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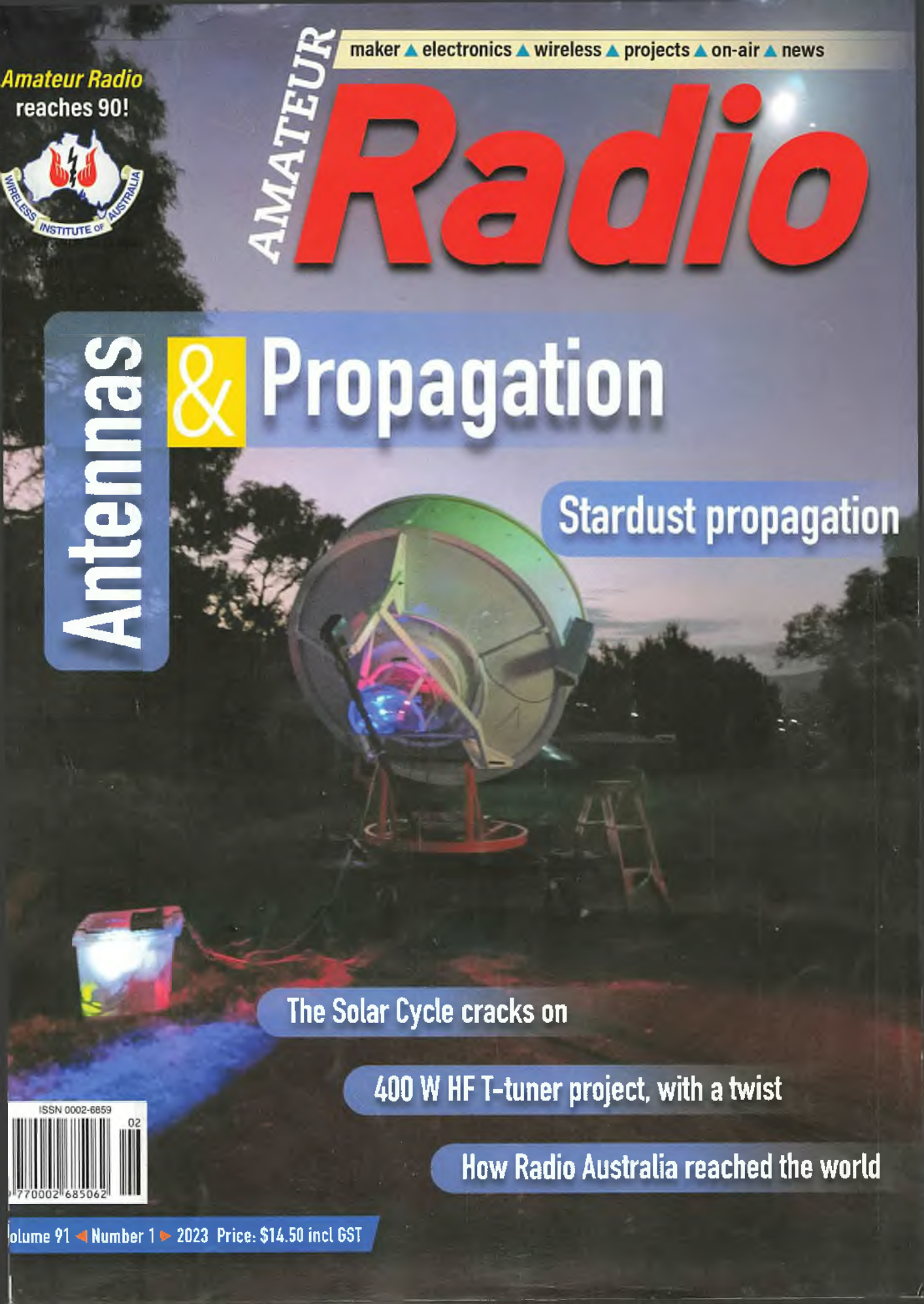
AMATEUR Radio

Amateur Radio reaches 90!

Antennas & Propagation



Stardust propagation

The Solar Cycle cracks on

400 W HF T-tuner project, with a twist

How Radio Australia reached the world

ISSN 0002-6859 02

Volume 91 ◀ Number 1 ▶ 2023 Price: $14.50 incl GST

Smart New Operating Features

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Simply Touch the displayed Channel Bar to Quickly Start Communications
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- Register the current display frequency into PMG with one press of the "PMG" key.
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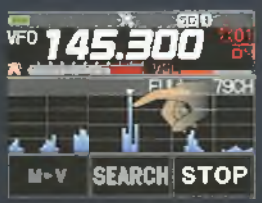

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AMATEUR Radio

Serving Australian radio amateurs since 1933

The Journal of the Wireless Institute of Australia

Volume 91
Number 1
2023
ISSN 0002-6859

Advocacy Education Support

Columns

General

Technical

This issue's cover: Richard VK7ZBX's portable 1.8 metre prime focus 10 GHz EME system wistfully contemplates the moon. See page 15.

Editorial

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Production deadlines
All articles, columns, Hamads, and advertising bookings for Volume 91, No. 2 - **3 March 2023.**

NEXT ISSUE: Hacks + hints for homebrewers

Contributions to Amateur Radio

Amateur Radio is a forum for WIA members' amateur radio experiments, experiences, opinions and news. Manuscripts with drawings and/or photos are welcome and will be considered for publication. Articles attached to email are especially welcome. The WIA cannot be responsible for loss or damage to any material. Information on house style is available from Phil Fitzherbert.

Back issues
Back issues are available directly from the WIA National Office (until stocks are exhausted), at $8.00 each (including postage within Australia) to members.

Photostat copies
If back issues are unavailable, photocopies of articles are available to members at $2.50 each (plus an additional $2 for each additional issue in which the article appears).

Disclaimer
The opinions expressed in this publication do not necessarily reflect the official view of the WIA and the WIA cannot be held responsible for incorrect information published.

Amateur Radio Service

A radiocommunication service for the purpose of self-training, intercommunication and technical investigation carried out by amateurs; that is, by duly authorised persons interested in radio technique solely with a personal aim and without pecuniary interest.

Wireless Institute of Australia

ABN 56 004 920 745

The world's oldest
National Radio Society, founded 1910.

Representing
The Australian Amateur Radio Service
Member of the International Amateur Radio Union

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Editorial

Roger Harrison VK2ZRH

90 Years of continuous publication!

It's our 'granite jubilee'! We're going to make rather a song-and-dance of *Amateur Radio* magazine's 90th anniversary.

This issue, we start with Part 1 of a two-part feature on how *AR* came into being. As is said on Facebook about personal relationships – it's complicated. In the environment of the times, in which the nascent WIA had survived 20 years, the Great War, the Roaring 20s, and global depression, during which many commercial magazines catering to audiences interested in the new wireless and radio technologies came and went, it is indeed a wonder the WIA's magazine venture got any sort of start. After all, the much better resourced American Radio Relay League's QST magazine had an early start, only to falter during WW1. But, the ARRL picked up the threads of QST from 1919 and hasn't looked back.

From the get-go in October 1933, *Amateur Radio* has maintained its presence as the WIA's journal. The story begins on Page 12.

Notable things this issue

Readers will notice a couple of things this issue that differ from AR's past editorial practices.

Our Silent Key this issue, on pages 62-63, commemorates the passing of an amateur of notable importance – Rod Champness VK3UG. He was a frequent contributor to this magazine dating from the 1960s (he devised and conducted Newcomers' Notebook "back in the day"), a widely known and respected stalwart of the broadcasting industry and a district radio inspector. Naturally, he was a notable WIA member.

The general practice with Silent Key pieces has been that they should not exceed 400-500 words. This is only relaxed in the case of particularly notable amateurs.

You will also notice that Rod authored a feature article on the history of Radio Australia, published in this issue. The editorial team worked with Rod on the feature's preparation over mid-late 2022. He will be missed.

A change from past editorial practice that is designed to hang on for many years is the title block for our long-lasting *VHF/UHF – An Expanding World* column. From this issue, the title becomes "Spectrum Horizons", with the hearty agreement of our columnist, David Minchin VK5KK. I commend it to the house!

Reflections on 2022

With 2022 finished and gone, we have completed a whole year's worth of *Amateur Radio* magazine in its new format, six vibrant issues. Comments from readers have been positive, ranging from conservative 'approval' through to enthusiastic support.

The other interesting thing to note about the 'new look & feel' magazine is that newsagent sales during 2022 have held up, maintaining much the same sales as over 2021, with perhaps a *hint* of an uptick in sales numbers. I confess that I was concerned about newsagent sales as two significant things were changed with the magazine – the banner and the newsagent distribution.

The latter action involved changing the distribution so that *AR* was delivered to newsagents in, or close to, those postcodes where amateurs are known to live (based on a postcode interrogation of the ACMA's Register of Radiocommunications Licences [RRL]). Better to "stick it under their noses" where *AR* is more likely to be seen than continue with "the way it's always been done."

I guess it's not too late to wish readers one and all a Happy New Year!

Notice of Annual General Meeting
The Wireless Institute of Australia

Bayswater
Victoria 3153 Australia
proxy@wia.org.au

BUSINESS

1. To receive and consider the Annual Financial Statements, Directors Report and Independent Auditors report for the year ended 31 December 2022
2. To confirm the results of the election of Directors
3. To consider a Special Resolution to amend a typographical error in the Constitution of the Wireless Institute of Australia (WIA). This typographical error was picked up at the Annual General Meeting held in May 2022. The amendment to be as follows:-

   That this meeting amends Clause 5.4 (e) of the constitution of the WIA that

   currently says "(e) is expelled under clause 5.6; or"

   To read "(e) is expelled under clause 5.7; or"
4. To transact any other business that may be brought before the meeting in accordance with the Institute's Constitution

Notice is hereby given that the Annual General Meeting of The Wireless Institute of Australia will be held on Saturday 13th May 2020 at 10.30am Australian Eastern Standard Time. The Annual General Meeting will be a Hybrid event conducted both in person and by video conference and able to be viewed on an internet streaming platform. The venue for the Annual General Meeting is yet to be finalised but is proposed to be held in Canberra ACT.

By Order of the Board
Peter Clee VK8ZZ
Secretary of the Wireless Institute of Australia
21st January 2023

NOTE:

A member is entitled to appoint one proxy only who must be another Member, and that proxy is entitled to vote on a show of hands or on a poll. The Instrument of Proxy is downloadable from the WIA web site (Information about the WIA), or upon written request to the National Office.

While non-members of The Wireless Institute of Australia are welcome to register to attend the Annual General Meeting and Open Forum, only members are entitled to vote. Members must be financial to register to join the meeting either in person or by video conferencing facilities.

Members and non-members must register in order to receive the streaming information to watch the internet streaming.

Section 250S of the Corporations Act provides that the chair of an AGM must allow reasonable opportunity for the members as a whole at the meeting to ask questions about or make comments on the management of the company.

OPEN FORUM:

Immediately following the Annual General Meeting an Open Forum will be conducted. An additional detailed report will be submitted on behalf of the Board, and the Institute's co-ordinators and those responsible for particular aspects of the Institutes activities will be asked to submit a written report which will be available for those attending the forum. Any major issues affecting each area of responsibility will be identified and the author of each report who is present will be given the opportunity to briefly comment.

Members are encouraged to discuss any matter arising from any of the reports, and to raise any other matter affecting Amateur Radio or the Institute. This format will avoid any restriction arising from the requirement to give notice of business to be formally raised at the AGM.

Declaration of Election of Directors

Clause 14 of the Constitution of the WIRELESS INSTITUTE OF AUSTRALIA specifies the way in which Directors of the WIA are to be elected to that position.

Four directors retire at the conclusion of the next Annual General Meeting which will be held in May 2023, namely Scott Williams VK3KJ, Peter Clee VK8ZZ, Greg Kelly VK2GPK and Peter Schrader VK4EA. Each retiring director was eligible for re-nomination.

A call for nominations for the position of Director of the WIA was made in the WIA National News Broadcast and in Amateur Radio Magazine in accordance with the Election Regulations.

I advise that I have received Four (4) valid nominations from WIA members for the position as director of the WIA by the advertised closing date for nominations, as follows:-

Scott Williams	**VK3KJ**
Peter Schrader	**VK4EA**
Peter Clee	**VK8ZZ**
Giles Kirby	**VK5GK**

As advised in the Call for Nominations there will be four vacancies at the conclusion of the AGM to be held in May 2023 and therefore no election will be necessary, I therefore formally declare these 4 nominees as having been elected to the position of Director of the Wireless Institute of Australia. These Directors elect will take up their role at the conclusion of the Annual General meeting in May 2023. They will remain in that role for a period of two (2) years.

Continuing Directors are:-

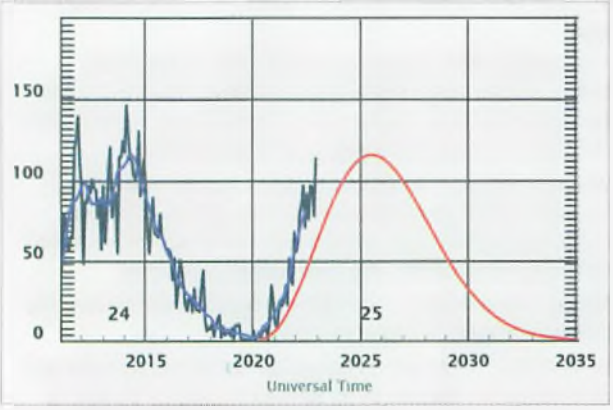
Lee Moyle	**VK3GK**
Chris Dimitrijevic	**VK3FY**
Steve Green	**VK2TSG**

These continuing directors will retire at the conclusion of the Annual General Meeting in 2024.

I John Marshall, the duly appointed returning Officer of the Wireless Institute of Australia confirm that these results are valid and in accordance with the Constitution of the Wireless Institute of Australia and the Election Regulations.

This is notice is authorised by
John Marshall, WIA Returning Officer
1st January 2023

WIA news



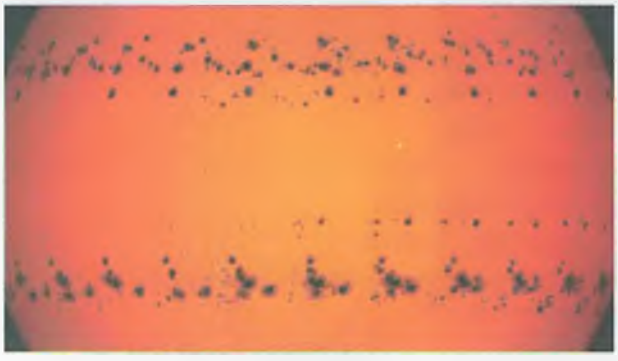
Solar Cycle 25 cracks on

Forecasts for the timing and size of the Solar Cycle 25 peak continue to excite and confound observers and interested parties.

As you can see from the plot here, the observed sunspot number for December 2022 hit 113.1, nearly twice the forecast 60.6, according to the Space Weather Prediction Center (SWPC) of the US's National Oceanic and Atmospheric Administration (NOAA).

According to SWPC, Cycle 25 is predicted to peak in around 30 months' time, around June-July-August of 2025, reaching around 150. The most recent time the Sunspot Number (SN) reached that vicinity was 1968, for Cycle 20. However, Australia's Space Weather Services puts its Cycle 25 forecast peak in late 2023, with SN around 118; rather like Cycle 24.

Meanwhile, Turkish amateur astrophotographer Senoli Sanli, took a series of time-lapse images of the Sun during December to produce the stunning image below, illustrating the march of sunspots across the face of the Sun.



WIA AGM on 13 May

The Annual General Meeting (AGM) of the Wireless Institute of Australia will be held on Saturday 13th of May, opening at 10:30am.

As we went to press, the venue was yet to be confirmed, but is understood that Canberra is proposed. Keep this date clear and we'll see a flock of members in our national capital, Canberra (or, wherever), for the 2023 AGM. There's a Special Resolution to consider to amend a typo in the Constitution. Visit: https://tinyurl.com/WIA2023AGM

For updates on the AGM, keep an eye on the WIA website and also listen-out for VK1WIA Weekly news.

Keep abreast of WRC-23

This year's World Radio Conference, WRC-23, organised by the International Telecommunications Union (ITU) will take place in the United Arab Emirates from 20 November to 15 December 2023, preceded by the Radiocommunication Assembly 2023 (RA-23) from 13-17 November.

A booklet on the WRC is available in the six languages of the ITU. It provides an easy access to the WRC-23 agenda, as well as to the resolutions referenced in it. The booklet can be downloaded from https://tinyurl.com/WRC23booklet.

The latest issue of the ITU News Magazine, "Countdown to WRC-23" can also be downloaded from the same web address. The magazine is said to provide insight on key ITU events and initiatives, as well as global information and communication technology (ICT) trends.

SOTA celebrates – 10yo!

Summits on the Air (SOTA) in Australia is celebrating its 10th year of activity in the VK1 region.

SOTA Manager for VK1, Wade Smith VK1MIC, obtained the special call sign VI10SOTA and launched the celebration station on 1 January 2023 from Mount Ainslie (VK1/AC-040) in the heart of the national capital, Canberra.

Any amateur with an Australian licence intending to activate a VK1 SOTA peak may seek to use VI1SOTA. As use of the call sign is available throughout 2023, look out for the celebration station using the special call sign VI10SOTA.

Big changes in Malaysian amateur regulations

The Malaysian Communications and Multimedia Commission (MCMC), the equivalent to Australia's ACMA, has introduced changes to the amateur radio licensing structure from the first of January, "to ensure the certification in Malaysia is in line with the practice in other countries."

MCMC said the changes include the examination format, examination syllabus, qualification requirements to sit for the examinations, and the introduction of a Class C licence to the existing Class A and Class B licences.

Morse code testing to gain a Class A licence is no longer necessary, now replaced by a computerised multiple-choice exam, said the MCMC.

According to Sion Chow 9M2CQC, from the Malaysian Amateur Radio Transmitters' Society (MARTS), Class-B licence holders are now permitted to operate on 3.5 MHz (80m band) and the 70cm band (430 MHz) with 50 watts. Previously, Class B licensees could use 40m, 10m, 6m, 2m and 70cm (low power).

Further, Class A licensees can operate with 1 kW, Class B licensees can operate on all HF bands, and both Class A and B licensees can access the 60m (5.3 MHz) band with 15 watts eirp as per the 2015 World Radio Conference (WRC-15) decision.

The MCMC said the changes were also aimed at encouraging students interest in the fields of Science, Technology, Engineering, and Mathematics (STEM) through amateur radio, "which would lead to the rise of amateur radio operators who can help during disasters."

In addition, the MCMC also announced publication of a handbook on amateur radio as an additional reference to those interested in the amateur radio examinations. The Commission added that a question bank was also created for all three amateur radio classes to provide exposure to the public on examples of examination questions as well as to assist candidates to prepare in advance.

HAARP thanks hams for help

In December 2022, the High-frequency Active Auroral Research Program (HAARP) conducted its latest ionospheric experiment of bouncing radio signals off an asteroid passing near Earth's orbit.

Radio amateur and radio astronomy enthusiasts were invited to monitor the test and send their results to HAARP for analysis.

While the results of the experiment will take some time to emerge, the HAARP Program Manager, Jessica Matthews, said the help was greatly appreciated.

A section of the HAARP antenna.

Continued on page 11

WestNews

Will McGhie VK6UU
e will2@iinet.net.au

Above: locations of the HF beacons. The NCDXF, in cooperation with the International Amateur Radio Union (IARU), constructed and operates a worldwide network of high frequency radio beacons on 14.100, 18.110, 21.150, 24.930, and 28.200 MHz. These beacons help both amateur and commercial HF radio users assess the current condition of the ionosphere and propagation. The entire system is designed, built and operated by volunteers at no cost to them.

I must open with a thank you to Steve Kennedy VK6SJ for his considerable effort in producing what was previously known as *VK6news* in years past.

I was asked if I could take on the task of producing a regular news column on what's happening in the west (hence the new title – Ed.) and I'm pleased to find and produce what I can. This takes me back to previous stints with AR magazine, even as far back as the early 1970s, when the West Australian WIA Division's local news was a loose leaf insert into AR magazine. Each state only received their local news.

VK6RBP international DX propagation beacon update

Western Australia was chosen as the best location for the NCDXF international HF beacon in Australia (www.ncdxf.org).

In the Northern California DX Foundation (NCDXF) system, there are 18 HF beacons installed and operational around the world, all GPS time-locked to transmit in a designated sequence. The HF bands used are 14, 18, 21, 24 and 28 MHz.

The Perth beacon was installed at the West Australian Repeater Group's site at Roleystone, located some 25 km south-southeast of Perth. It was switched on on Sunday the 18 of May 1997. Detailed information can be found at www.vk6uu.id.au/vk6rbp.html.

As an aside, the original callsign that was applied for could not be granted, and VK6RBP (beacon, Perth) was chosen. From memory, IB was wanted in the callsign.

The beacon's multiband, omnidirectional, vertical antenna, a commercial log periodic, is located away from the equipment huts at the site to prevent interference.

A 9.5metre guyed mast is anchored at the base to a large wooden pole that was a part of a large, vertically polarized, directional HF log periodic commercial antenna for maintaining communications to northern gas production sites in WA. A mining company owns the Roleystone site. The HF log periodic had long been removed and just a half metre diameter one metre high wooden stump remained to provide a convenient anchor point for the beacon antenna. The guy wires are made from non-conducting material.

Changing the HF vertical antenna was made relatively easy, by adding a five metre length of pipe to the side of the mast to act as a swinging hinge, allowing the antenna to be pivoted down to a near-horizontal position.

The original equipment supplied by NCDXF was a modified Kenwood TS-50S HF transceiver controlled from a separate controller. This keyed the transceiver in CW in sequence between the five HF bands and the five reducing power levels of 100, 10, 1, 0.1 Watts. The TS-50S was in place for many years but did have some issues and was eventually replaced about 10 years ago with an Icom TS-7200.

Considerable issues were also had with the original multi-band HF vertical antenna, requiring repairs or replacement. The current antenna is a Cushcraft. The all-important GPS sequencer controller was changed to an improved design in 2017, supplied by NCDXF.

If only

I've had some thoughts on the large commercial HF log periodic antenna that was removed from the site by the gas company. Oh, to have been given permission to use the antenna once it was no longer needed.

The guyed tower is a big one, some 80 metres high, and the vertical log periodic was strung off the tower from the 70 metre point on the tower. The longest element (from memory) would have been 65 metres and the antenna perhaps would have worked as low as our 40 metre band. What a signal that could have been to the North of Perth on 40 metres and above. However, we never were offered the option, as one day it had just gone.

The VK6RBP beacon equipment. Note the NCDXF-built controller atop the rig and the GPS antenna at top right.

The omnidirectional HF antenna for VK6RBP.

Continued from page 7

WIA news

"So far we have received over 300 reception reports from the amateur radio and radio astronomy communities from six continents who confirmed the HAARP transmission."

"We will be analysing the data over the next weeks and hope to publish the results in the coming months," said Mark Haynes, lead investigator on the project and a radar systems engineer at NASA's Jet Propulsion Laboratory in California.

"This experiment was the first time an asteroid observation was attempted at such low frequencies," Haynes said.

"This shows the value of HAARP as a potential future research tool for the study of near-Earth objects."

60m now in 85 countries

Editor of the 5 MHz Newsletter, Paul Gaskell G4MWO, has compiled a map that shows the 85 countries that now have 60m band allocations, a success story chronicled by the newsletter since it launched in Autumn 2011.

Paul's map (below) shows countries with 60m access in colour, while those countries in white do not permit access to the 5 MHz allocation determined at the 2015 World Radio Conference (WRC-15); the latest countries permitting 60m use are in green.

The latest newsletter – Autumn/Winter 2022 – (that's northern hemisphere) has articles about activities on the 60m band in Malaysia, South Africa, United States, Samoa, and a new allocation in Ireland.

The latest issue of the '5 MHz Newsletter', and archived copies, can be found on: wikipedia.org/wiki/60-meter_band.

Intruders on the rise

The latest issue of the Region 1 International Amateur Radio Union Monitoring System (IARU-MS R1) newsletter reads almost like a DX propagation report.

Apart from detailing the recurring problems caused by the over-the-horizon radars (OTHRs) of various origins, mainly from Russia, China, Iran and Cyprus, there are unusual reports about taxi radios and fishermen on 10m, and village radios in Indonesia heard on the 40m band.

The IARU-MS R1 newsletter can be downloaded from: tinyurl.com/bdf6dsba

Award honours Marconi

An international amateur radio award is being sponsored by Italy's ARI Fidenza Radio Club with the main objective being to commemorate, historically, some of the most important and significant Italian cities where Marconi performed his seminal scientific experiments in radio engineering.

The award period lasts the whole of this year.

Each month is being dedicated to a specific Italian city connected to the story of Guglielmo Marconi and is paired with a different special callsign. Visit: www.arifidenza.it.

90 years of continuous publication!

How the WIA's Amateur Radio magazine came into being

Peter Wolfenden VK3RV, WIA Historian

Part 1

As this magazine approaches 90 years of continuous publication in October, a glance back at some of our predecessors suggest that its gestation and birth was not quite straightforward. Here's a tour through the complex world of magazines before *Amateur Radio* emerged.

In the beginning, circa 1910, the printing presses in Australia were silent. At least, that is, on the matter of wireless magazines. Radio was, as-yet, a nascent term.

Following WWI, the excitement of the "wireless environment" was largely triggered by the invention and application of the electron valve – the early 'electronics embryo' was developing.

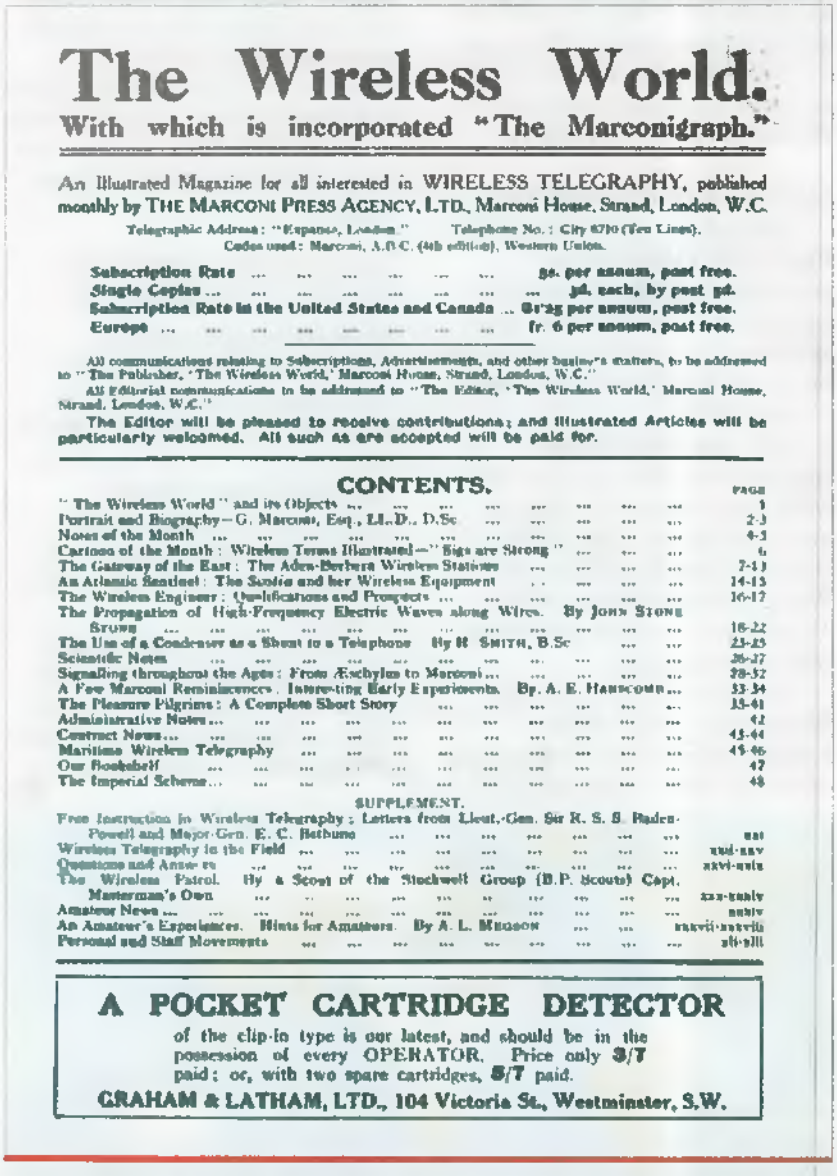
Many amateur experimenters were exposed to valves (or "tubes") during the Great War, and on returning home they were eager to apply the new technologies and techniques to their private radio stations although here, it would be 1923 before many could obtain a transmitting licence.

The application of valves enabled early experimental voice transmissions to take place from many towns around Australia. Consequently, prior to the start of broadcasting, the public's attention was frequently captured by "listening-in to the amateurs" where voice or music was infinitely more interesting than dots and dashes – well, to most people!

Wireless magazines appear

As the public became aware of what they could hear "on the wireless", even a simple crystal set, the demand for more information about these amazing devices and the sources of components for their home construction soared.

Individuals from all walks of life were "bitten by the bug" - from academics through the inquisitive to school boys, and yes, there were also



The Wireless World.

With which is incorporated "The Marconigraph."

An Illustrated Magazine for all interested in WIRELESS TELEGRAPHY, published monthly by THE MARCONI PRESS AGENCY, LTD., Marconi House, Strand, London, W.C.

Telegraphic Address: "Expanse, London." Telephone No.: City 6710 (Ten Lines).
Codes used: Marconi, A.B.C. (4th edition), Western Union.

Subscription Rate ... ... 9s. per annum, post free.
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Europe ... ... fr. 6 per annum, post free.

All communications relating to Subscriptions, Advertisements, and other business matters, to be addressed to "The Publisher, 'The Wireless World,' Marconi House, Strand, London, W.C."
All Editorial communications to be addressed to "The Editor, 'The Wireless World,' Marconi House, Strand, London, W.C."

The Editor will be pleased to receive contributions; and Illustrated Articles will be particularly welcomed. All such as are accepted will be paid for.

CONTENTS.

Figure 1. From the UK in 1913 sprang *The Wireless World*, which in time became known to many amateurs, electronics hobbyists and industry professionals the world over.

a number of notable young women who had an early involvement in the new science. This in turn led to an increased interest in books and particularly magazines dealing with any aspect of "wireless".

A few overseas magazines had been available for some years after the first decade of the 20th century, mainly by subscription. Examples include *The Wireless World* from the UK, launched in 1913 (**Figure 1**) – originally published as the *Marconigraph* from 1911. It was largely taken up by operators, particularly on ships, and the more technically minded.

From America came *QST* for the private experimenter (1915). It passed on a lot of relevant information for the experimental communicators – the amateurs, and subsequently became 'the standard' for most of the world's aspiring amateur magazine publishers.

As broadcasting became a way of life in Europe, broader-based, less technical magazines appeared, such as *Popular Wireless Weekly* (UK 1922). These brought to Australia the news about wireless developments in England and Europe, including reports on general broadcasting and later, the new shortwave stations, together with information about the people and the organisations involved.

