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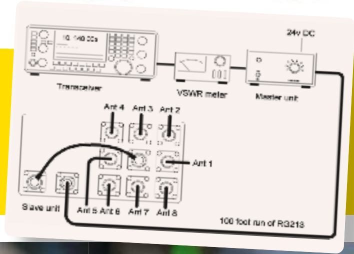
PRACTICAL WIRELESS

MARCH 2021 THE UK'S NUMBER ONE AMATEUR RADIO MAGAZINE SINCE 1932

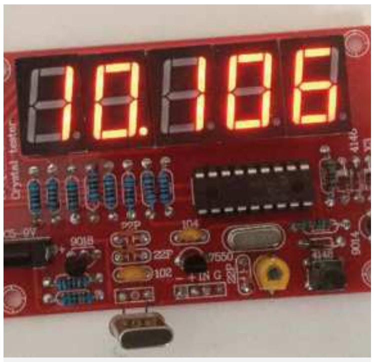
BUILD IT AT HOME | Construct an eight-way remote antenna switch



BOOST YOUR QRP RIG

Practical REVIEW Wireless

We test the keenly priced Xiegu XPA125B100W Linear Amplifier



Seeing the light

How you can build a handy frequency counter

Eddystone EA12

A delve inside this classic amateur band receiver

HISTORY There's more to Morse than meets the eye

A look at some of the lesser known facts about this form of radio communication

GEAR Palm-sized IC-705 antenna tuner

Plus all the news of this month's other radio product releases

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Operates in MW, we found that it could just manage the 160m Ham radio band. This receive only antenna requires no power and can be coupled to MW portable receivers just by placing it close to the radio and peaking the tune control. If your radio has an external antenna input, then it can be directly connected with the supplied cable. Greatly improves reception, is directional and reduces noise.
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Contents

PRACTICAL WIRELESS

March 2021 Vol. 97 No 3
On sale: 11 February 2021
Next issue on sale: 11 March 2021

ISSN 0141-0857

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This publication is printed by Warners 01778 395111

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Keylines

With the third lockdown we (most of us at least) are confined once again to our homes. The RSGB have been running more of their Hope QSO parties, there has been plenty of other activity on the bands and, hopefully, some of you have been indulging in home construction. It's great to have a hobby that works even during these strange times!

FT4 and FT8

In this month's *Data Modes* **Mike Richards G4WNC** explains how to use FT4, one of the programs within the WSJT-X suite. As he explains, FT4 was designed primarily for contest operation but is proving popular as a day-to-day data mode, to rival its brother FT8. This is because the user interface is exactly the same and while FT4 doesn't dig as deep (in terms of pulling signals out of the noise), it is perfectly adequate for many QSOs. Indeed, having decided to try it as an alternative to FT8, thanks largely to Mike's article, I found myself making plenty of contacts, including some quite juicy DX such as VP8LP on 20m as one of my first FT4 contacts and Japan on 40m in the middle of the day! This latter is particularly interesting in that, while in January band openings are considerably extended on 40m compared with the summer months, I would not expect to be able to work Japan on the band at that time of the day on either CW or SSB, so FT4 definitely brings something to the party. FT8, of course, goes further, and I have been regularly working Japan throughout the day on 40m during January using FT8, while East Coast US stations have been workable until well after midday (though in the latter case, I have also been hearing the louder ones on CW at that time too). And I have to say, going back to FT8 after using FT4 feels quite pedestrian!

I will now be trying FT4 in the RSGB FT4 contests to see how it works in that context too, especially as I am now lined up to run the 'HQ' station G6XX in one of the events.

Home Construction

While we don't run as many constructional articles in *PW* as in years gone by (largely, it has to be said, because fewer are submitted) we have a couple in this month's issue that I'd particularly like to draw attention to.

The first is the 8-way antenna switch by **Ken Ginn G8NDL**. This is quite a com-

plex project but demonstrates well the way in which hardware and software can be combined to make for an effective addition to the shack.

The second is **Richard White G6NFE's** description of building the Ilton kit from **Tim Walford G3PCJ**. Richard describes the process, warts and all, which may be enough to put some readers off kit building completely! That, though, would be a shame. It is equally clear that Richard has learned a lot from the build process and has the satisfaction of now being able to work stations with a transmitter and receiver that he has built himself. (I should mention that the Ilton is a crystal-controlled DSB transmitter, which may not have been the best choice in the circumstances but, again, Richard has learned from that.)

Personally, I have always enjoyed kit building, going right back to the days of Heathkit and valves. It overcomes the trials and tribulations of sourcing the components yourself (and, in days gone by, doing the chassis bashing) and let's you get on with the actual build.

Which reminds me that in the Ivel article (December 2020) we failed to give a link to the Walford Electronics website, from which both the Ivel and the Ilton (and indeed, other kits) are available:
www.walfords.net

Correction

Terry VK5TM writes that, with respect to his noise canceller mentioned in **Steve Ireland VK6VZ's** February article, he does indeed sell a kit of parts but it doesn't actually include the case. We apologise for any confusion.

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 have announced the release of a new miniature straight Morse key from Vibroplex USA. The Camelback key is aimed at portable operations, weighing just 66 grams, with an oval base 50 by 25mm.

Separate adjustments are provided for both spring tension and sending gap. The key is available for £109.95 from Vibroplex exclusive UK distributor Nevada: **www.nevadaradio.co.uk**

New from ML&S

The Anytone AT-779 is a simple entry to 4m operation, includes 199 memories, CTCSS & DCS, selectable power levels 5/10/15W output and a hard-wired DC lead and fist microphone with up/down buttons. The introductory price of just £79.95 includes PC control cable and free software via website download. Available now from ML&S: **www.HamRadio.co.uk/AT779**

New VLF Record

Very low frequency (VLF) enthusiast Joe Craig VO1NA reports that Stefan Schaefer DK7FC copied his 50-character message transmitted from Newfoundland on 8.271kHz with a radiated power of 10mW. *"This is a new record for amateur transatlantic VLF"*, he reports. The mode used was EbNaut by Paul Nicholson. EbNaut is a synchronous coherent BPSK mode for use at VLF and LF. Craig's tower supports a VLF RL (rotated L) 10m (33ft) average height and 100m (328ft) long. VLF is the ITU designation for radio spectrum in the range of 3 to 30 kHz, corresponding to wavelengths from 100 to 10km, respectively.

New from Icom

Icom have announced details of their forthcoming portable automatic antenna tuner for the IC-705. The AH-705 is a palm-sized portable antenna tuner that has been designed to work between the 1.8-50MHz bands. It can be powered either by alkaline batteries or DC 13.8V supply.

Also, new firmware updates for the IC-705, IC-7300, IC-9700 to include smoother FT8 operation. The firmware was due to be released from the end of January onwards starting with the IC-705 and then followed by the IC-7300 and IC-9700. The updates will be available as free downloads from the following website: **www.icomjapan.com/support/firmware_driver**

Icom also plans to update the RS-BA1 Ver2, CS-705 and the CS-9700 programming software.

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

WSJT-X 2.4.0 to Introduce New Digital Protocol Q65

WSJT-X version 2.4.0 will introduce a new digital protocol called Q65, which, according to the *Quick Start Guide*, is designed for *"minimal two-way QSOs over especially difficult propagation paths"*. The *Guide* says, *"On paths with Doppler spread more than a few hertz, the weak-signal performance of Q65 is the best among all WSJT-X modes. Q65 is particularly effective for tropospheric scatter, ionospheric scatter, and EME on VHF and higher bands, as well as other types of fast-fading signals"*.

The new protocol uses 65-tone frequency-shift keying and builds on the demonstrated weak-signal strengths of QRA64, introduced in 2016. User messages and sequencing are identical to those in FT4, FT8, FST4 and MSK144. Q65 employs a 'unique tone' to sync time and frequency. As with JT65, this 'sync tone' is readily visible on the waterfall spectral display. Unlike JT65, synchronisation and decoding are effective even when meteor pings or other short signal enhancements are present. Transmit/receive sequence lengths of 15, 30, 60, 120 and 300 seconds are available. According to the Guide, *"Q65 will enable stations with a modest Yagi and 100W or more to work one another on 6m at distances up to ~1,600 kilometers at most times, in dead-band conditions"*.

Textbooks Online

Clive M0DXJ writes, *"Please click the link below as I have free Electronics, Computing and Mechanics Principles educational eTextbooks for schools and colleges.*

"There are lots of Radio and Communication topics, including Attenuators and Filters. It's all available (and has been for several years) for free.

"Maybe your readers are also engaged in Home Schooling as I have Maths Principles as well!"

(see also the Epsoft advert in this issue)

www.eptsoft.com

QSO TODAY VIRTUAL HAM EXPO RETURNING IN MARCH: The QSO Today Virtual Ham Expo will return March 13/14th for a full 48 hours. The inaugural QSO Today Expo last August attracted more than 16,000 attendees.

The March event will feature new speakers and presenters, panel discussions and kit-building workshops among other activities. Attendees can log in from anywhere.

Registration is required, and to help cover the costs of staging this event, there will be a charge to attend. Advance tickets are $10 ($12.50 at the 'door') and include entry for the live, two-day show as well to the 30-day on-demand period.

For full details, including the programme, visit:

www.qsotodayhamexpo.com

BRARS NEWS: During 2021 the British Railways ARS will be celebrating 55 years since the forming of the society. BRARS had their inaugural meeting on October 29th 1966 at British Railways Board Headquarters after the work of acting Secretary SWL Gray. One of the founder members of BRARS who attended that meeting was SWL John Chappell who is now G4ZTQ. In 1967 Ronald Hooper G3SCW attended a meeting in Sweden, which led to the formation of FIRAC, the International Federation of Railway Radio Amateurs. France Germany and Switzerland initially formed FIRAC and the organisation has a membership exceeding 2000 worldwide.

Geoff G4GNQ has been the President of BRARS since 1979 and the first Congress meeting was held in1982 in Lowestoft. Membership is open to railway and non-railway members and more information is available off the following websites:

www.firac.de
www.BRARS.info
www.firac.org.uk

The Society will be running the special event call GB0LMR, which is also the suffix of the club call, to mark the occasion. The station will be operated by BRARS member Mark G1PIE from Preston in Lancashire. Bands of operation will be 40 to 10m in SSB, PSK31 and PSK63, and also on VHF/UHF. QSL cards are via the RSGB bureau or direct with sae to Mark. Further information is on qrz.com and the society website.

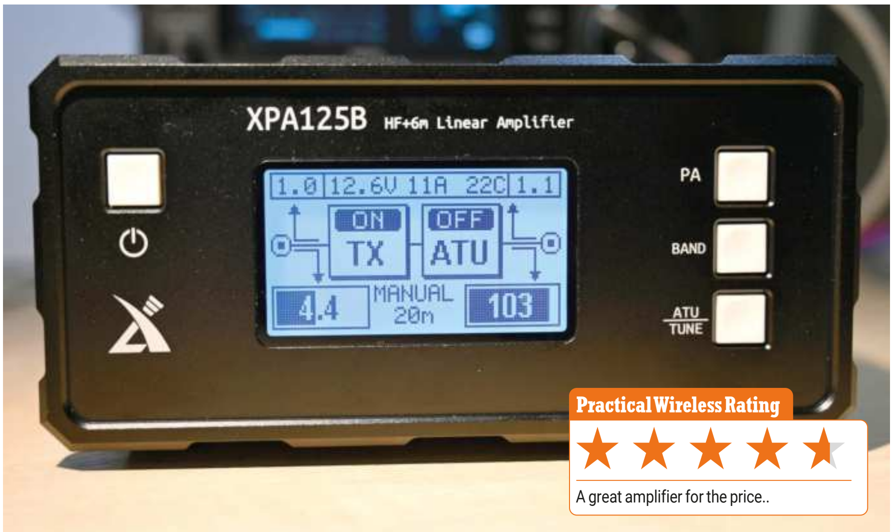
A NEW SLOW SPEED CW CONTEST FOR UK & EUROPE : The K1USN Radio Club, in conjunction with CWops, are expanding their existing and popular weekly Slow Speed CW Contests, held on Mondays at 0000-0100UTC, to include a second session more convenient for budding UK and European CW contesters. These run from 2000-2100UTC every Friday and share the same rules and format. They are also fully supported by the N1MM contest logger. There is no formal log submission; instead, participants are invited to upload their QSO totals and scores to the 3830 reporting website:

www.3830scores.com

These contests are to be conducted at 20WPM or less and are aimed at CWops Academy students and any other novice CW contesters who are not comfortable with normal contest speeds. Everyone is welcome to take part and it is a great opportunity for established CW contesters to come on and help encourage our new operators. Please see the website below for rules, easy to follow instructions and lots more. If you're new to CW contesting or are experienced and wish to help some newcomers take their first steps, please join in if and when you can.

www.k1usn.com/sst.html

Richard Constantine G3UGF
practicalwireless@warnersgroup.co.uk



Investigating the Xiegu XPA125B 100W Linear Amplifier

Richard Constantine G3UGF looks at an amplifier that can turn your QRP rig into a 100W station.

The XPA125B 100W, HF and 6m linear (including 30m) is the latest offering from Chinese manufacturer Xiegu. Smaller and more compact than its predecessor at, 260 x 150 x100mm, it's an attractive, satin black, package, complete with side carry handle and weighing just 2.6kg.

First impression – it looks really nice. The all-metal casing stands on four insulated feet for air circulation and it's vented at the rear. There is no internal or external fan because the substantial heat sink runs the whole length of the underside of the circuit board, inside the steel case.

A bail arm to angle the front panel would have been a nice addition for improved air circulation in warm environments, also to make the viewing angle much easier at desk height.

At less than £500.00 in the UK, it's attractively priced. It comes complete, with internal auto-tuner, six-pin mini-DIN transceiver PTT and ALC control lead plus a computer cable for software upgrades.

Originally designed to operate with Xiegu's low power transceivers, I was intrigued to explore its potential for use with other manufacturers' QRP equipment. Sadly, there is no out of the box automatic band switching function – more on that later.

From a reviewer perspective, the 7-page, photocopy handbook turned out to be less than comprehensive. For a user, there is adequate operational and interconnection information. Unfortunately, a search of the manufacturer's website revealed only the same information as already in the handbook. Without a circuit or layout diagram I've had to rely both on observation and somewhat limited investigation, which is a little disappointing.

Power in vs. Power out

Firstly, the rear Molex style power connector has no shroud or cable restraint. There are no in-line fuse holders but there's a very nice 30A covered blade fuse easily accessible on the back of the unit. Following tests, I'm tempted to reduce its value to 25A as typical consumption is around 18A, despite the handbook showing a graphic display of 28A.

How well any amplifier performs is always a movable feast and a trade-off between operating voltage, available current, drive level and output load impedance.

A very substantial power supply is an absolute must for any amplifier but seems somewhat critical for this device. I like traditional linear supplies, primarily because they don't generate noise, commonly associated with switch-mode types. Also, they tend to not derate to the same extent as the traditional PSUs that amateurs used to call 'meat and potatoes' supplies.

Questioning power level inconsistencies in online video reviews, I decided to check every band against the front panel readings for myself, using a calibrated power meter, into a 50Ω load. I first used a linear mode, 30A supply and also a typical 25A switch mode, from a reputable UK supplier, to replicate YouTuber results.

I wanted to confirm if the makers claim of 100+ watts carrier was realistic. It took time but along the way it revealed some interesting and helpful information.

On standby, the panel display always read 0.45V less than actual supply volts, presumably due to the presence of protection diodes and sampling point etc.

The handbook describes the standby current as 260mA, but the display on the test model permanently reads 3A, puzzling. I've seen similar in photographs on the internet and also some showing 0A. Maximum current drawn was approximately 18A, less on the more efficient bands. As expected, the linear PSU gave the best and more resilient results.

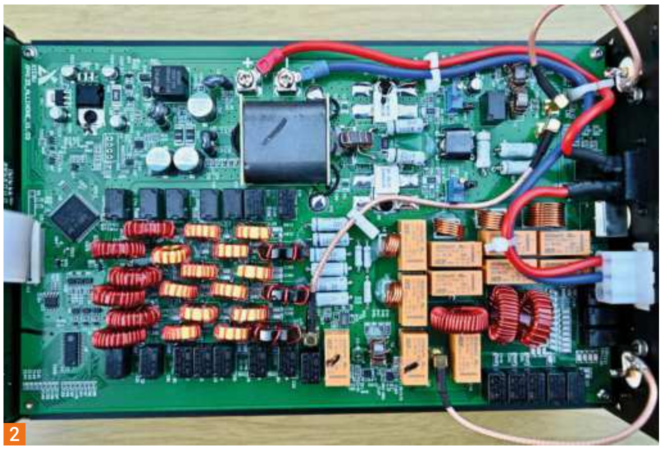
In summary, 13.9V DC off load, rather than 14.5V maximum as per handbook dropped to 13.3V fully loaded, delivered 93W output on 160m and 90W on 6m Increasing the supply made little difference.

The amplifier is most efficient on the 20 through10m bands. It proved necessary to drop the input voltage to below 13V to ensure the amplifier didn't exceed 100W. Higher volts started one of ten dire warning message options that can flash on the front panel at any time, striking fear into an unsuspecting operator. The handbook lists the maximum power as 125W on one page and 110W on another?

It's worth noting that a nominal 12V car battery type supply indicated an output of 95W on 20m falling to 80W on the 80m band. This is not enough to affect real life transmission and this 20% power loss was the worst-case scenario.

As for the switch mode, on load it de-rated by a mean of 1.2V across the bands with corresponding current changes and reduced power output. It struggled to meet the output specification on lower frequencies plus in my case increasing the receiver noise floor by a just audible 3dB.

1



2

Fig. 1: The amplifier along with the author's IC-705. Fig. 2: The amplifier's internals.

Overall, tests confirmed what I expected to find, i.e. the need for a decent, controllable power source. The makers claimed power output varies for the same drive level and is conditional on what I've briefly described here.

On a full duty cycle at 100W the PA temperature sensor indicated an increase of 10° in 60 seconds, data mode operators take note.

Of course, I've not pushed it to destruction. I assume that the ARM central processor visible on the front edge of the board that controls much of the operation of the Xiegu 125B, would shut the amplifier down before disaster.

Technical Description

Despite the lack of a circuit diagram, with the cover removed it's easy to follow the input signal path from the rear right-hand side input socket, through two dual edge-mounted ferrite couplers that sense the input power and VSWR monitoring. A small binocular ferrite transformer feeds RF to a pair of Mitsubishi RD100HHF MOSFETs. Comparing the v1.03 test model with earlier photographs revealed small upgrades to the PA circuit and elsewhere.

Each MOSFET is capable of producing 100W at 30MHz according to the maker's specification – comforting to know. The output passes through a much larger binocular ferrite transformer, before arriving at the low-pass filter network followed by a comprehensive auto-tuner/matching system similar to, if not the same as, the N7DDC design.

Having both the filter and the tuner in-line is a good way to reduce potential spurious signals being amplified by the 13dB gain broadband linear.

The manufacturer lists harmonic suppression at 39dB and I noted nothing alarming or otherwise on a spectrum analyser display.

The auto-tuner has a maximum impedance range of 500Ω. Compare that to a typical internal tuner in say the IC-7300 transceiver, at just 150Ω. The Xiegu tuner is compatible with a wide range of coax fed antennas. Dealing with conversion from the unbalanced output to some random wires and balanced antennas will perhaps require a little additional thought.

Control & Operation

Both the amplifier and tuner can be bypassed independently from the recessed front panel push-buttons.

The 3.5in screen from left to right gives continuous display of:

Top line: Input VSWR, Supply volts, Current, PA temperature and output VSWR.

Centre line: PA in/out of circuit, ATU in or out of circuit.

Bottom line: RF input, auto/manual band switching band in use, and RF output.

Initially it's disappointing to find that the amplifier doesn't change bands automatically, unless of course you have a Xiegu transceiver. In practice it's not too much of an issue in manual mode to step through the bands.

However, if you want to jump back from 40m to 160m, you have to step through the spectrum up to 6m before arriving again at 160m.

The PTT port requires a low-level switch, circa 0.1V. This is compatible with the Icom IC-705 and the Elecraft KX3 (Acc-2).

The Xiegu handbook contains a chart detailing the required level of mV signalling for each band, in order to also make the auto band change option work with other radios. I'm sure it won't be long before someone cracks this for most popular models. Band data switching is a common feature on many radios these days, including the FT-817/818, but requirements and outputs vary. Some are fixed values, while others are programmable. I haven't explored this fully but there's scope to think that solutions can be found to enable automatic operation.

Summary and Conclusions

My original thought was that this black box would be ideal for remote mounting in a vehicle, for QRP in the field and QRO on the road.

Not being able to change bands automatically put paid to that idea. It's certainly preferable to see the front panel as it gives valuable real time information of the operating parameters and any problems. As a way of providing higher power in the shack and with the right antennas, it represents good value.

As regards band changing, it's no different to any classic, manual power amplifier. If you consider that each PA MOSFET costs around £40.00 the finished product is well priced. Building your own amplifier is an option but likely to be far less sophisticated and with much less protection. Or, with much deeper pockets you might consider the Elecraft alternative.

It's relatively quick and quiet in operation when tuning and the changeover timing is nicely optimised for VOX/semi-break-in on both SSB and CW. Although not personally tested, data modes are being used by some owners.

In summary, it's a lot of tech, based around a conventional circuit, well protected and nicely presented. Yes, it has minor shortcomings, particularly if you're not already a Xiegu transceiver user. I like its professional construction and shortcomings aside it represents good value at this time, with little direct competition. I have come to the conclusion that the latest models perform somewhat better than earlier versions, possibly due to component changes.

As for scores, initial thoughts where it was going to be around 4 stars. Having now seen and used it up close I happy with 4.7. The XPA-125B is available from ML&S for **£469.95 inc**. VAT. Note, though, that a compatible radio interface cable is required, at additional cost.

Mobile Antenna Mounts

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

Multiband Mobile

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

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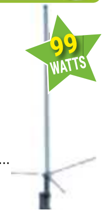

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Richard White G6NFE
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Building the Walford Electronics Ilton DSB Transmitter (Part II)

Richard White G6NFE adds a transmitter to complement his Ivel receiver.

Readers of the December issue of *Practical Wireless* may have read my short article on my experience of building the Walford Electronics Ivel receiver. They would have correctly surmised there was a second part to the story and here it is.

My plan from the beginning with the Ivel was to build both the receiver and transmitter, fit them into some sort of case and have a transceiver I could use and enjoy and more importantly say, *"I built that myself"* – albeit in kit form. The journey has been an education, it's definitely not been cheap (my fault for buying expensive hardware) and I have learned things along the way. I also decided to go slightly off-piste at the end and this is described later.

More Complex

The build has been more complex than the Ivel and I have to be honest here and say some of this was due to personal choice. Where I probably made life harder for myself, I will make this clear. I will also highlight lessons learned. At the end, I will provide a list of additional items should you wish to try some of my ideas.

As with the Ivel, the Ilton follows along similar lines; All components are carefully bagged up with clear instructions. I used the same methodology as before, read and re-read the instructions and ensured the bags and components were secured in a biscuit tin during the build.

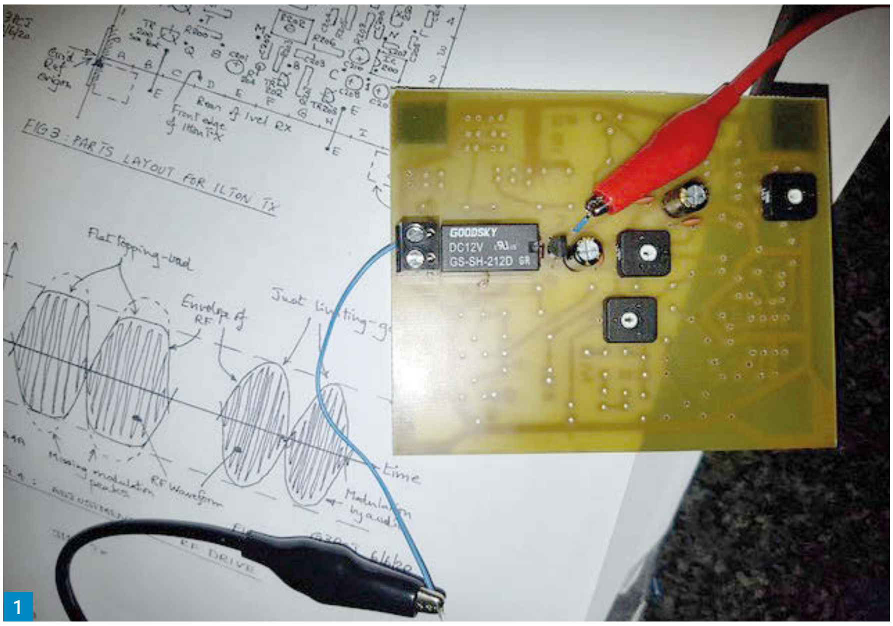
Test equipment does help and I concluded the most useful items are an oscilloscope (old and used will do), a cheap two-tone audio frequency generator, DMM, RF power/SWR meter, plus a general coverage radio receiver with AM/LSB/USB. You can tell an awful lot about the modulated carrier just by careful listening while transmitting into a dummy load.

Lastly, I found the Siglent Lab power supply indispensable. Much cheaper and perfectly acceptable devices can be found used and new on eBay for around £40.

Skim reading the instructions the first time around didn't really prepare me for the intricacies of the build, so I recommend grabbing your favourite drink, finding a quiet place and reading them very carefully.

Stage 1: the Electrical Assembly

So, first things first. Permission to play with my, quote; 'radio rubbish' (as my wife calls it) was again sought and granted, on the basis that it didn't interfere with normal kitchen duties and was put away when visitors came around. With that approval in place I started off with Stage 1, the electrical assembly.



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Again, the colour photographs are useful when you experience one of those *"have I really got this right?"* moments. The circuit diagram on page 12 and the parts layout on page 13 are also invaluable; keep them close at hand! One thing I decided after building the Ivel was to fit the test points and this was **lesson one**. If you do buy them from your favourite supplier, at least find a ruler and measure the holes *before* ordering. My laziness and guesswork wasn't good enough and my Vero pins are redundant for the Ilton. Bits of spare insulated wire saved the day though.

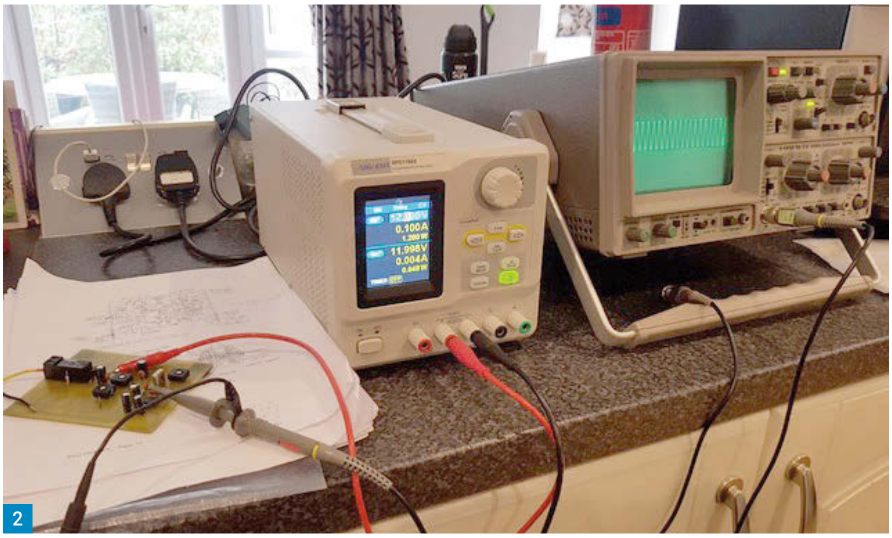
At this stage I very loosely fitted the output transistor, thermal tape, grommet, heat sink and mounting bolt together, to get a feel for how it mounted on the board. At the end of stage 1 the power was applied and the test result was 8V as required, **Fig. 1**.

Stage 2: Fitting the Modulator Chip

This is the first decisive stage and you need to consider carefully the band you will transmit on and, of course, the band you have chosen for the Ivel receiver.

Something the Ilton builder needs to be aware of; the kit comes with a ceramic resonator for the 80m band (3.69MHz). As I had already chosen the 40m band for the Ivel, I had to re-think this.

Firing off a brief e-mail to **Tim Walford** it became clear that as a transceiver, the Ilton and Ivel work together much more effectively on the 80m band than on 20 or 40m. The caveat here is that higher bands may work in transceiver mode, but it's not guaranteed. Remember this! At this stage I fitted a crystal for 7.159MHz to match my Ivel build and accepted the limitations of a single spot transmit frequency, but the benefits of a wide tuning range on receive. This is **lesson two**. Think about how you want to use the Ivel and Ilton together, before you start building them.



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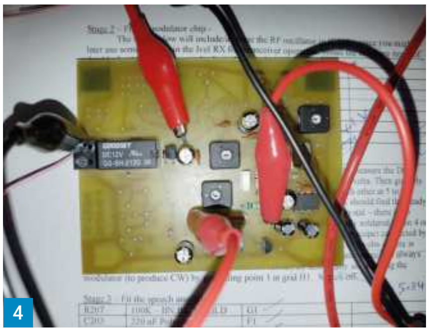

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Fig. 1: Measuring the voltage. Figs 2 & 3: Having suitable test equipment is a big help. Figs. 4 & 5: The board with test equipment connected.

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Importantly, using a 3.69MHz ceramic resonator in the Ilton Transmitter allows the builder, *if they have configured the Ivel for the 80m band,* to later on relocate the RF oscillator components from the Ilton transmitter to the Ivel receiver VFO. As I said earlier, remember this is tested for 80m only. The instructions are clear that this results in the Ivel receiver now having a restricted tuning range between 3.65 to 3.69MHz. Reading page 8, entitled *Alterations for Transceiver operation,* provides further details.

After fitting the 7.159MHz crystal, I applied 12V and tested the voltages on pins 1 and 2 of IC200, looking for between 1.0 and 1.5V. Both showed 1.41V. I then checked pins 4 and 5 looking for between 5.0 and 6.5V. I measured 5.84V, so no issues here.

Following the build guide, I could clearly hear the RF oscillator while using another receiver, but unfortunately attempting to use my 'value' frequency counter again proved fruitless. On the plus side my old Hameg scope could see the oscillator and a test with a Rohde & Schwarz CMT-42 Radio Tester did show a carrier frequency of 7.157MHz, which was good enough for me at this stage. This is **lesson three:** there is a reason good quality test equipment costs more, **Figs. 2** and **3.**

One other point here is that it clearly states in the notes for stage 2 that the oscillator stage will always run when the supply is on. Think about that for a moment. I didn't at the time but I certainly did later on!

Stage 3: Fitting the Speech Amplifier

The build out of stage three went without any problems with the required voltage at test point C being between 4 to 5V. Voltages at test point B needed to be between 1.75 to 2.25V. I measured 4.98 and 2.29V respectively. I didn't worry about the unexplained .04V.

One item of 'inexpensive' test kit that has worked correctly has been my FY6800 DDS Arbitrary Signal Generator/Counter. I set this for a 2kHz low level output and fed the output into point M then connected point C into the AF voltmeter on the R&S CMT-42. Playing around with R202 clearly showed the variable changes in voltage gain. I was happy this stage was working, **Figs. 4** and **5**.

