maker ▲ electronics ▲ wireless ▲ projects ▲ on-air ▲ news

AMATEUR Radio

WIRELESS INSTITUTE OF AUSTRALIA

www.wia.org.au

Since 1910

DIY – wide range RF power meter

Dick Smith's new book – memoir or text?

TV in Oz – hams who beat the broadcasters

'Reading' your oscilloscope

Test & Measurement tools and techniques

ISSN 0002-6859

02

9 770002 685031

Volume 90 ◀ Number 2 ▶ 2022 Price: $14.50 incl GST

Fun to Operate Multi-Functional Mobile

Leading C4FM Digital & High-Resolution Full-Colour Display

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

FTM-200DR

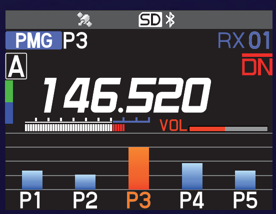
C4FM Digital Clear Voice — Clear and Crisp Voice Technology
AMS Automatic Mode Select
66 ch GPS
WIRES-X
microSD Card
Bluetooth®

《 Actual Size 》

PMG-SR Monitor

Monitor a Primary Memory Group with a Single Receiver

PMG-SR* operation provides constant monitoring and communication on up to 5 channels in the PMG group, regardless of the VFO or Memory channel operation. Instantly register the current display frequency to the PMG group by pressing and holding the "PMG" key.
AUTO mode or MANUAL mode PMG operation can be selected.

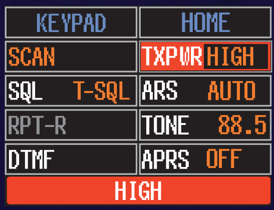


CFL Display

Custom Function List Display

The CFL screen allows checking and immediately executing priority functions simply by using the "F/Menu" key and dial.

Up to 8 functions or settings from the set-up menu can be registered in the custom function list.



3W Outstanding Audio Output

Worldwide WIRES-X

Internet Communications

APRS Fully Compatible

* FTM-200DR is a single receiver, there is no audio output when monitoring multiple registered channels.
While the Operating channel is active, the real-time reception status of other channels is not displayed.

YAESU The radio

YAESU Authorized Dealer

Andrews Communications Systems
Shop 8, 41-51 Bathurst Street, Greystanes NSW 2145
Tel: +61-2-9636-9060
URL : www.andrewscom.com.au

Strictly HAM Pty. Ltd.
Shop 12B Church Street Bayswater Victoria 3153
Tel: +61-3-9729-7656
URL : www.strictlyham.com.au

YAESU Authorized Service Center

Andrews Communications Systems
Shop 8, 41-51 Bathurst Street, Greystanes NSW 2145
Tel: +61-2-9636-9060, Fax: +61-2-9688-1995
E-mail: radioandrews@hotmail.com

VK Radio Repairs
347 Settlement Rd, Thomastown Victoria 3074
Tel: +61-3-9010-5070, Fax: +61-3-8682-8748
E-mail: yaesu@vkradio.com.au

maker ▲ electronics ▲ wireless ▲ projects ▲ on-air ▲ news

AMATEUR Radio

Serving Australian radio amateurs since 1933

Volume 90
Number 2
2022
ISSN 0002-6859

The Journal of the Wireless Institute of Australia

Advocacy Education Support

Editorial

Editor in Chief
Roger Harrison VK2ZRH
editor@wia.org.au

Production coordinator
Dr Brian Clarke VK2GCE

Technical editors
Phil Fitzherbert VK3FF
Dr Alan McPhail, VK2AMC
Jules Perrin, VK3JFP

Publications committee
Bruce Kendall VK3WL
Simon Rumble VK2VSR
Ewen Templeton VK3OW
Eric Van De Weyer VK2VE

All circulation matters
nationaloffice@wia.org.au

How to submit material
Phil Fitzherbert, VK3FF
philipfitzherbert@wia.org.au

Letters to editor
Simon Rumble, VK2VSR
simon@wia.org.au

Hamads
editor@wia.org.au
www.hamads.com.au

Advertising
nationaloffice@wia.org.au

Registered office
Unit 20 11-13 Havelock Road
BAYSWATER VIC 3153
Australia
Phone: 03 9729 0400
Fax: 03 9729 7325

Production deadlines
All articles, columns, Hamads, and advertising bookings for Volume 90, Issue 3 – **8 April 2022**.

General

Technical

Columns

This issue's cover: I said to Sergio, "Sergio. Maate, chuck all these pictures and cover lines on a white tablecloth and just see what happens!" See? That's what happens! Would I lie to you? Our graphics design artist, Sergio VK3SO, has excelled himself this issue. The T&M feature begins on page 20. VK2ZRH.

NEXT ISSUE: Homebrew hacks and hints

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).

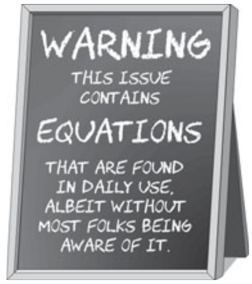
Disclaimer
The opinions expressed in this publication do not necessarily reflect the official view of the WIA and the WIA cannot be held responsible for incorrect information published.

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.

Editorial

Roger Harrison VK2ZRH



Here we are, Issue 2 for the year. I was here before! Two years ago, I grasped the nettle of getting the production of *Amateur Radio* magazine back on-track, delivering five issues from August through December so that members received their six issues for the year. Never mind the rampaging pandemic.

So, over these two years, the Publications Committee and I have taken the opportunity to spend some time, thought and effort developing the magazine, to improve its appeal to the readership and hopefully, to the retail audience buying copies through newsagents. At the instigation of David VK3BDX and the encouragement of Board member Lee VK3GK, we launched a reader survey via the weekly broadcasts, online and in the magazine (Issue 5, 2021). The results were both enlightening and encouraging.

In 2020, the concept of 'themed' issues was introduced. The pleasures of "Portable Pursuits" launched the concept with Issue 4 for 2020, followed by "Antennas and Feedlines," Issue 5. "Radio DF" – foxhunting in another guise, leapt forth in 2020's Issue 6. DIY Digital amateur TV leapt into frame from Issue 1 for 2021, followed by a min-theme focused on WSPRing in Issue 2. But the big bang theme that really struck a chord with readers was the "Antarctic Adventures" edition – Issue 5 last year. It was closely followed by Issue 6's "Antennas and Propagation" theme. Columnists have joined-in, aligning their content with an issue's themes.

Beavering along calmly and persistently is Newcomers' Notebook, the initiative of Jules VK3JFP, launched with Issue 5 last year and pitched to appeal to the needs and interests of those who are new to amateur radio. We can't be 'all things to all people', but we're working to appeal to as broad a spectrum of interests as we're able.

From Issue 1 this year, you've witnessed a 'refresh' of *Amateur Radio's* 'look and feel', to extend what we've been doing with the content. And there's more to come. Stick with us, folks.

That Bird slug

No doubt some readers will be wondering about the provenance of the photo of that Bird Thru-line RF power meter slug on this issue's cover at lower right, rated at 2500 watts. It belonged to me until last year. It was one of those items that I had to part with when I down-sized and moved from Sydney to the Gold Coast.

So why, when the Advanced licence conditions limits me to 400 Wpep, 120 Wmean RF power output, would I need such an item? Well, " . . funny you should mentions that . . ," as the line from an old joke goes. I became involved in aiding some colleagues working towards developing applications for high power permits from the ACMA, and the need to make measurements to an acceptable accuracy was part and parcel of that. Not that I didn't harbour similar ambitions, myself, I have to admit. LOL.

So, when the opportunity arose to add to the facility of my Bird 43 Thru-line RF power meter with the acquisition of that slug, I took it, and it kept company with its high-power stablemates acquired previously for frequency ranges above and below that 50-125 MHz (6m!) slug on the cover. My efforts in conjunction with my colleagues did not go to waste. I learned a lot in the process.

Having sold it, along with its stablemates, I guess I have fulfilled the wish lists of others.

IARU

Shaping the future

In October 2021, the Region 1 organisation of the International Amateur Radio Union (IARU), held a five-day online workshop to explore this topic. Some 50 countries and 100 participants joined in. Here is the report on the significant event.

Through a total of seven working sessions, the delegates built the picture of the future amateur radio we wanted to see and confirmed the key steps to get us there. As a result of this collaborative work, you will find:

- The list of key values we see as our guiding principles and must not be compromised,
- The reasons for Amateur Radio to exist and to endure for decades: our Core Purpose,
- What we want to see in 10 years when looking at Amateur Radio: our Overarching Goal,
- What must be done for this Overarching Goal to be a reality: our Strategic Objectives.

The last section presents the action plan we have prepared to go forward. You can download the summary of the workshop outcomes here: https://tinyurl.com/yckf52yp

Key values

The following key "values" describe what we see as central to amateur radio into the future:

Fun. Enjoyment. Passion. Hobby. Experiencing the magic of radio-electronics-wireless communications as a lifetime adventure (for all ages), just for personal interest, without commercial purpose. Amateur radio is not just fun: we are passionate about the use of electromagnetic communications and technology to make achievements and improve ourselves. We enjoy personal interaction with likeminded [people] and want to serve our society.

Global ham community. The global ham community is an inclusive environment without frontiers. Ham spirit is used within the community and is a multicultural, apolitical, open-minded and tolerant concept, where friendship is built around the world. Common interests are shared and developed within this community.