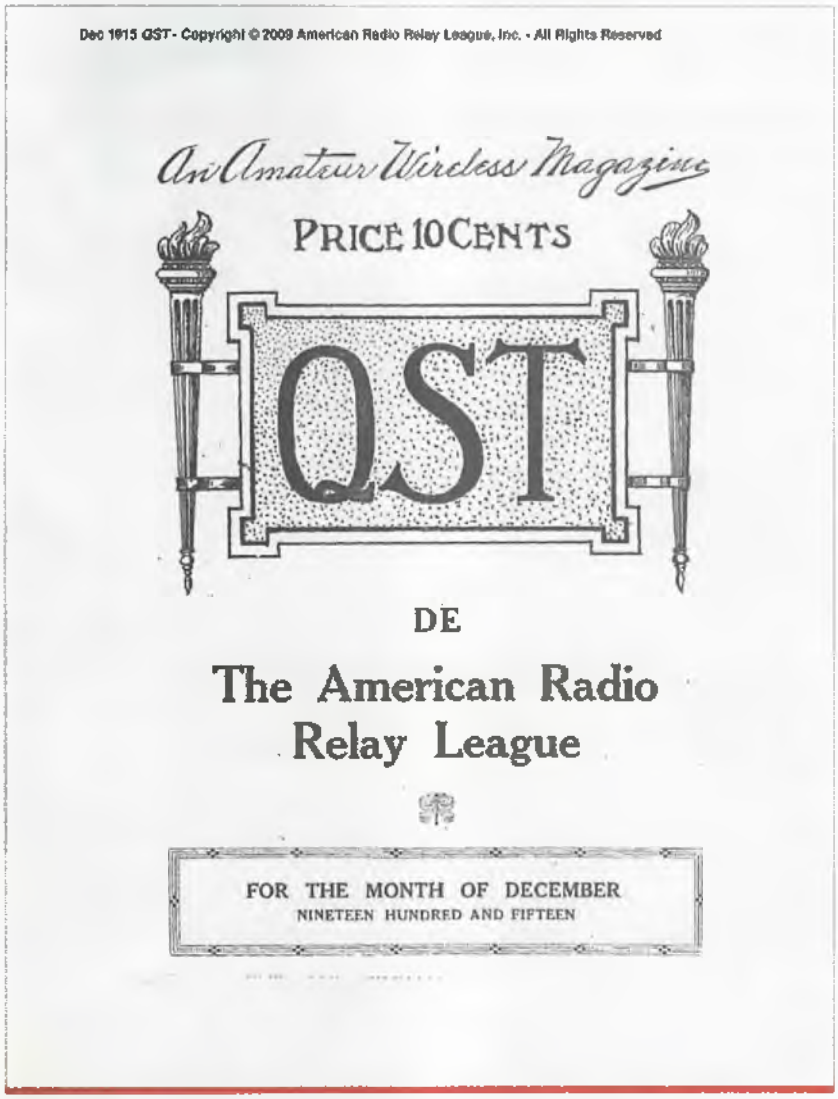


Figure 2. The first issue of the ARRL's QST magazine, December 1915 (image: Wikimedia). Advertisements inside extolled the features of commercial off-the-shelf transmitting and receiving equipment. Publication was suspended during WWI, from October 1917, returning in April 1919, first as a 'bulletin' then the magazine format from June 1919.

Australian magazines

Generally, commercial Australian radio magazines were not published until after WWI, many appearing during the course of the 1920s' decade. A few examples include: *Sea, Land and Air* (SL&A), published by the Wireless Press (AWA), which began in March 1918. It was an eclectic magazine full of reprints from overseas, supplemented with some local content. The magazine referred to itself as "The Australian National Monthly of Topical Interest," enabling a broad range of topics – radio was only part of the magazine's content.

SL&A also served for a short time as a journal for some WIA Divisions. Just before broadcasting opened up, the 1 March 1923 issue of SL&A announced that it would be incorporated into a fortnightly publication titled *Radio in Australia and New Zealand*, generally known as *Radio*. It turned out to be one of the better Australian magazines from the perspective of experimenters and receiver constructors.

Another well-known Sydney-based magazine, *Wireless Weekly* (**Figure 3**) became available from August 1922. Florence Wallace (later, McKenzie) – "Mrs Mac" – was financially involved in establishing it. *Wireless Weekly* later absorbed *Radio* magazine.

When Ross Hull returned briefly to Australia from the ARRL during 1929, he joined his brother Galbraith at the *Wireless Weekly* office, where he was immediately put to work heading up the magazine's "Experimenters' Department of Technical Progress" – a grandly-titled appointment indeed!

In the 27 September 1929 issue, the magazine published a very detailed construction article – "Ross Hull's 1930 Superheterodyne" – complete with a front cover promotion, although the art department slipped up

Figure 3. Wireless Weekly became the incubator for other journals and journalists of distinction. Australia's first female licensed amateur, Florence McKenzie (née Wallace), was financially involved at its start.

by referring to it as Ross' "1929 Superheterodyne"!

April 1939 saw the technical threads of *Wireless Weekly* morph into the monthly, Radio and Hobbies (**Figure 4**). The Editor was Galbraith (A.G.) Hull with John Moyle VK2JU as the Technical Editor. John soon became Editor and continued for many decades. He was a WIA member, President

Figure 4. From April 1939, Radio and Hobbies quickly became the pied piper of a flock of technical magazines (photo: Bob VK3XP). Many readers will recall that it morphed into Radio, Television and Hobbies and then Electronics Australia.

of the NSW Division, and in 1959, our delegate to the ITU Convention in Geneva. A gentleman, not unlike Ross Hull, who contributed so much to amateur radio over the years.

These commercial magazines (and others), often included articles for and by amateurs, especially the regular amateur radio columns written by past WIA Divisional officers; Federal President, Bill Moore VK2HZ, contributed *The Ham Bands* in Radio and Hobbies; later, Pearce Healey VK2APQ wrote *Amateur Bands News and Notes* in Electronics Australia; continuing the long-standing tradition from the 1930s, AR's current Editor-in-Chief contributed a column on amateur radio to *Electronics Today* over the early 1970s.

Communicating exclusively with amateurs via print

A multi-faceted complexity from the amateur radio magazine perspective in Australia was that initially, the WIA was made up of independent state-based organisations known as "Divisions". To publicise their local activities in those early years, the autonomous Divisions often appointed a local commercial magazine to be its "official organ" or journal. For example, the WIA SA Division (established 1919) appointed *SA Wireless (Monthly)*, from its first issue in April 1924, to be that Division's official organ.

This type of arrangement could add confusion to the national amateur scene, as occasionally a local magazine would simply declare that it was the 'Official Organ of the WIA' whereas, in reality, it was reporting on a particular Division's activities. On a positive side, however, often a good two-way relationship developed with the local magazine publisher – they needed suitable 'radio talk' copy, especially before regular broadcasting, and Divisions needed a vehicle to publicise their presence and activities locally.

So, overall, it was usually a win-win situation. But these columns were also reliant on the skills and punctuality of the Division's correspondent – often an individual who was left with the job and, on top of that, there was a need for the willingness of the magazine's editor to publish what at times was rather specialized and parochial content, which did not always happen! Communications with members could be erratic.

GESTATION . . IT'S COMPLICATED

THE reality behind the gestation of Amateur Radio magazine is that it was birthed by many mothers!

Through the 1920s and early-1930s, WIA divisions pursued publishing their own newsletters (under a variety of titles – CQ, QTC, Amateur-Radio), while a fleet of commercial wireless and radio magazines of various origins sought readers where they could. In the end, it seemed to come as a 'no-brainer' that amalgamation of components of the largest newsletters produced by NSW, Victoria, and Queensland could be a winning strategy.

And so, October 1933 saw the birth of *Amateur Radio* (first issue cover here), initially brought together by the Victorian Division, but almost immediately supported by all divisions. See it for yourself online, at: https://tinyurl.com/AR1933

Although the depredations of WWII impacted the WIA's magazine venture, as noted in the October 1943 edition, it hung on as a newsletter to then flourish in magazine format in the post-war years.

Amateur Radio magazine

In keeping with this article's focus, it's time to take a brief look at the first few issues of AR from October 1933, which also provides some continuity and clarity to its early development. In addition, recently, some further information was unearthed that provides a little more background to the magazine's birth.

Physically, from 1933, the early ARs measured about 150 x 220 mm (rather smaller than currently) and had 28 to 36 pages, including covers (rather fewer than currently). Clearly stated in edition one, AR was the Official Organ of the Victorian Division of the WIA, but from the second edition in November 1933, the pages were filled with material from most divisions, together with the *Association of Radio Amateurs (NSW)*, which was effectively 'the WIA' in NSW.

As it happened, ARA of NSW came into existence because another organization had managed to gain legal control of the 'Wireless Institute of Australia' name within NSW. It also appears that, from its earliest days, the magazine committee was steering AR towards becoming *the* national Australian amateur radio magazine. Minutes of the SA Division for 1 November 1933 tend to support this as they recorded that: "*Mr. Bowman was to be the State's Correspondent for the WIA Organ*". AR had launched barely a month earlier.

There is little doubt that the ARA supported and contributed to the life of the new magazine, which was later acknowledged by the Federal Council in formally accepting ARA (NSW) as the de- facto WIA, NSW Division. Of course, there were also positive financial implications for a growing in-house amateur magazine in having the ARA membership base included in the magazine's print run.

At the 11th Federal Convention, held in Hobart during January 1935, it was formally proposed and adopted that Amateur Radio magazine "…should be considered as the Federal Organ of the WIA" – a fact not declared on the front cover until the April Issue. Probably inadequate production funds dictated the use of existing cover stock before the wording was re-typeset!

The **WIA Archive** would like to hear about any other early amateur radio magazines produced by WIA State Divisions, in particular, Tasmania.

We would also like to find copies of the early Victorian magazine/newsletter, Harmonics. Contact vk3rv@wia.org.au.

Moonbounce musings after momentous efforts

The front cover photo this issue features the portable 10 GHz moonbounce (EME) system developed by Richard Howlett VK7ZBX, from Hobart. This shot was taken outside his home. It was a very clear, still night, Richard explained.

The '10 gig rig' features a re-purposed 1.8 metre prime-focus dish with a cylindrical skirt mounted on a trailer for portable use. Richard said he made a homebrew frame using a 4WD wheel hub for the AZ axis, with linear actuators used for both azimuth and elevation.

The RF system comprises a Kuhne G4 transverter, a Kuhne low noise preamp, and a waveguide Tx/Rx switch with a 20 watt solid-state power amplifier (SSPA).

The tracking system, Richard said, "is Raspberry Pi-based Raztrak from Gary N8CQ. Actuators driven by PWM and jog control," with "feedback of position from a US Digital absolute encoder for azimuth, and absolute inclinometer for elevation, allowing 0.1 degree accuracy."

Richard added that he'd spent four years on-and-off on this project. "It has been a long road," he said, but credited the support of Rex Moncur VK7MO, "who has been a great mentor for getting me this far and putting up with all my silly questions."

Roger Harrison VK2ZRH

How Radio Australia reached the world

Rodney Champness VK3UG #

A concise historical overview of the life and service of Radio Australia from 1944 through 2017.

In the early 1920s, several radio frequency transmitting stations were established around the world to communicate between nations within the British Empire. As time went by, and into the 1930s, several shortwave (SW) broadcasting transmitters were located near key capital cities in Australia to distribute the programs produced by the then Australian Broadcasting Corporation (ABC) throughout inland Australia. This became known as the Inland Service of the ABC.

This was necessary as it was uneconomic to place mediumwave (MW) amplitude modulated (AM) broadcasting transmitters in locations where all inland settlers would have had ready access to MW radio reception. The characteristics of SW radio propagation meant that relatively few transmitters were needed to cover the sparsely populated areas of Australia. In that era, domestic radios tuned the broadcast band, which was 540-1550 kHz at the time.

At the start of WWII, these services were re-appraised to ascertain requirements considering impending invasion by foreign powers. What ultimately became Radio Australia (RA) initially had political overtones to quell the fears people had of invasion and to provide encouragement for our troops with news from home, etc. Transmitters at Lyndhurst, an outer suburb southeast of Melbourne, were commissioned to provide this service, dubbed *Australia Calling*,

Map of the Radio Australia site (within the red lines) selected at Shepparton in Victoria, north of Melbourne, circa 1940.

along with transmitters at Perth and Sydney. Service opened on 20 December 1939, with Lyndhurst becoming the prime station.

The frequencies of 6140, 9580, and 11,880 kHz were selected, with antennas pointing to the areas of importance. Transmitters ranged in power from two to ten kilowatts.

Lyndhurst, where the studios were located, was sufficiently far from any expected immediate enemy activity to make it a much safer location than any of the northern transmitting sites. To preclude enemy attack on RA, Shepparton in north-central Victoria, was subsequently selected as a new site due to its distance from the coast.

The RA complex at Shepparton

Horse power was used during Shepparton's construction. Here, horses and a grader are filling-in control cable trenches circa 1943 or 1944.

Rod VK3UG became a silent key on 22 October 2022, after a valiant battle against cancer. See the Silent Key obituary in this issue. This article was prepared with Rod's assistance over mid-late 2022.

One of the curtain array antennas viewed from immediately beneath.

was the second largest radio transmitting station in Australia and the longest continuously operating shortwave broadcasting station in Australia. It was built to be shrapnel proof from bombs.

Powering the station during WWII was accomplished with a pair of 800 BHP diesel engines driving alternators delivering around 890 kVA output at 6.6 kVAC.

Northern RA sites

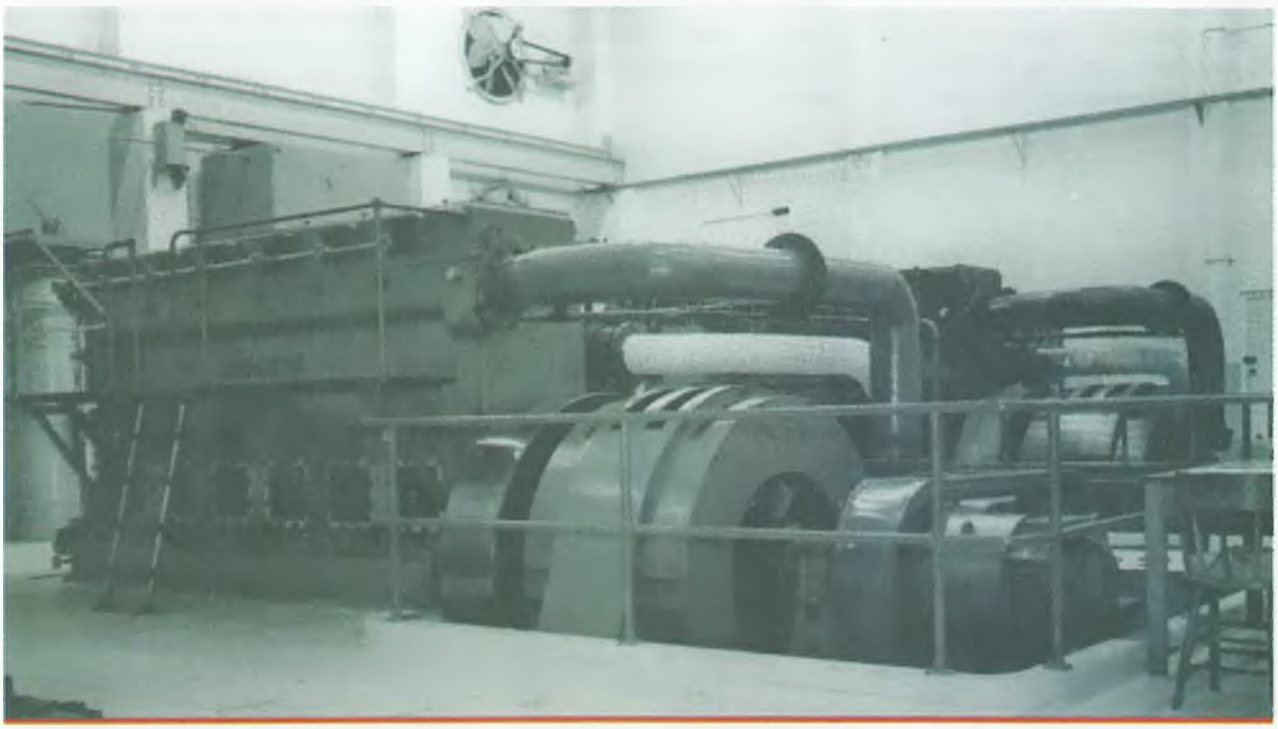
RA Shepparton began broadcasting on 15 May 1944 and ceased transmissions on 3 January 2017. The northern RA site on Cox Peninsular, near the Northern Territory capital of Darwin, began operation in 1968. It had five 250 kW transmitters and one 300 kW transmitter and closed in 1997, with a short period of interruption due to Cyclone Tracey in 1974.

RA's Carnarvon, Western Australia, site began transmissions in 1975 to service Northern Australia until Cox Peninsula took over once again. RA Carnarvon occupied the decommissioned NASA tracking station that supported its Gemini, Apollo, and Skylab programs.

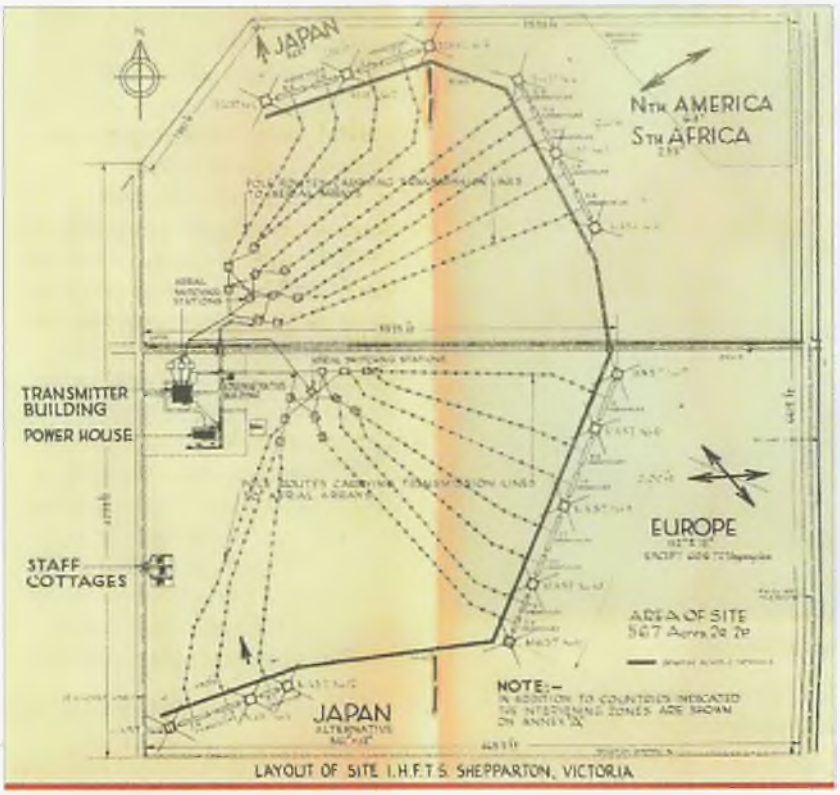
Carnarvon ceased operation in 1996. Brandon, near Townsville in Queensland, opened transmissions in 1989, continuing until January 2015. During the peak time of HF transmission throughout the world, RA leased time on overseas radio transmission sites, such as Taiwan.

Early transmitters, antennas and switching networks

Operations at RA Shepparton opened in May 1944 with a 50 kW RCA transmitter on a frequency of 15,315 kHz using an antenna directed towards the Philippines.



Two diesel 800 hp engines by Crossley driving 445 kVA alternators powered Radio Australia over many years.



Map of the original layout of antennas at RA Shepparton, showing the different groups.

The first 100 kW transmitter was installed and became operational in August 1945, a second 100 kW transmitter entering operation in 1946.

At its peak, RA Shepparton had 35 antennas comprising rhombics, dipoles, curtain arrays, etc. Some wooden masts were 34 metres high and weighed four imperial tons. Many of the curtain array antennas could be switched to transmit in either direction broadside to the elements to take advantage of propagation via the long or short paths.

The early antenna switching system was erected to suit the three transmitters installed over 1944-46. The addition of more transmitters and antennas necessitated a large matrix line switching system, installed in 1963. This was the most complex and versatile of the matrix systems deployed at RA and could switch 10 transmitters to any one of 35 antennas, or the dummy load in use in that period.

Time for new transmitters

With the original transmitters showing their age, from 1978, Harris SW100 series transmitters were installed. Two 50 kW RCA transmitters remained until the mid-1990s. In 1997, a redundant Harris SW100 from Carnarvon was installed at RA Shepparton. The transmitter complement became seven 100 kW transmitters, which remained until station closure.

These transmitters were considerably smaller than the original 100 kW transmitters. Most of the electronics was contained within one cabinet, a large power transformer, water cooling radiators, and some ancillary equipment were placed nearby, and the frequency and audio panel stood in a 19-inch rack alongside the transmitter cabinet.

View of the antenna switch matrix that could switch up to 35 antennas and 10 transmitters, including the dummy load.

Together, they used less electricity and each drew a maximum of 180 kW at peak modulation. The overall efficiency was in the order of 55-60%.

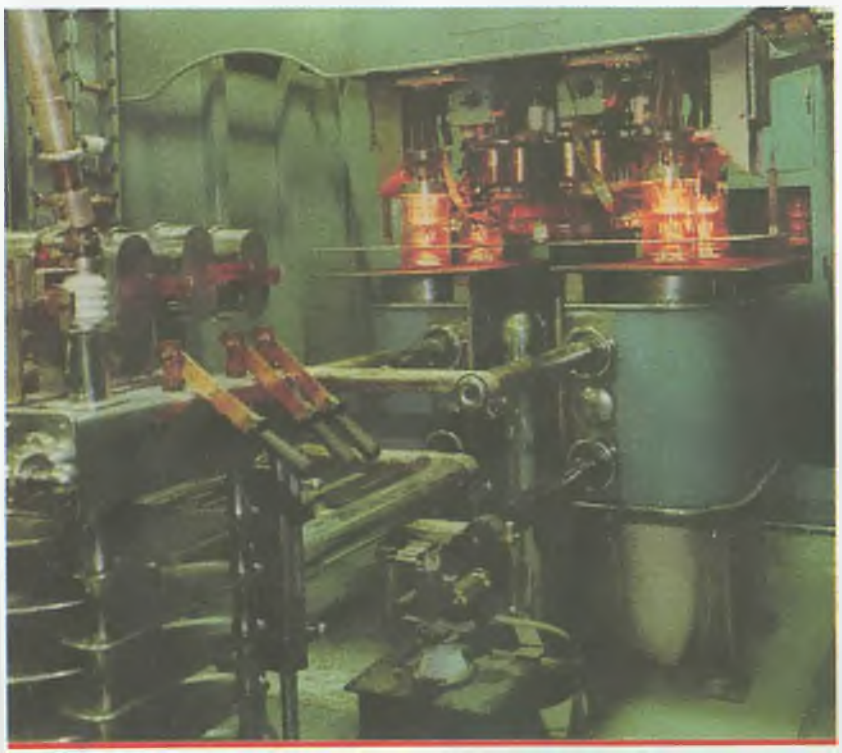
There were many advantages in using modem transmitters, such as higher electrical efficiency, simpler RF circuitry, and fewer staff needed to perform maintenance or to make frequency changes. With power on and transmitting, selection of a new frequency within the same broadcast band could take as little as five seconds from switch off to returning to full power on a new frequency. Changes from one band to another rarely took more than 20 to 30 seconds, compared to 30 minutes previously.

The modulation system used in the Harris transmitters was Pulse Width Modulation (PWM). In this system, the audio output modulator valve is switched hard on or cut off at an audio rate and the ratio of 'on' time to 'off' time determines the audio frequency and volume. The modulator is switched on and off at around 75 kHz and this frequency is filtered out of the output frequency leaving a good quality audio signal applied to the RF output stage.

This is quite efficient and means that the audio output valve is around 90% efficient compared to the early series modulating systems that were unlikely to exceed 20% overall efficiency. The audio fidelity is superior, too.

At 100 kW, size matters. At left is the STC100's 4CV100,000E output valve, with the 4CX1500A driver valve at right. A 12AX7 provides size comparison.

Tank circuit of the final stage of a 100 kW Harris SW100A transmitter. The torch provides size perspective.



The 100 kW final stage RF power amplifier of an AWA STC100 transmitter. Note the variable tuning capacitor at lower left.

Showing part of the power supply of a Harris SW transmitter.

Antenna system upgrades

In its heyday, RA Shepparton transmitted to all points of the globe. There was considerable maintenance required on such a large and complex antenna and feeder system. The various arrays were situated throughout the site and aimed at specific target areas throughout the world.

In 1991, an upgrade of the antennas and antenna switching systems took place, which resulted in 13 antennas being sufficient for the perceived needs of the services provided, rather fewer than before. The Cold War had ended! The target areas were now from east through north to northwest – Western Pacific and South East Asia.

The antenna complement became two terminated rhombics covering 9-17 MHz and 11-22 MHz, six narrowband curtain array antennas covering 6, 9, 11, 15, 17 and 21 MHz, five broadband curtain arrays covering 6-12 MHz, two for 9-18 MHz, and one covering 11-22 MHz. The effective radiated power in the favoured direction from the largest antennas was of the order of 10 MW with 100 kW input. The masts were of steel lattice construction, the highest being about 91 metres.

In the earlier years, when the transmitters and feeder lines were unshielded, radiation in known 'hot spots' on site was such that fluorescent tubes could be lit when held in a person's hand. Upgrades took place in 2005, resulting in the bandwidth and SWR of each antenna being improved.

Staffing, housing and sheep

During construction periods, the number of people on-site peaked at around 120. The operational staff in early days was over 50 people, which included transmitter operations, administrative, linesmen, gardeners, and ancillary staff.

It was necessary to have around five people on-shift as changing bands on the old transmitters required quite a bit of mechanical work to change coils and capacitors. Thirty minutes was allowed to effect a band change and transmitter tune. Lines staff looked after the sheep that grazed on the property to keep the grass down to a reasonable level, minimising the risk of fire should an antenna or feedline fall to the ground, as happened occasionally.

With the later model transmitters, a major band change usually took as little as four seconds if the frequency change was minor. As a result, staffing levels were reduced. The station ran 24 hours a day, much of the time with only one staff member on duty.

The station sheep kept the grass down, serving multiple purposes.

In 2015, transmissions were reduced from six transmitters in operation to three, and staffing reduced to four. This meant the transmitters were left unattended for several hours, even when frequency changes were to take place. Not ideal for transmitters not designed for unattended operation; however, protection circuitry kept them from major problems.

RA Shepparton was like a small village in the early days, with seven houses built to accommodate staff. In 1956, four houses were added. In 1989 the on-site accommodation was removed. There were several dedicated staff who became managers of the station. The first was Jack Hargreaves who handed over the reins to Bill Davidson in 1962. Bill worked in many positions from the start of station construction, retiring in 1980. Bruce Wilson then took on the job and ably looked after the station until 1998 when Doug Brodie took over.

In 1999, Telstra ceased to run the station and a succession of private companies took over with very limited staff.

Frequencies, services, programming and times

In the 1970s, transmission time was on the order of 89 hours per day from 10 transmitters. In the 1990s until 2015, the transmission time was 144 hours per day from six transmitters. One additional transmitter was kept in reserve to be used in case of a breakdown or where an extra service was needed, or maintenance on another transmitter required.

The Harris transmitters nominally tuned from 3.2 MHz to 22 MHz. RA transmitted in the 6, 7, 9, 11, 13, 15, 17, 19, and 21 MHz international broadcasting bands. A total of 24 frequencies was used each day over the six transmitters normally in operation during much of the '90s and early 2000s.

Three main variables were considered to ensure best

Memorable managers, standing in front of the last matrix switch: left, Bruce Wilson, OIC from 1980 to 1998; right, Doug Brodie, who took over from Bruce in 1998.

transmission to each target area. They were sunspots, variations between summer and winter propagation, and the difference between night and day propagation. These dictated the frequencies used. To minimise interference with other services and to maximise the effectiveness of the transmissions into the target areas, 34 frequency and/or antenna changes occurred per day. The number of changes per day varied for each transmitter.

RA Shepparton transmitted several foreign language broadcasts in years gone by, but in the last 20 years of operation, the remaining foreign language transmissions were reduced to Indonesian, Tok Pisin (Pidgin English), and Chinese. During the last few years of operation, transmissions were in English only. Program time was leased on transmitter sites in several Asian and Middle Eastern countries for Khmer and Vietnamese language broadcasts.

Extra-curricular

The purpose of RA was to transmit programs to overseas listeners. However, RA Shepparton was also used for other purposes. In 1946, the CSIR, forerunner of the CSIRO, conducted experiments with VHF radio equipment researching the effects of radio propagation through the ionosphere.

The CSIR also wanted to experiment with HF pulsed signals. They enlisted the aid of the PMG and the 50 kW RCA transmitter was modified so that it could be keyed like a pure Morse code transmitter. A receiver was set up in Hornsby NSW, and the transmitter was keyed remotely from this site. HF moonbounce experiments were undertaken when the transmitting and receiving antennas were aligned with the moon.

In November 1947, tests on 17.84 and 21.5 MHz succeeded. A 70 kW transmitter was also used in this series of experiments. This was the first successful series of moonbounce tests in Australia, and probably the Southern Hemisphere. (See "Moonbounce 1947", *Amateur Radio*, Vol. 89, No.6 for 2021, p52).

For some 50 years from about 1948, on Friday afternoons, transmissions to suit the widely spread Australian Antarctic research bases on the Antarctic continent occurred. These were half-hour transmissions dubbed *Calling Antarctica,* conducted initially by Jocelyn Terry, then later from the 1960s by Mary Adams.

This was a much sought-after program by the lonely men on the Australian Antarctic bases. These transmissions continued until the internet (via Inmarsat) became available in the late 1990s on Antarctic bases.

Cyclones and unrest

On 25 December 1974, Cyclone Tracey flattened Darwin and RA on the Cox Peninsular. RA Shepparton stepped into the breach, broadcasting many of the programs that Cox Peninsular had been transmitting. This involved a lot of re-scheduling so the maximum amount of programming normally transmitted from Darwin could be broadcast. Shepparton carried programs for Darwin until such time as Cox Peninsula was reopened 10 years later.

In several instances, when Australian military personnel have been posted overseas since WWII, special broadcasts have been transmitted. At times of national emergency, when cyclones or floods had devastated areas in Queensland and the Northern Territory, RA Shepparton has provided communications when other ABC services had been put out of action. This happened several times, proving helpful in these times of disaster.

In 2011, an extra service was provided to Queensland when cyclone Yasi caused considerable damage to property and disruption to communications. In 2006, RA Shepparton provided the Northern Territory with their normal shortwave 'Shower Services' while the transmitters in Alice Springs, Tennant Creek and Katherine were being upgraded.

This was probably the longest running extra service provided daily for many years. These transmissions were even being heard in Europe on 11,880 kHz.

In 2004, RA provided transmission facilities for Radio New Zealand International while its transmitters were out of commission. Transmissions have also been conducted for the BBC during periods of unrest in some small Pacific Island nations.

Radio Australia signs off. The final station manager, Nigel Holmes, turns off the last transmission from Radio Australia. The transmitter here was a Continental 418G AM-DRM (Digital Radio Mondiale) model.

The end of an era

On 31 January 2015, RA transmissions were reduced to only three. The two 10 kW transmitters at Brandon, QLD were shut down, as well as offshore HF transmissions from various sites. The final and complete closure occurred on 31 January 2017.

There was hope that the Australian Government and the ABC could be persuaded to reinstate the station, with perhaps a smaller complement of transmitters if cost was a concern, to cover many of the areas to which RA had broadcast.

Approaches from many people within Australia and Pacific Island nations pleaded with the Australian Government and the Australian Broadcasting Corporation to re-instate the service. Shortwave radio was no longer in favour, so the approaches fell on deaf ears. Many believed that Radio China International would take over the frequencies that Radio Australia vacated – which they did!

The last hurrah — VI3RA

The RA Shepparton site owner, BAI Communications Australia, was approached in 2019 to see if the antennas could be used by amateur radio operators for a short period as a 'last hurrah' for the site. Permission was granted, which allowed the Shepparton & District Amateur Radio Club (SADARC) to use the antennas over 14-15 March 2020. The event's enormous success was covered in *Amateur Radio* magazine, Vol. 89, Issue 6 for 2021, pp 49-52.