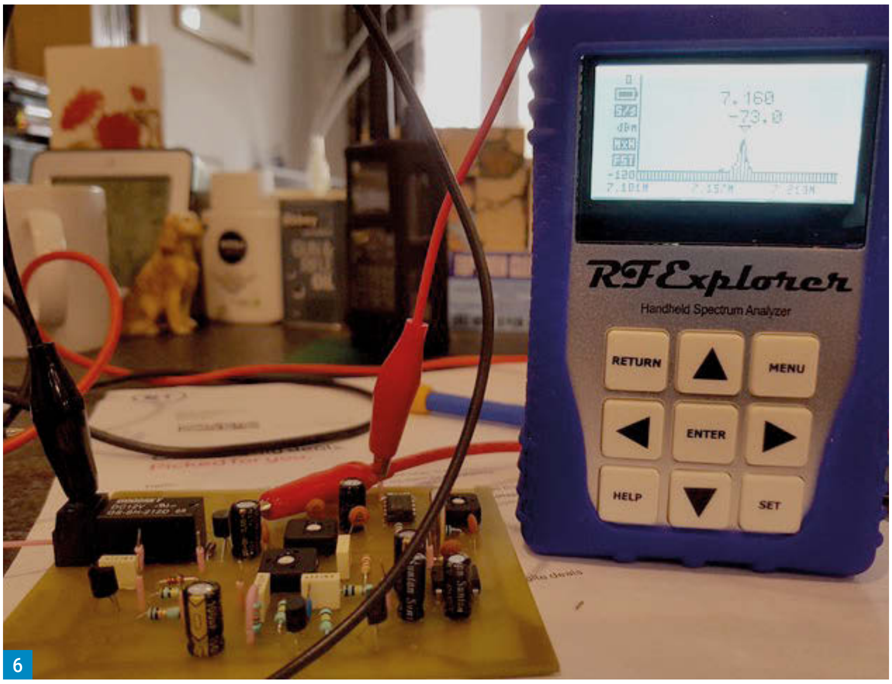
Stage 4: Fitting the Control Parts

Functional testing and voltage tests of stage four were completed without any issues. The only point to note here is a small typo; the instructions call for the PTT input at point 'P' at grid P3 to be grounded. P3 should read as D3.

Stage 5: Fit out the RF Amplifier/Driver Stage

Voltages measured on point 'D' were 1.372V minimum and 8.05V maximum when point 'P' was grounded and R209 adjusted. This

Figs 6 & 7: Measuring the RF output.
Figs. 8 & 9: The main boards fitted inside case.
Fig. 10: Heavy earth wire and 'finger' to overcome RFI inside case



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was near enough to the specifications for me. I didn't have a microphone to test with at this stage, but by adjusting the drive preset R212, the RF output level could be seen varying between −73dBm to −41dBm, **Figs. 6** and **7**.

Stage 6: Fitting the RF Output Stage Parts

This was straightforward and the colour photos show you how the heatsink and output transistor are anchored to the main board. The only thing that slightly annoyed me was not being able to get the transistor sitting completely parallel to the board, no matter how hard I tried re-seating the heatsink. It didn't matter in the end, with the transistor soldering to the board with no issues. Mental note to myself here; stop trying to do things perfectly!

Current measurements at this stage varied between 0.01A and 0.04A.

Stage 7: Fitting the Band Dependent Lowpass Filter Components

For some reason this was the stage I was really nervous about. I had never wound coils before and the perfectionist in me was horrified at the thought of messing this up. The funny thing is, toroid winding turned out to be stress free and quite relaxing. Reading the instructions clearly explains the number of turns required on each toroid. In my case, it was 14 turns of wire evenly spaced around each core. The toroid cores were wound and I was quite happy with the result. The only thing you need to pay attention to is to make sure you have scraped/burned off any enamel before you try to solder them into the board.

I fitted the necessary capacitors for the 40m band and that was the easy part over with.

At this point I jumped the gun a bit and decided to fit the Ilton board to the Ivel board. I started with my tried and trusted friend, Super Glue, then carefully lined up both boards before pressing the edges together. After this cured I soldered on the PCB jointing tabs and built up a copious supply of solder to ensure both boards were electrically connected.

The next stage was to source a suitable enclosure and this is where my decision created some 'interesting' and unexpected results later on. Be patient, all will be revealed!

As I said earlier, I had a vision of my Ivel and Ilton fitted inside a professional looking case; something that wouldn't look out of place in a shack but more importantly, it wouldn't look as if I had built it into a cigar box.

I decided to spare no expense and went 'all in' as they say. Foolish? Possibly. Expensive? Definitely. So, on to the Farnell website and out with the credit card. A word of warning here: Unless you operate a secret 'black ops' type of funding system, you will get found out eventually. The orders were placed and the invoices arrived in the post – to my horror. My wife did spot the spend and needless to say I won't be repeating this on the next project….

Anyway, moving on. I ordered a rather nice extruded aluminium box that would fit snugly around the transmitter and receiver, a 'concentric' type of DC socket and plug, a 'pig tail' small bore coax cable, with an SMA male and female fitted; a 12V LED, a panel-mount BNC socket and a panel-mount fuse holder, miniature loudspeaker, switch and headphone socket.

On eBay I found a shop in Cornwall selling a 'CB radio' microphone cable and from another supplier I found a 4-pin 'flying' microphone socket. Looking around the shack I found an unused 4-pin dynamic microphone and checking the wiring, pressed it into service.

With copious amounts of heatshrink sleeve, a super long microphone cable terminated in the supplied mic jack plug, was fabricated and tested. Hint: This is an area where I inadvertently 'made life harder for

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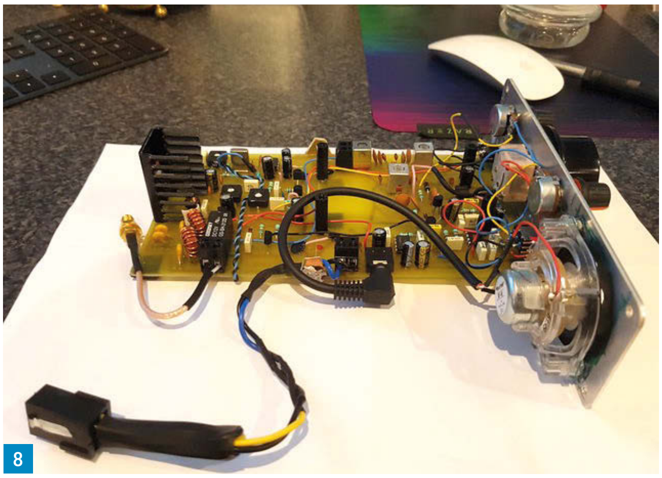
myself'. I will leave you to work out the possible pitfalls to my over-extended microphone cable…

All in all, a great time was had ordering the extra bits and pieces I needed and the next stage was to start bolting the separate parts together to produce the much-anticipated home-built HF transceiver.

Section 2: Making it All Work Together

Up to this point components were soldered in place, much aluminium machining and over enthusiastic drilling took place, boards connected together, power distribution and protection was designed and built and everything looked semi-professional (OK, it looked amateurish). Squinting at the assembled device in a certain light, produced a huge feeling of satisfaction. I was very pleased with myself, **Figs. 8** and **9**.

And then the fun really started. Initial tests consisted of setting up the mic gain, RF gain and drive to what I thought were the correct levels after checking current flow and power meter readings. It's worth noting at this point that adjusting the various pots for transmitter alignment is a very care-



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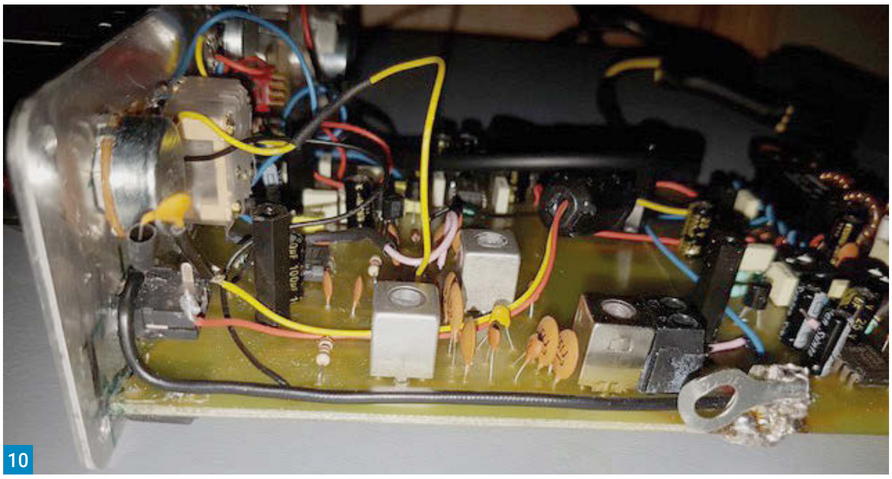

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ful exercise in precision. The adjustments are *extremely* sensitive and a fraction of a millimetre can cause stability problems. Listening on a broadcast general coverage radio the audio was there but not great sounding. Also, when looking closer, it was apparent the transmitter was pushing out 2.5W and drawing 600mA when test point '1' was grounded. This was definitely wrong. The other odd thing was, listening on my Yaesu FT-450, I could hear the signal on AM but not SSB.

Something was clearly amiss and it was time to contact the designer, Tim Walford, for some help.

Tim suggested various things and the area that made the biggest difference was re-checking solder joints around 8055, R212 and C215. Shining a very bright LED light under the board immediately showed five areas where the solder hadn't flowed properly. This was a revelation! The bad connections were re-made and the Ilton re-tested. The result was a huge improvement with audio sounding much better too. The decision was taken to install the Ivel and Ilton in the metal case. **Lesson four:** check and re-check all your solder connections.

Fitting the assembled boards into the metal case was easy enough, but powering up the transmitter produced some more interesting results. The first thing I noticed after fitting the boards into the enclosure was the RF output jumping to 5W with no voice audio on the carrier, just noise. The other hint something was amiss was the excessive current draw, a horrible screeching in the loudspeaker on releasing the PTT and the SWR/power meter behaving very strangely. The final straw was the grossly overheating PA transistor. Conclusion? The PA was bursting into oscillation every time I keyed the microphone. Hmmm. Very odd.

My first thought was a change in capacitance once the boards were inserted inside the case, or the boards shorting out against the metalwork. Checking for shorts showed none, and earth continuity across the Ilton and Ivel, the case, coax connector, power and microphone appeared solid on first inspection.

Oh dear. Another e-mail to Tim, this time explaining the instability once the Ilton was placed inside the metal enclosure. His immediate thoughts were along the lines of RF feedback into the microphone circuit and AF chain. He also suspected a grounding problem.

Tim's first suggestion was a 10nF capacitor across the microphone input and if this made no difference, then grounding was the culprit.

So, out came the boards again and the 10nF capacitor was fitted. Result? No change. However, something was nagging away at me that he was right about the grounding; the problem was I couldn't quite fathom it out. After all, I tested full earth continuity everywhere I expected it to be. Nothing had been left out. The only thing I didn't have was a separate RF earth and that just wasn't an option at this stage.

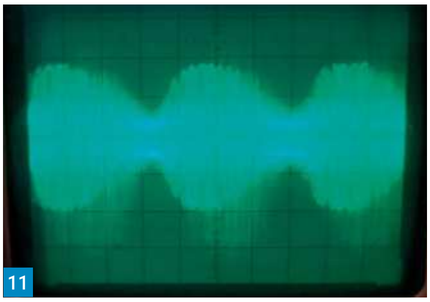
Finally, I decided on a belt and braces grounding solution following Tim's advice to run a substantial earth from the microphone input jack to the main board earth. To really make sure the connection was solid, I soldered a substantial metal tag on the board earth and bent it out so that it would act as a conducting 'finger' brushing against the inside of the case when the board was fitted, **Fig. 10**.

Result! The grounding was the main problem all this time and once the case was firmly bonded to the main board ground, the feedback and instability stopped and nice sounding audio was recovered. At last. **Lesson five:** you can never have too much grounding!

Additionally, I also put some ferrite cores over the microphone cable and DC supply cable. I don't know how much difference, if any, these made though.

Going for Broke

At the beginning of the project I had been thinking about the difference a speech compression module made to my Yaesu FT-817. Given the low QRP output of the Ilton, I searched for a speech compression module I could fit inside the case. Eventually



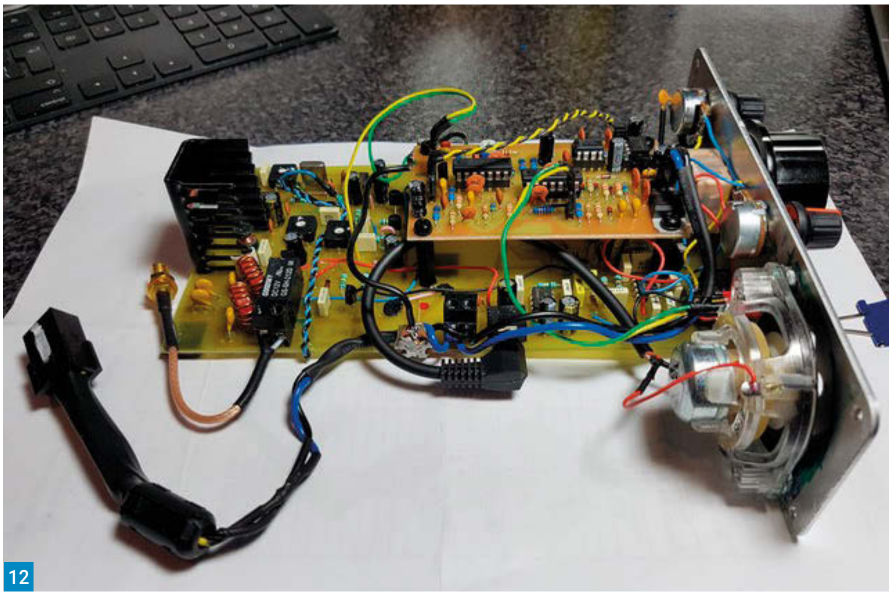


Fig. 11: Ensuring no flat topping in two-tone test
Fig. 12: The speech processor fitted in its final state.

I found a solution in kit form supplied by **Eric Edwards GW8LJJ**, called the FAT-MAX Speech Processor.

I ordered two kits in anticipation of building another kit next year (my wife doesn't know about this yet), and they arrived very quickly. The board and components are of very good quality and they went together really easily. Only undue haste meant I soldered a diode in the wrong way around, but a supply of spare diodes soon fixed that little problem. **Lesson six:** slow down when building and have spare components at hand for the invariable mistake!

Some nylon stand-offs were glued onto the Ivel board and the FAT-MAX was duly installed and wired into place. This time the lesson of good grounding was followed and another substantial grounding wire connected the earth on the FAT- MAX processor to the main grounding point on the Ivel and Ilton. Power was applied, the output checked on the oscilloscope and bingo, the effect of the speech processor could be clearly seen.

Time now for the real thing. The Ilton was terminated in a dummy load, power was applied and the microphone PTT was pressed. Result? My old friend – oscillation, instability, screeching, high current draw and a badly overheated PA transistor. Could I really contact Tim Walford yet again? Would he place me on the 'do not sell to this customer' list? Time to find out…

After gingerly e-mailing my next question the reply came back and I think it showed great restraint. To cut a long story short, the output from the FAT-MAX was just that, rather large. Putting 570kΩ in series with the audio output from the speech processor into the Ilton microphone 'audio in' at point 'M' tamed everything nicely.

Finally, I added a 10nF capacitor across point 'M' under the board, just to soak up any stray RF in the audio input. Possibly not necessary, but I wasn't taking any more chances. The lessons had been learned!

After a final prayer that I would never have to bother the designer again, I re-installed the radio back inside the enclosure and powered it up. This time I had a stable transmitter, good quality audio and no manic instability. The difference with the FAT-MAX Speech Processor switched in to the audio chain was very clear, with a richer, fuller sound.

One last commissioning test for RF drive adjustment was made with a two-tone oscillator and the oscilloscope. Flat topping was adjusted out and I was happy with the end result, **Fig. 11**.

On the Air

Strange propagation ensued while trying to make an 'across town' local test and I never did get that QSO. I know it is propagation and not the Ilton, as I initially heard **Colin G0PHO** on the pre-arranged test, then no more, even with him trying with an excellent antenna his end. That said, I am 100% satisfied it is transmitting a high-quality signal as it is quite audible two floors down on the broadcast receiver. I also recorded it to be quite certain.

Final Comments

I said at the beginning that the oscillator is running all the time power is applied. If you don't want this (I didn't), you can easily get around it by making sure the oscillator only fires up when the PTT is pressed. Read page 9 of the Ilton instructions for details.

I almost forgot this. Keep the microphone cable short. Don't try the 'clever' solution of making an adaptor as I did. It looks cool but it weighs a ton, it's clumsy, and it makes a great antenna for that stray RF!

Conclusion

With the benefit of hindsight I would have done some things differently. Really reading the build notes at the beginning might have made me think about my choice of band. That said, I don't have neighbours who appreciate an 80m dipole, so I had a good reason to go down my particular route of the 40m band.

The point is this though, ask yourself if you can live with a transmitter on a single crystal-controlled frequency. I thought I could, but it's a real pain.

Also, plan your metal cutting with great precision. Readers will clearly see the result of my less than perfect centre punch accuracy when they look at the front of the case!

Based on my experience with the Ilton I would not recommend a metal enclosure either. Plastic is far cheaper and much easier to machine, as well as less likely to cause RFI issues inside your finished project.

So, would I recommend the experience of integrating the Ivel and Ilton? Absolutely yes. You may, like me, remember things long forgotten. You might, once again, enjoy using test equipment and really thinking about what is going on with a circuit when things don't go to plan.

And finally, did I end up with a radio I could be proud of and use in my shack and was it worth all the effort? Yes and yes.

Acknowledgements:

My wife and family for their patience while the kitchen became a radio build and test lab for many months. Tim Walford for not refusing to answer my e-mails when I came unstuck multiple times. Colin G0PHO who tried in vain to make contact with me across town on 40m.

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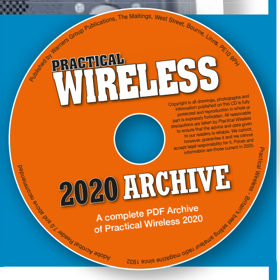

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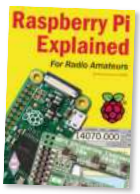

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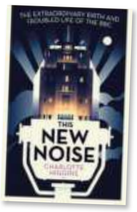

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Richard Constantine G3UGF
practicalwireless@warnersgroup.co.uk

What's a ZM-2?

Richard Constantine G3UGF sings the praises of a neat ATU for QRP operation.

In a recent article on QRP accessories (January 2021) I mentioned the ZM-2 matching device as an alternative to using an auto-tuner. It's been around in the QRP community for many years, both in kit form and as a ready-made item, but perhaps not much known to those new to QRP, if my e-post is anything to go by.

A relatively low-cost alternative, it's available in three basic forms, either as a balanced-only tuner with post terminals or with the addition of either BNC or SO239 coaxial sockets and switchable to unbalanced. It's available ready built, or in kit form, from Emtech in the USA. – see link: https://steadynet.com/emtech

The kit form is $25.00 cheaper and as a first or easy Winter project, ready for Spring it takes around four hours to put together. The instructions contain both physical layouts, wiring and circuit plans that so remind me of my teenage years as an avid *PW* reader.

I, like many others of my era, learned to read abstract circuit diagrams by first following the drawings that accompanied every project back in the day. For anyone wishing to build their own ZM-2, real world drawings are a bonus.

So what is a ZM-2?

What then is a ZM-2? It's a single coil, 80-10m Z-match ATU. It also has a novel VSWR sensor with a built in LED indicator. Power handling is limited to 15W maximum, due to the use of Policon variable capacitors, but as QRP is typically 5W, they are more than adequate.

There is much Z-match information both online and in many good antenna handbooks. Its novel design ensures that the low impedance, resonant frequency circuit load presented to the transmitter can be efficiently coupled to a wide range of antennas. It also provides a small measure of additional selectivity to the front end of a receiver and has several other benefits.

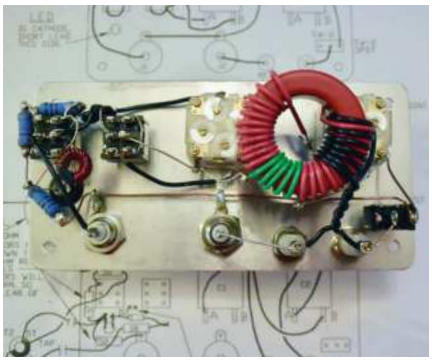
Its antenna connection is link coupled, fully isolated from earth and therefore balanced.

This makes it ideal for a comprehensive range of antennas, including, dipoles, doublets, open wire or 300/450Ω ribbon feeders and counterpoises. Unlike some Z matchers, the ZM-2 has a link switch fitted, that can earth one leg of the antenna coupling coil. With this in circuit the unit's options extend to include random long wires, earth connections and coaxial fed antennas.

A significant feature of the Z-match design, that dates back to early last century, is its ability to transformer match antennas exhibiting much higher impedances than many modern coaxial tuners. It's not uncommon to see automatic tuners limited to a maximum impedance range of between 500 to 1500Ω, easily exceed by any Z-match. Wideband, ferrite core based, baluns and UNUN transformers are commonplace today, both internal or external to a tuner unit. Sometimes these can be guilty of dissipating much needed QRP and QRO RF as heat, if used incorrectly. A well coupled Z-match can be a better choice.

Until recently and the explosion of commercially available QRP radios, less sophisticated homebrew rigs rarely contained a VSWR bridge. For this reason, the ZM-2 incorporates a simple but effective, bridge circuit tuning indicator. In normal operation it is bypassed. When in circuit for antenna adjustment, the brighter the LED indicator glows, the better the match.

As much QRP activity is portable, use of random wires of variable lengths is often the antenna of choice. This can mean



significant feed impedance variations according to the frequency in use. The ZM-2 has an option to switch in either a 250pF or 500pF fixed value capacitor into the series leg of the primary circuit, thereby extending its matching capability.

Personally speaking, and although much of my portable gear now include auto-tuners, I wouldn't leave home without my trusty, ZM-2. It requires no DC power, weighs only 205 grams and measures just 130 x 65 x 61mm, including controls and terminals. It's always in my bag. When others fail, the Z match is my go-to solution.

Currently a ready-built ZM-2 is available by post from Emtech USA at $87.50. The kit version $62.50 plus, shipping.

1

Multiphase Generator

Eric Edwards GW8LJJ describes a handy piece of test equipment for the shack.

Eric Edwards GW8LJJ
ericgw8ljj@outlook.com

This project, **Fig. 1**, is a useful generator for the shack and is based on the Linear Technology Corporation LTC6902, which is a multiphase oscillator with spread spectrum frequency modulation (SSFM). What all that means is that it is an oscillator that has a selection of two, three or four phase (square wave) outputs with a modulation function that can be used for designing with switch-mode power supplies (SMPSs). The SSFM is a pseudorandom noise signal to spread the oscillator's energy over a wide frequency band used for the design of SMPSs and is not used for this project as it is not a linear sweep function.

The output from this generator is suitable for driving general digital logic circuits and is designed primarily to provide an accurate and stable clock for switching regulators but there are many uses for the radio amateur.

Description and Features

The LTC6902 is a precision, low power oscillator with its frequency controlled by a fixed or variable resistor. The frequency range is 5Hz to 20MHz although the actual master oscillator is from 100kHz to 20MHz. It has a programmable divider to produce either a division ratio of 1, 10 or 100 simply by placing pin 2 at ground, open, or 5V to increase the range from 5Hz to 20MHz and it provides three types of output waveforms (multiphase). The supply voltage is 5V (2.7V to 5.5V). The size is small as it is housed in MSOP package and has ten pins (five per side), which is a bit tricky to mount onto an adapter that converts it to a standard DIL size. With this in mind I am supplying the LTC6902 on a 10-way DIL adapter. Pin 3 selects either two, three or four phase outputs by placing Pin 3 at ground, open or 5V.

The Circuit

The circuit is shown at **Fig. 2**. The component count is low because all the work is done within the device. The main part of the circuit is the LTC6902 and there are few components added to make it a useful shack project.

Power is from a PP3 (9V) battery via a low power regulator to supply 5V to the LTC6902. There are no other active components and the current consumption is very low at typically 400µA (0.0004A). There are four phases at the dedicated pins of the integrated circuit and they are taken to BNC sockets or any sockets that you care to use. I used SMA types on my first prototype but even phono sockets can be used.

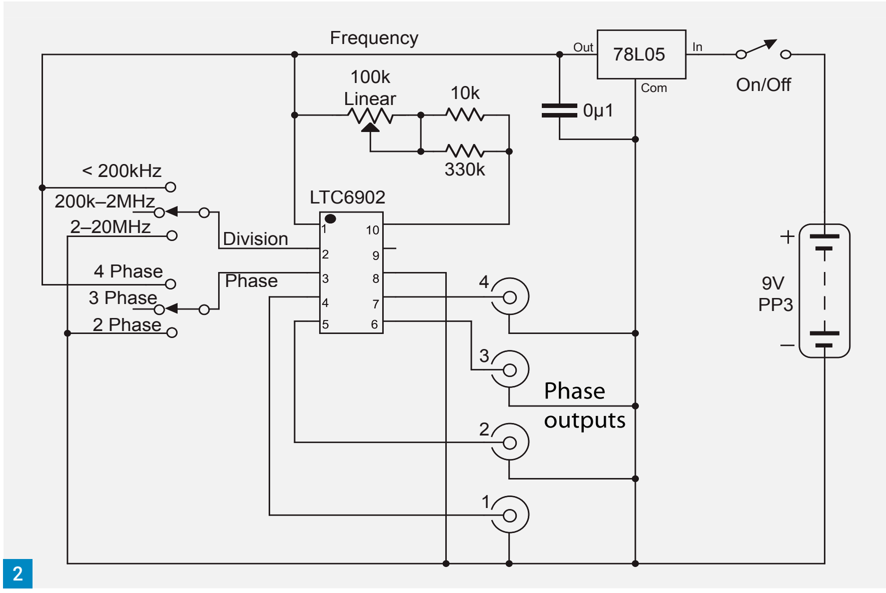
There are three slide switches with two used for the frequency range and number of phases and a third one for the power supply. A linear potentiometer (100kΩ) is used for the frequency control and has two fixed resistors in parallel to provide fairly accurate range coverage. The two parallel 1% resistors 330kΩ and 10kΩ provide 9.7kΩ.

Project Frequency Ranges

In this project I have set the frequency ranges for the three settings. The first is 2MHz to 20MHz. With the division set at 10 the range is 200kHz to 2MHz and with the division set at 100 it is 20kHz to 200kHz. There is some overlap on each of the three ranges so it will provide signals a little below and above the labelled frequencies for project development and experiments.

The Waveforms

The two-phase waveform is shown at **Fig. 3**. There are three settings for the different waveforms. With the two-phase mode the outputs are 50% duty, in other words, the mark to space is 50:50, which is 50% on and 50% off. This also means that the waveforms at pin 1 and pin 2 are 180° out of phase to each other. Although the waveform on pin 2 is an inverted version of the waveform at pin 1, it is not



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simply routed through an inverter because that would mean a delay of the waveform at pin 2.

The waveforms are matched so that they are exactly 180° out of phase. The waveforms on pins 3 and 4 are exact replicas of the waveforms at pins 1 and 2. The frequency output at these pins is as described above.

The three-phase waveform is shown at **Fig. 4**. With the three-phase mode, the outputs are on pins 1, 2 and 3 and have 33.3% duty cycles. There is no output on pin 4 and it is at logic low (0V). The waveform at pin 2 lags the waveform at pin 1 by 120° and the waveform at pin 3 lags the waveform at pin 2 by 120°. The output frequency is further divided by 3.

The four-phase waveform is shown at **Fig. 5**. The four-phase mode waveforms have 50% duty cycles and are all 90° out of phase to each other. The output frequency is further divided by 4 and on that range the lowest frequency is 1.8kHz (just below on this project).

Uses

The outputs are square waves and can be useful for connecting to logic circuits. They can be converted to sine waves with add-on lowpass filters (LPF) or bandpass filters (BPF). It can also be used to make triangle waveforms (ramps) by adding integrators. The 2-phase and 4-phase outputs are useful for experimenting with phasing receivers and transmitters.

The PCB

The PCB is a single-sided FR4 type and contains all the parts. The LTC6902 is very small (to me), MSOP type and is fitted onto a MSOP-to-DIL adaptor before dispatch as many others may have difficulty in soldering these tiny integrated circuits.

Fig. 1: The finished generator. Fig. 2:The circuit. Fig. 3: 2-phase waveform. Fig. 4: 3-phase waveform. Fig. 5: Four-phase waveform. Fig. 6: The potentiometer in place. Fig. 7: The three switches. Fig. 8: Location of battery. Fig. 9: Front view.

The potentiometer is pushed through the PCB on the top side and fitted onto pins that have been soldered onto the PCB, **Fig. 6**, and the excess pins can be cut back.

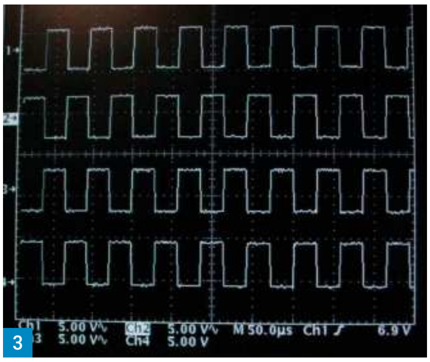
There are three three-position slide switches used in the project with two used for the division and waveforms and a third used for the power on and off. This third switch is the same type as the other two but only two contacts are used although the centre and top positions are used for off. These three switches are mounted on the PCB copper side and soldered with the pins of the switches protruding half-way through the board, **Fig. 9**.

The potentiometer is fitted with a control knob (supplied) and pushed through the plastic housing (part number supplied at the end of this article) with a hole cut to a suitable size, **Fig. 8**. A template is supplied with the parts list to show the cut-outs needed for this control and the three slide switches.

A PP3 type battery holder is also fitted in the PCB along with a set of pins for the screened leads for connecting the waveform outputs to the BNC connectors attached on the side of the case, **Fig. 7**.

Testing

Connect a 4-channel oscilloscope, or one or two channels at a time if a 4-channel scope is not available, to the four BNC (or whatever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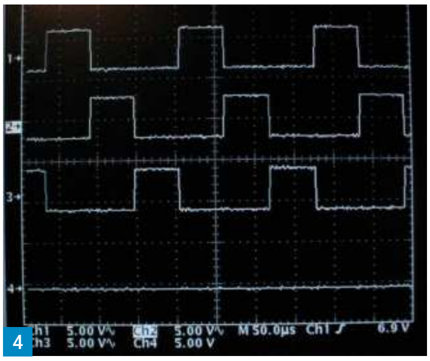
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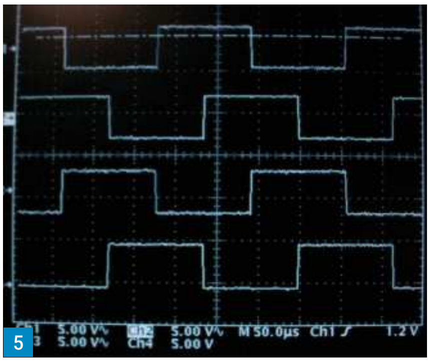
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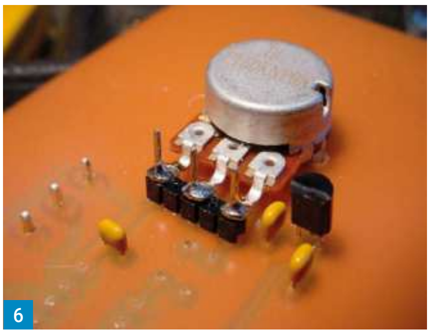
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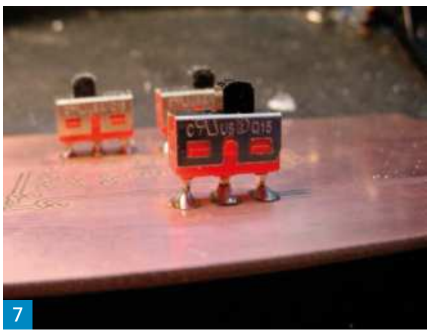
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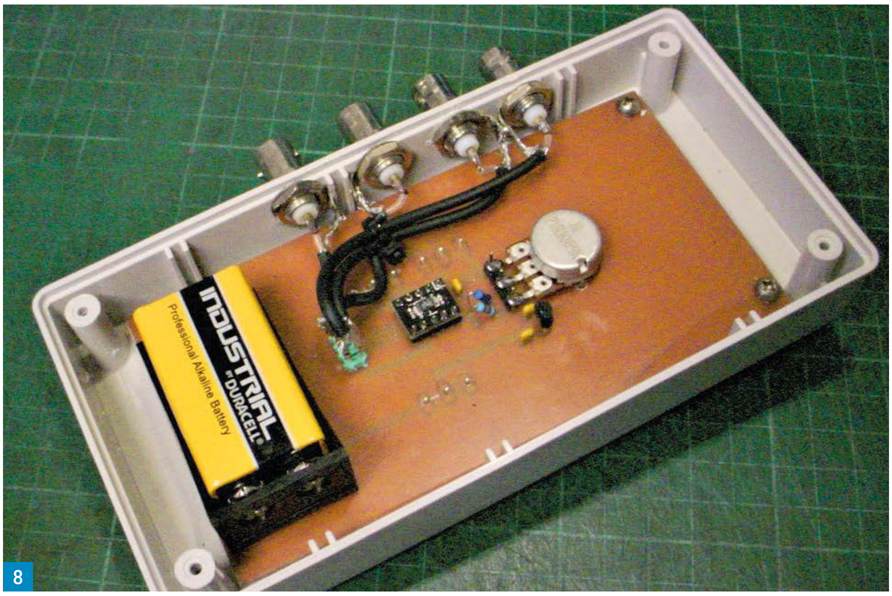

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sockets you have fitted) and set the scope channel amplitudes to 5V. Adjust the control on the multiphase unit to 3MHz (centre scale), the frequency slide switch to down (2 to 20MHz) and the phase slide switch to 4-phase. Turn the multiphase unit to on and the scope timebase to 1.00µS.