Practical experimentation (technology & communication). The freedom to experiment. Curiosity-driven experimentation with technology and communication techniques, re-using existing techniques and improving them, understanding and exploring the physics of electromagnetic propagation.

Innovation. A focus on creativity and innovation around leading-edge technology and an intense curiosity about what might be possible. Developing new techniques.

Learning and education (tech & comms). A foundation for amateur radio is the continuous self-training and education within technologies and communications. Curiosity and a wish to break existing technical boundaries are strong drivers, as well as sharing knowledge within the community to educate and help others.

Value to society. Promoting interest in science and technology subjects across society. Amateur radio also provides trained radio operators and radio engineers to businesses. Provide logistical support and radiocommunications expertise in emergency situations and public events.

Our core purpose and overarching goal

We then discussed "why" Amateur Radio exists, and agreed a sentence that summarised this:

> ***Provide an accessible way that people can enjoy and personally grow from experimentation with, and utilisation of, the radio spectrum, bringing together like-minded people in a community of common interest and offering social and economic benefit to others in our areas of expertise.***

Given this context, we considered what we wanted to see in ten years' time, allowing for both our vision for the future and the need to fix some of the weaknesses and address some of the threats in the SWOT analysis. This is what we want to see:

> ***Amateur Radio is booming across Region 1. It has evolved to become one of the leading communities of expertise for science and technology enthusiasts. It is rightly respected and admired, both for the self-development opportunities that it offers and for the value it delivers to society as a whole.***

Strategic objectives

We then considered what would make that 10-year ambition happen. We saw eight key areas ("strategic objectives") needing to be in place:

1. Amateur radio is continually redefined and refocused to be relevant and appealing to a wide range of science and technology interest groups;
2. Amateur radio is seen as a welcoming and accessible activity for people of all ages, backgrounds, genders, and ethnicities, providing fun, social community and personal development;
3. Amateur radio is seen to be providing social, economic, educational, and other benefits to society;
4. Experimentation, innovation, and creativity are central to amateur radio, which is publicly recognised as the leading non-commercial community on wireless communication;
5. Amateur radio provides a supportive environment for self-development and excellence within communications and technology, supporting the development of STEM (science, technology, engineering, and mathematics) skills;
6. Governments, non-governmental organisations (NGOs), professional bodies and academia acknowledge the relevance and technical capability of the amateur service and its benefit to society;
7. Amateur radio has an extensive media presence from its accessibility to new entrants to its high value technical and scientific contribution;
8. IARU has an active program and supporting tools to strengthen member societies, their mutual cooperation and their development and growth.

Ukraine amateurs off the air

On the morning of 24 February, following the Russian military invasion, the Ukrainian Amateur Radio League (UARL / LRU) circulated a message advising a 30-day ban on the operation of amateur stations in Ukraine.

Anatoly Kirilenko UT3UY, Vice-President UARL, said: "Early this morning, Russia launched a war with Ukraine," adding that Martial Law was declared and sending thanks to ". . USA, Great Britain, Canada, Poland, Baltic countries, Czech Republic, some EU countries for help and weapons."

A February 23rd 'state of emergency' decree from Ukraine President Volodymyr Zelensky included the regulation of TV and radio activities and "a ban on the operation amateur radio transmitters for personal and collective use."

The International Amateur Radio Union (IARU) Region 1 Secretary, Mats Espling SM6EAN, said: "The situation changes rapidly," adding "IARU Region 1 continues to monitor the development and [expects] all radio amateurs to follow their national laws and regulations." *The ban continued as we went to press.*

The UARL is a member of the IARU. Sources: ARRL, IARU, Southgate ARC.

13yo gains Advanced licence

Aged just 13, Frederike Dötsch from Amberg in Germany has gained a Class A amateur licence (equivalent to our Advanced).

With her newly-minted callsign, DH9FD, Frederike is the youngest holder of a class A license in the Deutscher Amateur Radio Club (DARC). She's been a DARC member since October 2021 and a keen participant in DARC radio competitions.

Passing the A-Class exam on 29 January, Frederike studied first for her beginners E-Class licence through an online course that she took along with her older brother.

Her enthusiasm for amateur radio began two years ago. She was supported through her study by her family in which both her parents and her grandfather are active radio amateurs.

The fascination with radio has existed in her family for several generations. Both her grandfather and her parents are active radio amateurs.

The aim of DARC's training courses and encouragement of young people is to introduce them to amateur radio, especially more young girls and women, and to inspire them to choose a technical profession when they later choose a career and so stand out from the crowd of applicants. Thus, by engaging in amateur radio, young technical and scientific talent is recruited and promoted, true to the DARC motto "From radio amateur to engineer." Visit: *https://tinyurl.com/3fr4heew*

At 13, Frederike Dötsch passed her German Advanced licence in January and is heard on air from Amberg signing DH9FD.

VI80BOD recalls Darwin bombing

The Bombing of Darwin on 19 February 1942, 80 years ago, was commemorated by the Darwin Amateur Radio Club (DARC) on 19 February this year.

Under the special callsign VI80BOD, the Club ran a DX Marathon on the 20, 15 and 10 metre bands, operating from the old QANTAS hanger at Parap, a Darwin suburb.

The date marked the first of at least 64 air raids on the Top End of Australia, which continued for 18 months, until November 1943. In commemorating this day, we are also passing the story on to the next generation.

In 2011, Bombing of Darwin Day joined Anzac Day and Remembrance Day as a National Day of Observance.

Special callsigns aplenty!

Members of the Radio Club Belge de l'Est are ventilating the special event call sign **OR100RCBE** during all of 2022 to celebrate the club's founding in 1922. QSL via ON4GDV. [ARRL]

The HF bands will light up with global operators hunting for contacts with two special event stations in the UK to commemorate 1900 years since the building of Hadrian's Wall.

Throughout 2022, Austin Vaughan M0MNE and Roy Nicholson M0TKF are operating **Hadrian's Wall** special event stations **GB1900HA** and **GB1900HW**. They plan to be active on the HF and VHF bands using voice, CW and digital modes.

The special event stations will be officially part of the Hadrian's Wall 1900 Festival that features hundreds of events and activities taking place across Hadrian's Wall locations. Further information on GB1900HA and GB1900HW is posted to QRZ.com. Also visit: *https://tinyurl.com/2p955r9j*

This shows the remains of a granary at Housesteads Roman Fort on Hadrian's Wall, England (Wikipedia).

DXpeditions on the move

Between 27 March and 9 April, the **Central African Republic** will be sought after on the amateur bands when the Italian DX team fire up **TL8AA** and **TL8ZZ**. The former will be operating CW-SSB-RTTY, while the latter will be running FT8.

Activity will be on 80-10 meters, including 60-m. The Italian DX team plans are to have seven operators and four stations. Operators include Tony I2PJA, Silvano I2YSB, Angelo IK2CKR, Stefano IK2HKT, Gino IK2RZP and Maurizio IV3ZXQ. Their official Web site is at: *www.i2ysb.com/idt*

Over 1-9 April, Wies SP1EG, Hans DK8RE, Frank DM5WF and Hans DL8UUF, will be active as **OH0EG** from Jomala on **Fasta Aland** (EU-002), in the Aland Sea off the east coast of Finland.

According to OPDX, activity will be on 160-10 meters using dipoles for 160 and 80, with a groundplane for the remaining bands. See: *https://tinyurl.com/2p8cu46u*

Over 19-26 April 2022, the 'DX Adventure Team' plans a DXpedition to **Svalbard** as **JW0X** and **JW1000QO**.

Comprising a team of 15 very enthusiastic people, it's a joint venture of Max ON5UR and Erik ON4ANN.

The aim is to be active with five stations on all HF bands in different modes (CW, SSB, RTTY, FT8-FT4). In addition, the aim to be the first to activate EU-026 on QO-100 (as JW1000QO). See: *https://tinyurl.com/2p8uhnp3*

5G service rollout may clash with aircraft altimeters

The relentless rollout of 5th generation (5G) mobile phone systems has triggered actions concerning potential interference to aircraft radio altimeter (RA) systems.

In Australia, the Civil Aviation Safety Authority (CASA) issued an Airworthiness Bulletin late last year highlighting the issue (AWB 34-020 Issue 3).

RA equipment may be stand-alone or as an input to multiple flight systems. "Many RAs form part of and support critical safety-of-life aircraft functions throughout multiple phases of flight," says CASA. They operate in the 4-8 GHz 'C-band', the 4.2-4.4 GHz sector being allocated for Aeronautical Radionavigation Services (ARNS) that is protected from interference under International Telecommunications Union (ITU) regulations.

CASA noted a number of reported malfunctions leading to flight altitude errors but said it has no confirmed reports of wireless broadband or telecommunication systems interfering with aircraft RA systems. The "3.5 GHz" band is being used to deploy 5G in Australia, currently.

The potential interference issue was raised with the ACMA, which is considering the reallocation of frequencies within the 3.7-4.2 GHz band. This ". . would allow telecommunication companies licences to utilise frequencies adjacent [to] the RA band for Wireless Broadband (WBB) 5G operations," says the Airworthiness Bulletin.

In the US, the 10 largest airlines raised a ruckus about potential 5G interference with the aviation authorities there, according to a report by BBC Business.