This undertaking proved that high gain antennas with moderate powered transmitters can provide very good signals into areas of interest. This was probably the only time that the RA antennas had been used for both transmission *and* reception. A special event call sign (VI3RA) was granted. However, a high-power permit was refused by the ACMA.

It was necessary to check that the antennas were all functional as no equipment maintenance had occurred since January 2017. One or two required maintenance and were serviced, while one rhombic was too expensive to restore so it was not used. The surviving antenna switch matrix also required maintenance, but this was not practical.

All transmission lines where they entered the matrix building were removed from the matrix and attached to 300 Ohm:50 Ohm baluns, then via a remotely-controlled switching network to three operational stations in rooms at the back of the transmitter hall.

The opportunity provided a chance to again bounce signals off the moon on 21 MHz. This was successful, but digital transmissions had to be used as Australian amateurs are only allowed 400 watts (120 W) transmitter output whereas, in 1947, 50 kW and 70 kW was used.

This was a successful weekend, which proved that large high gain antennas make all the difference to having strong signals far afield. DX addicts had a great time and many others had fun trying the antennas on frequencies that they were not

Happy amateurs using the Radio Australia antennas at Shepparton.

really designed for, with interesting results.

In the early days of RA, QSL cards were exchanged with shortwave listeners. Since the last hurrah with VI3RA, around 1000 QSL cards were distributed to overseas and Australian radio amateurs that contacted the station, making it a time in history to remember.

The back of the QSL card has a short story about the history of the site, as follows:

"The Radio Australia site in Shepparton Victoria was responsible for broadcasting worldwide a range of content on the shortwave bands between 1939 and 2017.

"Since the closure of the site for international shortwave broadcasting an opportunity developed to reactivate the station on the 14th and 15th of March 2020 using amateur radio. With the dedicated work of employees of BAI communications (the owners of the site at the time of the event) and members of the Shepparton & District Amateur Radio Club (SADARC), the event was a huge success.

"A range of antennas, including several high gain curtain arrays and a large rhombic antenna at the Radio Australia Shepparton site, were made available for the weekend and over 90 amateur radio operators participated It was a historic event for amateur radio and for the site that will always be a major part of Australia's proud broadcasting history."

Watching for the moonbounce signals on 21 MHz.

Summary

RA at Shepparton provided the overseas service of the ABC from 1944 on a continuous basis until closure in 2017. Other sites have come and gone, but Shepparton just kept on going and going, gradually improving with tweaks here and there, until closure in 2017.

The site will not be used as an International HF Broadcasting station again as a lot of the plant has been de-commissioned and removed. However, as of 2021, the transmitter facades, buildings and antennas remain. Without maintenance, the facilities will deteriorate.

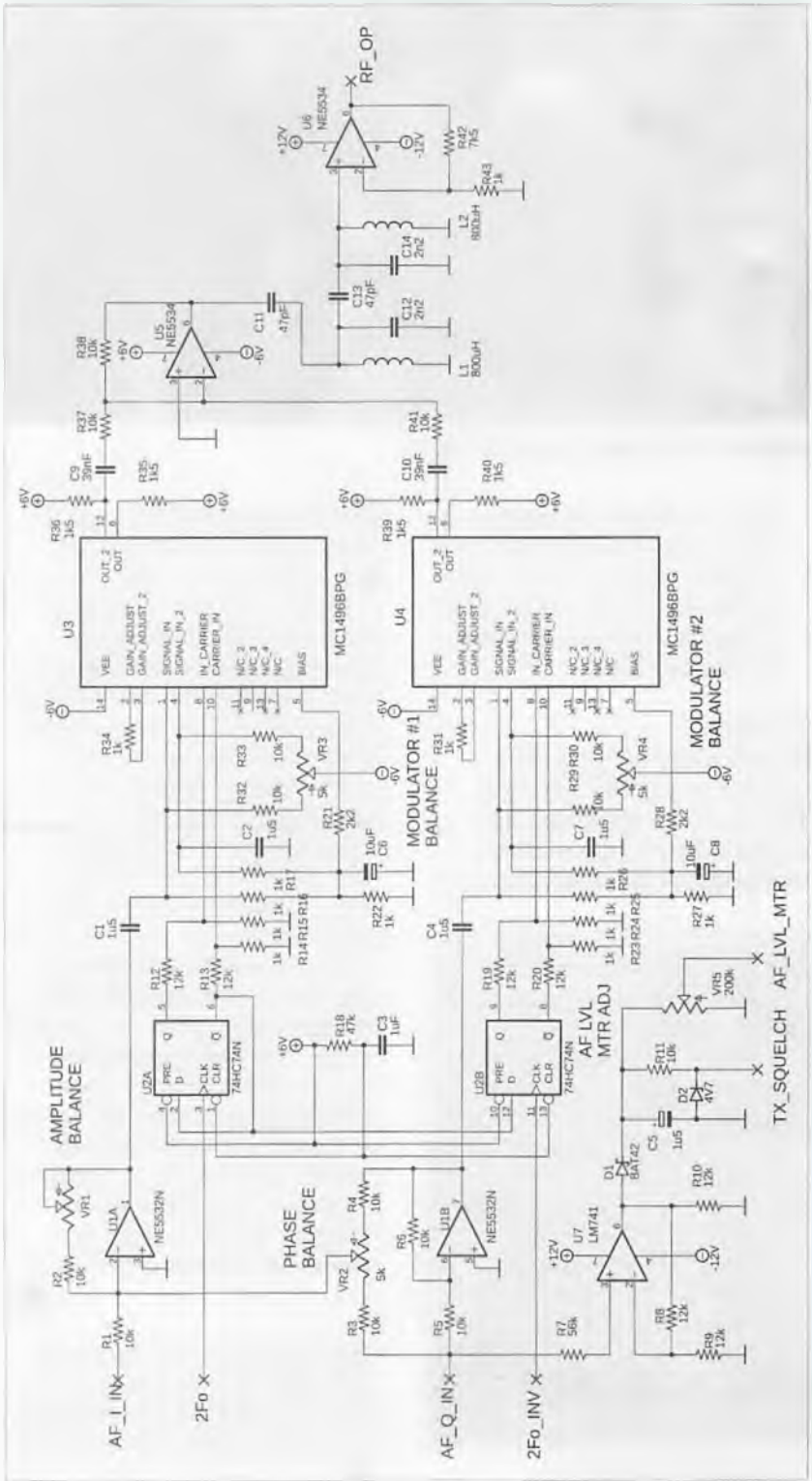
The keys to the Radio Australia site at Shepparton were handed over to a consortium of Shepparton businessmen in May 2020. What the consortium intends to do, short- or long-term, is unknown, although one hope is that part of the site could become a working communications museum, which would be unique to Shepparton. However, the consortium is not contemplating any such actions for 10 to perhaps 20 years. It is hoped that the site equipment will not deteriorate dramatically over this period.

Front side of the VI3RA QSL card, created for the 'last hurrah' of the RA Shepparton site.

Thank you to Bill Roper VK3BR OAM and Bruce Kendall VK3WL/9V1WL for their assistance in condensing what was a more comprehensive history of Radio Australia written by the author - Ed.

A Multi-Mode transmitter for the 2200 metre band with a Class-E final – Part 2

Dale Hughes VK1DSH



Having covered the background on the 2200 metre band allocation, an overview of the multi-mode exciter, and a detailed explanation of the rig's PA in Part 1, this part details the exciter, the direct digital synthesiser (DDS) and microcontroller, cooling, power supplies and tuning.

SSB phasing exciter details

A complete explanation of generating an SSB signal using the phasing method is beyond the scope of this article. Interested readers are directed to the standard amateur texts and the QST articles by Campbell, already mentioned (Ref. 3).

Over the years I have successfully used the phasing method for SSB receivers and transmitters on various bands (Ref. 5). It's a low cost and straight forward way of generating and demodulating SSB signals. The downside is that it uses a relatively large number of resistors and capacitors that have to be carefully matched. However, this is easy to do with a DVM and capacitance meter.

The method was selected for this application because it was a simple way of using any of the appropriate 'sound-card' modes (like WSPR or JS8call) to generate the RF drive for the 137 kHz output amplifier.

The schematic or circuit diagram of the SSB exciter is shown in **Figure 7**, and the associated audio phase shift network is shown in **Figure 8**. If the modem application you are using can output the audio signal in I-and-Q format, then it would be possible to dispense with the audio

Figure 7: SSB exciter schematic diagram. The bandpass filter comprising L1, L2, U5 and U6 etc. are mounted on a small circuit board beside the mixer and RF quadrature assembly, see **Figure 11** (under chassis view), later, for more details. **[NB:** Figure 6, the fan circuit, comes later].

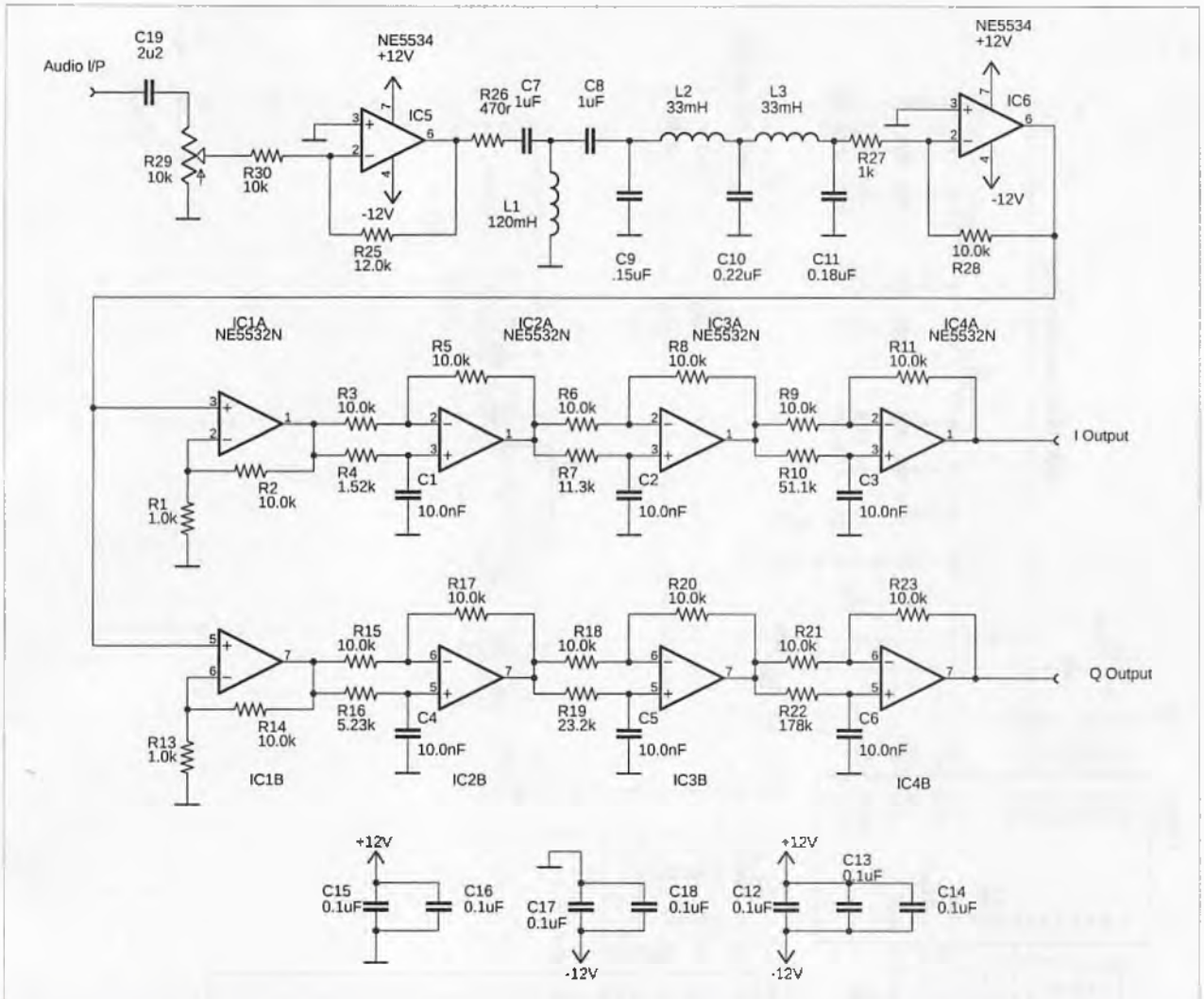


Figure 8: The audio phase shift network produces two audio outputs equal in amplitude with a constant phase difference of 90 degrees. Note the comments in the text about selection of capacitors C1 through C6 and resistors R1 through R23.

quadrature network and inject the I-and-Q audio directly into the mixer inputs.

The carrier signal for the exciter uses an AD9850 direct digital synthesiser (DDS) chip that provides the RF carrier at twice the output frequency (**Figure 9**). Because the weak signal modes used around 137 kHz require a high level of frequency stability, the DDS chip was clocked by a Temperature Compensated Crystal Oscillator module with an output of 19.44 MHz.

The differential output from the DDS module was used to drive a pair of 74HC74 flip-flops on the exciter board, which generates the two carrier outputs in phase quadrature at the wanted suppressed carrier frequency.

The AVR microcontroller used to control the DDS chip also implements the correct transmit/receive sequencing along with providing a transmit squelch function that prevents transmission of noise if no modulation audio is present when the transmitter is keyed. While I used a DDS and microcontroller circuit of my own design, there are plenty of commercial DDS and Arduino modules available at low cost that could be easily adapted for this purpose.

The incoming audio from the sound-card is amplified and band-limited; it then passes through the audio phase shift network that produces two outputs of equal amplitude but in phase quadrature.

The pairs of audio and carrier signals in phase quadrature are then mixed by a pair of MC1496 double balanced mixers. Each MC1496 produces double sideband outputs that are added together to produce the single sideband output. This is then filtered by the pair of tuned circuits and amplified before being routed to the power amplifier stage.

Indication of the incoming audio level is obtained by rectifying the

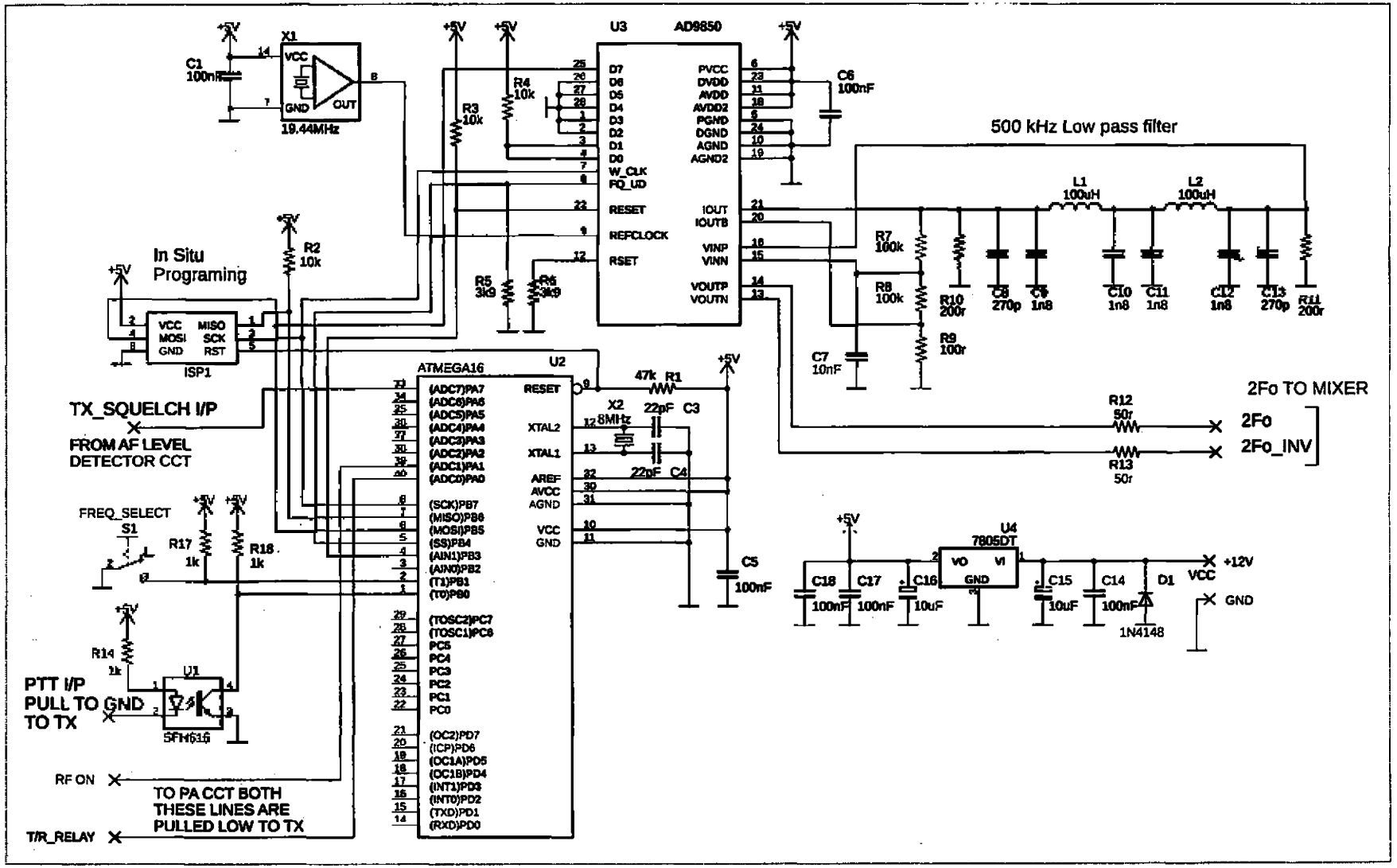


Figure 9: The microcontroller and DDS schematic. The push-to-talk input (PTT I/P) can be pulled to ground via a transistor or relay, depending upon the sound-card interface that is used by the operator.

signal buffered by U7 that feeds the panel meter through a source selection switch. The audio level signal is also routed to an analog input on the microcontroller that monitors the level and shuts off the transmitter if the audio level drops below a predetermined level.

A level of 1 V was programmed in the microcontroller firmware as the squelch trip point. Because of the low operating frequency, there are no particular difficulties with construction of the circuitry and much of my unit was built on Veroboard.

The DDS and microcontroller

I used an Atmel (now Microchip) ATMEGA-16 microcontroller programmed in AVR assembly language because I had the hardware and suitable assembler code available from an earlier project.

The assembly code is straight forward because it only has to set two DDS frequencies and implement the T/R switch sequencing. As such, it would be easy to implement identical functionality using an Arduino and a commercially available DDS module. However, I am happy to provide the AVR Studio-7 assembler source code to interested readers.

Figure 9 shows the microcontroller and DDS circuitry. The main feature to note is the use of the complementary DDS logic-level outputs that are used to drive the RF phase quadrature generator. The RF low-pass filter in the DDS sinewave signal path removes any high-order spurious frequencies.

The DDS is clocked by a 19.44 MHz TCXO obtained from surplus sources. Other clock frequencies can be used by changing a few lines of firmware code.

The relationship between the output frequency, reference clock, and tuning word of the AD9850 is determined by the formula $F_O = (\Delta \text{ Phase} \times CLK_{IN})/2^{32}$, where: Δ Phase is the value of the 32-bit tuning word; CLK_{IN} is the input reference clock frequency in MHz; and F_O is the frequency of the output signal in MHz.

It is easy to calculate the required tuning words for different clock frequencies. Table 2 gives some examples for some common reference clock frequencies in case a 19.44 MHz clock is not available.

Clock Frequency (MHz)	F_o = 2 * 135.7 kHz	F_o = 2 * 136.0 kHz
19.44	392F1F	394F6F0
10.0	6F2A5A4	6F69446
20.0	3795202	37B4A23
30.0	250E1E1	252316C

Table 2: Hexadecimal DDS tuning words for different clock and output frequencies. The DDS output frequency is twice the wanted frequency because the RF quadrature generator divides the input frequency by two.

Cooling fan control

The fan that cools the power amplifier transistors is temperature controlled so that the fan only comes on when the devices start getting hot; I set the turn-on temperature to 30 Celsius. Figure 6 shows the controller schematic and it is fairly simple.

The heatsink temperature is measured using an LM35CZ Celsius temperature sensor. This device

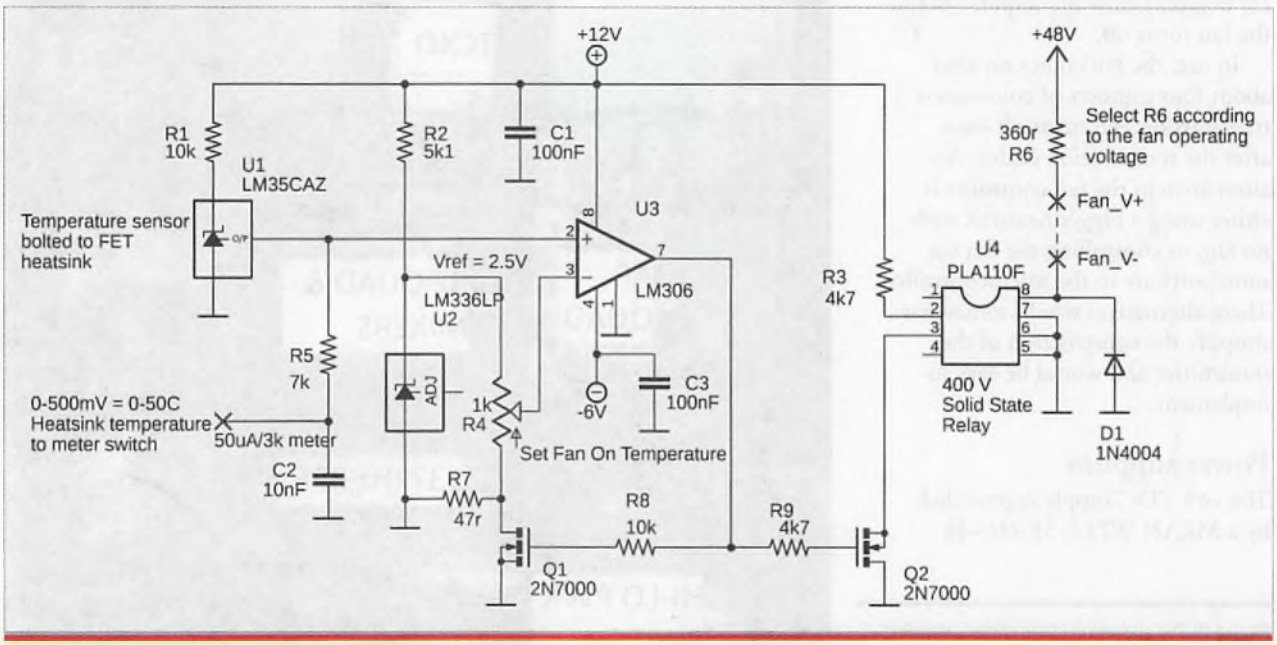


Figure 6: The fan control circuit. The temperature sensor U1 is mounted directly on the heatsink and held down with a small aluminium clamp. Resistor R6 is selected to drop the 48 VDC supply to that required by the fan.

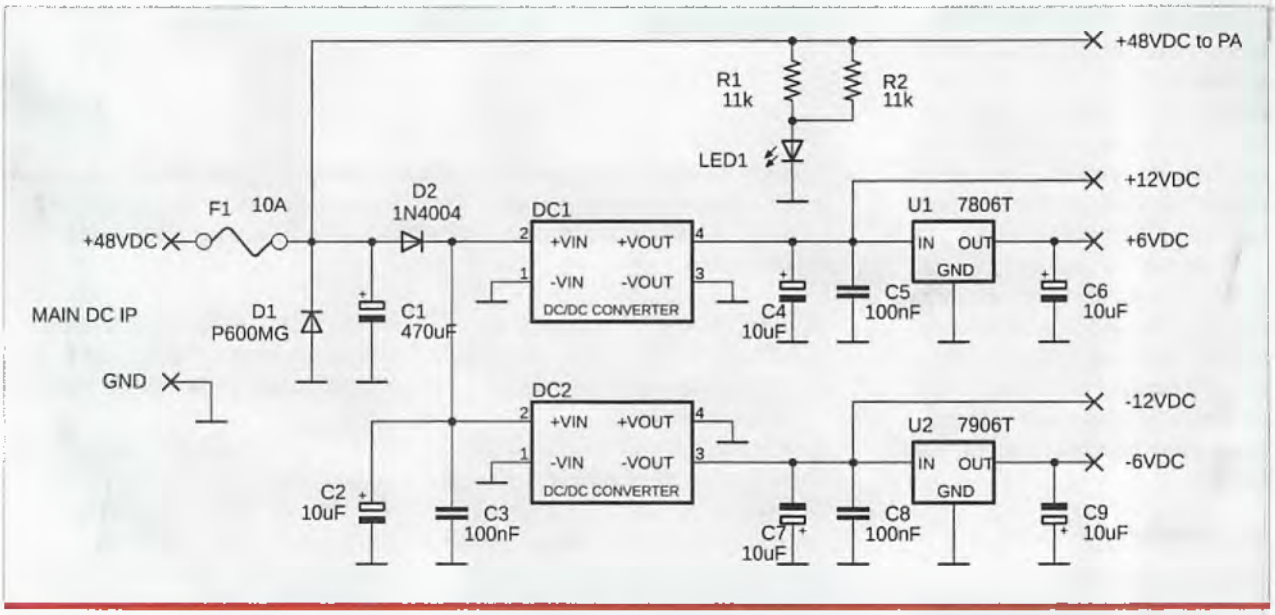


Figure 10: Transmitter power supplies. The two DC-DC converters have galvanically isolated outputs and are of the same type: MEAN WELL SKMW06G-12.

produces a 10 mV/C output that feeds a comparator. When the sensor voltage exceeds the reference voltage on the other comparator input (which is 300 mV for a 30 Celsius turn-on point) the fan is turned on.

A few degrees of hysteresis is provided by pulling down the reference voltage by about 30 mV when the fan is running so that the heatsink has to cool by about three (3) degrees below the setpoint before the fan turns off.

In use, the fan comes on after about four minutes of continuous transmission and turns off soon after the transmission ceases. An alternative to the fan controller is either using a bigger heatsink with no fan, or controlling the fan via some software in the microcontroller. These alternatives would somewhat simplify the construction of the transmitter and would be easy to implement.

Power supplies

The +48 VDC supply is provided by a MEAN WELL SE-600-48

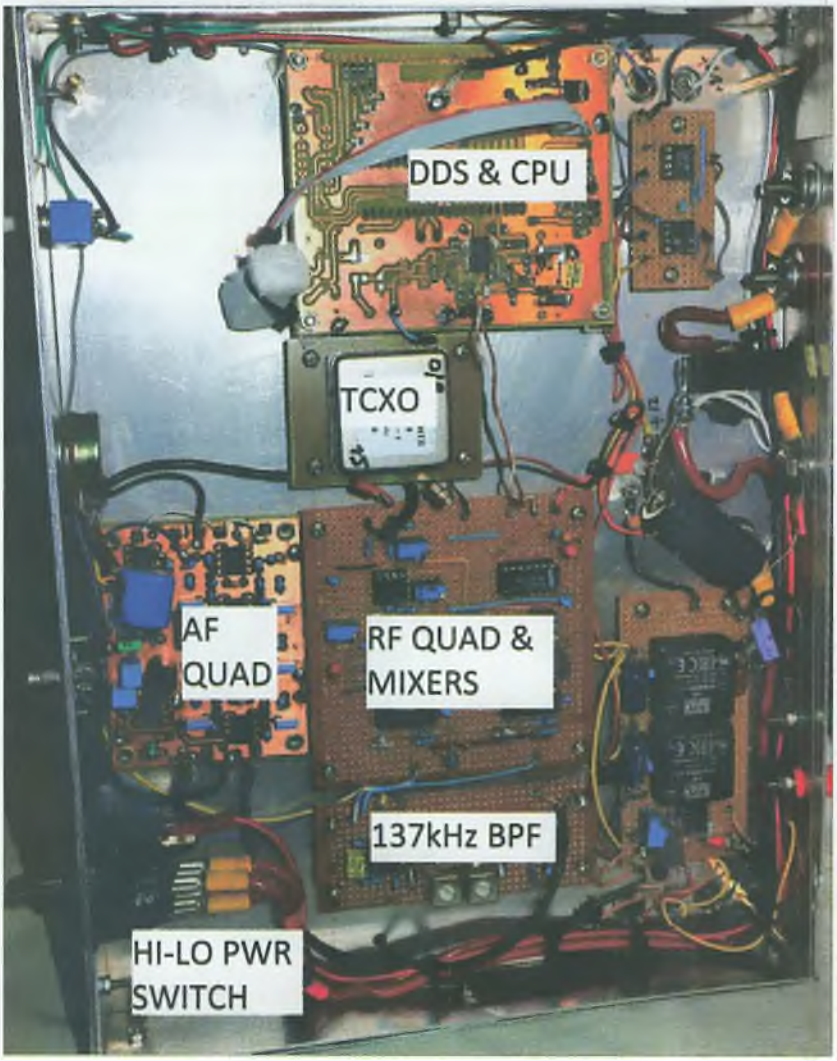


Figure 11: The underside of the chassis showing the audio, mixers, microcontroller and DDS circuitry.

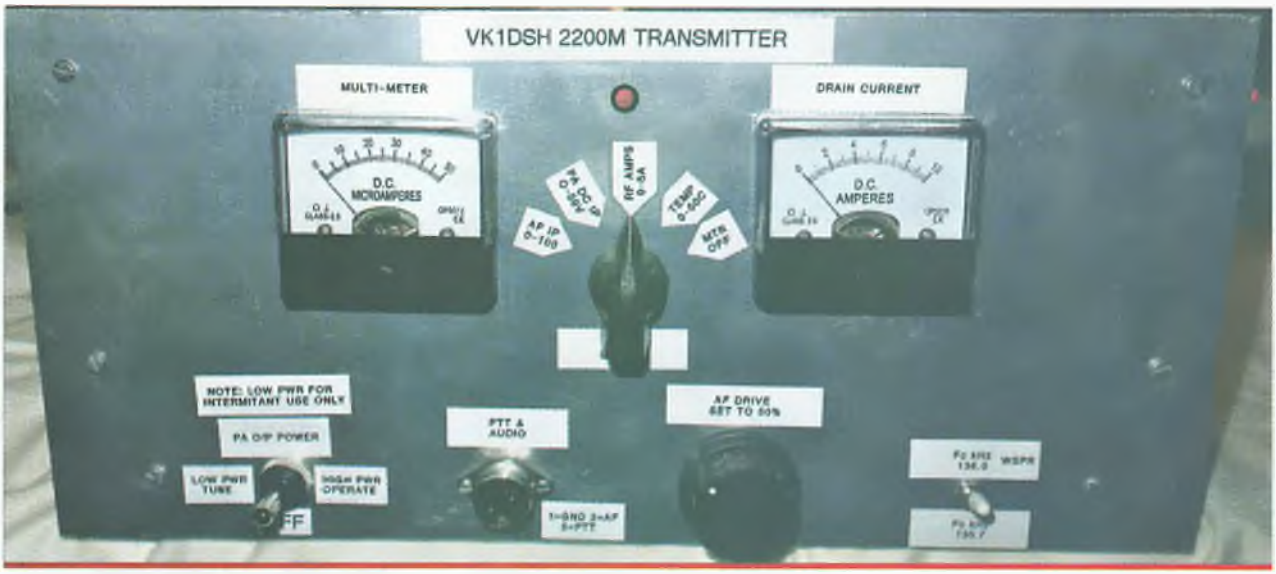


Figure 12: The front panel of the transmitter showing the various controls. The overall construction uses the conventional chassis-and-front panel configuration.

switch-mode power supply unit. The supply has a maximum output current of 12 amps and is relatively inexpensive. For convenience, the various voltages for the transmitter are generated by two small MEAN WELL SKMW06G-12 48 V to 12 V DC-DC converters. Lower voltages are generated using standard three-terminal regulators.