The scope should display the four phases with eight (approximate) mark-to-space (8 on and 8 off) waveforms with each channel being displaced by 90°. Set the frequency switch to <200kHz and the tuning control to 1.8MHz (which is 18kHz) and setting the scope timebase to 50µS the waveforms should look like Fig. 2. The 200kHz scale is the divide-by-100 of the main scale. The waveforms on channel 1 and 2 are 180° out of phase and the waveforms on channel 3 and 4 are replicas of channels 1 and 2. The different waveforms and frequencies will allow experimenting with many projects and can be used to evaluate lowpass, highpass and bandpass filters as well as using the different waveforms for the various types of phasing receivers and transmitters. The frequency is not spot-on accurate but is certainly good and stable for many tests and experimenting with. The waveforms are accurate in the phases and provide true phase relationships with no logic delays, which will be the case of using logic inverters to produce the bi-phases.

As usual I am supplying a 'picking list' for the PCB and the available parts.

Reference

- Picking list: GW8LJJ
- Suitable case: Farnell Part number 1426563
- LTC6902 data: **https://tinyurl.com/y5o5eesa**

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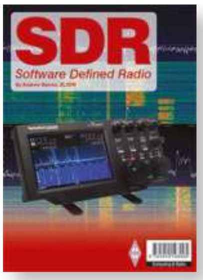

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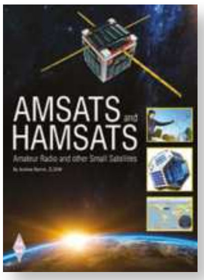

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Winter Es Propagation: Full of Surprises!

Tim Kirby GW4VXE reports on a surprising winter Es opening on 6m.

Tim Kirby GW4VXE
longworthtim@gmail.com

Anyone who's seen one of my recent Zoom talks for radio clubs will know that I've been mentioning Winter Sporadic E and the openings that can occur on the VHF bands (50, 70 and very occasionally 144MHz) from late December into January. Six and four metre openings are not uncommon and once in a while, there's even a 144MHz opening as there was in December 2019.

My general impression was that Winter Es was good for one-hop contacts around Europe and that the openings were a nice reminder, in midwinter, that the bands do open up sometimes.

What happened on January 12th rather changed my view! In the late morning, **Richard GW1JFV** kindly messaged me to let me know that 50MHz was open. I take my 6m beam down in the winter time to avoid the gales, but I recently discovered that the 20m vertical works 'acceptably' on receive and 'marginally' on transmit. So, I switched over to 6m with the makeshift antenna and was delighted to see some big signals from Germany and Hungary in particular. I worked a couple for fun and carried on with what I was doing in the shack while keeping an eye on the screen. To my surprise, I started to see a couple of stations calling A65BR and then someone else calling 9K2GS. This was not your average Winter Es opening, it seemed.

Even more surprising, a few minutes later, I heard 9K2GS (on the 20m vertical). It would be nice to report that I managed a QSO, but I didn't. The surprises weren't over, though and a few minutes later, I saw people calling – and working – WW1L and VE1PZ.

I don't recall such a widespread Winter Es opening on 6m before. When I had thought of Winter Es, I had imagined one or two small Es clouds around which we might be able to use fleetingly. Clearly this was all wrong because in addition to the widespread geographical nature of the opening, it started before noon and was still going six hours later.

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Was this some huge patch of Es, a series of smaller clouds or something completely different? I thought I'd drop a note to **Jim Bacon G3YLA** to see what he thought. Jim very kindly agreed that I could reproduce his e-mail here in print.

"It all feels very much like a traditional Es event profile with multiple and single-hop paths appearing to match regions of enhanced Es probability. I didn't get screen grab yesterday, but these upper air patterns today have shown a similarly favourable distribution. You would be able to construct a multi-hop path across the Atlantic and into the Middle East using the brighter EPI colour shading regions. These are suppressed in the 'close season' for Es but still give a geographical flavour. I doubt it was a super huge region, but a traditional combining of separate multi-hop steps. These patterns tend to be relatively slow moving so it's not surprising that good conditions lasted into the evening like a real summer Es season event. I was still hearing 10m CW in mid-evening.

"There is probably something significant about the mid-winter tendency for isolated Es events that needs further explanation. It could, for example, be a factor of enhanced meteor input, which is picked out in the background meteor count and the regular appearance of an important January meteor shower, the Quadrantids. It may also be partly due to changed background atmospheric flow in the stratosphere, possibly linked to Sudden Stratospheric Warmings, which puts the flow into a weak easterly pattern, similar to the high summer main Es season.

"All in all, it'll end up utilising the same physics as the summer Es, so we need to find one of the ingredients of the complex pathway towards making sporadic E, that was fundamentally different this January… and probably in other January events too."

Fascinating stuff. Jim and I agree that the intensity of operating that we have in the FT8-era really helps identify these types of openings, which might have very easily been missed previously.

The Magic Bands: a Guide to 6m and 4m Amateur Radio

A copy of *The Magic Bands – a guide to 6m and 4m Amateur Radio* written by **Don G3XTT** and published by the RSGB recently landed on the operating desk here. It runs to 224 pages and aims to appeal to all six and four metre enthusiasts whether they are newcomers or 'old-hands'. The book is a rework of Don's *Six Metre Handbook*, which was first published 12 years ago. This is an extensive revision, and significantly, in my view, incorporates useful information on 'digital operating techniques' as well as more traditional operating. **Justin G0KSC** has contributed two new antenna designs (one for each band) to the book, which will be of great interest to many. The propagation chapter is comprehensive and I was pleased to read a section on Short-Path Summer Solstice Propagation (SSSP), which has only really been recognised in the last 15 years and is responsible, from Europe on 6m, for the early morning openings into Japan and the Far East as well as the afternoon openings into the West Coast of the USA.

It's nice to see 70MHz covered in the book. Despite being 'close' in frequency, six and four metres are two quite different animals, with 'four' being a little more understated than its showy cousin! So, you'll find quite a lot more in the book about six metres than four, but there is plenty of information about four metres – certainly enough to answer all the questions you might have when getting onto the band for the first time or to 're-enthuse' you, if you are thinking of returning there.

The book is well illustrated with many interesting pieces of equipment, QSLs, expeditions and other graphics. It's written in an engaging style and I quickly found myself absorbed when I picked it up to flick through for a first impression. If you enjoy Six and Four, you'll enjoy the book, which you can find on the RadioEnthusiast website priced £15.99 with £2.99 delivery to the UK and £8 to Europe. RSGB members can also find the book in the RSGB shop, where you can apply your members' discount. The book is also available on Kindle, which is a nice touch.

D-STAR: DOOZY and Picture Exchange

Jef ON8NT writes, "*David PA7LIM, the man behind PEANUT and BLUEDV, has developed new software, which supports Icom radios in the terminal mode, no hotspot is required. See the website below to download the software and for further details. At the present time it is available only for Windows 10. With Doozy for Windows you can make QSOs using your Windows PC on D-STAR (DPLUS, DEXTRA, DCS and XLX), and you can also exchange pictures. The software is still experimental and under development. It is getting better every day. Hopefully, the Android version will be out soon. I exchanged perfect pics both sides with **Ted VE7VIB** from BC, Canada, who was using DOOZY. If you're one of the lucky people with a new IC-705, why not give this a go!*"

www.pa7lim.nl/doozy

The 6m Band

Chris Colclough G1VDP (Nuneaton), **Fig. 1**, has found some of the winter Es openings on the 6m band, including working YL and SP on Boxing Day. SM, SP, DL, OH, OH0, LY and LA were all worked on December 27th with another opening on December 28th when Chris worked OH, SM, EA, YL, SP, DL, OK, F, S5 as well as G.

Peter Taylor G8BCG (Liskeard) is another one to drop his 6m antenna during the winter. However, Peter was delighted to work WW1L and two other stations using a white stick vertical and a barefoot IC-7300 during an opening on the late afternoon of January 15th.

Tony Collett G4NBS (Cambridge) worked GI0OTC (IO65) using MSK144 on December 14th. Tony caught the end of an Es opening on December 13th and, with his beam to the SW, worked SM5EPO (JP80), OH3AWW (KP11) and OH1LXF (KP20), all on FT8. Tony says that the UK Activity Contest on January 14th suffered from 'the worst conditions ever'! Highlights were working GD8EXI (at ESP level), GW0GEI (IO72) who was peaking 599 at times and G0CNN (IO94).

Fig. 1: The neat and effective VHF antennas of Chris G1VDP. Fig. 2: A second operator appeared to 'help' ZB2GI during the Geminids meteor shower. Fig. 3: Patrick WD9EWK's VUCC/r award for operating from over 100 grid squares. Fig. 4: The Alinco DR-735 in use at WD9EWK. It offers full duplex operation.

The 4m Band

News from the **D4VHF** team on Cape Verde, via their social media channels, is that they will be on the 4m band this year, with up to 500W with a Yagi towards Europe, so that should make for some interesting contacts later in the year.

Chris G1VDP made his first MSK144 contact on the band, working DK2EA (JO50) on December 30th. Chris has also been active on tropo, working some more local stations.

The 2m Band

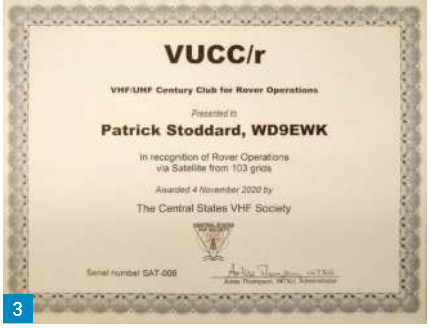
Here at **GW4VXE** I enjoyed the Quadrantids meteor shower for the first time from here. Using 250W to a 6-element InnovAntennas LFA Yagi, I worked F6CIS (IN94), EB1DJ (IN52), EB1A (IN73), LA4YGA (JO48), SM6TZL (JO67), OZ9FZ (JO46) and SM7WW (JO65). Perhaps the most interesting station heard but not worked was EA9ABC from North Africa! There have been some nice FT8 QSOs too, including some regular ones with **Andy G7GQA/P** (IO82) in Gloucestershire, who is running low power to a vertical.

Kevin Hewitt ZB2GI took part in the Geminids meteor shower from the top of the Rock of Gibraltar, carrying his FT-897, preamp, small Yagi, mast, notebook PC, interface and USB soundcard all up to the top of the Rock by the cable car, **Fig. 2**. Kev completed three QSOs with G1KAW (JO00), F1HQM (JN23) and EA7KP (IM97). Unfortunately, by the Quadrantids, Gibraltar, like us, was in lockdown, so no portable operation was possible.

Chris G1VDP is enjoying the band and sees DL6YBF (JO31) coming through on a regular basis. He has also worked a number of ON and PA stations.

Jef Van Raepenbusch ON8NT (Aalter) was active in the UK Activity Contest on December 1st, working G4CLA (IO92) and G3RGS (IO92).

2



3

The 70cm Band

Tony G4NBS was active during the January UK Activity Contest and found conditions reasonable, although there was some sudden and very deep fading. PE1EWR and PA5Y were worked from the continent while GD1MIP, GD8EXI, GM3SEK, GM4BYF, GM4JTJ and GI6ATZ were also nice contacts. The European FT8 activity period on January 13th was much busier than last year, Tony says, with conditions being average/poor with many traces not decodable across the North Sea. Tony's best DX was DL8DAU (JO40) and 46 stations in 17 locators. **Jason G4KVT** (Bristol) reported on Twitter that the band was so busy it looked like 20m, while **Matt M0LMK** (Margate) worked a good number of stations, including DL2DAA (JN48), using his vertical antenna and 50W.

The 23cm Band

Dave Thorpe G4FKI (Ampthill) says that the Barkway 23cm repeater in Cambridgeshire is back on. It's vertically polarised and operates in beacon mode when not in use. Dave says it's surprising how many people have access to the band now and that the repeater has also helped to encourage some simplex contacts.

The 13cm Band

Steve Macdonald G4AQB (Bolton) writes, "*There's quite a lot of interest on 13cm in my area at the moment. I am using an SG-Labs transverter and a 19-element Yagi. This* *has worked well during the UKAC Contests. We now have a number of stations in the Manchester area trying out 13cm and I have been able to put out a signal so that other stations can run tests. Most stations are using SG-Labs transverters, which is an excellent piece of equipment to get started on 13cm. A couple of stations have also bought the SG-Labs amplifier and pre-amp, giving a fair amount of RF on the 13cm band. We look forward to working other stations in the coming UKAC contests".*

Satellites

Jef ON8NT listened to the ARISS contact from the International Space Station on December 4th and took part in the ARISS Slow Scan TV event from December 24th to 31st. On December 27th, when there was a storm with winds up to 100km/h. Jef dropped his antennas and used the Goonhilly WebSDR to receive some of the images. Good thinking.

Kev ZB2GI also took part in the same event. Because some of the passes were after the curfew imposed by the Gibraltar government to try and slow the effects of COVID-19, Kev managed to get some good pictures by poking his log periodic antenna out of the window.

Graham Jones G3VKV (Cheltenham) says he's been listening on the QO-100 satellite and has heard the biggest pileup he's seen for a long while with stations calling DP0POL/MM on the Icebreaker *Polarstern*, which has been making a voyage south from Europe to the Antarctic station *Neumayer – Station III*. Graham worked them in IC47. You can see a video of the operation here:
https://tinyurl.com/y3s8lk7d

Peter G8BCG has also been enjoying working the /MM as it headed south from the Canary Islands towards the Antarctic, working them from an impressive list of squares: HK82, HJ99, HJ98, HJ95, HJ94, HJ93, HI94, HI91, HI90, HH99, IH09, IH05, IG08, IG04, IG10, IF19, IF10, IE26, IE25, IC47, IC46 and IC45. Once the team arrive at the base, they will be on as DP0GVN from IB59UI. DP0POL/MM made 2759 QSOs with 760 different stations in 50 DXCC entities, on the journey south. Peter also worked AP2AUM on QO-100 (SSB) who had almost as big a pileup as DP0POL/MM.

Patrick Stoddard WD9EWK (Phoenix) sends his much appreciated view of satellites from the USA. For space reasons, I have had to shorten it more than I would have wished – sorry Patrick! "*AO-91 and AO-92 are now both silent, as AMSAT is trying to see if a break will allow these satellites to resume operating. PO-101's FM repeater has remained available for amateur use, and AO-27 for those in the Northern Hemisphere.*

*"In mid-December, **Tyler KL7TN** made a trip from his home in Alaska to Hawaii for a few days of satellite operating. I have worked stations via satellite from Hawaii over the years from Arizona, and wanted to at least say "hello" to Tyler while he was out there. One afternoon, I drove to my nearest grid boundary in the Phoenix area (DM33/DM43) to work him. A couple of nights later, I drove south of Phoenix to work from grid DM32. Parked at a highway junction a couple of hours after sunset, Tyler showed up on an AO-27 pass, making a few of us in the western USA happy. Two days after that, I was at DM31 in southern Arizona, and was able to work Tyler as he visited two different grids (BK19, BK29).*

"In the past month, I received a nice certificate from the Central States VHF Society, the VUCC/r award [**Fig. 3**]*. The VUCC/r award recognises operators who go out and operate from at least 100 different grid locators. The rules for this award were changed to allow for the use of Logbook of the World confirmations along with QSL cards, when applying for this award. I was able to document contacts made from all over the continental USA, from 103 different grids, for this award. In total, I have operated from 124 different grids in the USA, along with three other countries (Australia, Canada, Mexico), but only used contacts made from the USA to get this award. More awards for other bands have been issued, as mine was only the eighth award issued to a satellite rover.*

4

"After almost a month of shipping delays, I received an Alinco DR-735 [**Fig. 4**] *I had ordered in early December. This 2m/70cm FM mobile radio looked like it might be suitable for FM satellite operating, and I haven't ever seen anyone mention using one for satellites. It is capable of cross-band full-duplex operation, and after cranking down the microphone gain I have been able to use it on many FM satellite passes, including the ISS cross-band repeater, in the past few weeks. Even though other radios may have slightly better sensitivity and selectivity figures, the DR-735 is a viable (and, possibly, cost-effective) option for someone wanting a dual-band mobile radio that would work well for FM satellites".*

Here at GW4VXE I wanted to take advantage of the re-appearance of AO-92 for a few days from Boxing Day, so tried to catch the westerly passes out over the Atlantic, making lots of enjoyable QSOs. The best DX was VE1CWJ worked on January 1st. The satellite is now off again, to see if the battery will recover to support further periods of operation.

DATV

Graham G3VKV has finished building two amplifiers for 2m and 70cm TV for use with his Adalm Pluto unit. Both of them give a clean 4W output. Graham had been testing with **Steve G4NZV** a few miles away in Tewkesbury and had received good pictures from Steve on 13cm. After that, they had a duplex video QSO from 437 to 2323MHz, which, Graham says, was a first for both of them.

That's it for this month. Thank you to everyone who has contributed. Please keep in touch.

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Getting Started (Part VIII)

Colin Redwood G6MXL
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Colin G6MXL introduces newcomers to soldering, a key skill for most home construction.

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As I write this in early January 2021, it looks as though most of the UK will be under some form of lockdown for at least a couple of months. Besides operating, I suspect that a number of readers may be considering trying out home construction for the first time. A key skill for this is an ability to make soldered joints. While you may think that you do not want to build your own transmitters and receivers, some basic soldering skills are needed even to set up a fairly simple station. Even if you are just putting a PL259 plug onto some coax or making up a DC lead from your power supply to your transceiver, you'll need to solder the connections.

For the purposes of this article, I'm confining my attention to soldering conventional components and excluding consideration of the small surface mount devices (SMDs). I'd suggest practising soldering some spare components into a piece of scrap printed circuit board (PCB) or Vero (matrix board with copper strips) to start with.

Which Iron?

If you look around, you will find that there is a wide range of soldering irons available. The ones used by plumbers are certainly not suitable for amateur radio purposes as the bit (the hot tip at the end of the soldering iron) is far too big!

Some of the more expensive soldering irons are thermostatically controlled. These are great if you really get into construction in a big way. They enable you to provide more heat when needed for a larger joint and less when soldering small components.

For general amateur use I think 25W irons are ideal for the typical constructor. If you go for more power, then you are likely to damage temperature sensitive components.

If you choose a lower power, then you might not have enough heat to solder larger joints. Beware that some of the cheapest soldering irons are not powerful enough for our purposes even if they claim to be rated at 25W.

I've been using a 25W iron from Antex for many years. Antex have been in the soldering iron business for decades and have a range of bit sizes to suit any printed circuit solder joint you might wish to make, and they have stands, replacement bits in various sizes and heating elements available: https://tinyurl.com/y3qjvd53

Stand

At the same time as you purchase your soldering iron, make sure that you purchase a suitable soldering iron stand, **Fig. 1.** The stand is designed for somewhere to safely put a hot iron between making soldered joints. Most stands provide a sponge, which you soak in water. While soldering you can wipe the hot tip of the soldering iron on the sponge to remove excess solder. Just laying a hot soldering iron on a table or bench is asking for trouble!

Solder

Just as plumbers' soldering irons are not suited to amateur radio needs, neither is plumber's solder. For amateur radio construction we need thin solder, **Fig. 2.** Until a few years ago, most solder sold in the UK contained lead, typically an amalgam of 40% tin with 60% lead. These days, most solder is sold 'lead free' with a typical composition of 99% tin with 1% copper. Both the lead and lead-free varieties contain flux, which helps remove any oxidised metal, seals out air to prevent further oxidation and also improves the flow of the solder ('wetting').

Safety

A soldering iron gets very hot – more than enough to burn you. So, take care not to touch the hot end. You should hold the iron by the handle only. Hold it as if you were holding a pen when writing. Don't be tempted to see if it is warming up by touching the metal parts! Use a proper soldering iron stand when you're not actually making a soldered joint.

Fumes

When you solder, fumes are produced. While the amounts are small, they can accumulate with time, so you should solder in a well-ventilated place. Indoors with a window open is a good idea. Soldering outdoors, particularly in winter, is not such a good idea as the components needing soldering are so much colder than indoors and any wind is likely to have a cooling effect.

Eyes

If you don't wear spectacles, then you should certainly wear some eye protection. In my experience, it is rare for solder to splash up into the air, but it is not unknown. This is most likely to happen when you're removing components from

Fig. 1: A 25W Antex soldering iron and stand. Note the moistened yellow sponge on the base. Fig. 2: Solder. Fig. 3: Fibre pen. Fig. 4: Side-cutters. Fig. 5: Compression-type PL259 plug. Fig. 6: Solder sucker.

a circuit, and when soldering a PCB where there is some moisture present (perhaps a new board that you have just washed). Don't lean down closer than is absolutely necessary to see what you are doing. I'd also avoid wearing your best clothing!

Preparations

Before you plug in your soldering iron, soak the sponge at the base of the stand in some cold water. Then check that the tip is clean (it will be clean if new). If not, you may need to lightly file it. If you are in doubt, try tinning it (see below).

Tinning the Tip

Plug the soldering iron in and wait for a few minutes for it to really warm up. After a few minutes, dab a bit of solder on the tip. If it doesn't melt immediately, then it isn't hot enough. Wait a few minutes longer.

Once it is good and hot, tin the tip. This is done by dabbing a little solder on to the tip and allowing it to flow around the surface of the tip. Don't overdo this – you just need a shiny surface on the tip itself. This process is very important as it helps transfer the heat of the soldering iron to the joint. Think of it as the equivalent of water or steam in a saucepan full of vegetables being used to transfer the heat of the cooker to the vegetables. If at any time you feel that there is too much solder on the tip of the iron, wipe if off on a small sponge soaked in water.

Cleaning

Before making a soldered joint, it is important that both items to be joined are clean (not oxidised). With a PCB, a quick scrub with some wire wool will do the job if the board is not really shiny. Wire wool can easily be obtained from DIY shops. While Brillo pads can be used, they tend to leave behind a soapy layer, which then needs to be washed off.

Make sure that you don't leave any wisps of the wire wool around to short out tracks! If you just need to prepare a small area, then an abrasive fibreglass pencil is very effective for cleaning PCB tracks **Fig. 3**.

Component leads probably will not need any preparation unless they have been lying around in a junk box for years. A gentle twist of wire wool will do the job if you have any doubts.

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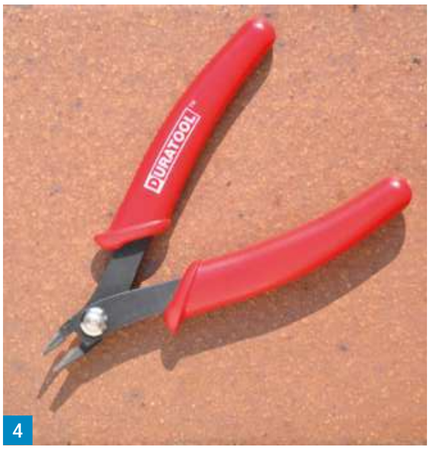

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Tinning

If you are soldering wires, then you should definitely tin the wire to be soldered. Bring the soldering iron and the solder up to the wire and allow the solder to melt and flow into a very thin layer around and along the wire lead.

Making a Soldered Joint

If you are new to soldering, or haven't soldered for a few years, I suggest practising with a few odd components and an offcut of PCB with some holes drilled for the components. Push the component leads through suitable holes and bend the lead back a little so that the component doesn't fall out when you turn the PCB over to solder the component leads. I find it best to solder components one at a time and then snip off excess leads, before moving on to the next component.

Apply the soldering iron tip to the work surface, ensuring that it simultaneously contacts the base material and the component termination to heat both surfaces adequately. This process should only take a fraction of a second.

Apply the solder to a part of the joint surface away from the soldering iron and allow to flow sufficiently to form a sound joint fillet – this should be virtually instantaneous. Don't just dab the soldering iron on to the joint. The solder needs to flow. Don't apply excessive solder or heat to the joint because this may result in dull, gritty fillets and excessive or darkened flux residues.

Remove the solder wire from the joint and then remove the iron tip and return the soldering iron to its stand. The total process will be very rapid (a second or two) depending upon thermal mass, tip temperature and configuration. Leave the joint to cool.

What Next

Dry Joints

Once the soldered joint cooled, if you find the component lead moves, then you have what is known as a dry joint. You'll need to re-heat the joint, apply a little more solder and wait for it to flow. If it still won't flow, then most likely you have an oxidised lead or PCB, the temperature of the soldering iron isn't high enough for the solder to really flow or you didn't leave the iron on the joint for long enough. Once you have a good joint, use some small side cutters to snip off the excess lead sticking through the PCB, **Fig. 4**.

PL259 Plugs

For the cheaper non-compression PL259 plugs, a really hot 25W soldering iron will tackle the centre pin. I find the best way is to tin the copper centre of the coax with a thin layer of solder. I then run a little solder down the inside of the centre pin of the plug before inserting the coax into the plug with a screwing motion. Having done that, I heat the centre pin with the soldering iron until I see the solder flow.

When it comes to the screen, there is simply too much metal to heat up to the melting point of solder for a 25W iron to cope with. Many PL259 plugs have a hole through which you are expected to solder the screen. One way is to use a much more powerful soldering iron, having filed the plug across the hole so that it is really clean and shiny.

The alternative, which I prefer, is to use the more expensive compression-type PL259s, **Fig. 5**, where the screen connection is made by compression in the same way as BNC and N connectors. These compression plugs seem to me to be far more satisfactory, with an added bonus of being a near waterproof arrangement. I use these on all outdoor connections.

Removing Components

Occasionally, you may need to remove a component from a PCB. I find a solder sucker, **Fig. 6**, works well for me. This is a bit like a bicycle pump in reverse. Heat the joint with a soldering iron until the solder is liquid and use the solder sucker to suck as much of the solder up into itself as possible. You may need to repeat this process several times. Once most of the solder has been removed, place a small screwdriver tip under the component, and while heating the joint gently apply pressure to lever the component up. Repeat this process for each lead of the component.

Radio Round-up

CORRECTION: The *70MHz Contest Results*, published last month, unfortunately carried the previous year's version of Table 3 (square leaders). Here is the correct version:

Square	Name	Call	No. entries
IO70	Darrell Jacobs	2E0VCC/P	1
IO71	Peter Harston	GW4JQP	1
IO72	Steve Jones	GW0GEI	1
IO73	Dafydd Ellis	MW0CHZ	1
IO75	Peter Moran	MM0CEZ	1
IO80	Martyn Wright	G4RLF/P	2
IO81	Steven Clements	GW1YBB/P	7
IO82	Andrew Lancaster	G0JCC	5
IO83	Keith Haywood	G8HXE/P	4
IO84	Pauline & Chris Kirby	G8HQW/P	1
IO85	Brian Howie	GM4DIJ	1
IO91	Jon Page	G1POS/P	3
IO92	Geoff Suggate	G3NPI	6
IO93	Warrington Contest Group	M0ICK/P	6
JO02	Fred Handscombe	M7Z	2
JO11	Frank L. Laanen	PE1EWR	1

DISTANCE LEARNING COURSE FOR FULL EXAM: The Bath Based Distance Learning team (BBDL) helped nearly 800 students to pass the Advanced exam under the old syllabus. Between 2011 and 2019 over 28% of the total UK Advanced exam passes were BBDL students and the pass rate was over 80%, compared with a national average of 65%.

After reworking their training material, and running a successful Intermediate course, the team are now planning their first course for the Full level exam syllabus. The course will run from March to June this year.

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

There are weekly quizzes to check progress and at the end of the course there will be a number of mock exams. There will be no charge for the training but applicants will need to work through a pre-course classroom and quiz to be eligible for a place. If the course is oversubscribed, places will be allocated at random from those successfully completing the pre-course work.

Each student will need to provide their own *RSGB Full Licence* textbook and arrange their own exam at the end of the course. It seems likely that the exams will be online with remote invigilation.

Advice will be provided as part of the course. The deadline for course applications is Wednesday February 17th. To request full details and an application form, please e-mail BBDL Team Leader, Steve G0FUW, via **g0fuw@tiscali.co.uk**

IARU NEWS: This year's World Amateur Radio Day takes place on April 18th. The COVID-19 pandemic has provided inspiration for a theme similar to a popular campaign in the UK. The International Amateur Radio Union (IARU) has chosen the theme of 'Home But Never Alone'. The theme also carries forward the activities that sprang up around the world last year, from special event stations that reminded people to stay home and safe, to local wellness nets where the elderly and others in isolation could check in regularly.

According to the IARU, on-the-air activity reached unprecedented levels and participation in major contests soared in 2020.

World Amateur Radio Day is observed every year on April 18th to mark the date in 1925 that the International Amateur Radio Union was formed in Paris.

Meanwhile, preparations continue on the part of the IARU to represent the interests of the amateur and amateur-satellite services at World Radiocommunication Conference 2023 (WRC-23). The International Telecommunication Union (ITU) sponsors WRCs, typically every four years, to consider revisions to the international Radio Regulations that define frequency allocations for various radio services.

"As an incumbent radio service with allocations at intervals throughout the radio spectrum, the amateur service faces challenges at every WRC," IARU Secretary David Sumner K1ZZ said. *"Successfully defending our existing access to the spectrum is a significant accomplishment at any WRC, but sometimes it is possible also to improve our existing allocations. WRC-19 resulted in major improvements in 50MHz allocations in Region 1. Without any doubt, this could not have happened without the concerted efforts of dozens of IARU volunteers over the course of several years."*

The next WRC is expected to be held in 2023. Under the direction of IARU Vice President Ole Garpestad LA2RR 20 IARU volunteers have been participating in virtual meetings of ITU working parties and preparatory committees of regional telecommunications organizations (RTOs) as they address WRC-23 agenda items of particular concern to amateur radio. Potentially affected bands are 50 – 54MHz (a new service has been proposed in an adjacent band); 1240 – 1300MHz; 3300 – 3400MHz; 10.0 – 10.5GHz and 241 – 250GHz. In addition, studies are being conducted to identify protection requirements for space weather sensors that operate in frequency bands from 13kHz to at least 15GHz.