In January, the chief executives of American Airlines, Delta Air Lines, United Airlines and others, sent a joint letter to the head of the Federal Aviation Administration (FAA), the chair of the Federal Communications Commission (FCC), the director of the National Economic Council, and the Transportation Secretary, warning that: "Immediate intervention is needed to avoid significant operational disruption to air passengers, shippers, supply chain and delivery of needed medical supplies."

The US airlines fear C-band 5G signals will disrupt planes' navigation systems, particularly those used in bad weather. Earlier this year, an expert witness told a US House of Representatives subcommittee that older radio altimeters lack filters that prevent interference with critical navigation, especially during landing.

The witness said this kind of interference is not believed to have been a factor in any crashes but the potential does exist because older altimeters are capable of picking up transmissions outside of their assigned band, such as those used by 5G.

Thanks to ***Gareth Davey VK4AGD*** and VK1WIA.

APRS creator Bob Bruninga WB4APR SK

The creator of the Automatic Packet Reporting System (APRS) Bob Bruninga WB4APR became a silent key on February 7th succumbing to cancer and the effects of COVID-19. He was 73. Bruninga announced his cancer diagnosis in 2020.

APRS is an amateur radio-based system for real time digital communications. Data can include GPS coordinates, weather station telemetry, text messages, announcements, and queries etc. APRS data can be displayed on a map that can show stations, objects, tracks of moving objects, weather stations, search and rescue data, and direction-finding data.

While best known for APRS, Bruninga was also a retired US Naval Academy senior research engineer who had an abiding interest in alternative power sources, such as solar power. In 2018, he authored *Energy Choices for the Radio Amateur*, published by ARRL.

APRS originated in 1982 when Bruninga wrote his first data map program that plotted the positions of US Navy ships for the Apple II. He later developed an emergency data traffic system for the VIC-20 and C64 PCs. The program was ported to the IBM PC platform in 1988, and was renamed APRS in 1992. The Australian national APRS frequency is 145.175 MHz; APRS is globally linked via the internet. [ARRL]

Author-editor-engineer Joel W1ZR SK

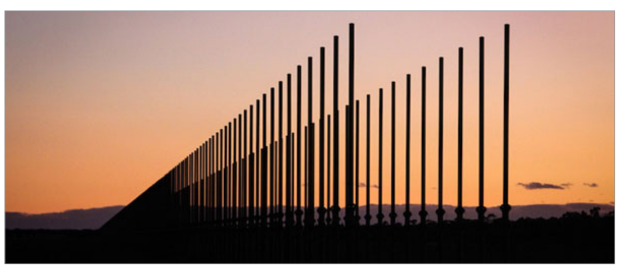
Retired QST Technical Editor Joel R Hallas W1ZR died on November 25. An ARRL member, he was 79.

Although retiring in 2013, Hallas remained active as a QST contributing editor, handling the popular *"The Doctor is In"* column and its eponymous podcast. He was licensed since 1955. Survivors include his wife of 58 years, Nancy W1NCY.

Hallas authored various ARRL-published books about communications, among them being *Basic Radio, The ARRL Guide to Antenna Tuners, The Care and Feeding of Transmission Lines, and The Radio Amateur's Workshop.*

He earned his bachelor's in electrical engineering from the University of Connecticut and an MSEE from Northeastern University. Before joining QST, he'd worked at Raytheon, GTE, IBM and AT&T. He also taught college level classes.

"Joel was not only brilliant, he shared that brilliance with the ham radio community in a way that taught innumerable hams things they needed to know in order to experience success and enjoyment," said ARRL Publications and Editorial Department Manager, Becky Schoenfeld W1BXY. "He was a fine mind, a generous mentor and colleague, and a consummate gentleman. He will be missed."



More over-horizon RADAR in our region?

A report on the Alpha Defense India website last year suggests India may build and operate its own HF Over The Horizon RADAR (OTHR).

Alpha Defense said the premier development lab of the Indian Defence Research & Development Organisation (DRDO) is working on an OTHR system to "keep a close eye on Chinese movement in [the] Indian ocean region. The Indo-pacific is now turning out to be the most important part of the world today. For India, this part of the world is even more important as it is India's Backyard."

The DRDO is working with partners saying that it will realise an OTHR prototype in 2022. The system design is already complete and is now entering prototype realization stage. The prototype will have two different types of antenna arrays – a wire log-periodic to identify the best frequencies to use, and a broadband vertical monopole array for operational use. Source: https://tinyurl.com/26yp86b5

Chipping away at 9-cm band

The spectrum regulator in the USA closed-off amateur use of 3.45-3.5 GHz from 14 April 2022. US amateurs have had secondary access to the 3.3-3.5 GHz, or 9-cm, band for decades.

Action by the US Federal Communications Commission (FCC) in recent years led to a spectrum auction of 3.45-3.5 GHz in January 2022. The American Radio Relay League (ARRL) took action over 2019-2021 to preserve amateur radio secondary use of the 9-cm band.

The ARRL advise that secondary operations are permitted to continue indefinitely in the remainder of the band, 3.3-3.45 GHz, pending future FCC proceedings. Get a view of the story at: www.arrl.org/3-ghz-band

Locally, secondary access to the 9-cm band (3.3-3.6 GHz) for Australian amateurs has been impacted by Apparatus-licensed Fixed Wireless Access (FWA) installations in support of the NBN that use 3.4-3.6 GHz point-to-point across major city routes.

World Amateur Radio Day 18-04-2022

On 18 April each year, amateurs across the world light-up the spectrum, calling each other to celebrate founding of the International Amateur Radio Union (IARU) in Paris.

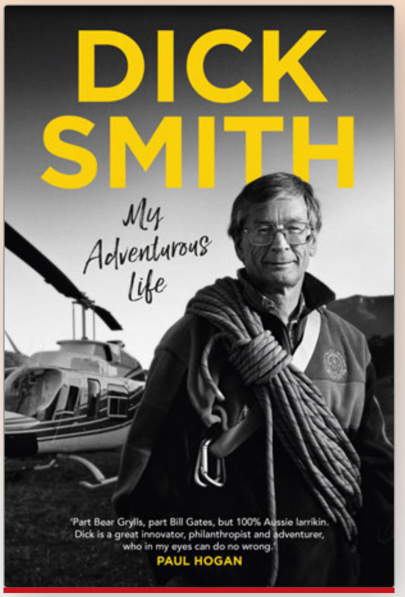
Amateur radio experimenters of the era were the first to discover that the shortwave spectrum could support worldwide communications. In the rush to exploit these shorter wavelengths, amateur radio was "in grave danger of being pushed aside," the IARU's founders noted.

Just two years later, at the International Radiotelegraph Conference, amateur radio gained the original frequency allocations still used today, at 1.8, 3.5, 7, 14 and 28 MHz. Radio amateurs are now able to experiment and communicate in bands allocated throughout the spectrum.

From the 25 countries that formed the IARU in 1925, including Australia, the IARU has grown to include 160 member-societies. The International Telecommunication Union (ITU), which determines regulations and frequency allocations globally, recognises the IARU as representing radio amateur's interests.

Today, there are more than 3,000,000 licensed operators worldwide. www.iaru.org

Book Review



In Dick's 'corporate colour scheme' of black-and-yellow (naturally!), the book is hard to miss in booksellers, whether on-street or online. Published by *Allen & Unwin*. AUD$39.99.

An autobiography, or textbook?

Andy Keir VK2AAK

"Dick Smith is the entrepreneurial businessman who founded **Dick Smith Electronics**, **Australian Geographic** and **Dick Smith Foods**. A Companion of the Order of Australia, an Australian of the Year and one of the National Trust's *Living Treasures*, an aviator who has flown five times around the world, including the first solo helicopter circumnavigation, and across Australia and the Tasman Sea by balloon." (Author bio, from *Allen & Unwin*; our emphases – Ed.).

Although *My Adventurous Life* is an engaging chronicle of Dick Smith's life and adventures, it's far more than just that. The book reveals many personal observations, thoughts, and philosophies from the man himself. It's a captivating insight into the person as well as his many achievements. Although a relentless self-promoter, this isn't just Dick Smith blowing his own trumpet.

The narrative is comfortable. Dick's accounts of everything from his business life to his many adventures are written in an easy and very personal style, almost like you're sitting next to him listening as he tells the story. Any readers who have been lucky enough to attend a presentation that Dick has given at a radio club will recognise the style.

He takes us on a journey through his life, from his birth in 1944 until the present day. From his earliest childhood memories, through his less than academically spectacular school years, to the founding and eventual sale of the hugely successful Dick Smith Electronics business.

There's his introduction to, and enduring fascination with, amateur radio and electronics, his involvement with scouting, his love of the outdoors, girlfriends and lost love, girlfriends and found love, his early career, the highs, and the lows. The humble beginnings of starting his own car radio business, and how it all so easily may never have happened. These early chapters are not just an insight into the man, but also a window into Sydney and Australian society and industry, from the 1940s until modern times.

Parallels

From my own perspective, what made the book so fascinating was that it brought back so many memories. For me it's not just an autobiography but almost a book on modern history. For anyone who was involved in electronics, CB or amateur radio through the 1970s and 80s there will be plenty that is reminiscent. There were many parallels to my own childhood and youth, such as scouts and dabbling with radio and electronics. I even learned to fly (fixed wing) at the same flying school as Dick. I'm left wondering whether some people are just drawn to certain things and are destined to become radio amateurs. Do some of us 'fit the profile'?

