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Contents

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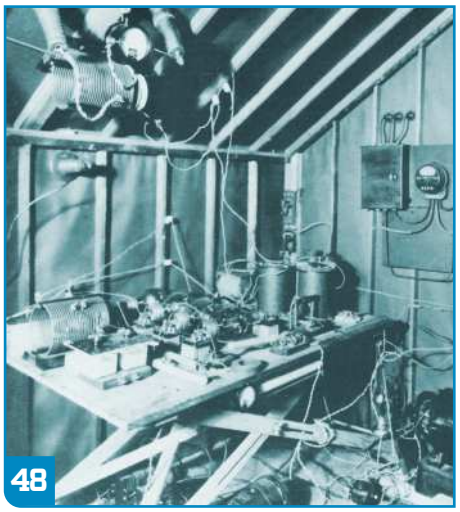


Keylines

The recent upturn in HF band conditions has been matched by an upsurge in DXpeditions, as more and more countries reduce their COVID-related travel restrictions. Which all makes life a tad more interesting. Meanwhile, here in *PW* we have some more great articles for you, both practical and entertaining. Unfortunately, space constraints have meant holding over the usual *Morse Mode* column and also the *Christmas Quiz*. Both will appear next time, in good time (for most readers at least) for the Christmas holidays.

Activity

Not all the activity is on the HF bands, of course, although they do come into their own during the autumn. I had a bash in the RSGB 6m AFS Contest in October and had a lot of fun. And while I tend not to frequent the higher bands, I believe that there has been plenty going on, as evidenced by the reports in **Tim Kirby GW4VXE's** VHF column. And I note with interest that more and more HF-oriented DXpeditions are also including QO-100 activity in their plans, which is great news.

Earth Systems, etc

I recently swapped my 80m inverted-vee dipole (ideal for the RSGB 80m CC Contests) for an 80m quarter-wave vertical (ready for the forthcoming LF DX season). I started with four radials while I checked the resonance, until I got this to where I wanted it in the band (low down in the CW/data modes section). I then added further radials. Interestingly, with four radials (each roughly a quarter-wave in length although the actual length is relatively unimportant when radials are laid on the ground), the minimum SWR (at resonance) was 1.7:1. With eight radials, it dropped to 1.3:1. With 12 radials, it dropped further to 1.2:1. A clear indication of ground losses reducing as radials are added. At the time of writing I haven't tried any additional ones, having, in my view, got to the point of diminishing returns. But my results do emphasise the importance of a decent earth system on vertical antennas (and the shorter the vertical antenna relative to a wavelength, the lower its natural impedance will be, so the more important it becomes to reduce earth losses).

The real work now starts – burying those radials such that, come the Spring, they will be well hidden and out of harm's way when I come to cut the lawn. I do actually plan to increase the total number to about 20 but I have to say that I have been very pleased with the antenna's performance so far. Indeed, on the very first evening I was working some European stations on FT8, only to be called by 3D2AG in Fiji – wow! This was pretty much a greyline path (my sunset, his sunrise) but, even so, that was pretty good going.

And in the past week I added a further length of wire to bring the antenna to a quarter-wave inverted-L on 160m, as I am looking to work the 7P8RU (Lesotho) expedition on that band. Trying it out on FT8, I have been working Japanese stations for the last three evenings, something that would be extremely unlikely on CW this early in the season (the Japanese path is usually best during December and January).

It's certainly interesting how expectations change. I recall the very first Europe to Japan contact on 160m, which must have been back in the 1960s and was between Czechoslovakia and Japan. Now JA QSOs on the band are pretty much routine due to the huge improvements in gear (especially receivers), some big antennas and, in recent years, the advent of low-signal digital modes.

Don Field
Editor, *Practical Wireless Magazine*

Newsdesk

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

New from Nevada

Nevada Radio are pleased to announce the release of the new Discovery PA500 portable amplifier.

The amplifier operates from 12 to 16V DC and will deliver up to 60W RF output from 5W RF input. It covers HF amateur bands from 80 to 10m, with a built-in auto tuner for ease of use.

The PA500 body is just 30mm thick and very rugged, using a CNC-milled durable anodised aluminium body for extreme operation.

Although designed to match the Discovery TX-500, the PA500 supports RF-VOX PTT, so no control cable is necessary to the transceiver and accordingly it will work with Icom, Elecraft and many other portable transceivers.

Weighing just 900 grams and sized at 30mm thick by 207mm long and 90mm wide, it is ideal for portable and travel use.

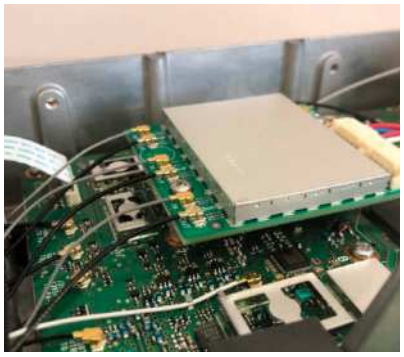
The PA500 will sell for £695 and should be available during November from UK distributors Nevada and Waters & Stanton:

Also new from Nevada is the Alinco DR-MD520E VHF/UHF DMR transceiver. This new transceiver has built-in GPS with APRS support, a large LCD full colour screen, automatic repeater roaming and 4,000 memory channels. It is ideal for the amateur DMR user as it allows easy import and export of CSV files and parameters, along with contact databases. The radio automatically detects and switches between analogue and digital modes depending on the signal received. An added bonus is FM broadcast receive with 100 memories and VFO. The radio is packed with many other features and sells for £299.95. It is available from UK distributors Nevada Radio and other selected UK dealers.

www.nevadaradio.co.uk
www.hamradiostore.co.uk

Moonraker (correction)

In last month's *News* item we mistakenly attributed all the new Moonraker antennas to Comet. To clarify, the MRQ-213, MRW-666 and MINI270 are new Moonraker products and nothing to do with Comet. Our apologies for any confusion caused.



New from ML&S

ML&S are pleased to announce the new PTRX-9700 panadapter interface for the Icom IC-9700.

Based on the same principle as their best-selling PTRX-7300, Radio Analog have finally released their internally fitted module enabling users of Icom's V/U/SHF transceiver to feed an SDR such as the SDRplay RSP-1A without any compromise to the transceiver's RF performance. Pre-delivery orders are now being taken at £279.95 and more information is available at:

HamRadio.co.uk/PTRX9700

WSJT-X 2.5.0: ReleasedThe WSJT Development Group has announced the General Availability release of WSJT-X Version 2.5.0: *"WSJT-X in this release is nearly identical to that in WSJT-X 2.4.0. The Q65 decoder has been enhanced to measure and compensate for linear frequency drift in Q65 signals. In addition, the Windows installation package now includes version 3.0 of application MAP65, which has Q65 support to match and improve on its existing JT65 capabilities"*. See the link below for the installation packages for Windows, Linux and Macintosh.

https://tinyurl.com/28k4njzh

POTA: In this month's issue, Colin G6MXL discusses Parks on the Air. In September POTA welcomed Brazil and Norway to the programme, which means there are now recognised parks in 102 different DXCC entities. Activators in Brazil can choose from over 700 different parks to activate, while activators in Norway, which is rich with nature reserves, have more than 2,500 parks to choose from.

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

New from bhi

bhi have two new products of interest. The new bhi In-Line Module cleans up noisy signals and works with most radios and receivers. It comes with the latest bhi DSP noise-cancelling technology, which brings improved audio quality to the listener when operating in noisy conditions across all radio bands. The In-Line Module accepts speaker level audio and connects between your radio and loudspeaker. The speaker audio is muted when headphones are connected, and when the unit is switched off the audio bypass feature routes the signal directly to the loudspeaker. The In-Line Module is powered from a suitable 10 to16V DC power supply and has a three-position switch that turns the unit on and switches the noise cancellation on and off. The 'Status' LED illuminates red when power is applied and changes to green when the noise cancellation is active. The unit has an audio input overload LED, an audio output level adjust control and comes supplied with a 3.5mm mono plug lead, fused DC power lead, user manual and four rubber feet.

- 8 noise cancelling levels 8 to 40dB
- Tone reduction up to 65dB
- Bespoke 5W audio amplifier
- Audio bypass feature
- Speaker output connection 3.5mm mono jack socket
- Headphone socket 3.5mm mono jack socket
- Audio input overload feature
- DC power 10 to16V DC (500mA)
- Compact unit, 135mm x 65mm x 46mm, weight 0.3kg
- Order code: In-Line

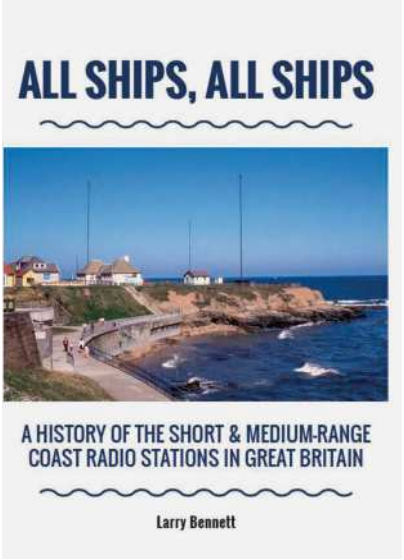
The bhi Dual In-Line and Compact In-Line units don't have an internal audio bypass facility and if you switch the power off on your bhi unit,

the audio will not pass directly through to your external speaker. The new bhi Bypass Switch enables this to happen by routing the audio from your radio directly through to your extension speaker without powering on your bhi unit. This can be particularly useful if you just want to listen to your radio without your bhi noise cancelling unit switched on. A single push-button switch on the Bypass Switch provides this facility. Press the button in and the audio routes through your bhi DSP noise cancelling unit (power on). Press the button again and the switch returns to the out position and the audio is routed directly between your radio and loudspeaker.

- Complete audio bypass of bhi DSP unit
- Latching switch: In – DSP audio, out – Audio bypass
- Four 3.5mm mono connections
- Audio power – 5W rms max
- 2 x 3.5mm audio plug leads supplied
- 80mm x 50mm x 22mm

Both new products are available from bhi Ltd, tel 01444 870333 or from one of their authorised stockists. The In-Line Module retails for £159.95 incl. of VAT, while the Bypass Switch retails for £34.95 incl. VAT

www.bhi-ltd.com



ALL SHIPS, ALL SHIPS: **Larry Bennett G4HLN** advises that his latest book *All Ships, All Ships* has finally been published and is available via Amazon UK for £17.99. It's a complete history of the UK Coast Radio Station service, and will act as an updated/expanded version of his former GKA colleague Brian Faulkner's excellent publication *Watchers of the Waves*, which was published in 1995.

Sadly, Brian passed away a few years ago but his family have given Larry permission to use extracts from his book to act as an excellent source of reference.

It's quite a massive tome, with over 500 pages in a large 10 x 7in format with numerous memories, press extracts, new photographs and detailed appendices. A limited number of signed copies will be made available for UK customers via the GKA website (below) in due course.

www.portisheadradio.co.uk

OG2Y: OG2Y is the new Youth callsign for Finland. The IARU member-society Finnish Radio Amateur Association (SRAL) has announced that OG2Y is the new callsign for all youth activities there. OH2YOTA, the callsign by which young radio amateurs in Finland are best associated, is only available for events sponsored by the IARU Youth Working Group. However, OG2Y may be used freely for any youth project. It will also be available for amateur radio contests. The youth section of the SRAL website has more details.

TOUR DE TRIGS CANCELLED: We are informed that this year's Tour De Trigs Hike has been cancelled, due to ongoing Covid concerns. Further information at:

www.tourdetrigs.org.uk

JAMBOREE ON THE AIR: As part of the 2021 JOTA, Essex Ham was once again active supporting GB1BEL at the Belchamps Scout Activity Centre in Hockley, Essex.

With no JOTA possible in 2020 due to the Covid-19 lockdown, it was great to be able to get back to supporting JOTA. Scout Leader **Derek Hagan M0SCE** put a huge amount of effort into organising the event. As well as 2m and HF stations, there was a collection of military radio equipment organised by **Gareth 2E0MZC** and his son **Jenson M6OIU**. There were opportunities to see Morse in action, and various internet-assisted video and audio communication technologies on offer too.

Greetings messages are a key part of any JOTA event, and this year's team consisted of **Dorothy M0LMR**, **Aubrey M7SDA**, **Mike G8EFG**, **Richard G7OED** and **Pete M0PSX**. Learning from previous events, the team used wipe-down crib sheets for the youngsters to use, to make sure that the more nervous Beavers, Cubs, Scouts (and leaders) had something to talk about. Each visitor had an activity booklet to complete with the more cunning cubs and scouts using their on-air QSOs to ask local amateurs for help with UK callsign prefixes and suffixes, to work their way towards the Communicator badge a little more quickly.

Outdoor activities are always popular, with some direction-finding taking place, as well as a version of radio hide-and-seek. ADSB aircraft tracking was also being demonstrated to highlight other uses of RF technology, and for the more artistic visitors, a competition to see who could design the best QSL cards for the GB1BEL activation.

The event was certainly a busy one, with many of the youngsters making a 90-minute coach ride from Middlesex to Essex, as they were unable to find a closer JOTA weekend activity centre. Planning has already started for the 2022 JOTA event.

GB100BBC: Members of the BBC's radio club, The London BBC Radio Group, have been granted an exceptional all-year special event callsign to help celebrate the BBC's centenary year in 2022. Following months of negotiations with Ofcom, the group's Special Events Officer, **Steve Richards G4HPE**, secured generous terms to use GB100BBC throughout the year, starting at midnight on New Year's Day from the headquarters station in Broadcasting House, London.

Operating slots will then be allocated for use by individual members, and local groups of operators, from their home QTH, or BBC premises throughout the UK.

The group hopes to make thousands of contacts and has designed an online logging system to meet the strict licensing conditions, and the expected appetite for QSL confirmations.

Group officers are expecting significant interest and are preparing for an influx of membership applications from BBC staff, freelancers, and retired staff.

The Group was launched in London in 2017, with the then BBC Director General, **Lord Tony Hall**, declaring G8BBC open with an on-air contact with GB2RN on HMS Belfast, thus reviving the long and rich history of amateur radio at the BBC dating back to the 1940s with station G3AYC.

In recent times the group has adopted several other BBC heritage callsigns, and can now be heard regularly under contest conditions using the calls G5, G6, G7 and G8BBC.

Nick Totterdell G4FAL, the society's HF contest committee chairman, reports that among all the other activities, there will also be a Transatlantic QSO Party to be held on 13/14 November, being sponsored by the Radio Club of America.

BATH BASED DISTANCE LEARNING 2022:

The Bath Based Distance Learning team (BBDL) helped hundreds of students to pass exams under the old syllabus with pass rates consistently above the national average. After reworking their training material the team restarted their courses under the current syllabus in November 2020.

The first new BBDL course was for the Intermediate level. It achieved a pass rate of 94% and the Full level course that followed achieved a pass rate of 88%, both well above the national pass rates. A second Full level course is in progress and due to finish just before Christmas.

The next BBDL Intermediate course will run from 12 January to May 2022.

Students will receive weekly work packages via a virtual classroom. There will be weekly online tutorials and revision quizzes. Students will also have access to one of the BBDL remote tutors who will provide feedback and additional guidance when required.

There will be lots of practical exercises to bring the theory to life. Students will be expected to do the exercises at home and report their results. At the end of the course there will be a number of mock exams.

There will be no charge for the training but students will need to provide their own textbook, scientific calculator, electronic parts and toolkit. Students will also have to arrange their own exam at the end of the course, but advice will be provided at the appropriate time.

As part of the application process, there will be some pre-course work to ensure students are able to use the online learning systems and they are ready to study in January.

Another BBDL course for the Full Licence will follow on from the Intermediate course, running from August to December. A further announcement will be made when that course is ready for enrolment. However, the organisers are encouraging all those who intend to study for the Full Licence and passed the Intermediate before September 2019 to join the Intermediate course for revision and to bridge the gaps created by the syllabus changes.

To receive course application details, please e-mail BBDL Team Leader, **Steve G0FUW**, via **g0fuw@tiscali.co.uk**

The deadline for course applications is Wednesday 15 December.

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

SIMPLE FT8 TRANSCEIVER PROJECT: Probably the most interesting facets of amateur radio in 2021 lie in the realm of digital modes. Using the limitless possibilities of software defined radios has freed digital radio communication from the limits of what could be done with analogue electronics alone, and as a result this is a rare field in which radio amateurs can still be ahead of the technological curve. One of these newer digital modes is FT8 created by the prolific **Joe Taylor K1JT**.

And it's for this mode that **Charles Hill** has created an easy-to-build transceiver. Its brains are a Teensy 3.6, while the receive side is an Si4735 receiver chip and the transmitter is an Si5351 programmable clock chip driving a Mini-Circuits GVA84 power amplifier with an appropriate filter.

The interface is via a touchscreen display. It relies on existing work that applies a patch on-the-fly to the Si4735 receiver chip for SSB reception, and another project for the FT8 software.

Read the full Hackaday article by **Jenny List** at: **https://tinyurl.com/9uxa6e52**

FOUNDATION PRACTICAL ASSESSMENTS: Following a meeting of the RSGB Examinations Standards Committee at which Ofcom was represented, the current mandatory Foundation practical requirements are, with immediate effect, permanently removed. If clubs want to retain a practical element of training to support the learning of their candidates, either as demonstrations or hands-on, they are strongly encouraged to do so.

For the full announcement please see the RSGB exam announcements web page.

FACE-TO-FACE EXAMS: Now that Covid-related restrictions are ending, from Wednesday 6 October clubs will be able to start booking online exams for groups of candidates using a new club online booking system. From 1 November, clubs will be able to book paper-based exams. All bookings must be made online. The RSGB expects to phase out paper exams in the future except where candidates have specific additional needs. Further details will be available in the coming weeks but you can see the full announcement about face-to-face exams on the RSGB website.

RSGB 2021 ONLINE CONVENTION: The RSGB is delighted that its 2021 Online Convention was watched by thousands of people across the world, many of whom have since thanked the Society for the excellent content and professional production. Hundreds more have watched the streams subsequently and are enjoying the 15 presentations. If you weren't able to watch the event live, the two streams are available on the Society's YouTube channel and you can also see the extra content and interviews that were broadcast from the RSGB National Radio Centre between presentations:

www.youtube.com/theRSGB

The individual presentations will be released in due course.

NEW PREFIX FOR SOUTH GEORGIA AND SOUTH SANDWICH: **Chris VP8WOS** (G3WOS) recently posted, *"We are pleased to announce that South Georgia and the South Sandwich Islands will adopt the prefix of VP0 for their amateur radio callsigns.*

This is brilliant news as it aligns with the prefix policy of many other South Atlantic and Antarctic DXCC entities. There is still clarification required to understand the use of 'G' and 'S' in suffixes, but this is in hand.

*"This has taken tremendous effort by **Alan VP8PJ** and myself, together with other Antarctic amateurs over the last two years. We want to thank the SG&SSI Government team for all the efforts and enthusiasm they have displayed to create the new telecommunications policies, laws and licenses and policies to enable this to happen".*

RAILWAYS ON AIR 2021: The Bittern DX Group was pleased to be invited to Whitwell and Reepham Station to activate GB2MGN during Railways on Air weekend. Due to Covid restrictions this was their first Special Event Station for almost two years and they worked closely with the management at Whitwell to achieve a Covid-safe environment for both operators and public. The following four members participated: **Alec G3YOA**, **Linda G0AJJ**, **Peter G6ZRV** and **Steve**, who hopes to obtain his callsign in the next few weeks. It was a busy weekend as the railway station hosted a wedding on Saturday and a Fabrics Sale on Sunday in addition to the usual motorcyclists; peddle cyclists and hikers that regularly frequent the site for refreshments and a welcome rest to soak up the 1950s steam railway atmosphere. Two radio stations were running most of the weekend on both FT8/FT4 and SSB logging around 130 QSOs from 29 countries. A TS590S running 75W into a Windom antenna was used for the data station and there wasa good spread of European contacts, which included the special event GB1SLR (Stansted Light Railway) and others. The photo shows (left to right) Linda, Peter and Steve.

In related news, after their AGM in August the Bittern DX Group has a new Chairman: Peter G6ZRV (see second photo). Grateful thanks to **Steve M0HET** for his sterling work for the club over the last years. Steve will carry on with duties of training officer for the club.

Richard Constantine G3UGF
practicalwireless@warnersgroup.co.uk

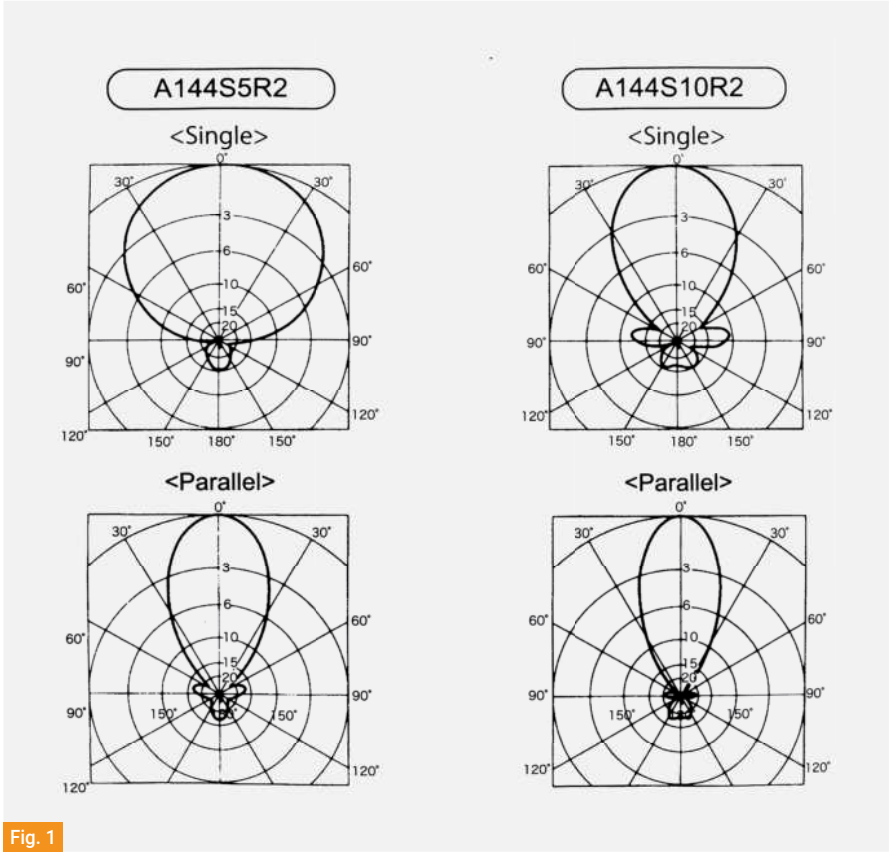


Fig. 1

Exploring the Diamond 144S-5 & A144S-10 Antennas

Richard Constantine G3UGF reports on using two lightweight portable antennas for the 2m band.

I suppose everyone likes to re-live their youth at some time or other and I'm no exception. In the pre-computer logging, hybrid radio, valve amplifier and heavy-duty petrol generator days (real radio) I was a keen /P, VHF/UHF contester with my local club.

In 2019, I planned to re-visit my youth as a solo operator. The *PW* 2m low power contest seemed an ideal re-introduction, as I could still use paper logging, QRP and it's a 'no ADIF file required' contest. How that dates me!

Aiming to operate locally at around 400m ASL in Yorkshire, I figured that I didn't need a huge antenna as in days of old. All I was looking for was something with reasonable gain that I could raise myself as, once an antenna is a couple of wavelengths high, it's not really subject to much degrading ground effect anymore.

Add to that the increased range of horizontal polarisation with its small, contour hugging, over the horizon benefit, plus SSB and I figured that I should be able to make a reasonable fist of things with something relatively simple.

Antenna choice: A144S-5 vs A144S-10

Casting around, the Diamond A144S-5, 5-element Yagi seemed to fit the bill, regardless that at today's prices, circa £50.00, it costs as much now as my now long gone, Cushcraft 19 element Super Boomer!

Note: From here on, most information in this article also applies to the Diamond 10-element version, unless explained.

The 5-element arrived nicely packed, with the 9mm capped, hollow, tubing elements already in their insulated mounting saddles, on the 20mm diameter boom. No chance of getting it wrong, I thought. All I had to do was slacken the mounting wing nuts, swivel the elements 45°, re-tighten and ensure that the pre-marked centres of the elements aligned in the centre of the boom saddles nice and foolproof… well, almost.

Surprisingly light, at a total weight of 700 grams, and 950cm in length, there was going to be no issue with mounting or raising this antenna on mast sizes up to 35mm (1.5in) diameter plus, it came complete with an appropriate bright metal, through the boom, U-shaped, mast clamp. The boom being conveniently pre-drilled for both horizontal or vertical mounting.

The slightly larger diameter driven element, so as to maximise the radiating surface area, was separately packed and mounted easily on to the boom. The central connector box has a locating lug that sits into a pre-drilled hole in the boom, to ensure it's correctly spaced, doesn't twist out of alignment and the whole thing is secured by a captive wing bolt, already on the boom. Diamond say assembly time is three minutes and that to my mind is a conservative estimate. A backpacker could easily do it in that, in a hailstorm.

More on the Construction

All of the ancillary steel metalwork is plated. Thankfully not like the old cast alloy, saddles and wing nuts I remember of the long-gone J-Beam days, when they were the only antenna game in town.

While plated components might eventually rust, and need silicon grease or other protection for a permanent installation, at least the Diamond nuts won't oxidise, fracture, or simply powder to dust.

I was thankful that assembly proved to be intuitive as the 5-element paperwork supplied was in Japanese. The later 10 element version thankfully arrived with both English and Japanese documentation.

Looking at the construction, I wondered why the power rating was limited to 50W carrier maximum, and what could be inside the sealed connector box. Logically, it was too small for a T-match, the driven element wasn't a folded design and both halves of the element were a DC short. It had to be a 1:1 balun match. As it's a weather sealed and riveted box, I wasn't for opening it.

Oddly, the reflector element appeared visually shorter than the driven element when design convention dictates that it should be around 5% longer. Most puzzling.

Fig .1: Polar diagrams for the two antennas, both singly and when bayed. Photo 1: A144S10 on painter's pole + van. Photo 2: A sky view of the 10 ele. Photo 3: Close up view of the 10 ele mast mount and joint clamp. Photo 4: The 5 element antenna.

Initial Evaluation

During my evaluation of both this and later its big brother the 10-element, I noted a number of queries and contacted Diamond in Japan. They responded both quickly and courteously, as is the Japanese way. I engaged with one of their design engineers who confirmed that the driven element is indeed balun matched as this produces reliable and repeatable results for users. Despite appearances, the driven element is physically shorter than the reflector as the two halves of the driven element are separated by the balun. The balun match dictating the power handling.

The closely mounted first director is also helpful in matching to 50Ω over the natural 75Ω impedance of a dipole. Bandwidth is indeed excellent for UK use.

Having some concerns about the use of plastic-type element saddles and the possibility of de-nature of the material, I enquired about the antenna's longevity. I was advised that the materials should be good for around ten years of use, subject to the usual weather caveats. Hmm… *"What about climate change"*, I hear you say.

Well, what amateur doesn't change his or her mind about their antennas in ten years?

As always. the use of a shiny metal, average quality, low cost, SO239 socket concerns me when it really should be a silver plated, PTFE, N type at both VHF and UHF for low loss, best performance and weatherproofing. Unfortunately, changing the socket isn't really practical unless you are determined, due to the mounting and sealed nature of the box.

In the design of the both the 5 and 10 element versions, provision has been made for horizontal stacking and vertical baying of these antennas.

Not so common in the UK but popular in some other countries, baying two antennas typically provides around 2.5dBi of gain. Diamond produces cables and bracketry for this purpose and there's some guidance on the leaflet supplied. I can't confirm that kits are available in the UK as UK importers tend to cherry pick what sells - can't blame them.

Stacking and Baying

Baying antennas particularly for vertically polarised FM use increases wind and head loading on masts.

1


2

For interest, look at the 3dB point polar diagrams in the plot, **Fig. 1**. The beamwidth and available gain makes for an interesting comparison between 2 x 5 element bayed or a single 10-element. In some locations the former may prove a better bet, especially if you factor in the bird's eye view from the mast and the surrounding take off. For my purposes as a mainly portable operator, the single 10-element version of the antenna, gives the same claimed gain figure as the bayed antennas, despite the increase in wasted energy in larger side lobes.

Real Gain. dBi or dBd?

This brings me to the thorny topic of gain. I grew up learning that gain should be referenced to a dipole of the same frequency in free space or, a vertical quarter wave and radial/grounding system and noted as 'dBd.' Decibel gain over a dipole is a reference to a real-world antenna, used as a baseline for measurement.

The 80's CB boom brought with it the need for makers to out-claim each other in terms of gain as a selling feature and there were some outrageous claims. Gain figures claimed in 'dBi', that is Decibel gain over an isotropic radiator, look bigger and sell better! In truth there is no more real gain, it's like Fahrenheit and Celsius, but dBi is where we are now. Diamond's single, 5 elements is rated at 9.1dBi and the 10 elements at 11.5dBi.

While the more director elements you add and the longer the boom becomes, gain increases but the beamwidth decreases, making the pointed direction more critical. Here again a look at the polar diagrams is quite revealing. For contesting, narrower beamwidth is both a blessing and a curse. Yes, you have more signal gain but, the longer the antenna, the more times you have to re-direct it, when all you want is

enough signal for a quick exchange, not a hi-fi report. This is yet another consideration if choosing an antenna for /P and contesting. You need to always consider the logistics of mast requirements, wind and weather etc, especially if you are on your own.

Adding directors and extending the boom is perhaps where the magic happens. Experimenting, playing with the dimensions and judiciously arranging the distances between elements can result in improved gain and with it a small increase in performance. Of course, creating a one-off is not the same as manufacturing a production model with guaranteed and repeatable gain figures, time after time.

Practical Comparisons

Returning to conventional theory and accepted wisdom, I expected to find the director elements decreasing in size towards the front, by around 5% per element, hence why they arrived pre-mounted on the boom etc.

This is true for the 5-element version and the front director is wider spaced from the fourth to maximise gain. It's more than easy to think that the 10-element version must simply be the same antenna with five more elements added. Not so. They are, to some extent, different designs.

I must confess I had considered homebrewing an add-on of my own to the five elements. Now I'm glad I didn't. I might have wasted many hours fooling myself, struggling to achieve better gain figures.

The 10-element version has a split boom that neatly joins by means of a slotted, plated steel, over tube. Thoughtfully, you don't actually have to remove the through-the-boom jointing bolt and wing nut to fit the two together. All that's needed is to slacken the bolt enough for the two halves of the boom to snugly and accurately join, before tightening. There's little chance of losing the bolt and wing nut in the long grass as someone has actually thought this through. Full marks Diamond!

Considering the 10-elements, eight of the directors are the same size. The reason given being that not only does this make production more straightforward but also has band/beamwidth benefits while maintaining the claimed gain figure. It wasn't a problem. Like the smaller version, directors 9 and 10 on the larger antenna are slightly wider spaced. Overall, the A144S-10 is 1.2 m long and weighs a mere 1.2kg.

An unconventional looking feature is that elements 4 and 5, located either side of the mast mounting U bolt and not to be confused with the boom jointing tube, are much closer together. At 12.5cm apart they are typically only half as far apart as the other directors. I will leave you to work out the fractions of a wavelength maths on this one.

I'm assuming that it takes care of interference from the supporting mast while presumably maintaining the overall impedance and performance.

Final Scores

Having satisfied my curiosity concerning the designs the real-world test was to be the *PW*-2m contest. In 2019 there were 72 entries. My result, 18th place, not bad for just 5 elements on a short 'painters' pole.'

This year, the extra five directors and revised design of the A144S-10 made possible an additional 11 contacts plus, most importantly, three additional, distant bonus squares. Of course, band conditions may take some credit, when measured against others' scores.

Final scores were published in last month's issue. My score improved by around 40% thanks to those extra few contacts and vital squares, gaining me 11th place overall- result! I think of contesting as being a little like golf. It's always nice to win. It's unlikely but I'm really trying to improve my handicap.