20:03
Looking for a Shack Clock?
MFJ-139RC. This wall clock is HUGE!
MFJ-115. 24hr analogue clock
MFJ-107B. Small sit on top of rig LCD clock
MFJ-108B. Dual version of MFJ-107B
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Each & every week new episodes of our Something for the Weekend featuring Martin & his team appear on MLandS.tv
Better still, we now have the 'Lynchy Weekend Webcast', a LIVE stream on the latest used equipment, news and general rag-chew on what's new.
Don't forget to subscribe to our channel and click the Bell icon for notifications of our broadcasts.
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Icom IC-7100 £999.95
HF/6m/4m/2m/70cm dstar Base & Mobile Transceiver with remote control head unit.
How many of you spotted the Icom IC-7100 when it was introduced? If you didn't take any notice of the spec, now's the time to have a proper gander at this great radio covering 160-10, 6/4/2/70. It was Icom's first venture into featuring 4m as standard on some of their products and I'm pleased to see they've continued the trend ever since.
At a discounted price of £999.95 you're getting a very special Touch-Screen display radio, all-mode including D-Star, remote control via the optional Icom RS-BA1 & more.
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Price and availability TBA
Icom ID-5100 £574.95
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Click www.HamRadio.co.uk for our full range of SDR products
QRP SDR with a twist. Introducing the ELAD FDM-Duo Range
New! FDM-S3 £949.95
Wideband Sampling SDR Receiver 9kHz-108MHz
The FDM-S3 receiver is an exceptional SDR with very strong performance features. Here the Italian manufacturer has taken the possibilities of modern SDR design to the extreme. For example, the FDM-S3 offers an incredible bandwidth of 24MHz, which can be scanned simultaneously and in which up to 4 receivers can be operated simultaneously. So far, this has only been reserved in this form for much more expensive receivers.
Elad FDM-DUO
Direct from the ELAD factory in Italy the FDM-Duo is a compact 5W SDR 160m-6m QRP Transceiver with unique modes of operation.
If you don't wish to be tethered to a PC like so many SDR products the Elad FDM Duo will work as a stand-alone rig offering performance far in advance of anything available today. Connect to a PC & you open up a new world of advanced SDR communications.
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Dual-Tuner wideband full feature 14-bit SDR, 1kHz to 2GHz, 10MHz of spectrum visibility. Simultaneously monitor 2 separate 2MHz bands of spectrum between 1kHz and 2GHz. 3 software selectable antenna inputs, & clocking features ideally suited to industrial, scientific, Ham & educational applications. Windows 10.
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Complete redesign of the popular mid-range RSP2pro 1kHz–2GHz receiver. Multiple antenna selection, Improved pre-selection filters, Even more software, Selectable attenuation steps, Special HDR (High Dynamic Range) mode for reception at frequencies below 2MHz.
Designed and built in Great Britain
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All ZUMspot Packages supplied by ML&S Include: ZUMspot Pi UHF Board, UHF Antenna, Raspberry Pi Zero WH, MMDVM software and Plastic Case.
ZUMspot RPi New Updated Version
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The ZUM-Spot USB new from KI6ZUM, uses the very popular BlueDv software to create a very versitile and simple to setup PC based hotspot. The ZUM USB comes ready to go with a small antenna and a very classy high quality case, it is a huge upgrade on the very popular DV4Mini and the BlueDV software is the cherry on the cake.
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E-Field Probe and SDR

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Joe Chester M1MWD continues his quest to eliminate noise and accentuate the signals.

Much to discuss this month. First up a report on the experiments with the e-field probe. Then some feedback from readers about that 2m multimode idea. Fair to say, it generated lots of comment – and, yes, all positive too! It's a huge subject, building with SDR technologies, and I will have to have a longer look at it later. But for now, and to keep you going, some ideas from the e-mails I received. So, let's begin.

How can a small square of copper work as an antenna? And it does work, as my tests below show clearly, with signal strengths the same as those of my inverted-L. However, signal strength is not the point of this piece of copper foil. But lower noise levels are. And I can say with certainty that the background noise level on 80m is lower than on my inverted-L. I know this sounds like magic, but it's not. Let me start at the beginning.

Focus on Noise

You know I have been talking about noise quite a lot recently. So is everyone else. It's overwhelmingly the single most discussed topic on the bands. It has been characterised as a buzzsaw sound, and as the sound of an Arctic wind. But to be honest, since the operator who says that has never been to the Arctic, how does he know what that sounds like? But let's leave that aside for now and concentrate on its effect. Sometimes I see large spikes of RF every 50Hz on the band, sometimes I see it as a background hiss. On a panadapter screen, it's a strong blue colour, with a strength up to S9 some days. What it is, is relatively easy – take your pick of plasma TVs, washing machines, switch-mode power supplies, and xDSL. Or all of the above if you wish.

To limit the impact of this noise on QSOs, I recently advocated using one of the many online web SDRs out there. The antennas for these are usually well sited away from the worst of the noise. Although this works, it has a certain unsatisfactory feel about it. And, although probably a valid QSO, it probably also means that I cannot claim the QSO for the likes of DXCC. Not that the latter is the point here. But the web-SDR at least allows for regular contacts on the low bands. The alternative seems to be some kind of low noise antenna, whether passive or active. I described some options for passive receive antennas last month. A couple of operators I know are building rotatable active loops, in an attempt to null the worst of the local noise. I decided to try the E-field probe. I contacted **Roelof PA0RDT**, who has championed this type of antenna for many years, and he kindly agreed to assemble one for me.


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The E-Field Probe

An E-field probe is basically a rectangular piece of printed circuit board. The components for a low noise amplifier are mounted on the lower half of this, the upper half being left as the antenna. There have been many reviews of this antenna, including one by **Steve G0KYA** in his book *Stealth Antennas* (available from the bookshop). In his review, Steve said that the antenna *"worked reasonably well, but was down on a dedicated 80m antenna"*. I didn't find this in my installation. I mounted it on a 2m fibreglass pole, on the bow of the boat, which put it up at a height of 3m. The antenna is tiny, encased with the amplifier in a piece of grey pipe. I attached a length of RG174 to the BNC connector sealed into the base, and powered it up. It was connected to my KX3/PX3, and immediately signals appeared all over the 80m band. On 3740MHz, I found EI7JN in a QSO with G0VVE – the first Irish station I've heard for quite some time. The WAB net on 3760kHz was 56 on the KX3, but only 53 on my IC-7300, which is connected to my 19.8m long inverted-L. Similarly, G2OT was stronger on the little E-field probe than on my inverted-L. Also significant was the number of French and Dutch stations I was hearing.

Now, just hearing stations on the mini-whip, **Fig. 1**, is not the point here. The reason I was hearing these stations more clearly than on the main antenna was due to the lower noise pick-up by the mini-whip (have a look at the two images, **Figs. 2** and **3**. One is the mini-whip, the other is the inverted-L). I suspect the slightly greater receiver sensitivity of the KX3 also played a role. Steve's review concluded by saying that Roelof's design was a *"fascinating little antenna"*, and I would agree with this. There have been many occasions in my life on the air when seriously compromised equipment has performed remarkably well. The little AX1 antenna from Elecraft was one of those (see my review in *PW* October 2019).

Roelof's mini-whip seems to be another of these occasions. It really should not work as well as it does; it's just a piece of copper attached to an amplifier. No need for a G5RV or doublet. For me, with my installation it works better than the inverted-L, because it's not hearing the local noise as well as that antenna.

But now comes the next issue – can this antenna be integrated into my station to help with the noise on the low bands? By integrated, I mean, is it possible to use the mini-whip/KX3 system as a receiver, while transmitting on the IC-7300 into my inverted-L? I also have an SDRplay, which I could use instead of the KX3. Not being an electronics expert, I put this question to Roelof. His reply left me floundering a bit. He said that when the mini-whip is exposed to a high RF-field, the J310 dissipates the excess power, which is of the order a few milliwatts. However, in this case the BFU590 may push too much power into

Fig. 1: The mini-whip in situ.
Fig. 2: Noise on mini-whip.
Fig. 3: Noise on inverted-L.

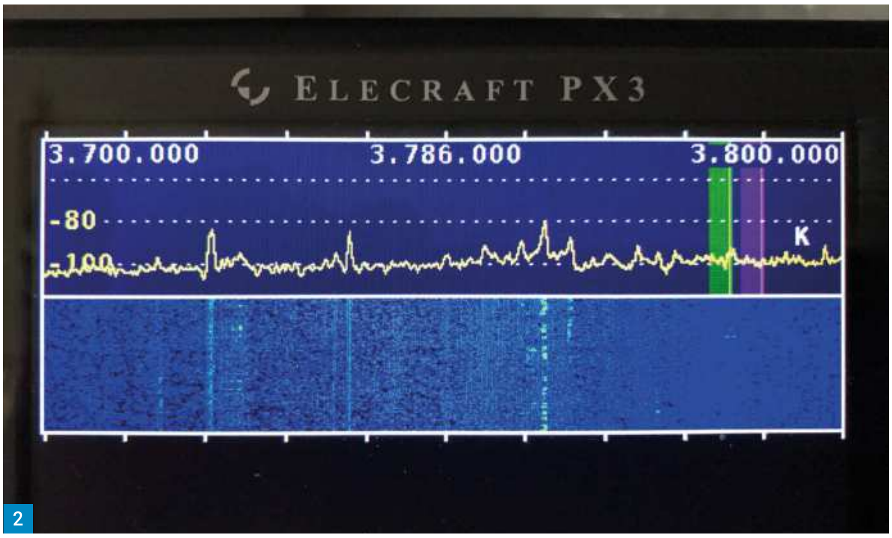
the input stage of the receiver. I'm not an expert, so I sent for help, from one of the chief electronics experts in this field. To be specific, I niGeled it! (note – please check the next OED for this new verb, a huge improvement over other well-known search engines, and available on air too). He kindly downloaded the KX3 schematics from the Elecraft website, and quickly pointed out that the KX3 has back-to-back diodes in the receiver input stage, which should protect it from nearby strong signals. He confirmed that the only device at risk in this test is the input gate, the J310, and that even if this gets overloaded, it will go to high impedance, and not cause problems further down.

A Test and a Thought Experiment

So, duly informed by expert opinion, I set up a test. I'm not brave enough to just push 100W into my KX3 straight off, so the SDRplay/RSP1 was hastily pushed into service. I connected this to the mini-whip, and set up the IC-7300 on the inverted-L. And yes, it worked. But I only used 1W output from the 7300! No blue smoke appeared, the mini-whip survived, as did the SDRplay. I then tried it with 5W and got the same result. I'm now waiting for a chance to try this out with the KX3, while still researching T/R changeover switches.

Now to that 'thought experiment' (*PW* December). There has been a very good response to this idea from many readers, which is most welcome. In the piece I admitted to not being a radio engineer, but I know amateurs who are quite expert in this area, and it was with their help that I put the idea together. When I set out, my thoughts were really an attempt to answer a question – how is it that there has been no successor to the famous FT-290, i.e. a standalone multimode 2m transceiver?

To get on 2m you either buy an HF transceiver equipped with 2m (the IC-705 and FT-818 seem popular choices here), or you engineer a solution using a transverter. I may be heading down this latter path myself next year, if /P operations are again allowed. My portable rig is a KX3, which doesn't do 2m, so I will need to find a suitable transverter for it. There is the option of an on-board add-on from the manufacturer, but its output is very low, and I would need to use an amplifier to get to any sensible output.



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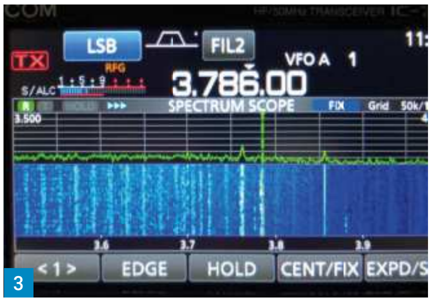
But back to the response to the DIY solution. Many e-mails mentioned the Langstone project – **Andrew G4XZL** was one of them, and he gave me these references (URL below). He says that he has built several SDR radios over the past few years. *"My main 2m station at the moment is an OpenHPSDR Hermes board that I built from scratch with a Microwave Modules 144/28MHz transverter, a mix of the vintage with the state of the art"*, he told me. What an interesting idea, but it probably breaks an unwritten and assumed requirement, which is to have the whole thing in a single box.

https://tinyurl.com/ybejwe24
https://tinyurl.com/y38pa2yj

Then there was the excellent e-mail from **Malcolm G4DMH**. He used a Lime board, just as envisaged in my design. He says he purchased the board a while ago, and connected it to a laptop running SDR Console, but only got RF out of it up to 143.9MHz. He went on to describe in detail what he planned to do, with sources for the required components, including for the changeover relay (first URL below), the lowpass filters (second URL below), and the 25W power amplifier, sourced from eBay (Malcolm says there are plenty of options here). This is great news – it suggests that this design is a feasible route to a 2m multimode. Malcolm hasn't finished this project, and he says that he has lots of other projects in hand too. I duly note that he didn't get RF in the 2m band. Others have also noted that some Lime boards don't always deliver the full output range. But Malcolm's e-mail is really encouraging.

https://tinyurl.com/y3habtm8
http://shop.qrp-labs.com/LPF

And finally, and selecting just one more



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of the responses I received, there is **Don GM4CAM**. He sent me a really long e-mail, with references, about his Teensy project. He uses the Elektor kit with his Teensy, which he describes as *"like an Adruino on steroids"*! Now, I'm not going to quote much from Don's e-mail, because he casually mentioned that getting his name in print was on his bucket list! So, I have invited Don to review the great e-mail he sent me for publication, either in this column, or as a separate piece (Editor: I trust this meets with your approval?).

I look forward to this, because, of all the e-mails I received, Don seems to be the closest to actually getting something working. I'm sure his description of the details of his project will be the starting point that many are looking for in order to get into the world of SDR technology.

Don also suggested, and I agree, that *"the SDR space needs clarity"* – and I will attempt to do this in a future *Notes*. I think that although a well-defined term, the SDR label is being attached to all sorts of projects, of various stages of sophistication.

This is a good thing, but I think it would help to be able to distinguish the numerous and varied threads here. Many, many thanks to everyone who e-mailed – more on this subject in a later piece.

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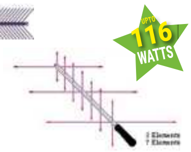

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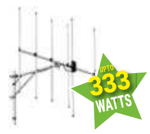

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Tuning a Slim Jim and an Airband Receiver

Geoff Theasby G8BMI
geofftheasby@gmail.com

Geoff Theasby G8BMI has two more, very different projects for those lockdown days.

I have been making antennas for the 2m band ever since I was first licensed in 1968. The original was designed by **Fred Judd G2BCX**, in this very magazine. I saw a Slim Jim made from copper piping in an *ARRL Handbook*, but thought it heavy and unwieldy. Many years later (last year!) I was making a simple 2m vertical and took up the Slim Jim again, this time made with 300Ω ribbon cable as Fred suggested. I housed it in a cast-off piece of electricians' plastic trunking, suspended from the top by a plastic tie, and the end of the trunking sealed from the weather with bath sealant, **Fig. 1**.

The feedpoint, **Fig .2**, is a little up from the bottom end, a matter of millimetres. However, the ribbon cable used is insulated, and adjusting the feedpoint quickly becomes a mess, with the possibility of short circuits and damage to your PA.

Why try to strip a wire without cutting it? Cut the thing about 40mm up from the end and fit the tuning aid to establish length and feedpoint. Then replace with the correct length, fed as originally noted. The difficulty lies in tapping an insulated wire at various points to find the feedpoint, and I tried ways of making this easier. I replaced the bottom few millimetres of ribbon cable with a number of trial pieces of 'accessible' feedpoints, which would be easy to adjust for best results. I tried Veroboard, Plastikard, with copper strips stuck on about 0.5in apart, also plain SRBP and tinned copper wire. This is more robust, helpful if you are adjusting many antennas. This device, **Fig. 3**, is soldered to the open bottom end of the antenna, and the other end shorted, also positionally adjustable. I used RG316 for the first few centimetres of feeder, as the PTFE insulation does not melt or distort under the soldering iron, and it is physically smaller too.

I tried Veroboard with mixed results. This is possibly due to the dielectric constant of SRBP being twice that of my other material, Plastikard, a form of polystyrene, about 0.5in wide, with self-adhesive, narrow copper strip stuck near to its edges. SRPB does not melt under the soldering iron, but Plastikard does, so joints must be made

Continued on page 45

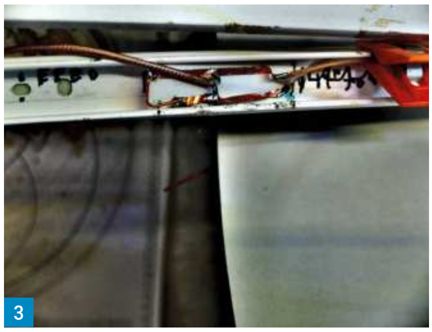
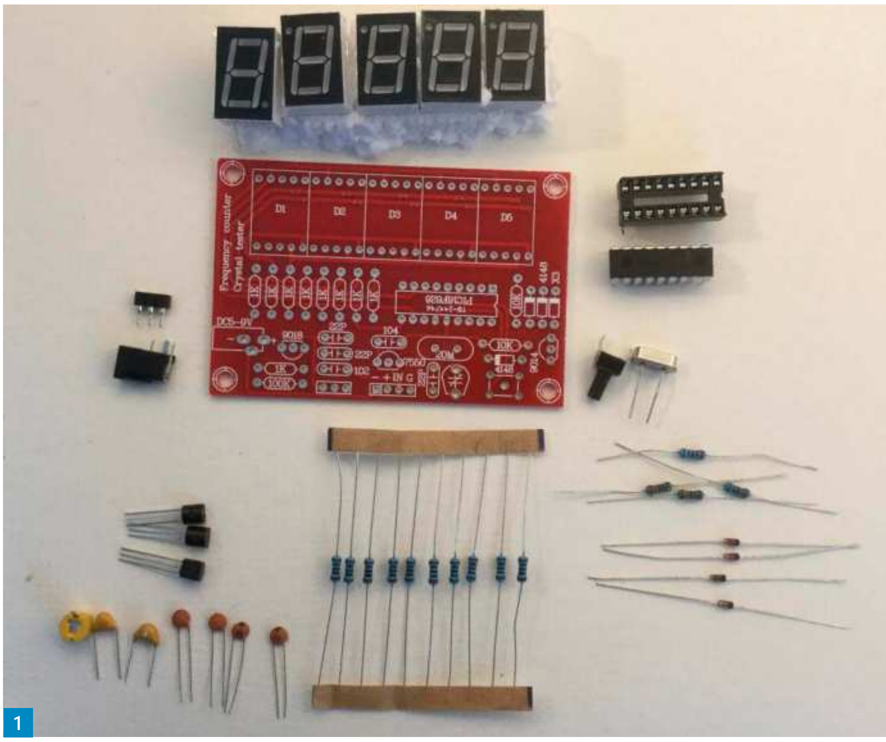


Fig. 1: Slim Jim in its trunking, beforehand.
Fig. 2: The feedpoint.
Fig. 3: The adjustment board.
Fig. 4: The PCB. Fig. 5: In its box.

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

Testing Crystals

Tony Jones G7ETW builds a handy frequency counter.



1

I am not a great kit-builder. I don't mean I can't do it; I just don't build things for the fun of it or to save a few pounds. Yet here I am, faced with two crystal oscillator frequency counter kits from China to build. The reason, as ever, is Training. Intermediate students must demonstrate that a crystal oscillator is more stable than an Inductor and Capacitor tank circuit design. I thought a piece of kit that could test crystals could save me a lot of time.

Why two kits? Murphy's Special Law of Test Equipment states that the chance of a rarely used piece of kit failing is inversely proportional to how many working examples one started with!

The Kit Itself

Fig. 1 shows a kit laid out for checking. Please note there are four 22pF capacitors. This will be relevant later. The next photo, **Fig. 2**, shows the board, both sides. The components are ordinary 'thru-hole' ones, there are no inductors to wind, and everything is marked by name and value. The board measures 80 by 53.5mm, so it's not cramped. Even so, with 137 joints to make, I'd call this an Intermediate-level kit.

No information comes with these kits. Personally, I hate that. Had this not been a very common kit and therefore problem-free (presumably), I wouldn't have bought it.

Start of Construction

I used an Antex 25W soldering iron with an '1100' 2.5mm chisel bit, ideal for working on boards with small solder pads. And I still use Lead-Tin solder, 22swg. Contrary to what many people believe, this is still perfectly legal to buy and use.

People have different approaches, but I like to start in the middle of the board, then I'm not hampered by finished joints when making later ones.

I'm right-handed, so the first to components to go in were the eight 1kΩ resistors on the left. I checked every one with a DMM. This may seem over the top, but I learned the hard way that diagnosing a rogue component is much easier before fitting it to a board.

Fig. 3 shows the board reverse with the resistors fitted. The joints are pleasingly tiny.

Problems with Chip Holder

Next up, the chip holder. The pin-1 dimple is clearly marked on the board and on the chip holder, so orientation was not a problem.

I usually insert a chip into its holder then solder in the whole thing. Received wisdom is to fit the chip holder empty, I know. The 'fit empty' approach is safer because it spares the chip any mechanical, thermal or static-electricity trauma as assembly progresses. But it is much easier put a chip into a holder when the holder is totally free to handle.

On this occasion I chose the worst of both worlds: 'fit empty' then insert. As I was trying to put the chip into its now awkward holder, a leg got bent back and in straightening it, I broke it off. Fortunately, I've been there before. **Fig. 4** shows how I repaired it with a section of scrap resistor lead-out.

Continuing right to left, I fitted the first 10kΩ resistor and three 4185 diodes.

Size is Important

I could have fitted the 7-segment LEDs next but that would have added 8mm of height to the board, making it harder to keep the remaining components flat and tight to the board when it was inverted for soldering.

Applying the same argument to the DC power socket, I turned my attention to the 22pF capacitors. I checked these as well; all were below the printed value. See **Fig. 5**. **Fig. 6** shows the build at this stage.

Semiconductors

There are three T092 devices in the kit, marked 7550, 9014 and 9018. My semiconductor component checker identified the 90-prefix devices as BJTs, **Fig. 7**, but it could not help with the 7550. But with two fives in the name and seeing it was connected to the DC socket, I guessed it was a 5V regulator, and that's what Google confirmed.

7-Segment LEDs

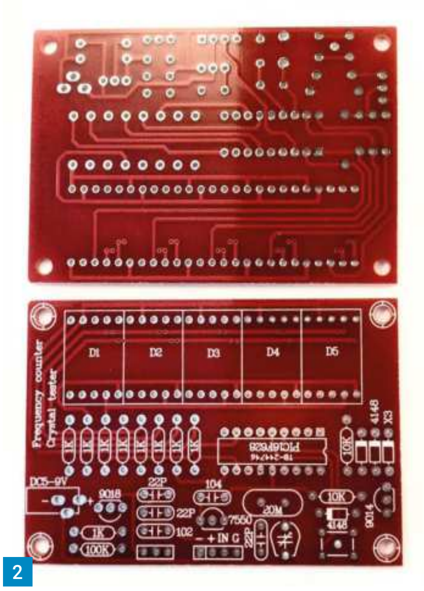
Fig. 8 shows the board with one 7-segment LED fitted. Common sense alone dictates which way round these should be fitted. They are symmetrical, with five legs top and bottom, so that's no help. But looked at the right way round, the numeral 'leans' to the right and the dot only makes sense as a decimal place with that orientation.

Finishing Up

(or perhaps this is why I don't often build kits)

Revisit Figs 6 and 8 and look at the two 22 pF capacitors by the 7550 regulator.

Fig. 1: The kit, on arrival. Fig. 2: Both sides of the PCB. Fig. 3: Reverse of board with resistors fitted. Fig. 4: The repair! Fig. 5: 22pF reads as 18pF. Fig. 6: The build at this stage (with error!). Fig .7: The BJT is an NPN. Fig. 8: The board with one of the seven-segment LEDs fitted. Fig. 9: 10.106MHz correctly displayed. Fig. 10: The board's DC socket connections with the negative terminals highlighted. Fig. 11: Sniffing RF from the FT-817. Fig. 12: Oops, an unintentional offset.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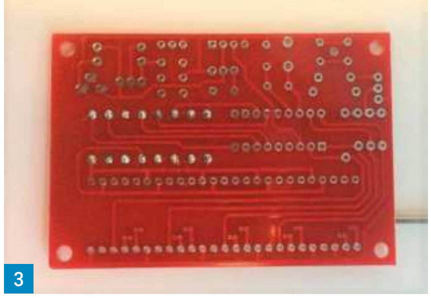
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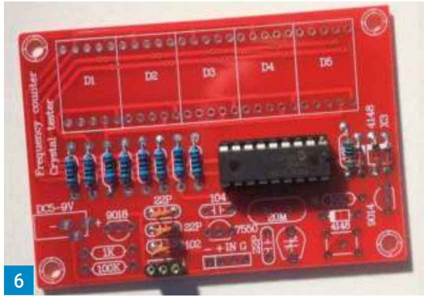
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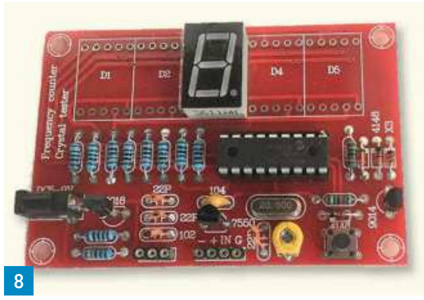
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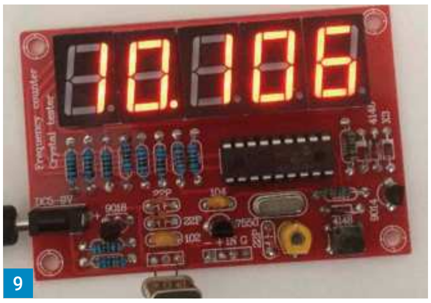
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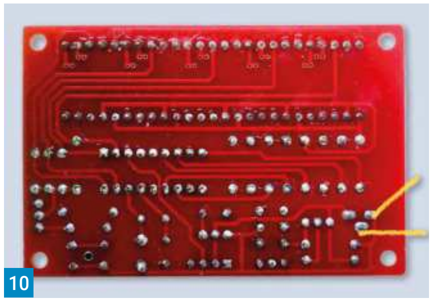
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When I fitted these capacitors, I had just soldered eight resistors all the same, then three diodes all the same. So, it's hardly surprising that I had fitted three 22 pF capacitors. It wasn't until this point, when I found myself with an unused 1nF capacitor that I noticed my error. The kit actually only needs three 22pF capacitors – hence (in part) the confusion.

After fixing that, I checked again and everything looked good.

Initial Testing

I soldered some red and black wires to the positive and negative connections on the 'socket-bank' on the right and applied 7.5V, expecting to see 0.0 displayed.

Result: Nothing. Gently inserting a 10.106MHz crystal across the left hand three-point socket-bank, I hoped to see a reading.

Result: Still nothing. Perhaps I had killed the PIC chip doing my repair? Or perhaps it was not even programmed?

So, with everything looking plausible, and lacking a circuit diagram, I made up the other board this time with no errors. And this time, for no better reason than the fact my flying power leads were constantly breaking off, I found a lead with a small coaxial DC power plug (Yaesu FT-817 size, I think) and tried again.

Result: Success. See **Fig. 9** – my 10.106 MHz crystal (after a minute adjustment of the variable capacitor) was shown oscillating at exactly the right frequency. With a power lead, both kits worked. So why had the first board played dead?

Mystery Solved

I had assumed that applying volts at the DC connections would power the board.

I think anyone would assume that.

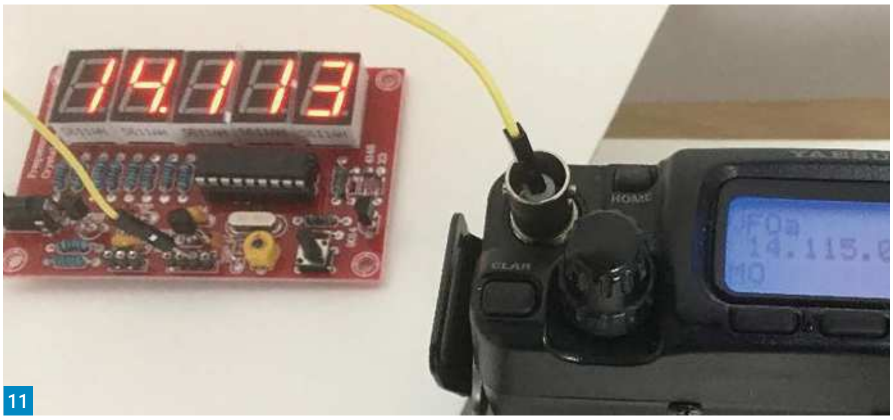
The DC socket has three connections. The centre pin goes to the regulator and other places, including the DC positive I'd been using. The socket's other connections are negatives, one becoming board ground and the other going to my DC negative. **Fig. 10** shows the board's DC socket connections with the negative terminals highlighted.

The socket was a very simple one, lacking an internal switch. So what connected the two grounds when there was no plug present?

Er …. nothing. The barrel of the plug makes this connection. With no plug, there is no DC ground. To test this theory, I bridged the socket's negatives. With DC coming in from the plus and minus, that worked fine. All I can think is that these contacts are intended as a DC output.

Use as a Frequency Counter

The frequency-counting range quoted is



11

1Hz to 50MHz. A scrap of very thin wire pushed into the IN connection resulted in a 0.050kHz signal, so that was promising. As **Fig. 11** shows, the correct frequency was displayed when the kit was fed a sniff of RF my FT-817. (Yes, I admit it. I was on FM on 20MHz, but my ERP must have been in femtoWatts and I was 'on air' for only about five seconds.)

From 9MHz to about 14MHz I could measure frequencies, but I had no success outside that range. But look at the test-rig I was using – what a lash-up! I would need to do some systematic testing with a signal generator before making any adverse judgements.

Circuit Details

I thought readers might want some information about the circuit and the PIC programming.

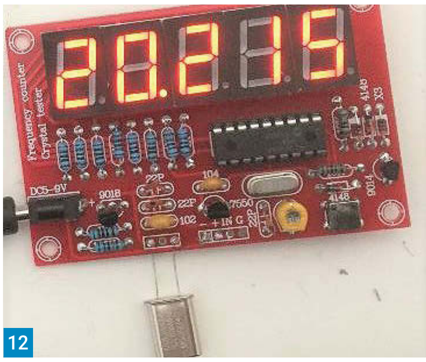
Once again Google triumphed, taking me to a handful of websites created by people who have built and investigated these. **Andrew Woodfield ZL2PD** saved me a horrible job – he reverse-engineered the circuit from the board. His website is:

https://zl2pd.com/xtalchecker.html

The kit has a prominent switch. I advise you to ignore this. Even better, leave it off the board. Pressing this switch opens up a menu system allowing, among other things, an offset to be set. This menu system has been documented by **Wolfgang Buscher DL4YHF**, who I think designed this circuit. His website is:

https://tinyurl.com/huvkf

Fig. 12 shows an unintended consequence of blundering blindly into this menu system. I had correctly read a slightly-off frequency crystal on 10.107MHz, then I unintentionally 'ADDED' an offset of this value. When I read the crystal again, the kit displayed twice the frequency! Having read DL4YHF's documentation, I was able to do a 'ZERO' reset and get back to correct readings.



12

All the menu options are displayed on the 7-segment delays in letters – think 1980s, and making pocket calculators spell out 'hello' etc. With the documentation, the programmed options increase the kit's scope tremendously, and customising operation becomes doable. But without the documentation, the word 'nightmare' springs to mind – hence my advice to omit the switch.

Conclusion

This is a useful kit, and anyone with patience and a small-tip soldering iron could build one in two to three hours, including tea-breaks.

As a frequency counter this kit could be a great addition to a homebrew radio. Using the offset facility, IFs can be monitored, showing the actual receive or transmit frequency.

For testing of crystals the kit certainly does the job (although it did not work with some 3.59MHz crystals I have).

I found the actual building enjoyable, even if getting things working was less straightforward. The finished product looks good.

To find this kit on eBay, search for '1Hz – 50MHz Crystal Oscillator Tester Frequency Counter DIY Module Kit meter' and variants thereof. Prices vary from about £3.50 to £7 depending on where the vendor lives. I paid £8.50 plus £1.46 postage from China for two kits.

Continued from page 42

quickly. With everything clean and prepared, this is not a problem. My antenna began with an SWR of 10:1 on 150MHz, then 2:1 on 145MHz and still to finalise. When I finished it was 1.2:1., where I called a halt. The finished dimensions are length 70mm, width 10mm, and shorted 25mm below the feedpoint. A calculator website by M0UKD gives dimensions, and both 'Essex Ham' and G0KYA criticise the figures commonly used. I couldn't possibly comment...

Air Band (& 2m) Receiver Kit

This little kit is one of the best I have encountered in recent years. Available from the usual sources for £15 or more, it is marketed as an Air Band radio, but is tunable to cover the 2m amateur band. It is a superhet, with an IF of 10.7MHz. It is AM only, but a small extra PCB could be made to provide a Carrier Insertion Oscillator for SSB reception. Mine came with a natty aluminium case, but the knobs are too close together for the average fingers.