Back in the mid-1980s I had the pleasure of working for a while at Dick Smith Electronics, in the R&D section at the head office in North Ryde. The fact that I got paid for doing this was something of a bonus because, if truth be known, I probably would have done it for nothing; such was the nature of the company.

A wider story

Although at that time, Dick Smith Electronics was in the process of being sold and on the cusp of much change, the ethos of the organisation was still evident. There was plenty of freedom and innovation, and boundless enthusiasm, but above all, integrity. For readers of *My Adventurous Life*, it will be easy to see how the personal values of one man were so pervasive in everything he did.

There is also so much that I didn't know. Despite being a part of amateur radio and the hobby electronics scene, it was captivating to learn about events that took place behind the scenes. The book has filled in many blanks.

Later times, other chapters

The Dick Smith Electronics heyday is only part of a much bigger story. For those readers who weren't around in that era, or were focused on other things, there is a lot to enjoy in this book. Dick's business success allowed him to indulge his passion for adventure and the later chapters of the book describe some of these in detail.

He recounts adventures (and a few misadventures) ranging from climbing Ball's Pyramid to flying solo around the world in a helicopter, and much more besides.

There are many photographs included in the book, not distributed throughout the text but spread over two separate sections for a total of around 32 pages. The majority are quite clearly personal snapshots, not commercially shot images. Many must have come from family albums. I really like that approach to illustration as it enhances the personal 'feel' of the narrative.

In summary

Dick Smith is a success in so many ways. He is a man who has used the money he's made for great benefit. Some business people accumulate wealth just for the sake of being wealthy. Dick has used the rewards he has earned to enrich not only his own life but those of many other Australians.

The book is a story well told of a life well lived. I would recommend this book to all Australians because it contains some great life lessons. I believe some business people should perhaps look at it not as an autobiography, but as a text book!

Virtual AGM & Conference Program

7th May 2022

Antarctic Gateway Theme

Saturday 7 May Morning

AGM – held online via Zoom registrations

AWST +8	ACDT +9.5	AEDT +10	Description
0830	1000	1030	Annual General Meeting
0925	1055	1125	Break
0930	1100	1130	Open Forum
1015	1145	1215	Break

Professor Elizabeth Leane

Saturday 7 May Afternoon

Held online and streamed via Zoom Webinar

Eventbrite registration required: www.eventbrite.com.au/e/250007648607

AWST +8	ACDT +9.5	AEDT +10	Presentation Description
1100	1230	1300	Announcements and Housekeeping
1105	1235	1305	Keynote Speaker – **Professor Elizabeth Leane** - presentation on Sidney Jeffryes and the role played by wireless in the Australasian Antarctic Expedition (1911-14)
1150	1320	1350	**Rex Moncur VK7MO** - Director Australian Antarctic Division (AAD) 1988-1999 experiences and challenges as a Director of the AAD. The good and the challenging!
1235	1405	1435	Break
1300	1430	1500	**Dr Andrew Klekociuk** - AAD - Atmospheric Studies in Antarctica
1345	1515	1545	**Peter Yates VK7PY** and **Kim Briggs VK7KB** – AAD - Antarctic Communication Challenges and Review
1430	1600	1630	Wrap-up

Australian Government · Department of Agriculture, Water and the Environment · Australian Antarctic Division | Australian Antarctic Program | IMAS Institute for Marine & Antarctic Studies | University of Tasmania | reast

Unsung pioneers of TV technology in Australia – Part 1

Secrets, shocks and surprises – beating the big boy broadcasters

Peter Wolfenden VK3RV - WIA Historian

Facets of Television in Australia, 65+ years ago; detailing some activities surrounding the start of broadcast television, when amateurs trumped the broadcasters.

About 65 years ago, a face appeared on a small screen in the corner of the sitting room and uttered: "Good Evening and Welcome to Television". The person on that small screen – 'the box', was officially the first of a multitude of unknown faces to enter our homes and lives, tell us what to buy, how to behave, and to contribute over the years to massive societal changes.

That interloper was one Bruce Gyngell, unknown to most who saw and heard him then as he introduced the opening program of Australia's first commercial television transmission from TCN-9 Sydney. That transmission all those years ago on 16 September 1956, is considered by the general public as the start, or dare I say 'the get-go', of Australian television.

The official opening of Melbourne's HSV-7 took place a couple of months later on 4 November 1956. According to 'history', television was primarily introduced to Australia because the impending 16th Olympiad that was to take place in Melbourne between 22 November and 8 December 1956.

Recalling times past

Test transmissions began earlier in both cities. They were primarily test patterns accompanied by recorded music – if you were lucky, and occasionally a short documentary film.

At the time, Phyl Moncur, although not an amateur but married to Len VK3LN, wrote *YL Corner*, a regular column in *Amateur Radio* magazine. In her October 1956 column and under the heading of "TV Fever", she wrote about the early test transmissions together with the 'goings-on' in the Moncur household leading up to HSV-7 officially opening. (And yes, Rex Moncur VK7MO is related, and I thank him for some family history.)

TV Fever is a delightfully humorous article, taking in typical activities of those early TV days, to which many OTs (Old Timers or well-aged amateurs) will readily relate. The only notable activity missing in my mind was the crowd of night-time 'lookers-in', staring through the local Radio/TV shop front window at two or three flickering television receivers, fitted with extension speakers hanging from the shop verandah.

It is certainly one of my fond memories of that time. Phyl's visit with OM (Old Man, or husband) Len to "Snow" Millbourn's (VK3CW) *Ham Radio Suppliers* store in Hawthorn, Melbourne, is a great reflection of some of those 'all but lost' antics from that time, both social and technical, which occurred during that small window of time back in 1956.

So, let's re-wind to the months before the beginning of broadcast TV and absorb part of Phyl Moncur's story from her *YL Corner* column:

"We called in on Snow 3CW. Business as usual? Good heavens no! It was the day the first test programmes were scheduled to be televised. We weren't the only ones to call in on Snow, there was a steady stream of them all morning, all with the same enquiry – 'Have you seen anything yet?' That same old glow, yes it was there in Snow's eyes.

"Snow had had his TV set ready for months. He kept switching to the various channels to illustrate effects of interference, etc., for our benefit. Snow had also been kept busy that morning making cups of tea and was washing up his limited supply of cups ready for the next surge of friendly enquirers when the screen went black.

" 'What the heck now,' he ejaculated and rushed to turn the switch, when in the dim light there appeared to be smoke rising from his precious TV set. There was a frantic turning off of switches and turning on of lights, only to find that the "smoke" was steam rising from his hands from the hot washing up water. Snow gulped and grinned that great big grin of his – 'Fancy me falling for that one,' he said.

"Eventually I saw TV, the test pattern; a series of odd shapes and lines. So this was TV. I was definitely not impressed. However it was enough to ignite that glow in my OM's eyes and send him straight off to order a TV receiver." [1]

Ham Radio Suppliers was a regular advertiser in *AR* and the *Call Book* and Snow was well known to most

Len with camera, Phyl, "the most televised woman in Australia", and unknown radio reporter c1949 (image source unknown).

of the active and potential amateurs in Melbourne and other states via his mail order service. He was always ready to help and advise young amateurs, and was quite a character!

However, Phyl did not mention in her article that her OM, Len, had been playing with **Cathode Ray** Television since 1949 and earlier, from 1935, with a **Mechanical** (Baird) type system. Neither did she mention that, by 1956, she had been 'televised' many, many, times and would have seen the 'odd shapes and lines' of test patterns previously! Whereas, at Snow's, Len was more of an 'educated, critical onlooker' at those first commercial broadcast test transmissions in Melbourne.

This article is largely based on newspaper reports together with a number of early magazine articles collected over the years by my father and I, and recently re-discovered. Other material is from *AR*, the WIA Archive, and Rex Moncur.

This is not a thoroughly researched article on all TV history in Australia, but I think it should introduce some interesting aspects of the subject to many amateurs, and others, and perhaps take a few of us for a stroll down memory lane.

Technology of the times

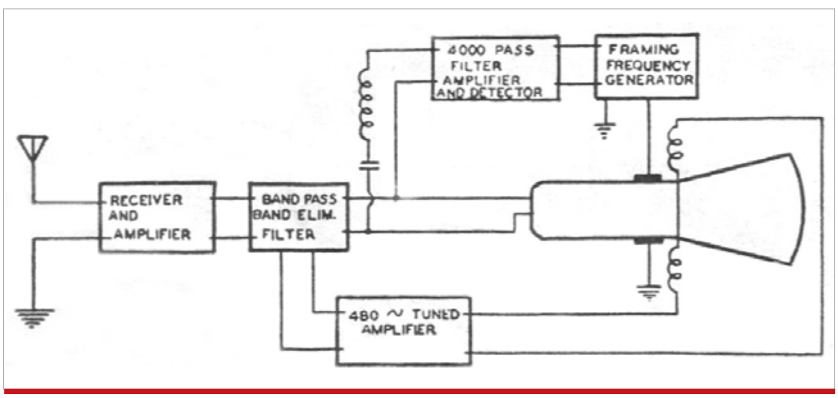
There are a number of early reports on mechanically scanned television, including a 1925 report published in *Radio Broadcast*, an Australian magazine that, for a time, was also the official organ of the WIA. Two notable amateurs, Ross Hull and Howard Kingsley Love, were involved with the editorial and production of this magazine. But early mechanically-scanned television is not the subject of this article. [2]

A magazine given to me by another early ATVer, Geoff Hughes VK3AUX, contained a detailed article on *"Cathode Ray Tube Television"*, prepared by a Westinghouse Electrical Engineer at the forefront of TV at that time, Vladimer Zworykin. The article was based on a paper he presented to the IRE (Institute of Radio Engineers) in Rochester NY during November 1929.