On reflection, perhaps the next move in 2022 is to forego my original ideas and increase the antenna height after all, so as to just to see a little further beyond the horizon.

Final Ratings and Impressions

In today's marketplace both antennas offer the user cost-effective, straightforward, no-frills assembly, reasonable gain and most creditable performance. They are lightweight and well designed. Bandwidth on both models is excellent and has been factored into the design by making use of the balun matching and the clever element dimensions and spacing. This makes them ideal for use right across the UK band. The trade-off being the limited power handling.

These antennas are not aimed at the dedicated QRO operator. The target market being the sub-100W PEP and 50W FM, average user.

The makers claim a lifespan of 10 years for all of the components but I still have some reservations, without additional protective measures.

As for the final scorecard. The A144S-5 is for me a 5-star portable antenna, for hill-topping, SOTA and casual /P use, no question.

The 144S-10 is a great antenna for the money and scores much the same as the 5, when used in the same settings. Hopefully, I've demonstrated it has much to recommend it over the smaller version

3

4

However, for long term fixed station use, particularly in an exposed location and if the user is contemplating running high powers, now or in the longer term, perhaps an alternative is a consideration, albeit at higher cost. In this potential scenario my star rating drops to 4 overall.

Diamond antennas are available from a number of UK sources, typical cost at time of press (from *PW* advertiser Moonraker), 5-element circa. £50.00 and 10-element £80.00.

A Footnote from History

The name Yagi is really a misnomer. The antenna should be called a, Yagi-Uda (or maybe the other way around). Firstly, the subject of work at the Imperial University of Japan by both **Shintaro Uda** and **Hidetsugu Yagi**. Shintaro-Uda published a theoretical paper in 1926. However, the patent was filed by Yagi in his own name and later became the property of the Marconi company. Largely overlooked in Japan until WW2. Following the fall of Singapore, it was realised that airborne radar antennas of this design were being used by the British and Americans. Search the web on this topic. It makes for fascinating reading.

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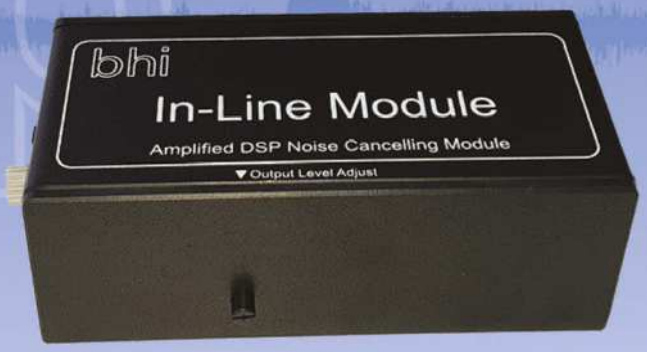

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CAA-500 MARK II Standing Wave Analyser 1.8-500MHz

Key Features:
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Buy the CAA-500 for just
£399.95

399 WATTS

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24KG - Dual Band 144/430 MHz Mobile Antenna

Super Linear Converter (SLC System) achieves highest gain in 2 bands, 144MHz and 430MHz. Frequencies are completely adjusted before delivery, at roof-side mount, having wide enough band width, with low VSWR. Fold-over system is convenient when parking the car.

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69 WATTS

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CF-530 - 600w Duplexer 1.3-90/125-470MHz

Comet CF-530 - 50Mhz/430Mhz Band Duplexer for Transmitting and receiving both 50Mhz (or HF Bands) and 144 MHz (or 430Mhz Band) at the same time. Combined high quality filters for preventing TVI at the same time. The isolation between the two connectors is more than 45dB, In the case of using the CF 530 for one frequency, the other connector can remain open, although an additional Dummy Load would be preferred.

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59 WATTS

COMET

CMX-400 - 140-525 SWR Meter

CMX-400 meter, up to 200 watts power handling on VHF/UHF 140-525Mhz. Large, clear cross needle display reads FWD/REF and SWR simultaneously, and to minimize power loss CMX-400 has a built-in low loss sensor. The meter is very well illuminated in red and green.

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119 WATTS

COMET

SB5 - Dual Band 144/430 MHz Mobile Antenna

This is the most popular antenna in the Comet line for several reasons: Mid-size / mid-price range / open coil flexs to absorb brushes with tree branches / black color fades into the skyline – ground independent.

Key features:
- Frequency / gain: 144MHz: 3.0dBi (1/2λ non-radial) 430MHz: 5.5dBi (5/8λ 2-stage non-radial)
- Input resistance: 144MHz: 120W (FM) 430MHz: 120W (FM)
- Wide reception 100MHz-170MHz, 350MHz-470MHz
- Length 0.95m • Mass 1.70g

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£27.95

27 WATTS

COMET

BMG-M - Magnet Mount With 4 Metre 3.5DQEFV COAX

Technical Specifications
- Connector: MJ Type – MP Type • Coax Cable: 3.5DQEFV
- Cable Length: 4 Metres • Size: 78mm (magnet diameter)

Buy the BMG-M for just
£39.95

39 WATTS

COMET

CAT-283 - Antenna Tuning Unit 144/430MHz, 250W (PEP)

The Comet CAT-283 covers a frequency range of 144/430 MHz and handles up to 250 Watts power. The built-in duplexer helps tuning each band separately.
Cross needle display shows FWD, REF and PWR simultaneously.
Display beautifully illuminated when connected to the power supply.

Buy the CAT-283 for just
£219.95

219 WATTS

COMET

SB0 - Dual Band 144/430 MHz Mobile Antenna

144/430MHz for dual band mobile

Key features
- Frequency / gain 144MHz: 1.5dBi (1 / 4λ) * Grounding required 430MHz: 2.15dBi (1 / 2λ non-radial)
- Input resistance 144MHz: 60W (FM) 430MHz: 60W (FM)
- Wide reception 100-170MHz, 350-470MHz
- Length 0.31m
- Mass 80g

Buy the SB0 for just
£22.99

22 WATTS

COMET

CSP-60 – SPEAKER

Technical Specifications:
- Maximum input: 6W • Impedance: 8Ω • Weight: 300g
- Connection Terminal: 3.5mm plug • Cable Length: approx. 3m
- Dimensions: 120mm (W) x 97mm (H) x 47mm (D)

Buy the CSP-60 for just
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24 WATTS

COMET

CF-50MR - Low-Pass Filter For 57MHz 1KW/CW

High Grade Low-Pass Filter for TVI, BCI from Comet, this model covers 50MHz, and can cope with high (500w CW) power. It makes sense on 6m to install a high-quality low pass filter, and this is the one.
Features / Specifications:
- Band Pass Frequency: -54Mhz • Impedance: 50 Ohms
- V.S.W.R.: Less than 1.2 • Max. Power: 500w CW, 1Kw PEP

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- Max power: 300 watts SSB (144MHz) / 200 watts SSB (430/1200 MHz)
- Impedance: 50 Ohms
- VSWR: less than 1 1:15
- Length: 2.42m
- Length: 1.78 m
- Weight: 1.28kg
- Mast: 30-62mm
- Connector: N-Type

Buy the GP95N for just

£119.95

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COMET

GH-50 - 2.42M Half Wave Antenna 50MHz

Technical Specifications:
- Frequency: 50MHz
- Gain: 2.15dBi (1 / 2λ non-radial with frequency adjustment function)
- Input Resistance: 120W SSB
- Overall Length: 2.4m
- Weight: 1.2kg
- Wind Speed Resistance: 45m/sec
- Connector: M-J Type

Buy the GH-50 for just

£119.95

119 WATTS

COMET

SB15 - Triband Mobile Antenna 50/144/430MHz

Comet SB 15 Mobile Whip 6m(50MHz), 2m(144MHz), 70cm(433MHz) 1.53m 120w 3 band mobile antenna
A longer tri-band mobile whip, covering the 6m/2m/70Cm bands. Fitted with the ever popular PL259 base socket, the antenna has useful gain figures of 2.15/4.5/7.2dBi per band. Antenna length is 1.53m, and is finished in high quality materials for a long life. Fitted with tilt over base for easy parking. A great way to work three bands automatically in the car without the inconvenience of fitting a triplexer etc.

Buy the SB15 for just

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GP-21 - Base Antenna For 1200MHz

Comet GP-21 UHF Base Vertical Antennas offer the best possible solution for 1240-1300 MHz Huge gain and famous Comet quality means that the GP-21 is an exceptional value for covering the entire 23-centimetre band! These superior-quality base station antennas feature a one-piece, heavy duty, UV-stabilized fiberglass covering for many years of reliable service.
With the highest power rating in their class, these base station antennas are ready to handle long QSOs from your high-power 1.2 GHz radios. The Comet GP-21 is equipped with an N-Type female connector for maximum signal transfer! Although light in weight, they incorporate strong, easy-to-use extruded aluminium and stainless-steel clamp-on mounting hardware.

Buy the GP-21 for just

£129.95

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CHA-250BXII - HF Multiband Vertical Antenna

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It fits together really well, nicely engineered, and if you're restricted for antenna installation space, this CHA 250BX-II could well be the answer to get on the main amateur bands from 80m - 6m.
Features / Specifications:
- Ultra-wide band coverage
- Thick base element (2mm) for heavy duty operation
- Stainless steel nuts and bolts used for longer life
- Type: Ground Plane antenna
- Transmit Frequency: 3.5 - 57 MHz

Buy the CHA-250BXII for just

£369.95

369 WATTS

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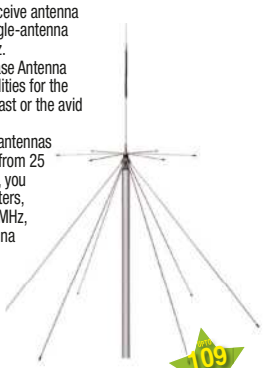
DS150S - 1.4m Discone Antenna 25-1500MHz RX TX 50/144/1300



Extremely wideband scanner/receive antenna with multi-band transmit - a single-antenna solution to VHF, UHF and 1.2 GHz.
The Comet DS-150S Discone Base Antenna offers unique multi-band capabilities for the Amateur Radio VHF/UHF enthusiast or the avid scanner listener.
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Buy the DS150S for just

£109.95

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GP-3M - Base Antenna For 144/430MHz (SO239)

A combination of special power feeding and phasing coil, ensures highest gain figures for this compact base antenna. The one piece fiberglass construction assures long durability, and full resistance to water etc. Completely factory tuned and no adjustment is necessary. The perfect solution to your dual band base needs. Also fitted with SO239 connector for easy connection.
- Frequency Coverage 144/433 MHz
- Gain 4.5/7.2dB
- Impedance 50 Ohms
- VSWR less than 1:1.5
- Maximum power 200 watts
- Length 1.78m

Buy the GP-3Mfor just

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• 10-Band 1.8-50MHz portable Antenna • 3-stage construction that is convenient to carry • Telescopic antenna for multi-band HF to 50 MHz bands • Frequency can be easily changed by short plug • 1/4 ⊠ base loading type antenna

Buy the HFJ-350M for just

£99.95

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COMET

CA-52HB4 - 4 Element HB9CV Beam Antenna For 50MHz

The COMET CA 52-HB4 is a very high gain, twin driven 4 element beam antenna, high quality construction from aluminium and stainless-steel hardware ensures a long operating life, and it's 2.1kg weight still makes it perfect for field day and outdoor operations.
Technical Specifications:
- Antenna Type: 4 element beam
- Frequency: 50Mhz • Impedance: 50 Ohm
- V.S.W.R: Less than 1:1.5
- Gain: 10.4 dB • Connector: M (SO-239) Type

Buy the CA-52HB4 for just

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1

The Kenwood Hybrids

Gary Clark G0BKR
gary@foxeshollow.com

Gary Clark G0BKR waxes lyrical about the classic hybrid range of transceivers from Trio/Kenwood.

Kenwood first started building communications products in 1955 and entered the amateur radio market in 1958. Products were sold under both the 'Kenwood' and 'Trio' brand names. Their hybrid HF transceivers were popular from the mid-1970s to the 1980s and many are still in use today. I am sure that for many *PW* readers one of these radios was your first commercial rig.

So, what is a hybrid transceiver? The term commonly refers to a class of radios where all the receiver and transmitter circuitry is solid-state apart from the final power output stage, which uses valves. Typically, there are just three valves - one driver and a pair of power output tubes. The very popular original Yaesu FT-101 series was a hybrid design but this article covers the slightly less well known Kenwood/Trio range of hybrids, which evolved over a period of about ten years and through many different models.

Hybrid Series Evolution

There are two main series of Kenwood hybrid radio, the 500 and 800 series. Four of my sets are shown in **Fig. 1**, with two models from the 500 series underneath the 800 sets. Bottom left is the 'classic' TS-520, the first in the 500 series. I found what I think is the first UK advert for the TS-520 in the September 1974 edition of *Radio Communication*, shown in **Fig. 2,** which shows that it was first introduced at £290. This is approximately £3000 in today's money according to the Bank of England's inflation calculator, so quite an expensive set. Lowe electronics, then a major dealer in amateur radio equipment, was the primary reseller in the UK. In the original advert, the TS520 it is described as: "*The latest in the new Trio line of superior amateur radio equipment. Its styling and finish put all other rigs in the shade*".

Indeed it did. The set had a stylish diecast front panel, strong steel chassis and delivered 100W output on SSB/CW. It included many high-end features for its day such as a VOX, RIT control, noise blanker, two-speed AGC, a 25kHz calibrator, speech compressor and LED indicators. It was even suitable for both fixed station or portable use, with a built in AC power supply and DC-to-DC converter, although I have never tried to use the 12V DC converter fitted to my own TS-520. The early sets also had the ability to fit four fixed channel crystals if required.

Three years later in 1977, Kenwood introduced the TS-520S shown in Fig. 1 bottom right. This added topband (160m) and supported the optional DG-5 digital display. The controls were also rearranged slightly on the front panel moving the meter selection switch to be next to the meter. On all the early models an optional narrow CW filter could be fitted in the IF stage, but one disadvantage was the inability to switch this narrow CW filter out if required.

As a result, a popular modification was to rewire the fixed channel crystal switch to select either the CW or SSB filter; a useful change, which was done by a previous owner on my own TS-520S. A 'cost reduction' model, the TS-520SE (E for economy), was also introduced to compete with the Yaesu FT-101EE economy model. Only a few minor features are missing on the SE such as the heater switch and the ability to fit an optional DC-to-DC converter. Not really much of an actual manufacturing saving I expect.

The TS-800 range started in 1976 with the TS-820. This was a more expensive and higher specification model than the TS-520 with the additional IF shift feature that made it possible to tune out moderate adjacent channel interference by shifting the IF passband. Also included was FSK,

Fig. 1: The author's Trio/Kenwood hybrid collection. Fig. 2: An early TS520 advert from 1974. Fig. 3: TS-820S with matching VFO. Fig. 4: TS-520S PA compartment. Fig. 5: TS-520S modular design. Fig. 6: Cathode resistor checks. Fig. 7: VFO lubrication.Fig. 8: T/R relay maintenance. Fig. 9: The 'classic' Trio TS-520.

an improved noise blanker, an attenuator and an option to accept the DG-1 digital frequency display as a kit. The TS-820S variant, Fig. 1 top right, included the digital display option factory fitted as standard. All the TS-820 models have quite a complex analogue frequency readout with three moving dials that work together to display the frequency and it's a joy to see although a bit fiddly to adjust and service. Overall, the TS-820 is the heaviest and physically largest of the range weighing in at 17kg.

The TS-530S was introduced in 1981 and replaced the TS520S, adding the WARC bands and the IF shift previously only on the TS-820S. The front panel had a more modern look and it is smaller and lighter than its predecessors. When I started out in the hobby in 1986 my budget could just about stretch to either a TS-430S or a TS-530S.

I ended up buying the all-solid-state TS-430S because it had a general coverage receiver and was a good starter rig. In fact, I still have it. However, it was a very close thing and I did agonise over the decision for ages as I really liked the look of the TS-530S!

The very final radio in the series is the Kenwood TS-830S, Fig. 1 top right, which was the pinnacle of hybrid radio design. By some, it is still regarded as one of the finest transceivers Kenwood has ever produced. It is certainly a really great looking radio. With an updated and larger digital display, it also possesses extra features over the TS-820S, such as a notch filter and dual-conversion variable bandpass tuning, which was quite a novel feature, and switchable narrow/wide CW filters. The double-conversion receiver has the option to have narrow or very narrow CW filters in each IF stage. If you don't have any of the optional filters fitted, the variable bandpass tuning still provides you with pretty decent filtering for SSB and CW. Even today, the TS-830S has a very respectable position on the Sherwood Engineering listing of receivers considering its age.

I bought my first TS-830S second-hand from a dealer about 30 years ago but it got so little use then due to pressures of work it ended up in storage for many years. I eventually sold it about ten years ago to fund the purchase of a modern rig. A few years later I regretted the sale so I picked up another second-hand one. I was fortunate that this set has the optional KB1 diecast tuning knob, which was an expensive option back in the day and is very nice for tuning. It also has a full complement of IF filters and matching MC-50 microphone.

2


3

I bought my first TS-830S second-hand from a dealer about 30 years ago but it got so little use then due to pressures of work it ended up in storage for many years. I eventually sold it about ten years ago to fund the purchase of a modern rig. A few years later I regretted the sale so I picked up another second-hand one. I was fortunate that this set has the optional KB1 diecast tuning knob, which was an expensive option back in the day and is very nice for tuning. It also has a full complement of IF filters and matching MC-50 microphone.

In 1987, the TS-830S finally went end of sale. The last advert I could find was in the November of that year and with its departure came the end of an era; no more valves in commercial amateur transceivers – both the excellent solid-state Kenwood TS-930 and TS-940 had already been around for some time.

Kenwood also introduced a range of matching accessories for each series, including external speaker, second VFO and 2m transverter. **Fig. 3** shows my TS-820S with the external VFO-820, which allows split TX/RX. Another nice option is the SM220 station monitor and you might be lucky to find one with the BS8 panoramic adapter option fitted.

What's the Interest in These Old Rigs?

What's the appeal of these old radios with today's world of high-end feature-packed computer-controlled DSP transceivers? Well, firstly there is obviously a huge nostalgic element to buying and using these older rigs. But beyond that, they are simply very good and lots of fun to operate. I have a couple of modern high-end transceivers in my shack but I find I use the TS-820S more.

In terms of value for money, if you can find a good one, and there are many still about, they all represent a fairly decent transceiver for a modest outlay with the added bonus of being easy to use and technically very easy to service. There are no complicated menus to navigate through, all the controls are right there on the front panel and it has everything you need. The audio quality both transmit and receive is one of the hallmarks of these Kenwood hybrids. Users get compliments on audio quality and it's a real a joy to listen

to the received sound produced by these rigs even on the internal speakers.

The PA shown in **Fig. 4** is pretty much a standard design across the range. All sets use a pair of 6146B final tubes and a 12BY7A driver and produce a very clean transmitted signal compared to some of the early all-transistor rigs. The valve PA is very reliable and the tubes are very resilient to being overdriven. The valves are not only easy to obtain, but also last for a very long time. I have never needed to replace any so far in my sets. If you just want to just receive, the valve heaters can be left switched off via a front panel switch. Also, there is no need for any external power supplies as the mains PSU is all built in.

On the negative side, however, you do have to learn how to tune up the PA stage when changing band. If you have never tuned a valve PA, this may sound very daunting, but don't let this put you off! Tuning is a well documented process in the original manual and also all over the internet, including YouTube videos, some of which I have listed in the references. Most importantly, you have to take great care not to overheat the final valves during tuning. They all have a special TUNE mode position, which allows you to tune up at reduced power to avoid damage. The aim is to get full power out with a plate current around 225mA. Once practised for a short while a full tune up can be accomplished in less than a minute.

The analogue VFOs also tend to drift a bit but this is not too bad after a few minutes of warming up. I've observed that the drift on the VFOs improved significantly with the range, in particular the TS-830S, which I've found to be very stable. Furthermore, these sets do not have FM or AM modes built in and only the later ones have the WARC bands.

Another significant negative of course is the fact that there are some very high voltages inside the valve PA so care must be taken when servicing the power supply circuits or PA sections. Don't take the lid off unless you are experienced in working on this type of kit and wait for the HT to discharge.

Servicing and Common Faults

When acquiring one of these radios an electrical safety test is a good first precaution, as for any equipment of this age, and check the earthing. Make sure that the correct fuses are fitted in the plug and on the rear panel. It's important that the fan on the back of the PA compartment is working. The fans are pretty quiet so you need to put your hand behind the set to feel for airflow. A drop of oil lubrication on the fan is also a good idea.

4

In general, these are very reliable sets. If needed, electronic parts are all easily available and the circuits are relatively easy to understand. They can be maintained and repaired without the need for special tools or expensive test equipment. **Fig. 5** shows the underneath of my TS-520S. Internally these radios are all very well designed with individual sub-systems such as the IF amp, PA stage, RF amp, etc, all on separate PCBs, which can easily be removed for servicing. Like all popular vintage equipment, there is a vast amount of information available on the internet, including fixes for common faults. There are also a couple of active Facebook groups for owners.

If you buy one of these rigs, there are a number of common servicing tasks and faults to be aware of, in addition to the usual capacitor problems common to any electronics of this period. One of the most common issues is low output power.

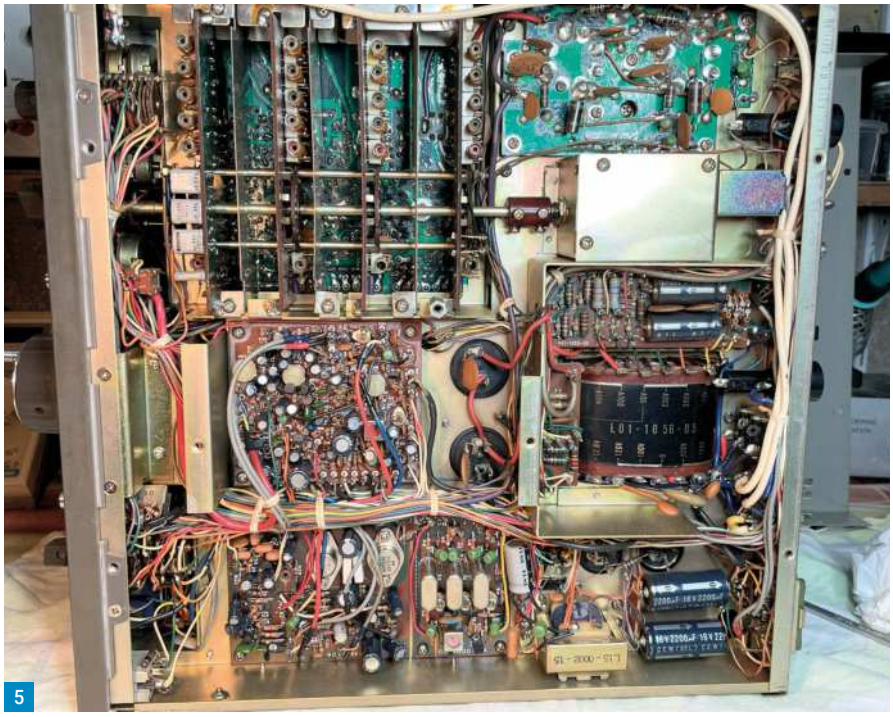
Low Output Power

A common cause of low or non-existent output power is the rear screen grid switch being turned off. This switch reduces the screen grid voltage to enable you to 'neutralise' the output valves; a procedure that must be followed if you replace the valves. If you find that there is almost no output, first check this switch. On the subject of neutralising the valves, it's worth checking this has been done by the previous owner when the valves were changed but take care to use a proper insulated trimming tool.

Another cause of low or distorted output is a problem with the HT circuit. These rigs provide an HV meter reading on the front panel meter when this is selected, and the rig is transmitting. They should be about 900V for idle transmit, and drop about 10% with key down. If the HT is low, check the two large smoothing capacitors and the HT rectifier.

Fig. 6 shows me checking the cathode resistors in the final PA stage. There is a 10Ω 1W resistor in each 6146 cathode so they are in parallel, meaning the resistance should be about 5Ω. If the radio has been worked hard, these resistors can age and drift in value. The IP current meter on the front panel uses the voltage drop across these to measure the plate current, so if they drift, the current reading will be off. When I first bought my TS-830S I was only able to get about 50W out of the PA. When I measured the cathode resistors these resistors had drifted to a total of about 8Ω and thus when the plate current was reading high, a reading of 225mA was actually only 140mA. As a result, replacing these with a pair of new 1W 10Ω resistors brought the PA back to full specification. Also, check the components around the output valves in the PA cage for signs of ageing.

If you are still getting low power and the ALC is not peaking as expected, it's worth replacing the driver tube first. Many owners say that the 12BY7A seems to age faster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than the output tubes but I have yet to find a problem with one of them.

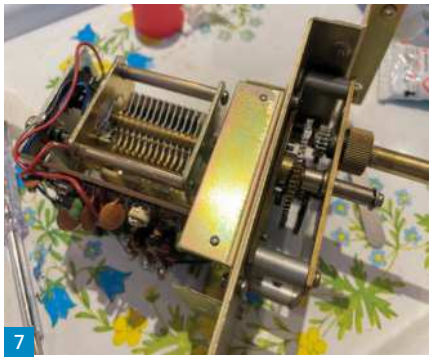
VFO Problems

The early models have a socket on the back for connecting the optional second external VFO. If you are not using one, then you have to insert a plug in the socket with a jumper wire to enable the internal VFO. If your frequency display suddenly dies or the radio goes quiet, check that this plug has not come loose.

Another problem I have had on two of my TS-520s is 'lumpy' and 'stiff' VFO tuning, and in some cases, at points along the dial, the VFO seemed to drop out. The problem here is that the original grease in the gearing has dried up and gone hard, in some cases causing connectivity problems in the main tuning capacity bearings. The fix is to remove the VFO module, locate the ball bearing joints in the main tuning capacitor and also in the reduction drive, carefully pick out any hard aged grease with a cocktail stick and replace. Once you get the VFO out, I would advise working over a metal tray as I am in **Fig. 7** because the reduction drive has some small ball bearings, which can fall out if you are not careful. Once lubricated properly with new grease, the VFO gives a very satisfying smooth action and it will probably be good for another 40 years.

Connector problems

One of my sets had an intermittent problem with the receiver, which I located to dirty contacts on the TX/RX relay shown in **Fig. 8**.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Again, servicing this is a joy, just two screws and the relay simply unplugs. Remove it from the plastic case and give it a squirt of cleaner.

Another common fault is the digital frequency display problems, particularly on the TS-820S, due mostly to dirty connectors. This is not a problem I have had yet with any of my rigs, but the fix is to clean the connecting plugs. This is again well documented on the internet.

On the subject of switch cleaner, while you have it to hand it is probably worth giving all the potentiometers and the switch contacts a quick clean.

While you have the case open, check the dial lights are working. In most of these sets there are two lamps over the S-meter and two or more around the tuning display. Replacements can be obtained on the internet if needed. Some owners replace with LEDs to modernise the set but I prefer the warm glow of the original bulbs.

The shaft coupling connectors on the Drive/Plate/bandswitch shafts were manufactured in plastic and they can crack, especially if you over-tighten the screws. Better replacements are available online. The tricky problem is if the bandswitch coupler on the 530S or 830S breaks. It's a lot of hassle to get at it to replace it because it's located inside the PA compartment.

Realignment

In general, all the sets I have bought have been pretty well aligned. Maybe I was lucky or maybe the previous owners looked after them. However, for basic RF section alignment the built-in crystal calibrator is very useful but you have to get yourself a non-conductive trimming tool. The built-in calibrator can be aligned against a modern receiver or against WWV. Indeed, there is a switch setting on these rigs to allow you to do the latter. The owner's manual details very clearly how to align the RF and IF sections.

If you are feeling more adventurous, you

9

could try adjusting the carrier set points. I found on my TS-830S that the centre of the SSB IF filter had drifted about 250Hz so to compensate I moved the carrier set point oscillators for LSB and USB very slightly to bring them in line with the actual filter response. There are a couple of trimmers next to the crystals. It made a significant improvement to the audio quality.

Buying Guide

These sets are mostly over 40 years old so you have to express a certain amount of caution when you buy. However, as long as it's in OK physical condition, it is likely that anything electrical can probably be easily fixed. As with all second-hand equipment, ideally see it working before you buy. Be careful if the seller is shipping to you by post, make sure they package it really well. These are heavy sets, and they must be double boxed if shipped. Ideally collect in person.

Check the PA stage for signs of damage, look for the optional filters fitted and if they come with a matching microphone, especially the MC-50 desk microphone, which is a real bonus. Don't forget to check that there is a mains lead included as it's a special Jones-type plug.

Prices second-hand vary a lot depending on condition and model. A really well looked after TS-830S with filters and healthy output valves can sell for £300-£400, but you might pick up a TS-520 for much less. Prices seem to be creeping up in recent years but the good thing in that after 40 years they hold their values now, so if you buy one at the right price for a bit of fun, you can sell it again a while later probably for what you bought it for, maybe more. Also look out for all the matching accessories such as external speakers and VFOs and the excellent matching Kenwood ATUs.

If you were a beginner to the hobby, I can well understand that you might be very cautious about buying old sets like these. But if you have access to a local club with amateurs who can give you a hand to check the set over for you, show you how to tune up, and help with any repairs that might be needed, then I would say that they are a good buy for a beginner to the hobby and great fun to use.

Which One to Buy?

So, how do they compare, which is the best? Well, the TS-830S is arguably the best set technically and is still comparable with many much more modern sets. However, I still find the older TS-820S the most fun to operate. The quality of the audio is just so very good, and it is very easy to tune up. If I really had to pick just one of these radios to keep, I think I would choose the TS-520 or TS-520S because, in my opinion, the TS-520 looks like the very definition of a classic amateur radio set, **Fig. 9**.

References

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https://tinyurl.com/3pk7r2re
Some great restoration information:
www.k4eaa.com
Kenwood Hybrids Facebook Group:
https://tinyurl.com/v28pk3w4
Tune up TS830S:
https://tinyurl.com/3wjmkt9m

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1

Winter Es

Despite the onset of autumn, **Tim Kirby GW4VXE** still has plenty of VHF and above news to impart.

Most of us associate Sporadic E with the spring and summer months, which is of course quite correct, with the vast majority of Es contacts occurring within that window. However, there's also a secondary peak in openings, which generally occurs from mid-December to early January.

The Es is normally intense enough to support contacts on 6m, sometimes 4m and even more occasionally 2m! Two years ago, just after we moved here, using 50W to a vertical antenna, I made my first Winter Es contacts on 2m in something like 36 years of operating. In fairness, I don't think 2m Es in Winter is quite that rare, I must have just been in the wrong place at the wrong time.

It'll certainly be worth keeping an eye on 6m over the period and if propagation gets intense on that band, or you see the skip distances shortening, then it may well be worth a look on the higher bands. Don't forget that multi-hop 6m openings may be possible too. Last year in early January, we saw openings to the Middle East and North America. It'll be fascinating to see if any similar openings occur this year.

Meteor Showers

For meteor shower enthusiasts, the Geminids peaking 13/14 December usually sees a fair bit of activity, although I am never convinced that the shower lives up to its billing as one of the major meteor showers. The shower is active from December 4th to 17th and I suspect that it acts as one of the triggers for the December peak in Sporadic E.

Although more properly fitting into next month's column, the Quadrantids meteor shower peaks after midnight on 3/4 January. The Quadrantids always seems a lot more dramatic with some big reflections and plenty of random activity on 6m and 2m especially, but it's well worth considering 4m as well.

Jamboree on the Air 2021

I'm writing the column on the weekend of JOTA 2021. I thought I would listen to the JOTA talkgroup on Brandmeister DMR and have been astonished by the amount of activity there is worldwide from Scout groups. Indonesia, Bangladesh and South Africa have been some of the more distant countries that I have heard, with plenty of activity from stations in Europe and the USA.

