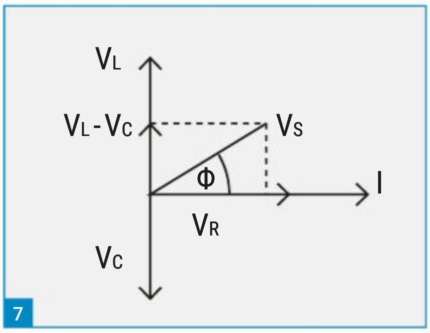


Fig. 1: Series circuit of capacitor and resistor. Fig. 2: Voltage and current relationships in simple circuit of Fig. 1. Fig. 3: Voltage triangle. Fig. 4: Impedance triangle. Fig. 5: Circuit with capacitor, inductor and resistor. Fig. 6: The voltages across inductor and capacitor are 180 degrees out of phase.



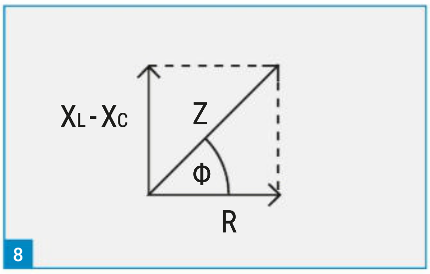


Fig. 7: Voltage relationship with inductive reactance greater than capacitive reactance.
Fig. 8: Impedance relationships.

$$Z = \sqrt{R^2 + X_C^2}$$

$$Z = \sqrt{100^2 + 500^2}$$

$$Z = \sqrt{260{,}000}$$

$$Z = 509.90\Omega$$

"And the phase angle is":

$$\Phi = \tan^{-1} X_C/R$$
$$\Phi = \tan^{-1} 500/100$$

$$\Phi = 78.69°$$

"As you can see, the reactance of the capacitor is the dominant factor for the impedance", Jeff added. *"And, as we did with our voltage examples, we can make either the resistance or reactance to be the subject of the formula. So, let's say that a circuit consisting of a resistor and a capacitor with a reactance of one kilo Ohm has an impedance of one point five kilo Ohms. What will the resistance be?"*

$$R = \sqrt{Z^2 - X_C^2}$$

$$R = \sqrt{1500^2 - 1000^2}$$

$$R = \sqrt{1.25 \times 10^6}$$

$$R = 1118\Omega$$

"And the phase angle is":

$$\Phi = \tan^{-1} X_C/R$$

$$\Phi = \tan^{-1} 1000/1118$$

$$\Phi = 41.81°$$

"This right-angled triangle and Pythagoras theorem stuff is quite useful isn't it", Natalie said. *"We've used it quite a lot in both maths with Reggie and engineering science with Arthur. Not just electronics but mechanical things as well". "Yes, it is"*, Jeff agreed. *"It saves us drawing a lot of scaled phasor diagrams a lot of the time".*

"Reggie also told us of other ways to find the phase angle", said Natalie picking up a pen and wrote:

$$\Phi = \tan^{-1} X_C/R \quad \Phi = \sin^{-1} X_C/Z \quad \Phi = \cos^{-1} R/Z$$

"But in all the examples that we've done in class and in all the textbooks that I've seen they always use the tangent one. Is there a reason for that?" "The reason that we tend to use the tangent formula", Jeff replied, *"is because it uses the opposite and adjacent sides of the triangle, which in many cases are known factors, whereas the hypotenuse is the resultant of a calculation. But it doesn't really matter so long as you've got your maths right". "Oh, OK"*, said Natalie. *"Just wondered".*

"Anyway", said Jeff, *"We'll do one more example, one that's a bit more complicated, then we'll move on to something else". "OK, fine"*, Natalie replied.

"Right, let's say that we have a capacitor of unknown value connected in series with a sixty-eight Ohm resistor across a supply voltage that has a frequency of one hundred and twenty Hertz. The circuit impedance is seventy-five Ohms and a current of one point two Amperes flows in it. Find:

1. The value of the capacitor
2. The admittance of the circuit
3. The supply voltage, V_S
4. The phase angle
5. The voltage across the resistor, V_R
6. The voltage across the capacitor, V_C

"So", Jeff continued, *"We know the values of the resistor and impedance, so we can juggle the formula for impedance around so that we can calculate the reactance":*

$$Z = \sqrt{R^2 + X_C^2} \qquad \text{So} \quad X_C = \sqrt{Z^2 - R^2}$$
$$X_C = \sqrt{75^2 - 68^2}$$

$$X_C = \sqrt{1001}$$

$$X_C = 31.64\Omega$$

"Now that we know what the reactance is we can calculate the capacitance":

$$X_C = 1/2\pi fC \quad \text{so } C = 1/2\pi f X_C$$

$$C = 1/2\pi \times 120 \times 31.64$$

$$C = 41.9\mu F$$

"From our previous session we know that admittance is the reciprocal of impedance, so":

$$Y = 1/Z$$

$$Y = 1/75$$

$$Y = 13.33mS$$

"The supply voltage will be the impedance multiplied by the current, so":

$$V_S = 75 \times 1.2$$

$$V_S = 90V$$

"The phase angle is given by the arctan of the reactance divided by resistance, so":

$$\Phi = \tan^{-1} X_C/R$$

$$\Phi = \tan^{-1} 31.64/68$$

$$\Phi = 24.95°$$

"The voltage across the resistor is simply found by Ohms law, so":

$$V_R = IR$$

$$V_R = 1.2 \times 68$$

$$V_R = 81.6V$$

"The voltage across the capacitor is found by multiplying the current by the reactance, so":

$$V_C = IX_C$$

$$V_C = 1.2 \times 31.64$$

$$V_C = 37.99V$$

"And for a final check on the voltages, we can say that":

$$V_S = \sqrt{V_R^2 + V_{XC}^2}$$

$$V_S = \sqrt{81.6^2 + 37.99^2}$$

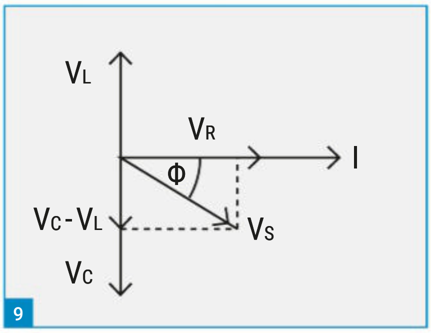
$$V_S = 90V$$

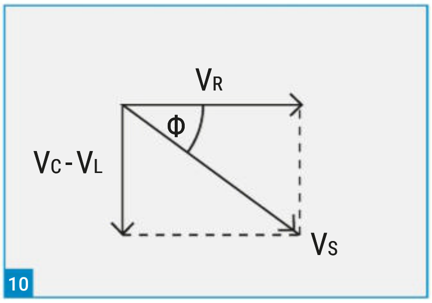
"Anyway, that's a series circuit of a resistor in series with a capacitor covered and we've already looked at a resistor and inductor in series". "So, I'm guessing that the next step is to look at a resistor, capacitor, and inductor in series", said Natalie. *"Yes, that's the next step"*, Jeff replied. *"Let's consider a circuit where we have a resistor, capacitor, and inductor in series and connected to an alternating current supply like this"* [**Fig. 5**].