The main thing to consider is that the 48 VDC connections must be suitable for continuous currents of 8 – 10 amps. Polarity protection is basic and consists of a reverse-biased diode that will blow the main fuse if the power supply polarity is incorrect.

The power supply schematic is shown in Figure 10. I found it was necessary to separately connect the main +48 VDC switch-mode supply case to ground to eliminate some radio frequency interference, I put a 5 mm bolt through an existing ventilation slot and connected the case to the radio earth, after that there were no more RFI problems.

Transmitter adjustments

The power amplifier will require some tuning to maximise efficiency and power output. Sokal, in his article, provides complete details of the adjustments and a useful chart that shows what components need adjustment to achieve correct Class-E operation, based on the voltage waveform observed on the FET drain.

I found the method straight forward and it was easy to make the adjustments by adding or subtracting capacitors and moving the ferrite rods in inductor L2. The calculated drain current is also a good indicator and I found that the current was very close to the calculated value when tuning was correct. Once set, the tuning covers the whole band and doesn't require tweaking.

Assuming the component values in the AF quadrature network have been well matched, adjustment of the exciter is straight forward and consists of balancing the two MC1496 modulators to minimise carrier leakage and then adjusting the phase and amplitude trim potentiometers to maximise opposite sideband suppression.

I was able to achieve an opposite sideband suppression of about 60 dB. The impact of excessive carrier and opposite sideband feed-through appears to be an increase in phase noise on the transmitted signal so it is beneficial to achieve the best possible suppression. While not required for this application, the phasing exciter has excellent linearity and could be used for various linear modes, if required.

Components

None of the components in the transmitter should be particularly difficult to obtain. At least, there should be suitable equivalents to the devices I used. The TCXO, transistors, WIMA capacitors, ferrite cores and solid-state relays were obtained from Rockby Electronics (www.rockby.com.au), but similar components are available from other suppliers.

Because of the low operating frequency, most alternative components can be used. The main thing to note is that suitably rated components must be used in the power amplifier and you must take into account capacitor voltage de-rating due to operating frequency.

The components in the audio quadrature network (Figure 8) did require some careful selection. The capacitors C1 through C6 were selected from a batch of 100 components and the units with the closest values were selected. What is most important is not the *actual* value of 10 nF, but that each of the capacitors is as close as possible to the *same* value. So, for example, if

you get six 9.9 nF capacitors, that will be fine.

Similarly, for R1 through R23, the various resistors were selected from batches of 1 % resistors; where necessary, parallel and series combinations were used to get the required values.

The main 48 VDC switch-mode supply and the 48 - 12 VDC DC-DC converters were purchased from Mouser. Other miscellaneous components were obtained from Jaycar and Element14.

See the RSGB publication *LF today* (Ref. 7) for useful information about component selection for use at LF, especially ferrite materials

Conclusion

The transmitter described in this article has been in use for many months and has performed very well. Moving away from hard-coded approaches and transverters that I have previously used has opened up communications possibilities on the 2200m amateur band.

The transmitter allows me to just reach 1 W eirp using my inverted-L antenna that is about 12 metres high and 26 metres long; the antenna RF current is about 2.5 amps at maximum transmitter power.

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2. Class-E RF power amplifiers, Nathan Sokal WA1HQC, QEX, January/February 2001.
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4. VK1SV web calculator https://people.physics.anu.edu.au/~dxt103/calculators/class-e.php
   OR: https://tinyurl.com/5fwdc232
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6. WIMA capacitor information can be found at www.wima.de/en/our-product-range/pulse-capacitors/mkp-10/. OR: https://tinyurl.com/52urv949
7. LF today. A guide to success on the bands below 1 MHz, book by Mike Dennison G3XDV, Radio Society of Great Britain, ISBN 9781 9050 8693 1, 3rd Edition 2013.

NB: Issues of *Amateur Radio* magazine can be accessed online, via www.armag.vk6uu.id.au.

March 2008 – LF allocation: *WIA Comments on Draft Spectrum Plan*, https://tinyurl.com/y29p4pva

June 2009 – LF band access: *135.7 – 137.8 kHz Now Available to Advanced Licensees*, https://tinyurl.com/2jru4v2f

December 2010 – Amateur LCD amended: *ACMA has given effect to several matters first requested by the WIA in December 2008*, https://tinyurl.com/2s4zxyrj

HACKS + Hints

A fine enough footswitch

In contesting stations with a multiple operator environment, a footswitch to operate the PTT line reduces stress considerably. Running VOX in these environments will ultimately risk the other people in the room false-keying a transmitter. Using a footswitch will ensure that the keying of rigs and amplifiers can be done efficiently.

While the use of Heil footswitches is popular in the global contester community, the poor Aussie dollar makes them expensive, which has led us to Jaycar and the very good (and cheap) Part number SP0760.

The description in the Jaycar catalogue describes the device thusly: this foot switch is a single-pole, momentary action (keep your foot down to hold the contact closed) and can be wired to be either push-on or push-off. The switch is rated at 250 VAC, 10 A. It has a positive switch feel and an audible click when pressed.

Applications include in PA systems, Dictaphones, etc. Colour is grey, cable is 850 mm long. Size: length and width = 80 mm; height = 30 mm.

A Contester

A project for that rainy Saturday arvo in the shack

A simple controller for bipolar stepper motors

Eric Christer VK3EAC

Found in all sorts of often-discarded consumer electronics/IT equipment – printers, scanners, faxes – stepper motors are 'easy pickings' for re-purposing projects (Wikipedia).

Inspired by Jim VK3JST's minimum-parts-count "uTurn" remote control in *Amateur Radio* Issue 3 of 2022 (Vol. 90, No. 3), I wondered if a simple speed control could be made up for a small bipolar stepper motor that I had rescued from and old printer. The stepper motor Jim used in his project is a 5-lead unipolar type, which works a little differently.

A simple control can be made up easily by using a readily available L298N dual 'H' bridge bipolar stepper motor driver module and a modified rotary switch with the stops removed. Great for remote control of a variable capacitor, for example. The schematic is shown here in Figure 1.

For clarity, the schematic shows the switch in basic form. A second set of contacts need to be paralleled so that, with 360-degree rotation, two lots of 'pulses' are produced.

A 2-pole, 6-way switch can be used in a similar way. At the positions where no switch contacts are used, there is no output to the motor windings and the LED is off. The 'pulse' input sequence and resulting outputs to the motor windings are detailed in Figure 1.

Depending on the voltage and current ratings of the stepper motor, some form of current limiting may be a good idea by inserting, say, a 22 to 39 ohm resistor in series with the main positive supply, provided that the 5 VDC supply from the module is not reduced too much.

If needed, information on the module rating limits and connections can be found on the internet.

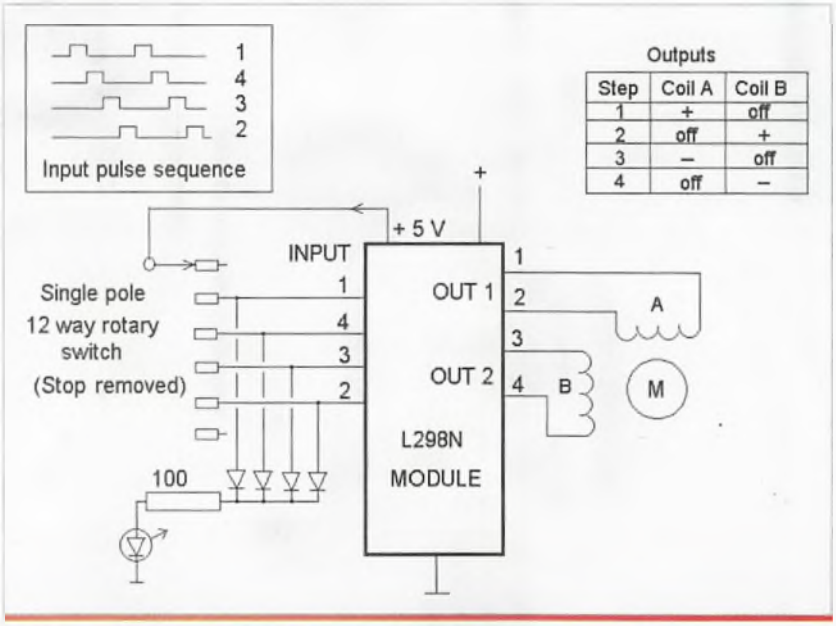


Figure 1. Simple control arrangement for a bipolar stepper motor.

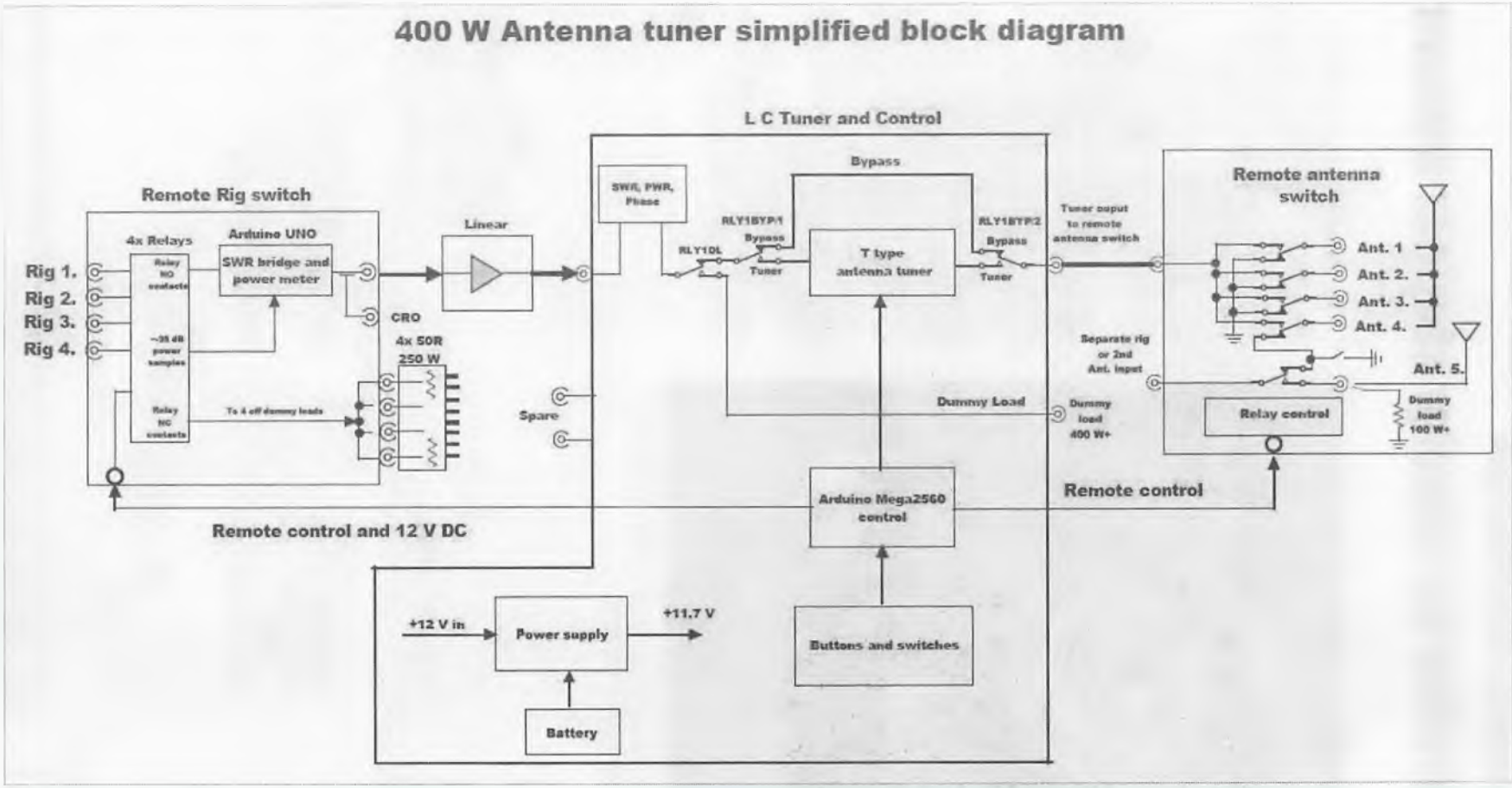


Figure 1. Block diagram of the antenna tuner

VK3AQZ's project is not "yet another tuner" – it features a twist, or two

Homebrew 400 watt T-network antenna tuner – Part 1

Luigi Destefano VK3AQZ

Photo 1. Antenna tuner front panel. Note the two knobs for hands-on tuning of the capacitors, the two analogue meters and the digital display.

This is a two-part article on a high-power antenna tuner I have designed and built.

The tuner is designed to handle 400 W of RF power and has a matching range from less than eight Ohms to more than 2000 Ohms. The variable T-network inductor is homebrew, as are the variable capacitors that use a common set of fixed plates. The project case is also homebrew, using commonly available aluminium sections and sheet.

Summary

This project is a high-power antenna tuning unit comprising a processor-controlled high-pass T-network. The variable inductance is a single eight-section (tapped) coil with tap selection controlled by an Arduino ATmega 2560 processor. The two variable capacitors are controlled by the same processor using stepper motors.

The homebrew variable capacitors use a common set of fixed plates, which are covered in Kapton tape to achieve a high flash over voltage rating.

The processor software provides nineteen memories. Each memory holds the values of L, C, radio number, antenna number, and the frequency used for those values. The values are displayed on a low-cost 16x4 LCD display.

Front panel controls include a rotary encoder, push buttons, and switches to adjust the various functions. The tuner contains dummy load and bypass switching. An internal SWR bridge samples forward and reflected power that is displayed on a pair of analogue meters. It also includes a phase discriminator that compares the phase between the RF voltage and current at the load.

Introduction

The foundation of the tuner is a high-pass T-network consisting of two variable capacitors in series in the top arm, and a variable inductor in the shunt arm. The basic circuit can be seen on the tuner's front panel in the photo here. The T-network is widely used in many amateur antenna tuners and features the ability to match a very wide range of impedances. [1]

Each of the variable capacitors is driven by a stepper motor. The multi-section inductor is switched by relays. The stepper motors and relays are controlled by an Arduino ATmega 2560 processor using software developed for my previous L-match tuner. [2]

As the T tuner can match a broad range of impedances, I conducted tests on my 80/40 metre band trap dipole, which achieved close to 1:1 VSWR from 160-10 metres. Tests on a 68 metre long-wire achieved comparable results. Both resistive and reactive loads were used in the tests.

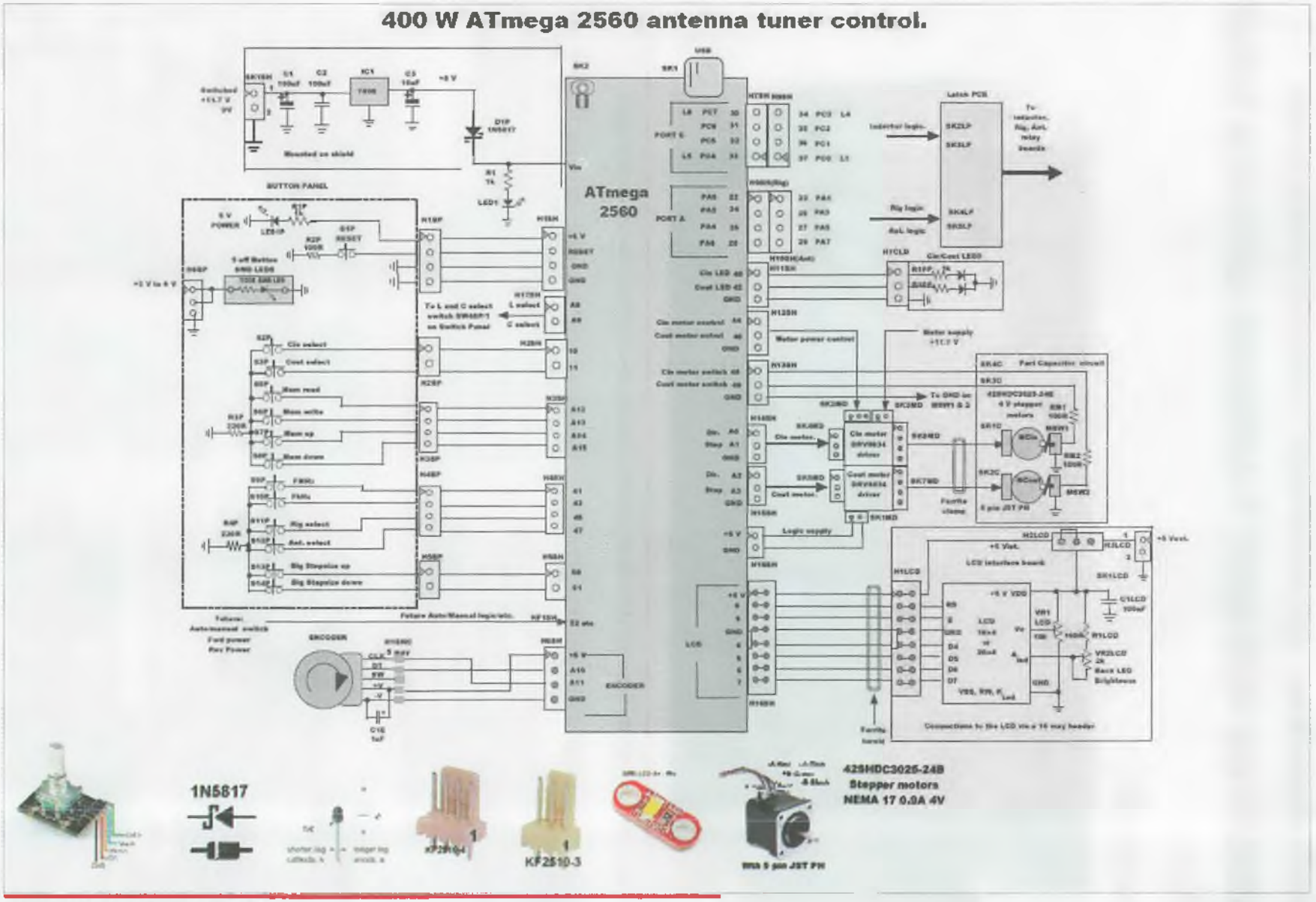


Figure 2. 400 W Tuner ATmega 2560 control.

The tuner is not automatic, but it can be upgraded for automatic operation with additional software. I prefer manually adjusting the tuner since I can react fast enough in the event of a problem.

When running high power, problems can be more spectacular and cause considerable damage. My experience with automatic commercial tuners has not been good due to the low speed of operation and the lack of a 'hands-on' feel.

Block diagram

A simplified block diagram of the tuner is shown in **Figure 1**. The main unit in the centre of the block diagram is the processor-controlled variable T-network.

The feed from the transmitter and the antenna switching are remotely controlled and these remote units were described in my previous L-match tuner article. This article focuses on the processor-controlled T tuner.

The processor

The brains controlling the tuner is an Arduino ATmega 2560 processor. The circuit diagram is shown in **Figure 2** and the component list is shown in **Table 1**.

Reference.	Value	Notes.
Main processor	Arduino™ Atmega 2560	
LCD interface. Small perf board holding parts and LCD module.		
LCD display	16x4, 20x4, etc	To suit Arduino, HD44780U or similar
C1LCD	100nf	Monolithic
H1LCD	2x8 pin PCB mount male boxed header.	
H2LCD	3 pin male PCB header	LCD power select
R1LCD	100R 5% 0.5W	
SK1LCD	KF2510-2	
Suitable strip conector to LCD module.		
VR1LCD	10k	Contrast
VR2LCD	2k	Back light brightness
Ferrite core	RF suppression ferrite split sleeve or toroid over cable.	
Button panel		
LED1P	3mm Red or Green LED	
LED2 to 7	SMD button LEDS	6V Red with 330R built in.
H1BP,H3BP,H4BP	KF2510-4	4 pin HF2510 polarised connetor
H2BP,H5BP	KF2510-2	2 pin
H6BP	KF2510-3	3 pin
R1P	1k 0.5W	
R2P	100R 0.5W	
R3P,R4P	220R 0.5W	
S1P to S14P	Momentary tactile push buttons clear tops	
Suitable prototype PCB with holes on 0.1" grid.		
Rotary encoder - mounted on front panel.		
Rotary encoder	Low cost 5 pin, 5V, with breakout PCB (threaded shaft).	
H6SH	KF2510-5	5 pin HF2510 polarised connetor
C1E	1uf	Across +V and -V on encoder.

Table 1. 400 W Tuner ATmega 2560 processor parts list.

The processor circuit is like my L tuner with the addition of two motor-driven variable capacitors instead of relay switched discreet capacitors. The processor is controlled using push buttons, switches, and a rotary encoder.

The LCD digital display presents the values of the variables, and the layout is shown in **Table 2**. The software functions and display are like my previous tuner so please refer to that article for more detail. [2]

Columns e.g. lcd.setCursor(column,row);

ROWS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	L		D	e	c	:		6	1	.		V	e	r	3	3
1	C		D	e	c	:		2	3	7		C	i	n		0
2	M	=	2			R	I	G	=	1		A	N	T	=	1
3	F	r	e	q	.			2	9	.	3		M	H	z	

Table 2. 400 W Tuner LCD display contents.

The tuner settings are stored in nineteen memories within the processor EEPROM. **Table 3** shows the EEPROM locations used by the variables.

Atmega 2560 EEPROM memory usage.

Memory number. Each variable occupies 2 slots.

0	
1	Display memory number
5	Start of each memory address
10	L value for memory number 1
12	C value for memory number 1
14	FMHz
16	FkHz
18	Cswitch value 1 or 0
20	Rig number 1 to 4
22	Antenna number 1 to 4
23	
To	Empty for future
29	

Slots 30 to 49	memory number 2
Slots 50 to 69	memory number 3
↓	
|	Memory 4 to 18
↓	
Slots 370 to 389	memory number 19

19 total memories each with 20 slots

Table 3. EPROM memory usage.

The connections to the processor are all made via a shield [3], which is like the one used in the L tuner. The main difference is the use of KF2510 polarised connectors to hook up to the various modules. The circuit is shown in **Figure 3**, the layout in **Photo 2**, and the components list in **Table 4**.

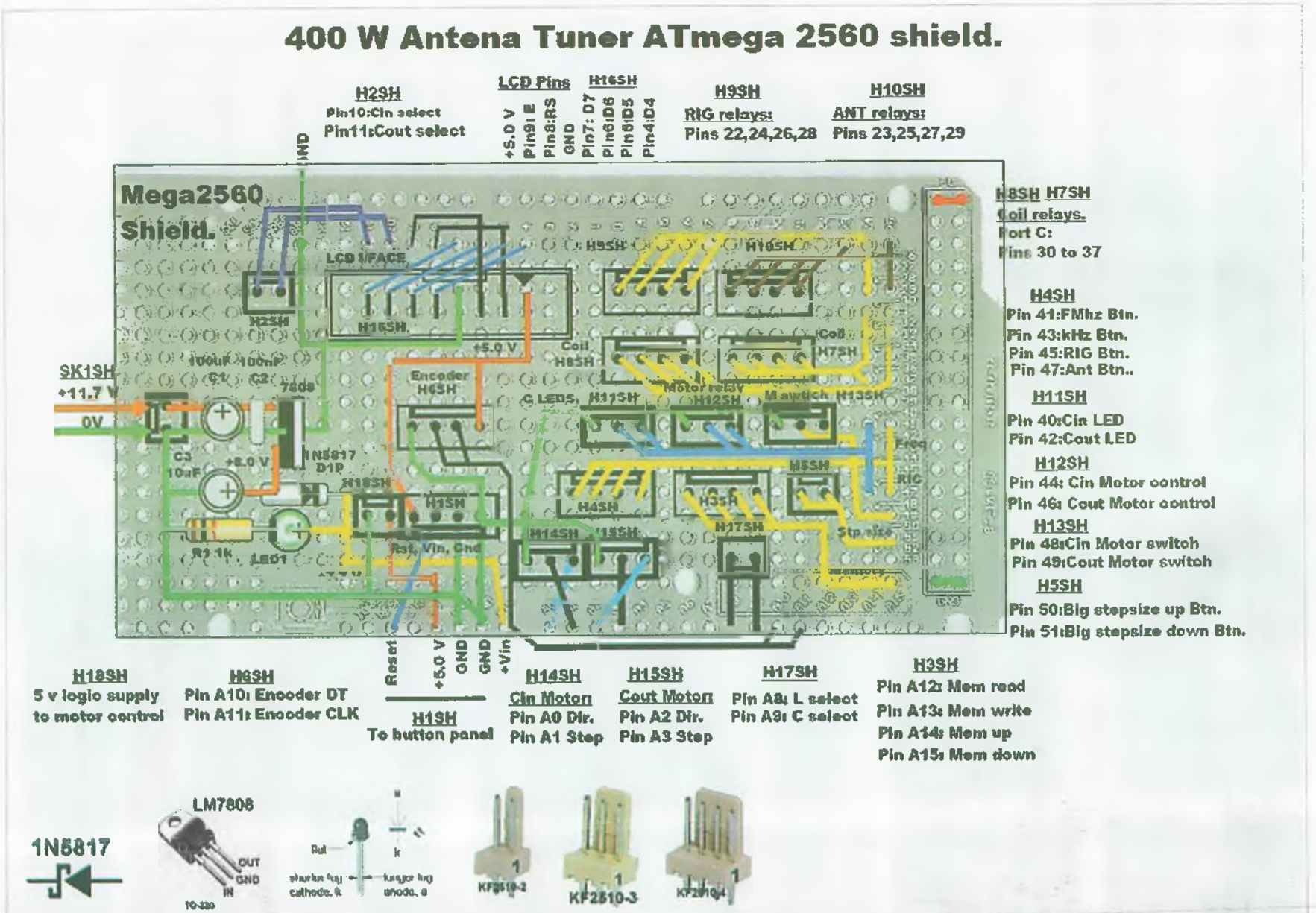


Figure 3. Arduino shield circuit diagram.

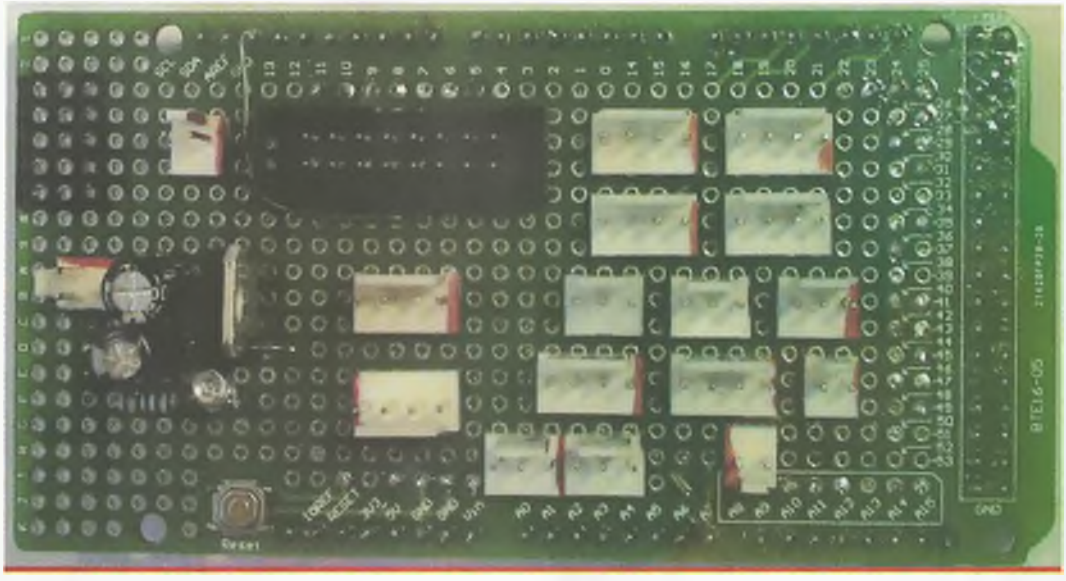


Photo 2. Arduino shield layout.

C1	100uF 25v	Electrolytic
C2	100nf	Monolithic or SMD
C3	10uF 25v	Electrolytic
D1P	1N5817	1A Schottky diode
IC1	LM7808	
LED1	3mm LED	
R1	1k 0.5W 5%	
SK1SH	KF2510-2	2 pin polarised connector DC input
H1SH,3,4,6,7,8,9,10,	KF2510-4	4 pin polarised
H2SH,5,18	KF2510-2	2 pin polarised connector
H11SH,12,13,14,15	KF2510-3	3 pin polarised connector
H16SH	2x8 pin PC male boxed header.	

Table 4. Arduino shield component list.

Reference.	Value	Notes.
C1L to C25L	100nF	SMD across relay coil, inputs, transitor bases,DC.
D1 to D8	LL4148	SMD across relay coil on PCB.
IC1 to IC8	PC817	Optocoupler 4 pin
Coils	See Table 3 for details.	
LED1L to LED8L	3 mm LED	
Q1L to Q8L	2N2222	NPN transistor
R1L to R22L	3k3 0.5W 5%	Every third resistor - inputs
R2L to R23L	1k5 0.5 W	Even third resistor -base to earth
R3L to R24L	1k5 0.5 W	Even third resistor - to LED
SK1L,SK2L	KF2510-4	4 pin polarised connector drive inputs
SK3L	KF2510-2	2 pin polarised connector DC input
RLY1 to 8	SPDT, 12 V, 10 A	OMI-112-D or any 12V coil/10amp contacts with a 240V AC contact switching rating

Table 5. Arduino shield component list.

Photo 3. View of the complete inductor mounted in the case. Note the relay board mounted immediately under the inductor. This enables short, direct connections to the inductor sections.

The variable inductor

The shunt component in the T-network is a multi-turn inductor (L1 to L8) comprising eight sections on a 190 mm length of 43 mm diameter PVC pipe. Sections of the inductor are switched in and out using relays controlled by the Arduino. The logic and software used to control the inductance is identical to my L tuner project. [2] The circuit of the variable inductor is shown in **Figure 4**, **Table 5** lists the components, and **Table 6** (in **Figure 4**) lists the coil information.

The smallest section of the inductor is 0.1 uH, while the next section is 0.2 uH. Each section is twice the previous section value, forming an eight-bit binary sequence. The largest section is 12.8 uH. There are 255 combinations, from 0.1 uH adding up to a total of 25.5 uH.

The eight relays involved are activated from Port C of the Arduino processor; the details are the same as my L tuner. **Photo 3** shows the inductor mounted in the case.

The variable capacitors

The circuit of the variable capacitors (Cin and Cout) is shown in **Figure 5**. The tuning unit contains two homebrew variable capacitors driven by stepper motors. The variable capacitors form the top arm of the T-network. Since the two capacitors are in series, they use a common set of fixed plates. This saves space and materials.

The variable capacitors are made from 0.5 mm flat aluminium sheets I bought at the local hardware store. The fixed plates consist of 24 rectangular pieces 80 x 80 mm. Each capacitor contains 24 semicircular movable plates, also made from pieces of 0.5 mm thick aluminium.

The 24 aluminium sheets, each 100 x 80 mm, are clamped together. The 80 mm diameter circles are scribed on the sheets with the centres about 15 mm apart.