Sometimes in the past when I have listened to JOTA activity it has seemed that there have been a lot of stations and not so many Scouts or Guides taking part, but this year it seems that most of the stations are hosting plenty of Scouts and Guides with some of them trying their hand at making contacts over the air.

Perhaps some of them will come back to amateur radio as an interest in years to come and I also noticed interest from some of the unlicensed Scout leaders who were trying their hand at using radios. Well done to all of the operators taking part in the JOTA activity for your 'outreach work'.

The 6m Band

Although we are now out of the main Es season, **Keith Watkins G8IXN** (Redruth) continues to monitor and noticed E73S at 1743UTC on 21 September. Keith is using a Tokyo Hi Power HT-106, amplifier and a halo antenna. He decided to beef up the capacitors that had been used on the halo with two 150pF high voltage ceramics in series. He tuned the antenna for 50.313MHz and gets an SWR of 1.35:1. On 27 September Keith called CQ and was surprised to be heard by DK8NE. Keith bought a 40A frame PSU to run the amplifier. It's rated at 12V but can be tweaked to 13.8V. These PSUs are pretty cheap and I have one here as a backup/supplementary PSU.

Photo 1: G8YIG's crossed dipoles for 6 and 4m along with a horizontal dipole for 2m. Photo 2: The 6m beam used by Kevin ZB2GI for his EME attempt with Lance W7GJ. Photo 3: An SSTV image taken from a stratospheric balloon launched in Poland, received by Kevin ZB2GI using a WebSDR receiver. Photo 4: A spectacular sunset in DM53, imaged by Patrick WD9EWK.


2

Robert van der Zaal PA9RZ (Sassenheim) took part in the Dutch locator contest, which encompasses all the VHF/UHF bands. On 6m he worked PI4HLM (JO22) and PA0MIR (JO22) while running 10W.

Kevin Hewitt ZB2GI tried something new, a couple of EME skeds with **Lance Collister W7GJ** on 4/5 September. Kevin was running 100W into a Radix 6-element Yagi. Lance and Kevin used Q65 with two minute transmit periods for 90 minutes before moonset. Unfortunately, nothing was decoded at either end of the path. Kevin sends his thanks to Lance for the test and his guidance.

Peter Taylor G8BCG (Liskeard) has been doing some maintenance on his 50MHz array ready for some forthcoming EME activity. On 10 October, Peter finished work and was able to test it with a nice QSO with YB2MDU at Peter's moonrise for country number 135 this year. Later in the day, J5HKT and S9OK were making QSOs into the Mediterranean area so Peter decided to keep monitoring to see what would happen. By 1800UTC things seem to have gone quiet, so Peter put out a CQ call to the south on FT8 and was rewarded with an easy QSO with J5HKT from Guinea Bissau. J5HKT was audible for around 30 minutes. S9OK proved more elusive and although Peter was able to see their signals weakly on the waterfall a few times, it was not possible to make a QSO. From further south, **Trevor EA5ISZ** (who many will remember as G3ZYY) could see S9OK for long periods of time, calling CQ with no replies. On 16 October, Peter was delighted to work FO/W7GJ via EME, during Lance's first moon pass of the expedition. Lance had been dogged by some bad luck getting the antennas up and getting active, but as ever is making lots of people happy with his activity.

Steve Telenius-Lowe PJ4DX says he doesn't have any news to report other than the fact that he has a new beam for the band so is hoping to take advantage of some of the Trans-Equatorial propagation to the south over the winter season. Steve says he's worked Brazil and most of northern South America fairly easily via Es but hasn't yet worked LU, CE or VP8.

Tony Collett G4NBS (Cambridge) says that on 13 October, after the 70cm Activity Contest, he looked on 6m and was surprised to work CT7ABA (IN60) using FT8. Tony says it was his first Es QSO since early August. During the UK Activity Contest on 14 October, Tony says he 'scraped' 67 QSOs in 14 locators. He says GI4SNA was reasonably easy to work but no sign of GD or GM. G8BCG (IO70) was very loud and F1CBC and F4HRD were the only EU signals that were workable.

Just as I was finishing off the column, Keith G8IXN messaged to say that the band was open into Scandinavia and I was delighted to make Es QSOs with OV2B (JO45), OZ1DLD (JO45) and SM7FJE (JO65) from here at **GW4VXE** (Pembrokeshire). With the beam down for the winter, I'm using the V-2000 vertical.

The 4m Band

Colin Fawcett G8YIG (Stalybridge) now has a set of crossed dipoles for 6 and 4m. Using this setup he took part in the September 4m UK Activity Contest and worked G4FZN (IO94), GW4ZAR (IO83), M1DDD (IO93), G3TDH (IO83), GW1YBB/P (IO81), GD0AMD (IO74), GW8ASD (IO83) and G4NTY (IO83).

The 2m Band

Keith G8IXN noticed good conditions to the north from Cornwall on 21 September, with the GB3LA repeater in Dumfries and Galloway coming in nicely. It just shows that it's well worthwhile listening on FM as well as narrowband modes. Keith regularly monitors FM channels on both 2m and 70cm as well as UHF DMR channels to get a full picture of propagation. On 24 September Keith was seeing the GB3VHF beacon at Wrotham at –3 with several German stations on FT8.

3

Also from Cornwall, **Simon Rodda G4PEM** (Redruth) continues to be very active on 2m FT8 and uses both horizontal (a small dual-band beam) and vertical (3-band vertical) polarisation. Simon is around 700ft ASL and has good paths in most directions.

Andy Doswell G7GQA/P (Gloucestershire) is back on 2m FT8 after a break over the summer operating on 6m and doing other projects. Andy uses a modest system of an FT-817 and a discone antenna but does remarkably well and is regularly copied here in Pembrokeshire. Andy has also worked EI3KD in County Cork.

During the Dutch Locator Contest, Robert PA9RZ worked PA0FEI (JO33), PG9W (JO22), PI4HLM (JO22) and PI4DHV (JO22) while running 100W to a 5-element Yagi.

Kevin ZB2GI used an OpenWeb receiver in Poland run by SP5LOT to monitor a stratospheric balloon launch in Poland made by SP5LOT and SQ5RB. The payload included a Raspberry Pi transmitter sending PD120 SSTV images on 144.500MHz FM and an M17 voice beacon on 144.600MHz. M17 is an open, free, digital radio protocol, which we'll cover in more details soon.

Steve PJ4DX reports that **Gerard PJ4GR**

4

worked into Argentina on 2m FT8 recently via TEP, running less than 100W into a 5-element home-made Yagi.

Simon Evans G6AHX (Twyning) spotted a path to northern Spain in early October, with the beacons coming through but there was no activity. Simon took part in the October 2m UK Activity Contest working 27 stations in 16 squares. Simon's best DX was PA5Y (JO21) in the last few minutes of the contest.

Tony G4NBS took part in the UK Activity Contest on 5 October, but unfortunately his local noise source was back with a vengeance. Tony made 46 QSOs in 18 locators with only GD0AMD/P, GD8EXI, GI4SNA, GI6ATZ and GM3SEK at any distance to the north. Tony says he managed to work M0AFJ/P, F1MKG and PA5Y for other 400+km QSOs.

Next day on 6 October, Tony took part in the European FT8 Activity session and found things easier, with the mast back at full height and FT8's capability of working through the noise. Highlights of the log were GW4VXE (IO71), M0AFJ/P (IO70), M0BKV (IO70), GI6ATZ, (IO74), MI0IHH (IO74), MM0CEZ (IO75) and three stations in JO31/JO32, which were the best DX. Tony says it was nice to see French stations joining in, including F1RVC (JN09), F4DJG (JN09), F1UFX (JN19) and F4HRD (JO00).

It was nice to work **Bob Harrison G4UJS** (Shropshire) on 2m FT8 for the first time. Bob's callsign will be very familiar to VHF/UHF enthusiasts who, like me, were around in the 1980s and 1990s. Bob is currently using an FT-847 and vertical and enjoying being back on the air.

Here at GW4VXE I noticed good conditions to the north on 21 September, working MI0IHH (IO74), 2M0TNM (IO67), GM0HBK (IO77) and GI4OWA (IO64). 11 October saw an interesting opening to the south when I worked EA1UR (IN53), F1HFW (JN03), EA1HRR (IN83), F4IAA (JN05), F5DYD/P (JN03), F1GTU (JN05), F4HER (JN06), EA2XR (IN83), F4FMB (IN96), F4HBY (IN97) and F6DUA (IN96), all on FT8.

The 70cm Band

Jef VanRaepenbusch OS8NT (Aalter) worked G4CLA (IO92) during the UK Activity Contest on 14 September. Jef runs 25W from an IC-9700 to a 5-element LPDA.

Robert PA9RZ worked PA1TK (JO22), G3XDY (JO02) and G7LRQ (IO91) on SSB and PI4HLM (JO22) on FM during the concurrent UK Activity and Dutch Locator contests.

During the 14 September UK Activity Contest Tony G4NBS found conditions slightly up on normal and made 109 QSOs in 25 locators. 2E0VCC/P (IO70) and G1YBB/P were worked on FM. Tony writes, *"M0AFJ/P (IO70), GW4JQP (IO71), GI6ATZ, GD0AMD/P, GD8EXI, GM3SEK, GM4PPT (IO75), GM4BYF(IO85), GM4AFF & GM4JTJ (IO86) all appeared to be worked without needing aircraft scatter assistance. F1BHL/P (IN99), F1MKG (JN08), F1CBC & F4HOG (JN09), and F4HRD (JO00) plus PE1EWR and PA5Y were the highlights from the continent".*

During the October UK Activity Contest Tony found conditions better North-South and worked a number of stations to the north, while beaming south! Totals at the end were 113 QSOs and 23 locators. Highlights of the log were M0AFJ/P (IO70), GW4JQP & GW0RHC (IO71), GI6ATZ, GD0AMD/P, GD6ICR, GD8EXI, GM4BYF, GM4AFF, GM4JTJ, F1MKG, F1CBC, F4HRD & TM7K, PE1EWR, PA5Y and PA0WMX (JO21).

Tony took part in the October UHF contest on 2/3 October but found UK Activity poor and he worked many DL stations off the back of their beams. Highlights were DL0GTH (JO50), DD2D (JN49), DK4VW (JO40), DB1BAC (JO43) and DR9A (JN48). During the European FT8 Activity session on 13 October, Tony found better activity from the UK this month. He made a total of 58 QSOs in 23 locators, split as 30 from EU and 28 from the UK, although Tony says he missed a fair few UK stations. Highlights of the log included EI8KN (IO62), GI6ATZ, GM4CXM (IO75), GM0HBK (IO77) and DJ6AG (JO51).

The 23cm and 13cm Bands

Jef OS8NT worked G3XDY (JO02) on 21 September during the UK Activity Contest and could hear the GB3MHZ beacon, also in JO02, weakly with some fading. Jef runs 10W from the IC-9700 and a flat panel antenna.

Simon G6AHX made a 23cm contact with G8DOH (IO91) during the October UHF contest on 2 October, by leaning out of the shack window and pointing his bi-quad antenna in the direction of Oxfordshire to make the QSO!

Steve Macdonald G4AQB is celebrating 50 years on the air, having got his licence on 12 October 1971. He says he started off on Topband AM and then moved onto 2m after a couple of years, using homebrew equipment, 'tuning High to Low' to find contacts. 'Happy Days', he says! Steve is still very active and writes with news of a fun session during the recent 23cm/13cm Trophy. *"I had an interesting contact during the 23cm and 13cm Trophy contest last*

week. I was trying to work ***Dave G4ASR*** *in Hereford and we arranged a contact using KST. At first, we worked with no problem on 23cm, so we then moved onto 13cm. Conditions were poor and this is where the fun began! Using Aircraft Scatter, we managed to complete the contact after over 30 minutes of calling, listening and a lot of patience! In all we tried three different aircraft. Is this a record for the longest contest contact I wonder?"*

Satellites

Jef OS8NT decided to try working **Lucky VU2LBW** (MK82) on RS-44 with FT4. Unfortunately, in spite of putting in a lot of effort, including having to be up at 0243 local time, he was unsuccessful, but **Thierry ON2ACO** was able to make a contact at a distance of 7800km on FT4, using his vertical antenna. Jef describes that his main antenna is facing to the west so doesn't do so well on low passes to the east. As he has an east facing balcony as well as his westerly facing one, he plans to put a temporary antenna on the east facing one and see if he can pick up some stations on the low passes to the east. Other stations worked on RS-44 include A65BR (LL75), EB4ADC (IN80), EA1G (IN73), ON2ACO (JO11), EA7TN (IM66), SM0TGU (JO89), EB3FWC (JN11), W0DHB (DN70), WA2MIS (FN64), EC5M (IM98), LZ1CWK (KN32), VE6WK (DO20) and K9CIS (EM59). Jef has also made a good number of FT4 QSOs on the CAS-4A, CAS4-B, XW-2A, XW-2B and XW-2F satellites. Jef says that he and Thierry ON2ACO are both available for skeds and can be contacted using the emails on their respective QRZ.COM pages. The satmatch.com website is a really excellent resource for planning when two stations have a mutual footprint of a satellite pass.

Peter G8BCG continues to enjoy operating on QO-100 and, in particular, working new countries, including 3DA0, 7P8, HV, Z38 and ZA!

Patrick Stoddard WD9EWK (Phoenix) writes, *"More satellite operating in the last month, along with more road trips, taking advantage of the end of summer in Arizona. And to help a few operators confirm a rare grid in eastern Arizona, DM53, I took a road trip out to that part of the state at the end of September.*

"I arrived in the mid-afternoon, and was able to work passes on PO-101, AO-27, and the ISS crossband repeater in FM. I also worked XW-2B in SSB, parked along a dirt track near an open-pit copper mine. As afternoon approached evening, rain started showing up in the area. Even with rain, it was a nice break from summer temperatures over 40C.

"Others are still doing road trips, before winter approaches. ***Tyler WL7T*** *has been taking trips from Alaska to the 'lower 48', the continental USA, and operating from lots of rarely heard grids in the northwestern part of the country. AO-7 and RS-44 continue supporting transatlantic contacts. For me, more desert road trips are coming up, taking full advantage of the cooler weather..."*

Although I've not spent as much time on RS-44 this month, looking back in the GW4VXE log, there are some nice QSOs, including WA2FHJ (FN13), VE6UM (DO33), K8YSE (EN91), W2GDJ (FN32), VE3KY (FN25), N8HI (EN73), KN2K (FM18), K2UF (FN32), R8AZ (LO95) and AD4ES (EL98), pretty much all on CW.

That's it for this month. Thanks to everyone who's written with news and information, but there's always room for more. Please let me know what you have been doing on the VHF/UHF bands – if you've been enjoying it, then there's every possibility another reader will do so too and perhaps be inspired to try something new, so please keep your emails coming.

Virtual Audio Cables – Under the Bonnet

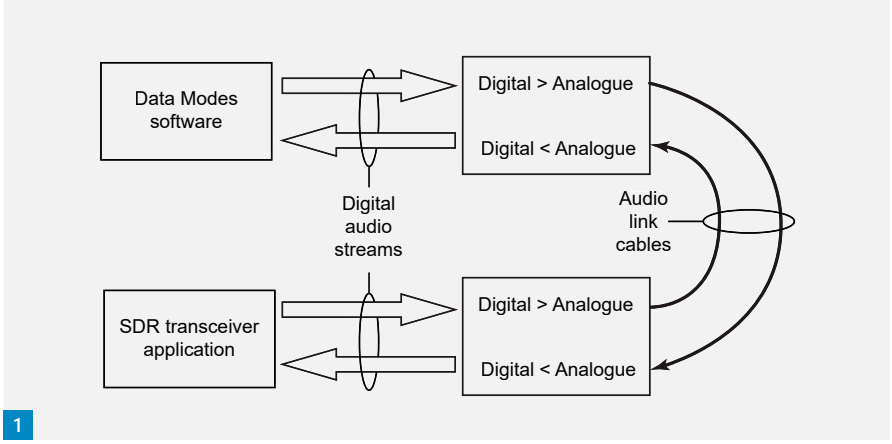
Mike Richards G4WNC starts with a look at Virtual Audio Cables before turning to the latest developments with SDR-Console and a quick mention of Nose-Red.

Mike Richards G4WNC
practicalwireless@warnersgroup.co.uk

I skimmed over virtual audio cables a couple of months ago but, as ever more operators move to pure SDR based rigs, there is a growing need to have a good working knowledge of how audio signals are routed around the computer. In this month's column I'll cover a bit more detail on how Virtual Audio Cables (VAC) work and how to use them. Pre-SDRs we just needed a set of dedicated leads to connect the rig with the computer so we could run our data modes. This has progressed to the point where many of the mainstream manufacturers now provide a standard USB connection that carries the digital audio and rig control signals. However, there is another breed of pure SDR rigs where the main controls of the rig only exist in software. Popular examples of this are to be seen in the Flex, Apache Labs and Hermes transceivers. In most of these rigs there are no physical controls on the rig.

When it comes to managing the audio, we could physically patch the ins and outs if we have a couple of soundcards installed in the PC. However, that is an unwieldy solution that degrades the signal. The degradation occurs because we would be putting our signal through two sets of analogue-to-digital conversions, **Fig. 1**. As the analogue-to-digital conversion process samples the signal in discrete steps, the process will lose some of the original information and add some new quantisation distortion. In a modern high-quality soundcard, the degradation is quite small, but we can completely avoid the analogue-to-digital conversion if we keep the audio in digital format. Referring back to Fig. 1, you can see that our SDR rig deals in digital audio streams and so does the data modes software. The obvious step is to link the digital audio streams together, so the entire process remains digital. Not only does this maintain the audio quality, but it simplifies the connections.

Although this sounds like a straightforward solution, you will soon discover Windows audio has very limited routing options. We can easily send an audio output to the speakers, headphones, etc. but there isn't a way to send the audio output from one device to the input of another device. In our case we want to take an audio output stream from the rig and connect it to the audio input of our data modes software. We have the same problem when dealing with transmit audio because there's no way to connect the audio output from the data modes software to the input audio of the rig. This is where what's become known as a VAC steps in. The reason it's called virtual is because it is just software, there's no cable involved, though it often helps to visualise it as a cable. In this case, the VAC can link any digital input to any digital output and vice versa, which is exactly what we need. In order to do this, the VAC reads the selected digital stream and sends an exact copy to the chosen destination. Under the bonnet it's not quite as simple as that. Windows is a multi-tasking operating system, which means the processor is hunting around the PC for jobs that need to be done, a bit like spinning plates. When it comes across an audio stream, it sends a burst of that data to a memory location known as a buffer and moves on to the next task, **Fig. 2**. Any device that needs the audio data will read it from the buffer. The use of a buffer introduces a small delay between when the data is created and when it is available to the destination program. This delay is known as latency. You can probably spot a problem here; if the program



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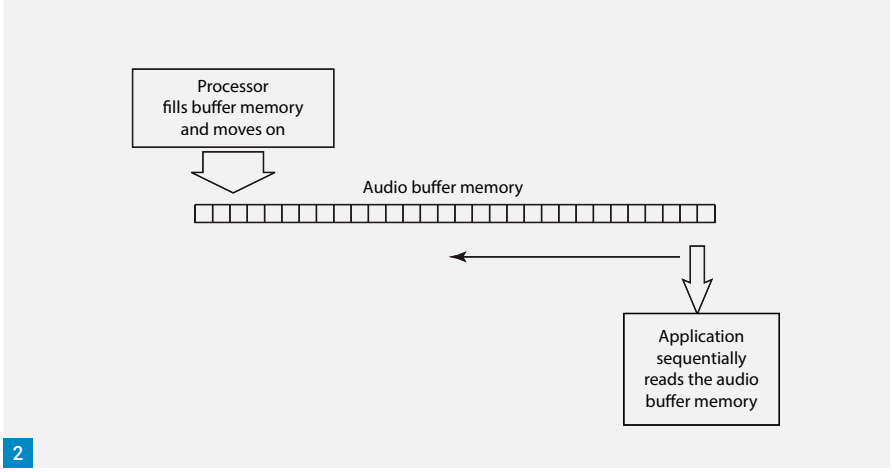

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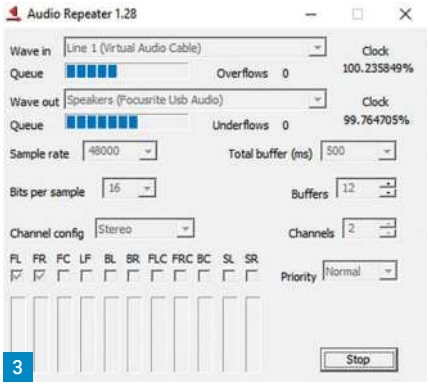
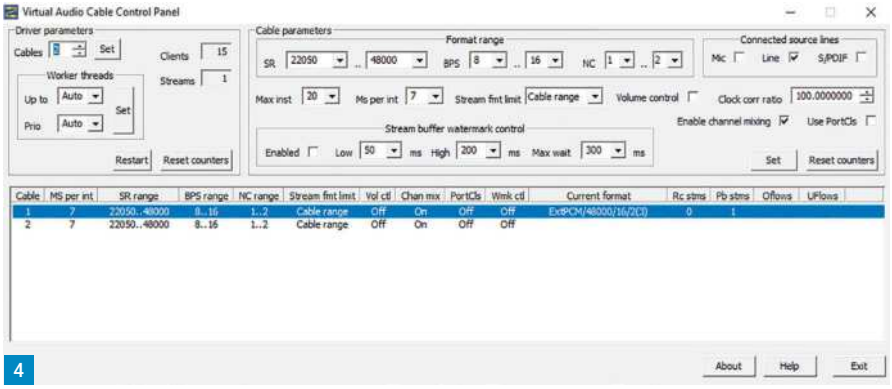




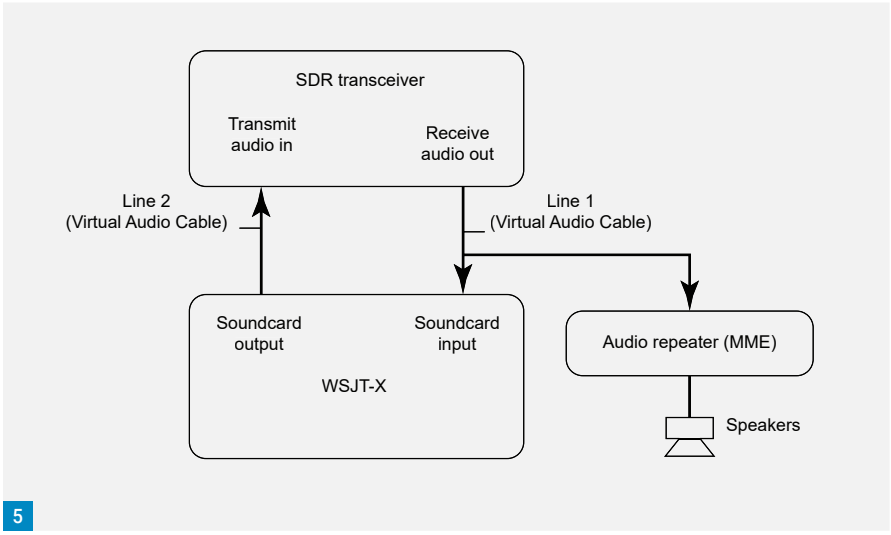


Fig. 1: Audio data between SDR rig and data modes software. Fig. 2: Reading audio data from a buffer. Fig. 3: Using a repeater to monitor a VAC. Fig. 4: VAC control panel. Fig. 5: Audio flows when connecting WSJT-X using VACs. Fig. 6: SDR-Console all the HF FT8 bands on one screen.

reading the data goes faster than the processor can supply the data, there will be a gap in the audio. This is quite a common problem that shows up as stuttering in the final audio. The normal solution is to either slow down the data rate (sample rate) or increase the buffer size, to give more time for the data to be populated.

To create a practical VAC, the software simply transfers the data on its input to the output, maintaining the same format. This simple transfer enables the VAC to feed audio to multiple devices. For example, if you're working a RTTY contest, you could have several different decoders running in parallel from the same VAC output in an attempt to get the best decode. All these decoders would read the audio data from the VAC output buffer.

PracticalVACs

There are two VACs available that are in common use. The first is VB-Cable from VB-Audio. This is a free application that installs a single VAC and can be useful for many applications. If you need more VB-Cables, the software is donationware, but with a twist, where you decide how much you want to pay! You can find VB-Cable here:

https://vb-audio.com/Cable/index.htm

I have been using **Eugine Muzichenko's** excellent VAC for many years and have found it to be very stable and trouble-free despite the wide range of software combinations I have thrown at it. VAC is a paid for product, but the perpetual licence cost is just $30US (£22) and that gives you an unlimited number of VACs. In addition to the virtual cables, VAC comes with a couple of useful repeaters. The repeaters let you monitor any audio path. For example, when I'm using FT8 with my Hermes Lite rig and SDR-Console software, I route the audio out to a VAC and then on to WSJT-X, but that means I can't hear any audio because there's only one output option. This is where the repeater helps. I can set the repeater to monitor the VAC and send the output to my speakers, **Fig. 3**. Although not particularly relevant to amateur radio usage, Eugine's VAC also fully supports surround sound audio. The VAC is available from:

https://vac.muzychenko.net/en

UsingVACs

While it's good to understand what's happening under the bonnet, VACs are actually very easy to use as you rarely need to change any settings. I'll run through configuring Eugine Muzychenko's VAC. This VAC is installed with a dedicated control application where you can configure the VAC parameters, **Fig. 4**. You will need administrator privileges to add cables, so you need to run the VAC control panel by right clicking on the program and choose Run as administrator. Here's how to perform a standard setup:

With the VAC control panel open, head up to the top left and set the cables to 2.

There's no need to change any other settings, so you can click Exit to close the panel

If you're asked to restart your computer, go ahead and do that.

Next check that the new cables have been created.

Go to the speaker icon in the bottom right of your computer screen, right-click and choose Open sound settings

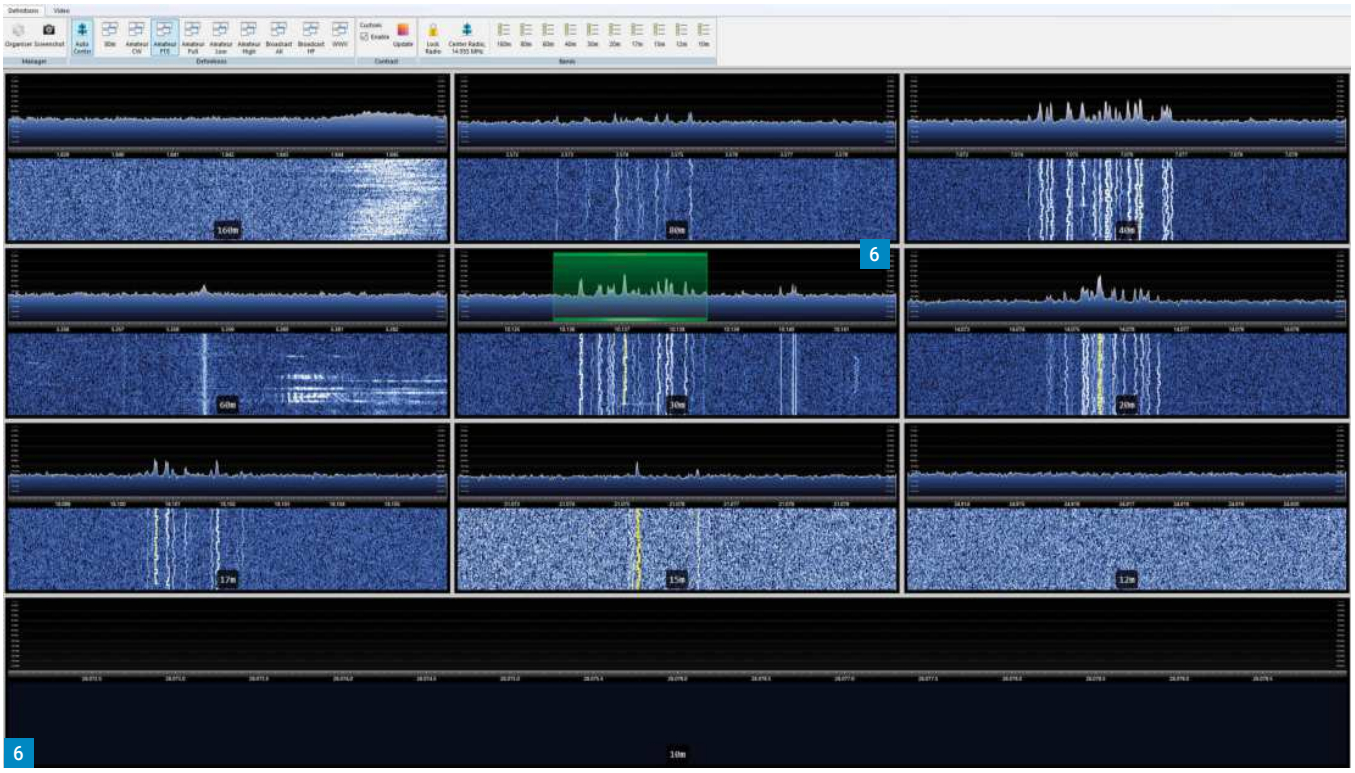
In the Sound panel under Output, you will see a drop-down that lists all your sound devices

The VACs will normally show up as Line 1 (Virtual Audio Cable) and Line 2 (Virtual Audio Cable)

You should see the same listing under the Input section

One thing that often confuses people is the Device Manager entry as there is just a single device shown in the Sound section. However, if you go to the top of Device Manager and open the Audio inputs and outputs you will see two entries for each installed VAC, one for the input and the other for the output.

One important point to note about VACs is that they are unidirectional, which is why you need two cables, one for the receive audio and another for the transmit. When using Eugine's VAC, I normally use Line 1 for receive audio and Line 2 for transmit. Here's an exam-



ple of how to link WSJT-X to an SDR, **Fig. 5**.

In your SDR software, set the audio out to use Line 1 (Virtual Audio Cable)

Set the transmit audio input to use Line 2 (Virtual Audio Cable)

Next move to WSJT-X and open the Settings panel, Audio tab

Set the Soundcard Input to Line 1 (Virtual Audio Cable)

Set the Soundcard output to Line 2 (Virtual Audio Cable)

At this point, the sound settings will let you transmit and receive data modes, but you won't hear anything through the speakers. This is where the audio repeater fits in. Locate Virtual Audio Cable in the Windows program list and select Audio repeater (MME). This will open the repeater panel where you set the Wave in to Line 1 (Virtual Audio Cable) and Wave out to your PC's speakers. Once set, just hit the Start button to begin monitoring the audio. That completes the setup and you can use the same virtual cables for other data modes software.

SDR-Console – One Screen to Rule Them All

Simon Brown's SDR-Console application continues to evolve and is an extremely powerful tool for a wide range of popular SDR radios. I use it to run my Hermes Lite 2 transceiver but it also works very well with my RX888 MkII wide range SDR. In addition to adding features, Simon has been working hard to reduce the processor loading so that it will run on very modest PCs. The latest addition is a big step forward and takes full advantage of the extreme bandwidth offered by full range direct sampling SDRs such as the RX888. The new Multi-Band window lets you simultaneously monitor as many bands or band segments as you like. It comes with a good range of preconfigured options such as the FT8 view shown in **Fig. 6**. This simultaneously shows the FT8 segment on every band from 160m to 10m! Viewing all this information is very impressive but you can also mouse-click on any band to instantly retune to the chosen band. Customisation of the band combinations has been well thought through and uses a Bands Organiser panel, **Fig. 6**. This provides an editor where you can quickly add and delete band segments. Once you've specified the required segments you can use the graphical organiser to move the blocks around to your preference. Resource usage is well controlled and on my main PC (10th gen i7 processor and GTX1650 super graphics card) I see around 6% processor usage and around 50% of the GPU. That's with the RX888 MkII receiver and the Multi-Band display showing all FT8 channels.