The instructions are the usual mixture of Chinese and English, although better than some. However, to see how it really should be done, visit the Vectronics VEC-131K page at the website below where you will find a comprehensive 37-page manual covering the construction and use of a very similar receiver.

www.manuals.repeaterbuilder.com

The process of building the kit was straightforward, thanks to a good silk screen on the PCB, **Fig. 4**, and only one confusing item. Although a switch and LED are provided, there are no details of where, on the PCB, to connect them. I used a spare position next to the Z1 ferrite bead. There is one surface mount device, an SA602 mixer. For this you need a magnifier, a steady hand and a small-bit soldering iron. Tack down one corner leg, verify the orientation of the IC and then solder it down. The rest of the components are through-hole types, and quite closely packed. I found the two evenings of quiet concentration quite therapeutic. Do I need therapy? This is a 'chicken and egg' question...

The radio, **Fig. 5**, worked first time, but a screaming instability made itself heard. When I soldered down the T1 screening can, it stopped. This is why they are there, folks! All I had to do then was find a signal, off-air or from a signal generator, and adjust T1 for maximum with a decent non-metallic trimming tool. The frequency is moved by adjusting L6, before fine tuning using the left-hand control. The central control is the squelch and the right-hand control is the volume.

A Surprising Code: Morse Revealed (Part I)

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Thought there's nothing more to know about Morse Code? Think again as **Mike Bedford G4AEE** looks at some of the lesser-known facts about this remarkable form of communication.

1

2

We might be well used to continuing change in so many areas of technology, but a quick history lesson makes the rate of change abundantly clear. One of the first computers to be affordable for home use in the UK – the Sinclair ZX80, which hit the market in 1980 – had a single-cored 3.25MHz 8-bit processor, 1kB of RAM, that's 0.000001GB. It used a separate audio cassette recorder for storage, and you had to use a TV as the monitor, on which is could display monochrome graphics display of 64 x 48 pixels – well, more blocks really. It cost just 5p short of £100. Given that this is the equivalent of £432 today when inflation is taken into account, you can easily find out how much vastly more computing power that would buy you today.

Coming closer to amateur radio – in the sense that it's a form of wireless communication – is the evolution of mobile phones. Since the first analogue phones appeared in 1979, we've seen five technological generations, each separated by around ten years, and the maximum speed of data transmission has increased from 2.4kb/s to 10Gb/s. We'd have to assume, therefore, that anything more than a few years old is unfashionable at best, and a technological backwater at the worst. So, it might seem a fair bet that a method of data communication dating back to the first half of the 19th century must be well past its 'best before' date. Yet Morse Code has recently celebrated its 176th birthday and is still going strong. What's more, its continued use on the amateur bands isn't just a matter of nostalgia; it often allows contact to be made when speaking just wouldn't have been possible. OK, so this is also true of some of the more recent data modes, but Morse differs in that the associated technology is readily understandable and the equipment can be almost trivially simple to build. With such a long heritage, it might be assumed that everything there is be known about Morse is already known to the amateur community. However, I challenge that assumption as I aim to reveal a rather surprising code.

Getting our Language Straight

If you like having your preconceptions challenged, this section is for you because Morse Code isn't a code. A code is a system in which a symbol – which could be a group of numbers or letters – represents a word or phrase and that's exactly how the Q Code works. Morse is different in that its symbols – in this case a combination of dits and dahs – represent individual letters or numbers. This is the definition of a cipher, as first used by Julius Caesar in the cipher that bears his name, in which 'A' was represented by 'C', 'B' by 'D' and so on.

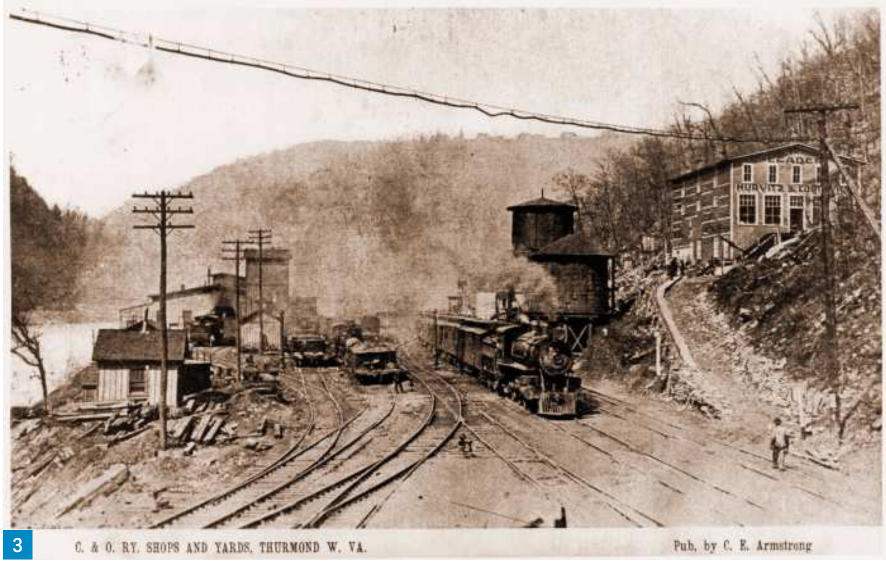
More commonly appreciated, of course, is the fact that although **Samuel Morse**, **Fig. 1**, was the key player in developing the telegraph system, the mapping of dits and dahs onto letters and numbers was probably the work of his business partner **Alfred Vail**. Taking these two facts together, we'd have to conclude that Morse Code should really be called Vail Cipher. Somehow, we don't see it catching on.

On a similar theme, at the risk of being branded a pedant – perish the thought – I really have to take issue with the term 'CW'. We all know this, but it isn't a synonym for Morse Code, even though it's often used as such by radio amateurs. It is, of course, the most common way in which Morse is transmitted, but it's not the only possible way, nor is Morse the only type of data that could be transmitted by CW. For example, I wouldn't recommend it but you could always send Morse by transmitting the words 'dit' and 'dah' via SSB while, conversely, Baudot Code, as used for RTTY, could be transmitted by CW instead of the more common frequency shift keying. What's more CW is a misnomer, even for describing the transmission mode officially designed A1. Needless to say, it's not a continuous wave, it's a discontinuous wave. CW, on the other hand, is a perfectly acceptable name for A0, that rather pointless mode that allows no information to be exchanged at all. So, with hobby horses duly exercised, and bees banished from bonnets, it's time to get down to business.

A Brief History Lesson

I promise to keep it brief, because this article is about technology, but I really ought to start with a bit of history to put Morse Code into context. Created from the two Greek words for 'far off' and 'writing', telegraphy involves passing textual messages over a distance, in much the same way that telephone and television refer to transmitting verbal messages and images over long distances. The first telegraphs, dating back to the late 18th century, were optical and involved

Fig. 1: Samuel Morse has been called the Father of Telegraphy, even though it's possible that Alfred Vail invented the code we think of as Morse Code (source: Wikipedia Commons).
Fig. 2: Although Morse's telegraph system came after this one by Charles Wheatstone, it was much more practical in requiring just a single wire plus an earth return. (Photo: Chailey)
Fig. 3: Although it was vital to the operation of America's growing railroad network in the second half of the 19th century, the Morse Code used on the railroad's telegraph was quite different from that we use today. (Photo: NPS)
Fig. 4: In the main, American Morse was used on telegraph lines and received on a sounder, rather than hearing it as tones as we're used to today. (Photo: Smoketronics. from Wikipedia Common)



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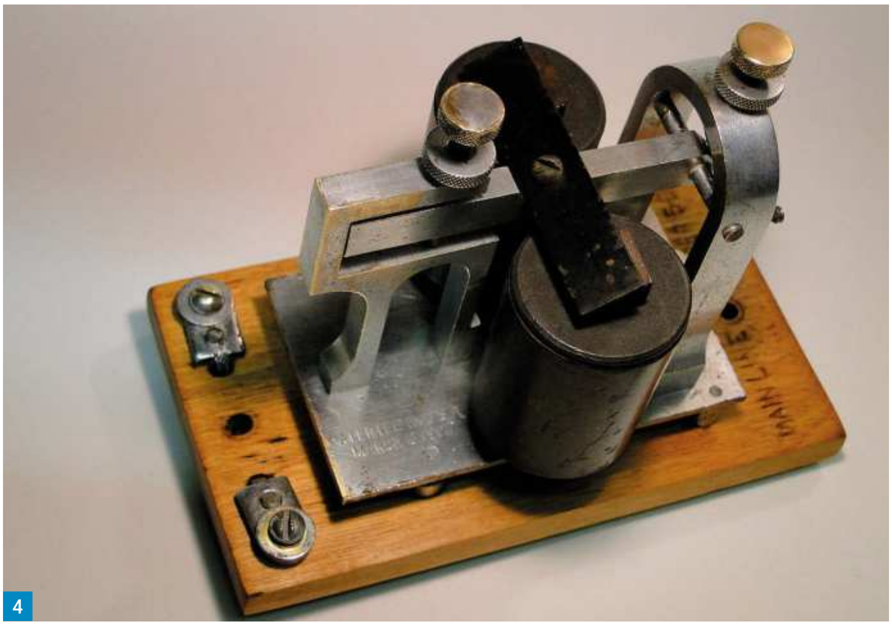

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the use of tall towers, located to be visible from a distance, on top of which were several wooden paddles, the position and angle of which could be controlled to represent letters of the alphabet. Depending on the weather, the maximum range between stations was about 15km, and it wasn't exactly fast, especially since messages had to be repeated several times to cover quite modest distances.

Morse's work related to the electrical telegraph, but he didn't invent the technique. Building on pioneering work by **Pavel Schilling**, the first practical electric telegraph was demonstrated by British inventors **William Cooke** and **Charles Wheatstone**, **Fig. 2**, of bridge fame. Their patented system used a device with five needles that could be deflected to one of two active positions and, in so doing, represent a letter, which was read off a board as the position where the headings of two needles intersected. The downside of needle telegraphs is that they needed several wires between the communicating parties. The major contribution of Morse, just a few years later, was to reduce this to two wires – and shortly after to just a single wire, using the earth as the return – thereby offering a huge cost saving. In today's terms, Morse's system employed serial communication whereas that of Cooke and Wheatstone was parallel.

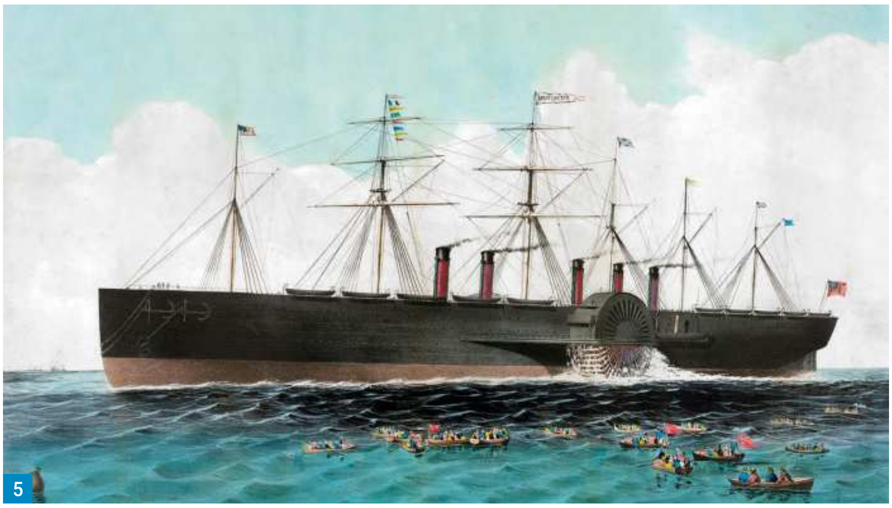
And so we come to that famous Bible quotation, which comes from Numbers 23:23 if you're interested. The date was May 24th 1844. Morse was in Washington DC and Vail was 56km away in Baltimore, to be greeted by that now familiar message *"What hath God wrought"*. But that begs a question. Morse Code on the amateur bands is heard as pure tones, while the well-known image of the railroad telegraph operator on western movies is invariably accompanied by clacking sounds, so what did Alfred Vail hear? In fact, he didn't read the code by ear at all. Instead, the code was transcribed as long and short lines on a paper tape, which was interpreted later. Yet those early so-called inkers were electromechanical devices so they made a noise as they drew those lines onto the paper tape. In time, operators discovered they could recognise letters by their sound, without looking at the tape and, since this was quicker, the Morse sounder – clicks, clacks and all – succeeded the inker. It would be some time later again, with the advent of radio telegraphy, before Morse would be heard as tones.

It's all in the Timing

If you're a seasoned Morse user, or even just an interested observer, you probably know that sending a receiving the code is all about timing. So, dits (dots to the uninitiated) are one time unit long, as are the gaps between the dits and dahs (dashes) in a letter, dahs are three units long, as are the gaps between letters, and the gaps between words are seven units long. The length of the time unit depends, of course, on the speed and its value, in seconds, is equal to 1.2 divided by the speed in words per minute. So, for example, at 12WPM, the time unit is 0.1 seconds. Interestingly, though, that probably wouldn't have applied to that first ever Morse message.

The timings quoted above relate to International Morse Code, originally called Continental Code, the code as used on the amateur bands, which was officially recognised by the ITU in 1865. But while it has many similarities to the original Morse Code – indeed some of the letters appear iden-

Fig. 5: When it was launched in 1858, Isambard Kingdom Brunel's SS Great Eastern was the largest ship ever built and it would stay that way for 41 years. If you're interested in communication, though, you'll probably more interested to know it laid the first practical intercontinental telegraph cable. (Photo: Wikepedia Commons)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Side-swipers and Bugs

Old fashioned 'pump handle' Morse keys are well known as, of course, are today's single- and dual-paddled automatic keys. Many of us are also aware of the bug key but have probably never used one in anger. But there's a lot more to the development of keys than that might suggest.

The term 'side swiper', for a key that's operated by sideways rather than by up and down movement, is relatively familiar, even if it's normally used to describe some sort of automatic device. However, the first side swipers were purely manual, just like pump handle keys, but with contacts to the left and right.

Undoubtedly there was an element of personal preference here, but it appears there were also health implications. Original telegraphers sometimes complained of a condition known as 'glass arm', which has variously been interpreted as RSI (repetitive strain injury) or carpel tunnel syndrome in today's terms. It seems, though, that this could be alleviated, to a degree, by shifting to a side swiper.

This led to the development of the bug key, which had a mechanical weighted spring that acted as a sort of horizontal pendulum, thereby creating strings of dits. Because dahs still had to be created manually, it has often been referred to as a semi-automatic bug key and that begs the question of whether there's ever been a fully automatic bug key. Well, it seems there has and, needless to say, it involved much cleverer mechanical engineering.

After all, most pendulums always take the same time to swing in each direction while, to generate a string of dahs, it would have to take three times longer to go in one direction than the other.

And this brings us to what most surely be the most unusual, and little know variant of the bug key. Called the Automorse, and launched by Hitchcock Bros. of South Australia in 1918, it had no fewer than three paddles, **Fig. 6**. At the top were dual paddles for mechanically generated streams of dits and dahs but, just below, was a single paddle that could be used to manually generate dahs. Part of the selling point is that it would be useable by those familiar only with semi-automatic bugs while learning to get up to speed with the fully automatic mode, but that extra paddle also allowed the long dahs of American Morse to be sent. Conceivably, that extra paddle could be used to send ultra-rapid dits in American Code too.

tical – it wasn't the code as first used by Morse and Vail. Called American Morse, or Railroad Morse, and used on American landlines, **Fig. 3**, until well into the 19th century, to today's telegraphers is seems bizarre in the extreme. An example will go some way to illustrating the differences, and we've chosen something from Morse's first message, the word *"wrought"*, because it contains several differences. In International Morse, it's:

.-- .-. --- ..- --. .... -

while in American Morse it's:

.-- . .. .- --. .... -

At first sight, that word in American Morse might seem to have too many characters, but all isn't as it seems. The letter, 'R' is actually composed of three dits, as is 'S', but is differentiated by having an extended gap between the first dit and the second two. Similarly, the letter 'O' is two wider spaced dots, which differs from an 'I', which has two normally spaced dits. To the uninitiated, it seems fiendishly difficult to have to differentiate between short and long intra-character gaps and the inter-character gap, all of which are so close together in length, but there's more. The letter 'T' is the single dah we're used to, but there are two other characters comprising a single dah, 'L', which is a long dah, and the figure '0', which is an even longer dah.

We've seen inter-symbol gaps of two different lengths and dahs of three different lengths but just what is the official timing of American Morse Code? It's hard to say really, because it rather seems that Morse didn't say anything more specific than the somewhat vague description we gave above. Generally speaking, modern day descriptions of American Morse tend to specify the three different dah lengths as two, four and eight units, and the two different intra-character gaps as one and two units. Inter-character and inter-word gaps are the three and seven units we're used to, although we rather suspect they were generally longer than that. Furthermore, a 1949 academic paper on the speed of telegraph codes refers to the dits like the final two in the letter 'R' as ultra-rapid dits, suggesting either that they are shorter than standard dits, or the gap between them was reduced, or both. We also learn that it was standard practice for the total length of any letters containing ultra-rapid dits and an intra-character gap to be the same length as the letter that contains the same number of ordinary dits so, for example, an 'R' would be the same length as an 'S'. All we can say is that, with so much variability, it's not hard to appreciate how early telegraph operators could be recognised by their 'fist', a concept many of us are familiar with even though there's much less scope for individuality in International Morse.

If you want to hear this bizarre form of Morse Code with your own ears, head over to:

https://morsecode.world/american

You can choose whether to listen to tones or the original Morse sounder, **Fig. 4**, but the timings are fixed, including a dah length of twice the dit length. On the other hand, if you were hoping to hear it on the bands, you might be in for a long wait. Amateur use of American Morse is now extremely rare, although it does occasionally get an airing for demonstration purposes at special event stations.

Introducing Cable Code

Mention of the Clifton Suspension Bridge, the Great Western Railway or the Thames Tunnel between Rotherhithe and Wapping will probably bring Victorian Engineer **Isambard Kingdom Brunel** to mind. But we'd like to think about another of his creations,

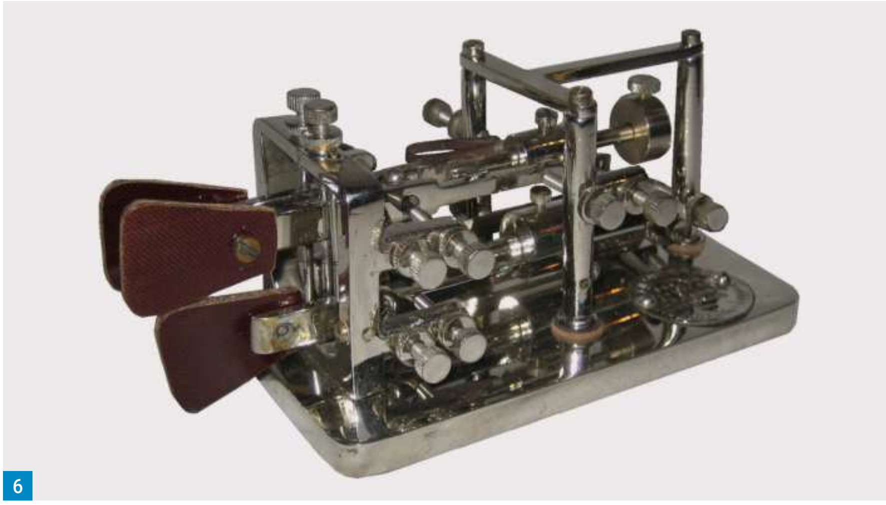
6

Fig. 6: This most unusual of mechanical side swipers had both automatic dit and dah generation and manual generation of long dahs for American Morse. (Photo: Mark Brundrit M6BRN).

the *SS Great Eastern* steamship, **Fig. 5**, and, in particular, the events of July 27th 1866. On this date, just 22 years after Morse's famous Washington to Baltimore communication, the first successful Atlantic telegraph cable was brought into service, reducing the time to exchanges messages between Europe and North America from ten days to minutes.

It will come as no surprise that messages were exchanged across the Atlantic using Morse Code but this wasn't American Code, nor International Code, but Cable Code. The first odd thing about Cable Code is that the coding, that is the combination of dits and dahs for each character, is just the same as for International Code. And this brings us to the second odd thing, and the point at with the two variants of Morse differ, which is its timing. Almost unbelievably, you'd be excused for thinking, in Cable Code dits and dahs are exactly the same length.

Unlike a radio link with all its vagaries of propagation plus the presence of noise and interfering signals, it's tempting to think of a telegraph line as being benign – what you get out is what you put in. While that might be true over short distances, though, once you get to the thousands of kilometres of an Atlantic telegraph cable, reality is very different. Enemy number one is resistance, and enemy number two is capacitance. Taken together these characteristics degrade an on/off signal from a square wave to a much less uniform signal in which successive dits and dahs are prone to merge into each other. Put another way, a long cable acts as a huge capacitor that charges up as each element of the signal is sent, requiring large gaps to be left to allow the charge to dissipate before another element can be sent. This was analysed by physicist and engineer **William Thomson** who worked out that, as a result of these characteristics of a cable, the maximum transmission speed was inversely proportional to the square of the distance. A quick calculation gives us an idea of what we could be expected of the Atlantic cable. It's not clear how fast Morse's line from Washington to Baltimore was but we know that in a previous demonstration in New York, Morse transmitted at 10WPM. If we assume that the same speed could have been achieved over the 56km of the 1944 transmission, the speed of the 4,300km Atlantic line would have been 0.0017WPM, which works out at about 17 words per week, operating 24/7. Yet it's on record that the 1866 Atlantic telegraph cable was routinely operated at 8WPM, so what's going on?

This brings us back to Cable Code and its equally long dits and dahs. But while they were the same length, they were represented by currents of opposite polarity, which could be differentiated on reception. Crucially, if a dit charged up the cable, a dah would have the effect of discharging it, and much more quickly than just waiting for the charge to dissipate. Cable Code was transmitted using a pair of otherwise standard Morse keys, with the operator transmitting dits with one hand and dahs with the other. And because the current at the far end of the cable was so tiny, it was received using a very sensitive galvanometer that deflected a beam of light left or right.

If this exposé of some of the less commonly known fact about Morse Code has revealed some new light on an admittedly old technology, albeit one that's still got lots of offer, to quote **Al Jolson**, you ain't heard nothing yet. Which is another way of saying that there's lots more to say on this grandfather of digital communication as you'll see if you join us for the second part of this journey of discovery.

Inspector Who?

It doesn't require an experienced telegrapher to notice that the theme tune for the *Inspector Morse* TV detective series contains a musical representation of Morse Code, specifically the title character's name. If you do count yourself as a telegrapher, though, you'll surely have noticed that, in the interests of musicality, the detective's name actually appears as Ttorse, as opposed to Morse, because of the exaggerated spacing between the first two dahs. If you're a fan of detective dramas, though, and you relish a challenge, you might be interested to learn that composer **Barrington Pheloung**, who also wrote the programme's incidental music, is on record as saying that he occasionally worked the name of the villain into the score, again in Morse Code, or sometimes the name of another character, as a red herring. A search revealed no examples, though, so perhaps that whole assertion is a red herring in itself, or musical licence has made any names pretty much unrecognisable. But, if you fancy a potentially wild goose chase...

Morse's Long Farewell

The end of maritime Morse Code in the UK, on New Year's Eve 1997, was widely reported. But the ending of the commercial use of Morse was a much more drawn-out affair. On the same day as the UK, France also pulled the plug on Morse with the evocative last message *"Calling all. This is our last cry before our eternal silence."* America's final moment was two years later. With an equally poignant and fitting final message, echoing that first ever message *"What hath God wrought"*, maritime Morse in the USA ended at the turn of the century. Yet Morse's long farewell was a lot longer than these two episodes might suggest. As long ago as 1930, in a milestone no less nostalgic than the events of 20 years ago, the Associated Press, once owner of one of America's biggest telegraph networks, phased out its last Morse wire in favour of teleprinter traffic.

Morse in the Commons

Morse Code raised its profile in the House of Commons in July 2019. To mark the centenary of the Government Communications Headquarters, MP **Alex Chalk**, whose Cheltenham constituency is home to GCHQ, wished the agency a happy birthday in a fitting way. Noting that the year was also the 175th anniversary of that famous message between Morse and Vail, he held his phone to a microphone and sent a 13 second congratulatory message to GCHQ in Morse Code.

Contests, Awards and DX

Steve Telenius-Lowe PJ4DX
teleniuslowe@gmail.com

Steve Telenius-Lowe PJ4DX brings his usual comprehensive round-up of the world of HF.

Welcome to the March *HF Highlights*. After an encouraging peak in solar activity, which started in October last year, the sun has become quiescent and, as of the day of writing (January 11th), there are once again no sunspots. The solar flux reached as high as 116 on November 30th but has since been declining, as can be seen in **Table 1**. These short-term fluctuations in solar activity are normal at all stages of the solar cycle but the present long-term trend should be upwards. We are still at the very beginning of Solar Cycle 25 and it is not expected to peak until 2025.

Try a Low-Key Contest

Some of those missing the excitement of chasing DXpeditions have turned to contest operating. The level of activity in the CQ WPX SSB contest in March 2020 for example, during the first lockdown period, was considerably higher than in previous years, leading to very overcrowded bands. If you can't face such conditions, one solution is to try a rather more low-key contest, and one of those takes place from 1200UTC on February 13th for 24 hours. In the Dutch PACC Contest, **Fig. 1**, there are separate sections for CW-only, SSB-only or mixed-mode entrants. Stations outside the Netherlands should work only Dutch stations. The multipliers are the 12 Dutch provinces worked on each band. You should send a report and serial number such as 59 001 and Dutch stations will send a report and a two-letter code representing their province, e.g. *"599 NH"* (for Noord Holland).

This is a very suitable contest in which to take part from the UK because there is good propagation to the Netherlands for long periods of time and, due to its proximity, signals are strong, at least on the lower-frequency bands (though contacts on 10m and 15m can be a challenge). Full details are on the website at:

pacc.veron.nl

RSGB Awards

After a period of time when the post was vacant, I was pleased to hear from **Lindsay Pennell G8PMA**, who has recently been appointed as the RSGB Awards Manager. The RSGB's HF awards range from certificates available to UK Foundation and Intermediate licensees only, through to a series of awards available to all licence holders, culminating in the prestigious *Commonwealth Century Award*. With the start of Solar Cycle 25, one award worth working towards now would be the *IARU Region 1 28MHz Award*, which requires confirmed contacts with amateurs in 40, 60 or all 99 countries in IARU Region 1, using the 28MHz band only.

	Jan '21	Dec '20	Nov '20	Oct '20	Difference
SFI:	73	81	86	73	(−8)
SN:	0	11	27	26	(−11)

Table 1: Solar Flux Index and Sunspot Number on January 11th compared with previous months.

Full details of the RSGB HF awards programme can be found on the RSGB web-site at:

tinyurl.com/vuxe3r5

Readers' News

First up this month is **Victor Brand G3JNB** who reported that *"Enhanced HF propagation continued into early December when **Andy 5Z4VJ** Kenya was running a huge pile-up on 17m."* At 2.45pm on the 2nd Andy finally heard the QRP signal from fellow CDXC member Victor, who said *"With instantaneous QSB and heavy QRM, I heard his rapid '...9 Victor K' and I felt that warranted a logging. Weekday band occupancy on HF CW then diminished here despite reasonable conditions but I could hear signals from JT1CO Mongolia on both 40m SSB and CW which, at least, reassured me that the aerial was connected! Then a major solar event occurred around the 9th and things went downhill. The ARRL 10m Contest was a washout for most EUs and I only heard the odd CW signal at around midday on the 13th. However, **Erik LA2US** was on 30m as JX2US from Jan Mayen Island, EU-022. He operates between his work shifts and, late morning on the 15th, he was remarkably strong here in Bedfordshire. Extended periods of 'NA UP', with breaks for 'EU' kept the pile-up flowing. At 1330, I adjourned for a spot of lunch but, back at 1430, to find Erik was still pounding away. Time passed and propagation was on the wane. Surely, he is going to need a break soon? I dropped down the split frequencies to the 'Up 1' mark and waved my few watts. Minutes passed and then 'G3JNB 599' – job done! Early morning on the 22nd, the 40m CW segment still seemed unoccupied until I heard ZL1ALA working a solitary DK. At midday, **Andy VK5MAV** was audible on 20m sporting a modest pile-up and, late evening, a loud VK2GR appeared on 40m. Much better! The year concluded here with a series of general QRP contacts and, on Christmas Day, the welcome arrival of an LDG Z817 auto tuner to keep my FT-818 company. It works like a dream."*

Carl Gorse 2E0HPI wrote that *"December has been a tough month with the Covid-19 lockdowns and tier systems here in the UK. However, I have managed to go to local WWFF sites away from the public by bicycle and activate a few areas on FT4 and FT8 with the small Elecraft AX1 antenna. [Also] some nice SSB DX contacts with such a small antenna, with extra help from the North Sea* (**Fig. 2**)*... I now have a home-made dipole located in the loft for 40, 30 and 20m and normally operate on FT4, FT8 and PSK31. I am hoping to get out this month even if it's only for a few short 20-minute activations over on the beach, running SSB and digital modes."*

Kevin Hewitt ZB2GI reported that at the time he wrote there was a 2200 to 0600 curfew in place in Gibraltar due to the second wave of Covid-19. However, during the month he says that he *"went up the Rock twice with **John** [ZB2JK] to operate portable. John worked over 50 stations in Europe and I worked stations across the 'pond'. The band was dead when we tried to operate the second time. I also operated alone from the top of the Rock in the morning, working stations in Europe, including **Etienne OS8D**. On Christmas Eve I operated 17m SSB from the club station and took the time to talk to stations instead of just exchanging reports. In December 2020, Austria was allocated 5351.3 to 5366.5kHz on a Secondary basis and I was pleased to work a few stations operating FT8 shortly after the allocation was awarded."* During December Kevin was awarded a certificate, **Fig. 3**, commemo-

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Fig. 1: The Dutch PACC contest is a good low-key contest to enter from the UK.
Fig. 2: Carl 2E0HPI operated portable from Seaham Chemical Beach at sunrise, before the Tier 4 restrictions came into effect.
Fig. 3: Commemorative certificate awarded to Kevin ZB2GI by the Polish national society, PZK, on the occasion of the 20th anniversary of amateur radio operations from the International Space Station.
Fig. 4: The Acom 1500 is back in pride of place at the shack of Etienne OS8D/ON8DN.

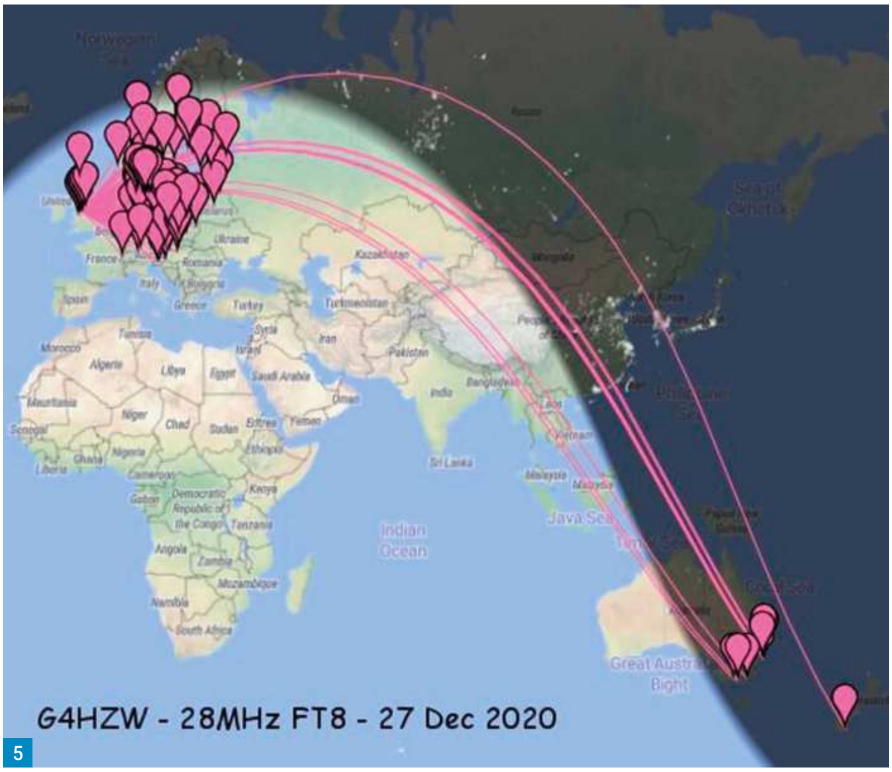
rating the 20 years of amateur radio on the International Space Station.