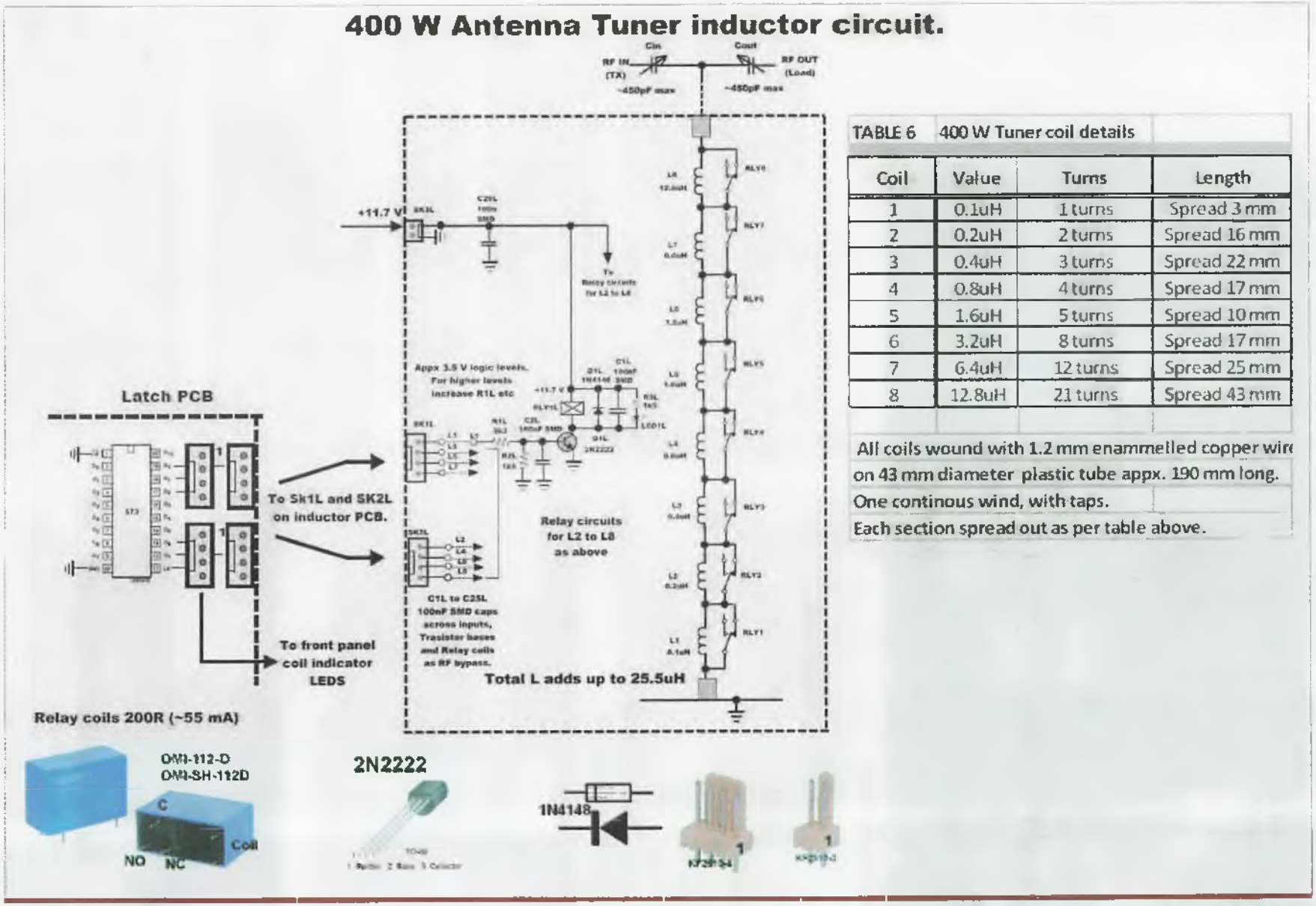


TABLE 6	400 W Tuner coil details	

Coil	Value	Turns	Length
1	0.1uH	1 turns	Spread 3 mm
2	0.2uH	2 turns	Spread 16 mm
3	0.4uH	3 turns	Spread 22 mm
4	0.8uH	4 turns	Spread 17 mm
5	1.6uH	5 turns	Spread 10 mm
6	3.2uH	8 turns	Spread 17 mm
7	6.4uH	12 turns	Spread 25 mm
8	12.8uH	21 turns	Spread 43 mm

All coils wound with 1.2 mm enammelled copper wire on 43 mm diameter plastic tube appx. 190 mm long.
One continous wind, with taps.
Each section spread out as per table above.

Figure 4. Inductor circuit.

Holes, 6 mm in diameter, are drilled at the centres and bolts used to hold them together. Additional clamps are used at the edges. The corners are cut back and filed to the circle edges.

The plates are cut down the centre to form two sets of semicircular plates with a 6 mm hole at the centre. I cleaned up and rounded the edges, and any surface damage was flattened out. The 0.5 mm aluminium is really a little thin for the movable plates, and in future I would use something slightly thicker. **Photo 4** shows the finished variable capacitor construction.

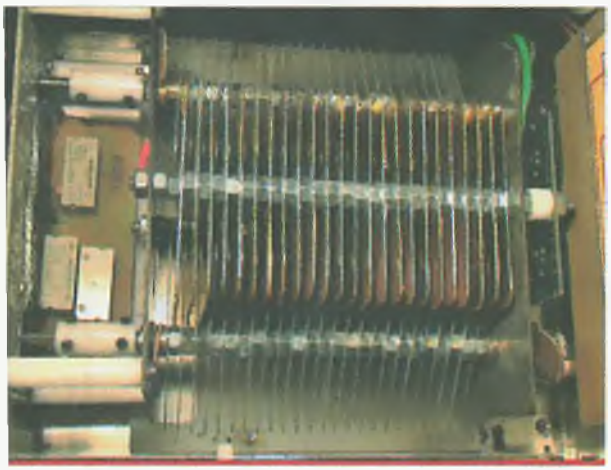


Photo 4. View of the homebrew variable capacitor arrangement installed in the case. The fixed plates common to Cin-Cout are seen here at the top. The two sets of variable plates are seen below.

The capacitors are assembled using 6 mm threaded stainless steel rods with the plates separated by 6 mm zinc-plated or stainless steel nuts. The measured capacitance limits of either are between 35 pF at minimum and 450 pF at maximum.

The resulting air gap with this construction is around 1.2 mm between the fixed and moving plates. A 1 mm spacing between two metal plates in dry air has a breakdown voltage of around 3.3 kV. Based on designs in various publications, a figure of around 5 kV should be adequate for this T-network application.

In the event that the moving plates get too close to the fixed plates, I covered the fixed plates in Kapton tape that has a voltage rating of 6.5 kV [2]. Tests I made using an electric fence controller and a tube linear power supply could not puncture the Kapton tape.

The variable capacitors will have high RF voltages on them with respect to earth. The capacitors are mounted on an insulated base, insulated couplers connect the stepper motors and the front panel knobs are insulated from the shafts. The couplers need to manage the high voltages occurring on the capacitors.

Double-sided copper clad circuit board material is used to support the fixed plates and the shafts of the rotating plates. Bushes taken from potentiometers with 6 mm shafts are used as bearings and washers ensure the shafts are not loose. Spring metal strips on tapped brass spacers at the ends of the shafts ensure good electrical contact between the shafts and the circuit connections.

The stepper motors have good bearings, which helps the shafts turn true. The couplers need to be accurately made to ensure there is minimal wobbling. The couplers are made from 12 mm Delrin rod [5], which is tapped to match the 6 mm threaded shaft rods and drilled 5 mm to match the stepper motor shafts. Sufficient separation between the threaded section and the motor holes ensures a high voltage rating. Tapping the couplers improves the accuracy of the connection and a couple of 4 mm grub screws lock the couplers to the shafts.

The variable capacitor assembly also contains microswitches actuated by levers on the rotating shafts. The processor needs to know the location of the moving plates to store that location in the memory. The microswitch determines the position of the variable plates at the minimum value of capacitance.

A logic low from the microswitches represents the minimum capacitance value. Optical detectors or solid-state sensing were avoided in this area due to the potential levels of RF. The software contains an offset value that can be changed for any positional errors of the microswitch.

The fitted NEMA 17 stepper motors (SM1 and SM2) are rated at 4 VDC @ 0.9 A. They rotate 1.8 degrees per step, resulting in two hundred steps for a full rotation. To increase the steps, low voltage DRV8834 controllers (Module 1 and Module 2) drive the stepper motors.

The controllers are capable of micro stepping up to 1/32. Jumpers on the controller are set at one-quarter stepping resulting in eight hundred steps per half rotation. Each step produces a capacitance change of around 0.5 pF.

When dealing with high powered tuners, the finer the control, the more accurate the result. My L tuner was designed to manage 100 W with a minimum step value of 5 pF and that was good enough for that power level. This tuner is designed to manage 400 W so the capacitors in this design need a good high voltage rating and finer control. The use of air-spaced variable capacitors can achieve this.

The processor needs only to send 'step direction', and 'move one step' logic to the DVR8834 controller, and the controller manages the rest of the motor functions.

Small trim-pots on the controllers limit the current to the stepper motors and the installed stepper motors are limited to 0.6 A. At the completion of a step, the motors will lock in position while power is applied. However, that means current is flowing in the coils of the motors.

The controllers have an enable input that is controlled by the processor. Software controls the enable input to remove motor power after five seconds.

The stepper motors can also move one step at a time using the front panel rotary encoder or 10 steps using push buttons. Steps moved are stored in the memory and displayed on the LCD. These attributes can be recalled

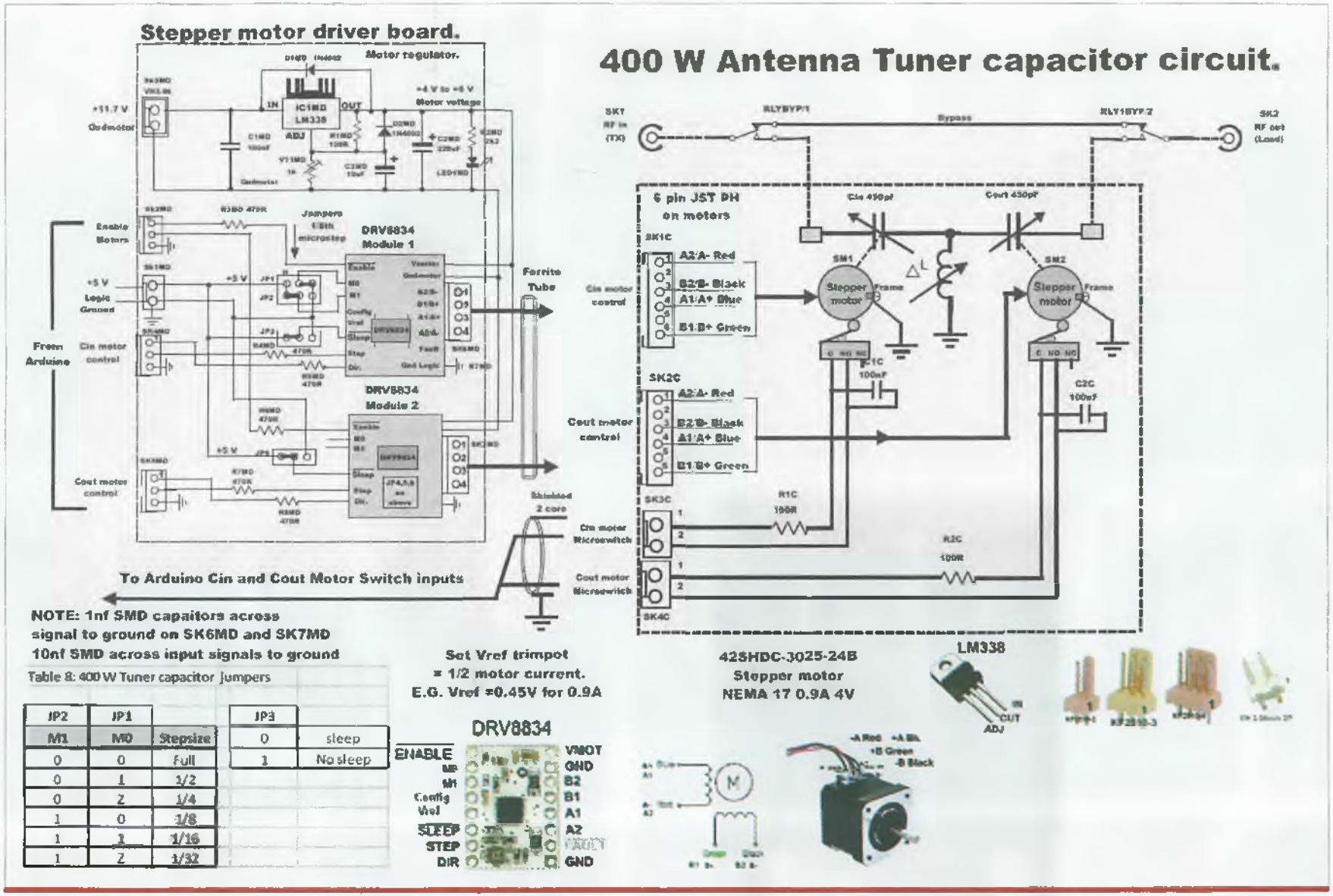


Table 8: 400 W Tuner capacitor Jumpers

JP2	JP1		JP3	
M1	M0	Stepsize	0	sleep
0	0	Full	1	No sleep
0	1	1/2		
0	Z	1/4		
1	0	1/8		
1	1	1/16		
1	Z	1/32		

Figure 5. Circuit of the series-connected Cin-Cout capacitors' drive and control.

rom memory along with the inductance value, frequency, ntenna, and radio used with those tuner settings. The epper motor controlling circuit is shown in Figure 5.

In Part 2, I will address the other components and onstruction of the antenna tuner.

leferences and Resources

] For an excellent treatment of the theory and the development of the 'I' tuner, I refer you to an article by James C Garland, W8ZR, [1], titled "*The EZ-Tuner*". The article contains a short history of the T tuner, followed by information on the selection of the components and performance figures. The article includes a processor-controlled design capable of handling the legal power limit in the USA. A second article by Andrew S. Griffith, W4ULD, [2], titled "*Getting the Most Out of Your T-Network Antenna Tuner*" derails methods used to adjust a T tuner for the best performance.

[2] L. Destefano, VK3AQZ, "The VK3AQZ HF antenna tuner Project Part 1", *Amateur Radio*, WIA, 2021 Vol. 89 No. 3, pp. 20-25

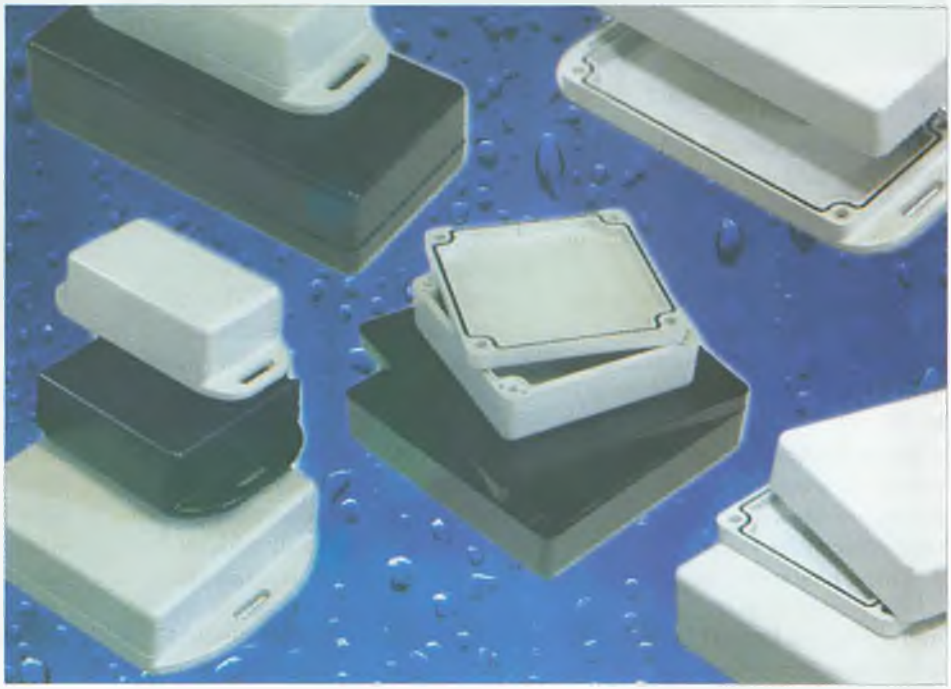
[3] A shield is a plug-in board mounted on top of the Arduino processor board.

[4] Kapton is a polyimide film developed by DuPont in the late 1960s that remains stable (in isolation) across a wide range of temperatures, from -269 to +400 C. Kapton is used in, among other things, flexible printed circuits (flexible electronics) and space blankets, which are used on spacecraft, satellites, and various space instruments (Wikipedia).

[5] Delrin (polyoxymethylene), also known as acetal, polyacetal, and polyformaldehyde, is an engineering thermoplastic used in precision parts requiring high stiffness, low friction, and excellent dimensional stability (Wikipedia).

rade Showcase

ew cases feature 68 seals



leased in the third quarter ast year, a range of plastic ses for housing electronics suitable for use inside or tside, being made from 94-V0 polycarbonate. pplied by Hammond ctronics, the new cases dubbed the 1551W Series, ng IP68-sealed versions ts popular 1551 miniature closure family.

They are available in black l grey with a soft texture sh, all are fitted with PCB nd-offs in the base and the formed silicone sealing ket provides excellent tection against the ingress of dust or water, protecting the ised electronics, according to Hammond.

The initial five sizes range from 60 x 35 x 22mm to 100 x 59 x m. The flanged lid versions make mounting to any surface mple and easy process and provide a degree of tamper stance by preventing access to the lid and base securing ews.

The rectangular and round vented 1551V versions are designed ouse sensors and small sub-systems. One of their key features is the snap-fit closure that allows repeated opening and closing without tools and also maximises the internal space for PCBs by eliminating screw fixings to secure the cover to the base. They feature ventilation slots on all four vertical faces of the cover and wall mounting slots plus a 15mm cable knock-out in the base. Unvented versions are also available.

Contact Hammond Electronics Pty Ltd, Queenstown SA 5014. www.hammfg.com.

Link it and sling it, then get on-the-air

The PLD – a portable linked dipole

Justin Giles-Clark VK7TW

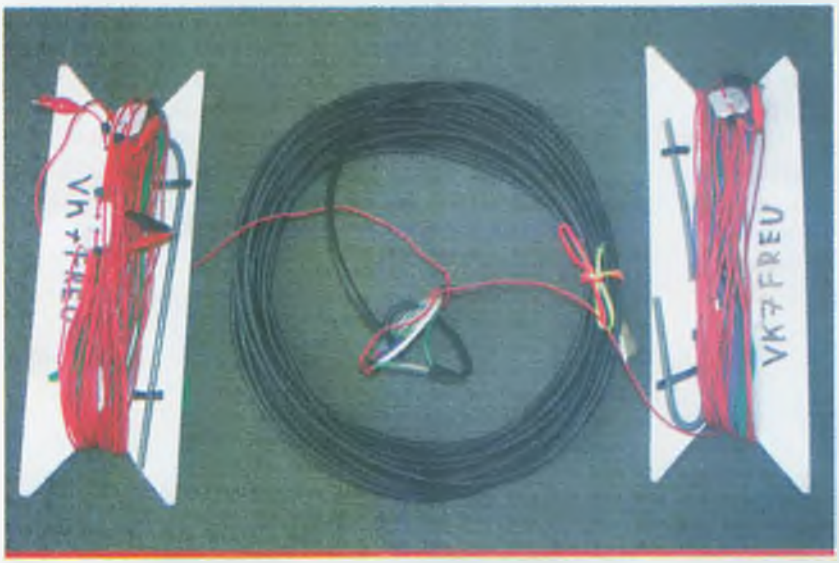


Figure 1. Foundation licence linked dipole, for the 80/40/15/10 metre bands.

Going portable for a SOTA- POTA-WWFF or field day activation can be great fun! This is about my journey with linked dipoles and operating in the great outdoors.

When I began SOTA activations in 2014, it was the start of my portable antenna experimentation with a centre-loaded vertical design by Phil VK7JJ [1]. This evolved into a linked dipole design, primarily to reduce the weight of the antenna and to provide a few S-points improvement for marginal signals.

I use a nine metre long fibreglass fishing (or squid) pole [2] as a centre support for my linked dipole as well as for supporting a vertical antenna.

To carry the fishing pole, I have stuck single-sided velcro tape around it to line up with the straps on my backpack. The fishing pole is then velcro'd with 300-400 mm lengths of double-sided velcro tape, hooks on one side and loops on the other. Rolls of this tape are available cheaply from suppliers on the internet. These double-sided velcro tapes are very handy to velcro the fishing pole base to a tree or trig point.

The first linked dipole that my son Reuben VK7FREU and I built was a four-band HF antenna covering the common SOTA calling frequencies on the Foundation licence HF bands of 80/40/15 and 10 metres.

We originally began with the SOTABeams Spreadsheet for calculating the four-band linked dipole. This spreadsheet has evolved into an applet (a small software application) that is available from the SOTA Beams website: www.sotabeams.co.uk/linked-dipoles/

The starting link lengths for a Foundation-bands linked dipole are as follows:

Band	Centre frequency	Starting length – each pole
80m	3.56 MHz	9,960 mm
40m	7.09 MHz	669 m
15m	21.25 MHz	850 mm
10m	28.51 MHz	2,500 mm
Total Length: 20m – 10m each side		

The original dipole feedline we used was RG-58, as seen in Figure 1. However, this proved to be overly heavy for the fishing pole and also added a couple of kilograms to the backpack! We changed over to using RG-174 coax feedline on subsequent dipoles. This results in a linked dipole weighing less than a kilogram

Figure 2. Dipole centre and strain relief.

The centre strain-relief, link insulators and the dipole winders were all made from high density foam adverting board, which is very light weight and the price was right – free, as it can be sourced from your local resource tip shop! The coax is threaded through multiple holes to provide strain relief and cable ties are used to strain-relief each dipole wire segment.

The centre strain relief is cut with a hole saw, with holes drilled in the centre and around the edge. The centre hole diametre determines how far down the fishing pole segment it sits. I have found from experience to avoid the first thin fibreglass segment and sit the centre strain relief on the second fibreglass segment.

The linking segments are small

jure 3. The linked dipole linking arrangement - first design.

ctangular insulators made from the me advertising board. Originally, e used small alligator clips that are adily available from Jaycar and her retailers.

This worked OK for a few onths. However, these alligator ps rust due to rain and moisture. arren VK7WN suggested using ld-plated radio control power connectors. These proved to be a fantastic replacement and have survived many SOTA activations so long as you place heat-shrink over the soldered connection on each connector. These connectors are readily available via many internet outlets – just search for "2 mm gold-plated Banana Plug Connector RC".

I rapidly realised that I needed to expand my original four-band linked dipole to remove the 80m band, shorten the dipole and cover all bands from 40m to 6m.

The shortening of the dipole has proven to be helpful in many mountain top activations where there is a lack of physical space to tie-off the legs of the dipole.

ure 4. Linked dipole linking - revised design. Inset - the male and female nector parts come from RC suppliers.

I added workbooks to the original SOTABeams Spreadsheet to cover up to eight bands and made it available on my *VK7TW Blog* site [3].

Band	Centre frequency	Starting length - each pole
40m	7.09 MHz	2,960 mm
30m	10.13 MHz	1,880 mm
20m	14.31 MHz	970 mm
18m	18.13 MHz	590 mm
15m	21.25 MHz	350 mm
12m	24.98 MHz	370 mm
10m	28.51 MHz	1,080 mm
6m	52.2 MHz	1,230 mm
Total Length: 9.43 m each side		

SOTABeams now has an Applet on its website [4]. However, it only allows you to calculate up to six bands.

Assembling your Linked Dipole

A/ Start by soldering connectors to only one end of all segments except the highest frequency segment.

B/ Tie-off or cable tie each end of the two highest frequency segments to the centre insulator.

C/ Thread the feedline coax through the centre insulator strain relief holes (see Figure 2) and terminate and solder your coaxial ends to each wire of the two highest frequency segments.

D/ Terminate your coaxial connector of choice on the other end of the feedline.

E/ Tie the other end of each segment with a half hitch to an insulator (don't cable tie it or solder a connector onto it, as this is the end you will be adjusting the length for each segment).

F/ Permanently tie the next segment (with connector on it) to the insulator.

G/ Repeat for all segments.

H/ On the final insulator tie 6-8m of good quality cord (the Author used fluorescent brick layers cord so you can easily see it in the bush).

I/ Find a suitable location (I use my local park) to setup,

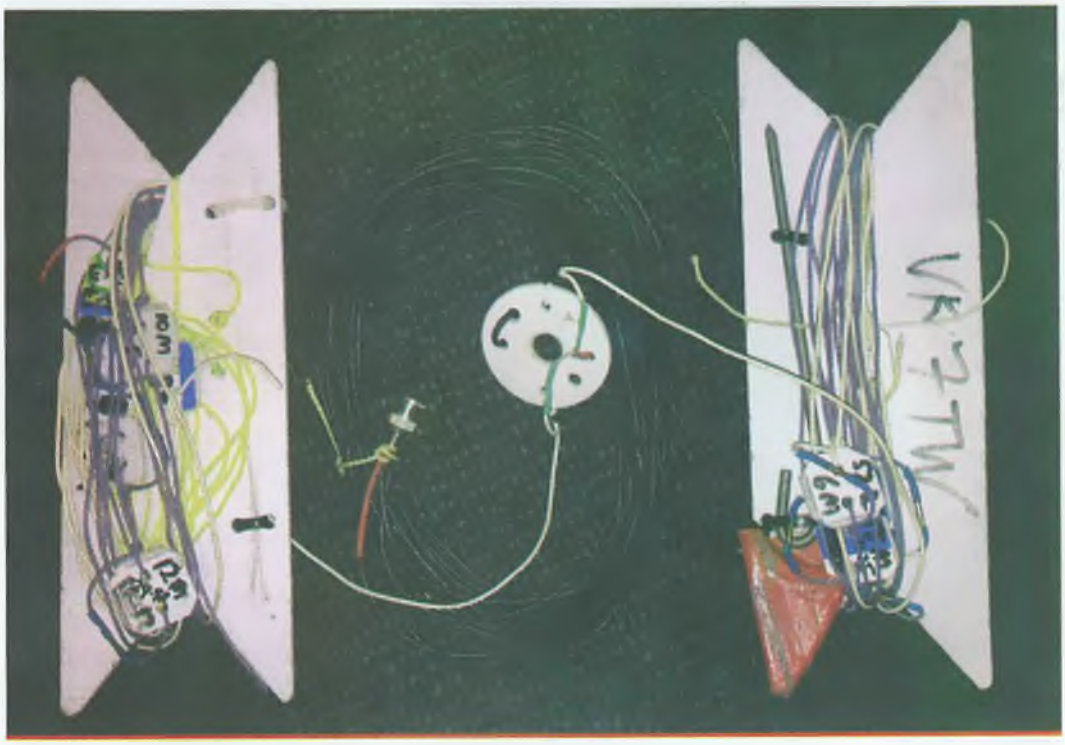


Figure 5. Well-loved and used PLD – the *VK7TW 8-band SOTA linked dipole.*

unobstructed, your fishing pole and dipole, ready for tuning.

Tuning your linked dipole

1/ Start with the highest frequency segments and use your preferred method for determining SWR at the frequency in question – this could be a transmitter with SWR meter, a NanoVNA, or an antenna analyser.

2/ Do a short test transmission, or connect your analyser and set suitable upper and lower test frequencies and see if the segment under test is too long (frequency too low) or too short (frequency too high).

3/ If too long – lower the fishing pole and undo the half hitch on the insulator, then shorten the segment (100 mm) – winding the excess back along the segment under test.

4/ If too short (which is unlikely) – lower the fishing pole and undo the half hitch on the insulator, solder on another short segment (100-200 mm), then retie to the insulator.

5/ Raise the fishing pole back to full height and run the test again.

6/ Repeat if necessary, until the frequency and low SWR combination is achieved.

7/ Now you have that segment length correct – solder the opposite connector on the end of the segment under test and connect to the next segment.

8/ Start back at number one and test the longer segment for the second highest frequency.

9/ Repeat the sequence for each frequency until you get to your lowest designed frequency.

Once this is completed, you have a pre-tuned dipole with no need for an ATU, unless you operate significantly outside the design frequencies.

Given the QRP power levels (<10 watts) that I used, I decided not to put a Guanella 1:1 balun in the mix as I have had no appreciable issue with RF coming back down the coax outer shield. If you are running higher power/s, then I suggest adding a balun at the centre strain relief ring.

I also put son cable ties on the dipole winders and mounted a light duty tent peg on each in case a suitable tr or bush can't be found to tie-off the dipole ends.

A little advic

I will finish with a word of advice that comes from son disappointing SOTA activatio When preparing for an activatior do a quick check of your linked-dipole (and equipmen to ensure links and critical connection points, like the centre strain relief coaxial transition, are a in order and don't need some TLC before taking them outdoors.

Resources

[1] VK7JJ – Phil Barnard centre loaded vertical design – http://perite.vk7jj.com/vk7jj/squidpoles.html

[2] Fishing or Squid Pole – Haverfords: https://haverford.com.au/collections/telescopic-squid-po – enter VK3YE into the discou field and get a further 10% off Thanks Peter!

[3] VK7TW Blog Site – https://vk7tw.wordpress.com/2015/01/26/vk7tw-linke dipole-experiments/

[4] SOTABeams Linked Dipole Applet – www.sotamaps.org/extras

Making and measuring the 2m Yagi

Antenna Modelling using 4nec2 – Part 5

Gregory Mew VK4GRM and Michael Barbera

This article is the promised continuation of the *Antenna Modelling using 4nec2* series published over 2022. In Part 4 (Vol.90, No.6 2022), we looked at modelling a 5-element Yagi and optimising it to achieve a low VSWR over 144-148 MHz. In this final part of the series, we describe construction of that 5-element Yagi and measuring its parameters.

2m dipole

In the process of developing the 5-element Yagi, we started with a single dipole that was also optimised to provide a 50 Ohm impedance at 146 MHz. The .nec file for this dipole after optimisation is shown in **Figure 4-15**, and the results of the optimisation in **Figure 4-16** and **Figure 4-17**.

From the model to the real world

To complete this paper, we built both the 2m dipole and the five-element Yagi using the dimensions determined by 4nec2 (shown in **Figure 4-12** and **Figure 4-15**) and tested the resulting antennas. A DG8SAQ Vector Network Analyser (VNA) (from the UK-based SDR-Kits, www.sdr-kits.net – Ed.) was used for the field testing.

Calibration of the VNA

In an attempt to ensure that a balanced load was applied to the Driven Element, a 1:1 common mode balun was initially fabricated and installed at the feedpoint of both of the antennas. Some significant testing was conducted on the balun to determine its common mode rejection ratio. In the end, this was replaced with a simple BNC connection directly to the antenna feed point, as the antenna was designed for 50 Ohm impedance. The slight skew in the radiation pattern that may result from this approach was ignored.

The termination is shown in **Figure 4-18**. This was also used for testing the 2m dipole. This approach makes it simple to calibrate the 50 Ohm SMA-to-BNC test lead at the antenna end with BNC 'Short', 'Open' and 'Load' calibration standards that move the reference point to the antenna termination.

The authors of this series of articles are shown in **Figure 4-19** during testing of the 5-element Yagi. At this stage, we were testing with the 1:1 balun in place.

Five-element Yagi

As the initial testing with the balun was not very successful, the Yagi was retested and the results of the VNA test for the 5-element Yagi are shown in **Figure 4-20**. A comparison of the Reflection Coefficient between the 4nec2 and the VNA results is shown in **Figure 4-21**.

While the measured VSWR is not as low as that modelled, the results are less than 1.43:1 across the band, as shown in **Figure 4-20**. Typically, they are better than 1.26:1 for most

2mDipole.nec - Notepad

Edit Format View Help

```
CM 2m Dipole
CM Simple 2m dipole
CM Dipole is in free space
CM Bandwidth 144 to 148MHz
CM
CE
' FREQ=146                    'Centre Frequency
' WL=300/FREQ                 'Wavelength is 300/Frequency
' DIPOLE_LENGTH=0.952443      'Start dipole length 0.5 x WL
' WIRE_RAD=0.5*10E-3          'Dipole Radius
' HEIGHT=0

GW    1       29      0       -DIPOLE_LENGTH/2        HEIGHT          0       DIPOLE_LENGTH/2         HEIGHT          WIRE_RAD

GE    0

GN

GM    5       0       0       0       3.69E+07                'Set all materials to aluminium

EX    0       1       15      0       1       0
FR    0       41      0       0       144     0.1
RP    0       361     361     1000    0       0       1       1
```

Figure 4-15. 2m dipole – optimised solution.