Node-Red

Node-Red is a free visual programming language developed by IBM that specialises in processing events and messages from a wide range of systems. Originally designed to help IBM developers prototype software for their customers, it has since taken on a life of its own. Node-Red programs are known as flows and there is an online repository where users can share their code. The main website for information and for downloading flows is: **https://nodered.org**

The system is built with Node.js and programs are built using flow-charts so it is easier to get to grips with than many other programming languages. My main reason for mentioning it here, is the growing number of amateur radio specific flows appearing in the repository. I recently noticed a flow that connects to WSJT-X and decodes FT8 messages. This could form the basis of an alarm or filtering application to spot specific transmissions or callsigns. Flex users may be interested in the flow that communicates with Flex 6000 series rigs and provides several nodes for sending and receive commands. There is also a meters node in development that identifies and reads the internal meters of these Flex radios. For WSPR users there's a flow that uses the ALL_WSPR.txt file on your computer to create a local map of all your spots. One of the many enhancements that's been added since I first came across Node-Red is the dashboard user interface. This makes it relatively easy to add a friendly interface with buttons, dials, etc. If you want to try Node-Red, the Raspberry Pi is a good place to start because it's included in the standard operating system. You can also install Node-Red on just about any other computer system. Instructions can be found in the Getting Started section of the Node-Red website.

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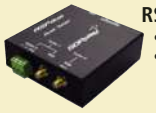

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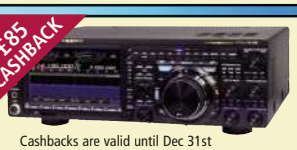

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The Bands are Back!

Steve Telenius-Lowe PJ4DX
teleniuslowe@gmail.com

Steve Telenius-Lowe PJ4DX reports on a busy month, with good propagation and plenty of DXpedition activity

Welcome to the December *HF Highlights* and although it is still only mid-October when writing this, let me be among the first to wish all readers a happy Christmas.

After the extraordinary rise in solar activity in mid to late September, when the Sunspot Number (SN) rose to 124 for a couple of days and the Solar Flux Index (SFI) peaked at 102, it is no surprise that both measures are lower this month. Despite that, the overall trend is still upwards, as can be seen in **Table 1** and this is reflected by much improved propagation on the higher HF bands in October.

Contest Season

Although this is the December issue of *PW* it should be with readers well before the CQ World Wide DX CW Contest, which takes place over the 48 hours of the weekend of 27/28 November. This is 'the big one' and there will be huge amounts of contest activity from all over the world. From here on Bonaire the new PJ4K contest station will be taking part in the Multi-Operator Two-Transmitter category. PJ4G will also be active in a multi-operator category. Exchange an RST signal report and your CQ Zone (the UK and Ireland are in Zone 14).

I took part from my home station in the 'sister' event of the CQ World Wide contests – CQ WPX SSB – which took place at the end of March, and was lucky enough to take World 1st place in the Tribander/Single-Element 'overlay' category, **Fig. 2**. This allows those with rather more modest antennas than those at the big contest stations to compete against similarly-equipped stations, in this case, those using a tribander beam on 10-15-20m and single elements (e.g. dipoles or verticals) on 40-80-160m.

DXpeditions Are Back!

The last month has seen a spate of DXpeditions to various exotic locations. **Dom 3D2USU** sailed from Fiji to Conway Reef and was active as 3D2CR, mainly using FT8, in mid-September. At the same time **Janusz SP9FIH** and **Leszek SP6CIK** were active from the Comoros as D60AC and D60AD respectively. Then in October there were not two, but three, simultaneous DXpeditions. First up was the **Czech DXpedition Group** who were active as **S9OK** from São Tomé and Príncipe, the small island nation off the west coast of Africa. They really hit the ground running, making nearly 10,000 QSOs on the first day of operation (I was able to work them on no fewer than 11 band-mode slots on Day 1 alone). After a few days they were joined by the **Italian DXpedition Team** from Guinea-Bissau as **J5HKT** (on FT8) and **J5T** (on other modes), as well as a Russian group operating as **3DA0RU** from the Kingdom of eSwatini (formerly known as Swaziland).

All of these DXpeditions provided a real shot in the arm for DXers who have had some lean times over the last couple of years, even if occasionally it was a little confusing with two or three operations on the same band and mode at the same time!

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Readers' News

Jim Bovill PA3FDR wrote to say he has been a reader of *PW* for over 35 years and that he looks forward to it dropping through the letterbox every month. As far as I know, though, this is the first time he has contributed to this column, at least since I started to compile it in 2015, so a warm welcome to Jim! He said, *"I recently exchanged my previous rig for an Icom IC-7300 and spurred on by the articles in* PW *about FT8* [see *PW* May and June 2021 – **Ed**] *decided it was time to try this mode. The IC-7300 is ideal for this as it allows you to pre-set the rig for FT8 on the push of a button. Between mid-August and the end of September I logged over 400 QSOs, ranging from the west coast of North America to the Far East, the best one so far was VK7AC (QE38, Tasmania, 16,921km)."*

Steph Foster G4XKH sent in a photo, **Fig. 1**, of members of the Riviera Amateur Radio Club in Torbay who operated GB8BB on 15 September. The special event station commemorated the 80th anniversary of the Battle of Britain.

On 1 September, **Victor Brand G3JNB** noticed **TZ4AM** in Bamako, Mali, calling North America on 17m CW. *"**Jeff** was S9 when, suddenly, he said 'EU UP' and heard*

Fig. 1: CQ WPX SSB contest certificate for 1st place in the Tribander/Single-Element category. Fig. 2: Members of the Riviera Amateur Radio Club at their GB8BB Battle of Britain commemorative special event station. Fig. 3: Portable location of John MW1CFN on Anglesey. Fig. 4: Results of about one hour of FT8 operation on 4 October by MW1CFN/P. 17m in yellow, 15m brown, 12m red. Fig. 5: Map showing ZG2GI FT8 QSOs on 60 to 10m between 4 and 10 September. Fig. 6: The Hexbeam of Etienne OS8D, almost hidden by the autumnal trees near Brussels.

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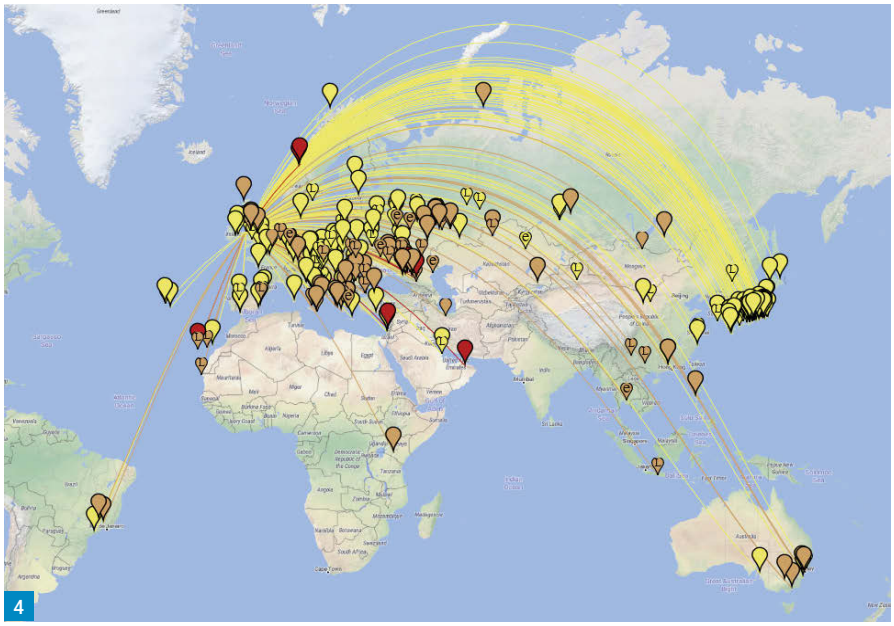

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	Oct '21	Sep '21	Aug '21	July '21	June '21	May '21	Difference
SFI:	89	95	72	72	77	78	(–6)
SN:	38	124	0	24	29	36	(–86)

Table 1: Rolling six-month Solar Flux Index and Sunspot Numbers as of 11th of each month. The final column shows the difference between the October and September figures.

my very first call with 12 watts to the vertical. His later email said his beam was actually pointing towards VK but that I had a good signal considering my low power and antenna. Then, next evening, ***Andy 5Z4VJ*** *in Nairobi, working 20m split, gave me 339, a realistic report for us weak callers. On the third night of my 'Bedtime DXing', going for the 'Hat Trick'... on 20m,* ***Claus CP4BT*** *Bolivia persevered until we finally made it through the horrendous noise and deep QSB. It took some doing! So, naturally, PM on the 4th I was back in the shack – but the magic had gone. Best I could do on the 5th was to work SX021IEEE (!) on 20m from their symposium in Athens. But by the 7th the SFI was up at 100 and ZX4AN in Brasilia was logged on 20m and 9K2HS also obliged with 17m on the 9th. At the unusually early hour of 0747UTC on the 10th, I checked in with Jeff TZ4AM, this time down on 30m, before enduring a couple of weeks with no shack time. In the closing days of the month there was little DX about, or so I thought. On the 28th,* ***Wald XQ6CF*** *was back on 17m but after my calls and his several 'G?'s, he went QRT. Early morning on the 29th I was reading ZL3XDJ on 20m running a major pile-up that I could not break but, moving back down to 30m, there was a strong signal from TZ4AM who reassured me by replying first call. 'You really had a good signal this AM' said his subsequent email. Morning on 30 September and I was actually copying weak 12m signals from both 3W1T Vietnam and TZ4AM. So, take heart, the DX really is back again..."*

John Rowlands MW1CFN/P sent *"a very quick note from Anglesey this month. Propagation on the upper HF bands continues to show strong improvement"*, he said. Working from the seaside with a 'stick' antenna on the car, **Fig. 3**, and no more than 15W, John reports that SSB QSOs have been enjoyed quite often recently with Japan on 17m, and China on 15m, from mid-morning onwards. *"FT8, meanwhile, continues to regularly provide large numbers of DX contacts globally, even on 12m and 10m,"* John added. He sent in the map in **Fig. 4**, which shows the results of about one hour of operating on the morning of 4 October.

Kevin Hewitt ZB2GI also attached a map, **Fig. 5**, showing the FT8 QSOs he made as ZG2GI from 60 to 10m between 4 and 10 September. He reported that *"Gibraltar celebrated National Day on 10 September to commemorate the sovereignty referendum of 1967. I used the ZG2 special prefix from the 4th to the 10th to mark the occasion. This year was the 30th National Day, I made 30 FT8 contacts on eight bands and 300 SSB QSOs... I also operated [as ZB2TEN] on 10m at the Quarry with* ***John King ZB2JK*** *on the 26th. Although conditions on SSB were poor, FT8 was open to South America."*

Etienne Vrebos OS8D reports from an autumnal Brussels, **Fig. 6**, saying that he now has a new antenna: a Bazooka dipole for 7MHz at 12m high, which seems to be quieter on receive than the End-Fed wires he also uses. Etienne says he has had *"a quiet period"* but still managed to make around 450 QSOs in the month, with some great DX (see 'Around the Bands'), including *"a lot of traffic from Indonesia, nice to catch. UK QRP stations are still my favourites every morning."*

Tony Usher G4HZW has been feeling nostalgic so bought a Lowe SRX-30D receiver on eBay, saying *"we had one back in the '80s, only £115 and it's working well combined with the Wellbrook antenna. I've had it set to the 7MHz QRP frequency (7.030) while I've been FT8-ing on 28MHz. Plenty of slow CW, wide*

as a barn door of course but very entertaining! Ten metres burst into life during the latest reporting period, with an SFI of 102 on 29 September... I saw well-equipped stations working JA and VK. I had no luck with them but was delighted to work KG6DX (Guam) on 30 September, for a new one on 10m FT8. Also new this time 3B9FR (Rodrigues Island) and V51MA in Namibia. The band has been open to South America every evening."

Ken Churms EA5/G4VZV has been out to the salt lagoons of the Costa Blanca just south of Santa Pola, Spain. Ken has found the ideal spot, which gives his ground plane a super low-angle take-off via long path to the Pacific. He has concentrated on early morning propagation and worked many VK and ZL stations. He says the long-path propagation was evident first to eastern Europe then moved towards the Mediterranean and it was another 30 minutes before it moved up into the north-west part of Europe and the UK.

Owen Williams G0PHY said *"Thanks for the contact in the WAE* [Worked All Europe – **Ed**] *contest. In last year's contest I worked some west coast USA stations and an Alaskan station but this year USA contacts were limited to the east coast. There has been some good DX to chase over the last two weeks, starting with D60AC followed by S9OK and 3DA0RU, with the Oceania DX contest as well and 3DA0WW to come. The pile-ups have been ferocious. I managed to work a VK2 and a VK5 in the Oceania contest. These were the first contacts I've had with VK for a long time. I had a contact with S9OK on 21MHz, the first time I've had experience of Club Log Live Streaming. There was some QRM and QSB and I wasn't sure if he had my call correctly. When I looked at the streaming I was logged as G0EHY so I called him again and I was in the log with the correct call. It was also a bit of an 'ego boost' to click on the green spot on the UK and see my call."*

5

Around the Bands

Jim Bovill PA3FDR: 7MHz FT8: TA4AEI, TA6B, UN7ZV, VK7AC. **14MHz FT8:** 4L8A, 5Z4VJ, CO8RCP, CU3HN, KJ7JDH, OD5ZZ, PY7ZZ, RU0LL, RV9CW, SV5AZK, TA6B, UA0ZK, VA7ON, VO1IV, VR2ZUZ, W1EHQ, W3MJ, W9KIM, ZA5G.

Kevin ZG2GI / ZG2GI: 5MHz FT8: EA8RH. **7MHz FT8:** 9G5FI, PY2XYZ, PY4OY, VO1IV. **10MHz FT8:** 4X5MZ, AA1SU, JA1JRK, JA4LXY, JA9NLE, KN4GDX, N3NGE, VK4TUX. **14MHz SSB:** 5B4AIX, 9G5FI, 9Z4SB, AA2AS, AL7AF, AL7KC, K1DSK, K2CBI, K3WKJ, KB0SS, KD8NVP, KL7KK, KN6MYI, N9FDE, PJ4KY, PZ2YT, PR7TU, TA3YJ, VA2ZE, VE1BB, VE3AT, VK2ACK, VK3BNR, VK5KV, W4FNZ, WP3EF, ZL1XS, ZL2ME. **14MHz FT8:** AG9S, JA0DAI, JA1PSS, JR7IWL, K4CVL, VE3BOE, W2RF. **18MHz FT8:** K1RI, N4JKO, N6DVR, NA8W, NZ5O. **21MHz FT8:** 5B4AMX, 9G5FI, AA4V, AG5CN, HZ1LG, JA9FFS, JI2FBG, KE8QYK, KP4DQC, LU2DAJ, LU9HRM, N0JYZ, NR1DX, OD5ZZ, PJ4DX, PU2YMH, PU4YEN, PY7GB, RA8AF, W3MR, WO2T, W9DSP, YC7JZ, ZS6WN, ZW16ZT. **24MHz SSB:** 9Z4FE, PU7BGC. **24MHz FT8:** 5B4AMX, AA8R, CX7BBR, HC1HN, HK3X, KP4HF, L21RCA, LU1CFU, LU2NI, LU3DI, LU5FCI, LU7FIN, LU9DO, N0PCL, N2QT, N4JOW, PJ4DX, PP2CS, PP5AMP, PU3VON, PU4DEE, PU7BCG, PV8AAS, TI200I, W2QO, W3UUM, W4KBP, YV1DIG, YV4GLF, YV5ZV. **28MHz SSB:** CX5CDV, FY5KE, WP4RF. **28MHz FT8:** 3F200AT (Panama), CE1PTT, CE3BKN, CO2WP, CO8MCL, CX7CO, CX9ARH, HC1KX, HC6PE, HI8VJS, HK3X, K0LUZ, KO4OSA, KP4ZZ, LU1DPW, LU2MCX, LU3DI, LU4QBF, LU5BPT, LU7DUE, LU8HF, LU9EBZ, N9ZTC/PY4, NP4JE, P41E, PJ2MAN, PJ4GR, PJ4NX, PP5TI, PU2TNT, PU3LYB, PU4JLV, PV8BR, TI200I, WP3KW, YV4FUE, YY2AVT, ZP6CGE, ZW2RA.

ZB2TEN: 28MHz FT8: CE1BF, LU1HPR, PU2YYD, PU4DCN, PU5DPL, PY1LC.

Etienne OS8D: 7MHz SSB: ZL4RMF. **14MHz SSB:** 4L2M, 6W1QL, 9G5FI, 9T6TMT, BD7BM, E29TGW, EP2MRK, FK8HW, S79VU, UN0LM, UN7LZ, UN9LW, V31MA, V85T, VK6CB, VU3EUE, VU3TPW, YB0AR, YB2MM, YB4FIK, YB7MP, YB7NUS, YC1AYO, YC1BIQ, YC1CWO, YC1DIU, YI1WWA, Z62NS, ZL1T. **18MHz SSB:** 3W1T, JA0DCQ, JE2HVK, S9OK. **21MHz SSB:** 9X2AW, 9Z4Y, CO8WN, CX7SS, D60AC, EX2V, EY7AD, FR5EC, JL1MWY, LW1D, PT5J, PY2RH, PY2XV, PY3CW, PY6HD, S01WS, TI200I, UP7L, VU2DSI, VU3NPI, YB0IBM, YB0JVZ, YB1AR,

6

ZS6CCY. **24MHz SSB:** 9Z4FE, CU2CO, PY3TD, PX8L, VP2ETE.

Tony Usher G4HZW: 28MHz FT8: 3B9FR, 4J880M, 4X6YA, 5B4AMH, 8Z91ND, CE1BF, CE3DOH, CO2WP, CP4MG, CX1BBS, CX2SA, CX3AL, CX6VM, CX7CO, EA8W, HC6PE, HI8KW, KG6DX, OD5SK, R8CEG, UW5EJX/MM, V51MA, VO1IDX, VP8LP, VP9NM, VU2RCY, VU3CAU, WP4G, XQ3MCC, XQ5CIE, YB1MIG, YC0VM, YD1CBC, YD2ULK, YV5JLO, ZP6CGE, ZS1HG, ZS6AF.

Ken EA5/G4VZV: 14MHz SSB: VK2AUS, VK4IM, VK5PAS, VK6ACF, VK7ROY, ZL1ACE, ZL3ET.

Owen G0PHY: 14MHz SSB: 4X1DX, D60AC, K0EJ, PJ4DX, PX8L, RM9I, TC3N, VE9CB, VK2BM, VK5ARG. **21MHz SSB:** D60AC, S9OK. **24MHz SSB:** S01WS.

Signing Off

Thanks to all contributors. Please send all input for this column to **teleniuslowe@gmail.com** by the 11th of each month. Photographs of your shack, antennas, or other activity would be particularly welcome. For the February 2022 issue the deadline is 11 December. 73, Steve PJ4DX.

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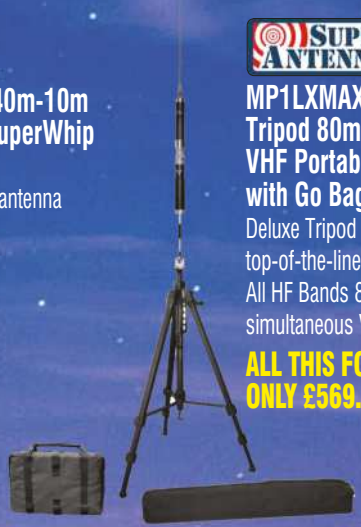

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This month's Featured Icom Radio

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Widescreen display & top performance keeps this spectacular Base from Icom at No.1.

The Icom IC-7610 is a complete redesign of the former IC-7600 following on from the huge success of the IC-7300. 100W, Dual band receive and a huge widescreen display.

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IC-705 optional accessories include:
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ML&S for SDR Radio

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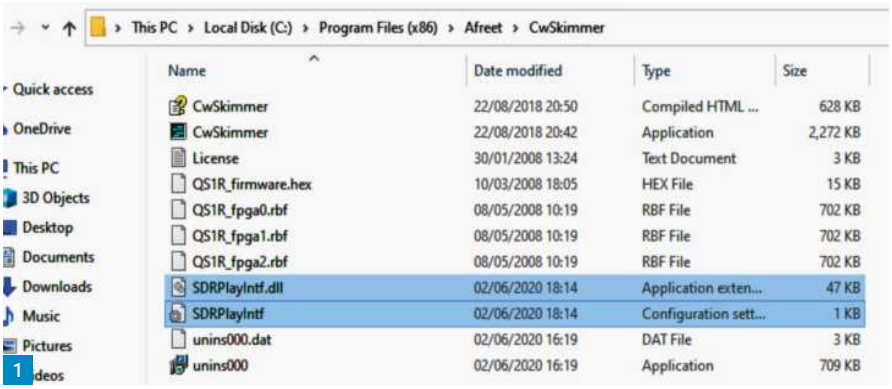

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SDRPlay RSP1A: CW Skimmer Install

Billy McFarland GM6DX explains how to combine a great SDR receiver and some excellent software to set up a really useful receiving capability.

I was looking at the idea of setting up a receive station at my home QTH, for the purpose of propagation studies. Knowing what band, what DXCC and at what time of the day I was able to receive that particular station at home would be useful data for working DX and general operating.

I had recently purchased an SDRPlay RSP1A receiver, which I had connected to my home-made loop, so this made the obvious choice for use in this new receive station. Being a regular user of the reverse beacon network (URL below) I decided to use CW as the receive mode, interfacing the station with reversebeacon.net telnet.

www.reversebeacon.net

Reversebeacon.net is a great website where stations from all over the world share their received data. The website allows you to search on a callsign, which then populates a list containing what stations are receiving you, at what CW speed, on what band, at what date and time and at what signal strength in dB. As well as this you can create a list of stations that you have received, so with all this information you can easily start to see how useful it can be.

In order to set up this basic CW Skimmer, I used:

- 1 x RSP1A Receiver
- 1 x antenna (I used a 1m diameter active loop available at:
  https://tinyurl.com/4pmfa8xv
- 1 x CW Skimmer Server software by DX Atlas
- 1 x Reversebeacon.net Aggregator software
- 1 x CW skimmer driver for RSP1A
- 1 x PC with internet connection

Software for 3, 4, and 5 can be located on my one drive at:
https://tinyurl.com/4yrjpzwy

Setting Up

Before I proceed to explain the setup you must have a basic understanding of how to operate your PC and you must have your RSP1A working with your PC and also connected to an antenna. There is plenty of information on the SDRPlay website on how to set up the RSP1A with your PC.

First step is to download and install CW Skimmer Server software by DX Atlas (note this is a paid product but available on a trial period) onto your PC's hard drive. Make sure you know where the installed folder is located on the hard drive (usually something similar to C:\Program Files (x86)\Afreet).

Next step is to open up the files located in the SDRplayIntf.zip (two files, one of which is a .dll file), copy both files and paste them in the folder on your hard drive that CW Skimmer Server.exe file was installed into. When in that folder also delete the QS1R.dll file. See **Fig. 1**.

Start-up CW Skimmer Server software. On starting up you will see a few tabs going along the top. The skimmer tab is where you select the SDRPlay RSP1A from the drop-down menu and the bands that you want to decode on (three bands at 192kHz wide). The telnet tab is just a standard 7300 port, no password, and you can select for CQ only spots. The next tab is operator. Here you put in your callsign, first name and grid locator square information (6 figure grid square), **Fig. 2**.

If this is set up correctly and the software is seeing your RSP1A, then the status tab will be full of information as seen on **Fig. 3**.

The CW Skimmer Server software must run all the time, so leave it running in the background. Now open up Aggregator.exe (this is just an .exe file and doesn't get installed onto the hard drive, so keep the folder in your documents or so and just create a short cut from the desktop to the aggregator.exe file).

Once the Aggregator.exe software is running again it has a few tabs across the top. Only a few tabs need our attention. First click on the tab that is called 'Connections'. You will see the port is defaulted to 7300, that's fine,along with an IP address (don't worry about that) and a callsign which is n0call (just leave that callsign in there). Make sure you tick the remaining boxes relevant to your needs and then press 'connect'. You will then see green writing informing you that it is connected to the RBN telnet, **Fig. 4**.

Now your RSP1A is decoding signals using the CW Skimmer Server software. This data is getting shared with the Aggregator software, which then shares this with the

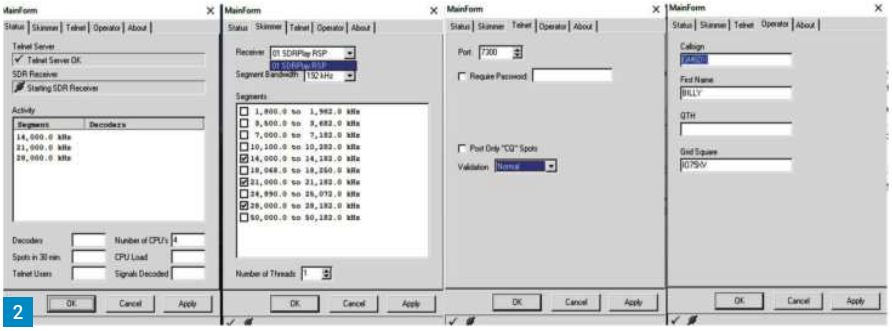
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Fig. 1: Installing the SDRPlay files into the CwSkimmer folder. Fig. 2: Entering your station information. Fig. 3: The status tab. Fig. 4: Green text confirming connection. Fig. 5: The listing of received stations. Fig. 6: The small receive loop. Fig. 7: The receive setup located in a garden shed away from the main station. Fig. 8: Using the Aggregator feature.

reversebeacon.net service via your internet connection. You can see the status of the Aggregator software by looking at the status tab. From there you can see a list of your decoded stations and whether it is connected to the reversebeacon.net telnet or not, **Fig. 5**.

There are a few things you will need to take into account when doing this. Firstly, the antenna. I chose a loop. It is small, only 1m in diameter, and covers from 1.8MHz to 30MHz so it can cover any band I select on the CW Skimmer Server software, **Fig. 6**.

This install requires an internet connection and the PC running continuously. I have installed the PC in a plastic shed in the garden to keep it away from the main shack, **Fig. 7**.

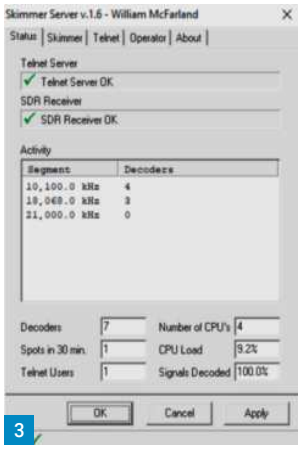
The RSP1A only allows three bands to be selected for decode, where it will cycle through each band, for three minutes continuously. I am now running 2 x RSP1A receivers on two antennas so I can decode and receive up to six bands simultaneously.

There is an option in the connection tab on the Aggregator software that allows you to create a log file of all your received stations as seen in **Fig. 8**. This has got to be one of the best available features as you can search in the .TXT file for a particular prefix (when in the .TXT file hold Ctrl and F for the find tool) such as VK or ZL. It will take you through the list of callsigns received with that prefix. It will also show you at what time, day, band and signal strength you received them. With this ability you can create a spreadsheet with particular prefixes, allowing you to gather times and bands of where your home QTH is receiving that particular DXCC, which in my eyes is a great propagation tool.

Results

Using this setup I have so far received ZL, VK, JA, W6, PY, 3B8 on topband (160m) through to 15m (not had much 10m propagation yet for the higher bands) so provides a great tool in finding the right time and band for working that DX.

Should you have any queries or need help with setting this up at your own QTH, then I can be emailed at gm6dx@outlook.com



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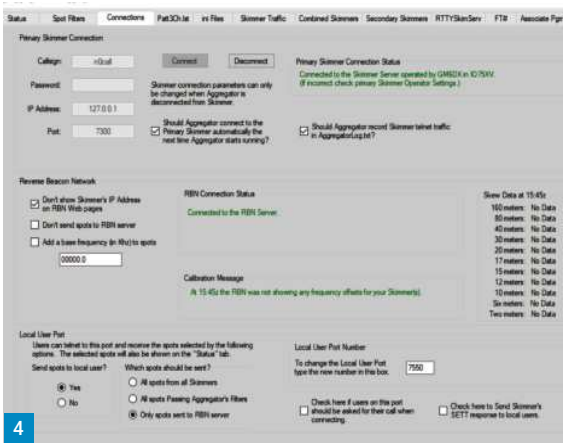
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8

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Two Award Schemes

Colin Redwood G6MXL
practicalwireless@warnersgroup.co.uk

Colin Redwood G6MXL looks at two award schemes that share many common attributes: World-Wide Flora and Fauna (WWFF) & Parks on the Air (POTA).

I'll be the first to admit that it seems strange that amateur radio has two award schemes that appear to credit almost identical activities based on operating and contacting stations located in areas of countryside such as national parks and nature reserves. So, what is the history?

WWFF

The oldest of these two award schemes is known as the World-Wide Flora and Fauna (WWFF). It started life in 2008, and was initiated by the Russian Robinson Club as World Flora and Fauna (WFF). In November 2012 the program was relaunched as WWFF. It covers all parts of the British Isles, most of Europe and many other parts of the world, including North America.
https://wwff.co

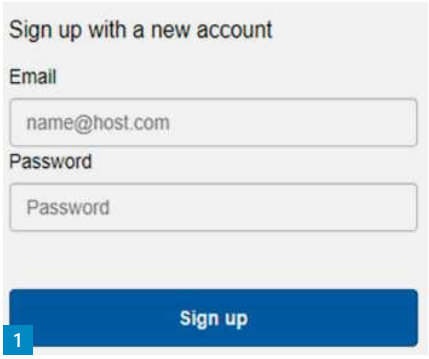
POTA

Parks on the Air (POTA) started more recently in 2016 and has its roots in the USA. The scheme is slowly extending worldwide. At the time of writing, POTA includes 500 English, 189 Scottish and 103 Welsh 'parks', many of which have yet to be activated. POTA is yet to cover parks in Northern Ireland, Eire, Jersey, Guernsey and the Isle of Man. In fact, many DXCC entities in Europe such as most of Scandinavia, the Baltic states, many Balkan states, some eastern European countries and Russia are not yet included in POTA. This is a pity as these are readily and frequently worked from the British Isles. Incidentally, when POTA refers to 'parks' it does not mean local council-owned recreation parks in towns and cities – places where you might see swings and slides, football pitches etc.
https://parksontheair.com

Countryside Categories

It appears that these two award schemes have an almost identical scope in respect of the categories of countryside they cover. However, when I came to cross-check some local areas here in Dorset, I found a few differences.

For reasons I am not sure that I understand, four POTA parks did not feature on the WWFF list. I found the exercise helpful as I now have a cross-reference for the local areas that I might activate, see **Table 1**. It also introduced me to the local qualifying areas of countryside. I'd suggest readers planning activations consider doing a similar exercise for their areas of interest. I should also point out that local names of areas may differ from the names used by WWFF and POTA.



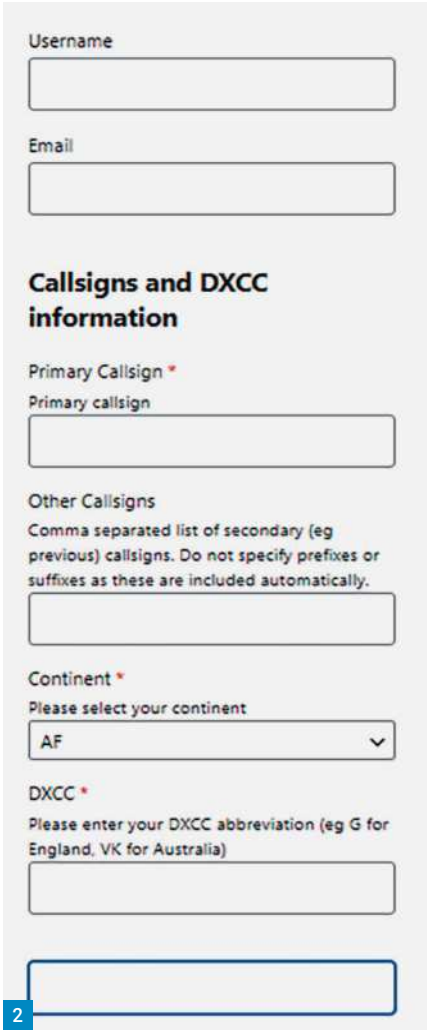
1

Hunters and Activators

Both award schemes have the concept of hunters and activators. You can participate as a hunter from the comfort of your home shack, no matter where it is on the planet. As a hunter, you just need to register with the relevant website. Hunters don't even need to submit their logs. Just make contacts with activators operating from National Parks and other relevant countryside. As the name suggests, an activator is someone who operates from designated areas of countryside. Activators submit logs from their operations in areas that are in the relevant award scheme, thereby crediting hunters. I suspect that many WWFF and POTA operators will be both hunters and activators.