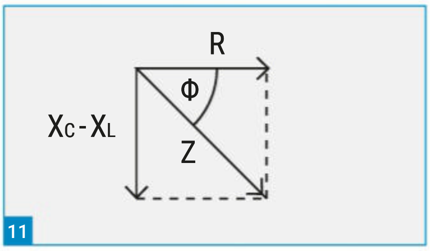
"Here, the voltages across the capacitor and inductor are one hundred and eighty degrees out of phase." [**Fig. 6**] *"Depending upon the values of the inductance and capacitance, three different cases arise". "Oh, OK"*, said Natalie. *"As usual"*, Jeff continued, *"the voltage across the resistor is in phase with the current, but as I've said depending upon the values of the inductor and capacitor, and hence their reactances, the voltages across them can be one of three conditions". "Go on"*, said Natalie. *"I can see why there might be two, but not three".*

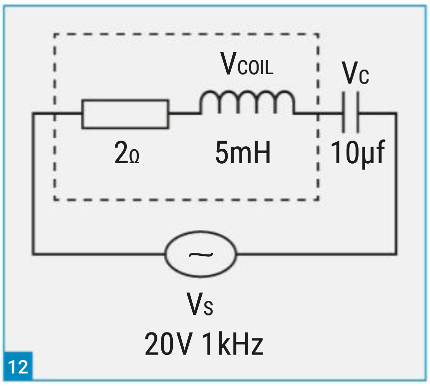
"Firstly", Jeff continued, *"There is the case where the inductive reactance X_L is greater than the capacitive reactance X_C. In this case, the voltage across the inductor, V_L will be greater than the voltage across the capacitor V_C. Now, because V_L and V_C are in opposite directions, we can subtract V_C from V_L to give a phasor that represents the voltage across the inductor and capacitor"*, [**Fig. 7**]. *"Mmm, OK, I see"*, said Natalie looking at Jeff's diagram. *"Here we can see that the resultant voltage is leading the current by an angle, Phi, and so we can determine that the circuit is behaving like an inductor in series with a resistor and use our usual*

Fig. 9: Voltage relationship with capacitive reactance greater than inductive reactance.
Fig. 10: Resultant voltage triangle.
Fig. 11: Resultant impedance triangle.
Fig. 12: Circuit for Jeff's worked example.









methods to find the impedance etc", [**Fig. 8**].

$$V_S = \sqrt{V_R^2 + (V_L - V_C)^2}$$

$$\tan \Phi = (V_L - V_C) / V_R$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\tan \Phi = (X_L - X_C) / R$$

"And we can also say that cosine of Phi will be the resistance divided by the impedance", Natalie put in. *"Correct"*, said Jeff and jotted the equation down:

$$\cos \Phi = R/Z$$

"The second case, as you have probably guessed, is when the capacitive reactance, X_C is greater than the inductive reactance X_L. We can follow the same approach, but this time subtract the voltage across the inductor V_L from the voltage across the capacitor V_C." [**Fig. 9**]. *"Here we can see that the resultant voltage is lagging the current by an angle, Phi and so we can conclude that the circuit is behaving like a capacitor in series with a resistor". "Yes, I understand that"*, said Natalie. *"And again"*, Jeff continued, *"We can construct voltage and impedance triangles"*, [**Figs 10** and **11**].

$$V_S = \sqrt{V_R^2 + (V_C - V_L)^2}$$

$$\tan \Phi = (V_C - V_L) / V_R$$

$$Z = \sqrt{R^2 + (X_C - X_L)^2}$$

$$\tan \Phi = (X_C - X_L) / R$$

$$\cos \Phi \; R/Z$$

"Let's do some examples. Let's say that we have a coil with an inductance of five milli Henrys and resistance of two Ohms connected in series with a ten micro Farad capacitor to a twenty volt supply with a frequency of one kilo Hertz", [**Fig. 12**]. *"Find the current flowing, the phase angle between the voltage and current, and the voltages across the coil and capacitor." "Do we start by calculating the reactances?"* Natalie asked. *"Yes"*, Jeff replied, *"So for the coil we have"*:

$$X_L = 2\pi fL$$

$$X_L = 2\pi \times 1000 \times 0.005 = 31.42\Omega \text{ and}$$

$$X_C = 1/2\pi fC$$

$$X_C = 1/2\pi \times 1000 \times 1.0 \times 10^{-5} = 15.92\Omega$$

"Now as we can see the inductive reactance is greater than the capacitive reactance, so the circuit will behave as if it were inductive with the voltage leading the current. Also note that in this example, the resistance is a part of the coil, there is no other resistor in the circuit". "I was wondering about that", said Natalie. *"Anyway"*, Jeff continued, *"The next step is to subtract the capacitive reactance from the inductive, so"*:

$$X_L - X_C = 31.42 - 15.92 = 15.5\Omega$$

"Now we can find the impedance":

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$Z = \sqrt{2^2 + 15.5^2} = 15.63\Omega$$

"Now that we know the impedance, we can find the current":

$$I = V/Z \quad \text{so } I = 20/15.63 \quad I = 1.28A$$

"The phase angle is":

$$\Phi = \tan^{-1} (X_L - X_C)/R \quad \Phi = \tan^{-1} 15.5/2 \quad \Phi = 82.65°$$

"To find the voltage across the coil, we first need to find the impedance of the coil, so":

$$Z_{Coil} = \sqrt{R^2 + X_L^2} \quad Z_{Coil} = \sqrt{2^2 + 31.42^2} \quad Z_{Coil} = 31.48\Omega$$

"Now we can find the voltage across the coil, so":

$$V_{Coil} = I \times Z_{Coil} \quad V_{Coil} = 1.28 \times 31.48 \quad V_{Coil} = 40.30V$$

"The voltage across the capacitor is the current multiplied by the reactance, so":

$$V_C = I \times X_C \quad V_C = 1.28 \times 15.92 \quad V_C = 20.38V$$

"And, so there you are", said Jeff, *"That's circuits containing a resistor and an inductor (RL), a resistor and a capacitor (RC), and all three (RCL) covered. As I said earlier, there is a special case for a RCL circuit where the reactances of the inductor and capacitor are equal, but since you haven't covered it in class yet, we'll leave that for another time"*:

"OK, thanks", said Natalie. *"Can you write some more questions for me that I can pass on to Isla, Poppy, and Tommy as well please?" "Sure"*, Jeff replied.