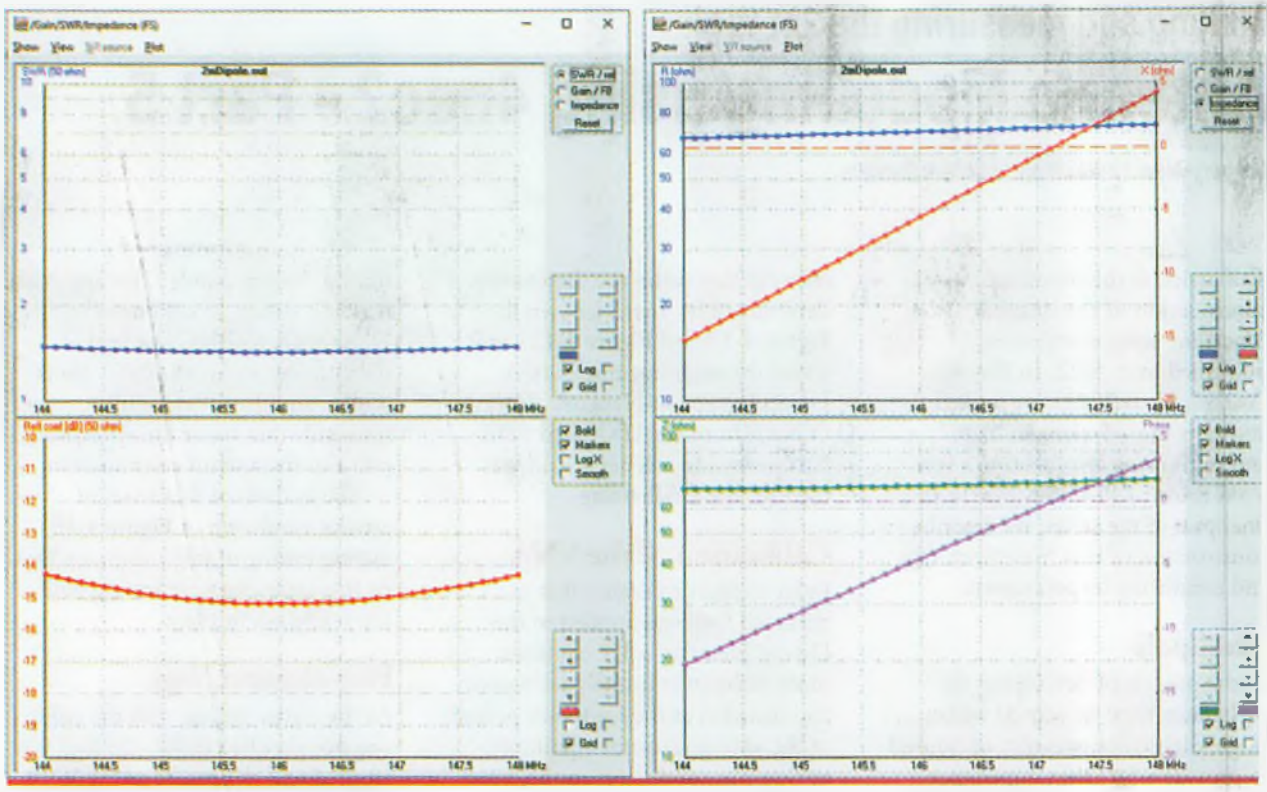


Figure 4-16. 2m dipole - return loss and impedance.

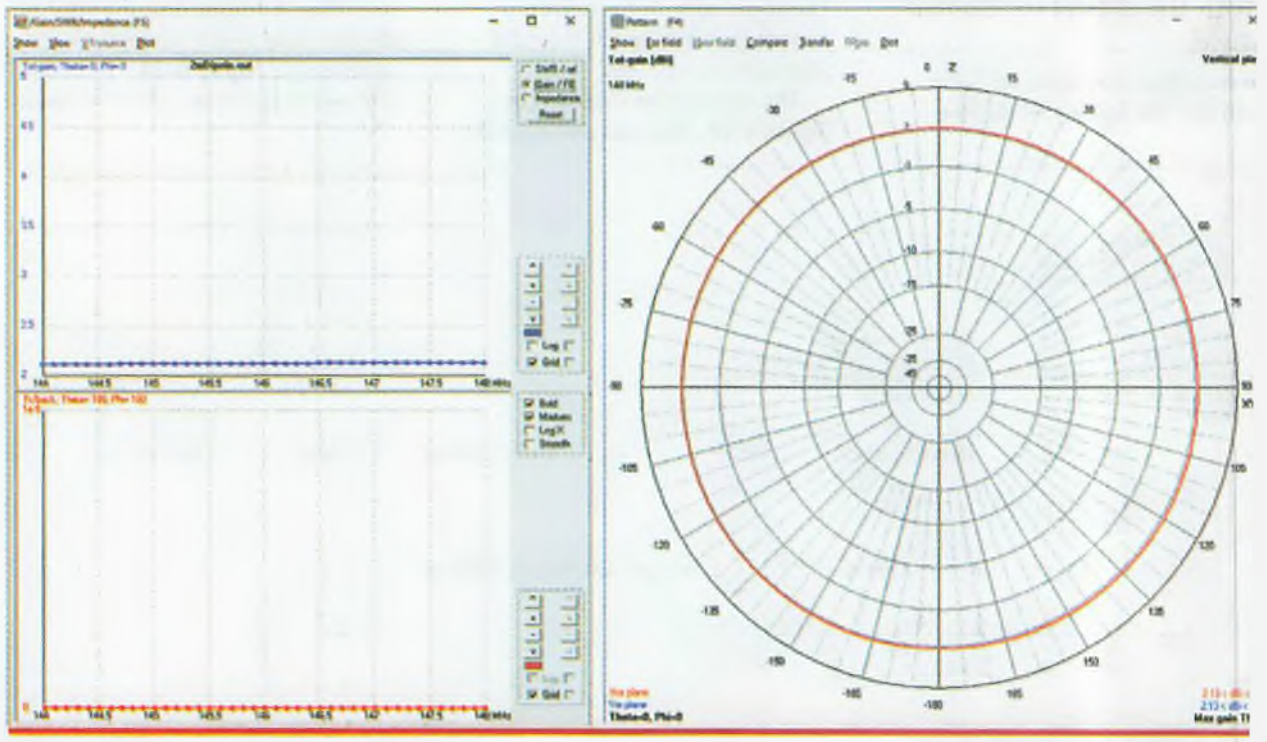
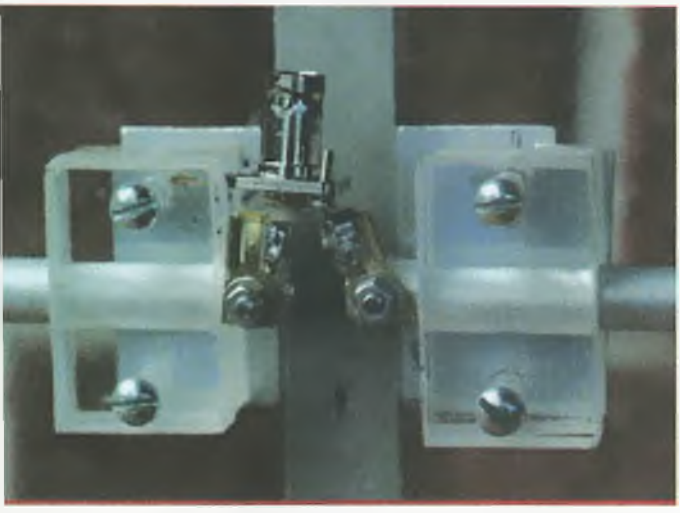


Figure 4-17. 2m dipole - gain and radiation pattern.



igure 4-18. Driven element termination – a BNC socket, right at the feedpoint.

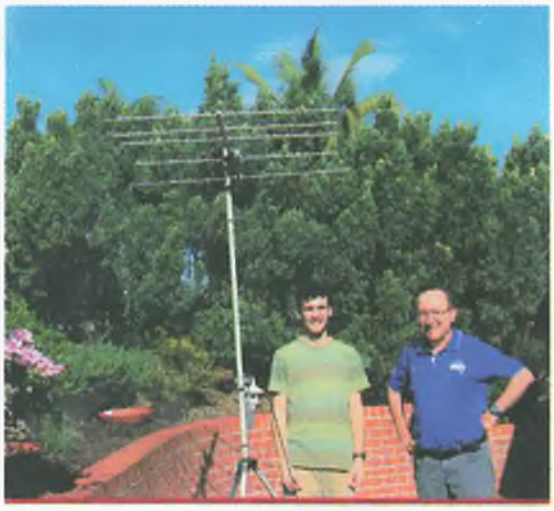


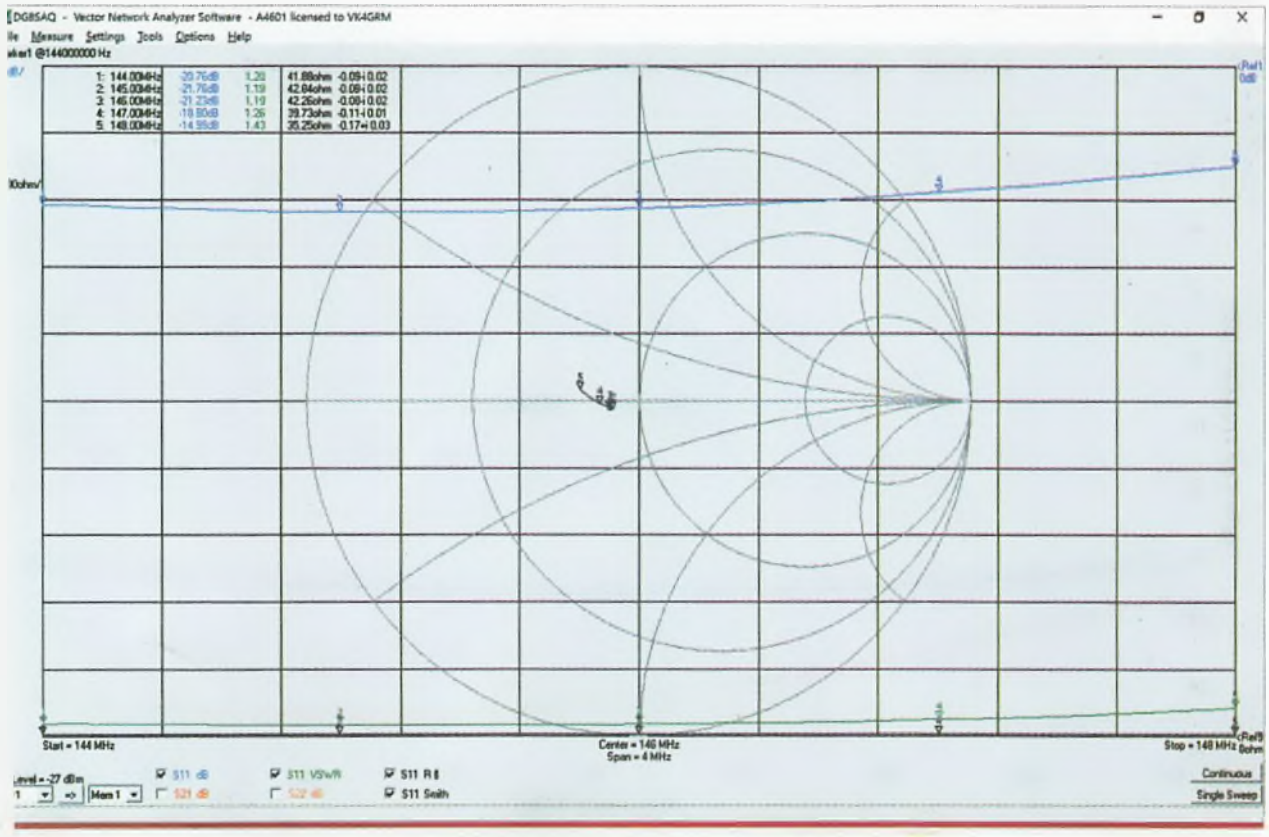
Figure 4-19. The authors during testing the 5-element Yagi; left to right Michael and Greg (VK4GRM).

f the band. This probably indicates hat some more effort is required to nake sure that all dimensions and lement orientations are fine-tuned a it more.

2m dipole

The results of the VNA test for the 2m dipole are shown in **Figure 4-22**. A comparison of the Reflection Coefficient between the 4nec2 and the VNA results is shown in **Figure 4-23**.

The results shown in **Figure 4-23** display a much better correlation than those of **Figure 4-21**. It is anticipated that this is due to the much simpler antenna structure –



gure 4-20. VNA measurement of the 5-element 2m Yagi's characteristics. Apologies for the small type size.

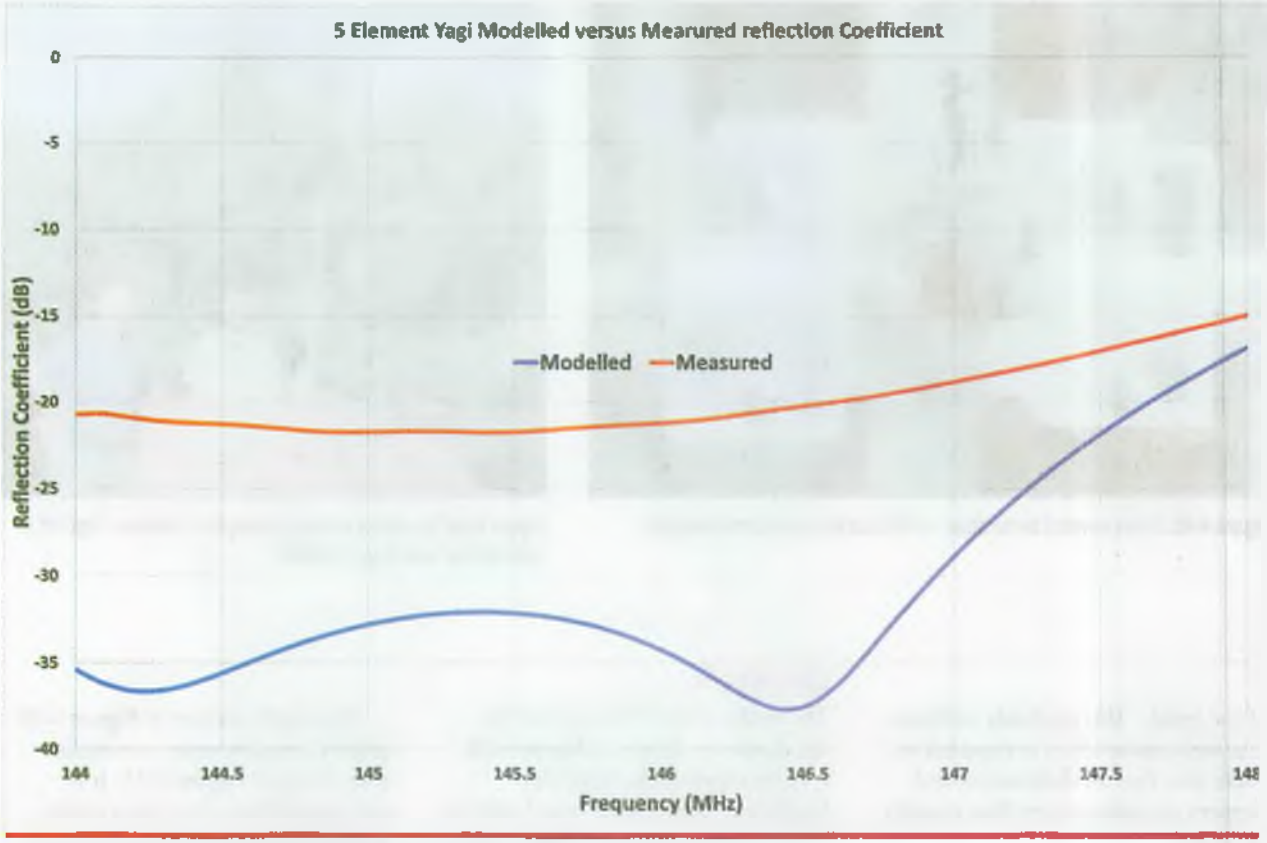


Figure 4-21. Comparison of NEC vs VNA Reflection Coefficient for the 5-element 2m Yagi.

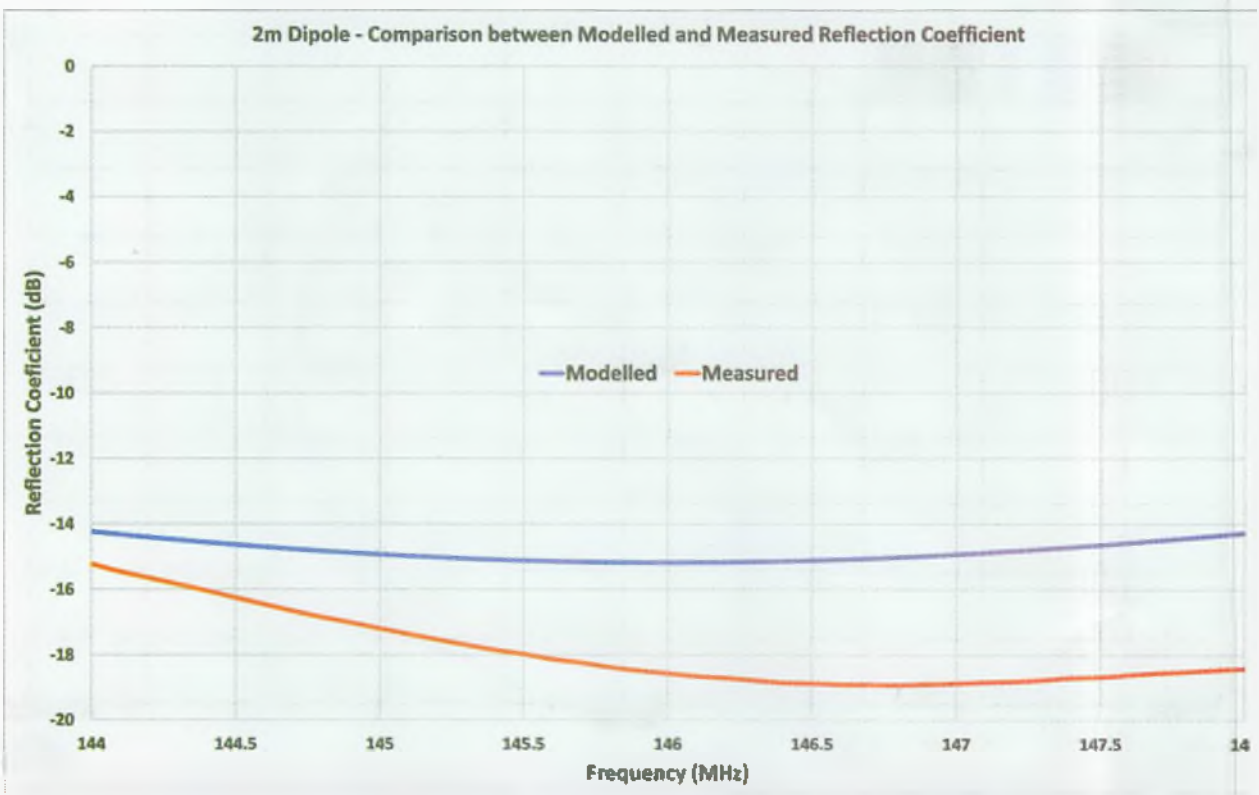


Figure 4-23. Comparison of NEC vs VNA Reflection Coefficient for the 2m Dipole

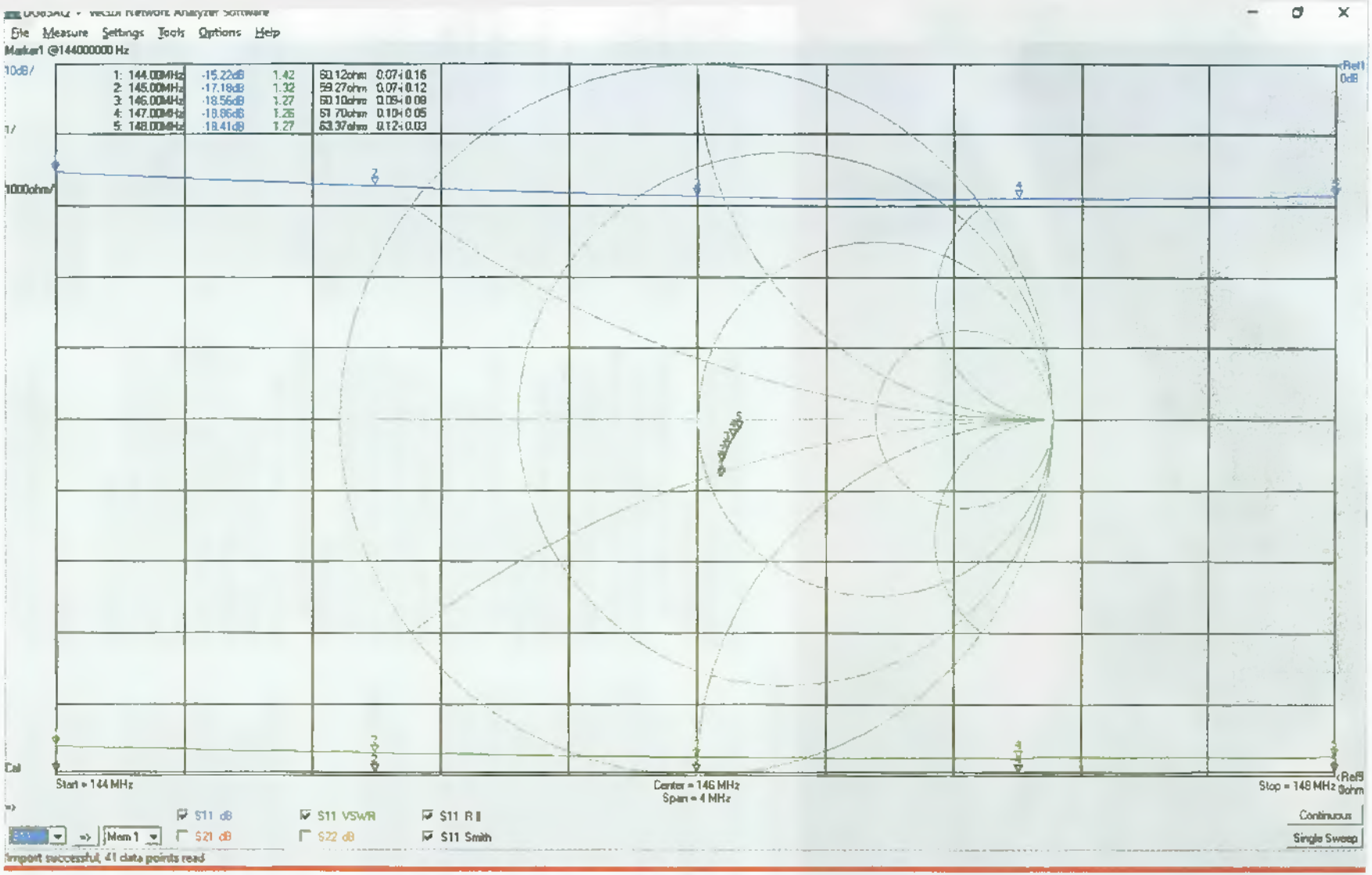


Figure 4-22. VNA Measurement of the 2m dipole.

Figure 4-24. The test range for the revised testing.

just a dipole that we had to cut to the correct length.

The 5-element Yagi has five elements that need to be the correct lengths and have the correct separation distances. Further, the elements need to be parallel and in the same plane. The Yagi was fabricated using a drill press and taking as much care as possible. The results are as good as can be expected from any ham's workshop. On the 2m band, small changes can have a significant effect on the results that are obtained.

The revised test range for the second set of tests is shown in Figure 4-24.

Conclusion

That concludes this series of articles. As has been shown in this article, the results that 4nec2 give for a simple dipole can be quite accurate. However, the more complex the antenna, the greater the divergence from the results, at least in the 2m band.

For simple antennas in the HF band, the error tolerance associated with dimensions is much greater. But, the effects of the Earth become more significant and this becomes another unknown.

The main benefit of using 4nec2 for antenna modelling is that the electronic model will get you much closer to the final answer quicker than can be achieved with the cut-and-try methods that have been used in the past.

Also, by adjusting the dimensions of your antenna, you can look for effects that can enhance its performance in the ways that you want it to. In the examples shown, the antennas were optimised for 50 Ohm feedpoint impedances and not antenna gain.

We hope that this series of articles has helped you to understand the benefits that can be gained by modelling your antennas. There are many features of 4nec2 that have not been covered in these articles, so the interested reader is encouraged to review the references and also what is available on the web.

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gmew54@gmail.com

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34	VK3FZ	Roger Stafford	Open

XCC Multi-band (3)

#	Call	Name	Mode	Band	Count
27	VK3TU	Albert Gnaccarini	Open	20-15-10m	454
28	DJ7ZZ	Thorsten Meirich	Open	20-15-10m	490
29	DJ7ZZ	Thorsten Meirich	Phone	20-15-10m	468
30	VK3HJ	Luke Steele	Digital	30-20-17m	428
31	VK4TW	Robert Waegele	Open	20-17-10m	368
32	VK4TW	Robert Waegele	Digital	20-17-10m	368
33	SV1OCA	Leonidas Bairaktaris	Open	20-17-15m	616
34	SV1OCA	Leonidas Bairaktaris	Digital	30-20-17m	534
35	VK4VO	Shaun Stoddart	Digital	30-20-17m	341
36	VK6OZ	Stephen Hill	Open	30-20-15m	574
37	VK6RZ	Peter Drew	Digital	40-30-15m	426
38	VK6OZ	Stephen Hill	Digital	30-20-15m	571
39	VK3XV	Tony Hambling	Digital	40-20-15m	342
40	VK3XV	Tony Hambling	Open	40-20-15m	406
41	VK2IO	Gerard Hill	Digital	40-30-20m	362

XCC Multi-band (5)

	Call	Name	Mode	Band	Count
58	VK6SJ	Stephen Kennedy	Digital	40-30-20-15-10m	608
59	VK6SJ	Stephen Kennedy	Open	40-30-20-15-10m	661
60	SV1OCA	Leonidas Bairaktaris	Open	40-30-20-17-15m	945
61	SV1OCA	Leonidas Bairaktaris	Digital	40-30-20-17-15m	821
62	VK6OZ	Stephen Hill	Open	40-30-20-17-15m	925
63	VK6OZ	Stephen Hill	Digital	40-30-20-17-15m	920
64	4Z4UO/QRP	Omer Tsouk	Open	30-20-15-12-10m	512
65	VK3WE	Rhett Donnan	Open	30-20-17-15-10m	585

XCC Multi-mode (Phone)

	Call	Name	Count
30	DJ7ZZ	Thorsten Meirich	237
31	SV1OCA	Leonidas Bairaktaris	182
32	VK4IM	Adam Jaroszuk	103

DXCC Multi-mode (Triple Play)

#	Call	Name	Count
29	VK4VO	Shaun Stoddart	157
30	VK6RZ	Peter Drew	200
31	VK3NX	Charlie Kahwagi	100

DXCC Multi-band (7)

#	Call	Name	Mode	Band	Count
96	VK6JJJ	Craig Hayhow	Open	40-30-20-17-15-12-10m	786
97	VK6JJJ	Craig Hayhow	Digital	40-30-20-17-15-12-10m	781
98	SV1OCA	Leonidas Bairaktaris	Open	40-30-20-17-15-12-10m	1241
99	SV1OCA	Leonidas Bairaktaris	Digital	40-30-20-17-15-12-10m	1042
100	VK4VO	Shaun Stoddart	Open	40-30-20-17-15-12-10m	1292
101	VK3EW	David McAulay	Triple Play	80-40-20-17-15-12-10m	1209
102	VK3TZ	Tony Burt	CW	40-30-20-17-15-12-10m	1002
103	VK6OZ	Stephen Hill	Open	40-30-20-17-15-12-10m	1203
104	VK6OZ	Stephen Hill	Digital	40-30-20-17-15-12-10m	1195
105	VK6RZ	Peter Drew	CW	40-30-20-17-15-12-10m	1334

DXCC Multi-band (8)

#	Call	Name	Mode	Band	Cou
58	VK3OHM	Marc Hillman	Open	80-40-30-20-17-15-12-10m	1234
59	VK3KTT	Steven Barr	Open	80-40-30-20-17-15-12-10m	1459
60	VK3KTT	Steven Barr	Digital	80-40-30-20-17-15-12-10m	1135
61	VK4VO	Shaun Stoddart	Open	80-40-30-20-17-15-12-10m	1406
62	VK6RZ	Peter Drew	CW	80-40-30-20-17-15-12-10m	1439

DXCC Multi-band (9)

#	Call	Name	Mode	Band	Cou
36	VK4CAG	Graeme Dowse	Digital	160-80-40-30-20-17-15-12-10m	1524

DXCC Multi-mode (Digital)

#	Call	Name	Count
161	VK5VC	Charles McEachern	103
162	VK2HV	Paul Hanna	106
163	VK3PUB	Anthony Lance	139
164	WO/VK3BDL	Mike Goode	101
165	SV1OCA	Leonidas Bairaktaris	249

DXCC Multi-mode (Open)

#	Call	Name	Count
541	VK3PUB	Anthony Lance	150
542	DJ7ZZ	Thorsten Meirich	244
543	SV1OCA	Leonidas Bairaktaris	266
544	W7ONY	Tony Atkins	101
545	VK4IM	Adam Jaroszuk	103
546	VK2PKT	Keith Turk	101

DXCC Single-band

#	Call	Name	Mode	Band	Count
1106	VK2EY	Douglas Rosser	Open	20m	109
1107	VK2EY	Douglas Rosser	Digital	20m	108
1108	VK6JJJ	Craig Hayhow	Open	30m	103
1109	VK6JJJ	Craig Hayhow	Digital	30m	103
1110	VK3XV	Tony Hambling	Open	40m	129
1111	VK6SJ	Stephen Kennedy	Digital	10m	102
1112	VK3TU	Albert Gnaccarini	Open	10m	110
1113	VK3OHM	Marc Hillman	Open	12m	101
1114	VK3KTT	Steven Barr	Open	12m	114
1115	VK6JJJ	Craig Hayhow	Open	40m	101
1116	VK6JJJ	Craig Hayhow	Digital	40m	101
1117	VK3EW	David McAulay	Triple Play	10m	115
1118	DJ7ZZ	Thorsten Meirich	Phone	17m	115
1119	DJ7ZZ	Thorsten Meirich	Phone	10m	126
1120	DJ7ZZ	Thorsten Meirich	Phone	15m	166
1121	DJ7ZZ	Thorsten Meirich	Phone	20m	176
1122	VK3HJ	Luke Steele	Open	40m	294
1123	VK3HJ	Luke Steele	Open	30m	304
1124	VK3HJ	Luke Steele	Open	17m	285
1125	VK3HJ	Luke Steele	Open	15m	270
1126	VK3HJ	Luke Steele	Open	10m	223
1127	VK3HJ	Luke Steele	Open	12m	229
1128	VK3HJ	Luke Steele	Phone	40m	177
1129	VK3HJ	Luke Steele	Phone	17m	146
1130	VK3HJ	Luke Steele	Phone	15m	155
1131	VK3HJ	Luke Steele	Phone	10m	114
1132	VK3HJ	Luke Steele	CW	160m	145
1133	VK3HJ	Luke Steele	CW	80m	172
1134	VK3HJ	Luke Steele	CW	40m	259
1135	VK3HJ	Luke Steele	CW	20m	286
1136	VK3HJ	Luke Steele	CW	17m	249
1137	VK3HJ	Luke Steele	CW	15m	237
1138	VK3HJ	Luke Steele	CW	12m	197
1139	VK3HJ	Luke Steele	CW	10m	175
1140	VK3HJ	Luke Steele	Digital	40m	102
1141	VK3HJ	Luke Steele	Digital	30m	155
1142	VK3HJ	Luke Steele	Digital	17m	115
1143	VK3HJ	Luke Steele	Triple Play	20m	131
1144	VK3KTT	Steven Barr	Digital	12m	107
1145	VK6SJ	Stephen Kennedy	Digital	30m	100
1146	VK6SJ	Stephen Kennedy	Open	30m	100
1147	VK4SN	Alan Shannon	Open	10m	101
1148	VK4TW	Robert Waegele	Open	10m	117
1149	VK4TW	Robert Waegele	Digital	10m	117
1150	VK3SN	Stephen Warrillow	Open	20m	107
1151	VK3FZ	Roger Stafford	Digital	10m	103
1152	VK4CAG	Graeme Dowse	Digital	160m	103
1153	VK2BY	Bradley Devon	Triple Play	20m	101
1154	VK3KTT	Steven Barr	Triple Play	20m	103
1155	VK4TW	Robert Waegele	Open	17m	111
1156	VK4TW	Robert Waegele	Digital	17m	111