Sign-Up

The process of signing-up so that you can be credited as a hunter and/or activator is straightforward for both POTA and WWFF. For POTA you initially sign up with your main callsign (G6MXL in my case). You then sign out and log in again and you can then add other callsigns that you use, G6MXL/P and GW6MXL/P in my case, **Fig. 1**. For WWFF the signing-up process is similar except for the sequence that information is requested **Fig. 2**.



2

Information

For most areas, the WWFF and POTA databases provide plenty of information, although I did notice a few inaccuracies in the POTA database, which were promptly corrected when I advised the relevant POTA contact.

References

WWFF references are made up of the ITU prefix and a unique identifying number. For example, Durlston Country Park, a national nature reserve in Dorset, GFF-0376. The same park in the POTA scheme is G-0187. The WWFF reference for the Snowdonia National Park in Wales is GWFF-0074, with

Fig. 1: Signing up for POTA.
Fig. 2: Signing up for WWFF.
Fig. 3: The signage and map in the cark park at the entrance to Durlston Country Park and National Nature Reserve in Dorset (WWF GFF-0376 and POTA G-0187).
Fig. 4: The WWFF award for contacting activators in 7 European DXCC entities.

the equivalent POTA reference being GW-0001.

There are some instances where, for example, a nature reserve is located in a national park. For WWFF purposes you can only operate using one reference at a time. POTA permits the use of multiple references simultaneously.

Preparing to Activate

If you are thinking of activating a WWFF or POTA reference, you'll need to do a little research first. You'll need to find a map that clearly shows the extent of the area of countryside in question, so that you can choose where to operate from. Most of the areas will have maps on the internet showing their boundaries. You'll often find maps at the entrance or throughout the area in question, **Fig. 3**. Having set up your station, you call CQ WWFF or CQ POTA, or just CQ and work stations, making sure that you keep an accurate log.

Equipment

There are no WWFF or POTA specific rules regarding what equipment may or may not be used. However, it is expected that park activators consider other users of the park, so a noisy generator in the most tranquil spot is not the most appropriate source of power. Otherwise, you'll probably want to use lightweight or portable equipment, battery powered in many cases. SOTA and HEMA activators will already be suitably equipped.

GettingThere

Unlike awards such as Summits on the Air (SOTA) and HEMA, there is no requirement to get to the operating location by foot. It is perfectly OK to operate from a vehicle. In fact, it is quite possible to operate from a building or even your home if it is located in a WWFF or POTA area. You could find that in many cases a SOTA or HEMA activation also counts as a WWFF and POTA activation. If you join in a Worked All Britain (WAB) net, you could also be exchanging your WAB square with those you contact. The WWFF database helpfully provides WAB references for some UK areas.

If that's not enough, you might also find that a favourite VHF contest site is in a WWFF and POTA area!

Name	WWFF Reference	POTA Reference
Avon Heath Country Park	n/a	G-0362
Avon Valley SPA/RAMSAR Protected Area	GFF-0377	G-0111
Ballard Down National Nature Reserve	GFF-0099	G-0082
Brownsea Island Country Park	n/a	G-0372
Chesil Beach & The Fleet SPA Protected Area	GFF-0330	G-0066
Cranborne Chase and West Wiltshire Downs Area of Outstanding Natural Beauty	GFF-0249	G-0051
Dorset and East Devon Coast World Heritage Site Provincial Park	GFF-0276	G-0183
Dorset Area of Outstanding Natural Beauty	GFF-0251	G-0008
Dorset Heathlands - Arne Reedbeds National Nature Reserve	GFF-0098	G-0177
Dorset Heathlands - Hartland Moor National Nature Reserve	GFF-0235	G-0292
Dorset Heathlands - Holt Heath National Nature Reserve	GFF-0101	G-0157
Dorset Heathlands - Holton Heath (inc Wareham Meadows RSPB) National Nature Reserve	GFF-0314	G-0093
Dorset Heathlands - Stoborough Heath National Nature Reserve	GFF-0234	G-0154
Dorset Heathlands - Studland & Godlingston Heath National Nature Reserve	GFF-0105	G-0047
Dorset Heathlands - Upton Heath Nature Reserve	GFF-0315	G-0211
Durlston National Nature Reserve	GFF-0376	G-0187
Garston Wood RSPB Reserve	GFF-0100	G-0202
Isle of Portland SAC Conservation Reserve	GFF-0331	G-0133
Lodmoor Country Park	n/a	G-0407
Lodmoor Country Park (and RSPB) Country Park	GFF-0102	G-0102
Radipole Lake RSPB Reserve	GFF-0104	G-0196
Upton Country Park	n/a	G-0443

Table 1: The cross reference for Dorset prepared by Colin.

Operating in an Area

With both schemes, you can operate anywhere in an area limited by the local bylaws, rules etc. of the area. Just because you want to activate an area, doesn't give you any more rights than any member of the public who wishes to have a walk there. For example, you can't operate in any part of the area that is closed to the general public, and you mustn't block footpaths, rights of way or harm the wildlife and environment etc.

You can operate from a tent, a bench or any other way that suits you provided that you comply with the local bylaws and similar. You can operate from a vehicle, which means that there is no need to climb to the top of hills or mountains. This makes WWFF and POTA very accessible to those with disabilities or no longer as agile as they once were. It also enables operation in inclement weather.

Making Contacts

You don't have to exchange any specific information for a contact to be valid for WWFF or POTA. The minimum information to be logged is just date and time (UTC), callsign worked, band, mode, report sent and report received. If you are looking to make some Park-to-Park contacts, then it makes sense to record the other activator's park reference.

Contacts via repeaters, IRLP, remote stations and EchoLink are not valid for WWFF purposes. POTA allows the use of repeaters to announce your arrival, but not to make contacts towards the awards.

WWFF Activation

To gain a WWFF activation credit, you'll need to make at least 44 QSOs from the same area of countryside. The 44 QSOs can be accrued over multiple outings. So, for example if you activate a WWFF reference area today and make 30 QSOs, you could return on another day and make a further 14 or more QSOs, making 44 QSOs in total, and thus qualify as an activator of the WWFF area.

POTA Activation

For a POTA operation to be counted as an activation, at least ten QSOs need to have

been made on the same day within a period between 0000 and 2359UTC. A hunter can still claim credit even if you've made just a single contact, so it is good practice to submit a log every time you operate from a park, even if you didn't make ten QSOs. POTA gives additional credits for 'Late Shift' contacts made after dusk or in the dark.

Logs

Both award schemes accept logs submitted in .adi format. Almost all computer logging programs have a facility to export .adi files as do many data-mode programs such as Fldigi, WSJT-X and MTTY. In addition, the WWFF award scheme also accepts logs in a prescribed .csv format.

WWFF Logs

For WWFF, logs are submitted to the relevant National Coordinator or Log Manager who in turn will upload the log to Logsearch. The log file should be named in the format :

callsign@referenceYYYYMMDD.adi

The WWFF Log Manager for Great Britain is old friend of *PW* **Carl Gorse 2E0HPI**.

The email address is

logs@gxff.uk

For Eire the National Coordinator and Log Manager is **Andrew Banks M0YMA**

qrz@m0yma.uk

POTA Logs

For POTA, logs must be named correctly and sent to the relevant 'manager' according to the prefix number of your callsign. The file name format is Kx@parksontheair.com

where 'x' is the number in your callsign prefix. If you have an intermediate licence, you should ignore the leading 2. So 2E1ABC should send to

K1@parkrsontheair.com

I was pleased to find my first log was accepted with no problems. Note that it can take up to 48 hours for logs to be credited as the process is not fully automated. You should also make a point of emailing your log, no matter how many QSOs you have made, so that hunters can claim their credits.

Old Contacts

WWFF allows contacts as far back as 1 July 2008 to be uploaded. If you have contacts that you made from a park before joining POTA, you can submit your log after you have joined up. I was pleased to find that the whole of the Isles of Scilly is part of an area of outstanding natural beauty,

3

4

so I could load my log from my activity in 2018 as POTA G-0347 (Isles of Scilly), which I had previously uploaded to WWFF. I also found a number of contest logs that I could potentially upload from entries made from qualifying countryside.

Claiming Awards

You can claim awards via the WWFF and POTA websites. I was pleasantly surprised to discover that my contacts over the years qualified me for a WWFF Hunter certificate for working WWFF activators in seven European DXCC entities, **Fig. 4**.

Videos

There are several videos that can be accessed from the POTA website. I found them quite helpful in getting an understanding of the principles of POTA. There are numerous other videos on YouTube depicting various activations.

Conclusions

Both WWFF and POTA provide award schemes that encourage operation from the many areas of designated countryside without the need to operate from hill and mountain tops or the need to arrive on foot or cycle. Being able to operate from a vehicle makes them particularly attractive options for those wanting to get out of the house and 'play radio' during the winter months.

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- Dual alarm clock function
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Tecsun PL-880
This new Flagship SSB portable radio uses multi-conversion technology

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- DSP technology
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- Alarm clock with snooze function
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Accessories supplied include:
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- USB charging lead
- Stereo earphones
- 18650 type 2000mAh lithium battery
- Quality soft carrying case

Tecsun PL-680
Portable world band receiver with SSB

- Full frequency coverage including VHF Airband
- SW SSB with BFO control
- 1900 station memories
- Multi-tuning methods
- Built-in Ni-MH battery charge function
- Power sources: 4 x UM3 (AA size) batteries (not supplied)
  230V Mains adaptor (included)

£149.95

Accessories supplied include:
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- External antenna
- Mains adaptor
- Carrying case

Tecsun PL-330
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- FM stereo, LW/MW/FM/SW
- 650 memories
- DSP technology

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Tecsun PL-380
Multi-band Radio
- FM/LW/MW/FM/SW
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- 550 memories

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Joe Chester M1MWD
m1mwd@gmx.com

Voice over IP

Joe Chester M1MWD reflects on the merging of analogue and digital voice over IP in amateur radio.

Amateur radio, like any hobby, is a very diverse range of activities. And people too. And I don't want to start an argument here, but there is an old story about a village with three amateur radio operators living there. The question is how many amateur radio clubs are there in that village? Yeah, I know, trivial, we've all heard it. It's two if you haven't come across this aphorism before. Though slightly trivial, it does in a way describe the amateur radio hobby in some respects. Another way to say this is that we have a predilection for division. Pick any topic, ask any question, and the world of amateur radio operators divides instantly in two. *"I wouldn't buy one of those"* vs *"wonderful bit of kit"*, sort of thing. I can think of loads of examples, but you know them all. Which, neatly, brings me to DMR. Or Fusion, or D-STAR, or whatever you want to call digital voice QSOs (see what I mean? – instant division, three different ways to transmit voice as a digital data stream, almost a divide and conquer, or is that too harsh?)

The Smallest Station

This column is about small radio stations. Now a question the answer to which will not divide opinion – what does the world's smallest amateur radio station look like? The answer is a handheld radio. For example, this from **Peter G5AIB**, *"I've had a lot of fun from a £30 Baofeng handheld (GT3-TP) 8W, on SOTA, getting contacts over 100 miles away on 2m FM, with a telescopic whip antenna (a £30 add on) screwed in the top"* (thanks for your email, Peter). OK so far? But you've guessed that I'm not talking only about analogue V/UHF ones, but yes, the digital ones too. Stay with me, for I have a really good example (thanks guys – you know who you are). Mike (not his real name) moved to a nice room in a care home when he was 93 years old. An avid operator down the years (it is rumoured that he was trained by Marconi himself!), he has to leave behind all his amateur radio equipment, unless he just wants it for use as shelf ornaments. The guys in his radio club decided that going into a care home was hard enough, without being asked to give up his hobby of more than 70 years. So, they organised a whip around, bought him a DMR handheld and a hotspot, configured it all for him and set it up on the table in his new room. Through the magic of modern amateur radio, Mike now chats daily to his friends both in the local club, and even all over the world, just by using that handheld radio. The world's smallest amateur radio station! There are many more stories like this, and about other amateurs with restricted or even no outside antennas (what do you do if you live in a tower block?). Yet I can hear the heckling from the back already, even before this is sent to my Editor – *"that's not amateur radio"*. Clearly heard, Sir, but wait, I have more news for you. For there is one other aspect of digital amateur radio in all its flavours that I want to highlight. After this, I will return to the technical discussion – I promise (there is much interesting stuff to discuss!).

1

Evolution

Once upon a time, we all used telephone wires directly connected to switching exchanges in order to make phone calls. The early 'exchanges' were manual plug-in cord types, until **Mr Strowger** invented a way to do this job mechanically. End of the 'operator' – a well-known story. But then someone (actually a disparate group of friends of mine, both here and in the US), invented the packet switched network, the notion that communications traffic could be packaged in addressable pieces, called datagrams, and shipped all over the world using simple computers that used look-up tables. It works like this: 'is this datagram for me? yes keep it, no ship it on', sort of thing. The router was born, and with it the internet became a thing. And what happened next? We (yes, a bit me and my friends again) persuaded the telephone companies to digitise all voice calls, and stick that voice data in datagrams. Voice over IP (VoIP) was the new wave, the future of voice communications. No more mechanical Strowger gear, or the legions of technicians needed to maintain that system. (OK there are legions maintaining xDSL modems, and router tables, but that's another story).

Now, running in parallel with all of this is the history of radio communications. I won't go into the details, you know it all, anyway. So, we amateur operators arrive today with our HF transceivers, antenna farms, radio rooms, and all the assorted paraphernalia of the broadcast world. But this world too has (very nearly) gone the way of the telephone world. It's all IP traffic today. Call it digital radio/TV if you like. We are amateur radio operators:

UK AMATEUR RADIO LICENCE
Section 2
Terms, conditions and limitations
1. Purpose
1(1) The Licensee shall ensure that the Radio Equipment is only used:
(a) for the purpose of self-training in radio communications, including conducting technical investigations"

Yet when some very smart people (for once not me!) adopt the VoIP protocol to link analogue (and now digital) repeaters into a vast network of accessible radio nodes, some people instantly go *"not radio"*. Go figure!

This radio network is worldwide – yesterday, as I began writing this piece, I was listening to amateurs in Ohio in the USA and Perth, Australia, talking with a mobile station in Scotland. How fantastic an achievement is that? Amateur radio adapting, as many industries have had to do, to the impact of the internet. The future of amateur radio? If

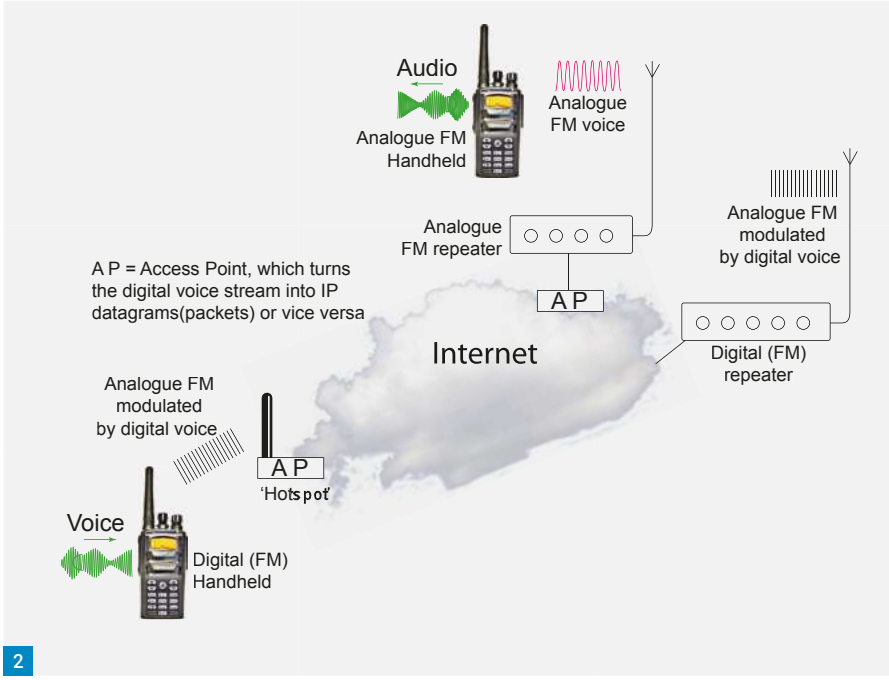
Fig. 1: RT3S connected to Zumspot hotspot (access point), and talking on Talk Group HUBnet.
Fig. 2: How it all looks from the technical side.

various industries have been changed utterly by the internet, then why should it not be the case that amateur radio will also be changed. But changed, as in other areas of life, into a world of new possibilities. For if we can technically solve the question of how to get an analogue repeater to generate VoIP data traffic, and send it around the world, then surely there might be other gateways too? And here I make a prediction – if we amateur radio operators, with our technical knowledge and achievements in radio communications, also embrace the opportunities of IP datagrams and the internet world, then who knows where it will lead us. And maybe the computer and internet savvy young people out there might be persuaded that there is some merit in taking the exam, getting a licence, and joining us in the quest for new insights into the world of radio communications.

Let'sTalkTechnology

OK, so much for the philosophical discussion – now let's talk technology. First point, it doesn't really matter which version of digital radio you acquire, because there are gateways, and other workarounds, which can convert from one digital mode to the other. With just a brief look around the web pages, I discovered that DMR handhelds were surprisingly cheap (at least compared with other options, such as Fusion or D-STAR). I think you will also find that the choice tends to be influenced by what your radio friends are doing. In my case, I bought an RT3S, direct from Retivis, but there are other sources around, some of them may even be cheaper.

Now comes the fun bit. This radio was designed for the commercial market and not for amateur radio use. So, a bit of work, not much, is needed to get it going. Again, your friend – the one who told you to buy it! – is probably your first call. It was mine! Now **Nigel G4RWI** is an award-winning wizard of the technology world, so after a half-hour or so of coaching over the phone, the radio came to life. Technically, the RT3S, in common with all other digital radios, needs what is called a codeplug. This is basically a list of settings, much like (but rather more than – I'll come to this later) a list of repeaters with their transmit and receive frequencies and tone settings on a V/UHF handheld. The RT3S is both an analogue and a digital handset, so the settings for some of analogue repeaters went into Channel B on it, with the digital settings on Channel A.



First up was a check call on the local repeater – no problem, good audio report. Then a quick digital call to The Wizard using the RT3S – again, no problem, and a good audio report. You need to understand that the digital world is not quite like an analogue repeater. Recall, that this is VoIP. The handset basically takes your spoken sentences, turns this into a digital data stream, and then transmits this to an access point using an FM radio signal. The access point, sometimes also called a gateway, can be a repeater local to you, or it can be what is called a hotspot – basically an internet-connected computer configured to send this data stream to the internet. The Raspberry Pi is popular for this, but any computer, running the right software, will do. The photo, **Fig. 1**, shows my RT3S connected to a hotspot.

The digital radio world is also organised differently from, say, a local V/UHF repeater. It's organised in what are called Talk Groups (TGs). These are basically just collections of access points grouped into a single label. Of course, these access points also have a geographic location – which may not be just local. In fact, many TGs have regional, national or even global reach, because the access points, including the analogue repeaters that are configured as access points, are connected to the internet. When you transmit to a TG, your call is transmitted by all the access points in that TG, wherever these are in the world. As an example, take TG23526. This is a group of access points, mostly in the UK, but with a few overseas (there is a lot more detail here, but I'll save it for a future piece). So, TG 23526 is a set of internet access points, some analogue, some digital. The result is that if I connect my DMR handheld to TG 23526, I can join the conversation there. I can make the connection in several ways – one is to use a V/UHF handheld via an analogue repeater that is also set up to connect to the internet. Or I could use a digital handheld to connect directly to an access point, which is internet-connected. Note that in all cases, the initial connection is over an FM radio channel. There are other ways to do this, of which more later. And you can do this from anywhere in the world. For example, US and Australian amateurs can connect to TG 23526 just as easily as UK amateurs. Finally, as I mentioned earlier, some of the gateways are also capable of mapping between the various flavours of digital radio.

I have created the figure, **Fig. 2**, to summarise the whole system, from a high-level perspective. This clearly shows how analogue and digital technologies are merged together to create fantastic new opportunities for radio amateurs. Perhaps now you understand how I heard US and Australian stations on my RT3S handheld. And why the guy in the care home can now play radio with the world's smallest radio station. I will follow this up with a piece about setting up a digital radio. At least, I have notes about what I did and will share them with you. Meantime, I want to figure out how to mount the RT3S safely in the car. For, of course, one of the joys is that this a mobile/portable handset. Time to have fun!

A Transatlantic Radio Centenary

100 years ago amateur radio signals first spanned the Atlantic Ocean.

Dr Bruce Taylor HB9ANY
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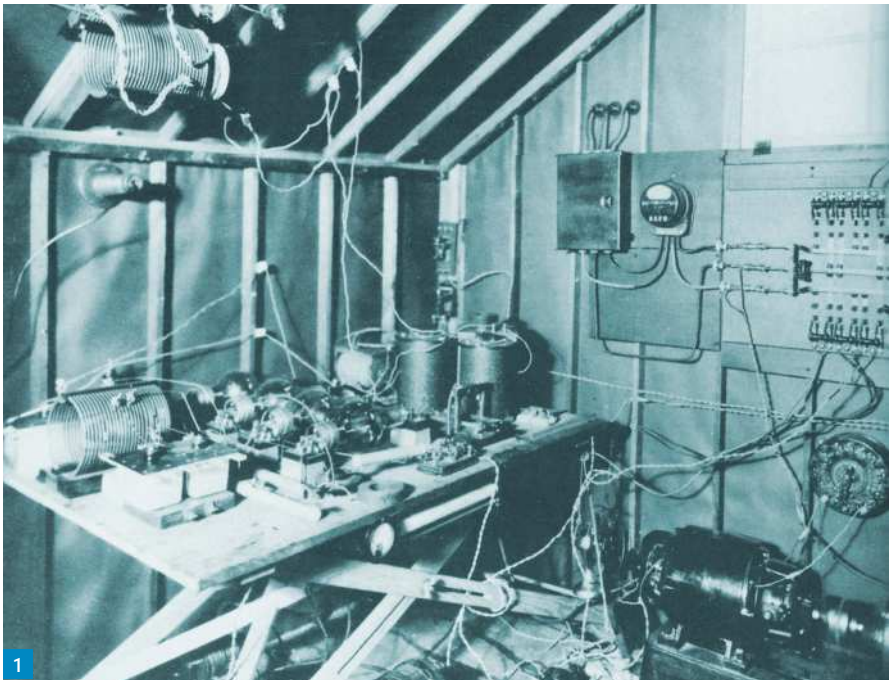
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When Cunard's express ocean liner, the luxurious *RMS Aquitania*, docked in Southampton on 22 November 1921, one of the 3000 passengers who disembarked carried somewhat unusual luggage. 32-year-old radio amateur **Paul Godley**, whose home callsign was **2ZE**, had sailed from New York on 15 November with a very strange mission, for which he brought a shortwave Paragon regenerative receiver, a tuner, a 9-valve superhet and a separate 100kHz beat frequency oscillator. His aim was to see whether signals from the most powerful amateur radio stations in the US could be received in Britain.

The First Tests

This was not the first time that amateurs had attempted to bridge the Atlantic. Following a proposal in September 1920 by **Milton Sleeper**, the radio editor of *Everyday Engineering*, the ARRL had organised a series of tests during which 25 of the best-equipped American stations transmitted their callsigns and secret verification codewords according to a prearranged schedule, while over 250 British amateurs competed for prizes to receive them. The tests were made on a wavelength of around 200 metres (1.5MHz) to which radio amateurs had been banished since these short wavelengths were considered useless for commercial purposes by the telecommunications authorities. Since amateurs had found that propagation is best during long winter nights, the tests were scheduled on 2, 4 and 6 February 1921 during the early hours of the morning in Britain, when most of the Atlantic path is in darkness. This phenomenon was fully understood only in 1924, after **Edward Appleton** discovered that the attenuating D layer of the ionosphere almost disappears after sunset, so that shortwave signals can be reflected back to earth at great distance by the higher F layer.

In the UK, the tests were organised and actively promoted by **Philip Coursey 2JK**, an experienced engineer employed by the Dubilier Condenser Co who had been an assistant to **Ambrose Fleming** (of diode valve detector fame) and later became Honorary Secretary of the RSGB in 1924. Receivers of this period had limited selectivity, and Coursey appealed to all British amateurs to observe radio silence while the US stations were transmitting.

Unfortunately, these first tests were a complete failure. None of the UK stations received the codewords that would prove unequivocally that signals from a US station had been heard. Since shortwave conditions are so variable, it had been a mistake to limit the tests to three short sessions. And at the time, little was understood about high frequency radio wave propagation and it wasn't realised that communication could be much easier on an even shorter wavelength. Although no-one qualified for the reception prizes, a 3-valve Burnham audio amplifier was awarded to a Bristol amateur for his home-built receiver, a fine 7-valve design, including a separate heterodyne oscillator.

On both sides of the Atlantic there was much enthusiasm for a longer series of tests and these were scheduled for the period 8 to 17 December 1921. This time the duration of each test was extended to six hours, from 2300 to 0500 UTC, with a free-for-all followed by a longer session reserved for twenty CW and seven spark stations that were allocated individual schedules. These US stations were selected because their signals had been received at a range of over 1000 miles in a qualifying test that attracted 78 entrants. For this second test series more than 12 British companies offered awards, including three cash prizes from the Marconi Scientific Instrument Co and a Sullivan laboratory wavemeter worth £35 (over £1500 in today's money).

A DXpedition to Britain

After the first transatlantic tests, it was understandable that **Kenneth Warner**, the Editor of *QST*, would attribute the failure to the 'decidedly inferior' receivers of British amateurs as well as their lack of experience. (Four days after the start of WW1 the UK Postmaster General had ordered that all experimental wireless apparatus be dismantled and antennas removed. British amateur radio transmitting licences weren't reintroduced until six years later, and then operation was restricted to two hours per day with a maximum output power of 10W).

Photo 1: On December 12 (UTC) 1921 the 4-valve 1kW MO-PA transmitter of 1BCG was used to send the first complete message ever transmitted across the Atlantic Ocean by shortwave radio.
Photo 2: Because of his expertise in shortwave reception, Paul Godley 2ZE was chosen by the ARRL for the DXpedition to Britain.
Photo 3: Reginald Fessenden's station at Machrihanish received the first transatlantic AM phone signals but the 450ft hollow steel mast collapsed in a gale.
Photo 4: Ardrossan was more accessible than Machrihanish because it had a direct rail link to Glasgow.


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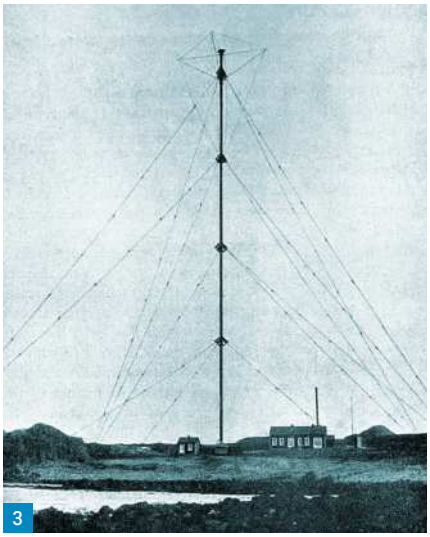
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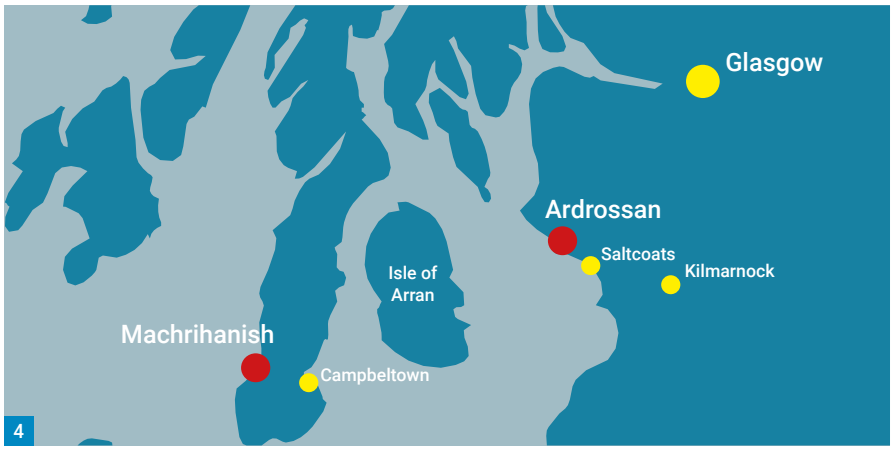

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However, there were other factors. As the UK is a small maritime nation, no populous mainland location was far from powerful shore stations actively communicating with ships, often using spark transmitters that created a high level of interference. Harmonics from high power longer-wavelength commercial stations in Europe, such as those at Bordeaux, Nantes and Hanover, were also troublesome in the south of England. In spite of this, in *QST* for May 1921 Warner wrote *"if a good US amateur with … an Armstrong Super could be sent to England, reception of US amateurs would straightway become commonplace"*.

As a result, the ARRL Board of Directors decided at its first National Convention in Chicago to send a US amateur to Britain to participate in the tests. They chose Paul Godley as he was a recognised wireless expert who had developed the Paragon line of receivers for Adams-Morgan, with whom he had a one-third partnership. These receivers were among the first that used self-resonant anode and grid variometers to successfully implement regeneration in shortwave sets.

Godley's interest in radio had been aroused in 1908 when the first commercial wireless station was constructed in Chicago. He studied at the University of Illinois and in 1913 worked in the Amazon, installing a radio system for the Brazilian Government. On his return, he was amazed to learn that these stations had been received consistently in the US. During WW1 he was in charge of receiver design at the Marconi factory in Aldene, New Jersey, which was taken over by the US Government and did secret military work on static elimination after the US entered the war in April 1917.

Quite by chance, Godley encountered another noteworthy radio amateur during his passage on the *Aquitania*, for **Harold Beverage 2BML**, RCA's transoceanic communications receiver designer, was also a passenger. Beverage suggested that, because of its directional characteristics, the long wire 'wave antenna' that he had just patented would be more effective than the short vertical that Godley had planned to use.

London

Godley received a VIP welcome when he arrived in Britain. The local Marconi Co superintendent at Southampton helped him import his radio gear and he was given a lavish reception In London, where a dinner was held in his honour. He attended a lecture by Ambrose Fleming at the Royal Society of Arts and was introduced to the chief of the GPO Wireless Section, whom he lobbied for greater freedom for British amateurs. He also met **Guglielmo Marconi** and other radio pioneers such as **Henry Jackson**, **Campbell Swinton** and **Frank Hope-Jones**.

Frank Phillips, who had designed the Burndept III Ultra receiver that was among the prizes, invited Godley to stay at his Wembley Park home and it was there that he first sampled reception conditions in the London area. Five nights of fruitless listening until 4.30am convinced Godley that the situation was hopeless. As well as spark splatter from Poldhu transmissions on 2600 metres, he found the shortwave band crowded with harmonics from powerful single-valve and Poulsen Arc transmitters and the atmospheric noise level (QRN) was something he had never experienced in winter in the US. Godley realised that he had to move to a more remote part of Britain, further from major population centres and the sources of interference in the south of England and continental Europe. As Plan B, he had already decided that the ideal location would be on the west coast of Scotland, where he could erect a large antenna with a clear path in the direction of North America.