Reg Williams G0OOF said *"I was looking forward to giving some points away in the ARRL 10m SSB contest and decided to make a homebrew 10m-only Cobwebb antenna, which I could raise to just about half a wavelength above the ground on a temporary mast. I had enough parts at home for the construction excluding the balun, which was not expensive. Come the day, conditions were poor to say the least, certainly not like a few weeks before when conditions were good on 10m. I only managed a few European stations over both days. There was little difference in signal, comparing the Cobwebb to the 10m section of the Hustler antenna. Next was the RAC Canada winter contest. Conditions again were not too good on any of the upper HF bands, just a handful of Canadian stations worked on SSB.*

"My best DX of the month was working JH7MQD on 40m SSB with the Hustler antenna at 0800UTC. He was a very strong signal with lots of stations working him. I do not know if it may have been the greyline effect but European stations tended to fade out as they came into daylight, which left the band open with a quiet space to work him and he then went on to work a few more UK stations before his signal faded. The FT8 mode has produced some decent contacts over the last month but nothing exceptional. World grids and USA county collecting keeps me going but I'm looking forward to working more DX stations on SSB when conditions hopefully improve." Reg's contact with Japan on 40m at 0800UTC would certainly have been via the 'greyline', when it is around dawn at one station and around dusk at the other. Such contacts with Japan on 7MHz are fairly common in mid-winter – though not at other times of year!

Etienne Vrebos OS8D/ON8DN has just received his Acom 1500 amplifier back, **Fig. 4**, after repair at the factory in Bulgaria and it is giving *"great performance since back in the shack, using carefully at 1000W with 60W input from the Icom IC-7851 and everything runs well... I'm always amazed when people reach me with power as low as 5W and an indoor magnetic loop (OM0ET) or even 10W from Canada (VA3AAA). I continue to give some priority to /M or /P stations, I really appreciate their efforts and patience."* Etienne made about 350 QSOs during the month, all on SSB, and 90% without the use of the amplifier. He says he is *"still very happy that I have HF radio on, all day long, in these bad Covid times, allowing us to speak world-wide without a mask."*

Fig. 5: The 28MHz opening from the UK to New Zealand on December 27th.
Fig. 6: G4HZW's 28MHz FT8 contacts made during 2020.



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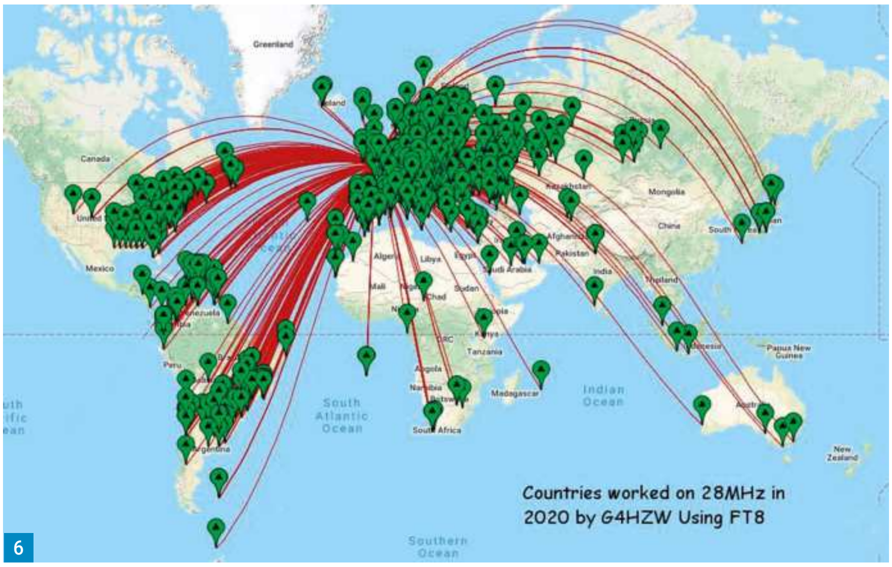

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Tony Usher G4HZW says that the *"highlight of the latest period was the opening of 28MHz to New Zealand from the UK for the first time during sunspot cycle 25,* **Fig. 5**. *This took place on December 27th 2020 at around 1000UTC with the SFI at 88. I wasn't able to secure a two-way contact but I did copy ZL4AS and PSKReporter shows that my signal was copied over there. I did see some well-equipped G stations working him."* Tony also sent a picture, **Fig. 6**, showing his 28MHz FT8 contacts made during the whole of 2020 while running just 50W to a 4-element Yagi at 40ft, which Tony says *"illustrates the power of FT8"*.

Owen Williams G0PHY had *"a bit more on-air activity this month. There were three more of the RSGB's Hope QSO parties with the majority of contacts being within Europe on 7MHz. During the ARRL 10m contest in mid-December there was a short opening at about noon on the Sunday to Eastern Europe with contacts with LY, SP and OK. Despite the low SFI numbers I have heard signals from VK. This past weekend I managed 14MHz contacts with D4* [Cape Verde Islands] *and a couple of Ws and on 7MHz a contact with EA9. I have also recently received QSLs for my contacts with 4U75UN and T6A."*

Around the Bands

Carl 2E0HPI/P: 7MHz SSB: F4GYM/P (FFF-2928), EA4DE (EAFF-1829), OK2MG/P (OKFF-0493), SP1MME/P (SPFF-2095). **7MHz FT8:** AO50UPC, PA20XMAS, TM20XMAS. **10MHz FT8:** LA1PHA, SM7OYP, **14MHz SSB:** KA8H, KG8P, LZ1WTA/P (LZFF-0778), VE9GLF, VE9MY, W2/CT1GIF.

Kevin Hewitt ZB2GI: 5MHz FT8: A45XR, AA3AZ, AA7A, CU3AC, K1CP, K2IW, K4MY, K5RK, K8KS, KR0P, PB75A, PY1VOY, TA4SO, TM20ISS, VA2ZO, VA3DIF, WP3UX, WP4G, WP4JLU. **7MHz FT8:** AB5VJ, K2IW, MD/EI7HDB. **14MHz SSB:** DB0YOTA, EA8M, K6VF, K9MBQ, KE1Y, KX3UP, VE3EIG, VE7APF, VK2CPC, VK2CR, W8NSS, W9GU. **14MHz FT8:** 9Y4DG, BI4XDT, JF2XGF, JG1PST, KC1NYY, LW4EAZ, NF5KF, PY2UGO, PY8ABH, VK2DX, VK2PWS, VK4XU, W8BLA, YB1MIG, YC9BHJ, YC9CT. **18MHz SSB:** MW0UPH. **18MHz FT8:** BG8TFN, BX5AA, BX6AD, JH6ETS, JR6GV, LU7BCS, ZR6AMC, **21MHz SSB:** 4F3OM, AA4VV, BG5UTE, BH7AHS, JR6GV, K2IBM, K6JDC, K8OM, K9JN, KJ5RC, LU1DVH, LU3PI, N3MK, PP5VA, PY2GAS, PU4LSB, VA3SF, W0SJ, W1ATV, ZS2EZ. **28MHz FT8:** RA2FL.

Reg G0OOF: 7MHz SSB: JH7MQD. **10MHz FT8:** HB0RER, VK5NG, XE1KK. **14MHz FT8:** OY1DZ, PY5AP, W0IEA. **21MHz FT8:** PU2MSP, RA0R, SV5AZK.

Etienne OS8D/ON8DN: 7MHz SSB: C31LK. **14MHz SSB:** 4L1BB, 7C9N, 9Z4FE, EP2HAM, FP5AC, FR4QT, HP1DSD, JY6ZZ, NP3XF, PY6RT, UP21HNY, VU3WEW, YB3DY, YB7TUU, YN2N, ZB2GI. **18MHz SSB:** 9Z4FE, UN8PT. **21MHz SSB:** HP9SAM, PY2FDC, PY5QW, Z81S.

Tony G4HZW: 7MHz FT4: 8P2K, CM8JFL, CT3MD, JT1CO, KM4RL, KN1OLA, NY2KW, W3CHH, WB8JUI, ZF1EJ. **28MHz FT8:** HZ1SK, K8YFM, KE3JP, N1EK, OY1DZ, PU5CRD, TA1D, TF3LB, TK5IH, V51WH, VK2DX, VK2LAW, VK3JA, WB2WMF.

Owen G0PHY: 7MHz SSB: EA9KB. **14MHz SSB:** D41CV, K9PPY, KN4IRM.

Signing Off

Thank you to all contributors. Please send all input for this column to telenius-lowe@gmail.com by 11th of each month. Photographs would be particularly welcome. For the May issue the deadline is March 11th. 73, Steve PJ4DX.

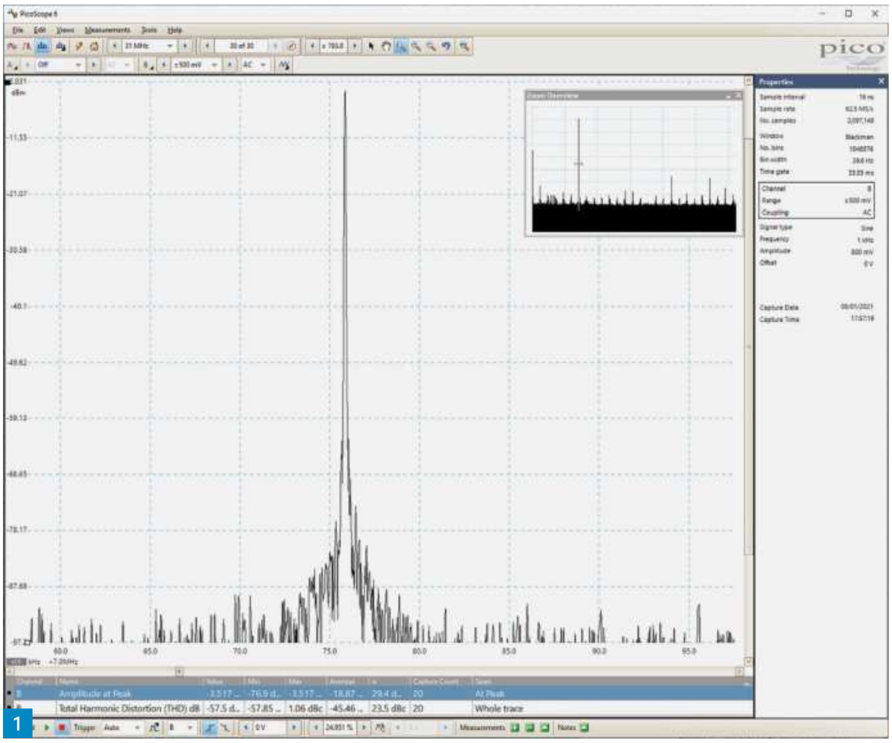
Mike Richards G4WNC
practicalwireless@warnersgroup.co.uk

FT4 Contest Mode

This month **Mike Richards G4WNC** moves on to look at the FT4 digital mode and he's also covering an upgrade to his RF network analyser.

FT4 was first introduced in 2019 and was intended for contest use where high QSO rates are desirable. For a long time, RTTY has prevailed as the preferred data mode for contest operation due to its instant decodability. This is because each RTTY character is clearly marked with start and stop information. This packaging enables the decoder to lock-on to the signal after receiving just a single character. As a result, RTTY contest operators usually operate with very terse messages to increase the QSO rate.

While FT8 provides a huge increase in communications reliability, its 15 second Tx/Rx cycles result in a relatively slow QSO rate that has hampered its take-up as a serious contest mode. FT4 was developed specifically to provide a high QSO rate that would rival RTTY, while maintaining many of the reliability and sensitivity benefits of FT8. The main differences between FT8 and FT4 are the use of 4-tone CPFSK (Continuous Phase Frequency Shift Keying) as opposed to the eight tones used in FT8, combined with a shorter Tx/Rx cycle of just 7.5 seconds. These changes give a 3.2dB reduction in sensitivity when compared to FT8. However, reliability is still a strong point and FT4 uses the same advanced parity and CRC structures as FT8. The net result is that FT4 can decode signals that are some 10dB weaker than that required for RTTY. The bandwidth requirement is also reduced. FT4 only requires a 90Hz slot and thanks to the use of CPFSK has very steep skirts down by about 80dB, **Fig. 1**. The measured results show that FT4 has a 50% decoding probability with signals that are 16.4dB below the noise in a standard 2.5kHz bandwidth.



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Signal Subtraction

One of the other recent developments that is used in both FT8 and FT4 is two-pass decoding with signal subtraction. This is an ingenious technique that enables the decoding of two signals on virtually the same frequency or a weak signal underneath a much stronger one. With FT8 and FT4, the signal decoding process occurs in the short gap between the end of the transmit period and the beginning of the next slot. If you look carefully at the decode screen, you will see that the first batch of decodes occur just before the end of the cycle, then a few more decodes appear a little later. This second batch of decodes is from the two-pass decoding algorithm. When using two-pass decoding with signal subtraction, the waveform of the first decoded signal is regenerated and then subtracted from the received signal, thus eliminating that signal. The result is then passed through the decoder on its second pass, where it can detect a weaker signal that was previously hidden beneath the first. This is a particularly useful feature for contest operation when bands are likely to be heavily congested.

Operating FT4

Although primarily designed for contest use, many operators have adopted FT4 as an everyday operating mode, so you will find plenty of activity on the HF bands. One of the reasons for it being used outside of contests is FT4's use of the same message structure as FT8. It's just a faster way to achieve those minimal contacts. I've shown the primary FT4 operating frequencies in **Table 1**. Before starting operation, there are a few adjustments to make to the Wide Graph for the best display of FT4 signals. The recommendation is as follows:

- Bins/Pixel = 7
- Start = 0Hz
- Average = N Avg 1
- Waterfall Palette = Digipan
- Flatten = Ticked
- Data for Spectral display = Cumulative

Once these parameters are set, you can adjust the sliders for your preferred display.

A new feature in FT4 is the Best S+P

Band	FT4 Frequency
80m	3.575MHz
40m	7.0475MHz
20m	14.080MHz
17m	18.104MHz
15m	21.140MHz
12m	24.919MHz
10m	28.180MHz
6m	50.318MHz

Table 1: FT4 operating frequencies.

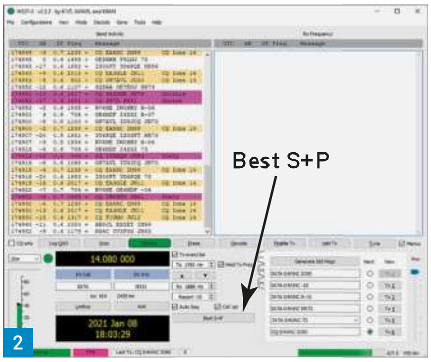

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Fig. 1: RF spectrum of an FT4 signal showing the very well controlled bandwidth.
Fig. 2 The S+P button is available in WSJT-X when the FT4 mode is selected.
Fig. 3 Inside view of the VNWA showing the original unit and the new front panel and case.
Fig. 4 View of the upgraded VNWA.
Fig. 5 Magi-Cal calibration aid for the SDR-Kits VNWA.

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button that appears as soon as you select the FT4 mode, **Fig. 2**. One of the problems with the faster QSO rate of FT4 is the speed with which you need to respond to call the next station. While it's easy to find someone to call, finding the best station that will give you the most contest points is not easy. The Best S+P button provides a degree of automation to help you work the best CQ calling station. When activated, this system examines all the received CQ calls at the end of each receive cycle. It will then select the best call to answer based on 1st priority – New Multiplier (DXCC), 2nd priority – New Call on band. Once Best S+P has located the best call, it will automatically call that station as if you had double-clicked on that station.

As I mentioned previously with FT8 operation, you will get the best results by using split-frequency operation. To set this up, begin by making sure the Hold Tx Freq box is checked. Next you need to watch the Wide Graph for a few Tx/Rx cycles to find a clear frequency. Once you've located a free slot, press and hold the shift key and left-click just above and to the left of that slot. If all is well, you should see the red square bracket symbol appear above the slot. To start using Best S+P, just click the button and the text will turn red to signify that it's active. At the end of the next receive cycle, WSJT-X will select the best station from those calling CQ and will begin calling that station. If your call is unsuccessful, try shifting the transmit frequency using the shift-click combination I mentioned earlier. If you want to give up on a station, just hit Halt Tx and then press Best S+P again to start a new cycle.

When it comes to operating a contest using FT4, you will need to alter the message format to match the contest rules. This has been made simple and is accessible via the Advanced tab in the Settings menu. At the bottom of this section, you tick the Special operating activity box and select the contest type that you want to use. Once you've done this and click OK, the message format will change and a new contest log will open that will store your contacts.

VNWA Upgrade

I've been using my Vector Network Analyser (VNWA) from SDR-Kits for many years and it's my go-to device for measuring RF projects. I recently noticed that SDR-Kits have introduced a couple of interesting new additions. As we're moving into another lockdown, I decided to treat myself and went ahead and bought the automatic two-port upgrade and the Magi-Cal calibration aid. When measuring two-port devices such as amplifiers and filters with the original VNWA, you had to manually reverse the connections to the Device Under Test (DUT) to measure the full set of s parameters. The two-port upgrade adds an electronic switch that automates the measurement process. The result being that you can measure the forward, reverse and reflection characteristics of the device with a single click and no lead swapping! Not only is this considerably faster but it saves on connector wear and increases the repeatability of the measurements.

The upgrade was supplied as a self-install kit and I've shown the completed modification with the lid removed in **Fig. 3**. Installation was very well described in the printed booklet that accompanied the upgrade. In addition to the new front panel and switching circuitry, the upgrade kit included a new outer case and a ribbon cable that carries the switch signals to the control socket on the rear panel. The only modification required was to cut a small rectangular slot on each side of the brass chassis of the original VNWA, to allow the control cable to pass. While this could be done with a small file, SDR-Kits supply a handy nibbler tool at a very reasonable price that makes light work of the job and avoids creating troublesome metal filings. The kit even included some double-sided foam to protect the control cable from the sharp edges of the slot. The entire upgrade took less than an hour and I'm delighted with the result, **Fig. 4**. As usual with products from SDR-Kits, the upgrade had been individually tested and was supplied with a printout of the measurement results.

Software for driving the two-port upgrade is already included in the standard VNWA software so I just had to make a few minor configuration changes and it was ready for action. Having now spent some time with upgraded version, I wish I'd done it sooner because it works extremely well. For those that prefer N type connectors, there is a separate upgrade kit available. The SMA upgrade kit costs £142.80 inclusive of VAT and is available from SDR-Kits at:

www.sdr-kits.net

My second upgrade was to add the SDR-Kits Magi-Cal calibrator, **Fig. 5**. As you're probably aware, obtaining accurate measurements with a VNA requires regular calibration, particularly when the test conditions change. For example, if you change the measurement cable or connectors, you should recalibrate so that the new test connections can be eliminated from the results. This can get a bit tedious and also increases the connector wear. This is where the Magi-Cal comes to the rescue. As you can see from the photo, the Magi Cal is a very compact device that is connected in place of the DUT between ports 1 and 2. Inside are the electronically switched short, open and load conditions that are controlled via a USB lead connected to the host computer. The characteristics of the Magi-Cal device are critical, and these are individually measured and stored in the memory of the Magi-Cal. The Magi-Cal is already included in the standard VNWA software and automatically reads and compensates for the load characteristics. The net result is that a full two-port calibration run is now a single-click process and the test leads only need to be connected once! The Magi-Cal costs £126 inclusive of VAT and is available from SDR-Kits at the previous URL.

Radio Round-up

CLUB TALKS ON ZOOM: One of the benefits of lockdown is that, not only are many clubs keeping going by using Zoom for their talks, but those Zoom talks are then being made available on YouTube and other platforms, allowing everyone to have access. Recently, for example, the Denby Dale amateur radio club has hosted talks (from the USA, again a benefit of remote working) by both Rob Sherwood KC0B (talking about radio performance) and Frank Howell K4FMH (talking about whether price buys performance or satisfaction in an HF transceiver). These and other recent talks to the club can be found on YouTube by searching for Denby Dale Amateur Radio Society. From the USA, Contest University recently hosted a Propagation Summit, which was recorded for posterity. Topics were:

- Update on the Personal Space Weather Station Project and HamSCI activities for 2021 by Dr Nathaniel Frissell, W2NAF.
- Solar Cycle 25 Predictions & Progress by Carl Luetzelschwab K9LA.
- Maximizing Performance of HF Antennas with Irregular Terrain by Dr. James Breakall WA3FET.
- HF Propagation: what to expect during the rising years of solar cycle 25 by Frank Donovan W3LPL.

Slide decks and videos are available from the Contest University website:

www.contestuniversity.com

An Eight-Way Remote Antenna Switch

Ken Ginn G8NDL
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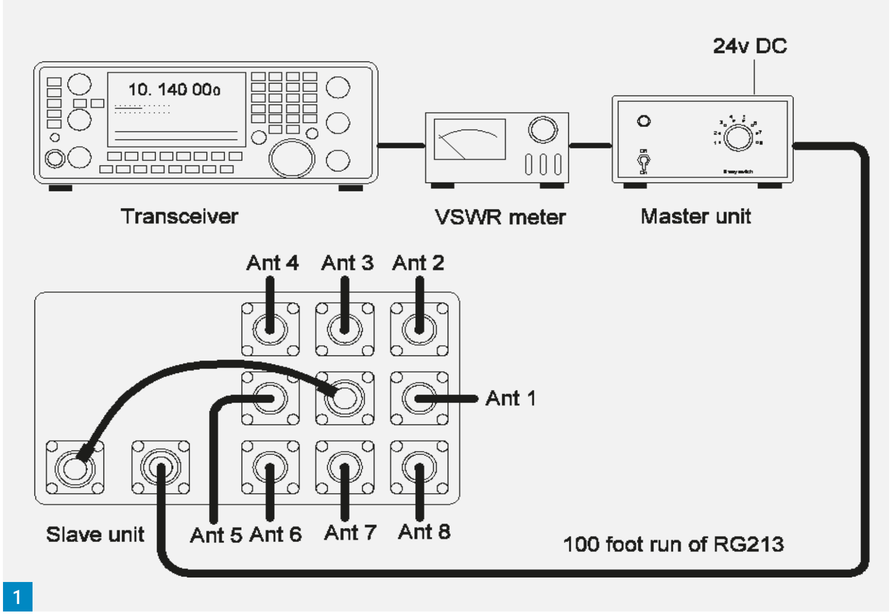
Ken Ginn G8NDL describes a remote antenna switch that combines a clever mix of software and hardware.

I have a single run of neatly installed RG213 coax running from the shack to my antennas in the garden. These antennas consist of a number of permanent antennas and other antennas that I experiment with; some of these designs come and go. These antennas are located at the end of 100ft of coaxial cable. I have no desire to go through the trouble and expense of installing additional coax cables or indeed a control cable run required to operate remote relays close to the antennas. To make the most of the single coaxial feed line I designed a microcontroller-controlled remote antenna switch, which selects one of eight antennas connected to the coax. The remote antenna switch is powered by a direct current imposed onto the coaxial feeder with a bias tee circuit. Control signals selecting the appropriate antenna are sent to the remote switch by modulating the DC voltage supplied to the bias tee and a remote switch.



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Circuit Design

The key feature of this antenna switching system is that a single coaxial cable from the shack to the end of the garden serves three functions. First, the transmission and reception of RF signals between the radio and the antennas. Second, DC power is supplied to the remote switching unit (the slave unit) and third, the transmission of serial data from the master unit in the shack to the slave unit's antenna switch. Here I have used an Amicus PIC development board at each end to do the hard work. The system block diagram is shown at **Fig. 1**.

The master unit uses an eight-position rotary switch to select the specific antenna at the far end. The Amicus microcontroller scans the eight antenna select inputs and produces a series of pulses to instruct the slave unit to actuate a specific relay. The structure of the serial data sent includes a 3mS start pulse, and a series of 1mS pulses, all pulses spaced 1mS apart. The number of 1mS pulses sent relate directly to the remote antenna select pulses. This being one pulse selecting antenna one, two select pulses for antenna two and so on. An illustration of this is shown in **Fig. 2**.

From the 24V supplied to the master unit by a separate mains-to-DC power supply, 18V in its quiescent state along the coax supplies power to the slave unit. This supply is modulated to 24V momentarily when the start and select pulses are sent. After which the DC supply relaxes back to 18V. Both DC power and serial data are injected in the feeder with the bias tee at the master end, and recovered at the slave end with a similar bias tee. The 18V DC received at the slave is sufficient to power the slave circuit via this second bias tee in the system.

Bias Tee

One bias tee circuit is used to inject a DC voltage on to the coaxial cable carrying an RF signal and a second one to recover the DC voltage at the far end without disturbance to the RF signal. There are similar bias tee circuits associated with the master and slave units. The maximum DC current the bias tees will safely handle is in the region of 400mA, but in this application the maximum current drawn by the two units in operation does not exceed 110mA from the 24V DC supply. 30mA is drawn by the master unit and an additional 70mA drawn by the slave unit when a relay is actuated. The photo, **Fig. 3**, shows the construction of a master bias tee while **Fig. 4** shows the circuit diagram of the bias tee used in the master unit. The three capacitors C4, C5 and C6 are all 2kV rated, while C7 and C8 are rated at 50/63V. My system is rated at 100W, therefore no testing was undertaken at power levels above this. However, the bias tee should be capable of handling 400W. Radio-to-DC port isolation (SK8/7 to SK5) was measured at >90dB from 3MHz to 30MHz, and RF insertion loss within the same frequency range was <0.1dB. On topband the loss is slightly higher and the DC to RF port isolation is lower but reports a respectable 60dB.

The bias tees used in this project were robbed from previous projects, which had been in use with earlier remote switch systems.

Master Unit

The master unit is built around a Crownhill Associates Amicus board, similar in appearance to the Arduino. The Amicus board is a PIC-based development board, using the microcontroller manufactured by Arizona Microchip. The PIC used is the PIC18F25K20, whereas the Arduino uses the ATMEL ATMEGA328P device. The shields in this project are all built on copper clad stripboard for one development board and these will fit either Amicus, Arduino or Firewing boards. One other difference between the Amicus and the Arduino is that the Amicus processor runs at 3.3V and the Arduino runs at 5.0V. In addition, the Arduino is programmed in C, whereas the Amicus and Firewing are programmed in PIC BASIC. The author has a quantity of Amicus boards that can be supplied new and unprogrammed or with master and slave codes preprogrammed into the microcontrollers. Firewing produce a similar version to the Amicus, using the same microcontroller, PIC18F25K20, and is pin for pin compatible with the Amicus. In common with the Amicus board, the Firewing firmware is developed in PIC BASIC. No code has currently been written for the Arduino for this project. The photo, **Fig. 5**, shows (left to right) the Elegoo Uno R3 (Arduino), Amicus board and Mechanique Firewing board.

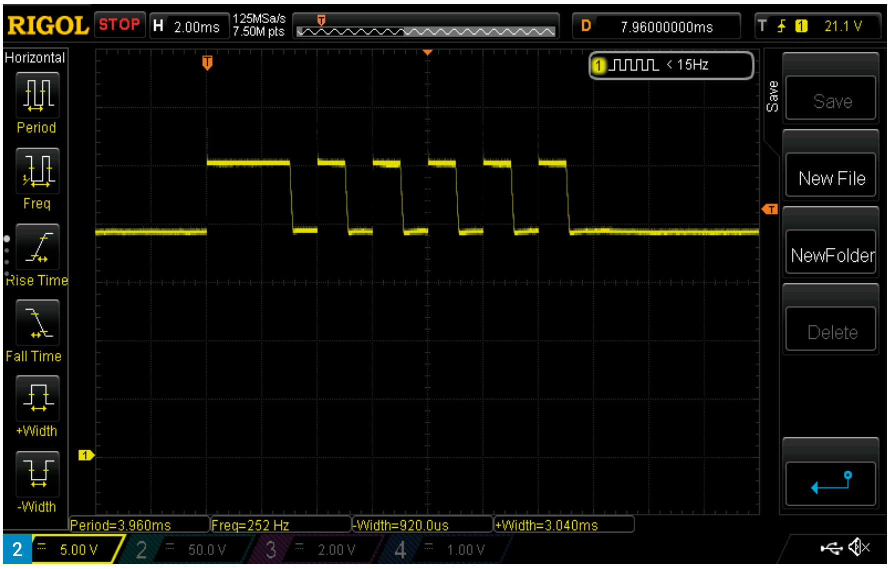
Home made shields are manufactured on stripboard, the master board is shown in the photo, **Fig. 6**. This is simply plugged into the Amicus board. The circuit of the master unit appears as **Fig. 7**.

Bias Tee

The master unit's bias tee is constructed in a small aluminium die cast box as shown in **Fig. 8**. This type of construction produces a particularly effective design that has good performance values, with an RF transmission loss of less than 0.1dB and high RF to DC port isolation figures. Similar units are constructed for both the master and slave units. SK6 and SK7 can be either SO239 or N-type sockets and SK5 is shown here as an SMA chassis mounting socket. The screen shown in Fig. 8 between the two inductors helps to support these two components and also improves the isolation between the RF and DC ports. Inductors L1 and L2 in both bias tees are 30 turns of 32SWG (0.22mm diameter) enamelled copper wire wound on a T52-50 Micrometals toroid.

The power to the master unit is supplied from an external 24V DC supply. A semiconductor Polyswitch fuse F1 restricts current under fault conditions. A conventional fuse is best avoided because there will be times when shorts and over-current situations will occur and the replacing of cartridge fuse can be somewhat annoying. F1 is mounted on the DPDT power switch S1.