Jeffs questions

1. A resistor and capacitor are connected in series across a seventy-five volt alternating current supply. If the voltage across the resistor is twenty-eight volts, what is the voltage across the capacitor? (69.58V)

2. A twenty micro-Farad capacitor is connected in series with a one hundred and twenty Ohm resistor across a two hundred volt five hundred Hertz supply. Calculate a, the impedance, b, the phase angle, c, the current, d the admittance. (a, 121.05Ω, b, 7.56°, c, 1.65A, 8.26mS)

3. A coil with an inductance of one hundred milli Henrys and resistance 5 Ohms is connected in series with a one hundred and fifty micro-Farad capacitor across a two volt fifty Hertz supply. Calculate: a, the impedance, b, the phase angle, c, the current, d, the voltages across the coil, and capacitor. (a, 11.37Ω, b, 63.91°, c, 176mA, d, V_{Coil} 5.6V, V_C 3.73V)

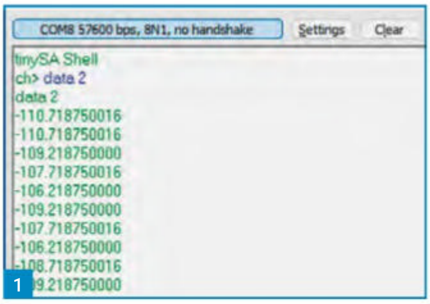
4. A two micro Henry inductor with a resistance of eight Ohms is connected in series with a ten nano Farad capacitor, across a ten volt five hundred kilo Hertz. Calculate: a, the impedance, b, the admittance, c, the phase angle, d, the current, e, the impedance of the coil. (a, 26.77Ω b, 37.35mS c, 72.61° d, 374mA e, 10.17Ω)

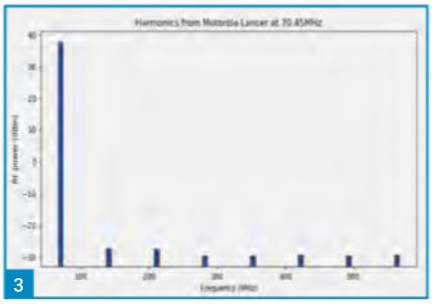
5. A series RCL circuit consists of a coil with a reactance of forty Ohms and negligible resistance, a capacitor with a reactance of ninety Ohms, and a sixty-five Ohm resistor. The circuit is connected to a seventy volt fifty Hertz supply. Calculate: a, the impedance, b, the inductance of the coil, c, the value of the capacitor, d the current. (a, 82Ω, b, 127mH, c, 35.36μF, d, 854mA) **PW**

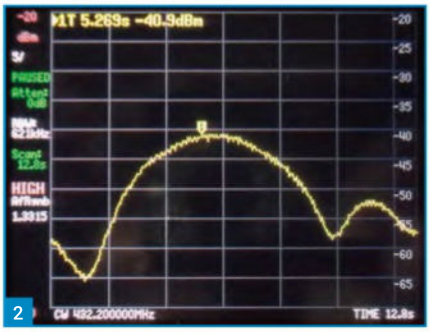
Ross Wilkinson G6GVI
practicalwireless@warnersgroup.co.uk

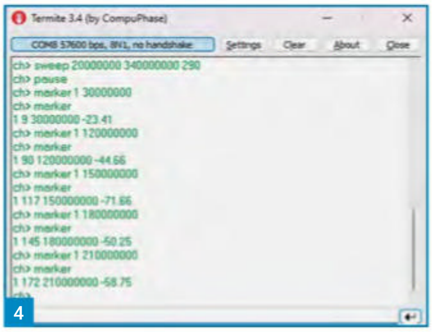
Signal measurements using a TinySA

Ross G6GVI discusses Zero-ing in to the time domain









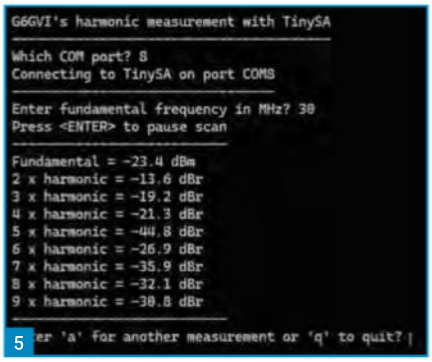


Fig. 1: The TinySA in console mode. Fig. 2: The pattern of a 70cm beam antenna, swept through 180°. Fig. 3: Harmonics from a 4m handie, measured with the SSA. Fig. 4: Manual Console measurement of harmonic levels. Fig. 5: Python harmonic script in action.

A few months ago, I wrote an article in this magazine about measuring antenna patterns using a handheld *TinySA* analyser [**1**]. That was an example of using the analyser in 'zero-span' mode: to plot signal amplitude against *time* rather than frequency. But not all spectrum analysers have this facility: my handheld *RFExplorer* Spectrum Analyser unit [**2**] didn't, so the best I could do with that was to use its narrowest span and then read and sum together a set of adjacent frequency bins around the signal on each sweep.

Then for years I have been using a little USB-powered receiver unit with a log-detector and ADC, known as a *Simple Spectrum Analyser* [**3**] in zero-span mode. But it was quite a challenge to read its output: a stream of byte-encoded 16-bit values which then need unscrambling, scaling and offsetting to recover the dBm values. Nonetheless this simple receiver has proved very useful, covering from VHF up to 4.4GHz on a single input, with a wide dynamic range of >60dB. It uses an IF around 100kHz, with a fixed bandwidth of a few tens of kHz (and hence an image response 200kHz away), but it's given me some excellent results when measuring antenna patterns on 23, 13 and 9cm: [**4**, **5**].

Exploring the TinySA's 'console mode'

But last year I discovered the *TinySA* handheld spectrum analyser [**6**], which despite its fiddly little screen *(stronger glasses required!)* is really easy to use via its USB interface. It has a zero-span mode and provides a straightforward output of the dBm values as text via its serial port. All that's needed is a simple terminal program such as *Termite* [**7**], then a full list of commands can be found by typing "**help**" in the console (more details are in the online guide [**8**]).

For example, sending the command "**data 2**" triggers the unit to output a list of all the values across its screen (290 points by default) on the previous sweep, as shown in **Fig. 1**. While the default units are dBm, it can also be set to use dBmV, dBμV, Volts or Watts, if preferred. The device also has selectable 'RBW' bandwidths and Sweep Time, so can be set to display an antenna pattern (in rectangular format) on its little screen after each scan. For example, **Fig. 2** is the plot of my 70cm 7-ele antenna as I rotated it through 180° in 13 seconds (but on that occasion I'd forgotten to narrow the RBW from 600kHz down to 10kHz, so that trace is noisier than it should be).

It's easy enough to capture these reported signal values into a file and import them into a spreadsheet for further processing. Alternatively, I have compiled a *Python* script to read and save this output as a custom (.PLP) file, for direct import into the G4HFQ *PolarPlot* program. This presents the plot in a circular format, as I've documented on my web-page [**9**].

Other useful zero-span measurements could include the keying transient of a transmitter (using the Trigger function), the envelope of an AM signal (using linear scaling) or even long-term monitoring of the signal (or noise) level in a channel.

Extended harmonic measurements with the TinySA

Now back into the frequency domain: in the past I have used a *Python* script to quickly step my *SSA* receiver through each of the harmonics of a signal in order to measure the spectral purity of a transmitter. **Fig. 3** is such a plot, from a *Motorola* ex-PMR handie, which I use on 4m (if you try this on a broadbanded *UV-K5*, prepare yourself for a shock!).

Although the *TinySA* already has a built-in 'Harmonic' utility, this just uses its four Markers to measure the fundamental plus the first three harmonics on a wide sweep. However, even the basic *TinySA* model (with 350MHz frequency range on its 'Low' input) is capable of measuring up to the 6th harmonics of the 6m band (although it won't quite reach the 5th harmonics from 4m).