There was a precedent. In January 1906 a commercial station for transatlantic radiotelegraphy operating on 80kHz had been built by the Canadian-born radio pioneer **Reginald Fessenden** at Uisaed Point, near Machrihanish on the Kintyre peninsula**.** Fessenden had invented the heterodyne method in 1902 and later held the callsigns 1XS and VP9F. But in spite of the ideal location and high power used, communication on this long wavelength with its sister station at Brant Rock in Massachusetts wasn't reliable and couldn't

be maintained during daylight hours or the summer months. Although the station was short-lived, it is credited with having received the first transatlantic AM phone signals during exceptional conditions in November of that year, one month before the 450ft mast collapsed during a storm because of defective joints in the guy cables.

Ardrossan

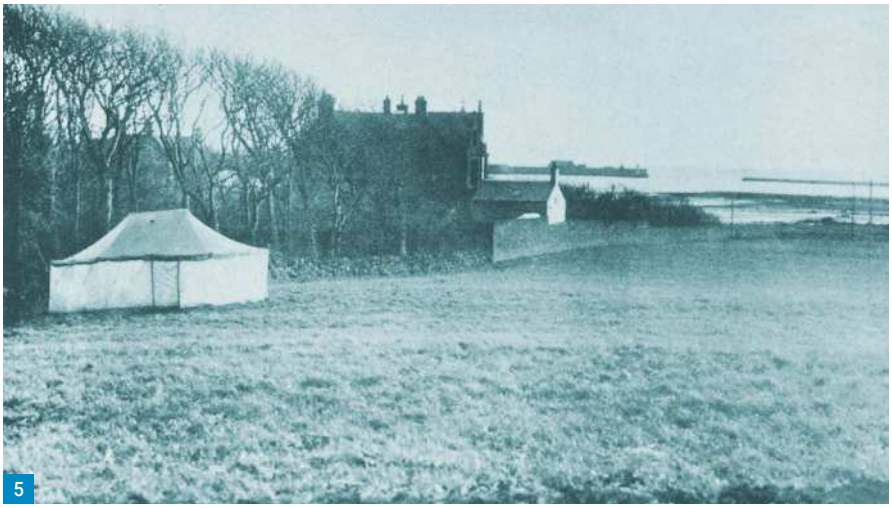
After obtaining a new one-month operating permit from the GPO, Godley arrived in Glasgow on 3 December in dismal winter weather. He was met by two representatives of the Marconi International Marine Communications Co (MIMC Co), who helped him get a tent, antenna poles, GPO insulators, wire, accumulators and other essential accessories, such as a lantern and oil heating stove. From there, Machrihanish could only be reached by steamer to Campbeltown or by a long circuitous road journey via Inveraray and Lochgilphead. So, Godley elected to set up his station about 60km further east, near the small North Ayrshire coastal town of Ardrossan, which had a good rail link to Glasgow and a clear outlook to the west over the Firth of Clyde.

Since Ardrossan's beaches were submerged at high tide they couldn't be used for the station, but with the help of the local town clerk and police sergeant he found a suitable field adjacent to a large property called the Linn, later for many years the home of a renowned Scotch whisky blender. The landowner, **Hugh Hunter**, became enthusiastic about the project, readily gave permission, and provided welcome assistance, since the field was covered with slimy seaweed used as fertiliser and access by horse-drawn supply cart was difficult.

Godley was joined by **D E Pearson**, the MIMC Co District Inspector, and in spite of the muddy conditions, strong winds, drenching rain and freezing temperatures, local labourers were able to install a 1300ft Beverage antenna on a row of 12ft wooden poles aligned on a heading of about 280°. On a second attempt they managed to get the tent erected and all the equipment was installed just a few hours before the first transmissions were due. Pearson assisted Godley throughout the whole period of the tests and confirmed his reception logs.

Results

Godley's superhet consisted of a regenerative RF amplifier and local oscillator, followed by five RC-coupled amplifier stages with input and output circuits tuned to the IF of 100kHz. For CW reception, a harmonic signal from a separate beat frequency oscillator was loosely coupled to the detector feeding the final audio output amplifier. All the equipment was powered by batteries and there were individual filament rheostats for all ten valves.



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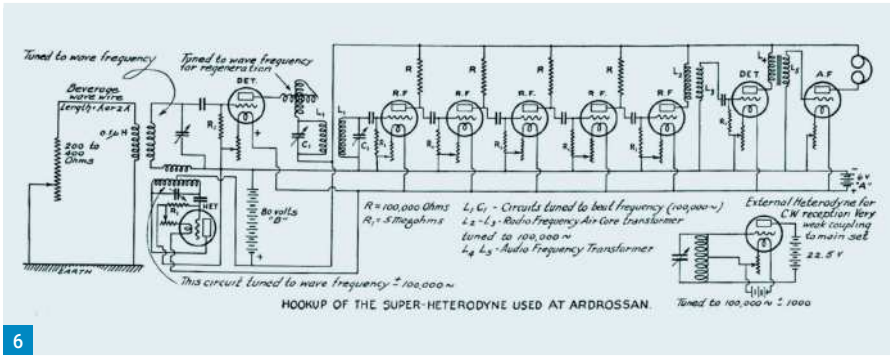

HOOKUP OF THE SUPER-HETERODYNE USED AT ARDROSSAN.

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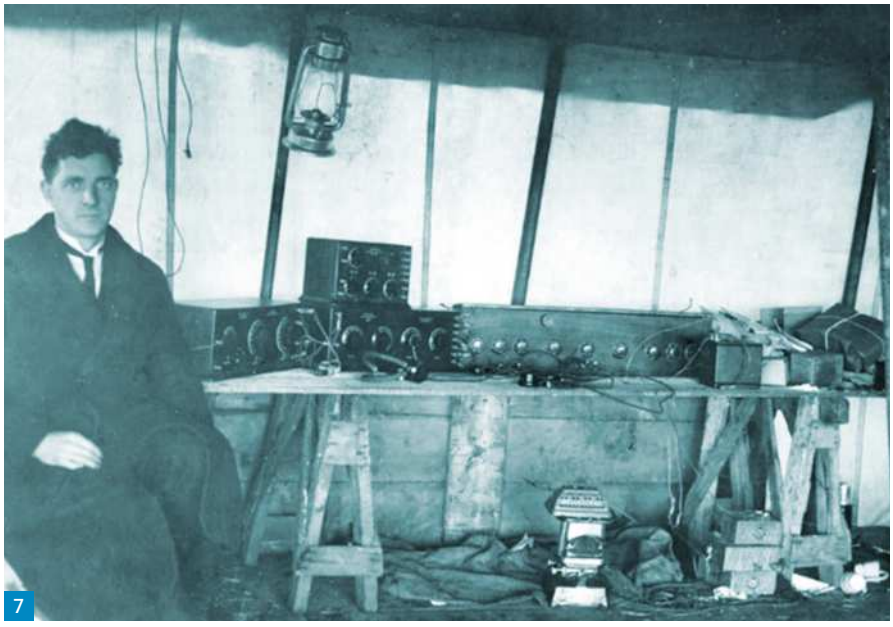
At Ardrossan, he was relieved to find that harmonics were much less troublesome than in London, although QRN levels were still high and there was strong interference from Clifden in Ireland and a high-speed GPO transmitter in the north of Scotland. From 1.30am on 8 December Godley and Pearson started hearing what were probably US stations and in spite of severe QSB they finally identified spark station 1AAW on 270 metres, although the operator sent no verification code for he turned out to be a pirate! History had been made on the very first night of the tests, although it was later discovered that the first positive identification of a legal American station had actually been made by a British amateur, **W R Burne 2KW** of Sale, Cheshire, using a 6-valve homebrew receiver.

Between 8 and 16 December, although exhausted by the atrocious weather conditions, minor illness and sleepless nights, Godley identified a total of 27 US and one Canadian station. Propagation conditions varied greatly, with several strong signals being heard on some nights and none at all on others. At 7am every morning the reception logs were transmitted to the US by Marconi's 14,300 metre (21kHz) 400kW commercial station MMU at Caernarfon, using hand-sent Morse at 12wpm so that amateurs could also copy the signals. Marconi took a personal interest in the tests and provided this service free of charge. As confirmation, the messages were repeated back to MMU by WII in New Brunswick, which allowed the logs to be copied by US amateurs who couldn't receive MMU directly.

Owing to an error in the code used between Godley and Coursey, 1AAW was first reported as 1AAY, sending ARRL officials on a wild goose chase through Connecticut, New Jersey and Massachusetts to locate that station. When the licensee was found by the Chief of Police of Fitchburg it turned out to be a young lad possessing nothing but a small coil and no antenna. After the callsign correction came through, the search moved to Roxbury, but when 1AAW was finally tracked down he declared that he hadn't used a transmitter for the last six months! He and other amateurs in the area confirmed that an unlicensed station had been heard on other occasions usurping his callsign. As the pirate remained undercover, he was never able to claim the honour of being the first US amateur radio station to be heard in Britain.

Photo 5: Godley and Pearson set up their operating tent in a field near the Firth of Clyde.
Photo 6: State of the receiver art in 1921. Godley's superhet had one regenerative RF amplifier, five RC-coupled IF stages and one AF amplifier. The BFO was a separate oscillator loosely coupled to the detector.
Photo 7: In the tent, MIMC Co District Inspector Pearson assisted Godley throughout the tests and confirmed the reception logs.
Photo 8: At 7am every morning Marconi's high-power transmitter near Caernarfon transmitted the reception logs to the US on 14,300 metres.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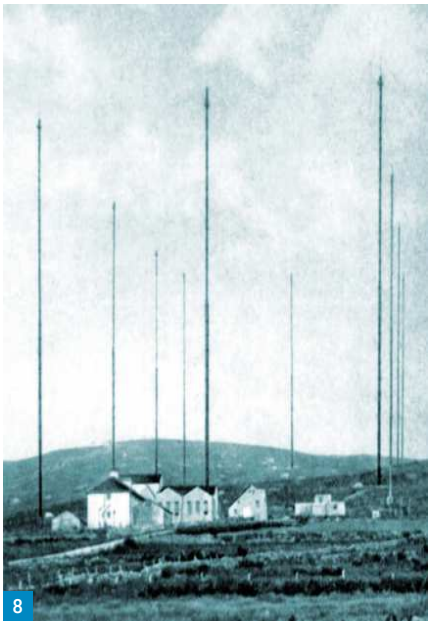
1BCG

Some of the strongest and most consistent signals were received from the station 1BCG of **Minton Cronkhite** at Greenwich, Connecticut, operating on 230-235 metres (around 1.3MHz). This 1kW station had been set up in record time specially for the transatlantic tests by a group of six members of the Radio Club of America (RCA), including **Edwin Armstrong**, considered by many the father of regenerative detection, the superhet receiver and VHF FM. Since the station had been built after he left New York, and the identities of the qualifying stations were kept secret, Godley knew nothing about it.

In addition to high power, 1BCG had a large T-vertical antenna supported by 75ft and 108ft pipe masts, with an elevated counterpoise system of 60ft radials fanning out from the roof of a wooden shack that was located centrally at the base of the feedline. The antenna was found to resonate at 1.56MHz but it had a reasonable resistance of about 16Ω at the operating frequency and the measured antenna power was 560W. The 4-valve transmitter was distinguished by unusually good frequency stability for the period, when the notes of other CW stations were often seriously disturbed by antenna movement in windy conditions. This was achieved by a two-stage Master Oscillator - Power Amplifier (MO-PA) design with a continuously running oscillator. Keying was achieved partly by biasing the PA and partly by an FSK shift of about 30kHz.

The anodes of the three paralleled Radiotron UV-204 output valves were fed at 2.2kV from a 1.5kW DC generator driven by an AC motor, whereas many other stations used less stable batteries or even raw unrectified AC for the HT supply. (This practice led in 1934 to the introduction of the RST signal reporting system with nine levels for Tone!). During the tests, 1BCG was received at good strength by five different British amateurs, while eight amateurs copied ten other US stations.

So consistent were the signals at Ardrossan from 1BCG that Pearson cabled Armstrong to ask him to send real messages instead of just 'TEST'. But the telegrapher used the British abbreviation 'SEND MGES' instead of the American 'SEND MSGS', so the 1BCG operators misunderstood the request and transmitted the letters 'MGES' all night long! However, this was clarified by the next cable and at 0252 UTC on 12 December 1BCG sent a formal 12-word congratulatory message with preamble, text and signatures that is acknowledged to be the first complete message ever transmitted across the Atlantic Ocean by shortwave radio. The message was also copied by several British amateurs, including **Bill Corsham 2UV** of Willesden, London (the inventor of the QSL card), using a simple 3-valve receiver and a 100ft inverted-L antenna.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Beverage Antenna

Because of the interference problem, Godley's decision to use a single-wire unidirectional Beverage antenna gave him a significant advantage over such stations. By struggling back and forth across the seaweed-covered field in the darkness and freezing rain to adjust the terminating resistor at the far end, he optimised the antenna for reception of the 1.3MHz signals from 1BCG. At this frequency his 1300ft wire (much longer than was permitted for British amateurs at the time) had an ideal length of 1.7 wavelengths but a main lobe at an elevation of about 45°. As the bandwidth of a Beverage is quite large, the reception of the other stations on 1.5MHz wasn't severely compromised.

Being close to the ground, the Beverage was relatively easy to erect and the fact that it couldn't be rotated was of little consequence for the transatlantic tests. Most importantly, the antenna had high directivity, greatly reducing the troublesome interference from stations on other headings. While antenna directivity is normally associated with gain, a Beverage actually exhibits significant loss relative to an isotropic antenna. Hence it isn't suitable for transmitting and is only used for receiving on the longer wavelengths at which atmospheric noise overwhelms receiver noise.

Beverage was an enthusiastic amateur (his CW station 2BML was among the US stations copied by Godley) who also had a long and distinguished radio career. He became Chief

Research Engineer of RCA Communications in 1929 and was President of the IRE in 1937. In 1944 he helped set up post D-Day skywave radio links for the Allied forces and later worked on communications for the Polaris submarine fleet. He died in 1993 at the age of 99.

Aftermath

In spite of dismantling his station before the last night of the test, it was too late for Godley to catch the *Aquitania* sailing from Southampton. So, he rebooked his return passage on the *Olympic*, leaving on 21 December, giving him time to return the borrowed equipment to Glasgow and report his adventures to Coursey in London. This was fortunate, because his tent would probably have been blown away on the night of 17 December, when Britain was hit by a cyclone strong enough to cause severe flooding and havoc on land and some loss of life at sea.

Godley was heartily congratulated by the London crowd, but also teased for having endured the bitter Scottish winter weather under canvas, while British amateurs had copied eleven of the US stations in the warmth and comfort of their homes. They had used simpler home-built receivers with as few as three valves and their normal antennas, which were limited by GPO licence conditions to a total of 140ft of single-stranded or 100ft of multi-stranded wire! Perhaps as a result of the transatlantic tests, the Postmaster General relaxed the restriction on the length of receiving antennas from 4 May 1922.

During the 1921 tests, several US stations with less than 50W output had been heard in Britain. So, in December 1922, US amateurs tried listening out for transmissions from European stations and 5WS in Wandsworth in South West London was copied by ten amateurs in the US. Finally, during a fourth series of tests in 1923, **Jack Partridge 2KF** in the London Borough of Merton achieved the first two-way UK-US contact with a long 100 metre QSO with **Ken Warner 1MO** on 8 December. Soon, radio amateurs discovered that long distance contacts, and even daytime DX QSOs, could be made with lower power on even shorter wavelengths.

Paul Godley died on 20 October 1973 at the age of 84. Today, the Ardrossan field in which he set up his pioneering station is built upon. But in December 1989, on the 76th anniversary of the founding of the ARRL, a commemorative plaque was erected by the RSGB on the front wall of Abbotsford Nursing Home, a short distance from the spot where he had received the historic transatlantic amateur radio signals 68 years earlier.

9

Impact

In 1921 the results of the transatlantic tests were widely reported in the media. While they were a major milestone for international amateur radio, they also unexpectedly catalysed important developments in the professional radio world. On 29 December 1921 the Wireless Society of London (forerunner of the RSGB) and 65 affiliated clubs presented a petition to the Postmaster General, calling his attention to the success of the tests as evidence of the importance of encouraging experimentation by radio amateurs and citing the educational and economic value of the hobby. It also mentioned the advantage, in the case of any future war, of the existence of a body of amateurs skilled in wireless; a factor that proved of pivotal importance in 1939.

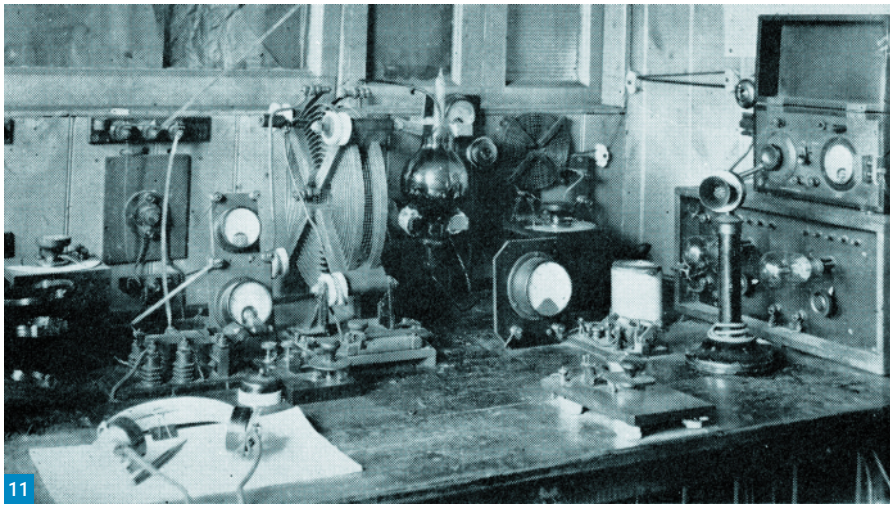
This petition led to the authorisation on 25 January 1922 of regular transmissions by the station 2MT (Two-Emma-Toc) in Writtle, housed in a modest ex-army wooden hut in a field on the outskirts of Chelmsford in Essex. The station was operated under the enthusiastic leadership of the charismatic **Peter Eckersley**, who later became Chief Engineer of the BBC. This was followed by the start of broadcasting by the 100W transmitter 2LO in London on 11 May and, after a power increase to 1.5kW, its inauguration as the first station of the British Broadcasting Co in mid-November. A subsequent £30,000 order for 10,500 radio receivers was won by a tiny firm called Plessey that occupied two rooms in shared premises in Holloway. That started the transformation of the fledgling company into a major enterprise that employed over 10,000 people during WW2 and produced 161,500 pieces of wartime electronic equipment, including the well-known R1155 receiver and T1154 transmitter.


10

As early as 1903, Marconi had visualised an 'Imperial Wireless Chain' of high-power longwave stations that would girdle the world and link Britain to Canada, Egypt, South Africa, India and Australia as well as Singapore and Hong Kong. A first proposal for 18 stations was made to the Colonial Office in March 1910, and a tender to build six stations for £60,000 each was accepted by the Post Office two years later. After the Parker Committee had studied the technical aspects of the project and investigated the unfortunate 'Marconi Scandal' in insider share-trading, a modified contract was ratified by the Government in 1913, only to be cancelled at the outbreak of WW1.

In 1919, having received £590,000 compensation for the cancellation of the pre-war contract, Marconi resuscitated the Imperial Chain project. He submitted a new proposal in 1920, and three years later yet another government committee under newspaper editor **Robert Donald** was duly set up to study it. For some time after the surprising results of the 1921 transatlantic

Photo 9: The QSL card of N1BCG shows the T-vertical antenna of the 1921 station 1BCG. In the inset photo of the memorial dedication in 1950, Godley is on the extreme left and Armstrong is standing next to him.
Photo 10: In 1921 Harold Beverage patented the 'wave antenna' used successfully by Godley at Ardrossan.
Photo 11: Jack Partridge 2KF achieved the first UK-US contact on 8 December 1923.
Photo 12: The transmitter at 1MO used by QST Editor Ken Warner for the first transatlantic US-UK QSO.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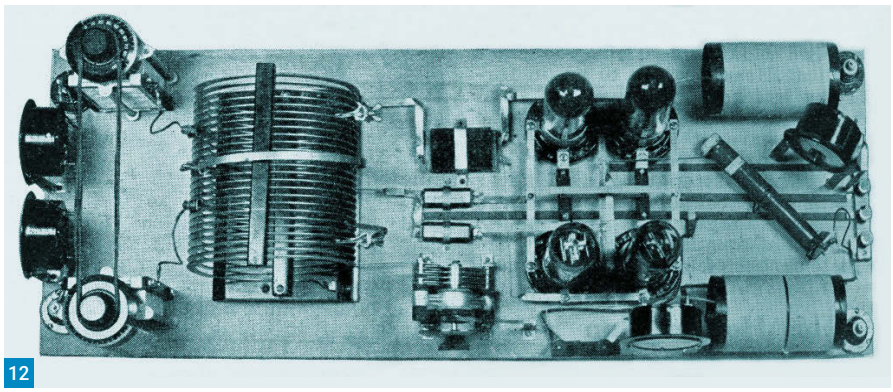
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tests were announced, Marconi continued to declare that the huge high power longwave stations were required because shortwave communication wasn't reliable. But by 1924, having confirmed the amateur results by carrying out his own tests on his yacht *Elettra*, he had been won over. So, he recommended to the Donald committee that the project to build more expensive longwave transmitters should be scrapped, with much lower power shortwave stations being built at a tenth of the cost instead.

This revolutionary change of plan was ratified by Parliament in August of that year, and in October 1926 Marconi inaugurated the first commercial shortwave transatlantic radio link, operating between Britain and Canada on 16.5 metres during the day and 32.2 metres at night. The move to short waves, pioneered by the amateur radio transatlantic tests almost five years earlier, opened the way for professional global radio communications.

Since 1996, the backbone of transoceanic communications has been provided by fibre optic links, but it's interesting to note that shortwave radio is still the fastest way to span the Atlantic. Compared with the fastest fibre link available today (Hibernia Express), radio saves over 20ms on the round trip between London and New York. High performance computers can execute automated electronic arbitrage trades in less than a microsecond. For such applications, in which low latency is more important than wide bandwidth, the higher speed of shortwave radio provides a critical advantage.

Commemoration

The success of the 1921 transatlantic tests was a major achievement for international amateur radio communication and in celebration of the centenary, several events have been organised by groups on both sides of the Atlantic.

From 1 to 26 December 2021 the Prestwick-based *Crocodile Rock Amateur Group* (CRAG) will commemorate the centenary with the special event callsign GB1002ZE. Volunteers are most welcome to operate the station, which will be located at the Heritage Centre in Saltcoats, near Ardrossan. Contact **Bob Alexander GM0DEQ** via email to robert@gm0deq.force9.co.uk

CRAG has arranged with Ofcom that during this period all stations in the UK or Crown Dependencies are authorised to append the suffix **/2ZE** to their normal callsigns.

In the US, the RCA will recreate the historic transmissions from 1BCG with a replica of the 1921 transmitter that has been constructed by the Antique Wireless Association. The transmitter will use the only two working UV-204 valves available, so the power will be limited to 350W. The station will operate on 160m in the early hours of 12 December (UTC) from near the location that was used in 1921. The RCA has also organised a 6-band CW/SSB Transatlantic QSO Party from 1200 UTC on 13 November to 0400 on 14 November 2021. Participants in this contest should call *"CQ TQP"* and exchange signal reports and CQ Zones. The ARRL will issue a Commemorative Transatlantic QSL Card to amateurs working the Hiram Percy Maxim Memorial Station W1AW between 11 December 2021 and 31 December 2022.

The RSGB and the ARRL have organised several joint events. The first of these will be the 2021 ARRL 160m CW Contest, which begins at 2200 UTC on 3 December and ends at 1559 on 5 December. During the contest, the RSGB will be activating the Contest Club historic callsign G6XX with all of its seven prefix variants. The callsign G6XX was held on behalf of the RSGB by Philip Coursey and used from the London premises of the Dubilier Condenser Co during the 4th series of transatlantic tests in 1923/24.

The main event will be the 160m CW Transatlantic Centenary QSO Party, to be held on the anniversary of the tests from 0200 to 0800 UTC on Sunday 12 December. In Scotland, members of the GMDX Group will operate GB2ZE, whereas in the US the ARRL will activate W1AW from Newington, Connecticut. If transatlantic propagation holds up, the stations may continue to operate after 0800. The GMDX Group will award a quaich (a traditional Scottish drinking cup representing friendship) to the first amateurs in North America and the UK to contact both stations, while the RSGB and the ARRL will publish successful QSOs jointly and award commemorative certificates to amateurs that work either station or both.

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

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1

Heathkit - A Short History

Ray Howes G4OWY delves into the history of one of the most iconic manufacturers of amateur radio kits.

Everybody has heard of Heathkit, right? The American company that set the world alight selling electronic kits. If you were into DIY, and soldering irons, this was the place to be. You name it, and Heathkit would probably be advertising it in their extensive catalogue. Including, of course, almost all things amateur radio, basic kits to full-blown HF and VHF transceiver kits. For those that loved to build instead of buy, it was a kit builder's paradise. Fill your boots, switch on the soldering iron and get building.

Yes, it was a wonderful era. I built several Heathkits. And they all worked first time, except one. In my excitement to get it completed, I discovered that I'd put one of the transistors the wrong way around on one of the circuit boards. I'd love to show you my handy work. Unfortunately, I gave it all away to charitable causes - to two or three mates I recall, who were eager to accept my unbridled generosity.

I liked that green colour that the folks at Heathkit habitually used on most of their products too. I know some people hated it, but it was a good marketing device.

But what was important, rather than what colour paint was used, was the enormous impact that Heathkit had on the then entire amateur radio marketplace. It was transformational. Especially from an economic point of view. It gave those with lesser filled wallets the ability to stock their shacks with rigs and accessories that they could only dream about. Provided, that is, they were prepared to build it themselves. Which they did, in their thousands. Products literally flew out the door. Some of their amateur radio products, such as the SB100 ('Sugar Baker') conveniently introduced for Christmas time 1965, for example, were so popular that the company couldn't keep up with demand. The SB101 and the SB102, the most successful (1967/70. All three were Collins KWM2 lookalikes and a lot cheaper!), were destined to be the last vacuum tube rigs produced by Heathkit, when production ceased in 1976. I was once a proud owner of an SB101 and a HW101, both now long gone. Maybe chopped up for spares? Or risen from the ashes?

Hi-Fi too

And Heathkit didn't forget the Hi-Fi aficionados out there either. Nor those who wanted to build test gear, maybe to fault-find their pride and joy kit (their mainstay business in many respects, in the early days). Wattmeters, Line Voltage Monitors, Deviation Meters, PSUs, Impedance Meters, Field Strength Meters, Station Monitor Scopes and so on. As well as Digital Weather Stations, Clocks, and linear amplifiers, one of which was named after a North American Indian tribe, the *Chippewa* (other Heath products featured *Shawnee* and *Pawnee*). Perhaps Yaesu, Icom or Kenwood should name one of their rigs after a North American Indian tribe? How about *Cherokee*? *"The rig this end is a Yaesu Cherokee"*. Sounds much better than *"the rig here is an FTdx101MP"*.

Early Days

The company that would one day become famously known worldwide as Heathkit began way back in the roaring twenties, making aircraft kits. **Edward Bayard Heath**, the founder, and whose surname would inauspiciously become synonymous with all things amateur radio kit-wise, unfortunately lost his life during a test flight in 1931. Four years later, an astute engineer named **Howard Anthony** bought Edward Heath's company at auction. At the close of WWII Howard got a eureka moment that would be the beginnings of a lucrative kit building business. He'd bought a large quantity of war surplus electronic equipment. Exactly how much is still open to question. However, Howard's theory was bang on, that many people even without much technical knowledge could probably put together

Photo 1: An early Heathkit ad. Photo 2: The range is growing. Photo 3: The single band HW-32A. Photo 4: The SB102 transceiver. Photo 5: The HW100. Photo 6: A classic line-up with scope, speaker and power/SWR meter.

a kit of parts and save themselves a pile of cash in the bargain.

Early ads though, listed various components and military receivers and transmitters. Not kits. Just yet. So, with his vast stock of electronic inventory and an eye on the cash register, come 1947 (incidentally, the year of my birth), Howard Anthony advertised his first kit, a five-inch oscilloscope. Price, $39.50. Luckily, he hit the jackpot (Howard had already purchased a huge number of five-inch CRTs). One magazine ad produced thousands of orders! The Heath company was on a roll. Then fate struck a mortal blow. Howard, like Edward Heath was killed in an aircraft crash, in 1954.

Sale to Daystrom

In the interim, Howard's grieving wife had taken over the reins of the company. However, during 1958, she made the decision to sell it to Daystrom, a holding company that owned some other electronics companies. Daystrom, would be bought by Schlumberger (because Heathkit was then, a major buyer of semiconductors from a company called Fairchild, so Schlumberger thought if it acquired Fairchild too, it would control both ends of the supply route. It didn't happen). Subsequently, Heathkit was acquired by Zenith Radio Corporation from Schlumberger during 1979 (primarily, as Zenith had seen the upcoming rise of PCs and viewed Heathkit as a convenient opportunity to exploit Heathkit's expertise - Heath had previously brought out the H89, a part-kit computer that went out the doors as fast as they could manufacture them). The 1970s propelled Heathkit into the world of TVs, computers, audio equipment and Heathkit Educational Systems and expanded their operations into the digital realm.

Back to 1948 and into Amateur Radio

Anyway, not surprisingly, as a result of the explosive popularity of the five-inch oscilloscope, 1948 would see an exponential demand for Heathkit's test equipment. Subsequently, all sorts of test equipment kits were pouring out of the factory gates. And, of course, the main reason why Heath's test gear was so ridiculously popular (particularly Heathkit valve tube volt meters, VTVMs) was the fact that it was cheap compared with factory-built stuff. Many budding radio enthusiasts probably cemented their dreams of one

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day becoming a fully functioning amateur radio operator simply by buying into the Heathkit philosophy of learning by building it yourself. Buying an actual transceiver kit was still a while away though.

Come 1948, the K1 and K2 receiver popped up and a CW 80 metre transmitter. Fast forward to1952, an idea for a novice class amateur licence was being kicked about by the FCC. Howard got wind of it and was convinced that if the idea of a novice licence got off the ground, it could bring forth a future revenue stream. So, the then chief of engineering, **Gene Fiebich**, was told to go find a radio amateur to hire. That amateur would be **Robert Mace**. Later, allegedly poached by **Leo Meyerson W0GFQ**? He of World Radio Laboratories.

Introduced in time for Christmas 1952, Heathkit's first major inroad into amateur radio was the AT1, a six-band CW transmitter. Robert Mace masterminded the introduction of the AT1 - a marketing strategy to beat the competition price-wise. Mace also knew that Heathkit had piles of war surplus stock all ready to go to turn into lots of transmitters and profit. Although not a huge seller, it would set the dye for Heathkit to be the go to company for low-cost amateur radio kits and be the catalyst that would propel Heathkit into a remarkable amateur radio folklore. Mace was convinced that he could repeat another coup. Again, the same strategy to undercut the then competition (the Johnson Viking II) appeared in the guise of the DX-100 AM/CW kit transmitter (the DX-20 replaced the AT-1, then came the HX-11). But unlike the Viking II, the DX-100 sported a funky VFO. However, the gestation of the DX-100 was not an easy one. But this rig was a huge seller. Then along came a DX-35/DX-40/DX-60 and so on.

Its development coincided with the demise of Howard Anthony during 1954. Heath was sold to Daystrom for around 1.8 million dollars (which they quickly recovered plus some!). Luckily, Daystrom knew a good thing when they saw it, so they pumped a load of cash into R&D and not only that, moved Heathkit to a new bigger factory location during 1956. Business perked up by leaps and bounds.