The Amicus board provides 3.3V to the wiper of Sw2, and supplies current to ports



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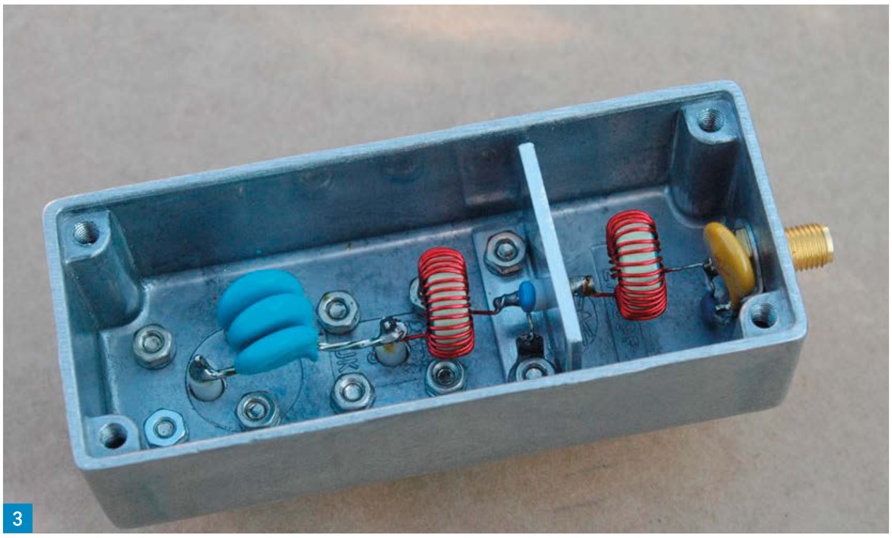

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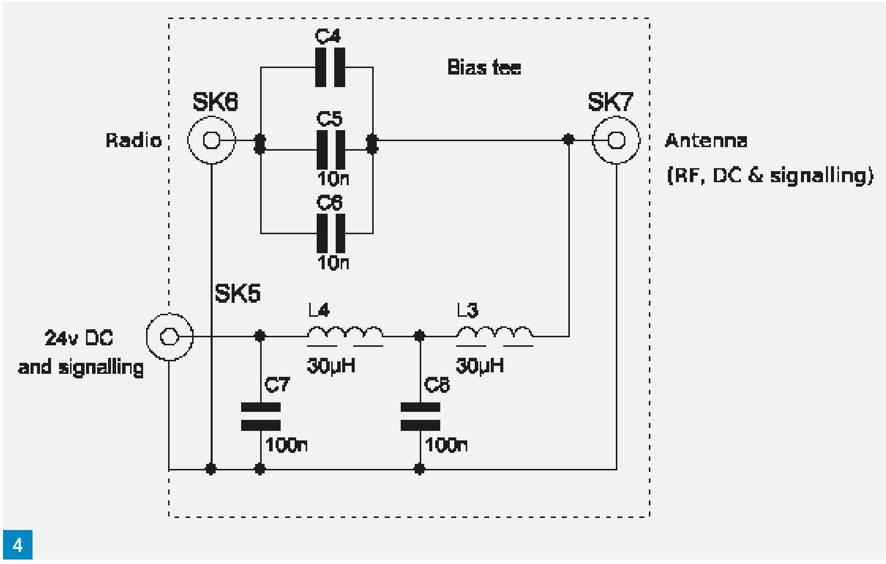

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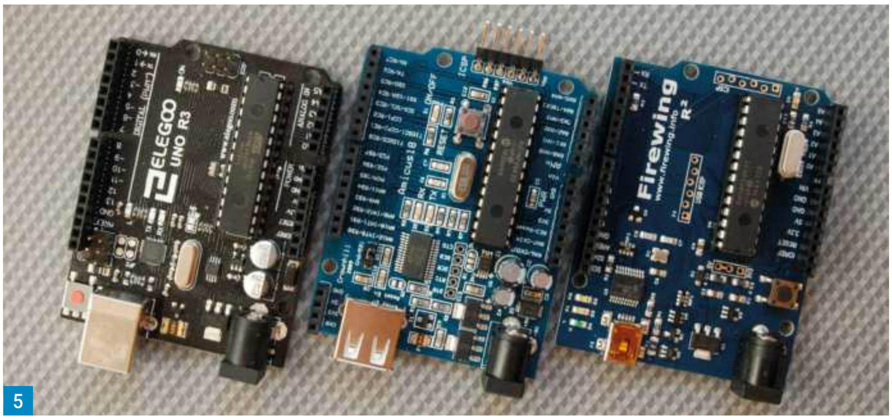
Fig. 1: System block diagram. Fig. 2: Structure of the serial data generated by the master unit. One start pulse (3mS) and five select pulses (1mS) shown. Fig. 3: Construction of a master bias tee. Fig. 4: Circuit diagram of the bias tee in the master unit.



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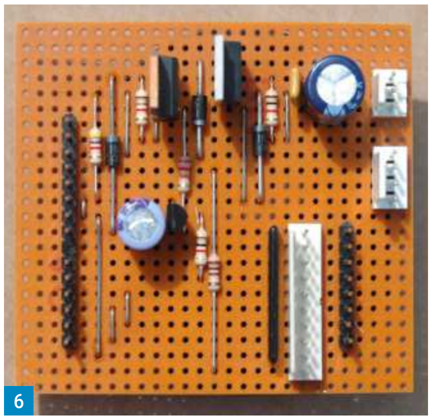

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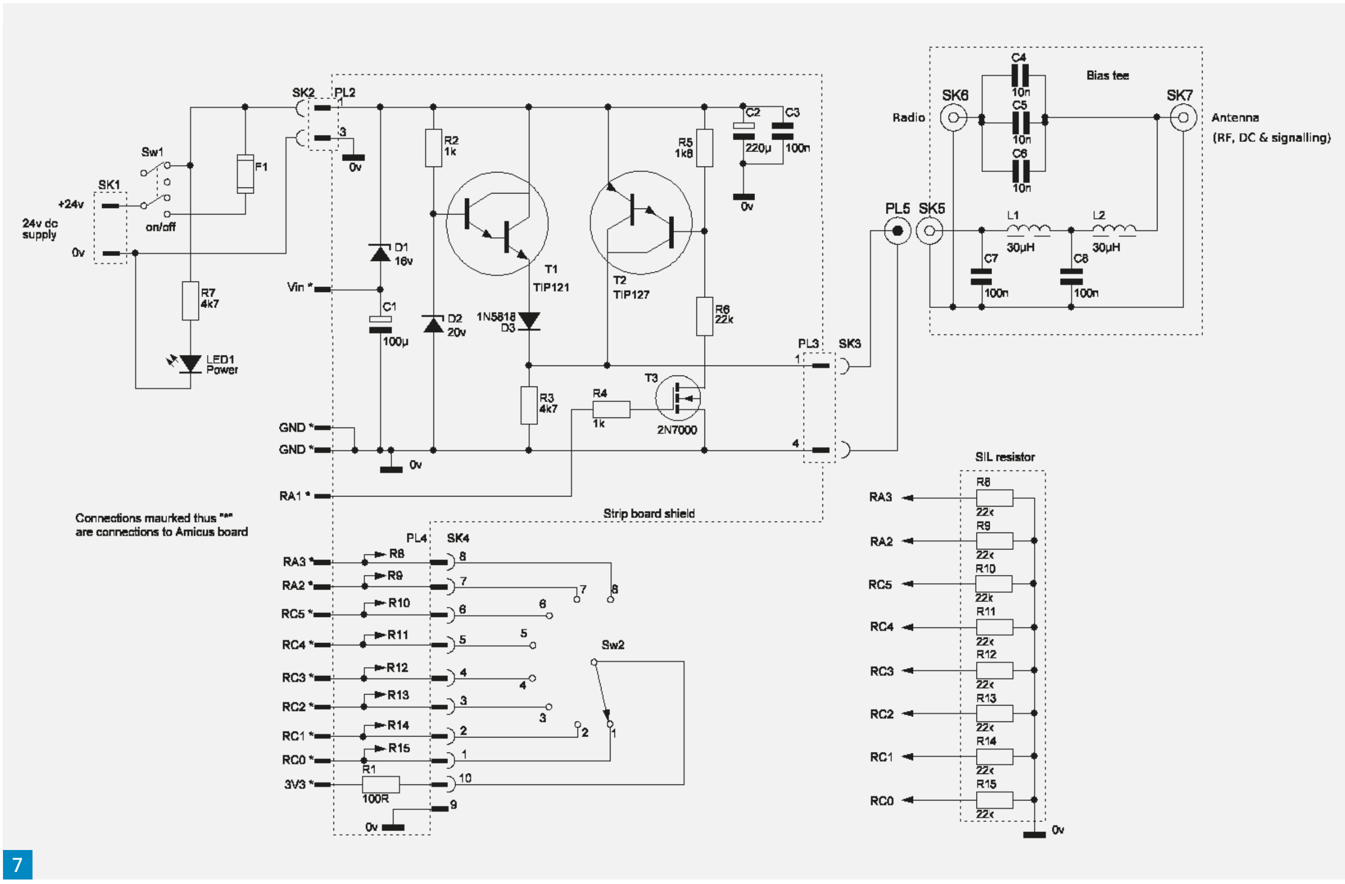

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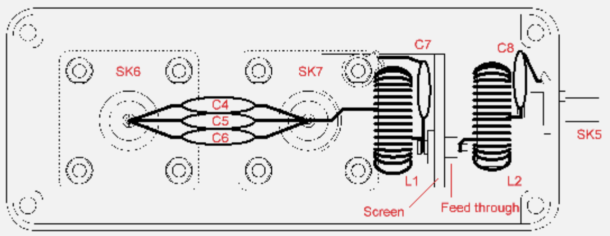
Fig. 5: Left to right - Elegoo Uno R3 (Arduino), Amicus board, Mechanique Firewing board. Fig. 6: Master shield. Fig. 7: Circuit diagram of the master unit. Fig. 8: Construction of the master bias tee. Fig. 9: The master shield component layout. Fig. 10: Position of all the internal master's components and the externally mounted bias tee. Fig. 11: Internal components of the slave unit. Fig. 12: The Amicus board is located on the bottom of the stack of three boards. Two shields plugged in to one another and the Amicus board. Note additional earth lead via a solder tag to the Amicus's earth connection. Also the L-shaped piece of aluminium located between the Amicus and the relay board – this acts as a screen. The USB port is for programming. Fig. 13: Slave shield, bottom board. Fig. 14: Component layout of bottom board. Fig. 15: Component layout of top board.

RA2, RA3 and RC0 to RC5 as selected by Sw2. Resistors R8 to R15 pull down any voltage that may be present on the antenna select inputs. Selecting the appropriate input initiates the start and antenna select pulses, which is available at RA1. The switch select data is sent from the master to the slave unit at switch-on and only when a new port is selected.

In the system's quiescent state the 18V supply, comprising D2, D3, R2 and T1 (TIP121) supplies current to the slave unit via the two bias tees. During the time the start and select pulses are sent, signals arriving from RA1 turn on T3 (2N7000) and effectively short out T1 with the use of T2 (TIP127). This supplies the 6V pulses on top of the nominal 18V DC supplied under quiescent circumstances. The DC supply and the pulses are delivered to the DC port of the bias tee.

Master Shield

Fig. 9 shows the location of all the components on the master stripboard shield. Tracks run horizontally across the board and are cut as shown in the illustration. Take note the connections on the left-hand side



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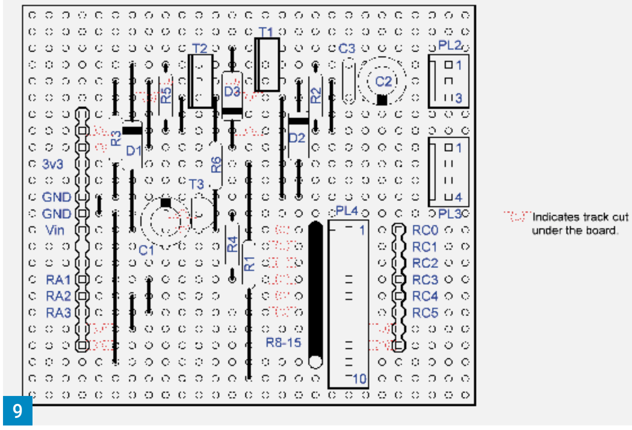

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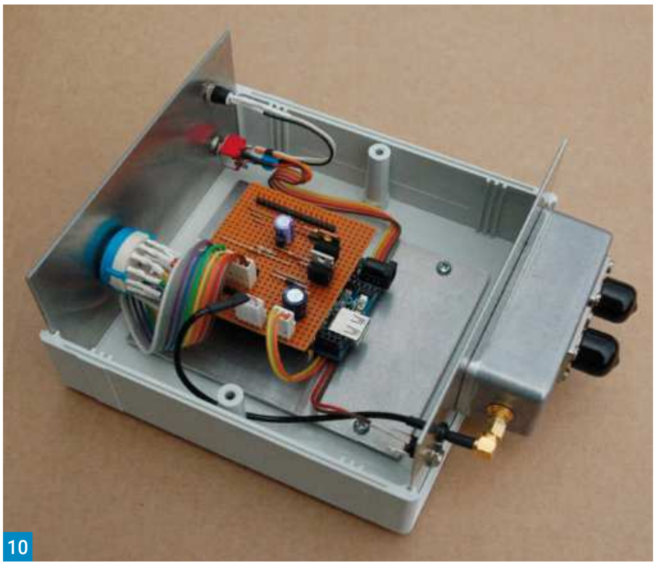
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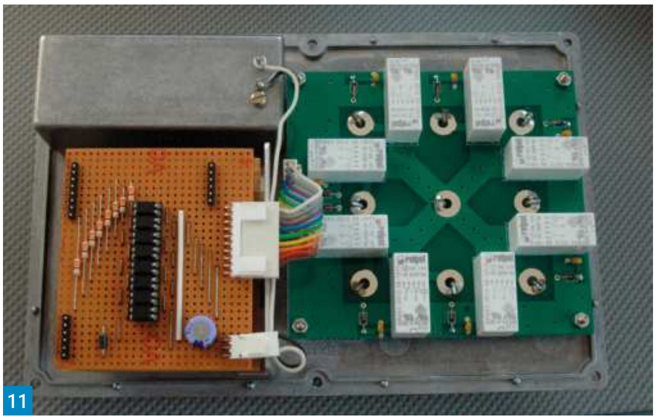
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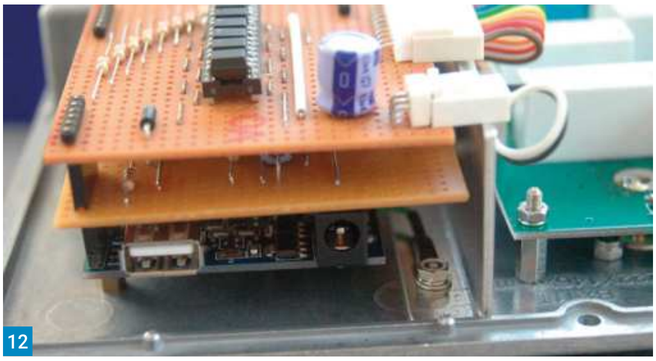
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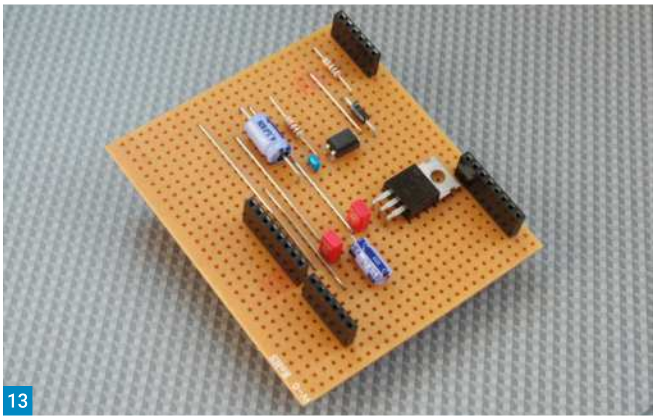
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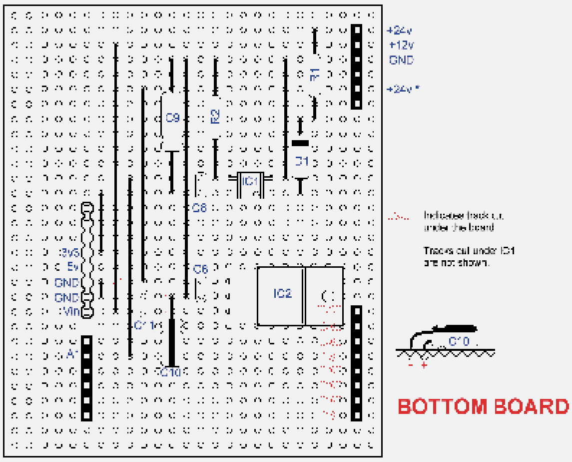

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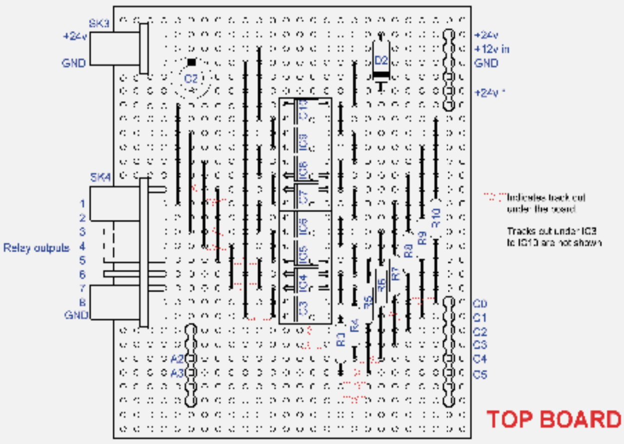

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Fig. 16: Slave top shield. Fig. 17: Circuit diagram of the slave unit. Fig. 18: Relay board. Fig. 19: Position of components as seen from above, also details of multi-way cable connecting the relay driver to the relay board. Fig. 20: Master unit rear. Fig. 21: Slave unit.

SIL connector have the seventh pin from the bottom removed. Connection is made to the Amicus board simply by plugging the master shield on top of the board. Connections to other components of the master unit are made by multi-way connectors PL2, PL3 and PL4.

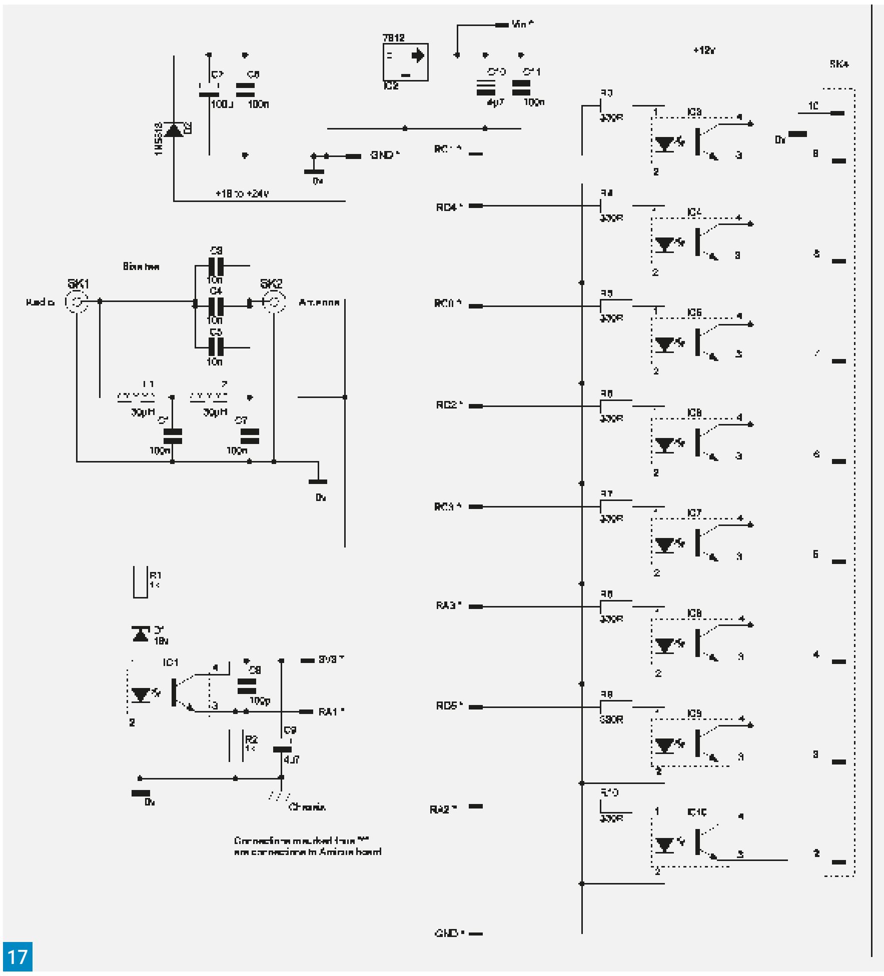
The photo, **Fig. 10**, shows the internal construction of the master unit, with the bias tee located on the outside of the case. In addition there is a lead (not shown) connecting the metal mounting plate the Amicus sits on to the rear panel mounting the bias tee.

Slave Unit

The slave unit accommodates all the components within a single diecast aluminium box. This includes the bias tee, microcontroller board (Amicus) and the two shields as shown in **Figs. 11** and **12**. See also the photos and drawings **Figs. 13** through **18**.

The bias tee passes the RF signal either way and isolates the antenna from the DC supply and low frequency signalling. The DC supply and the serial data is fed via D2 and smoothed by C2 and C6, and supplies a 12V regulator IC2 (7812). The regulated output supplies current to the Amicus board and the relays in the relay board.

The serial data is also fed to IC1 via an 18V Zener diode D1 and a current limiting resistor R1 to an opto-coupler IC1. IC1 offers a degree of isolation to the Amicus board from the RF power. This helps to protect the Amicus board from RF transients and reduces any electrical noise emanating from the Amicus board itself. Measurements of the 8MHz crystal and the 64MHz PLL show there is no measurable spurious greater than −140dBm. Whatever noise is generated by the Amicus is well below the noise floor threshold.



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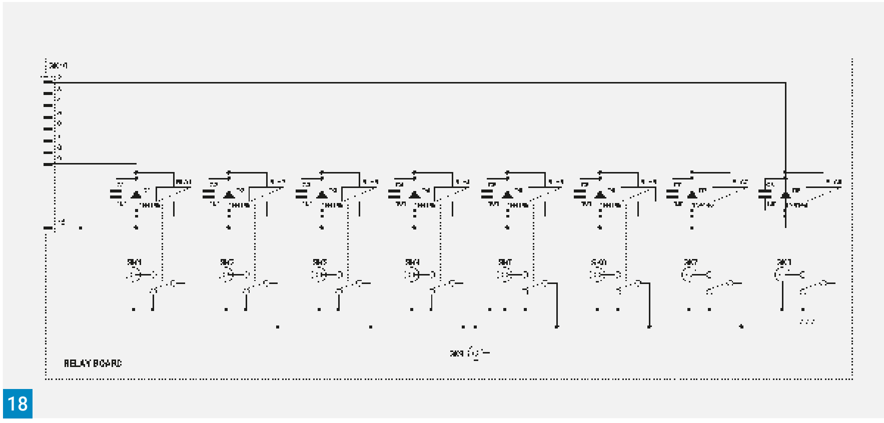

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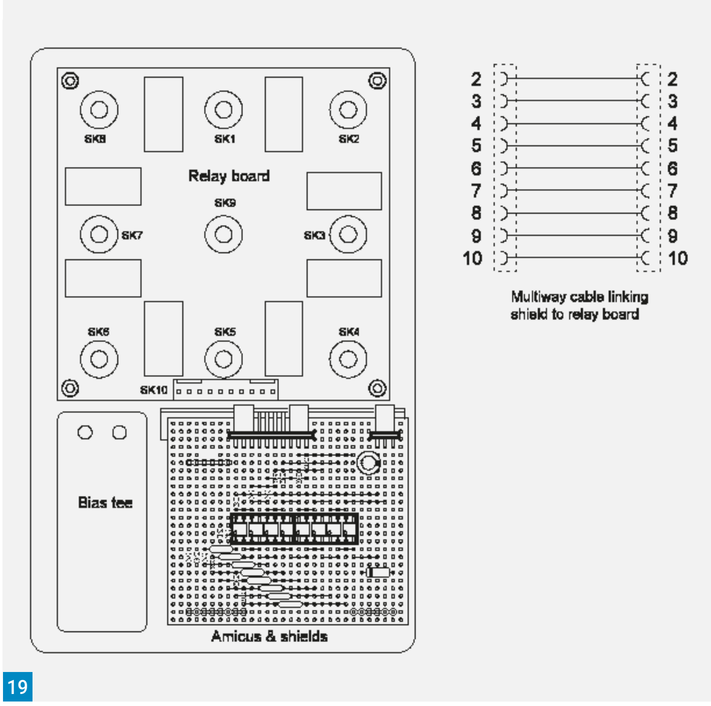
The firmware programmed into the slave's Amicus is looking for the start and antenna select pulses. An illustration of this is shown in Fig. 2; selection of antenna port five. When the selection is decoded the appropriate output goes high (3.3V) and the related opto-coupler's transistor turns on, actuating the selected relay. When the system is initially switched on RLA1 actuates, then the selected port from the master unit actuates. This is to take into account should no serial data be received at the slave unit that a known output will be selected. In this example the master is powered and then the slave unit is later connected. In that circumstance selecting a port from the master will send the serial data selecting the desired port. The serial data is only sent when initially switched on and when a new port is selected.

The relay board purchased on eBay for this project has the supply switched to the high side of the relays. Ordinarily I would have preferred to have switched the relay to earth, making the circuit easier to construct with



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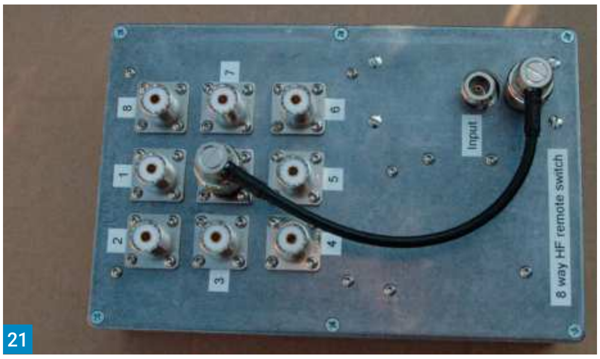

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an octal relay driver such as the ULN2803. If an alternative arrangement was considered, for example with open frame relays, the opto-couplers can be modified in an alternative arrangement with suitable modification to the circuit boards shown. Alternatively, low side switching with opto-couplers or integrated relay drivers such as the ULN2803 can be used. **Fig. 19** shows the position of the components as seen from above and also details of the multi-way cable connecting the relay driver to the relay board. The remaining photos, **Figs. 20** and **21**, show the completed units.

Alternative Use

This circuit was constructed to select one of eight antennas at the remote end of a 30m length of RG213. The circuit can be modified and used to remotely switch phasing harnesses or anything remote along a length of coaxial cable. Remote ATUs can be used with the system, where the isolating capacitors in the slave bias tee can be removed. Provisions in this configuration need to account for a DC voltage being present on all the outputs. Isolating capacitors may then be needed. Also, if a higher current is drawn, heatsinking arrangements would have to be made for T1 in the master unit.

Measured Parameters

Transmission loss: 0.1dB per unit (0.2dB through both master and slave units, excluding cable losses). Port/port isolation (relay board). 63dB; Spurious outputs (8MHz and 64MHz): -140dBm.

COMPONENTS LIST

Master Unit

- R1 100Ω All resistors are ¼ watt carbon film unless otherwise stated
- R2&4 1kΩ
- R3&7 4.7kΩ
- R5 1.8kΩ
- R6 22kΩ
- R8-15 22kΩ SIL resistor
- C1 100µF 25V electrolytic
- C2 220µF 35V electrolytic
- C3, 7&8 100nF 63V ceramic
- C4-6 10nF Suntan Y5U Ceramic disc 2kV
- D1 1N4745A 16V Zener diode
- D2 1N4747A 20V Zener diode
- D3 1N5818 Schottky Barrier diode
- F1 Littlefuse RXEF025 0.25A Polyswitch Fuse
- L1&2 30µH – 30 turns of 32SWG enamelled copper wire on a Micrometals T50-52 core
- LED1 Panel mounting LED
- SK5/PL5 SMA chassis socket and SMA plug
- SK6 N-type/SO239 chassis mounting socket
- SK7 N-type/SO239 chassis mounting socket
- T1 TIP121
- T2 TIP127
- T3 2N7000
- Sw1 DPDT toggle switch
- Sw2 12-way single-pole rotary switch

Slave unit

- R1&2 1kΩ
- R3-10 330Ω
- C1,6,7,10&11 100nF 63V ceramic
- C2 100µF 35V electrolytic
- C3-5 10nF Suntan Y5U Ceramic disc 2kV
- C8 100pF 63V ceramic
- C9 4.7µF 16V axial electrolytic
- C10 4.7µF 16V radial electrolytic
- D1 ZPY18 18V 1.3W Zener diode
- D2 1N5818 Schottky Barrier diode
- IC1 SFH-618A opto-coupler
- IC2 7812 12V 1A regulator TO220
- IC3-10 FOD852 Darlington opto-coupler
- L1&2 30µH – 30 turns of 32SWG enamelled copper wire on a Micrometals T50-52 core
- SK1&2 N-type/SO239 chassis mounting socket
- RLA1-8 DPDT (SPDT) 12V PCB mounting relay 360Ω coil

Relay board

- C1-8 10nF 63V ceramic
- D1-8 1N4148
- SK1-9 N-type/SO239 chassis mounting socket

Miscellaneous Components

- 2, 3 and 10-way board mounted plugs and matching cable connectors (0.1in pitch)
- Long pin headers 6 & 8 way.
- Header pins.
- M3 screws and nuts.
- SIL plugs and sockets to fit boards
- Case
- Wire
- IC sockets
- Diecast boxes

1

The Eddystone EA12

Dr Bruce Taylor HB9ANY
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Dr Bruce Taylor HB9ANY describes Eddystone's ultimate top-line amateur band receiver.

Stratton & Co of Birmingham had accumulated over 37 years of experience manufacturing shortwave radio receivers when they launched the Eddystone EA12 model in 1964, **Fig. 1**. At this time miniature thermionic valves had reached their apogee of performance and reliability, and their RF characteristics hadn't yet been surpassed by the embryonic semiconductor technology that would eventually mature to dominate the world of radio electronics. In fact, the 12-transistor Eddystone S960 communications receiver was discontinued in 1964 because it worked less well than the valve 1962 S940 model that it was supposed to replace!

The better classic Eddystone receivers from this period are now collectors' items that can be quite readily restored to original specifications. Although they have fewer bells and whistles than modern radios, they are very well engineered, have excellent performance, and are straightforward to maintain and a pleasure to operate.

Heritage

The origin of the EA12 can be traced back to the very successful Eddystone S750 model (see *Practical Wireless*, August 2020), a general-coverage communications receiver of which more than 2000 were made between 1950 and 1958. The receiver was Eddystone's first true double-conversion set, with a tuneable converter to the first IF of 1620kHz followed by a frequency changer to a second IF of 85kHz. The S750 used all-glass miniature valves, had continuously variable selectivity and separate RF, IF and AF gains, and introduced the wide open 'slide-rule' tuning dial that would be the striking visible hallmark of many future Eddystone receivers, including the EA12.

Since the early days of the company many Eddystone staff, such as **EJ 'Pick' Pickard G6VA**, **George Brown G5BJ** and Chief Engineer **Bill Cooke GW0ION**, were licensed radio amateurs and the works had its own station with callsign G6SL. Project Engineer **Jerry Walker G5JU** published review articles in amateur radio magazines, as well as many construction articles using Eddystone components. Hence it was no surprise that the factory developed a modified version of the S750 specially for the amateur bands and this was introduced in 1956 as the Model 888. It was superseded the following year by the 888A with a product detector for improved SSB reception and a total of 550 of both versions were made.

After production of the 888A ceased in 1961, Eddystone's Commercial Director **Arthur Edwards G6XJ**, who was himself a keen CW/DX HF band operator, pressed for the manufacture of a more modern high performance amateur band receiver, but Technical Director **Harold Cox** thought that the market for such a set was too small to justify the cost of the development that would be required. Then fortuitously an opportunity arose that allowed the dream to become reality.

Conception

In 1962 Eddystone introduced a high performance 15-valve general coverage communications receiver called Model 830 that was designed to the specifications of a Swedish customer. It was the first of a very successful series of receivers that ran to 12 versions and remained in production until 1973. The 830

Fig. 1: The EA12 has a wide range of features for AM, SSB and CW reception. Fig. 2: The heart of the EA12 is a diecast coil box carrying the RF stages, flanked by two subchassis and secured to a sturdy front panel. Fig. 3: The date of manufacture can be deduced from the EA12 Serial No. Fig. 4: The ratio arm (arrowed) produces a near-linear frequency tuning scale.


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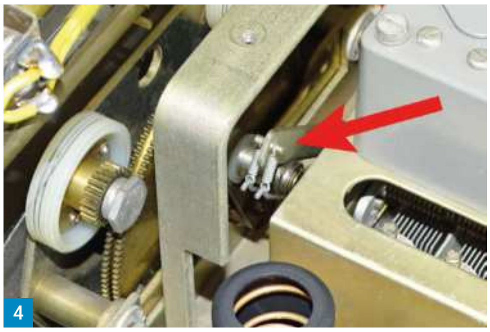
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was a versatile but expensive double-conversion superhet with tuneable first and second local oscillators. The first LO was the main tuning control, giving coverage from 300kHz to 30MHz in nine switched ranges. The second LO was used for incremental tuning over a range of ±100kHz around the first IF of 1350kHz, with conversion to the second IF of 100kHz. The main tuning rate was 250kHz per revolution at 30MHz, while the incremental tuning rate was about 10kHz per revolution, independent of the input frequency.

Edwards realised that if the incremental tuning range of the 830 were increased to 600kHz, then it would be possible to use it to cover the six major (pre-WARC) amateur bands by selecting nine crystal-controlled frequencies for the first LO. (10m being covered in four ranges). The incremental tuning then became the main tuning of the receiver, covering a first IF range of 1.1 to 1.7MHz. In addition to high stability, the low-noise crystal first LO reduces the intermodulation distortion, while the second LO range of 1.0 to 1.6MHz is one over which very high stability is readily achieved.