Fig. 4 shows an example of using simple Console commands to measure first the fundamental (of the internal 30MHz

calibration signal) and then harmonics at 4x, 5x, 6x and 7x frequency in turn. The only commands required are:
• **sweep <start f> <stop f> <n points>** (where the frequencies are in Hertz);
• **pause** (hold the sweep data for analysis);
• **marker 1 <desired freq>** (set the marker on target frequency);
• **marker** (read back the value, for example "210000000 -58.75");
• **resume** (un-pauses the sweep for further measurements).

Then it's just a case of using your favourite scripting language (e.g. *Python*) to automate the process and calculate the relative harmonic levels, as shown in **Fig. 5**.

When measuring the (high-power) output of a transmitter, external attenuators are needed to reduce the analyser input down below milliwatt level: as well as avoiding damage it's important to operate analyser in its linear range, so it measures true harmonics from the transmitter, rather than distortion within its own circuitry!

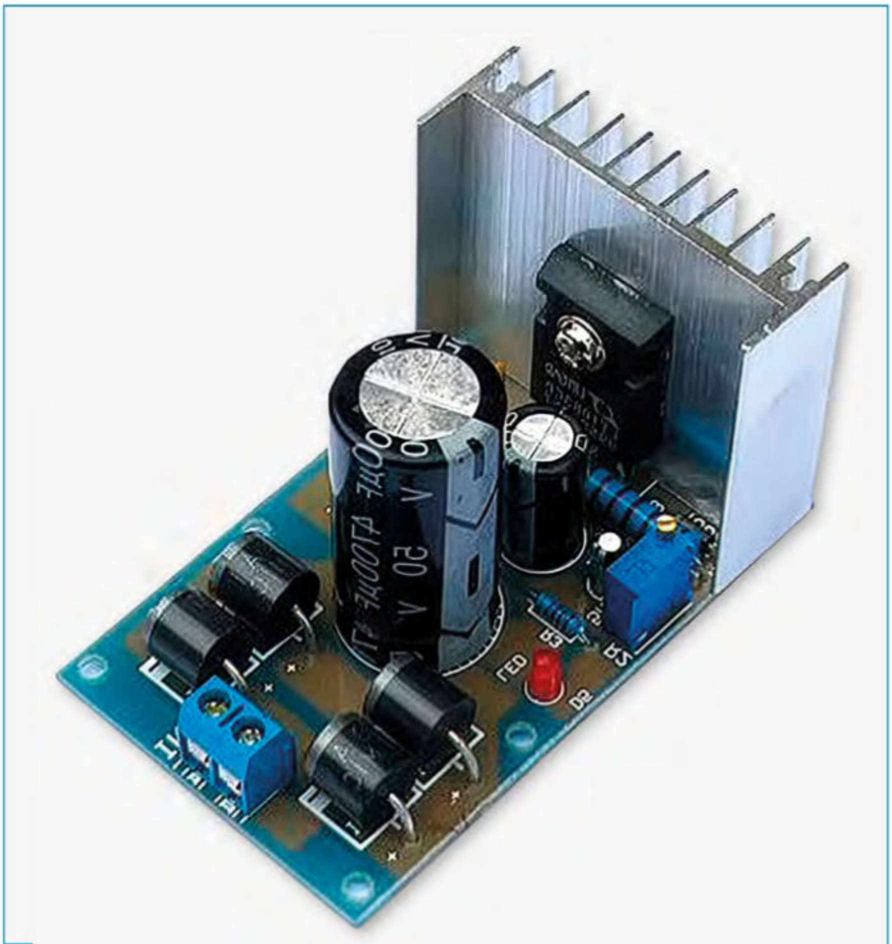
A good way to check for analyser overload is to add a few more dB of attenuation and see if the measured relative harmonic suppression appears to improve.

Conclusions

The *TinySA* is a very versatile tool, one which many amateurs already own. It has plenty of built-in measurement features, but don't be put off by its fiddly little touchscreen: its straightforward console mode makes it really easy to create and run your own custom utilities as required. I quickly found mine so useful that I've upgraded to an *Ultra* model, with a 4in screen and extended SHF coverage! **PW**

References

[1] Practical Wireless, March 2026, pp 16-17
[2] RFExplorer analyser: **https://tinyurl.com/35y2zvuj**
[3] These 'Simple Spectrum Analyser' units are no longer available – superseded by the TinySA?
[4] 23cm antenna measurements in 2025: **https://tinyurl.com/34bx2yje**
[5] 9cm antenna measurements in 2022: **https://youtu.be/5c6NeAqik9E?t=58**
[6] TinySA: **https://tinyurl.com/3mas4vmt**
[7] Termite serial terminal: **https://tinyurl.com/cpsezuub**
[8] TinySA online guide: **https://tinyurl.com/mr3b9fwk**
[9] G6GVI's antenna plotting: **www.qsl.net/g6gvi/polarplots.html**



1

A Simple Portable Power Pack

Bernard Nock G4BXD explains how to repurpose a handy DiY power supply for your radio needs.

Bernard Nock G4BXD
military1944@aol.com

There are amateurs who enjoy operating, buying a rig, an antenna, maybe even the cable with the plugs fitted and simply talking to others around the world. Then there are the bodgers, the messing abouters, who cut, drill, hammer, screw, bolt and generally make a mess. Being one of the latter I, like many others, have a whole host of battery-operated power tools. So, when I was thinking, in a weak moment of desperation, of going out and operating portable I started to think about the batteries I would need.

Options

It crossed my mind I already had numerous batteries for all my power tools, a well-known yellow brand of tools for which I had several 2Ah and 4Ah battery types. I had thought of using them before but the main drawback was how to connect to them. They usually dropped into a moulded plastic housing at the base of the relevant tool and replicating the shape of the holder, then trying to connect to the actual terminals left me stumped. It was while inserting a battery into its charger one day that the proverbial light bulb went on. I needed

Fig. 1: The regulator with heatsink – too large to fit in the case.

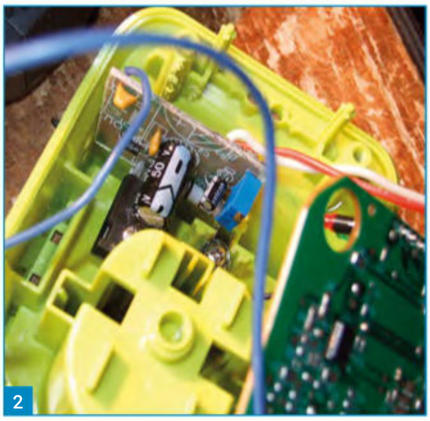


Fig. 2: The regulator fitted inside the case.
Fig. 3: The completed project.

another charger, rip the guts out and simply fit a suitable regulator.

Just then I spotted on Marketplace a charger being offered for sale quite cheaply. I bought it and awaited delivery. Upon arrival I attempted to take it apart only to find it was held together with those silly Torx screws. After ordering a set of suitable drivers the unit was opened up. A very neat circuit board was inside which charged the battery and gave visual indication of the charging state. After a little more thinking it crossed my mind that as there was sufficient space inside the unit, I might as well retain the charging function and simply add the required regulator. The regulator was needed as this range of batteries are nominally 18V.