#	Call	Name	Mode	Band	Count
1157	SV1OCA	Leonidas Bairaktaris	Open	40m	153
1158	SV1OCA	Leonidas Bairaktaris	Open	30m	176
1159	SV1OCA	Leonidas Bairaktaris	Open	20m	218
1160	SV1OCA	Leonidas Bairaktaris	Open	17m	204
1161	SV1OCA	Leonidas Bairaktaris	Open	15m	194
1162	SV1OCA	Leonidas Bairaktaris	Open	12m	149
1163	SV1OCA	Leonidas Bairaktaris	Open	10m	147
1164	SV1OCA	Leonidas Bairaktaris	Phone	20m	131
1165	SV1OCA	Leonidas Bairaktaris	Phone	17m	102
1166	SV1OCA	Leonidas Bairaktaris	Digital	40m	125
1167	SV1OCA	Leonidas Bairaktaris	Digital	30m	176
1168	SV1OCA	Leonidas Bairaktaris	Digital	20m	187
1169	SV1OCA	Leonidas Bairaktaris	Digital	17m	171
1170	SV1OCA	Leonidas Bairaktaris	Digital	15m	162
1171	SV1OCA	Leonidas Bairaktaris	Digital	12m	118
1172	SV1OCA	Leonidas Bairaktaris	Digital	10m	103
1173	VK4VO	Shaun Stoddart	Digital	20m	106
1174	VK4VO	Shaun Stoddart	Digital	30m	125
1175	VK4VO	Shaun Stoddart	CW	15m	135
1176	VK4VO	Shaun Stoddart	Open	80m	114
1177	VK4VO	Shaun Stoddart	Open	40m	195
1178	VK4VO	Shaun Stoddart	Open	30m	197
1179	VK4VO	Shaun Stoddart	Open	17m	156
1180	VK4VO	Shaun Stoddart	Open	15m	218
1181	VK4VO	Shaun Stoddart	Open	12m	120
1182	VK4VO	Shaun Stoddart	Open	10m	160
1183	VK4VO	Shaun Stoddart	Phone	15m	125
1184	VK4VO	Shaun Stoddart	CW	40m	122
1185	VK4VO	Shaun Stoddart	CW	30m	129
1186	VK3EW	David McAulay	Triple Play	80m	104
1187	VK6APK	Aleksandar Petkovic	CW	80m	102
1188	VK4TW	Robert Waegele	Open	15m	107
1189	VK4TW	Robert Waegele	Digital	15m	107
1190	VK3TU	Albert Gnaccarini	Digital	20m	106
1191	VK3XV	Tony Hambling	Digital	40m	105
1192	VK6RZ	Peter Drew	Open	30m	276
1193	VK6RZ	Peter Drew	Open	20m	257
1194	VK6RZ	Peter Drew	Open	17m	196
1195	VK6RZ	Peter Drew	Open	15m	191
1196	VK6RZ	Peter Drew	Open	10m	145
1197	VK6RZ	Peter Drew	Open	12m	142
1198	VK6RZ	Peter Drew	Phone	20m	152
1199	VK6RZ	Peter Drew	CW	80m	104
1200	VK6RZ	Peter Drew	CW	30m	268
1201	VK6RZ	Peter Drew	CW	20m	217
1202	VK6RZ	Peter Drew	CW	15m	129
1203	VK6RZ	Peter Drew	CW	17m	170
1204	VK6RZ	Peter Drew	Digital	30m	139
1205	VK6RZ	Peter Drew	Digital	20m	101
1206	VK6RZ	Peter Drew	Digital	15m	114
1207	VK6RZ	Peter Drew	Triple Play	40m	132
1208	VK6OZ	Stephen Hill	Digital	80m	115

XCC Single-band

#	Call	Name	Mode	Band	Count
209	VK6OZ	Stephen Hill	Digital	40m	175
210	VK6OZ	Stephen Hill	Digital	30m	177
211	VK6OZ	Stephen Hill	Digital	20m	214
212	VK6OZ	Stephen Hill	Digital	17m	174
213	VK6OZ	Stephen Hill	Digital	15m	180
214	VK6OZ	Stephen Hill	Digital	12m	139
215	VK6OZ	Stephen Hill	Digital	10m	136
216	VK6DW	Ian Cook	CW	15m	102
217	VK3XV	Tony Hambling	Digital	15m	102
218	VK3XV	Tony Hambling	Open	15m	102
219	VK4VO	Shaun Stoddart	Digital	12m	105
220	VK4VO	Shaun Stoddart	Digital	17m	110
221	VK3WE	Rhett Donnan	Open	10m	106
222	VK3WE	Rhett Donnan	Open	17m	100
223	VK5MN	Michael Nedic	Open	20m	120
224	VK5MN	Michael Nedic	Digital	20m	120
225	VK6RZ	Peter Drew	CW	12m	109
226	VK6RZ	Peter Drew	CW	10m	117
227	VK2IO	Gerard Hill	Digital	30m	108

fty On 50

	Call	Name	Count
	VK5UR	Andrew Hodges	50
	VK5PJ	Peter Sumner	56

ands of Australia

	Call	Name	Count
	VK5PAS	Paul Simmonds	30

ceania

	Call	Name	Count
	JA1CCH	Nanao Tsuboi	54
	DJ7ZZ	Thorsten Meirich	29
	SV1OCA	Leonidas Bairaktaris	27
	VK2EY	Douglas Rosser	25
	VK4VO	Shaun Stoddart	55
	VK2BV	Waverley Amateur Radio Society	25
	VK6MIT	Brian Mitchell	25

HF Century Club

	Call	Name	Mode	Band
	VK4CAG	Graeme Dowse	Open	6m
	VK5SA	Chris Levingston	Open	6m
	VK6RZ	Peter Drew	Open	6m
	VK6RZ	Peter Drew	Digital	6m

rked All States VHF

	Call	Name	Mode	Band
	VK6RZ	Peter Drew	Open	6m
	VK6RZ	Peter Drew	Digital	6m

Grid Square

#	Call	Name	Mode	Band	Count
645	VK4VFO	Steven Sim	Open	HF	218
646	VK4VFO	Steven Sim	Digital	HF	216
647	VK5LJG	Liam Gunning	Open	HF	326
648	VK3HJ	Luke Steele	Open	HF	1543
649	VK3HJ	Luke Steele	CW	HF	1079
650	W7ONY	Tony Atkins	Digital	HF	702
651	VK4TW	Robert Waegele	Open	6m	65
652	VK4TW	Robert Waegele	Digital	6m	65
653	W7ONY	Tony Atkins	Open	HF	722
654	DJ7ZZ	Thorsten Meirich	Phone	2m	166
655	DJ7ZZ	Thorsten Meirich	Digital	2m	65
656	DJ7ZZ	Thorsten Meirich	Open	6m	65
657	DJ7ZZ	Thorsten Meirich	Phone	6m	60
658	VK5SA	Chris Levingston	Open	6m	59
659	VK2BY	Bradley Devon	Open	6m	51
660	VK2BY	Bradley Devon	Digital	6m	51
661	SV1OCA	Leonidas Bairaktaris	Open	HF	1551
662	SV1OCA	Leonidas Bairaktaris	Open	6m	149
663	SV1OCA	Leonidas Bairaktaris	Phone	HF	480
664	SV1OCA	Leonidas Bairaktaris	Digital	HF	1441
665	SV1OCA	Leonidas Bairaktaris	Digital	6m	126
666	W7ONY	Tony Atkins	Phone	HF	100
667	VK4VO	Shaun Stoddart	Digital	HF	786
668	VK4IM	Adam Jaroszuk	Open	HF	410
669	VK4IM	Adam Jaroszuk	Phone	HF	404
670	VK6RZ	Peter Drew	Open	HF	598
671	VK6RZ	Peter Drew	Open	6m	62
672	VK6RZ	Peter Drew	CW	HF	119
673	VK6RZ	Peter Drew	Digital	HF	527
674	VK6RZ	Peter Drew	Digital	6m	62
675	DJ7ZZ	Thorsten Meirich	Open	2m	192
676	VK3EW	David McAulay	Digital	6m	53
677	VK6IR	Stephen Chamberlain	Digital	6m	58

Worked All VK Call Areas HF

#	Call	Name	Mode
2448	JH2RIH	Ryuichi Yamanaka	Open
2449	JA1CCH	Nanao Tsuboi	Open
2450	DK3UA	Reinhard Michaelis	Open
2451	VK3HJ	Luke Steele	Phone
2452	VK4VO	Shaun Stoddart	Open
2453	VK4VO	Shaun Stoddart	Phone
2454	VK3MB	Philip White	Phone
2455	VK6WX	Wesley Beck	Digital

Refurbishment of a classic rig line – my journey

Collins S-line conservation and conversion – Job

Phil Fitzherbert VK3FF

Figure 1. My Collins 75S-3 receiver.

The 75S-3 is a serious communications receiver designed for the amateur bands available when it was manufactured – 80, 40, 20, 15, and 10 metres. It is a double conversion superhet, with both crystal and tuneable BFOs.

We can't show you a circuit diagram, it is almost a metre long! However, I will describe the layout of the receiver. See **Figure 2**, here.

The first valve is a crystal calibrator. It is a 6DC6 pentode with G3 grounded. Its output is fed into the antenna circuitry.

The first signal valve is the RF amplifier, a 6DC6 that couples into the first mixer, the triode section of a 6EA8 triode-pentode. The pentode section of this valve is the crystal oscillator which feeds into the triode mixer.

A second 6EA8 pentode section forms the second mixer. It is fed by the signal and the output of a variable frequency oscillator (VFO), a 6AU6. The next step is a cathode follower formed by the triode section of the 6EA8 mixer valve.

This flows into the crystal filter and out to a Q-multiplier formed by both sections of a 12AX7 twin triode. Next is the IF amplifier, a 6BA6, which is transformer-linked to the second IF amplifier.

This feeds into the Product Detector the triode section of a 6EA8. The pentode section of this valve forms the crystal BFO. The tuneable BFO is a 6DC6.

IF signal is fed to a 6AT6, a dual-diode triode. The two diodes take care of the AF detection and AGC generation. The triode is an audio preamplifier.

Finally, the audio output amplifier is a 6BF5, a very robust valve. More on the choice of this tube later.

The first IF is 2.955 MHz to 3.155 MHz, which determines the receiver's 200 kHz tuning range, while the second IF is 455 kHz, featuring the famous Collins mechanical filter.

Finding and fixing the problems

As presented, the set was deaf! I would have to check it out thoroughly.

I was anticipating a real chase to find the reason for it deafness. I put my signal generator into the aerial circuit of the receiver. No success. So, I put the signal generator input about half way along the signal path, at the grid o the second 455 kHz IF tube. Success! We have output! So, the fault is in the front section.

Then, I put input to the control grid of the second mixer, and we still had output. The next point of entry was the control grid of the first mixer tube, and we still had output. This meant the fault had to be in the RF amplifier section.

When I measured voltages around the RF amplifier tube, a 6DC6 (V2), they were all close enough to their nominated values; maybe the anode voltage was a little high. Just to eliminate the valve, I replaced it with a new item, and everything came good! What was wrong with the original, I don't know. I just breathed a real sigh of relief.

Further work

I replaced all the electrolytic capacitors throughout the unit but, in contrast to the 516F-2 power supply, this is a 110 VAC unit, so a separate stepdown transformer w required.

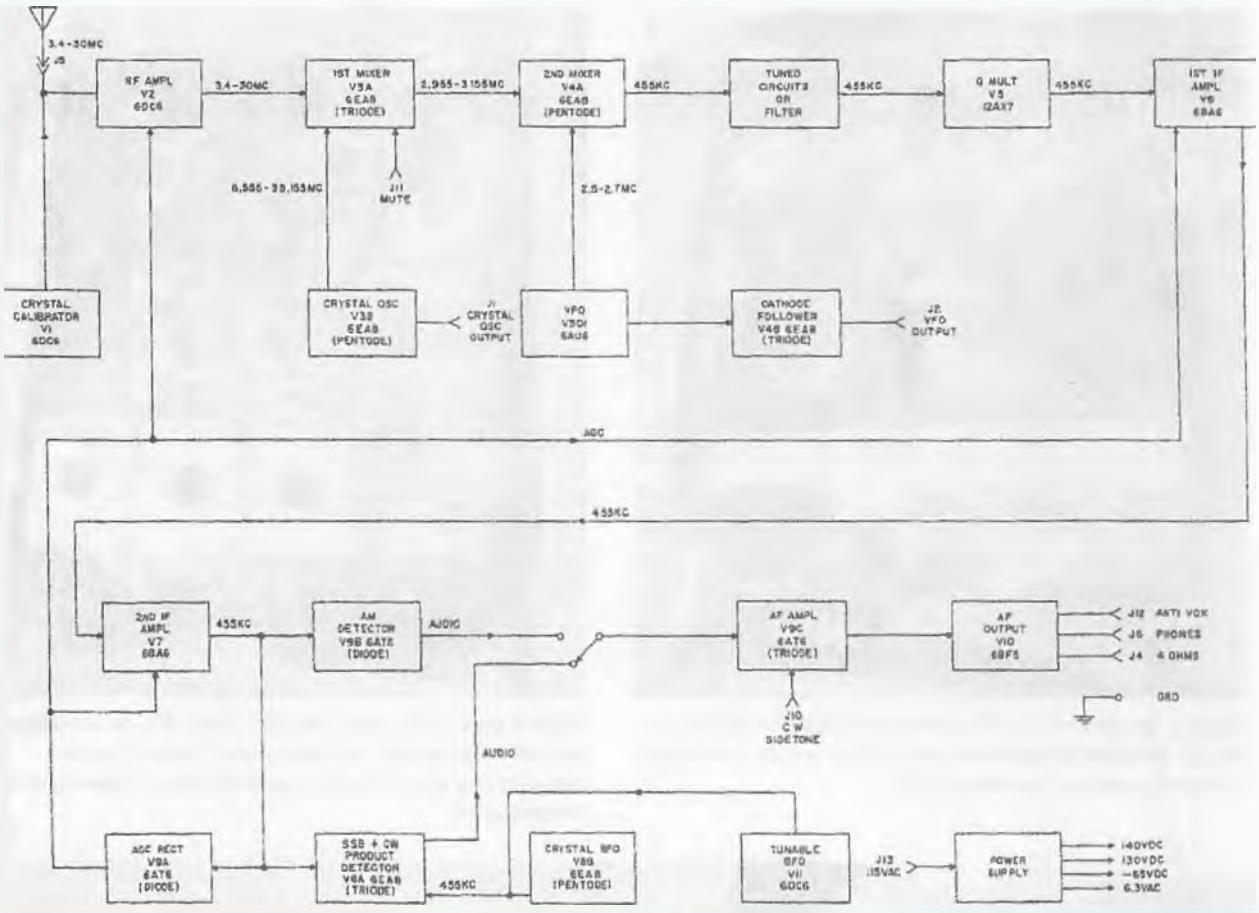
Also, unlike the 516F-2 power supply, it has all solic state rectifiers. In replacing the electrolytics, there is on capacitor that is a triple 40 uF can, mounted above the chassis. A replacement unit for this was obtained court of Mark Olsen KE9PQ (www.ke9pq.com). It is mount on the chassis right alongside the audio output valve, a 6BF5.

The 6BF5 is a very robust tube with a 1.2 amp heat It runs very, very hot. In fact, if you spit on it while it's operating, the spit will turn to steam almost instantly! I mentioned, this valve is situated very close to the 3 x uF capacitor can. The existing triple capacitor was tota dried out. I have no doubt because of the serious heat right alongside it.

I looked at replacing the 6BF5 with a 6AQ5. They share the same base connections. The 6BF5 is biased with 11 volts negative on the control grid, with cathod earthed. I tried several resistors from grid to earth to tr to alter the bias to suit the 6AQ5. The closest was a 39 resistor to earth. However, THD was still rather too hi

I then thought of the hundreds of thousands of 6A and before that, the 6V6, used as Class A output tubes radios over decades. These used cathode-biasing to set the tube for the correct operating characteristics.

I therefore removed the bias line from the grid, inserting a 470k resistor to earth. The cathode was



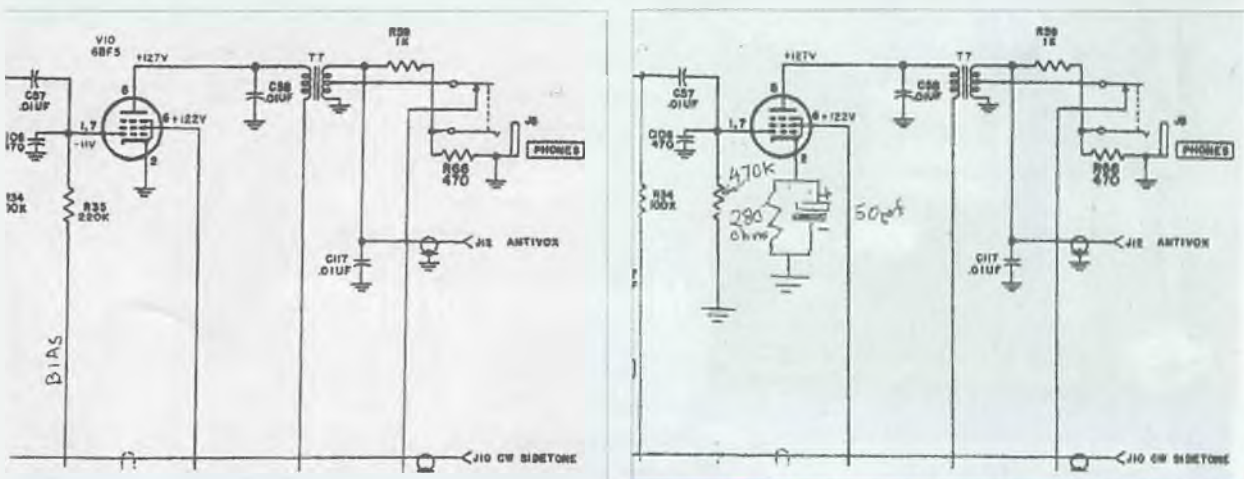
ure 2. 75S-3 block diagram.

noved from earth, and a 280-ohm resister paralleled th a 50 uF, 60 VDC electrolytic, the combination ed from the cathode to earth. Every reader who has yed with old radios will recognise this circuit. See gure 3 for old and new circuits.

Figures 4 is an above-chassis view of my 75S-3, while gure 5 shows the underside.

I now have a beautiful receiver which really performs very well. With the new 6AQ5 in the audio output, the heat level is much reduced. Audio output had been reduced but it's still more than adequate for the normal shack environment. I'm now a very happy 75S-3 owner!

A further article will cover the restoration of the companion transmitter, the 32S-1.



e 3. Original output valve circuit on the left, using the 6BF5, and at right, the new 6AQ5 circuit.

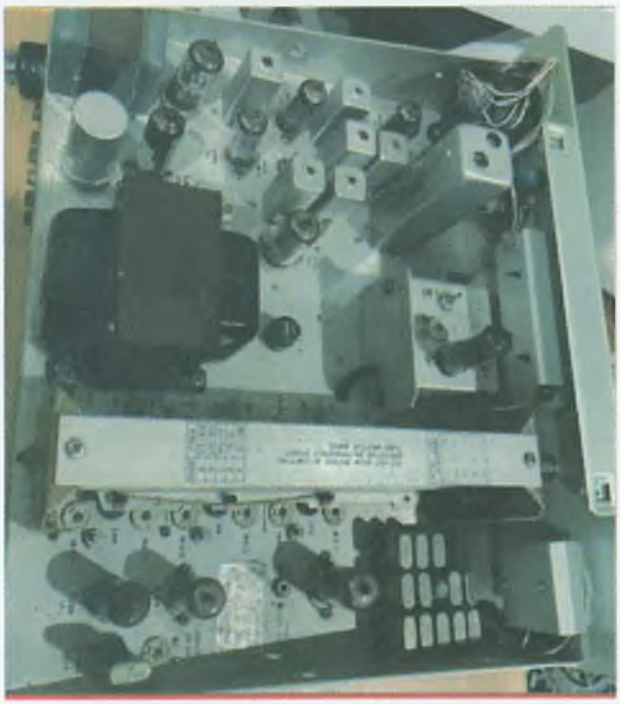


Figure 4. Top-side view of my 75S-3. Note the 240-110 VAC transformer at top right. Immediately below it is the new 3 x 40 uF capacitor can adjacent to the audio output tube, now using a 6AQ5.

Figure 5. Below chassis view of my 75S-3. Clearly, this unit was design and built in the days when hand wiring ruled! The three prominent aluminium cans along the bottom edge of the chassis shield sections c the band switch.

SPECTRUM HORIZONS

VHF/UHF an Expanding World

David K Minchin VK5KK
e *david@vk5kk.com*

e thing about change, it is all
ınd us and for this column that is
lifferent.
he column has evolved since
9 when the banner *VHF/*
F an Expanding World was first
l. In the day, the column was a
ette' of activity to be shared with
emporary peers and to provide
ɔrical reference. DX band
ity was mostly AM on 52/144
z, while 420-450 MHz activity
still mostly localised. 1200 MHz
above was the new frontier, with
ets of activity in different states.
ince then, it's been a series of
stones. Early seventies, AM
on VHF and SSB took over;
te 1970s contacts beyond 2000
were achieved on 432 and 1296
z. In the mid-1980s, the same
nces became VK world records
304/3456 MHz, and then
ly in 1994, on 10,368 MHz
just 200 mW of SSB!
t the same time, we got back
fHz in most states and aircraft
er became popular on 144
z. SSB – and even FM – tropo
acts occurred on 144 – 1296
east to west over 2000+ km.
activity expanded as new
ıologies improved equipment
24 GHz was the new terrestrial
ier.
ıe new century brought the
d mode age, enabling contacts
more modest equipment or
.cts that were not previously
ɔle.
ıe 2010s opened up 47 GHz,
Hz and 122 GHz. The Spring
VHF/UHF Field Day had
cts on 13 bands from 50 MHz
gh 134 GHz for the first time.
itle of that contest doesn't quite
ymore either, with 60% of the

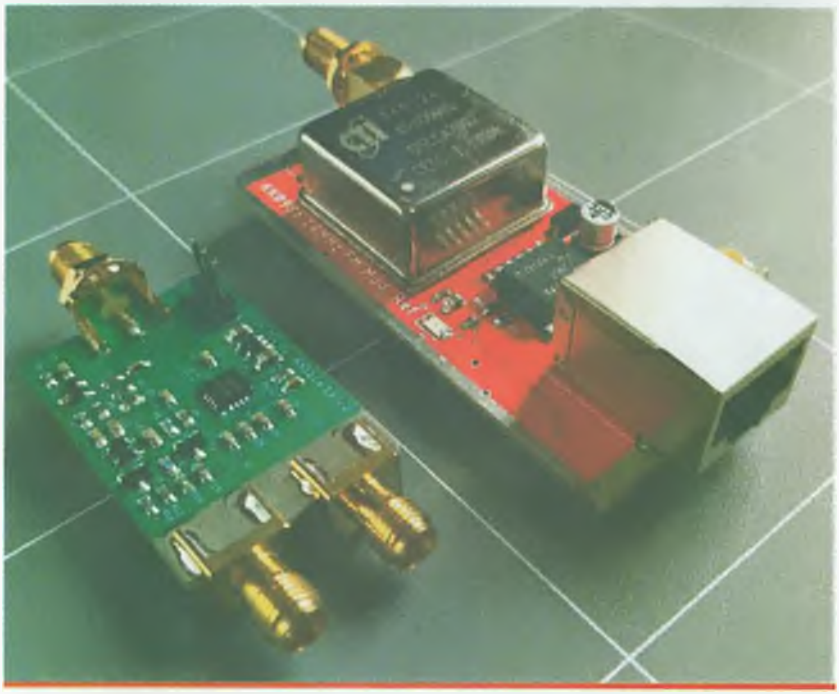


Photo 1. 10 MHz FM reference and PLL reference switch projects.

bands used being above UHF!

It is time for change. However, instead of renaming the column 'VHF/UHF/SHF/EHF' we've moved to "Spectrum Horizons" (thank you Roger!) as the main tag. The old title will remain for the time being as a sub-heading to pay respect to the history of the column.

When I've been doing the research for the "Looking back 20 years" part of the column, it is clear that it has moved from 50/50 technical content and activity reports to largely technical content. This is a direct result of more automated web-based activity reporting. In future, we hope to encourage more diverse input, not just pushing frequency boundaries but also other technologies we can use on VHF and above.

In this edition, we have the next instalment of the construction series continuing, with more frequency reference projects and the latest edition of what happened 20 years ago with exploits on 50 MHz DX.

Construction Series Part 10: more frequency reference projects

It seems frequency references are a popular subject with feedback and requests every time they feature in this column. This month, I again have two projects on references, both of which can be used for other purposes, no doubt!

The first is an adaption of the 10 MHz reference using the surplus (eBay) 5 VDC CTI OCXO previously featured in this column,

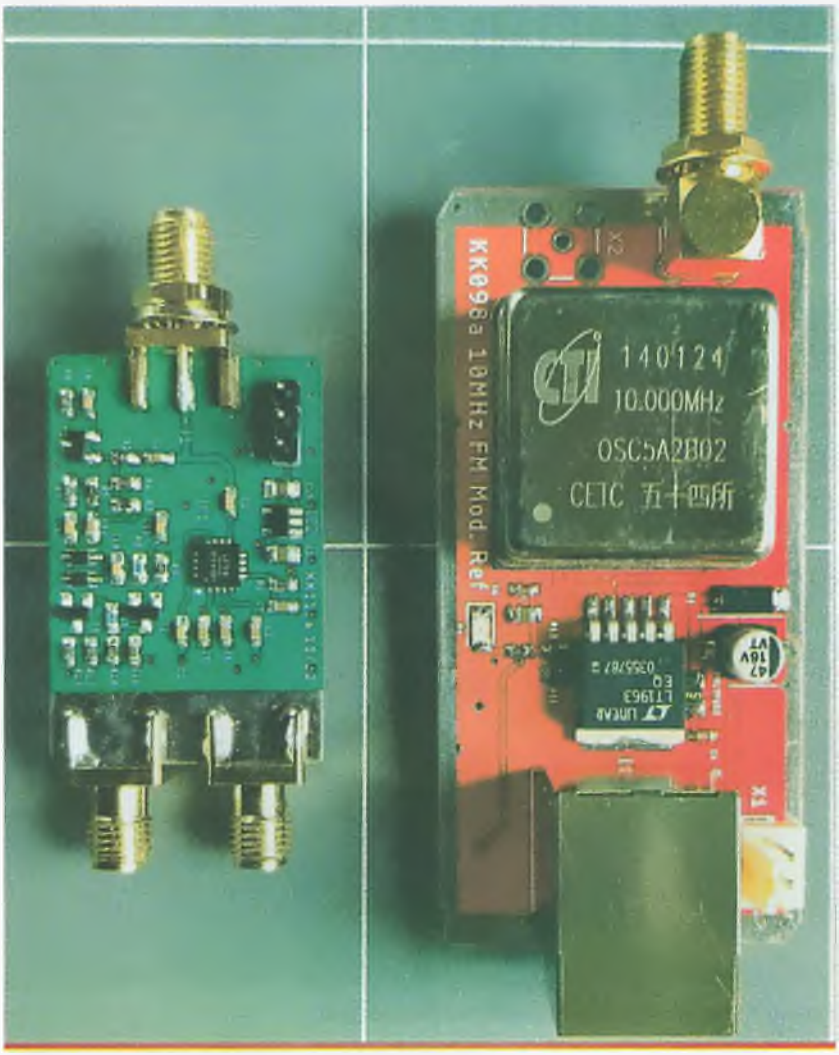


Photo 2. Top-down view of the reference and switch PC boards.

but with added FM modulation capability.

The initial request was to be able to use FM with 122 GHz modules (VK3CV or VK5KK). However, it is equally adaptable to use with any microwave PLL. There is enough deviation for a reasonable level of modulation from 24 GHz and above so it could be used with existing diode multiplier chains.

I have one connected to a PLL used as a short-range beacon using an older DL2AM multiplier for talkback.

Ultimately, FM capability will be limited by the total OCXO pull range at 10 MHz multiplied by 'X' (+/- 2 V = a few Hz). While intended for voice, digital modes can equally be used. Any connected PLL will need a loop bandwidth of at least 10 – 20 kHz, else modulation will be attenuated!

A new PCB (KK098a) was created with the addition of a TL082CD dual op-amp to accept audio from a condenser-type microphone. The microphone jack is an RJ45 socket configured to accept a Yaesu FT817 microphone (or FT857/897).

The microphone PTT is used to switch power onto the microphone amplifier and supply a normal PTT output to trigger external transmit changeover. Without the microphone plugged in, the reference works the same as the original OCXO, with no degradation to signal purity. Pre-emphasis circuitry is not included.

The KK098a PCB is sized to fi a Shubert 72 mm x 35 mm tinpla box, with either one or two SMAs for 10 MHz output. Mounting in tin box is entirely optional, the P could be mounted in a diecast bo and long-thread right angle SMA used for panel mounting. Figure shows the schematic and Figure 2 shows the layout for top and bott sides of the double-sided PCB.