Thus, the EA12 concept was born, and its 830 foundation was enhanced with several technical refinements of particular value to radio amateurs and SWLs. In spite of the high retail price of up to £185 (over £3000 in today's money) the receiver proved popular and during a five-year period well over 350 sets were sold.

Production

The date of manufacture of an EA12 can be deduced from the Serial No. stamped on a plate affixed to the rear panel next the antenna socket, **Fig. 3**. The first letter of the prefix (A to L) indicates the month from January to December, while the second letter (P to U) indicates the year from 1964 to 1969. For example, Serial No. FS0226 was made in June 1967 and I received it in November of that year. The original Plessey electrolytic HT smoothing capacitors carry their date of manufacture.

Many earlier Eddystone receiver models were identified by an 'S' number, such as S640 and S750. (The 'S' stood for 'specification', not for 'Stratton'). In the factory, the EA12 was designated S923 but the final catalogue prefix EA stands for 'Eddystone Amateur'. The number 12 is arbitrary. The receiver has 13 valves but Harold Cox, who had the final say on Model Nos, thought that 12 was more propitious.

Design

I've provided a high-resolution PDF of the original EA12 circuit diagram for download here:

https://tinyurl.com/y5x5vq8d

and a list of circuit revisions from December 1966 is provided here:

https://tinyurl.com/y46a42ux

The receiver is built around a diecast coil box, which carries the RF amplifier, both LOs and the mixers. This is attached to a sturdy front panel and flanked by two subchassis; with the power supply, BFO/SSB detector and its associated audio filter on one side and the second IF and AF amplifiers, AM detector, AGC rectifier and crystal filter on the other, **Fig. 2**.

The smooth flywheel tuning control drives a spring-loaded split-gear system to eliminate backlash and the cursor travel is about 26cm on each range. To achieve substantially straight-line frequency calibration the mechanism incorporates a linearising ratio arm, **Fig. 4**, the brainchild of Bill Cooke. The reduction ratio of 140:1 results in a tuning rate of about 12kHz per revolution of the tuning knob throughout the range. A quirk is that, as with the S640 receiver, the frequency increases from right to left on the tuning scale. The scale divisions are 10kHz apart and frequencies can be set within 1kHz when standardised with the crystal calibrator. Drift does not exceed 100Hz in any one-hour period and short-term drift is less than 20Hz for temperature changes up to 20°C and 100Hz for a mains voltage variation of 10%.

Calibrator

The crystal calibrator is a self-contained diecast module mounted on top of the first local oscillator cover, **Fig. 5**. It uses a GEC JCF/193 close tolerance 100kHz quartz crystal in an evacuated envelope and a trimmer capacitor allows the frequency to be pulled slightly to align it with an external standard. Since the first LO is crystal controlled, the harmonic output of the calibrator is injected to the second mixer by proximity coupling.

As the fundamental is also fed into the second IF, the BFO doesn't need to be switched on when checking the calibration.

When the calibrator is enabled, the gain of the RF stage is reduced to avoid interference by incoming signals. Having zero-beat the calibrator signal, the cursor can then be moved slightly by a mechanical shift control to align it exactly with the appropriate 100kHz division on the tuning dial. As the calibration signal is introduced at the first IF, it corrects for all the bands at the same time.

On the LF bands, there can be some leakage of the harmonics of the crystal calibrator into the first mixer. As a result of the slight inaccuracy in the frequency of the first LO crystals, this can result in a constant low-pitched beat being heard in the background when tuned to a crystal check frequency. The error is typically of the order of 100Hz, well within the specified accuracy of the receiver.

RF stages

To prevent breakthrough at the first IF, the signal input from the antenna is first passed through a multi-pole highpass filter with an input impedance of 75Ω that attenuates signals below 1.7MHz by at least 90dB. The RF amplifier uses a frame-grid ECC189 double-triode in a cascode (grounded-cathode/grounded-grid) circuit. This has improved signal-to-noise performance on 10m and 15m and provides greater protection against cross modulation and blocking than the 6BA6 pentode amplifier of the S750 and 888A.

The three signal frequency circuits are tuned by a front-panel 'Peak RF' control that is independent of the main tuning. The control has a two-to-one reduction drive and its coverage is restricted to 600kHz except on 10m, where the tuning range is extended to 2MHz to allow coverage of the whole band with a single set of coils.

Oscillator injection from the crystal controlled first LO is on the high side of the signal frequency on all ranges, so that the IF spectrum is a mirror image of the input spectrum. On the lower four frequency ranges injection is at the fundamental crystal frequency, while on the five ranges covering 10m and 15m the triode section of the first mixer acts as a frequency doubler. The HT supply to the crystal oscillator and the amplifier/doubler is stabilised, while that to the tuneable second LO is not. This surprising arrangement was found to reduce the frequency change with variation in mains voltage. The drift produced by a change in the HT voltage is compensated by that caused by the corresponding change in heater voltage! Replace the EC90 oscillator valve V5 in the event of any significant drift or chirp.

100kHz IF Amplifier

The second IF stage of the EA12 has seven tuned circuits in addition to a crystal filter with preset phasing for CW reception. In the S750 and 888 models, Eddystone used a technique pioneered in Hammarlund Super-Pro receivers that allows the selectivity to be varied by a front panel control that alters the coupling between the primary and secondary windings of the second and third IF transformers. In the EA12, this mechanism is applied to three IF transformers instead of two, **Fig. 6**. The selectivity control has detents at bandwidths of 6kHz for AM, 3kHz for SSB and 1.3kHz for CW. Rotating the control further switches in the crystal filter, reducing the bandwidth to 50Hz. IF breakthrough attenuation is greater than 110dB on all ranges and the change of IF centre frequency when the selectivity is varied is negligible.

Another front panel knob controls a slot filter whose narrow 'T' notch can be positioned at any point in the IF passband. With a rejection of over 40dB, the filter is very effective in removing an interfering heterodyne. When receiving SSB signals and not required for interference suppression, it can be used to steepen the carrier side of the passband. Exalted carrier reception of an AM signal is also possible by using the filter to notch out the carrier and taking it as an SSB signal using the BFO. When set 'off', the slot is positioned slightly more than 3kHz from the centre frequency.

A low impedance IF output is provided at a coax socket at the rear of the receiver for use with the Eddystone EP20 panoramic display or ancillary units for decoding digital modes. The sweep width of the EP20 can be reduced to 100Hz for detailed spectral analysis but the maximum display bandwidth is limited by the selectivity of the IF channel to 6kHz.

S-Meter

A feature of the EA12 is the large S-meter fitted on the front panel behind the glass window, **Fig. 7**. 'S1' on the scale corresponds to an input of 2μV at the antenna socket and each division represents a 6dB change in input signal level. This differs from the external Model 669 S-meter used with many earlier Eddystone receivers, which is calibrated at a generous 4dB per S point, allegedly because Harold Cox thought it would make the sets look more sensitive than they really were!

A potentiometer on the rear panel of the EA12 allows the S-meter to be zeroed with a non-inductive 75Ω resistor connected to the antenna socket. Damping resistors are included across the primary windings of some of the tuned circuits coupling the cascode and first mixer stages to maintain the same calibration when changing from band to band. A thermistor can be inserted between the centre tap of the HT winding and ground to prevent the S-meter hitting the end stop at power-on. The meter is controlled by the AGC level and is out of action when the AGC is switched off.

AGC and Noise Limiters

With the AGC on, time constants of 150ms can be selected for AM reception or 4.5s for SSB or CW. When receiving SSB signals there is an automatic reduction in the AGC delay (the signal strength threshold at which AGC feedback begins). The AGC voltage is provided at a rear terminal for recording or control purposes, or for linking receivers for diversity reception if you have more than one of them and don't QSY often!

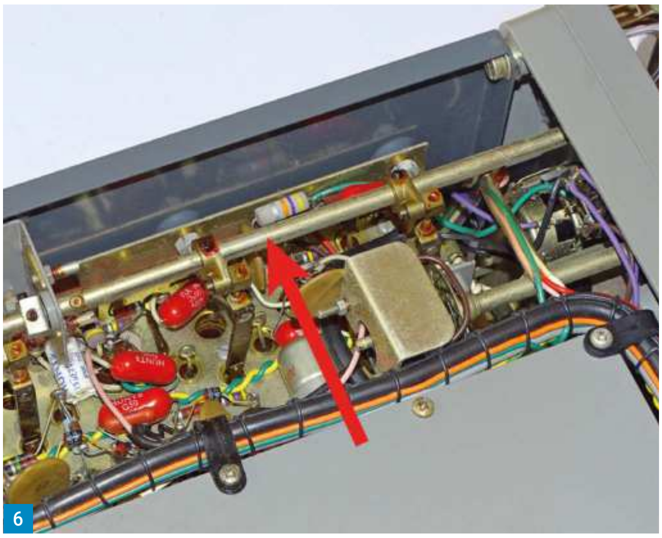
A rear panel control allows the muting level to be set if the standby switch is used for transmit/receive switching, or if the mute input terminal is grounded by an external relay. Alternatively, the receiver can be muted by applying a negative voltage to the AGC terminal. The voltage should be adjusted to suit the strength of the transmitted signal, since the muting level control is not active in this mode. A voltage of -50V is sufficient to mute the receiver completely. A chassis ground terminal next the antenna socket should be used to complete all such external circuits (see Fig. 3 again).

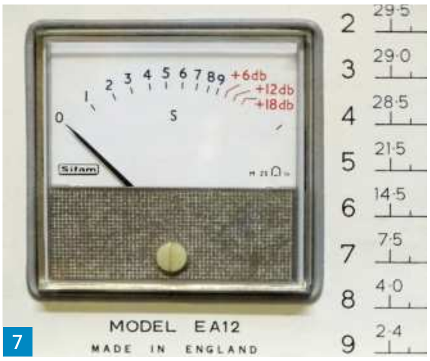
The AGC selector switch also controls the two noise limiters; a simple series diode type for AM and a double-diode clipper for SSB and CW. An internal control for the SSB/CW noise limiter allows the degree of clipping to be adjusted. Advancing the control too far will result in excessive distortion on SSB and a tendency for CW characters to run together because of the square shaping of the keying envelope. This control has no effect on the AM noise limiter.

AF Stages

Separate audio filters are provided for AM and for SSB/CW signals. On AM, the response is within ±3dB (relative to 1kHz) over the range 400-7000Hz. When receiving SSB or CW, the output from the product detector is filtered to modify the audio response to 10dB down at 500Hz and greater than 30dB down at 5kHz. When the CW audio filter is switched in, the circuit is reconfigured to use the same Mullard Vinkor ferrite pot-core inductor as a tuned audio filter with a 6dB bandwidth of 300Hz centred on 800Hz.

In addition to a front panel headphone jack, the EA12 has an internal 11cm diameter loudspeaker at the right side of the cabinet. This speaker is connected to the audio output terminals on the rear panel, which allows it to be





disconnected when an external loudspeaker is used. Unusually for Eddystone, the output transformer is not a potted component. The maximum audio output is 2.5W, with 5% distortion at 1W into 3Ω. A matching Type 906 plinth accessory was available that incorporates an elliptical speaker and tilts the receiver to a convenient operating angle of 13°. Unlike the diecast mounting blocks for earlier Eddystone receivers, the plinth is made of sheet steel. Hence it can easily be customised to accept additional sockets, meters, switches, or other station controls, **Fig. 8**.

Restoration

Today, EA12 receivers in good original (unmolested) condition can be purchased for around £300. If possible, the mains input connector should be procured with the set, since this is quite a rare Bulgin type with asymmetric contact diameters and a side ground clip, **Fig. 9**.

Initially it can be quite difficult to remove the close-fitting cabinet. Place the receiver face down on its handles and remove the four retaining screws. Then apply inwards and upwards glancing blows with the palms of the hands on the long sides of the case. Only if this fails, exert leverage with a screwdriver in the two slots in the leading edge of the underside of the cabinet. Apply Vaseline around the inside edge of the front panel when reassembling.

If the receiver has not been used for many years, old lubricant should be cleaned from the tuning mechanism and the cursor slide to avoid damaging the fine 0.3mm diameter drive wire. When relubricating the moving parts with fresh light oil or grease, apply sparingly and avoid contaminating the stainless steel drive disk that forms part of the main tuning mechanism.

Unlike many earlier Eddystone models, the glass window of the EA12 can be readily extracted for cleaning without the fastidious task of dismounting the front panel. This is achieved by removing the small shaped castings at each end of the dial aperture by

Fig. 5: The beehive trimmers for the tuneable IF are accessible at the side of the crystal calibrator module. Fig. 6: The variable selectivity control acts on all three 100kHz IF transformers. Fig. 7: The large clear S-meter is calibrated at 6dB per S point. Fig. 8: The Type 906 loudspeaker plinth can be readily customised. Fig. 9: The Bulgin EA12 mains connector is polarised by asymmetric contact diameters. Fig. 10: The 4BA bolts securing the glass retaining castings can be accessed through side slots.

accessing their retaining bolts with a 4BA or 6.5mm spanner through rectangular cut-outs in the side panels, **Fig. 10**.

The Achilles' heel of Eddystone receivers of this vintage is not the tuning mechanism, the transformers, the controls, the crystals,

Fig. 11: The coil box houses the bandpass RF transformers, the RF coils, the second LO coil and the two Vinkor inductors of the IF bandpass circuit. Fig. 12: EA12 alignment tools: *1* Crystal filter phasing, *2* Beehive trimmers, *3* Vinkor inductors, *4* 2nd LO and 100kHz IFTs, *5* RF bandpass transformers and coils.

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the RF and IF inductors or even the valves, all of which are very reliable. Instead, the most usual cause of inferior performance is the failure of humble fixed resistors and capacitors. Fortunately, these are inexpensive but due to the point-to-point wiring of the receiver it is sometimes necessary to remove several components to gain access to replace a defective one at a deeper layer, particularly inside the coil box, **Fig. 11**. The original soldering is not always to the highest standard, with some component leads just tacked to tags instead of being mechanically wrapped first, but dry joints are rare. The receivers were built entirely by hand and original factory wiring errors are not unheard of.

The least reliable capacitors are the metallised paper ones and the small white electrolytic capacitors, which tend to drift in value or become open circuit. The HT smoothing capacitors rarely give trouble but after more than 50 years it may be wise to replace them in view of the mess that can be produced if they do blow. Adding an inline fuse between the centre tap of the HT winding and the chassis can prevent the diodes or surge resistors acting as fuses in the event of a fault. Wirewound components are stable but carbon composite resistors tend to drift high in value, especially those having a high nominal resistance or carrying a significant DC current. Simple voltage checks and signal tracing will identify most of the defective components and, once these have been dealt with, performance measurements will indicate where further work is required.

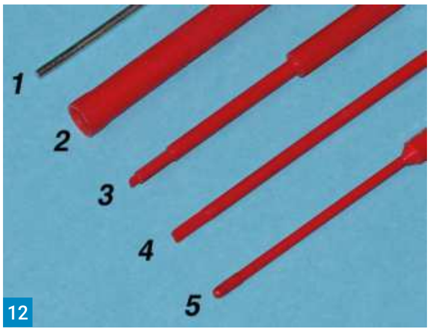
Realignment

Since the tuneable LO has only one range, the realignment of an EA12 is quite straightforward using a signal generator, a DMM and the appropriate trimming tools, **Fig. 12**. In addition to a standard flat-blade non-magnetic screwdriver, these include a hex ferrite core trimmer with a narrow spindle that can be passed through the secondary cores of the RF bandpass transformers to adjust the primary cores below them. A beehive trimming tool is required for the three concentric capacitors, as well as a narrow-bodied screwdriver with a non-magnetic 2mm-wide tip for adjusting the Vinkor inductors used in the first IF bandpass circuit and a 2.1mm diameter tommy bar for the crystal filter phasing.

First, all the second IF transformer cores should be peaked with the 100kHz crystal filter switched in. A wobbulator or equivalent sweep generator is useful for optimising the symmetry of the response curve at wider bandwidths, and for adjusting the phasing control, which is accessible at the side of the crystal filter can. The BFO control has a 5:1 reduction drive and should be adjusted to provide a symmetrical swing of ±3.5kHz on CW and ±100Hz on SSB, centred on the carrier insertion frequency for the sideband selected by the USB/LSB mode switch. When tuning the slot filter notch to the centre of the IF passband, ensure that the control knob is midway between the stops.

Normal tracking procedure applies when realigning the second LO and first tuneable IF stages, with the trimmers being adjusted at the high frequency end and the cores at the low frequency end of the range. But remember that the LO tunes in the opposite direction to the signal frequency calibration on the main tuning scale! The three beehive trimmers are accessible through a slot to the side of the crystal calibrator (see Fig. 5 again), while the LO coil and the two Vinkor inductors of the IF bandpass circuit are located in the two front compartments of the coil box (see Fig. 11 again). The split vanes of the tuning capacitor can be bent to improve the calibration accuracy at the intermediate 100kHz points on the scale.

Alignment of the RF stages should be carried out with the Peak RF control set at 10



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o'clock and the main tuning in the centre of the scale. Using the corresponding signal generator frequencies, the upper and lower cores of the bandpass coils and the cores of the first mixer coils should then be peaked for each band from 160m to 15m in order. Range 2 should be selected for the 10m adjustment. Finally, check that the Peak RF control covers the full range of each band. The CW/SSB filter Vinkor and the antenna input filter should not normally require adjustment.

In spite of its age, a restored and realigned EA12 should fully meet the original performance specification of a signal-to-noise ratio of 10dB at 50mW output with a 2µV input signal 30% modulated at 400Hz, the selectivity control being in the 6kHz AM position. On CW, the sensitivity is 0.5µV for an SNR of 20dB and IF bandwidth of 1.3kHz. With the narrowband crystal filter and 800Hz audio filter switched in and the slot filter optimised, the CW performance of the receiver is outstanding even by modern standards.

Specialist Dealers

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Your Letters

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Fusing in Domestic Equipment

Dear Don,

In the letter from **Robert G3JRD** he makes some valid points on the evolution of AC electrical supplies in the US/UK and equipment in general. However, he unfortunately misunderstood the plug-top fuse in that its purpose is not to protect the equipment; it is to protect the domestic supply in the event of 'equipment failure'. Each plug-top fuse can, and should be selected to suit the current requirement of the equipment (while allowing for surge currents etc.) and is usually considered part of the equipment when in use. Thus, if the power cord/lead is damaged or the equipment dies spectacularly, the fuse will blow rapidly to protect the domestic supply and its source.

If the fuse was removed from the plug, then for the same protection, it would have to be installed into the socket. Then, when different loads are used, a fuse change would be needed to provide the same protection as with the plug-top fuse. Human nature being what it is, the plug-top fuse is more foolproof, albeit not idiot proof. Equipment protection is by means of the 'internal' fuse, usually positioned in a holder on the back panel. Here, when the manufacturer specifies a fuse type and rating, they mean it. Even 12V DC supplied rigs are fitted with supply protection fuses in the leads and panel-mounted fuses for the rig.

Expanding on the characteristics of the domestic supplies discussed, the 110V supplies for building sites use a transformer where the secondary winding (i.e. the output) is centre-tapped and referenced to ground with the live and neutral each never exceeding 55V from ground potential and thus reducing the shock threat to users considerably. The American supply system of 110V with two core leads should only be used with double-insulated equipment. Where a grounded chassis is accessible then the US spec. 3-pin plugs, with earth connection, would be needed, with the fuse in the wall socket. In addition, while the voltage at 110V about ground is lower than in the UK, it can still easily kill because the 60Hz frequency of the supply can, during electrocution, induce the heart to enter ventricular fibrillation as it naturally 'resonates' at about 60Hz in this state. Unless treated rapidly this is usually fatal. The US frequency of 60Hz might be more efficient than 50Hz in the UK but its adoption did come with this unexpected drawback.

The moral is that the devil is in the detail of each system – mains electrickery can still bite!

Ian Robinson GW1AWH
Cardiff

A Plea for Help!

Dear Don,

Is there a sympathetic PW reader who can write an article along the lines of *Complex Numbers for Dummies*? I mean really, really, dummies. Many times I have tried to get to grips with complex or imaginary numbers, through textbooks, online searches etc. I follow the equations for a page or so then at the bottom of the second page there will be a statement along the lines of *"so it can be seen that – (2 – 6i) = 3 – 2i – 2 + 6i = 1 + 4i"*. No, no, I say, it can't be seen at all! I comb all the preceding pages for a clue and end up pushing the topic onto the back burner. That is not a good example but I hope you see what I mean. Actually, in this instance, I can see the last part after the first equals sign = 1 + 4i. What I don't see is the relationship to – (2 – 6i).

I'm sure that I am not alone in this, but I really need to have a better understanding (no, some understanding) of complex numbers and Smith charts. I think complex numbers should come first because understanding their operations is central to understanding Smith charts.

I have managed building and designing many projects over the years, but the time has come when, for instance, I need to do more critical impedance matching of circuits. I can't just rely on educated guesswork.

I suspect that a part of my problem lies in a poor understanding of algebra. I can transpose formulae as far as I need to for most electronics work, but soon hit a barrier.

I think 'Imaginary' is an unfortunate term for numbers as I can't help thinking that if a number is imaginary it has no substance. A complex number seems to be a much better term.

So how about it – two potential articles, Complex Numbers followed by Smith Charts?

Michael Jones GW7BBY/GB2MOP
Llangeler

No More Harry

Dear Don,

Well, I was saddened to read that this issue (February 2021) of *PW* would be the last one featuring *In the Shop*, by **Harry G3LLL**.

Needless to say, I've always enjoyed reading his words of wisdom whenever they appeared. His infectious enthusiasm was sometimes a sight to behold. Yep, Harry getting down and dirty deep inside the depths of numerous things electronic was both instructive and encouraging, particularly for those who think that taking the covers off a rig is the sole province of someone with a degree in electronic engineering. Now I've said that though, maybe I should qualify that comment because, as I'm sure Harry has noted many times, indiscriminately digging about in the innards of transceiver with a dodgy digital multimeter and an insulated screwdriver with a pretty LED on the end of it might not be a great idea to fix a problem in the PA department. Or any other department come to that. But there again, most amateur radio ops are born tinkerers. They just love to shove their dinky digits into some places where they shouldn't.

Lastly, all those letters also in the February issue about RF earths, fuses and electrical standards got me thinking that I should maybe take a look at my QTH setup. And I must confess that some of it was DIY. My house hasn't exploded yet, so I guess I can still sleep peacefully at night.

★Star Letter★

The Star Letter will receive a voucher worth £20 to spend on items from our Book Store, or other services offered by Practical Wireless

Radio – the Thrill

Dear Don,
Picture the scene. It's a cold, wet night and I can hear the rain hitting the patio doors 12ft away. Everyone has gone to bed, including the dog who knows better than to stay downstairs once the heating goes off for the evening.

Inside the tiny radio shack, a cupboard under the stairs, the 40 year old Yaesu FT-101ZD Mk3 sits a few inches away, fan spinning quietly and the soft warm orange glow from the driver and PA valves just visible. The warmth from its cooling fan just takes the chill off the tiny room.

The Yaesu is tuned for maximum output on 40m but, so far, the only station I have spoken to is IZ6BXV who is an excellent signal on the rooftop MFJ-1788 Mag loop.

Gently turning the VFO reveals the usual spread of European stations only interested in DX and then…did I hear correctly, did he say he was in Brazil?

I listened again. Yes, I'm right. I can hear PY4BZ working European and British stations. Would the MFJ-1788 cut it? At this distance, with the Brazilian station south-west of me, highly unlikely based on previous efforts. Switching to the end-fed longwire sloper antenna, the signal improved dramatically to a 5+8.

PY4BZ was working stations by numbers and when 5 came around I picked up the microphone in anticipation…my heart started beating faster, ready for number 6. Three separate attempts over the next half hour or so proved fruitless. Frustrating, but after years of playing with HF radio, not surprising.

There will be a next time. Hopefully a house move later this year will provide for a more remote location and a large garden suitable for a huge increase in antenna capability. I will make that contact next time.

The point is this – how is it possible a technology discovered over 100 years ago can still be so thrilling in 2021 when we are surrounded by instant, high-quality communications? It seems that the same thrill I felt as a 10-year old boy, when I first built crystal receivers and a rudimentary spark gap radio, hasn't left.

That thrill makes amateur radio special. Still.

Richard White G6NFE
Ashford, Kent

Mind you, the other day, my partner noticed a small 'firework display' pop out of one of the shack sockets. Better take a look at that, then. Dust off my cheap Chinese digital multimeter and insulated screwdriver, with or without the pretty LED.

Ray Howes G4OWY/G6AUW
Weymouth

On a Budget

Dear Don,
It was with interest that I read the recent letter by **Ray G4OWY/G6AUW** (February). Ray made some good points and I believe his thinking is reasonably well aligned with my own, but there were a couple of issues I just wanted to clarify as a result.

First of all, it is not my intent to be controversial, or to try to persuade people to shun new equipment – I have purchased plenty of new equipment myself. Rather, what I am aiming to do is encourage newcomers to the hobby not to be put off by cost. Amateur radio has always been a great leveller, where everyday people from all walks of life and financial means can communicate, even with royalty (the late JY1, for example).

However, glancing through the ads in *PW* and elsewhere, people thinking of joining the hobby might be forgiven in thinking you need to spend thousands on just one piece of gear. Having had fabulous fun once again this weekend, working all over Europe with just 4W from a QCX-Mini costing £40, I can say that is definitely not the case!

The country is in the midst of an enormous crisis and COVID-19, as well as having had a massive negative health effect, has also brought real financial hardship to people who are furloughed or have lost work. Now, more than ever, there is a need for a cheap route into the hobby for some, and if this route also keeps great vintage gear going and encourages more homebrewing, then that is all to the good.

Ray makes a good point about maintenance too. There is a risk that newcomers might buy used gear that eventually needs attention. Thankfully, there are still people and resources out there to help those needing to address such issues, but it is a very real issue.

I must also respond to Ray's final point about the apparent 'expensive HF transceiver' in my shack, which appears to be an SDR. This is a great illustration actually. In the article, I point out that this SDR transceiver, which covers all of the HF bands and 6m, with general coverage receive, is a homebrew design by a local radio amateur, which has won the RSGB construction competition. It cost me a hefty £250 new and built and is remarkable. The software is an adaptation of PowerSDR by KE9NS and is frankly superb, and free. SDR technology – on a budget!

So, in conclusion, I am certainly not shunning cutting-edge technology – I am embracing it and spending money on expensive new gear from time to time myself. I just want to encourage the widest possible thinking in equipping an effective shack. It can either be hugely expensive, or very, very cheap, and anything in between. Whatever route readers choose, I am sure they will find a route they prefer and make a great contribution to our hobby.

Daimon Tilley G4USI
Wiveliscombe, near Taunton

Pop Blundell

Dear Don,
In the 80s I was a young radio enthusiast with no real future. I'd studied and acquired a B Tech in electrical engineering and electronics. Seeking new horizons – literally – I joined the Royal Navy to see the world. An avid reader of *Practical Wireless*, I had no real shortwave gear. I've never purchased those magazines since 1987, when I started a career in radio 'reception' – the Y Services.

So, imagine my surprise when I bought *PW* for the first time in years, opened a random page, only to find **Pop Blundell**, Morse code and the Y Stations.

I did some unclassified radio training with GCHQ as a small part of a very interesting career. Funnily enough I ended up living in North East Scotland and eventually heard about an old Army Y station. Hidden in the forest, it was away from EMF

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and EMI, obviously less noise. The gent who bought the site was very old and blind by the time I visited but he and his wife took the time to show me the various buildings, explaining the roles they played in WW2. I am pretty sure his house retained some of original memorabilia in his living quarters, the officers mess.

Is it fate to come back to my radio hobby, or were you expecting me?

John Masterton

Home Contsruction

Dear Don,

I have always constructed radio gear right back to the 70s using valves, and drilling chassis and panels means sweeping and vacuuming afterwards.

For quite a few years I have made this much simpler, not having a workbench in the extension I work in either the kitchen or back bedroom. The bedroom is ideal as I can get right up to the window for light.

My idea is simple and might interest other constructors if they have not thought of it: put the item to be drilled into a cardboard box to contain the swarf in the bottom as shown in the photograph. Cleaning up is easy, just empty the box and look for any stray bits outside the box. I didn't find any.

Bill Kitchen G4GHB
Ashton-under-Lyne

Circuit Diagrams

Dear Don,

I must take *PW* to task on the quality of circuit diagrams in *PW* these days.

I find that, even with the use of a magnifying glass, I can't always see the component numbering, nor the values, where printed on the diagrams.

The *Doing it by Design* column in the January 2021 edition is a case in point. Virtually unreadable and it has black text on a blue background. How can builders be encouraged when the plans are unreadable?

Why can't *PW* return to the printing standards of years past, when diagrams were clear and readable? I don't think they need to be in colour and if it means sacrificing photos to provide more space for diagrams, then so be it.

William Jones G7WHP
Hockley

*(**Editor's comment**: Thanks William and my apologies. Unfortunately, we are no longer in a position, as in the past, to have all circuit diagrams redrawn. The task fell to our Technical Editor, **Tex**, who retired a few years ago. Tex is still available to draw the occasional diagram, usually where it has been submitted hand-drawn, but is no longer 'on tap' as he used to be.*

However, if any reader does want an original of any of the diagrams we use in PW, *I am happy to supply in return for an e-mail request.)*

Constructional Projects

Dear Don,

I watched with great interest your appearance on YouTube TX Factor 27:

tinyurl.com/txfactor27

You mentioned that you were interested in construction projects along with the possibility of a competition so maybe this Expanded Range Voltmeter will interest your readers.

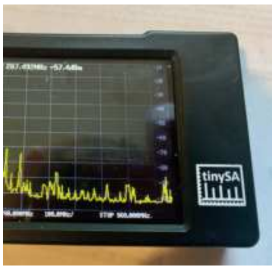
Thank you to **Norman G8VER/G8ATO** of Verulam ARC for technical advice. Apart from the meter it uses just three components a potentiometer, Zener diode and resistor:

g4pvb.eu5.net/erv.htm

Bob Houlston G4PVB
St Albans

Next Month

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



- **THE TINY SA SPECTRUM ANALYSER AND SIGNAL GENERATOR:** Tim Kirby GW4VXE takes a look at this device and its uses around the shack.
- **METAL OXIDE VARISTORS AND THEIR USES:** Colyn Baillie-Searle GD4EIP explains what they are and how they are used.
- **THE INSPIRING STORY OF ARTHUR (ARTIE) MOORE:** Scott Caldwell relates the story of one of radio's pioneers.
- **MORSE REVEALED, PART II:** Mike Bedford G4AEE has more fascinating facts about Morse code.
- **NOTES FROM A SMALL STATION:** Joe Chester M1MWD continues his quest to operate successfully from his houseboat.

There are all your other regular columns too, including HF Highlights, World of VHF, What Next, Morse Mode and Data Modes.

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

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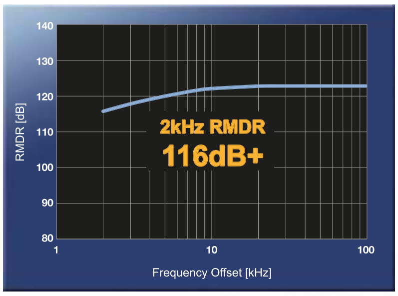

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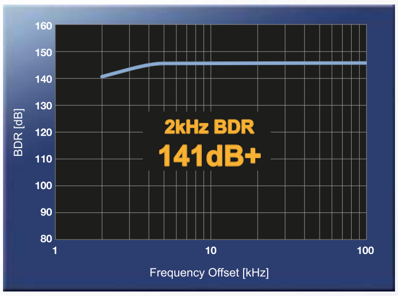

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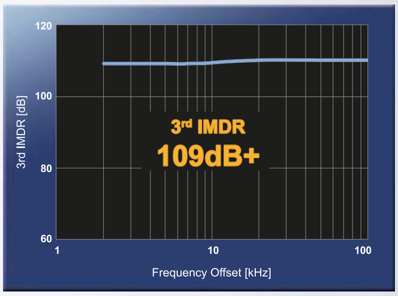

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If you have enjoyed this magazine then do the next thing to shouting it from the rooftops and leave us a review instead! We all like to know when something is good and if something has been rated highly by others. Leave us a review to let others know what you think of Practical Wireless.