The Search for a Receiver

Trouble was, Heathkit needed a receiver. Then, amateur band receivers were not cheap! So, Mace, the chief engineer got cracking on design. Enter the RX-1 (1958) Mohawk in what would be the beginning of the Heathkit 'Green Boxes'. The RX-1 front end tuned assembly was farmed out for pre-assembly, primarily to make it viable for kit construction. Besides, Heathkit's marketing mantra was that anyone could put together their kits without any previous electronic knowhow, including a complicated receiver. Next, the TX-1 Apache (1958) appeared, almost a match to the RX-1. A sideband adapter, SB10 mated up with the TX-1. **Al Robertson** joined the Heath gang during 1957 and was responsible not only for building a similar box to match the RX-1, but also shoe-horning the existing RX-1 VFO linkage mechanism into the TX-1. Knobs had to match!

4

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Not only did the RX-1 and TX-1 meet with rapturous raves from their army of Heathkit devotees, Heath splashed out big money on several pages of *QST* promoting them. These rigs would cement Heathkit's future in the amateur radio world, and would also start an era in which the company would dominate the marketplace with an ever expanding output of innovative amateur radio classics for a couple of decades or more. An ocean of 'green boxes' would make Heathkit an almost unstoppable force.

Meeting Collins Head-On

Come late 1958, Collins Radio announced the 75S-1 receiver. A momentous event. Because it was small in size and didn't weigh a ton! Although it did cost an arm and a leg to buy. This rig pointed to the future and its arrival didn't go unnoticed at Heathkit. Enter **Joe Shafer**, a 26-year-old engineering whizz-kid. Together with Al Robertson, they embarked on a mission to compete with Collins equipment and manufacture a look-alike line that would sell for much less money. It seemed that if the tech gurus at Heathkit could get it right, they'd hit the amateur radio market bullseye. They did. In the meantime, the heavy crew kept coming. The HW-20 2m rig, the 'lunch-box' specials, GC-1 'Mohican' and Heathkit's first SSB rig. And that weird but very profitable HN-31 'Cantenna' thing. Courtesy of whizz-kid Shafer and Al Robertson.

Work had begun on a clandestine project. Again, the VFO (renamed an 'LMO'. Local Master Oscillator) had to be a preassembled sealed unit (the race was on to emulate a Collins PTO and crystal filter). After much blood sweat and tears, and again, a pre-assembled aligned VFO, the 'SB' series was about to hit the headlines. The priority was to make a Collins look-alike but at a third of the price. Come October 1963, the SB-300, looking remarkably like a Collins 75S-1, went gangbusters, everyone wanted one. For the following decade, Heathkit hit pay dirt. The SB-400 transmitter followed along with a linear amplifier and an SB-301/401. Collins had introduced the KWM-2A in 1961. Four years later, the SB-100 five-band transceiver arrived in late 1965. A dead ringer for the ultra-expen-

6

sive Collins rig. It became a huge seller. Next, the SB-101 with a CW filter. During 1968, a 2m rig the HW-17 arrived. Then, an HW-2026/A in 1977. And the HW-202.

Enter the 'Hot Water' 100, March 1968. Probably, the most successful HF rig of all time. And advertised as such. 1970 arrived and brought forth the 2kW SB-220 linear amplifier powered by two Eimac 3-500's. This thing could run all day at full whack. The same year, just in time for Christmas, the HW-101 appeared. Again, it went out the door like gold ingots being sold at copper ingots prices. Apparently, about 3000 units a year for 13 years! However, the Heathkit 'Hot Water' rigs were destined to be the last rigs using valves. Transistors were the 'new valves'. Not only that, Heathkit had to up the stakes and embrace the new way of doing things or be left behind. Plus, the Japanese rig manufacturers were bringing solid-state products to market at far less cost with more bells and whistles. And, they were ready built and ready to go.

So, to Solid-State

Heathkit got busy with solid-state. The SB303 all transistor receiver arrived during 1970. Then, an SB310/SB313 and a SW-717/SW-7800 solid-state receiver. Spinning to 1973 or so, a Lone Ranger type figure appears on the scene courtesy of a nasty debacle at Collins Radio and its subsequent buy-out by Rockwell International. The fallout left many employees disgruntled. One of whom was **Mike Elliot**. Hired immediately by Heathkit, Elliot's engineering prowess would be instrumental in bringing Heathkit's first all solid-state transceiver to market. The SB-104 was released in 1974. An SB-104A was released in 1977. Primarily, to overcome various internal problems that had plagued the SB-104 HF transceiver. It wasn't destined to be a big money-spinner.

1978 (the HW8 came out) ushered in computer technology and Heathkit stepped up to the plate. The H8/H11 'computer' arrived in kit-form. They sold well. However, a replacement for the hobbled SB-104 was in the works. Labelled the SS-8000 and computer controlled. Then along came the SS-9000 in 1982 (it gets rave reviews today, and was once a competitor for the Collins KWM380). And the HW-5400, the last kit build. Both rigs were quickly kicked out of the amateur market - too expensive compared with Icom and Yaesu, etc. The writing was on the wall, and several of Heath's best engineers baled out, not liking the lay-offs and that the management had blown cool on amateur radio - it was QRT time.

QRT Time

It was time to shut up the amateur radio store. Heathkit soldiered on collaborating with Yaesu and Standard putting a Heathkit badge on their amateur radio products. Meanwhile, Zenith Corporation (the parent company) was mired in financial problems, as a result of the intense competition in the personal computer manufacturing business. It sold off Heath to a French data processing company Groupe Bull during 1989. Then it got messy. In 1995, Groupe Bull sold Heathkit to an outfit based in Miami, Florida - H.I.G (a private equity company). In 1998, DESA International bought the Heathkit name. That went bankrupt and H.I.G bought it back in 2002. 2007, Duchossois Group Inc bought Heath/Zenith from H.I.G. That could have changed now? But guess what, Heathkit are still in the business of selling kits. Yippee! Log on to their website: **www.Heathkit.com**

As they point out on their website, news of their demise is greatly exaggerated. And if you require a Heathkit construction manual, this is the place to be.

In passing, I should mention that most Heathkit products went through a 'proof build' stage. Whereupon, several employees would be selected to build the kits to test whether a kit went together without any problems. If so, the kit would go into production and into the Heath catalogue. Ditto, the manuals would undergo a proof build review. Buildability was the essential key to ensure customer success and profitability.

Whether an old style Heathkit company could ever pop up again and thrill us all with a product that has become legendary in amateur radio folklore, selling SB-200s and the like, is probably beyond hope. But don't fret. All is not lost. Okay, it's not Heathkit of yesteryear, but kit building is still alive and well. Some brave people still want to roll up their sleeves, heat up the soldering station and get going stuffing a circuit board with tiny components. It seems then, that the Heathkit 'Green-Machine' philosophy is showing no sign of abating any time soon. Lastly, a few enterprising souls, call them brave or what, are totally disassembling dead or alive Heathkits and putting everything back together again all shiny bright and new. Long may it continue, eh? The end...

(With thanks to **Steve G3ZPS** for the photos, all taken from from his website)

Further Reading

www.g3zps.com/Heathkit.html
https://wa7zze.com

Practical Wireless 2021 Index

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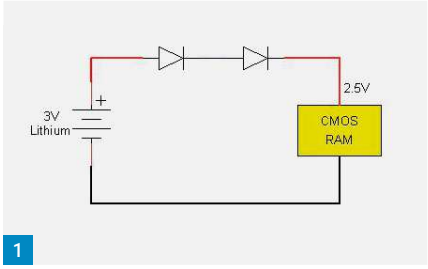

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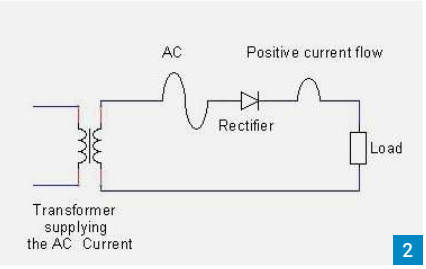

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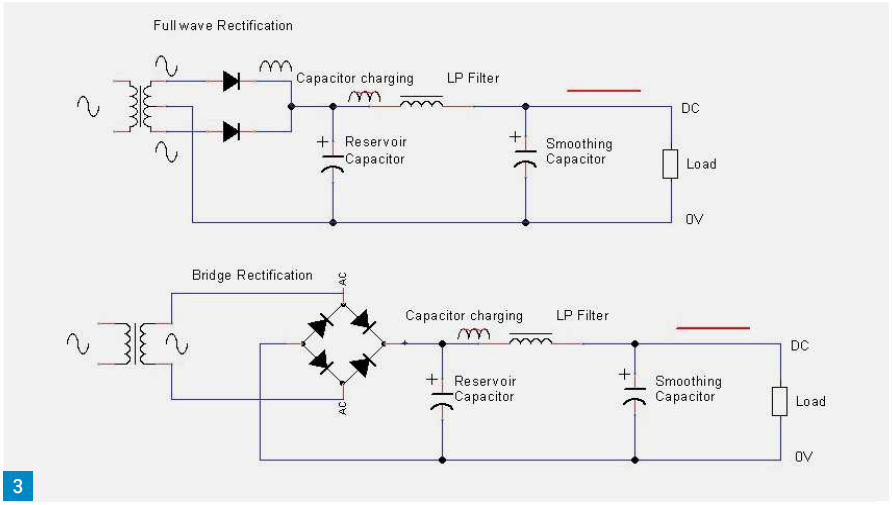

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Semiconductors (Pt II)

Eric Edwards GW8LJJ continues his exploration of diodes, explaining their differences and uses.

In Part 1 (*PW* October 2021) it was shown that it was possible for diodes to conduct without overcoming the barrier voltage (0.2V for Germanium, 0.7V for Silicon). **Fig. 1** shows a typical example when using a backup battery and silicon diodes to supply a standby voltage for a CMOS RAM. Very little current is needed by the device in standby. The circuit has 3V supplied by a lithium battery and taking as an example, if the standby resistance of the CMOS is 1MΩ, and the current drawn is 2.5µA (0.0025mA or 0.0000025A), then the voltage supplying the CMOS will be 2.5V.

This means that there is a total voltage drop (3V-2.5V) of 0.5V, so each of the diodes will have a 0.25V drop, which is well below the barrier voltage for a silicon diode. Replacing the CMOS with a load (resistance) of 100Ω, the current passing through the diodes and the resistor to the negative contact of the battery will be 14mA (0.014A).

The voltages at the diodes will have the barrier voltages (0.7V) and the voltage across the resistor load will be 1.4V (3V-1.4V = 1.5V = 0.75V drop per diode). These are rounded voltage numbers but indicate that when current is increased the barrier voltage comes into force.

Rectifier Diodes

Germanium diodes can be used as rectifiers when 'detecting' or 'demodulating' a radio signal but Silicon types are used when higher power is required such as in mains power supplies. The rectifier passes the current in only one direction so that when AC (varying positive and negative) is presented to the anode of the diode it only allows the positive current to pass, **Fig. 2**. This is commonly known as half-wave rectification as it is only conducting half of the full waveform. **NB**: *I am explaining the current as the conventional flow, which is positive to negative. We have learned now that current is a flow of electrons (negatively charged particles) that are attracted (flow) to the positive particles, which are called protons. Nothing is exact as there are many other factors involved but for these explanations I will use conventional current flow.*

The circuit needs a reservoir capacitor along with a filter (inductor or resistor and a 'smoothing' capacitor) to complete the conversion from AC to DC. To convert all of the AC current to DC, full-wave rectification is used. **Fig. 3** shows two types of full-wave rectification. The top circuit is using a transformer with a centre tap, which is the DC negative of the power supply. This transformer works in the same way as a conventional transformer (no centre tap) but produces two voltages, opposite each other with respect (reference) to the centre tap. When the top end of the secondary is positive the bottom is negative. When the top is positive the top diode conducts and when the bottom is positive the bottom diode conducts. This combines the two voltages at the cathodes of the diodes providing a DC output (pulsed) and then filtered in the usual way with the capacitor and inductor network. Because there are two diodes rectifying both parts of the phase it is called full-wave rectification (positive and negative parts of the waveform), which means the AC content is 100Hz (100 cycles per second). The frequency of the AC component of a half-wave rectified power supply is 50Hz, or 50 times per second. These are referring to UK mains frequencies. For low voltage power supplies the filter inductor is normally replaced with a wirewound (W/W) resistor because the current is greater (amps) than with the higher voltage power supplies where the current is usually in Milliamps (mA). To use an iron core inductor (choke) it would have to be a lot bigger to handle the current so an open-to-air W/W resistor is used.

Bridging it

The bottom diagram in Fig. 3 is using a normal transformer (one secondary winding) and the four diodes create bridge rectification. An explanation of how this works appears in *PW* Feb 2021 (*From the Ground Up, Capacitors and capacitance, Part 2*). The main difference is in the use of the different types of transformers. The one in the top diagram of Fig. 3 uses a transformer with a secondary centre tap so the voltage across the total (end-to-end) secondary winding needs to be twice that of the one in the bridge rectifier circuit to have the same DC voltage output because it is using a centre tap as the 0V DC supply.

Fig. 1: Using silicon diodes to drop the voltage supplying a CMOS RAM.Fig. 2: Diode action, allowing only every other half cycle to pass. Fig. 3: Two types of full-wave rectification. Fig. 4: Creating a split supply. Fig. 5: Voltage doubler using diodes. Fig. 6: Measuring the input and output voltages of the voltage doubler. Fig. 7: A diode-based voltage tripler circuit.

Splitting it

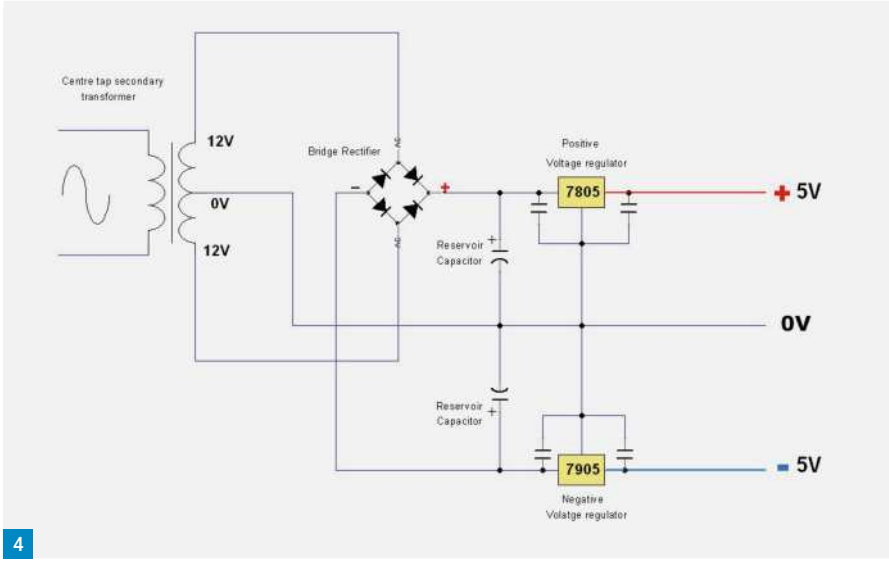
Using a bridge rectifier and a tapped secondary transformer it is easy to make a split supply. This is a power supply that has positive and negative DC outputs that can be used to supply the voltages for OpAmps, as an example. This is more convenient than having two separate power supplies, one for a positive and another for a negative voltage.

It can be seen in **Fig. 4** how this is achieved. The secondary of the mains transformer is connected to a bridge rectifier as in a standard bridge rectifier power supply but the transformer has a centre tap, which is used in a full wave power supply using two diodes. The centre tap is the 0V DC output and the positive voltage regulator provides the required positive DC output while a negative voltage regulator provides the negative DC voltage. The reservoir capacitors are usually very high capacitance values, typically about 1000µF for a low power (1A) supply. The regulators used for plus and minus (positive and negative) 12V power supplies are standard 7812 for the positive and 7912 for the negative voltages.

The current draw should be a maximum of 1A for each voltage when using these, which is more than capable of supplying several OpAmps. The 'smoothing' is provided within the regulators so there is no need for the filter (inductor/capacitor) circuit.

Doubling it

From Wikipedia: *A **voltage doubler** is an electronic circuit which charges capacitors from the input voltage and switches these charges in such a way that, in the ideal case, exactly twice the voltage is produced at the output as at its input. The simplest of these circuits are a form of rectifier which take an AC voltage as input and outputs a doubled DC voltage. The switching elements are simple diodes and they are driven to switch state merely by the alternating voltage of the input. Voltage doublers are a variety of voltage multiplier circuit. Many, but not all, voltage doubler circuits can be viewed as a single stage of a higher order multiplier: cascading identical stages together*



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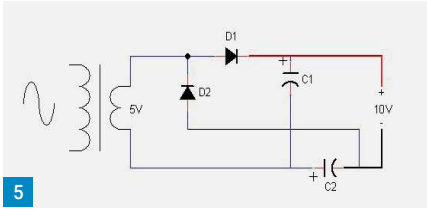

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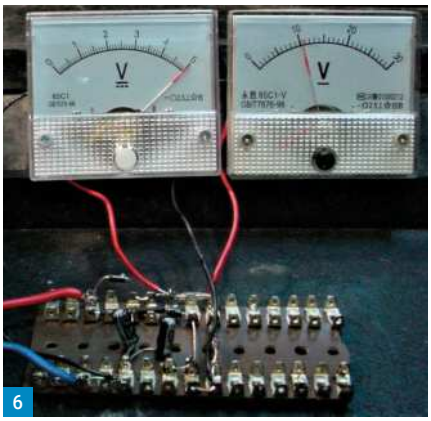
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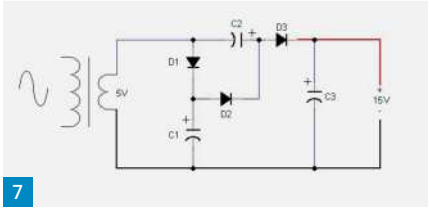

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achieves a greater voltage multiplication.

Shown in **Fig. 5** there is an AC voltage source powering the circuit, which is a voltage consisting of a positive cycle for one half of the AC voltage and a negative cycle at the other half. When the AC is positive on the top of the AC cycle, the current travels through the diode D1 and charges up capacitor C1 and when it is fully charged, C1 equals the same voltage as the input voltage (5V).

When the bottom half of the AC cycle is positive, the current travels through diode D2 and charges up capacitor C2. Once again, capacitor C2 charges up to the same voltage as the input voltage. However, because there is 5V across C1 and now 10V across C2 they both add to provide 10V so the voltage is doubled, or twice the input voltage, as can be seen in **Fig. 6**. When the top half of the input is positive, diode D1 is forward biased, which allows current to flow through it and charge capacitor C1. When the bottom half of the cycle is positive, diode D2 is forward biased and allows current to flow through it and charge capacitor C2.

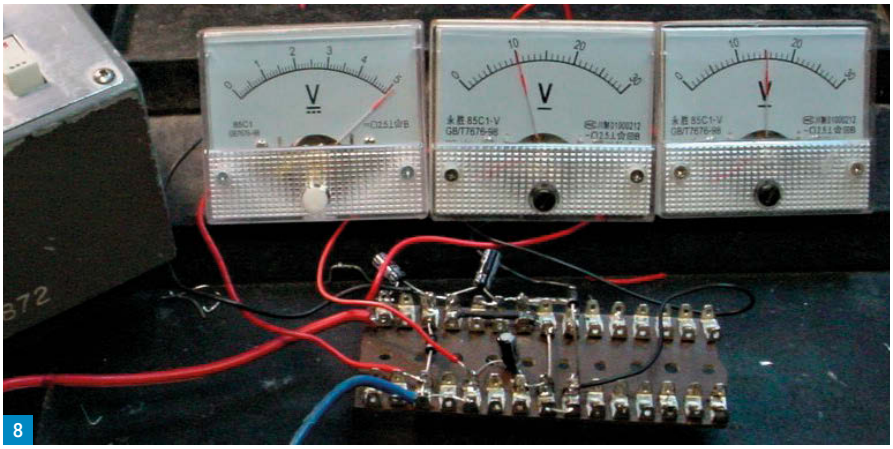
Tripling it

Fig. 7 is a Tripler circuit, which means the DC voltage output is three times the (AC) voltage input. As with the doubler circuit, diodes and electrolytic capacitors are the only components used. Let's take the top as the positive half of the cycle to charge C1 and C3 through the diodes D1, D2 and D3. This will charge the capacitors to the source voltage (5V).

When the phase reverses to place the bottom half at positive, D2 conducts (forward biased) and C2 is charged to twice the source voltage because it is added to the already charged C1. C2 will have 5V on its negative lead plus 5V from C1 positive charge.

No current can pass through D1 as it is reverse biased. Diode D3 is also conducting during this period, placing a charge into C3, and this is added to the other capacitor charged voltages bringing the total charged voltage to three times (tripled), **Fig. 8**. There are other multiples such as four times and more.

Fig. 8: Showing the addition of the voltages in the tripler circuit. Fig. 9: A times ten multiplier! Fig. 10: Showing the ten times output voltage of Fig. 9. Fig. 11: Two types of SCR. Fig. 12: Using an ammeter to monitor current through an SCR. Fig. 13: Increasing the gate voltage leads to current flowing through the SCR. Fig. 14: Using an SCR in a 'crowbar' circuit.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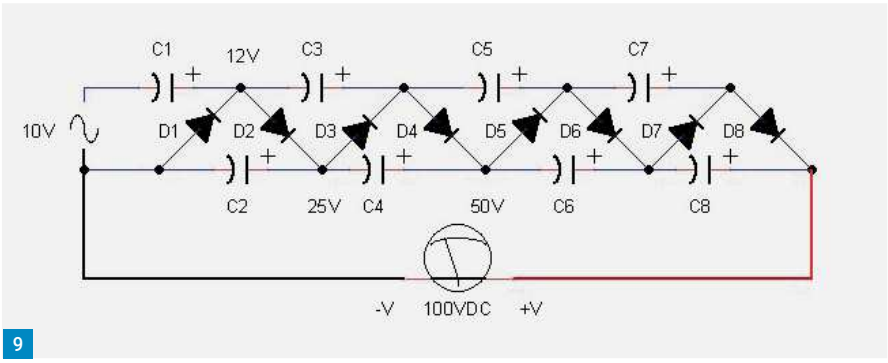

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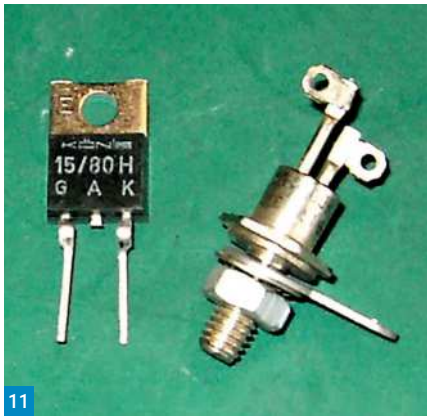


11

Decouple it (ten times)

The diagram in **Fig. 9** shows ten diodes and ten electrolytic capacitors as a times ten voltage multiplier. Let's start with a positive at the bottom of the AC input so that the current signal travels through D1 and charges C1, which places 12V across it because the negative terminal of C1 is connected to the negative (top) of the AC input voltage. When the polarity changes so that the positive is at the top of the input voltage, it places 12V on the negative side of C1 and because there is 12V on the positive side this adds so that there is now 24V from the positive of C1 to the bottom of the AC input voltage signal (anode of D1).

The current now flows through D2 and charges C2 to 24V. The polarity of the supply is reversed so that the bottom is now positive and between the top input and the + of C2 is 32V. It flows through D3 and back to the top charging C3 to 25V. When the top of the AC input is positive, there is 12V at that point plus 12V on C1+ and 25V at C5 and the current flows through D4 and charges C4 to 50V. Reversing polarity places + at bottom such that current passes through D5 and charges. You can see how the voltage is building up during each charging of the capacitors.

At the junction of C1 and C3 there is 12V (derived from the rectified 10V AC) and where C2 and C4 join there is 25V so it has doubled. It has doubled again at the junction of C4 and C5, and at the end of this multiplier there is 100V DC, ten times the input voltage. This is high impedance as little current can be drawn because it is converted to voltage, meaning there is no power gain.

The voltage increases and the current available decreases. This is similar to a transformer where the voltage (or current) at the secondary may be higher but the power dissipation is the same in the primary and secondary.

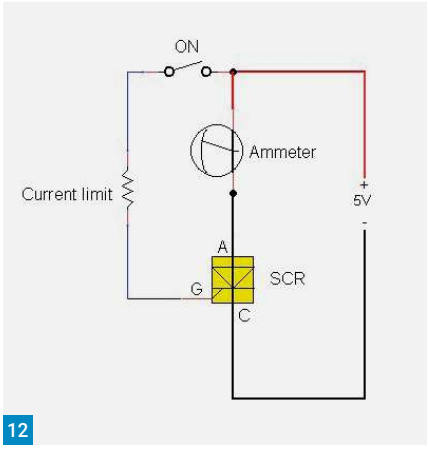
Fig. 10 shows the voltage multiplier with a meter displaying the input AC voltage and another showing the multiplied DC output. A low impedance power supply will have a large electrolytic capacitor connected across the output but if a capacitor or any low impedance load was placed across this multiplier, the voltage would collapse because it is trying to draw current that is not available.

However, it can be used with a light load such as a photomultiplier tube where the anodes require very little current. The EHT (Extra High Voltage) is generated by the voltage multiplier connected to the main anode of the tube and the other 11 accelerator anodes are connected with a series of resistors (resistor chain). Voltage multipliers were commonplace in the CRT (Cathode Ray Tube) type television receivers to provide a high voltage, where 15kV or higher was obtained from a Tripler (or other multiples) connected to a tap on the line output transformer, which the television service engineer of years gone by will recall.

Controlling it

Current through a device can be controlled using a silicon controlled rectifier (SCR), part of the thyristor family. It is a three-terminal device with an anode and cathode, as in a conventional diode, but with a third terminal called a gate. This controls the current through the device and it can be considered a diode with a switch to turn it on (and off). As with diodes, an SCR is a unidirectional device as it can only conduct in one direction.

This is 'triggered' by a small positive current going into the gate to control a much larger current through the device (cathode



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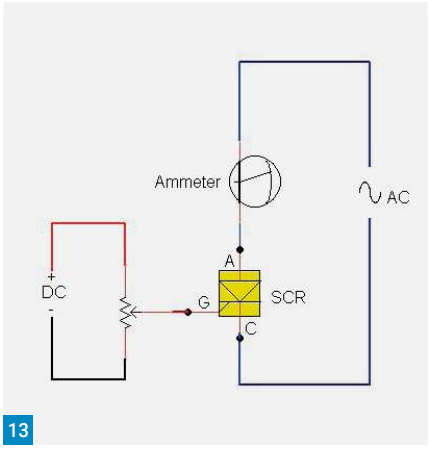

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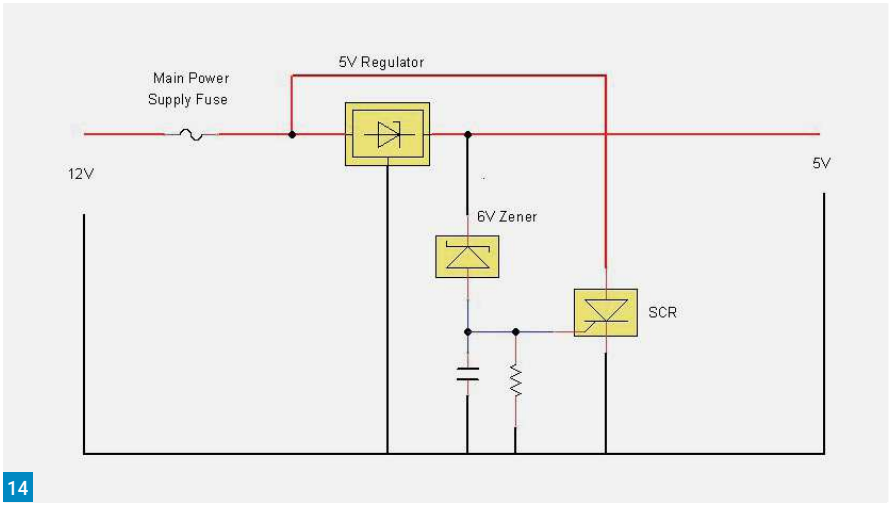

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to anode). This is not to be confused with the amplification of the input current as with a transistor. The gate current is separate from the main current flowing through the device and is a control (signal) current. It is there to gate (turn on) the main current from cathode to anode (in electron terms) or in conventional current terminology, from anode to cathode.

It is annoying (to me) that the direction of current flow was not corrected many years ago. In **Fig. 11** two body types of SCRs are shown with the connections on the TO220 case (part number 15/80H) easily seen. The other all-metal type (2N4170 or BT101 part number) may not have any markings to identify the terminals. It can be taken that the body is the anode, but it will be prudent to check with the manufacturer's datasheet. The larger of the two tags is the cathode and the shorter one is the gate. If an ammeter is connected to the SCR as shown in **Fig. 12** with a 5V DC power supply, no current will flow through the SCR and the ammeter until the switch is closed. When the switch is opened, the ammeter will still be showing current flow until the 5V is removed. Connecting the 5V again, no current will flow until the switch is closed again. The current when the switch is open can be turned off either by removing the 5V or reversing the polarity to the anode.

Dimming it

We saw that when a DC supply is connected to the SCR and an ammeter with the switch closed, current flows and still flows even when the switch is open. The only way to stop the current flowing is to either remove the power supply or reverse it. It not always convenient to reverse the supply but if the DC power were replaced with an AC power supply and the same test carried out, when the switch is closed current flows as in the last test but when the switch is open the current stops flowing. This is because the power supply has been reversed. In fact, it is reversing 50 times per second or at whatever AC frequency is being used.

This is the same as reversing the DC voltage on the last test. The advantage of using an AC power supply as the main source is that it allows the current to be varied and not just switched on and off. This is achieved by varying the DC voltage applied to the gate. Reducing this voltage reduces the main current flow and it can even be turned down very low to stop current flow altogether. But as the gate voltage is increased so is the main current thereby providing a variable current through the SCR, **Fig. 13**.

If the ammeter were replaced by a 'bulb' (incandescent lamp) of suitable voltage, the current could be varied through it, thereby dimming the lamp. Another use is to control the speed of a motor. This dimming or speed control is done at 50Hz (UK mains) because it is turning on at one half of the mains cycle and off at the other half. This may not be a problem although some flicker may be seen with the lamp dimmer.

Another use for an SCR is to protect an overvoltage in a power supply and used in this way it is called a 'Crowbar', **Fig. 14**. In the diagram the input to the 5V regulator is supplied from a 12V power supply via a fuse, which is rated for the circuit current requirements. If the voltage output from the regulator increases to an amount set by the Zener diode circuit, in this case 6V, the SCR will be triggered and a heavy current will flow through it thereby 'blowing' the power supply fuse.

This is a drastic way to protect a power supply, hence the term crowbar. The fault can then be located and repaired and with the fuse replaced the circuit should work again as normal without damage to any circuit components or the SCR and associated components.

Triacs (and Diacs)

A Triac is a three terminal device that can be used as an AC switch. This is similar in characteristics to but differs from the SCR in the sense that it conducts in both directions, so it is bidirectional when it is triggered by a positive or negative signal at the gate. The terminals are labelled MT1 (Main Terminal), MT2 and Gate.

Diac (Diode for Alternating Current)

A Diac is represented as a pair of back-to-back diodes and is similar to a pair of Zener diodes in action as it only conducts when a certain voltage has been exceeded momentarily (called the breakover). It can be turned off by reducing the voltage below its avalanche breakdown. It is also known as a 'transistor without a base'. It is bidirectional, so it can be turned on or off with either positive or negative polarities.

Continued on page 66

Experiments on 6cm

Bernard Nock G4BXD takes his first tentative steps onto the 6cm band.

Bernard Nock G4BXD
military1944@aol.com

Having sorted out my receiving and transmitting operations on the 23, 13, 9 and 3cm bands my attention was directed at the 6cm amateur allocation, basically 5.7GHz. There are three allocations in the 6cm band but the main narrowband activity is at 5760MHz. While there is a lot of equipment available for both the 23cm (1296MHz) and the 13cm (2.3GHz) bands there seems slightly less for the 9cm (3.4GHz) and 3cm (10GHz) sections.