In practice

Though there is room inside the plastic charger housing it's still a bit of a wiggle to get a regulator and heatsink etc in there. I had bought several small regulator kits some time ago, at really silly prices, which was less than the cost if the components were bought individually, and I still had one or two left. This unit uses the LT1083 device rated at 7A but as my portable operations would be with my IC-705 only 2A or so was envisaged as being needed. I guess a standard 7812 1.5A regulator, with a suitable Zener in the ground lead to make 13.5V or so, would probably have been OK but the 1083 was already to hand. There are many DC-DC regulator PCB's and kits online but I prefer the linear type for the low noise output.

The kit of parts for the regulator came with a silk screened PCB on which the rectifier diodes and smoothing capacitor could be mounted. As these were not needed, and to reduce the size of the unit the PCB was cut at a suitable point. Little extra bits were trimmed off the PCB until the regulator IC and just the parts needed to make it work were left. The kit supplied a decent heatsink, **Fig. 1**, but it was too large to fit in the charger case. I found a few small bits of aluminium and bolted then to the IC to form a small heat dump.

The heatsink was smaller than I would have liked but I figured the portable operations would be on SSB or CW so the duty cycle of pulling current would be low and the IC-705 has a very nice power control meaning the rig would always be operated at the lowest power, and hence current draw, needed at the time.

To aid heat dissipation numerous 3mm holes were drilled into the plastic casing, along the top above where the heatsink was mounted and to the side walls to allow the ingress of cooling air. I had to use my battery-powered Multi tool, the flat bladed vibrating thing that sounds like a dentist's drill, to remove a couple of moulded ribs inside the case and make a small notch in one of the ribs so that the regulator PCB would fit snugly, **Fig. 2**.

Before fixing the PCB into the case the small multi-turn potentiometer on the board was adjusted, with the battery connected, to give a nominal 13.5V output. Once the voltage was set I used a hot glue gun to fix the PCB into place so it wouldn't move about during transport.

I fitted a pair of 4mm banana terminals on the rear wall as the IC-705 had 4mm plugs fitted to its 13V lead though, of course, you could fit whatever you wanted. The input to the regulator was soldered directly to the base of the spring contacts that engaged the battery when inserted and leads from the regulator output went to the new rear terminals. I will add an inline plug and socket to the transformer unit making the power pack a standalone item. The photo, **Fig. 3**, shows my finished unit. Now I just need to decide where to go for my portable stint. **PW**

NEWS EXTRA

ARISS BEYOND THE ISS: With 25 years of experience connecting astronauts and cosmonauts to tens of thousands of kids and adults around the world via amateur radio, ARISS is plotting a course to continue its mission in the government and commercial space realm beyond the targeted decommissioning of the ISS in the 2030 timeframe.

ARISS has already been active in conducting ham radio operations in commercial space ventures including all four Axiom Space flights to the ISS and the Fram2 free-flying mission, and that's a big hint on where they will be focused in the post-ISS era. They have identified commercial space stations as a key growth area for ARISS and are in conversations with anyone and everyone in this emerging sector about making ham radio an asset for crews. Based on publicly available information, there are at least four companies developing or interested in developing commercial space stations: Vast, Axiom Space, Starlab Space and Sierra Space's Orbital Reef. Vast has stated that it could have its four-person, single-module Haven-1 space station for low-Earth orbit as soon as 2027.

In addition to their pursuit of commercial ventures, they are also continuing with full support of ongoing ISS radio contacts and working with NASA to make ARISS a fixture on moon and Mars missions. That includes a partnership with AMSAT to passively track the upcoming Artemis 2 mission around the moon and back.

For the latest updates on school contacts and other exciting ARISS news, please follow the ARISS Facebook, X, Instagram, BlueSky, Mastodon, LinkedIn, YouTube and Discord social media channels.

REMINDER THAT ONLY FULL LICENCE HOLDERS CAN OPERATE ON 5MHZ: The RSGB is reminding radio amateurs that the frequencies at 5MHz are only available on a secondary basis to holders of a UK Full amateur radio licence. Foundation and Intermediate licence holders are not allowed to operate on 5MHz. You can find details about this in the OFW611 amateur radio licence terms and conditions booklet which is available from the OFCOM website and there is also more information about operating on this band at:
rsgb.org/5mhz

NEW DIGITAL MODE: FT2: This is a new, experimental digital mode that has entered its on-air beta testing phase since 16 February. According to its developer (IU8LMC), it is not intended to replace FT8 or FT4, but it is a specialised mode for when pure speed is what matters. FT2 achieves 3.8 second cycles, allowing it to reach 240 QSOs per hour. More in **Tim Kirby's** VHF column this month. See:
https://www.ft2.it

Specialist Dealers

PRACTICAL WIRELESS ARCHIVES

YEAR BY YEAR

All issues of Practical Wireless published from selected years are now available on a handy CD.

Available from just £23.99

plus postage and packing

ITREGENERATION

BUY ALL FORMS OF ELECTRONIC SURPLUS

COMPONENTS/I.T
TEST EQUIPMENT

LARGE QUANTITIES ALWAYS WANTED

PLEASE FORWARD LISTS TO
Email: frtc@aol.Com
Telephone: 07927 807327

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

DISCLAIMER Some of the products offered for sale in this magazine may have been obtained from abroad or from unauthorised sources. Practical Wireless advises readers 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.

Kit Suppliers

KANGA PRODUCTS

www.kanga-products.co.uk
ATU's, Receivers, Transmitters
Morse Tutors and Much more
Now sole distributor for K1EL Products
Inc Winkeyer3 & K16
Chips

K1EL
HAM RADIO KITS

Scotland

TENNAMAST

A complete range of Multi purpose Masts
The best of Scottish engineering!
Tel: 01505 503824
www.tennamast.com
sales@tennamast.com

TechnoFix UK

We supply a variety of accessories for amateur and professional transceivers, including

Programming and CAT cables, Linear switching cables, RTL-SDR.com products, Microphones

and much more!

For these and other great items go to
technofix.uk or www.technofix.co.uk

Classified Adverts

Repairs

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

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

Bargain Basement

Wanted

BATTERY. B103 Ever Ready/Batrymax combined LT/HT for all-dry valve portable radio. Dead, dried out or reproduction would do. Even just a 4-way output socket from this or similar battery.
Godfrey G4GLM (020) 8958 5113
cgmm2@btinternet.com EDGWARE

TO ADVERTISE IN PRACTICAL WIRELESS

Contact Alex Lyon on: 07350 360313 or email: Alex.lyon@warnersgroup.co.uk

Bargain Basement Adverts Cost Just £5

BY EMAIL Firstly email your advert's wording to **kristina.green@warnersgroup.co.uk** 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).

PLEASE NOTE that your advert's wording must be supplied either by email or by post. We cannot take any wording over the phone.

Cheques should be made payable to Warners Group Publications plc, credit card payments also accepted. Advertisements from traders or for equipment that it is illegal to possess, use or which cannot be licensed in the UK, will not be accepted. No responsibility will be taken for errors and no correspondence will be entered into on any decision taken on any of these conditions. The Publishers of Practical Wireless also wish to point out that it is the responsibility of the buyer to ascertain the suitability of goods offered for purchase.