This very early article included information on receivers and a motion picture film-scanning 'transmitter' that used a vibrating mirror to scan the film frames. Vladimer was a Russian-born American immigrant, who later moved to RCA to up their cathode-ray television development. In the conclusion to the magazine article, he stated that, in summary, the conventional scanning disc type of television produces a red image (from the neon glow lamp), whereas the picture as viewed on the end of a cathode ray tube is superior, but green. His new system had no moving parts, produced a larger image, so more people could easily watch it and it was bright enough to be viewed in a moderately lit room. [3]

Post-WWII, *AR* magazine for September 1947 included a detailed five-page article entitled "Amateur Television", by G. Horrocks VK6GS. Surprisingly, this article is largely about his experimental work between 1935 and 1942. It includes Horrocks' early involvement in the use of 78 rpm gramophone recordings of early BBC Television images, together with his experiences in making various mechanical scanners and their integration with cathode ray tube picture displays.

Following the end of WWII, his work concentrated on a flying-spot motion picture film scanner with aspects not unlike Vladimir Zworykin's early developments, including a vibrating mirror in the film scanning process – and all this experimental work done in the isolated South Western district of Harvey, in WA. His final comments



Block diagram of 1929 cathode ray television receiver (see Ref.3).

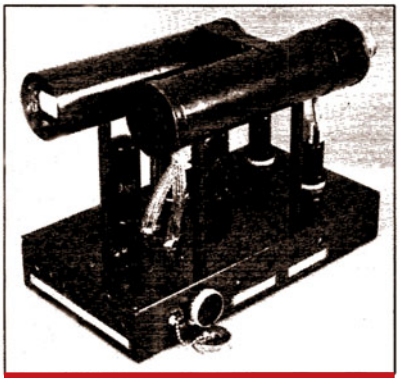
included a statement that he hoped it will not be too long before electronic pick up (camera) tubes will be available to amateurs in Australia.

During 1940, *QST* published an article detailing a television camera using an Iconoscope image pick-up tube, then available to amateur experimenters in America. WWII saw many Australian servicemen experience RADAR and the electronics surrounding the use of cathode ray tube technology. This was an important influence on ATV here. So, the combined WWII experience and the earlier *QST* article provided a path for a number of Australian amateurs to become involved in cathode ray amateur TV (ATV). Len Moncur was one such amateur who had those experiences during his WWII service. [4]

Photographs of cameras built by both Len VK3LN and Geoff VK3AUX reveal that this 1940 design was substantially the approach they adopted in developing their ATV systems, as the physical layout and construction appears to be like that in the *QST* article. From limited other reports, Len succeeded in having his system operating ahead of Geoff's, perhaps a year ahead.

Immediately post-WWII, the Australian government was not prepared to allow TV broadcasting of any form, as it was considered to be frivolous and there were many other essential activities requiring Australian's efforts and taxes at that stage. But, at the Royal Easter Show in March 1948, the first public demonstration of a 405-line Pye television system took place. It was conducted by a consortium made up of the Shell Oil Company, Pye, and Astor (Radio Corporation Australia).

But as it turned out, 1949 was to be the significant year for TV here – including ATV. More widespread public demonstrations took place around the country from May, when the same consortium provided 'entertainment demonstrations' in all capital cities. This began in Melbourne over 9 to12 May 1949,



Camera head, as described in 1940 QST.

moving to Sydney, followed by Adelaide, Brisbane, and Perth. A new local magazine, *Australian Radio and Television News* reported on the Melbourne and Sydney tests in their second issue, published in June 1949. [5]

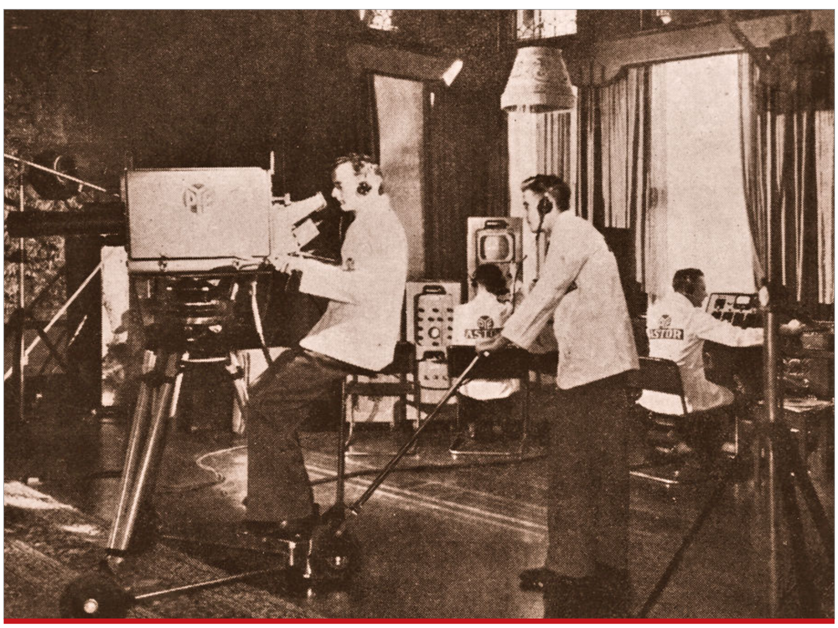
The August 1949 issue of *Radio Science*, another Australian magazine, stated that the general TV standards for Australia had been broadly settled. The CCIR 625-line system with FM sound was to be employed here, and not the 405-line UK standard. There was also a statement that broadcasting should not start in Australia "for another couple of years . .". [6]

Amateurs beat broadcasters

From the ATV perspective, it appears that when government permission was granted for importing the television demonstration equipment from the UK, a spin-off occurred – 'a window of opportunity' that enabled amateurs to legally import image pick-up tubes from America. Both Len and Geoff obtained their camera tubes at about this time; there were possibly others as well.

Two sources of information broadly support this view:

1. A short newspaper report during January 1949 stated:
   "…. The Customs Department will not give him a licence to land it. 'Everything is ready to plug in the valve' [camera tube] Mr. Moncur said today. 'If I got that valve tomorrow, by the weekend I could televise something in Ascot Vale and it could be seen in Geelong'…" [6]
2. A personal letter, dated 20 January 1986, from Geoff Hughes VK3AUX to the author, includes:
   "… Please find enclosed 4 photos of my early camera unit, (ideas from QST October 1940, built 1949 - 1950) …"



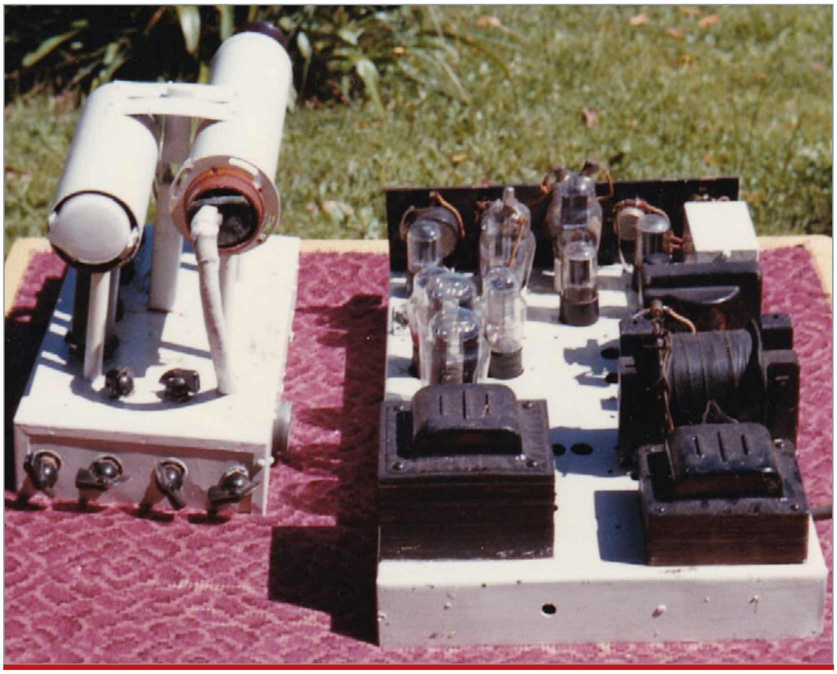
1949 TV Demonstration, *Australian Radio & TV News.*

That newspaper article in 1 above entitled: "Can't get valve to test television", also included the comment about Len transmitting a TV signal from Ascot Vale to Geelong. While possible using the 288 MHz, (or 1-m) band, it was strictly speaking, not legally permissible then. But, by mentioning the possibility of transmitting his television signal to Geelong, Len drew the attention of the press and public to his activities and his frustrations with the authorities. It helped to continue the pressure on them to formally allow the importation of camera tubes and allow amateur TV transmissions in Australia. [7]

Len finally obtained his hard-to-get camera tube via an unusual source and a totally unexpected person. At the 1976 *RAOTC* (Radio Amateurs Old Timers Club) Dinner, Len told the story about how it occurred. During 1948, he was asked by the organiser of the Melbourne *All Models Exhibition*, the Reverend L.L. Elliott, if he would demonstrate television. Len explained that at present he could not, because he needed an iconoscope, or camera tube, and that the government would not allow their importation.