The second project is perhaps a bit more obscure, an automatic reference switch. The main use is with transverters that have a gene internal reference but need a mor accurate external reference for dig modes. Instead of disconnecting internal reference, the small PCB detects when an external referenc is connected to the main SMA ja and switches over to that referen

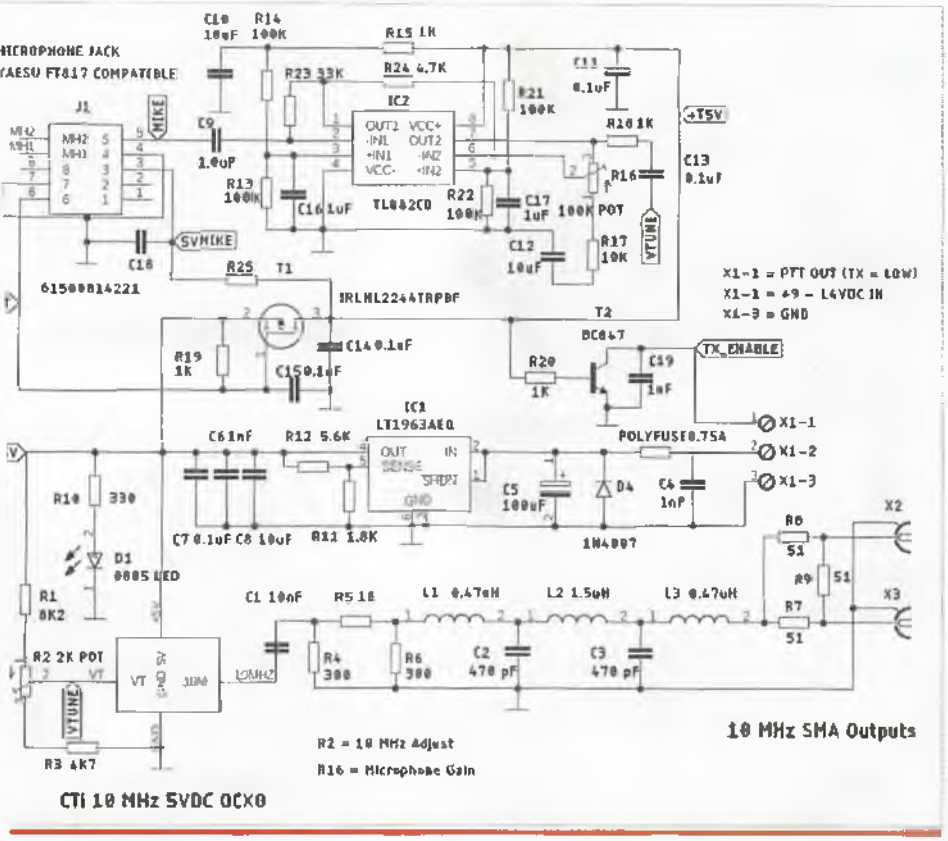
A new PCB has been created (KK112b); Figure 3 shows the schematic and Figure 4 the topsi layout (only one side is used).

The reference switch uses the HMC849ALP4CE high isolatio non-reflective DC to 6 GHz Ga pHEMT SPDT switch. The swit provides up to 60 dB isolation, with low insertion loss of 0.8 dB up to 6 GHz. The chip has a P1 compression point of +31 dBm Watt) so can be used for low pov transmitters.

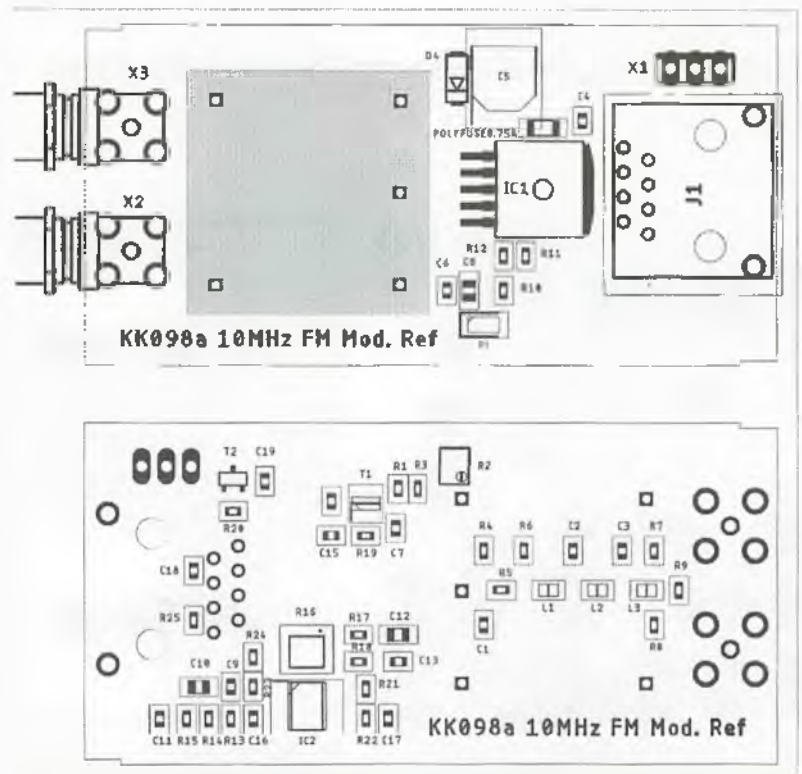
The isolated port is connecte to 50 ohms so either reference c be 'hot-switched' without causir any frequency pull. The chip is probably overkill, but costs und $20, making the whole project l than $50.

The design has a simple RF detector using a buffer amplifier Schottky diode rectifier and son DC switching. In line with mos PLL reference input requiremer about minus 10 dBm of referen RF is required for changeover t occur. I've provided access to th enable pin on the HMC849 ch grounding J4 pin 2 stops the sw change over.

The KK112b PCB is 40 mm



e 1. 10 MHz FM reference schematic.



2. 10 MHz FM reference PCB layout - top (above) and bottom (below).

25 mm and designed for edge connected SMAs. The external input SMA can be a long-threaded type so the whole PCB can be panel mounted for connection to an external reference.

The switch can be used with any reference frequency or VHF/UHF local oscillator. The only limitation is the use of FR4 PCB material, I've only tested it up to 1296 MHz so far, where the through loss is still acceptable at about 1 dB.

For either project, most surface mount components are 0603 size. All semiconductors are available from Mouser or Digikey, as are all other parts. Substitution of parts from other manufacturers is allowable if you run into parts shortages, except for the HMC849 (no equivalents). For resistors and capacitors, those "SMD books" available online are ideal to use.

If you are interested in making either or both projects, please drop me an email. I do have small quantities of PCBs, but as JLCPCB or similar companies can make five PCBs for only a few dollars, I can send the Gerber files, full schematics and BOM.

What happened 20 years ago

Continuing in the series of what happened 20 years ago, 50 MHz long range DX still prevalent despite the sunspot peak(?) being past.

> Bruce VK2EM reports … we had a reasonable opening into Hawaii yesterday (Friday 22-11-02) on 6 Metres. I worked NH6YK for 53 x2, KH6SX for 52 x2 both in BK29. I also heard NH7RO at 57 but he couldn't verify my signal due to bad QRN at his end. I also

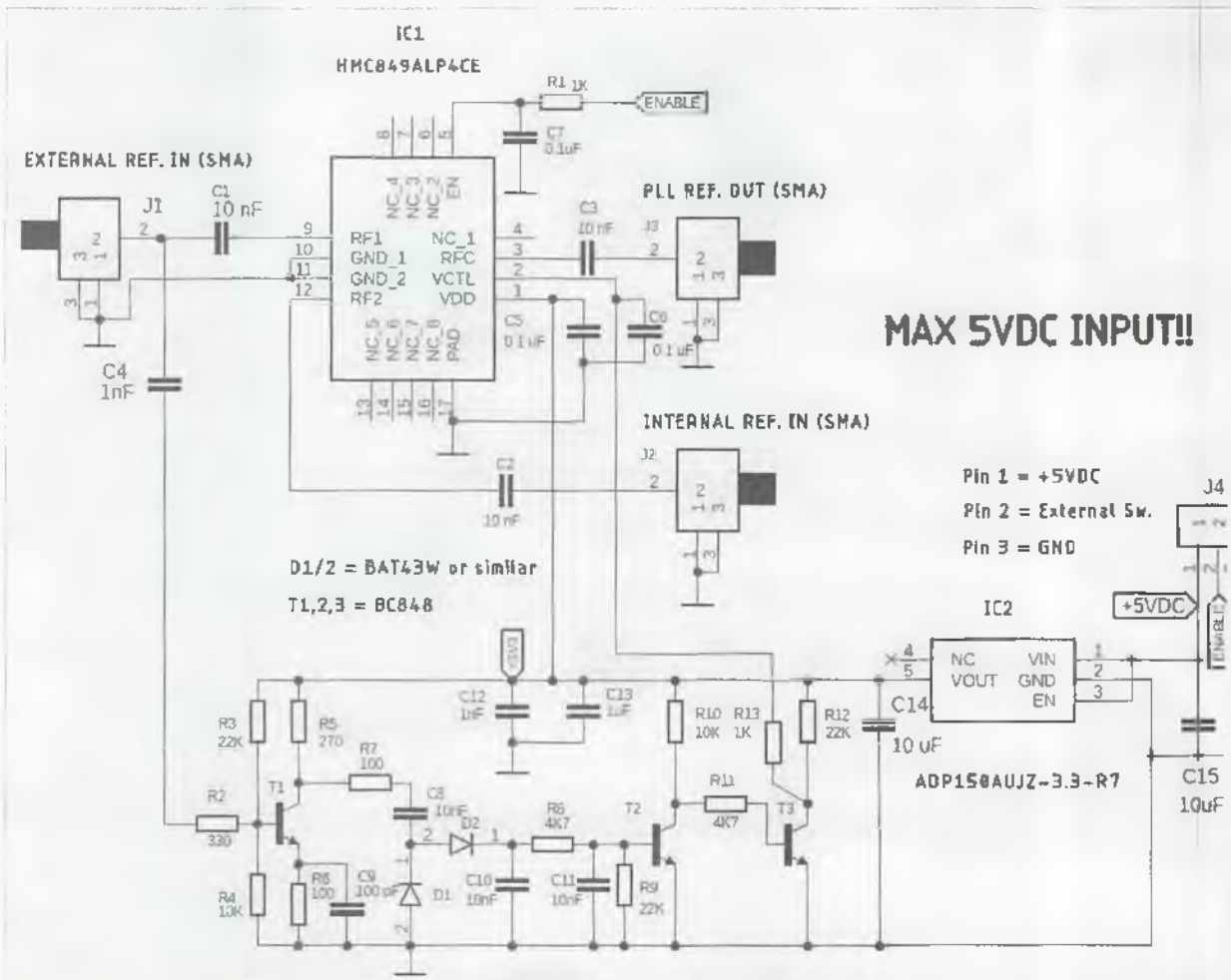


Figure 3. Schematic of the PLL reference switch.

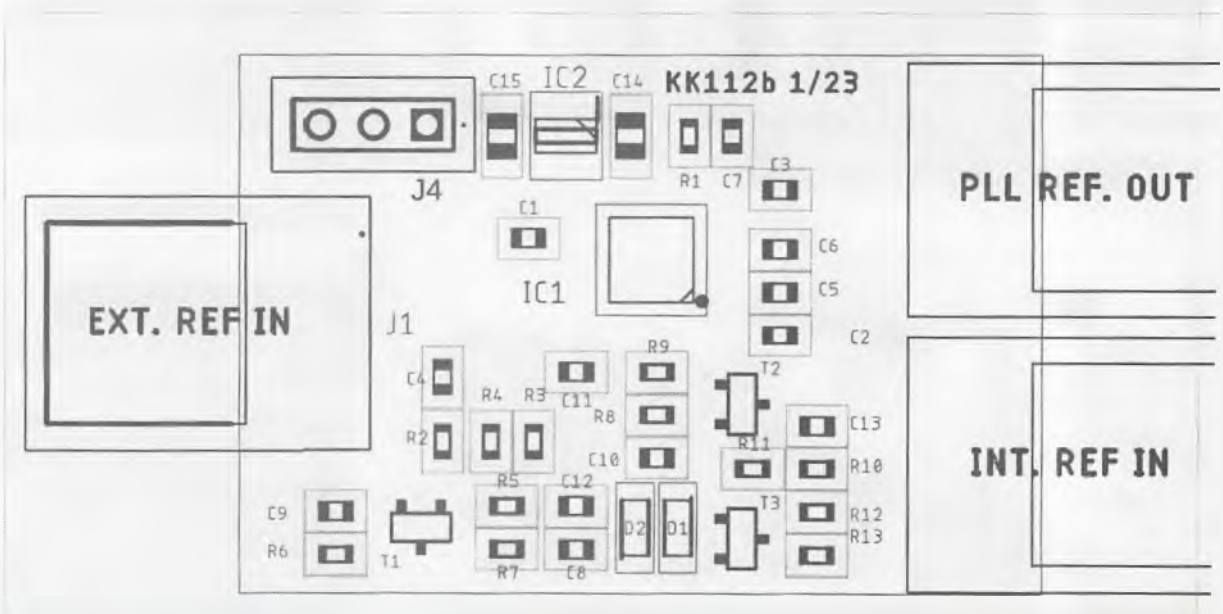


Figure 4. PLL reference switch PCB layout (top side – single-sided board).

heard Brian VK2UBF in Bulli and Wayne VK2TQP near Coff's Harbour working a few so the opening covered quite a bit of the NSW coast … Bruce VK2EM

Bevan VK4CXQ reports … Activity report from Townsville mid Oct to mid-November on 6 Metres. From 15 Oct to 26th most activity was from Japan with the occasional signal from China. On 27th EU opened a little with 9A, LZ, YU, and IT as well as a few stations from Ukraine. It was a bit quiet until 2 Nov when ZK1, HW1 and 9N7 were worked. 7 Nov worked HV0A, and Bulgaria, Italy and Croatia. 8 Nov QSO with K8T, YA4, some more EU stations, A45 and EX8.13 Nov . EU opened a bit more with Ukraine, lots of DLs and SPs and some OKs, S5, ON, Italy and France. 51 QSO's in about 2 hours. Not as many QSO's as this time last year. Have finally made the DX100 club on 6 (100 countries worked), now the hard work begins trying to get the QSL cards. Hope it doesn't take as long as the QSO's (2 years & 9 months).

How things have changed; 20 years later with digital modes such as FT8 has made it possible to be alerted to band openings that were marginal or not detected previously. Sunspots still matter, but not as much! More on what happened 20 years ago next issue.

In closing

A reminder that Kevin VK4UH has volunteered as the VHF-UHF Records Manager. The new email for all record applications is: distancerecords@wia.org.au.

Feel free to drop me a line if you have something to report or a project you are working on, it doesn't take much to put a few lines together and helps with the diversity of this column. Just email me, at: david@vk5kk.com.

Sporadic E – stardust propagation

Sporadic E propagation on the 6m and 2m bands can provide quite some excitement, for as long as an 'opening' lasts.

When the band opens, it's often chaotic. Propagation may jump from area to area. Stations a few km away work others you can't hear. The MUF might rise over hours, or only minutes.

Signals can appear and disappear suddenly. They may last only minutes or for hours on end. Signals are often strong, punctuated by deep, rapid fades and sometimes appear from unexpected directions.

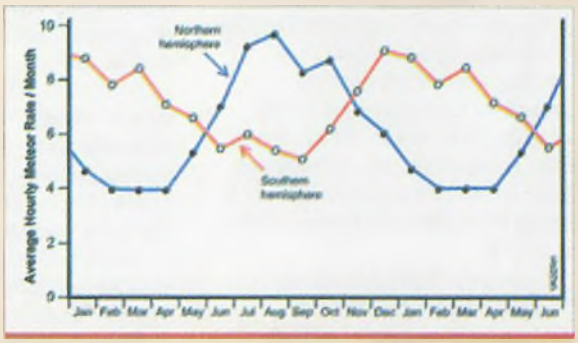
The last hour of the 2023 Summer VHF-UHF Field Day provided some excitement for a few contestants exploiting the serendipitous propagation between VK3/VK5 and southern VK4. Doug Friend VK4OE managed to put a string of VK3s in the log: VK3KQ at QF12vg, VK3EV at QF32nv, VK3FS at QF21mr, VK3R at QF22pd, VK3OM at QF21nw, and finally VK3ZL at QF22fe; Doug couldn't complete a contact with a VK5.

Every Sporadic E propagation 'event' is different.

Stardust

The formation of sporadic E everywhere across the world begins with meteor ablation. Random meteors ranging in size from grains of sand to schoolyard marbles plunge continually into the Earth's upper atmosphere. Descending into the ionosphere, they disintegrate in the E region, between about 100 and 140 km height, known as the "ablation zone", where they are worn to fine molecular dust by friction from collisions with the atmospheric gases up there.

This meteor deposition is relentless, even on the Earth's trailing side, although more meteors are collected on the Earth's leading face. It results in some 100 to 200 tons (90-180 metric tonnes) of meteoric debris falling through our



Deposition rates of meteors in the northern and southern hemispheres. There's a clear peak over the summer months in each.

atmosphere every day! Although it's a never-ending rain, it does vary – daily, seasonally, annually, and over longer periods.

As stone meteors consist mainly of iron (Fe) and magnesium (Mg), ablation leaves them as atoms. A proportion may become ionised during ablation, but most are ionised by a multi-stage process involving solar photo-ionisation and charge exchange with existing ions.

These metallic (Fe and Mg) molecules are easily ionised and have long lifetimes, ranging from hours to days. By comparison, the lifetimes of E region gaseous ions (mostly oxygen and nitric oxide) are about a minute; photo-ionisation and charge exchange reactions maintain a constant production of new gaseous ions.

Thus is born the stardust from which sporadic E ionisation is crafted by E region winds into thin, highly reflective clouds for enjoyment in our sport.

Roger Harrison VK2ZRH

Silent Key Rodney Champness VK3UG

Rodney Donald Champness VK3UG, passed away on 22 October 2022 at the age of 82, after a brief battle against cancer. He is survived by wife Lyn, two sisters, Denise and Lyn, two sons, Brendan and Leonard, stepson Andrew, and five grandchildren.

Rodney was born into a farming community at Kaniva in Western Victoria on 4 January 1940. He was educated in both Victoria and South Australia. His passionate interest in radio started as a teenager and he obtained his amateur radio licence in 1958 at the age of 18.

He graduated from Marconi School of Wireless in Melbourne with a First Class Commercial Operator's Certificate of Proficiency and a Broadcast Operator's Certificate of proficiency.

***Rodney at his retirement from Radio Australia** in 2007, with wife Lyn in front of the 100 kW HF Transmitter No. 2.*

His career included Radio and TV repair technician, sound booth operator at the Melbourne ABC Broadcasting Studios, radio maintenance technician at 3GI AM broadcasting station at Sale in Victoria, radio supervisor at the Macquarie Island Antarctic base (1966), radio inspector/District radio inspector (DRI), and in later years, radio technician at the Radio Australia high frequency (HF) shortwave transmitting station, Shepparton (2000-2007).

Rodney held various positions in the former PMG Department Radio Branch that eventually evolved through a few name changes to what we now know as the Australian Communications and Media Authority (ACMA).

Rodney was highly principled, noted for his integrity and technical ability and always seeking to improve things that he was involved in. Whilst engaged in marine radio survey work on behalf of the then Department of Transport and the Marine Board of Victoria, he developed improved methods of testing the capacity of emergency batteries on ships, a matter of maritime safety.

When pre-recorded cassette tapes were first introduced for the amateur radio licence Morse code receiving tests, he developed a Morse code regenerator to ensure imperfections in tape reproduction did not affect exam candidates.

Rodney held the position of District Radio Inspector (DRI) at Benalla in Victoria until that office was closed in 1997.

During those years, Rodney actively sought to promote better technical knowledge of deficiencies affecting radiocommunications and radio and TV reception, as well as remedies against many causes of radio interference affecting the public and also the specialised needs of amateur radio operators.

Power Line Interference (PLI) is a common problem affecting amateur radio operators, domestic AM radio and (then) analogue TV reception in weak signal areas. So, Rodney – as DRI Benalla, jointly with the DRI Bendigo – wrote a detailed technical article in the mid-1980s explaining the most common causes of PLI and potential remedies, from a Department of Communications (DOC) viewpoint, published in Amateur Radio magazine in June 1987. It was also included as part of an in-house training manual for DOC Radio/Interference Inspectors that was produced in the 1980s, for which Rodney was the major contributor.

That substantial manual, with many colour photo examples of interference products plus useful reference texts, was produced via the DOC Melbourne Head Office and issued to all the regional offices to assist technical officers. It was called the: DOC Radio Frequency Interference Handbook.

***An article on RF interference** by Rodney became a manual that became a training handbook.*

Vintage tech not lost

Over many years from 1998, Rodney wrote monthly columns on Vintage Radio for Silico Chip magazine and also regularly contribute articles to Amateur Radio magazine.

He actively helped others with his considerable knowledge of vintage domesti radio designs over the years since public broadcasting began, spanning almost 100 years.

The World War 2 years spawned many new technologies that were also of great interest to Rodney. He maintained a collecti of representative communications equipme that western powers used and was always ready to impart knowledge to others of such equipment.

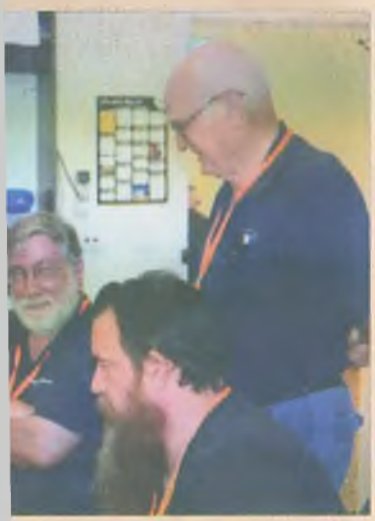
As ex-WW2 radio equipment became readily available, many amateur radio operators of that era were able to convert such equipment for communication on amateur radio bands. Rodney was among those and gained valuable technical knowledge in the process. The only options amateur radio operators in those earlier yea were either to build their own experimental stations, or convert ex-military gear.

The availability of modern commercial amateur radio equipment (from Icom, Yaesu

and Kenwood, among others) now more easily allows valuable on-air time for amateur radio operators!

Rodney was a member of the Wireless Institute of Australia (WIA), the Historical Radio Society of Australia (HRSA), and the Radio Amateurs Old Timers Club Australia (RAOTC).

He also contributed significantly over the years to his local amateur radio club, the Shepparton & District Amateur Radio Club (SADARC). This included the Club's March 2020 commemorative radio amateur reactivation at the Radio Australia Shepparton ex-transmitting station, using its high-gain HF Antennas for DX working with amateur radio transceivers (with spectacular results, including moonbounce on 21 MHz, as done by JPL scientists in 1947 – Ed.), just before the remaining Radio Australia HF facilities were finally dismantled.



***Rodney and other amateurs** at the commemorative Radio Australia event in March 2020.*

In 2017, the Abbot Federal Government had decided to close down all Radio Australia (RA) HF international and inland transmitting services, stated as a cost-saving exercise!

Rodney (among many others) was a passionate advocate that these HF services should be restored in the interests of under-served remote communities inland and in the Pacific Islands, many of whom still rely on shortwave radio broadcast services and do not have RA access via higher technology sources.

***A recent picture of** Rodney and wife Lyn.*

Radio Australia's HF Services remain silent and their vacated HF broadcast frequencies were eagerly snapped up by Asia-based broadcasters – Radio Peking, and Radio New Zealand; the latter is now the only substantial HF broadcaster in our nearby Pacific region.

Rodney had previously worked as an operations technician at Radio Australia from 2000 until his retirement in 2007 (see Photo 2, above). Will future Governments see the benefit of re-establishing a valuable Radio Australia HF (digital radio) service? Only time will tell!

Prolific author

Rodney was a prolific author of quality technical and historical articles for various magazines including Amateur Radio, the RAOTC's journal OTN, Silicon Chip and no doubt other publications (eg. Radio Waves – Ed.). Rodney was the recipient of the WIA's prestigious Higginbotham Award for service to the amateur radio community in 1968 and 1969.

In 2004, he published a meticulously researched book – Outback Radio - from Flynn to Satellites, for which he was presented the Ron Euling Writers Award. This book has become a standard reference for those interested in the development of the Royal Flying Doctor Service (RFDS) radiocommunications, from the early beginnings of Alf Traeger's pedal-powered outback radios, through to the modern era.

Rodney lived a strongly principled life and cared deeply about his family, his Christian faith, nature in its many forms, and the role of Government in the wider Australian community. He always sought to make a positive difference in everything he did.

He was a good man who shared his wealth of knowledge. He will be sorely missed by many!

Compiled by Volker (Vic) Pleuger VK2VP
(with contributions by family and friends of the deceased).

ALARA

Jenny Wardrop, VK3WQ
e secretary@alara.org.au
w www.alara.org.au

A Happy New Year to you all, if it's not too late to say that. I hope that you all had a good Christmas and that Santa brought you the "gear and gizmos" that you had been hoping for. I also hope that 2023 will be a safe and healthy one for all.

We start the column with some happy and some sad news.

Imogen, granddaughter of Dot VK2DB, awarded "New Colombo Plan" scholarship.

Dot Bishop VK2DB, one of our Honorary Life Members, was very pleased to tell us recently that her granddaughter Imogen (20) has been awarded a New Columbo Plan Scholarship.

Here is a slightly edited version of Imogen's letter to Dot just before Christmas:

"I have been extremely fortunate to have been awarded a government scholarship called the New Colombo Plan scholarship, and it's considered one of the most prestigious scholarships you can get in Australia which aims to get Australian university students out into Asia-Pacific to live, study, work, and learn languages.

It was a long 8-month application period. I'll be leaving Australia in about 6 months and going to South Korea! I'll be living there for 10 months, during which time I'll be attending a language school, completing an internship, and spending a semester at KAIST, which is the Korea Advanced Institute of Science and Technology.

After that, in early 2024, I'll be leaving South Korea and moving to Japan for 4 months, where I hope to go to another language school as well as complete an internship. The scholarship gives you enough money to attend a language school full-time. In the second half of 2024, I'll be flying from Japan to Singapore where I'll be living for another 4 months and studying for a semester at the Nanyang Technological University.

Earlier this month I was flown down to Canberra for Pre-Departure training and the Awards Ceremony. I got to meet the other scholarship winners, as well as the Governor General. The Department of Foreign Affairs and Trade (who run the scholarship) covered all the costs of the trip. We received a "swag" from the people at the Korean embassy.

I'm very busy trying to learn Korean and Japanese, as well as planning out my long 18-month program - I'll be living overseas for a year and a half in total and I'm excited for all the adventures and life experiences that coming my way!"

Congratulations Imogen, I'm s you've worked hard for this and it will be a wonderful life experienc Please keep us informed.

Elsie, mother of Jean VK3VIP, at Moorabi Hamfest 2019.

The sad news is that Jean Fisher VK3VIP rang me just after New Year to tell me that her mum, El had passed away in hospital, afte very short illness. Most of you w remember Elsie as she attended VK3 ALARA lunch, helped on t ALARA table at many hamfests attended a couple of ALARAme She nearly always held one end the banner in the ALARA photo

Elsie will be remembered for fun personality and cheeky grin.

Valé Elsie, you will be sadly missed by us all.

.RA presentation by Linda VK7QP at Tassie Expo.

ssie Ham Radio
ɔnvention and Expo 2022

: Tassie Ham Radio Convention
l Expo took place on the first
ɔkend of November. This is
same weekend on which
ARAmeet will be held this year. I
report that the weather was really
ısant for the whole weekend,
ch bodes well for ALARAmeet.
The weekend started on the
lay evening with a BBQ at the
lio and Electronics Association
outhern Tasmania (REAST)
ɔrooms. This was a well-catered
well-attended event that got the
rolling for the serious business of
conference the following day.
)n the Saturday there were twelve presentations on a variety of topics. About 100 people were registered for the conference, and I was pleased to meet Andrea VK7AAC and Marija, VK5MAZ., ALARA Contest Manager, for the first time.

These presentations are available on the Ham Radio DX YouTube channel playlist. Of particular interest to ALARA was *The How and Why of Youth Engagement* presented by Steve Goodgame K5ATA. While this focused on youth engagement, there are also messages here that relate to our new members and grant recipients. Can we keep better connected with them?

Paul VK5PAS gave a presentation about WWFF in VK, which celebrates 10 years next year – look out for events and certificates in relation to this. The QRP SOTA presentation was fascinating – how small can you make a radio so that you can work from a summit. The answer is: surprisingly small.

I finished off the day with a promotion for next year's ALARAmeet – so watch the presentation for the latest information. It's on the Ham Radio DX YouTube channel, here: https://youtu.be/oyPLOe44wds

While you are on the Ham Radio DX YouTube channel, take a little time to look at some of the other videos that Hayden VK7HH has produced. There are lots of items of interest for new and old hams.

Sunday was the Ham Expo and about 150 attended that event. ALARA had a table that Catherine VK7GH and I staffed for the day. We were pleased to welcome Di VK4DI, Margaret ZL3YF, and Katherina VK1FKAT, amongst others.

Some of us arranged to head off for coffee as a group, and Lee VK7LEE took a photo of us together before we went. It was a good opportunity for a chat and to get to know each other.

It was a great event overall, particularly as it has been a few years since VK7 amateurs have got together, and we were also able to welcome interstate and ZL visitors.

It is anticipated that this may become a biennial event, and I certainly look forward to the next one.

A ladies at the Expo 2022 ALARA table – left to right: Andrea VK7AAC, Catherine VK7GH, Jane , Linda VK7QP, Margaret ZL3YF, and Marija VK5MAZ.

ALARAmeet 2023 – It's this year!

Here is the latest update of the ALARAmeet 2023, from coordinator, Linda VK7QP.

ALARAmeet 2023 is scheduled for 4-5 November 2023. We look forward to welcoming you to Hobart for the event.

The provisional program is:

Friday 3 November

- Optional pre-conference cruise to Peppermint Bay for lunch.
- Opportunity to attend the Tasmanian Symphony concert in the evening.

Saturday 4 November

- Morning. Welcome: displays of radio items of interest and all the other interests. We have photographs to record the event.

Salamanca market

- Afternoon. We look forward to sharing information about what we do on the air. This can include chasing and activating parks, contesting, working with young people, ANZA net. If you want to share your activities let us know.
- Evening – dinner – guest speaker.

Sunday 5 November

- Morning. Visit to the historical Female Factory. Visit to REAST, our local radio club: Echolink net, fox (or native animal) hunt: Operate the club station with the special event callsign. BBQ.
- Afternoon. Visit to Richmond.
- Evening – dinner – guest speaker, awards.

Monday 6 November

- Optional post conference tours.

During this year we will be finalizing the program and costing the event, so that registration will be available with the April ALARA newsletter.

Bookings on the Spirit of Tasmania are already tight for next year, particularly if you wish to bring a motor-home or caravan, so book now if you want to come on the ferry.

Have a look at the presentation by the Tassie Ham Radio Convention and Expo to see some photos of what to look forward to, visit: https://youtu.be/oyPLOe44wds

If you want any more information, or wish to offer to share your activities on the air, please contact me at luther8@bigpond.com.

That's it for this month. Ladies, how about dropping me a few lines about any interesting contacts you've had of recent times or a word or two about your "mountain-top" adventures.

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ce - supporting your on-air activities

ollect your precious QSL cards. Free to members!

Well, at least a certificate

yourself? And your station?

IHF. Field days. Local and

ional contests

- the one source you can trust

and protecting our privileges

nsee has a stake!

action over decades achieved all we enjoy

ed voice with the authorities - nationally and globally

regular consultations with the amateur fraternity

suring our privileges are aligned internationally

Protecting our spectrum

- Retained continuing access to the 6m, 70cm, 13cm & 9cm bands
- Always acting to have intruders removed from our bands
- Opposing interference threats

National news service - VK1WIA

- Keep up-to-date - local, global and space news
- Weekly *nationwide* broadcasts - 30 minutes of audience-based news
- On the bands and online in text, audio and video
- Trusted support for amateur radio clubs and societies

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- Website - www.wia.org.au
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- Twitter - twitter.com/VK1WIA
- Youtube - tinyurl.com/WIA-News-Videos
- Memnet - member-exclusive email bulletins

WIA history

Our origins go back to 1910, when the first Institute was formed to represent wireless experimenters to the government. Major reform of the Radiocommunications Act over the early 2000s, and to amateur radio licensing worldwide, saw a single national organisation formed in 2004 to meet the emerging challenges

WIA around the world

The WIA represents you internationally. We're a member of the International Amateur Radio Union (IARU), which advocates for amateurs' interests to the International Telecommunications Union, particularly at its World Radio Conferences. These determine global radio regulations and frequency allocations. The WIA is the only Australian amateur radio body with membership of the International Amateur Radio Union.

WIA national office: Unit 20, 11-13 Havelock Road, Bayswater, Victoria 3153
Hours: 9am-5pm EAST, Mon-Fri. Postal: PO Box 2042, Bayswater, Vic 3153

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