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

Starting Radio for Free

Dear Don,
I thought **Godfrey Manning's** comments (*PW* March 2026) on my article *Starting Hobby Radio for Free, Part 2*, (*PW* February 2026) were a little harsh. My articles are aimed at complete beginners in radio. Studying propagation is like standing on the edge of a vortex; the unwary will easily get sucked in by its complexity and, if I had not been careful, my piece could have resembled a PhD thesis. I explained, in very simple terms, why medium wave signals vary by night and day. I agree that the 'D' layer is relevant but maybe beginners need something easier to follow if they are not to be deterred by a complex treatise at an early stage. My readers may not go down the path of studying for an exam, but if they do, they will soon need to study texts appropriate to their level, which may well discuss the 'D' layer.

I hope my articles will encourage new people into the hobby, and not just those who want to obtain an amateur radio licence. There are many reasons to take up the hobby (practical applications for STEM students, linguistics, culture, unfiltered world news to name a few), and as I don't want to cloak it in technical complexity at an early stage I believe simplification was justified.

David Howard M0BGR, CEng, F.I.E.T.
London

Circuit Boards

Dear Don,
I'd just like to say how much I enjoyed reading the article by **Tony Jones G7ETW** about construction on circuit boards. Like many I must have used many square metres of Veroboard and Matrix board over the years, as well as homemade printed circuit boards.

One thing that I find useful, however, before committing to boards which require soldering, is to build the circuit on a solderless breadboard. These can be picked up quite cheaply, less than £5 and allow components to be easily changed to get the best results from the circuit.

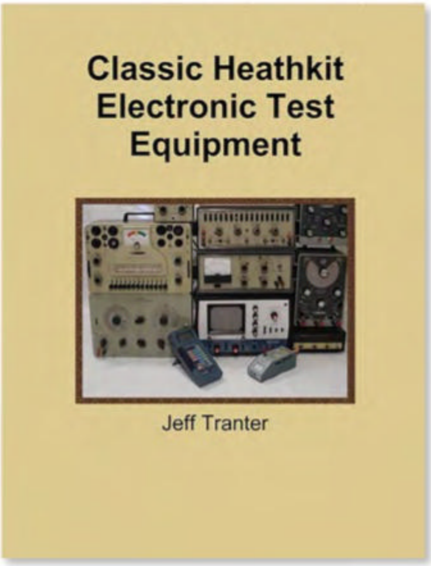
Also, does anyone remember the two-tone Vero Cases? Not seen any for ages.

Along the lines of construction, I recently purchased a book about Heathkit test equipment. I'm sure that many readers will have heard of Heathkit even if they haven't built any of their kits.

I have built quite a few Heathkit kits over the years, although sadly they're not easy to find nowadays. Many of the kits were for test equipment hence my interest in the book. The kits always came with a very comprehensive instruction manual that guided the builder in well illustrated steps.

A shame that they're not still around.

Chris Murphy M0HLS
Derby



The Telegraph, 'Black Holes' & Cheese entrepreneur

Dear Don,
Ever since I fell into the mire of all things radio, the telegraph has been a bone of who-actually-invented-it-contention. Notwithstanding **Samuel Morse**, **Georg Wiessala** (March 2026), mentions two more well-known suspects - **William Fothergill-Cooke** & **Charles Wheatstone**. I've often thought that like the history of making bread, where the originators of the concept are in a constant state of flux - was it the Egyptians, the Babylonians or perhaps the Sumerians who stumbled upon the process, likewise, the originator of the telegraph is also often contested. Occasionally, and I don't mean it to be seen as being facetious, the names of those who may or may not have invented the telegraph, waxes and wanes like the phases of the Moon.

One name that Georg didn't mention in his article, was former cheese entrepreneur **Sir Francis Ronalds** (appropriately described by some, as the First Electrical Engineer). Pioneer, inventor and apparently, a custodian of esoteric knowledge. And was celebrated in the Institution of Engineering as the being the first person to develop a working electric telegraph (1816), decades before **Mr Morse** (he also built the world's first electric clock). He'd previously demonstrated a working model at his home in Hammersmith Hall, London. Ronalds immediately offered his device to the British Admiralty, who promptly declined. Saying that it was *"wholly unnecessary"* - that it would not be a substitute for semaphore then in use. Ronalds was later knighted in 1870 as the original inventor of the electric telegraph. A large swathe of his achievements, including 200 inventions - some of which, are still in use today. He was also streets ahead of **Faraday** with regard to electrical induction, and the effects thereof, once proclaiming, *"Give me material enough, and I will electrify the world"*. We had to wait until Wheatstone and his chum William Cooke finally commercialised Ronalds' innovation 20 years later or so - a consequence of the battery and the electromagnet.

Ronalds was a keen meteorologist too. Establishing the Kew Observatory in 1842 (the Greenwich Observatory wasn't best pleased at the success of its competitor). Probably, the leading meteorological facility at the time.

A modest man, Sir Francis Ronalds was imbued with considerable talents. He left behind a legacy that underpins modern-day electrical engineering. He died 28 August 1873 aged 85. Fortunately, he lived long enough to witness some of his visions being fully deployed.

Unsurprisingly whenever inculcated beliefs are challenged, it is often the fact that someone will appear with a brickbat or two. This time, it's **Tim G4WFT**, taking me to task with regards to my comments about Black Holes (**Newton**, **Hawking** and **Einstein**,

Rallies & Events

All information published here reflects the situation up to and including **9th March 2026**. Readers are advised to always check with the organisers of any rally or event before setting out for a visit. To get your event on this list, email the full details, as early as possible, to: **practicalwireless@warnersgroup.co.uk**

19 April 2026
LIMERICK CLARE AMATEUR RADIO CLUB RALLY AND IRTS AGM: Treacy's Oakwood Hotel, Shannon, Co. Clare V14NH97. Doors open 10.30AM. Traders 8.30AM. Entry €5 as in previous years. Free parking. Refreshments. Trader stands and bring and buy sales. Monster Raffle. Pre-booking of tables via email to dermotgleeson1@gmail.com by 15 March is essential. IRTS AGM to follow at 2.00PM.
limerickclareamateurradio@gmail.com

4 May 2026
DARTMOOR SPRING RADIO RALLY : The Yelverton War Memorial Hall, Meavy Lane, Yelverton. Devon, PL20 6AL. Free Parking. There will be the usual Bring and Buy, Trader Stands and Refreshments available. From 10am – 1pm. Admission £3.00. Please check the website (below) before setting out.
Contact Roger: Tel: 07854 088882
2e0rph@gmail.com
www.dartmoorradioclub.uk

15-17 May 2026
HAMVENTION 2026: Greene County Fair & Expo Center, 210 Fairground Rd, Xenia 45385, USA
https://hamvention.org

17 May 2026
LEARC RADIO RALLY: Share Discovery Village, 221 Lisnaskea Rd, Lisnaskea, Enniskillen BT92 0JZ. Usual facilities - Food and Drink, Parking, Bring & Buy. Doors Open 11:00 Hrs (Traders to arrive around 09:00 Hrs). £/Euro 5 Admission to include Draw Ticket (try to have correct change), Usual Draw, RSGB Books/QSL Bureau, IRTS.
Please contact me by email if you want tables. We aim to fit everyone in but try not to leave it to the last minute.
Alan R Gault, GI6PYP
Email: argault91@gmail.com