The Rev. Elliott was a man who delighted in challenges and simply said to Len, "Leave that to me". The outcome was a success, achieved by getting the Missions to Seamen (now known as Missions to Seafarers) of New York, to gift – obviously, of their own free will, and with no money changing hands – the Missions to Seamen in Melbourne with not one, but two, iconoscope camera tubes. These were duly handed over to Len for him to 'produce the goods' for the Rev. Elliott at the next *All Models Exhibition*. [8, 10]

A later article about Len and his pioneering ATV activities in *AR* for July 1985, states that the iconoscopes arrived too late for the 1949 exhibition, but were successfully used in the 1950 exhibition, **six years before the start of commercial television!**



The camera that beat the broadcasters! It was built by Geoff Hughes VK3AUX and used to demonstrate TV in Melbourne.

Perhaps there is a degree of confusion about the dates here, as so far, no information about a 1950s exhibition can be found and all other reports seem to point to 1949 as the year that Len first demonstrated his closed-circuit ATV. But we are only talking about a possible one-year discrepancy.

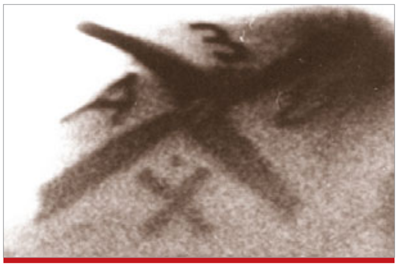
Details of the *QST* 1940 camera design stated that it was a 30 frames per second (fps), 120-line system, whereas Len's system operated at 25 fps and 130 lines, to fit in with the 50 Hz Australian power system frequency. [8]

Presumably, the system at VK3AUX was initially the same, although I believe that it was later modified for 625 lines, as the early 1970s ATVers, were using conventional 625-line television receivers fitted with home-made 70-cm to VHF TV front end converters. Many employed Ian McKenzie's (VK2ZIM) very good *Electronics Australia* design of 1972 to enable the reception of the 70cm ATV transmissions.

Len's closed-circuit ATV was demonstrated at a number of the *All Models Exhibitions* held at the Melbourne Exhibition Buildings from 1949. These were very popular events and the WIA had the prime position on the building's main stage. Photographs indicate the extent of public interest in amateur radio at that time and the preparedness of the then Victorian Division of the WIA to publicise amateur radio.

The WIA exhibit covered the large stage area of the grand and immense 1880 heritage protected building that was used for the formal opening of the first Australian Parliament in 1901, depicted in the notable Tom Roberts oil painting of the *First Commonwealth Parliament*. In 1919, the Exhibition Buildings served as a hospital for the Spanish Flu pandemic, just as it is presently used as a major inoculation hub for COVID-19. *Plus ça change, plus c'est la même chose!* (The more things change, the more they stay the same).

Closed circuit ATV activity in Victoria, and perhaps elsewhere in the country, was certainly gaining momentum during 1949 and through the early 1950s. The *AR* Editorial for November 1952 stated:



Early VK3AUX screen shot – something is better than nothing!

> *"…. many Australian People saw themselves televised as far back as 1949. But what was unique is the fact that the television equipment with which they were televised was Amateur equipment; the first known Amateur television equipment in Australia. This was a working exhibit at the Exhibition completely home built and installed by Len Moncur VK3LN…." [10]*

In Part 2, I will visit in more detail Len's closed circuit ATV equipment at the *All Models Exhibitions*, a brief review of AR articles about television during the early-to-mid-1950s, together with a couple of relatively unknown commercial pre-TV activities. Also, a quick look at some of the PMG's (the then regulator) technical requirements for both the Television Service and the Amateur Service leading up to 'switch-on day', as well as some interesting statistics about the 1956 Olympic Games, the raison d'être for the start of Australia's television broadcasting service.

References

1. "YL Corner" column, *Amateur Radio* magazine, WIA, October 1956, p18.
2. "Seeing by Wireless", *Radio Broadcast* magazine, September 1, 1925, p38.
3. Zworykin V, "Cathode Ray Tube Television", *Citizens Radio Call Book Magazine and Technical Review*, USA, January 1930, p90).
4. Lamb JJ, W1AL, "Television Camera-Modulator Design for Practical Amateur Operation", *QST* magazine, ARRL USA, October 1940, p11.
5. "Television Demonstrations in Melbourne and Sydney", *Australian Radio and Television News* magazine, July 1949, p14).
6. Editorial, *Radio Science* magazine, Sydney, August 1949, p1.
7. "Can't Get Valve to Test Television", *Herald* newspaper, Melbourne, January 5, 1949.
8. "Len Moncur speaking at ROATC Dinner", Voice recording 1976, WIA archived recording, CD11, pt4.
9. "All Models Exhibition". *Amateur Radio* magazine, WIA, October 1952, p9.
10. "I Was Televised in 1952", Editorial, *Amateur Radio* magazine, WIA, October 1952, p3.

The COVID Chronicles

Tales from the shack of Arthur VK2BBI

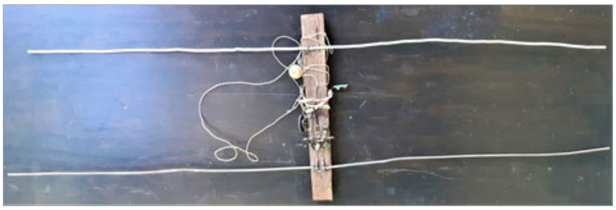
Arthur Day VK2BBI

(Lockdown month #3: September 2021)

There is nothing like being under house arrest during a pandemic to force a domestic clean-up and, in the process, unearth some long-lost construction sins committed in the name of our hobby.

I describe two surviving examples from a childhood misspent in the *Westlakes Radio Club* at Teralba, near Newcastle. These projects date from the mid-1960s.

Project 1: the runs-on-air 2m racing sniffer



This project was constructed at zero expense using 100% recycled components. Essentially, it's a beam and a crystal set. The beam elements comprise strands of aluminium wire obtained from a high voltage power transmission line found 'lying about in the bush'.

The second photograph here illustrates the informal construction style typical of the era. Not so much a 'breadboard' design but more a 'random-piece-of-wood' form of component support. The beam elements are mounted using U-shaped nails of the sort otherwise seen fastening-down chicken wire. The rest of the components were scavenged from old radios and TV sets liberated from the nearby *Speers Point garbage tip*.

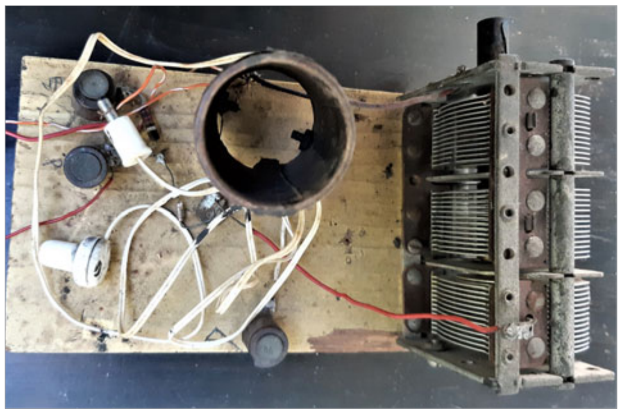
Note the valiant attempts at soldering to aluminium…

The design is a basic one. RF rectification is achieved using an OA91 diode mounted directly across the driven elements of the beam. The resulting audio has been judiciously directly coupled to a high input impedance amplifier. The input was carefully balanced so as not to destabilise the operation of the all-important OA91.

The amplifier was constructed around a single TT641 transistor whose heightened audio output was harvested and converted into human-readable form using a crystal earpiece (piezoelectric earphone). Everything was powered from a single nine-volt battery.

The KISS design principle (keep it simple, stupid!) made this sniffer a highly competitive piece of kit for its time. Hidden transmitter hunts were all the rage!

Project 2: A self-powering zero emissions broadcast receiver



The third photograph shows an innovative single-stage radio receiver powered entirely by free energy. Its power is obtained using the nifty principle of electromagnetic induction to excite a passive collector known as a long-wire antenna. While the front end might resemble the tuned circuit from a late-1950s 'valve job', this is merely coincidence. The frequency-filtered RF from the tuned circuit is rectified into audio through an OA91 and converted directly to sound via a crystal earpiece.

The receiver was good for all the local medium wave broadcast stations and was safe to operate – so long as there were no thunderstorms brewing in the vicinity.

The provenance of the components is similar to that for Project 1 – junk from the tip.

As an aside, the local garbage tip was a key resource for many 12-to-13-year-old electronics enthusiasts at the time. My accomplice on the tip raids was David Lawrence who, to this day, still attends Westlakes every Saturday afternoon. He is the club's longest continuously serving member and remains an avid collector of vintage radios.

Our enterprise was not without its risks. Aside from the occasional snake, the tip was under constant surveillance by an angry adult tip troll who carried a big

Join the WIA – we're for you!

Advocacy Education Support

The Wireless Institute of Australia

Congratulations

In becoming a radio amateur, you have joined the ranks of more than 13,000 Australian radio amateurs and a worldwide fellowship of some 3 million, from all walks of life.

Your voice since 1910

The WIA – a united, truly national organisation run by radio amateurs for radio amateurs.

Join, benefit and contribute.
Here's what you get and what you can do.