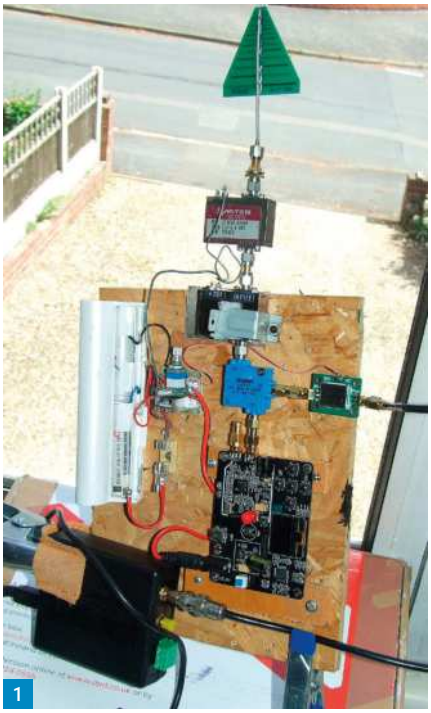
There seem to be even fewer commercial amateur units for the 6cm band although it is very popular with many entrants during the RSGB UKAC contests and the UK Microwave Groups events. The usual supplier in Germany, Kuhne Electronics, does make a suitable transverter although it is quite costly, I feel. Certainly too costly for the amount of use I thought I would be getting out of the band but probably ideal for those interested in EME (earth-moon-earth or moonbounce) communications. While I am a great fan of 'plug and play' I felt I was getting a bit more adventurous regarding building stuff from scratch or at least smaller units.

What is Available?

This led me to consider just what I either already had in my component boxes, or was available from China via eBay or other suppliers. The amateur section is close to the 5.8GHz Wi-Fi bands so some of that equipment can be repurposed. There are many little amplifiers, oscillators and the like coming out of China but unfortunately the quality or indeed specifications leave a lot to be desired.

I recently bought some quoted 1W amplifiers, rated to 2.4GHz, from a Chinese eBay seller only to find I get about 200mW out of them at 2.3GHz. Many others have found similar results, Chinese Watts being a different standard to Western Watts apparently. It seems the Chinese are not averse to simply copying the silicon chips, printing them with the names of reliable manufactures and passing them off as genuine.

So, just what would I need to make a 5.7GHz receiver to start with? I found I had a



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rather nice double-balanced mixer marked up at 2.5 to 10GHz and, being US made, was probably reliable. This would need a local oscillator (LO) and some RF amplification to produce an output at the IF frequency chosen.

I have several of the very useful ADF4351 PLL oscillator boards, Chinese of course, to which I have added extra decoupling on the various voltage regulators to reduce the phase noise generated. The common ADF4351 unit only goes up to about 4400MHz and if I were choosing a 70cm (432MHz) IF, say, I would need a 5328MHz local oscillator. The ADF5355 chip does go up to 6GHz but those boards, even from China, are quite costly.

I decided to test the theory using the local oscillator set to 4000MHz, which would give me an IF of 1760MHz, meaning I could use my RSP2 software defined radio to act as the IF receiver. I now needed some RF amplification at 5.7GHz to feed into the mixer. I have to admit I am attempting this basically at random. I am not taking into account LO levels, how many dBm the mixer needs, how much RF gain I need or such. It really is plug and play.

Again, there are various little amplifier boards offered on eBay coming out of China. I have bought several over the past few months but none were suitable at 6GHz. If you enter Microwave Amplifier into the eBay search line, you'll see many proper, professional type amplifiers, usually of limited bandwidth and upper limits. I managed by luck to drop on a UK seller offering a 6GHz unit, which I bought, and he offered me a second one, which was very handy.

These little units had about 13dB gain and were designed for the 6GHz band so were ideal as the front-end of the receiver lash-up. I arranged the two amplifiers connected with barrel connectors and then to the RF input of the double-balanced mixer. The ADF board was connected to the LO input at the same time.

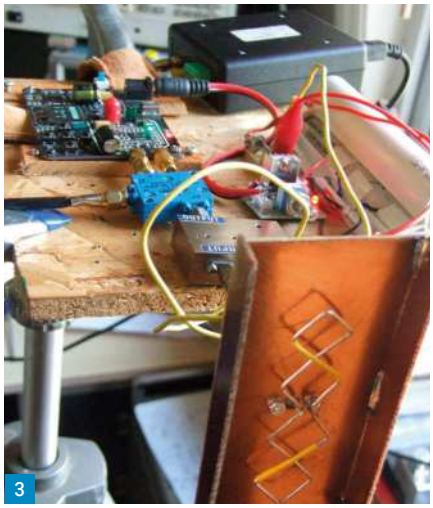
I used one of the little Chinese made amplifier boards on the output of the mixer unit, quoted as 50 to 4000MHz and using an SPF5189 chip, the spec sheet of which says it has 18.7dB at 900MHz. I was only using the device at 1760MHz so it should work fine.

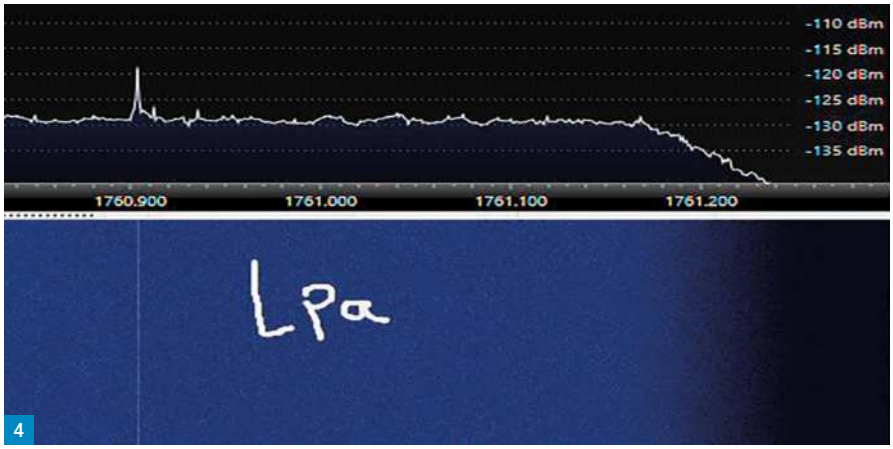
In Practice

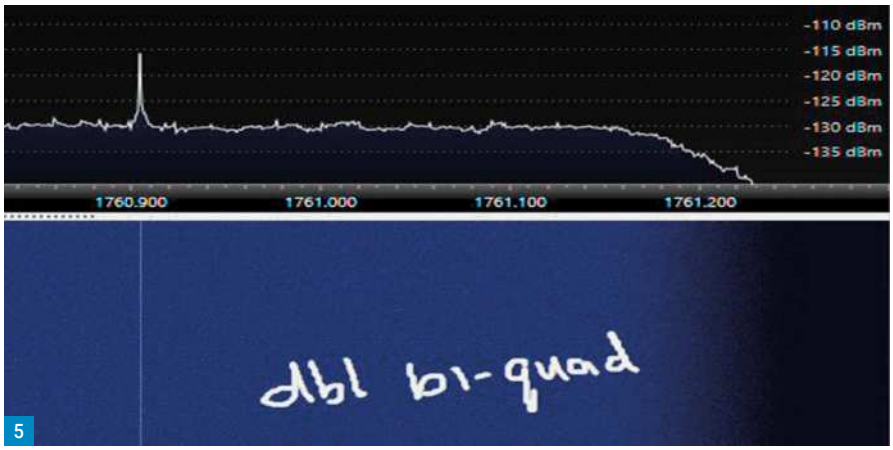
So, **Fig. 1**, I had some RF amplification at 5.760GHz, a mixer, a local oscillator on 4GHz and some IF amplification at 1760MHz. I now needed an antenna of some sort. Obviously in a finished state the goal would be to use a parabolic dish with some sort of feed, either a horn or dipole type. I remembered I had a PCB-mounted log periodic antenna (LPA) that covered 2 to 11GHz. Basically, it acts as a two-element beam at this frequency range, low gain but worth a try I thought.

Luckily, I have my office workroom window facing east, directly towards the South Birmingham microwave beacons, 21km away, on 6 and 9cm. I get the 9cm beacon 5 and 7 with an indoor antenna. I balanced the breadboarded setup on some books in the window with the LPA pointing in the right direction, set the RSP2 to 1760.900MHz and switched on my project. Imagine my surprise when up popped the 6cm beacon keying away, **Fig. 4**, only slightly off where it was expected.

I could swing the board with LPA attached left and right and could peak the signal from the beacon. It was weak but fully readable. Interestingly, during my 9cm







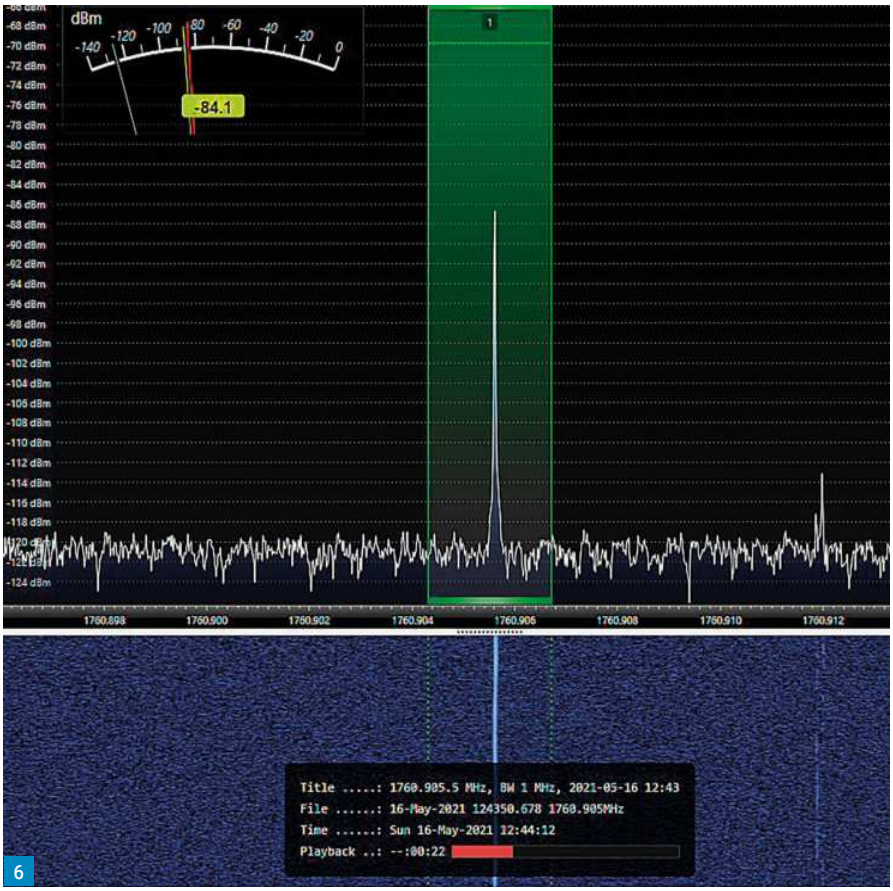


Fig. 1: The breadboarded 6cm receiver.
Fig. 2: The Double Bi-Quad antenna.
Fig. 3: Bi-Quad fitted to receiver.
Fig. 4: The first beacon reception.
Fig. 5: The increased beacon signal.
Fig. 6: The received signal with dish reflector.

experimentation I could receive the South Birmingham 9cm beacon on the same heading and see the Telford 9cm beacon, 10kHz higher or so, obviously by reflection as its direct path is through the house and behind me.

I couldn't see any sign of the Telford 6cm signal during the first tests. Later in the day though I did see the Telford signal, receiving it via rain scatter of storm clouds southeast of my location. Receiving the weak signal led me to think about what I could do to improve the antenna – the RF amplifiers can only amplify what you feed into them.

Remembering how simple it was and how well it worked, I decided to build a double bi-quad antenna, **Fig. 2**, using PCB and 1mm wire. The antenna is easy. The back plate is 11 x 5.6cm with a 1.3cm skirt each side. The element, 1mm wire, is 1.3cm on each side mounted 0.5cm off the reflector. I used an SMA connector with the element soldered directly to it.

A short time later a very nice little antenna had been constructed and was connected to the front of the setup, **Fig. 3**, pointed at

the beacon. On switch-on there was indeed a good amount of extra gain, **Fig. 5**, off the bi-quad proving it was a little better than the wideband LPA used before.

The truth is though the real game changer would be a dish antenna and luckily I had a small ex-satellite TV dish, which was light and small enough to be tested in the confines of the office workroom. With the breadboard clamped to a tripod and with the bi-quad facing away from the beacon, I attempted to place the dish in the right place, distance and angle-wise to reflect the beacon signals into the bi-quad.

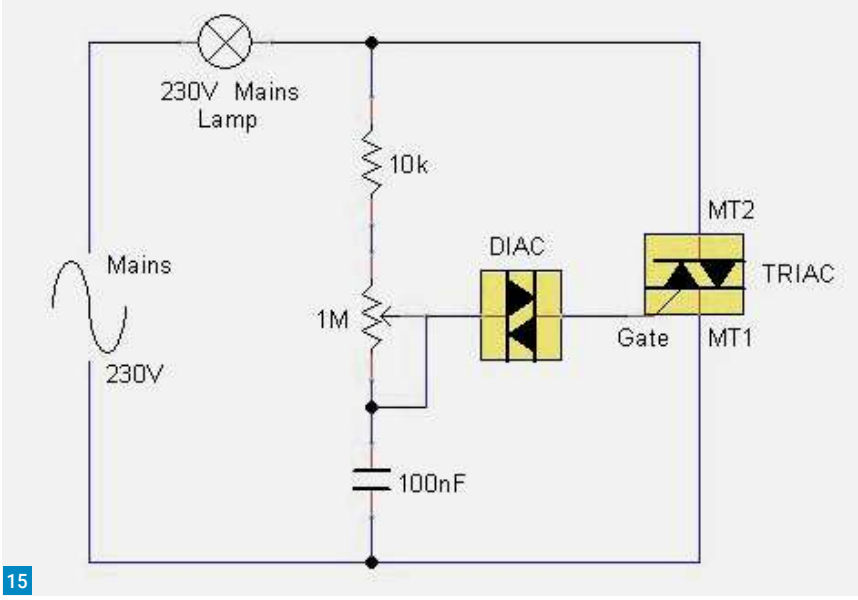
The results were very encouraging, **Fig. 6**, with a large increase in the signal received, both the Birmingham and Telford beacons coming in loud and clear. In fact, while experimenting I was discussing the results online and a fellow, more experienced microwaver, **Graham G3VKV**, invited me to listen for his signals, some 57km away to the south of me.

With Graham transmitting dots from his station I was just about able to see the dots on the SDR waterfall though of course very weakly. This is very encouraging and rather pleasing to think how easy it was to assemble these units into a near working receiver. Of course, carrying a breadboard around clamped to a tripod is hardly convenient but it has shown me that I am on the right track.

With this in mind I have ordered a purpose-built local oscillator from a German supplier, **Dieter DF9NP**, which will give me a stable 5328MHz signal with enough power to split to supply the receiver and transmitter mixers. A flat panel 5.8GHz Wi-Fi 24dBi antenna is on order, which will make testing a lot easier than trying to hand balance a dish. The remaining problems will include amplifying the transmit RF to a level to make it usable on the air.

One solution for the transmit RF side might be to use one of the FPV (first person video) amplifiers sold to boost the 5.8GHz signal used with Drones and the like. Various units are around apparently delivering 2 to 4W, probably Chinese watts though. Hopefully I can bring you the tale of the transmit side of things in the near future along with news of my first proper QSO.

Of course, these are very simple experiments. Those more experienced in the black arts will no doubt be laughing all the way to their re-flow stations and CNC lathes but as a relative newcomer to these frequencies I think it shows that even with a little knowledge you can get things to work and, as I seem to be told often, it's the fun of the hobby. Enjoy.

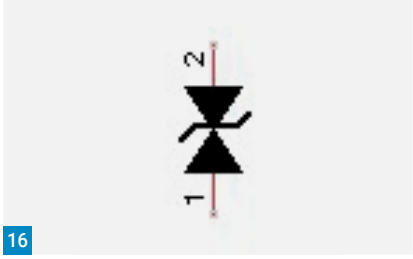


15

Continued from page 63

The diode I used in my test has a 2A rating and a trigger of 32V. The main application of a Diac is in a Triac triggering circuit. When it is connected to the gate terminal of the Triac and a suitable voltage is applied to the Diac, the Triac will conduct. When the voltage across the gate decreases below a predetermined value, the gate voltage will be zero and the Triac will be turned off.

A use of the Diac/Triac combination is with a mains lamp dimmer **Fig. 15**. This is a better method of the use for a lamp dimmer or motor speed controller etc because it uses both halves (positive and negative) of the AC waveform and the frequency is then 100Hz per second, so there is much less flicker (if any). One connection of the lamp is to the live lead of the household mains and the other to the MT2 terminal of the Triac. This also has a resistor (10kΩ in the diagram) connected to the lamp and Triac with the other end connected to a 1MΩ potentiometer. This value is not critical but should be quite high to provide a linear dimming of the lamp. The slider, which is connected to one lead of the Diac, is also connected to the other end terminal of the potentiometer because it is used as a variable resistor and not a potential divider so only the centre and one end is needed. There is also a capacitor connected from there to the neutral lead of the mains. The other end of the Diac is connected to the gate and the MT1 of the Triac is connected to the mains neutral lead. The purpose of the capacitor is to allow it to be charged through the potentiometer and when the required charged voltage is reached the Diac conducts and triggers the Triac.



16

Fig. 15: Mains lamp dimmer circuit.
Fig. 16: Symbol for a transorb.

Transorb

Transorb, **Fig. 16**, is a common name for a Transient Voltage Suppression (TVS) Diode and is used to protect sensitive electronics from voltage spikes. There are unidirectional (only conduct in one direction) and bidirectional types and similar to Zener diodes but are designed to handle very high peak currents and therefore they do not fail as would a standard Zener diode, and don't need resetting or replacing after passing a heavy peak current as they will return to normal open state when the voltage spikes are not there.

As with Zener diodes they have voltage ratings and the correct type should be used in a circuit.

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- *Electronics Engineer's Reference Book*, 6th Edition
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Transistor, Thyristor & Diode Manual. RCA

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Rallies & Events

Due to the ongoing Coronavirus situation, the Rallies calendar remains dynamic at the moment, and there will be more cancellations and postponements. All information published here reflects the situation up to and including 26th October 2021. Readers are advised to check carefully with the organisers of any rally or event, before setting out for a visit. The Radio Enthusiast website will have updates, please check here regularly: www.radioenthusiast.co.uk To get your rally or event onto this list, please, e-mail full details as early as possible to wiessala@hotmail.com

7 November
HOLSWORTHY RADIO RALLY: Holsworthy Leisure Centre, Well Park, Western Road, Holsworthy, Devon, EX22 6DH. Open 10 am. Traders. (BB | CR | D)
Howard M0MYB
m0omc@m0omc.co.uk

3 & 17 December
HORNDEAN & DISTRICT AMATEUR RADIO CLUB (HDARC): Club Meeting
Stuart Swain (Secretary)
https://www.hdarc.co.uk
g0fyx@msn.com

2 January
SPARKFORD WIRELESS GROUP RALLY: Davis Hall, Howell Hill, West Camel, nr Yeovil BA22 7QX. Open 9.30am to 1pm, entry is £2. (FP | CR)
wjh069@gmail.com

30 January
LINCOLN SHORTWAVE CLUB WINTER RADIO RALLY: Wragby Town Hall, Louth Road, Wragby, Market Rasen. Lincolnshire LN8 5PH; Doors open at 10 am, with disabled visitors gaining access at 9.30am. Indoor event; CR; entry £2 Talk-In 145.375MHz. Please follow prevailing Covid rules. To book tables:
contact@m1dhv.co.uk
m5zzz@outlook.com

6 February
RED ROSE RALLY: St Joseph's Hall, Mather Lane, Leigh WN7 2PR; FP | CR | RSGB | TS | All one level for disabled access, Individual stands, LAMCO stand, low-cost Bring and Buy.
rally@wmrc.co.uk
http://wmrc.co.uk/rally.htm

11 June
ROCHDALE & DISTRICT AMATEUR RADIO SOCIETY SUMMER RALLY: St Vincent de Paul's, Caldershaw Road, off Edenfield Road (A680), Norden, Rochdale OL12 7QR. Doors open to the public at 10:15 am, with disabled visitors gaining access 15 minutes earlier.
Tel: 0777 811 3333.
m0nvq@outlook.com

12 June
JUNCTION 28 RADIO RALLY: South Normanton, Alfreton and District Amateur Radio Club
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NEWBURY RADIO RALLY: Newbury And District Amateur Radio Society
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24 July
FINNINGLEY ARS RALLY: Car-boot style rally. Food bar. Near J2 M180, Doncaster.
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In Retrospect - An HF Signal Generator

Dear Don,

Firstly, a thank you to those that have shown an interest and placed orders for the recent project.

Page 64, Amplitude Modulation

To explain linear mixing a little further: An example of Linear Mixing is the use of a microphone mixing desk where two or more mics are mixed and the output is the result of the mics and no other signals (excepting harmonics) whereas non-linear mixing produces sum and differences as observed in a superhet mixer.

Explaining the linear mixing in terms of voltage and current is only to show the current increases in proportion to the voltage and the term 'square law' is more applicable when explaining power circuits.

To be pedantic, the use of the term 'Product' should be called 'Sum of' and not the product. Also Intermediate refers to sum and difference and not just the difference.

Page 65. First paragraph.

With reference to using varicap diodes back to back:

From *Wikipedia*

Another common configuration uses two back-to-back (anode to anode) varicap diodes. (See lower left circuit in diagram.) The second varicap effectively replaces the blocking capacitor in the first circuit. This reduces the overall capacitance and the capacitance range by half, but has the advantage of reducing the AC component of voltage across each device and has symmetrical distortion should the AC component possess enough amplitude to bias the varicaps into forward conduction.

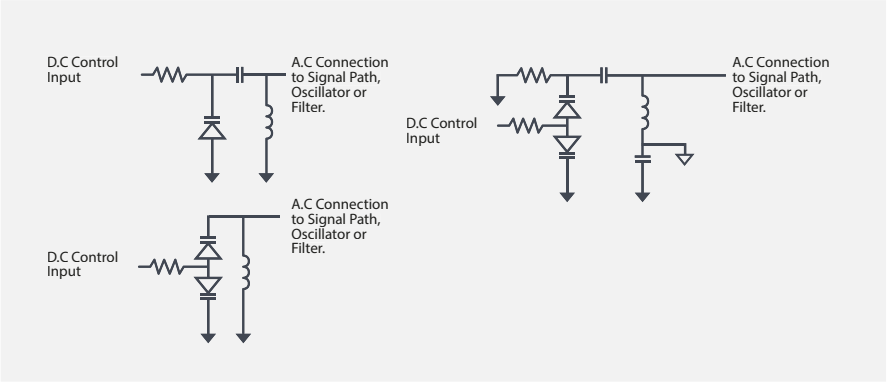
Page 65, 'Output'

The voltages (1V) and (2V) are used as an example of 0dB and 6dB in this explanation but we all know that dBs are, of course, 'ratios' and do not possess values.

The datasheet shows the MAX452 as having an output impedance of 2Ω but can drive 75Ω directly. I have used this chip in many 50Ω video mixers and amplifiers several years ago. It worked well and it is used here to provide a 50Ω output.

The output from the 220Ω output level pot produces an output at 50Ω and at just about all settings because of the 50Ω sending impedance at the output of the MAX452. To test this, set the level at, say, 1V output using a scope as the display. Place a 50Ω terminating resistor at the scope input and the signal level will drop to 0.5V. Repeat the operation setting the level at 0.5V (without the termination resistor) and then fit the 50Ω terminating resistor and the level seen on the scope will drop to 0.25V. This displays the output impedance of the generator to be 50Ω (or very approximate).

Eric Edwards GW8LJJ
Barry



Foundation Licence

Dear Don,

'The current mandatory Foundation practical requirements, as detailed in Section 10 of Syllabus 2019 v1.4, are, with immediate effect, permanently removed'.

In my view, this move does not advance amateur radio, nor does it represent the interests of the RSGB's membership. It looks like part of an agenda designed, along with broad Industry and Government failure to observe EMI regulations, to cheapen and reduce amateur radio to the level of nuisance while at the same time opening it up to all, with a hoped-for increase in membership and revenue before it dies out altogether and becomes yet another internet pastime. Or is it just misdirection and incompetence? The level of technical ability, etiquette and protocol, as discerned from listening to on-air discussions, is already as low or lower than many unlicensed operators' standards. One can have little hope for the future.

If this was done in an attempt to garner popularity among those with aspirations of becoming radio amateurs, I can only think that the RSGB is out of touch to a degree I would have thought impossible for an organisation purporting to represent its membership. If, however, the RSGB was under duress to make these changes, may I suggest that it be honest enough to make this known.

Looking at the ages of most of the men on the RSGB Board, all volunteers and therefore under obligation to no-one, I am surprised that they do not appear to hold similar values to those of its older members. They must realise that amateurs of long standing will feel abandoned and disheartened by this continual reduction in requirements, but probably not surprised. It is time for the RSGB to study its mission statement and to ask some serious questions of itself:

Is the RSGB being honest with its membership about the reasons for the ongoing lowering of standards? Is the RSGB becoming inward-looking and self-serving rather than exclusively and selflessly representing its members' interests? Has it started to disregard all external stimuli and begun to dictate (OFCOM's?) terms instead of arriving at consensus within its membership? Does it genuinely believe that this latest announcement will do any real long-term good for amateur radio in the UK at all?

Considering recent diktats regarding EMF rulings, it appears that political, dispassionate people with little or no technical acumen are now presiding over the RSGB, either from within or without. This can only be bad.

Having said all that I am reminded of a

letter to *PW* re. the RSGB some 30 years ago in which the writer observed that an indifferent membership will end up with the representation it deserves.

Pat Walton M1BNH
Bury, Lancs.

(***Editor's comment**: Thanks Pat, I'd be interested in what other readers think. Back in the days of the RAE there was no practical assessment but, of course, it could be argued that the standards were higher – no Foundation or Intermediate en route to a full licence.)*

IF Transformers

Dear Don,

I wonder if this problem I had with jammed IF transformer cores and how I overcame it might be of interest to other readers who might have a similar problem?

On my Wireless 19 Set I felt that the IF and input coils might need adjusting, it's still a bit deaf. So much was wrong with it when I first got it that they could need some adjustment. I removed the wax and turned the green threaded portion only for it to keep turning with no change in received signals.

On removing the screening can I found the green threaded part had broken off from the ferrite core. Only one ferrite came free with its green threaded adjuster. I tried super-gluing a short piece of plastic between the ferrite core and green part but it broke off again in the coil former when I screwed it in. It would have to be perfectly central and not off at an angle. It wasn't, which is why it broke the very top off the ferrite. Do I go online to look for some more IF transformers and aerial input coils, if available? I could just buy the same problem again.

I abandoned the idea of screwing them in and got some pieces of plastic slightly smaller diameter than the ferrites, cut them to about one inch in length and super-glued them to the cores. I could now push the ferrites in and out of the cores but they were too long to put the chassis back into the cabinet. I tried cutting one down but didn't have enough to grip to pull it out again. I tried long nose pliers but pushed it further in. The set was working quite nicely now but how to pull them out if I pushed them in too far without leaving them too long?

My solution was to glue a small length of cotton to the plastic, which I could pull the core back out if it went in too far. To help it to stay in place I used a small hacksaw to cut into the plastic to make a groove to tie the cotton into and super glue it. On all six coil formers I had to roll up a piece of sandpaper and work it inside the coil former to enlarge the inside so the cores would run freely. They were so tight I originally thought they had been glued. I guess over 71 years the formers had shrunk resulting in gripping the ferrite cores tightly. Two formers were loose in the

coils so I fixed those into position with candle wax.

The photo shows the original green adjuster, which didn't break off, although it's a bit tight, two ferrite cores with long plastic pieces and at top left is the shorter plastic piece with a length of cotton attached. At the bottom is a ferrite core with the long plastic glued on. The final job is to slightly lean the set forward and tune all six cores then drop some melted candle wax into the top of the cores to seal the plastic that hold the ferrites in place.

Not yet though because I want to try a *Q* Multiplier from a circuit I found in *PW*, December 1966 for an R1155 set and it says the first IF cores need re-aligning. Although the article is for the R1155 with an IF of 560kc/s details are given for an IF of 465kc/s.

Bill Kitchen G4GHB.
Ashton under Lyne

Next Month

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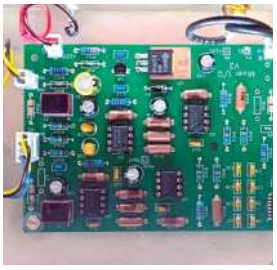

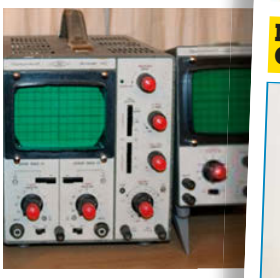

AN SDR RECEIVER: Samuel Ritchie EI9FZB embarks on a seven-part series describing the build of an SDR receiver.

DOING IT BY DESIGN: John Dunton G1RXC has a design for a Pico Farad Resolution Capacitance Meter Adapter

TEST EQUIPMENT: Chris Murphy M0HLS discusses what test equipment it is worth having in the shack.

THE MORSE MODE: Roger Cooke G3LDI has a cornucopia of Morse-related topics, starting with a report on the recent CWops Open event.

VALVE RADIO REPAIR: Bernard Nock G4BXD discusses how to tackle the repair and maintenance of valve radios.

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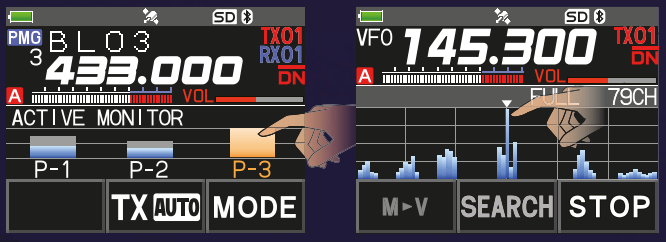

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The Battle of Britain
IN COLOUR

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THE BATTLE OF BRITAIN IN COLOUR

The Battle Looms

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

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

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

Predicted Catastrophe

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

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

— 6 —

BACKGROUND TO BATTLE

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

Right As the unstoppable juggernaut of German military might advanced across Europe, the deadly Junkers 87 Stuka dive-bomber came into its own. However, the RAF quickly learned how aircraft, and this stood t when facing the Stuka a Britain.

Below right Panzer IV t France in May 1940. Th was rapid and overwhel weeks France had colla were evacuating from D

THE RAF FIGHTER PILOT

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

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

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

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

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

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

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

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

Mentally and Physically Draining

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

— 19 —

THE RAF FIGHTER PILOT

other pilots concentrated on what was going on in their cockpits: oil temperatures and pressures, fuel state, oxygen contents checked and selected to 'On', microphone not on 'Transmit' (this could effectively block all other transmissions), straps tight, gun-sight 'On' and illuminated, straps tight and canopy firmly shut. A surprising number could carry out a little good luck routine – the feeling for a lucky charm, or even crossing themselves.

Now, the workload was high, and still they needed to concentrate on formation keeping while permanently keeping a wary eye open for the enemy and quartering the sky in a relentless search. A moment of relapse could literally spell death. The squadron 'Weaves', winding from side to side, kept a rather more wary eye open than the rest, as the squadron got closer by the second to their quarry. Brief instructions might crackle through the headphones: 'Close up Red 2' or, on receipt of further instructions from the Fighter Controller: 'Turning to Port, Go!'

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

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

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

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

Chatter Of Gunfire

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

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

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

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

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

— 21 —

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