14 June 2026
JUNCTION 28 RADIO RALLY: New venue for 2026. The Post Mill Centre, South Normanton, Derbyshire DE55 2EJ. Doors open 1015. Admission £4. Large and small suppliers and individuals providing new and used equipment, components, accessories and test gear. Free onsite parking, toilets and fully accessible venue. Licensed bar and café serving refreshments. Indoor and outdoor tables available. For more information and to book tables contact
j28rally@snadarc.com
snadarc.com

21 June 2026
EAST SUFFOLK WIRELESS REVIVAL (IPSWICH RADIO RALLY): Kirton Recreation Ground, Back Road, Kirton IP10 0PW (just off the A14). Doors open at 9.30am and the entry fee for visitors is £3. The venue has free car parking. Trade tables are from £10. There will be trade stands, a car boot sale, a Bring & Buy, special interest groups, GB4SWR HF station and an RSGB bookstall. Catering is available on site.
Contact Kevin G8MXV
07710 046 846
www.eswr.org.uk

26-28 June 2026
HAM RADIO 2026: Messe, Friedrichshafen.
www.hamradio-friedrichshafen.com

5 July 2026
NEWBURY RADIO RALLY: Newbury Showground, next to junction 13 of M4 in Berkshire, RG18 9QZ. This is the 38th year of The Newbury Radio Rally and is the ideal event for anyone interested in radio communications, computing and electronics. There will be a display area with an amateur radio station, exhibits, special interest groups, clubs and societies. Open to sellers at 08.00hr and visitors at 09.00hr. Free parking. Entry is £4 visitor, £15 seller's pitch. Advance bookings (with discount) can be made via the website. On-site catering. Disabled facilities.
email: NewburyRally@nadars.org.uk
www.nadars.org.uk

11 July 2026
HUMBER FORTRESS DX AMATEUR RADIO CLUB – RADIO RALLY 2026: Welwick Village Hall, Northfield Lane, Welwick, Nr Hull, HU12 0SH. Doors open from 10:00am. General admission: £3.50 per visitor (under-14s free). Fully disabled-friendly access. Free local parking. Refreshments available – including our ever-popular bacon sarnies. We have a limited number of tables available, so early booking is strongly recommended. For more information or to book a table, email:
Rally@hfdxarc.com or visit:
https://hfdxarc.com/booking-form-2026

9 August 2026
FLIGHT REFUELLING ARS HAMFEST: Cobham Sports and Social Club Ground, Merley, near Wimborne, Dorset BH21 3DA. 9am to 3pm. Admission £5 (includes parking). Talk-in on 145.550MHz. Onsite catering and bar. No dogs except assistance dogs. Indoor and field pitches. Car boot sellers and field traders welcome from 7am. Booking forms available via:
frars.co.uk

14 August 2026
31ST ANNUAL MINI_RALLY NIGHT: Cockenzie & Port Seton Amateur Radio Club. Community Hall, Main Hall, Port Seton. Bring along your own "junk" and sell it yourself. Tables on First Come First Served basis. Entrance fee £4 for everyone. Rise in entrance fee is due to rising costs. 1800 to 2100.

16 August 2026
WEST MANCHESTER RADIO CLUB RED ROSE SUMMER RALLY: Venue - Mather Hall, Mather Lane, Leigh WN7 2PJ. Doors open 10am. For further info and bookings, please contact
rally@wmrc.co.uk
lesjackson@ntlworld.com
07796 264569

13 September 2026
CAISTER LIFEBOAT RADIO RALLY: Caister Lifeboat station, Caister on Sea, NR30 5DJ. Entrance via carpark on Beach Rd. Raffle, onsite cafe, gift shop, museum. Free entry, open 10am-3pm (9am for sellers). Inside and outside spaces available. Contact:
Zane M1BFI
m1bfi@outlook.com
Tel 07711 214790

4 October 2026
WELSH RADIO RALLY: Hosted by Blackwood and District Amateur Radio Society GW6GW. Llanwern High School, Hartridge Farm Road, Newport, NP18 2YE. South Wales. Entry: Traders at 7:00am Public at 09:30am, Raffle 12:00, Admission £3.00. Large & Small Traders, Talks/Lectures, Bring and Buy. Free onsite parking, toilets, and fully accessible venue. Onsite Catering. Traders please pre-book ASAP with:
Philip Price GW5JJV. Tel: 07762159734
Email: welshradiorally@icloud.com

25 October 2026
GALASHIELS RADIO RALLY: The Volunteer Hall, St Johns Street, Galashiels, TD1 3JX. Doors open 1115 ,disabled access 1100 ,admission £3. There will be traders ,bring and buy and refreshments:
www.galaradioclub.co.uk

7 June 2026
SPALDING & DARS ANNUAL RADIO RALLY: Spalding Rugby and Football Club Centenary Park, Drain Bank North, Spalding, Lincs PE12 6AF. General Admission £3.00 per person. Free On-Site Car Park. Inside and Outside Traders. Onsite catering
Graham G8NWC Tel: 07754619701
Email: rally2026@sdars.org.uk
https://sdars.org.uk/spaldingrally
What3words ///jumpy.either.pipe

6 December 2026
MID DEVON AMATEUR RADIO & ELECTRONICS FAIR 2026: Winkleigh Sports & Recreation Centre, Devon EX19 8HZ. 09:00 – 13:00. Entry £3 per person, no charge for partners & under 16s. Easy access from the A3124, free parking, free WiFi, hot food and refreshments available. A chance to track down those hard-tofind electronic components, two-way radio and computer hardware. NOTE - as per last a maximum 4 tables per booking, we may remove the 4 table pre trader restriction after October 1st if the rally is not fully booked. Tables are 6 foot frontage (tables supplied), Mains electricity available on request at no extra charge. Please pre-book ASAP:
Phil G6DLJ Tel: 07990 563147
email wrg2024@hotmail.com
What3Words ///focal.fountain.laminated

the perennial gatekeepers, staked their whole careers on the concept of 'gravity', the saving grace of Black Holes). I have to mention gravity, simply because without it, the established arena of astrophysics, the Big Bang, Black Holes (it was a theoretical physicist, **John Wheeler**, who coined the idea of black holes) and the current cosmic explanations of spiral galaxies and so on, all collapse like a pricked balloon. At best, twiddling with tensors and table-top theories are used as a mathematical modelling device to uphold current established viewpoints. We've reached a point, where the dogma of the Big Bang theory is self-sustaining, irrespective of whether there is an alternative explanation or not.

So those who question its validity, are not tolerated within the cosmology hierarchy. They're excommunicated as dangerous heretics. However, the Big Bang theory (**Terry Pratchett** once opined: *"In the beginning there was nothing, which exploded"*) violates the first law of thermodynamics. So we'll ignore that fact?

People often get upset about those (crackpots?) who oppose the importance of gravity (ditto, Black Holes) - because they think that it is the 'glue' that holds the entire concept of their reality together. It has to be real - because if not, how could anything exist! Anyhow, here's one problem, because gravity is such a weak force (so weak, that


Feature

1

Telegraphy Meets Cryptography

Georg Wiessala discusses Cooke, Wheatstone and the Playfair Cypher.