WIA membership benefits

Amateur Radio magazine – supporting your interests

6 issues a year – print and online

- The **trusted source** for Australian amateur radio since 1933
- Covering ***all facets*** of amateur radio
- Produced ***by*** Australian amateurs ***for*** Australian amateurs
- Hamads free – For-sale/Wanted – print and online

Membership card – gets you discounts at vendors

WIA Online Bookshop – supporting your self-learning

A curated list of recommended books from trusted sources

- WIA books discounted to members, e.g. Foundation Manual

QSL Service – supporting your on-air activities

Send and collect your precious QSL cards. Free to members!

Awards

Go for gold! Well, at least a certificate

Contests

Want to test yourself? And your station?

- HF. VHF/UHF. Field days. Local and multi-national contests

The WIA – the one source you can trust

Advancing and protecting our privileges

- Every licensee has a stake!
- Collective action over decades achieved all we enjoy
- Your **trusted voice** with the authorities – nationally and globally
- Effective, regular consultations with the amateur fraternity
- Always ensuring 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

Member Engagement

- Website – www.wia.org.au
- Facebook – www.facebook.com/wiavk
- Podcast – www.wia-files.com/podcast/wianews.xml
- 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

Join or renew / encourage a friend

Use our Online Membership system, visit:
www.wia.org.au/joinwia/wia/onlinejoin/
Or call (03) 9729 0400.

GOT A NEW LICENCE? 1-Year Free Membership!

If you received an Amateur Operators Certificate of Proficiency (AOCP) – Foundation, Standard or Advanced – at any time since 1 January 2018 and are not a member of the WIA, you are eligible for a **complimentary 1-year WIA membership.**

If you are already a WIA member (now, or when you receive your qualification in the future) you are eligible to receive a 1-year membership extension or a $100 discount off a 5-year membership. If this is you, or someone you know, all that is needed is a completed WIA membership form and a copy of the relevant AOCP qualification showing the date of qualification.

stick. But we had getaway vehicles – our bicycles. That tip is now a sports field. If only the players knew of the countless unexploded TV picture tubes lurking beneath.

Someone asked if I followed schematics for these projects. The existence of such documents would imply that some kind of formal construction plan was followed, but this was the swinging sixties. Schematics were for squares, man!

Several years later…

The final photograph commemorates an achievement in our senior high school days when the Westlakes team was co-opted to construct a homebrew PA system and install it in the ceiling of the Booragul High School assembly hall. This was done under the capable leadership of my mate "Jack" VK2ATR. The output was a pair of 6L6s lashed together in one of those symbiotic circuitry embraces illustrated in the text books but, alas, any other details have been lost in the mists of time.

'Booragul High' had a chequered history. After we left, it was re-named 'Lake Macquarie High' due to reputational issues.

Characters in the piece: back row, left – "Jack" Lorentzen VK2ATR (now VK2AE); front row, 2nd from right – David Lawrence; 3rd from right – the author.

Would anyone ever be allowed to do today what we got away with back then?

ANNOUNCING: di-dah!
The Don Edwards Memorial Slow Morse Contest 2022

St George Amateur Radio Society Inc.

The contest is to remember Don Edwards VK2NV (SK), a long-time member of the St. George Amateur Radio Society and keen Morse operator. It is also to encourage amateurs who rarely or never use Morse code to give it a try. Open to all VK and ZL amateurs. Only single, non-assisted stations. No multi-operator stations.

Saturday 14 May 6pm to 9pm EAST (0800-1100 UTC) – **80 metres**

Sunday 15 May 1pm to 4pm EAST (0300-0600 UTC) – **40 metres**

Amateurs can enter either or both sessions – home, portable or mobile.

The speed limit is 10 words per minute to encourage inexperienced or rusty operators to try their hand or fist – all contacts sent by hand and received by ear. No keyboards, memory keyers or computer readers allowed. Hand sent Morse code can be from a straight key, mechanical bug, or electronic keyer (but no memory or canned messages).

Scoring: Each contact will be counted as 1 point. To encourage those who never sat for or passed a Morse exam for their licence, an extra 2 points per session can be claimed. Contestants who also self declare that "they had fun" during the contest can add 1 extra bonus point.

Logging requirements and all other details are set out in the SGARS website.

www.sgars.org

Test equipment for the ham shack

Andy Keir VK2AAK

Amateur radio is an extremely diverse purstuit, covering the whole gamut between enthusiasts who predominantly operate and those who predominantly construct. However, no matter whether you spend more time with the microphone than you do with the soldering iron, you can be sure that at some point something in your station will either break or won't work as expected. and if you're going to do something about that, you'll need the right tools.

The problem with electricity is that we can't usually see, smell, or touch it. (OK, I admit we may be able to touch and feel electricity, but if it's there in sufficient quantity the sensation might be all too brief!).

We can't use our eyes to see that an antenna isn't matched. We can't smell an open circuit patch lead. We can't hear a short circuit. (OK, I admit that we may be able hear a short circuit, but once again, if the electricity is there in sufficient quantity the sensation might be all too brief!).

What we need are instruments and tools that enable us to find out what's happening. So, in this article I'm going to try to give some insight into what sort of test and measurement equipment is appropriate as well as what's available, from the frugal to the fancy, and from the essential to the esoteric.

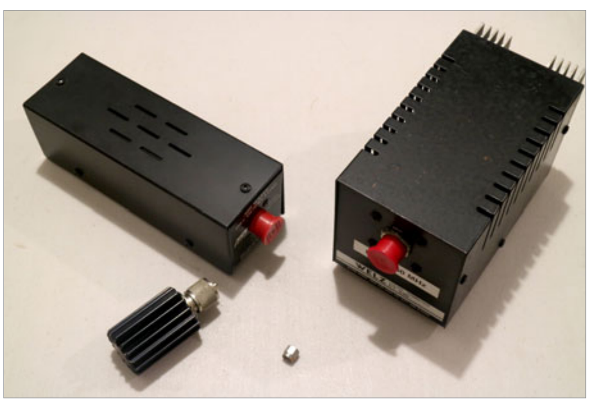
While there is plenty of both new and used test equipment out there, I'll be concentrating mainly on what I have found appropriate for the average radio amateur. This is about the 'active' ham shack, not so much the development laboratory.

My test bench; modest by some views, well-stocked to others; but it serves me well.

Dummy load!

OK, let's get this out of the way first. Yes, I know a dummy load isn't really a test instrument itself. However, it is something essential to the use of other test instruments and it is something that every radio amateur should own. They are relatively cheap, widely available and yes, you *need* one.

Try to find one that will handle up to 100 watts (intermittently,



Dummy loads come in various sizes and styles. The 'button' thing in centre-front is a 50 ohm dummy load built into an SMA plug for use with a VNA. These dummy loads scale up in size and power going clockwise to the Welz at right, rated at 100 W (av.), 500 W max., with low VSWR to 300 MHz.

Multimeters come in many styles. On the right is a DMM with 10 MHz oscilloscope, as well. Don't dismiss analogue multimeters, they can be extremely useful when measuring fluctuating signals. The clamp meter at left can measure current without 'opening' the circuit under test.

for a few minutes, is fine) at up to VHF and most of your needs will be covered. Seriously, if you don't have one, get one!

Multimeters

There have been plenty of articles written about ham shack test equipment that are framed around a list of 'must have' items. The number one item on many such lists is a multimeter. I agree. You can't do even the most fundamental tests without a multimeter, whether it's something as simple as checking a suspect fuse or a patch lead for continuity, or whether you're home-brewing a valve power amplifier, a multimeter will likely be the most-used piece of test gear in your shack.

A basic digital multimeter can be purchased for around $20 to $30; as a minimum, they will permit measurement of AC and DC voltage, current and resistance. Even budget multimeters may include all manner of other useful features, such as diode and transistor checking and audible continuity testing. More sophisticated models may even have the ability to measure quantities like capacitance, temperature and frequency.

Don't neglect analogue multimeters. Yes, they are still available brand new. If you ever try measuring a fluctuating voltage with a digital multimeter, you'll know why. Some digital multimeters incorporate an analogue bar graph in addition to the digital display. The 'best of both worlds' perhaps?

Multi-functionality doesn't stop there. Among the collection of multimeters I've accumulated over the years, I have one that is not only a digital multimeter but also a quite decent 10 MHz storage oscilloscope! More on oscilloscopes later, but hang on to the concept of buying one instrument that can do lots of different things.

Lab quality or consumer grade? As with most other items of test equipment, this depends on what you're doing, how you're going to be using it and on what. If you're working professionally in the electronics or communications trades, or have deep pockets, then by all means buy top-of-the-range brand name stuff, but really, for most of us, there's not a lot to be gained in practical terms by spending up big. However, avoid the *very* cheapest. A well-made, mid-range multimeter will serve you well and if a protective case is an option, take it.

New or used? With multimeters it's probably going to be new as used units seem to be few and far between. People hang onto them. I did see a lovely analogue multimeter in a hand-made wooden case at a field day last year. It probably dated from the 1970s, undamaged, working perfectly, and from memory it ended up being given away. Such gems should be sought out at car boot sales.

This Digitech handheld digital multimeter provides measurement of DC and AC voltage and current (including true-RMS), along with resistance (to 40M), capacitance (to 100u) and frequency (to 10 MHz), plus transistor gain, continuity and diode checks. It comes with a hi-vis protective case. We review it on page 33 of this issue.