Georg Wiessala
wiessala@hotmail.com

Welcome back to the amazing world of radio history. As I write this, I am investigating the fascinating history of radio and cryptology, hoping to share more on this with you here soon. I also enjoy learning about early radio equipment (**Fig. 1**). Plus, I am currently inspired by three books you might enjoy as much as I did. *50 Codes That Changed the World*, by **Sinclair McKay** (2023), *How the Victorians Took Us to the Moon*, by **Iwan Rhys Morus** (2022; **Fig. 2**), and *The Victorian Internet*, by **Tom Standage** (2024; **Table 1**). To cap things off, I am always intrigued by unusual and 'weird' signals (e.g., *TSM* January 2025: 27). For me, covert transmissions, clandestine stations and cryptography are bedfellows. This month, I'd like to invite you to time-travel back with me to meet some electric, and eclectic, inventors, pioneers and entrepreneurs in this field.

Less than halfway through the revolutionary age that was the 19th century, we meet two gentlemen of great engineering talent and sharp business acumen, **Charles Wheatstone** (1802-1875) and **William Fothergill Cooke** (1806-1879) (**Fig. 3**). On 10 June 1837, these two were granted a patent for their *Electric Five Needle Telegraph* (**Fig. 4**). Thus, the Victorian 'Internet' was born. Wheatstone and Cooke made the Victorian heart beat to the click of their telegraph and coding machines. The Victorian Age was 'turbo-charged' by the widespread use of telegraphy, the growing railway network, and the global undersea cables.

When one looks even just a little more into technology, telegraphy and metrology (measurement) throughout the Victorian era, one cannot help but come across Charles Wheatstone. Not only was he one of the fertile brains behind the telegraph, but he also devised ground-breaking cryptologic devices and systems, among them, the eponymous *Wheatstone Cryptograph* (**Fig. 5**), the *Playfair* Cypher (of which more below) and the *Wheatstone Bridge*, by which an electrical balancing of currents could be achieved. Wheatstone and Cooke must surely count as two of the most innovative scientists of the Victorian Age.

Victorian genius genes: innovation and spectacle

But high-tech 'progress' was in the age's DNA. Victorian technology expert Rhys Morus notes (2022: 145) that, *"the appreciation of innovation was ingrained in Victorian culture"*. The notion of progress through an *electrical* future, and the desire to make a 'spectacle' of new machineries, are not unique to our times. They were utterly characteristic of the Victorians. The 'spectacle' happened during events, such as the *Great Exhibition* (1851)

Buy back issues and archive CDs at www.mymagazinesub.co.uk/practical-wireless

March 2026 PRACTICAL WIRELESS 47

butterflies can easily overcome it), how is it able to seemingly hold the whole population of Earth, all the oceans and everything else onto its surface, while it spins allegedly at 1000 mph (the Heliocentric theory). Gravity is greatly exaggerated. It is nothing more than a cute explanation for the effect of falling.

The universe is electric - based on the electromagnetic force, which is many times stronger than the forces of gravity. Therefore, an Electric Universe presents a far better solution (the deductive nonsense of Dark Matter was invoked to paper over the cracks of Newton's gravitational theory), because gravity plays a very minor role with respect to the much greater forces of electromagnetism.

The cataclysmic Big Bang event theory (and black holes) is based on a couple of big assumptions - that gravity alone determines the structure and movement (the so-called 'redshift/Doppler effect') of celestial objects. A hypothesis that is clutching at straws. An insubstantial theory. Again as mentioned, Dark Matter and Dark Energy were invoked because the movements of galaxies and so on couldn't be explained solely as a consequence of gravity. It's a very feeble force. And of course, the effects of gravity are bound by the inverse square law. So it seems, that the Big Bang is a 'settled' scientific fact. No need to question it, then. Perhaps one day soon, there will be a reawakening of some sort? Oh, at the risk of more opprobrium, I'd better not mention my thoughts on quantum theory. So I won't. Unless you want me to?

Ray Howes G4OWY/G6AUW
Weymouth, Dorset

*(**Editor's comment**: Thanks as always, Ray. Somewhat outside the remit of* PW *so we should probably park this one for now at least. I believe the whole essence of science is to promote 'theories' which remain just that until finally proved or overturned. Who knows what future physicists will come up with but, for now, we have what we have!)*

Next Month

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

SOTA LoRa APRS TRACKER: David Howard M0BGR reviews the SOTA LoRa APRS tracker.
SERVICING AND RESTORING BAYGEN/FREEPLAY SPRING-DRIVEN RADIOS (Part 2): Phil concludes with a description of some of the repair techniques used in his ten years of servicing Freeplay radios.
THE TRANSIT SATELLITES: Tony Jones G7ETW looks back at the precursor to the modern GPS system.
GETTING COMFORTABLE WITH USING dB's: Dr Samuel Ritchie EI9FZB explains the meaning and use of the decibel as a way of relating powers.
SHACK CONTROL UNIT: Peter Edwards GW8ARR builds a switching unit for connecting multiple radios and antennas.
RENOVATING A CLASSIC RUBIDIUM FREQUENCY STANDARD: Mike Dunstan G8GYW refurbishes a classic piece of test equipment.

There are all your other regular columns too, including HF Highlights, World of VHF, Data Modes, Antennas, The Morse Mode, Vintage TV & Radio, What Next and Amateur Radio on a Budget as well as your Letters, the latest News and more.

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

JUNE 2026 ISSUE ON SALE 14TH MAY 2026 AT ALL GOOD NEWSAGENTS

Carries the Yaesu genes for true RF performance

- SDR circuit emphasizes Receiving Performance
- Powerful RF Front-End & Low Noise Oscillator Enable Phenomenal Multi-Signal Receiving Characteristics*
  - RMDR : 113dB+
  - BDR : 127dB+
  - 3rd IMDR : 102dB+
  - TX Phase Noise : −143dBc/Hz
- Band-Pass-Filters dedicated for the amateur bands to eliminate out-of-band unwanted signals
- Built-in High-speed Automatic antenna tuner
- Effective QRM rejection by Dual-core DSP

*Multi-signal receiving characteristic: 14MHz band/2kHz separation
*TX Phase Noise: 100W, CW mode

- **AESS** (Acoustic Enhanced Speaker System) with SP-40 speaker to create High-fidelity audio output
- **3DSS**, real-time 3-Dimentional Spectrum Stream presentation
- High Resolution 4.3-inch TFT Colour Touch Panel Display
- **VMI** (VFO Mode Indicator) shows the current operating mode
- "PRESET" Mode functions most suitable for FT8 operation
- Equipped with the External Display terminal

FT-710 AESS

- Includes External Speaker SP-40

FT-710 Field

- Includes Carrying Belt
- To use the AESS function, External Speaker SP-40 (Optional) is required

- Display is not included. The image is shown with an optional third-party external display that may be connected using a DVI-D digital cable.

* Photo shows the FT-710 AESS

HF/50MHz 100W SDR TRANSCEIVER w/ SP-40
FT-710 Aess
Acoustic Enhanced Speaker System

HF/50MHz 100W SDR TRANSCEIVER
FT-710 Field