Analogue meters – the question of accuracy

A common misunderstanding associated with analogue meters – both panel meters and analogue multimeters – involves the interpretation of the specified accuracy. Analogue meters have their accuracy stated as a 'percentage of FSD' – Full Scale Deflection.

Consider this typical panel meter here, 0-100 microamps with a specified accuracy of +/- 2.5% of FSD; the "CLASS-2.5" at the scale's lower left tells us that. With 100 uA flowing through the meter, the actual reading might be 97.5 or 102.5. At the left, the reading is 98 uA and thus within specification when 100 uA flows through the meter.

In the instance where 50 uA flows through the meter, for +/- 2.5% FSD accuracy, it might read between 47.5 or 52.5. In percentage terms, however, that's +/- 5% of the reading.

It can be difficult to get your head around this, but the easiest way to think about it is that the stated accuracy is a **constant percentage** of the Full Scale Deflection, it is *not* a percentage of the reading. Thus, if the FSD is 100 units and the accuracy specification is +/- 2.5% FSD, the meter error will **always** be +/- 2.5 units. If the reading is 10, as in the photo at right, an FSD accuracy of +/- 2.5 units represents a possible error of **25%!**

For this reason, with analogue panel meters and multimeters, you should always choose the appropriate scale, or range, for measurements. That is, one where the maximum is close to the expected value being measured, e.g. measure 2.9 V on the 3 V scale, not on the 10 V or 30 V scale.

RF power and VSWR measurement

Meters that measure only VSWR were around in the CB radio heyday ('60s – '70s), but have largely been supplanted by types that also measure power. Generally, we're looking at 'through-line' type instruments with an input socket for connection to the transmitter and an output socket for connection to an antenna or dummy load. Terminated power meters lack an output connection and instead have an integrated, fixed load, usually 50 ohms.

Look for versatility. Many VSWR/power meters are only good over a limited frequency range, so rather than buying several different meters it may be more economical to have one meter that covers a wide frequency span. It's worth noting that most common combination VSWR/power meters are only accurate for measuring RF power when they're correctly terminated. Furthermore, most common meters only read average power rather than peak power, hence are not particularly suitable for directly measuring peak envelope power (PEP) for single sideband (SSB) transmissions.

Most through-line type power meters will also function as VSWR meters, even though they don't directly read VSWR. An example is the ubiquitous Bird model 43. This is a through-line type power meter, but to save swapping the input and output connections, the sensing element (dubbed a 'slug') can be rotated 180 degrees to read either forward or reverse power. The VSWR can then be readily calculated, or looked-up on a chart.

Professional or consumer grade? Once again, it's horses for courses. While meters such as the Bird 43 are considered the holy grail (or 'gold standard') by many (including the ACMA), they can be particularly expensive even if you buy used, and especially if you plan to accumulate a set of inserts (slugs) to cover a range

The legendary Bird 43 portable through-line RF power and VSWR meter. The removable inserts, or slugs, sample the RF in a section of 50 ohm transmission line and provide current to the meter; the slugs rotate 180 degrees to measure forward and reflected RF. Slugs are manufactured to operate at various power and frequency ranges.

Some 'vintage' test equipment is well worth finding and hanging on to. Using just three inserts, this ex-US military Douglas Microwave power meter measures RF power from 10-1000 W over 2-1000 MHz. The inserts are reversible to measure forward or reflected power. This unit was bought for a fraction of the price of a Bird 43, is very accurate and can even be user-calibrated! Do you need a VSWR/power meter? For checking or testing antennas and transceivers, a VSWR/power meter is invaluable.

of frequencies and power levels.

I have found and bought US military RF power instruments dating from the 1950s and 1960s that have proven to be just as accurate, robust, and reliable, but at a fraction of the price.

For most purposes in the average ham shack, something like the Avair AV-1000 should prove more than adequate. I've found mine to be surprisingly accurate on the power ranges, even at 1300 MHz.

There are less expensive models in the Avair range if you don't operate on UHF, or higher bands. There are many competing brands, so do your research.

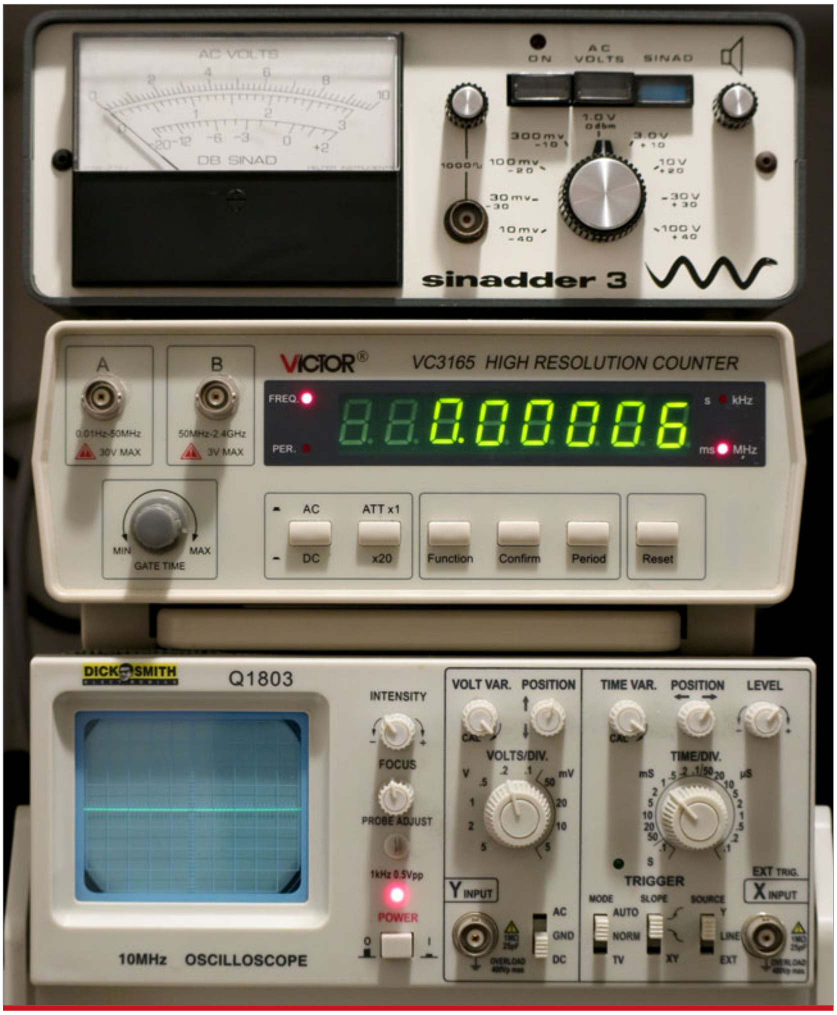
Antenna analysers

These instruments have been around for a while but it's only over the last decade or so that they have become widely available at very attractive prices. Antenna analysers are active devices (as opposed to a simple, passive VSWR meter or RF Noise Bridge) that allow extensive and quite sophisticated measurement of all manner of parameters associated with antenna systems. The instruments essentially comprise a signal generator, sensing circuitry, a display and some clever firmware.

These relatively inexpensive little marvels now commonly offer features we could only dream about a few years ago, often including everything from on-screen Smith Charts to graphical plots of VSWR, to vector network analysis (VNA), even to time domain reflectometry, and more.

This antenna analyser is a VNA with some extraordinary capabilities at a likewise price! On its 4.3-inch colour LCD touch-screen, you can display VSWR, return loss, and Smith Charts, between 100 kHz and 1.3 GHz. A USB port enables use with a PC for extra facilities.

Run-of-the-mill SWR and RF power meters. These units cover an extensive range. The white unit was assembled using an inexpensive module and can directly measure power up to 1 milliwatt at 10 GHz. I didn't expect miracles from this but it compares very well with my old HP power meter.



Oscilloscopes and frequency counters are commonly found in ham shacks. You don't need to spend a fortune. The CRO and counter came from the disposals tables at hamfests for bargain prices. The little CRO sees plenty of use despite its modest specs. The frequency counter is good to beyond 2.4 GHz and agrees well with the 10 MHz reference signal from the GPS-disciplined oscillator I use as a shack standard. The **Sinadder** at top is a good-to-have unit for testing signal-to-noise and distortion (SINAD) of receivers.

The ubiquitous Nano VNA is a good example of what is possible these days at very affordable prices. These amazing little units cost barely more than a basic multimeter, yet offer amazing flexibility. The Mini 1300, pictured here, is a 'big brother' version. Antenna analysers would be right up there on the list of "best bang for the buck" test gear.

Frequency counters

These used to be quite an expensive bit of kit, but like most things, technology has improved and prices have fallen. I still have the 500 MHz counter my wife put together from a Dick Smith kit, back in the 1980s. It still works perfectly, but is the sort of thing that you should be able to pick up at a hamfest or boot sale for $20.

Unless you're looking for laboratory quality, there's not much point in paying more when brand new frequency counter modules and even complete instruments are widely available out of Asia that are surprisingly accurate and amazingly cheap.

That glorious old 20 kg 400 MHz counter that you drooled over decades ago is now probably worth more for the Nixie tubes in the readout than it is as a piece of test gear!

Oscilloscopes

The next piece of test equipment many amateurs get hold of is an oscilloscope. At this point we're starting to move away from basic, routine maintenance of an amateur station into the realms of constructing and repairing. If you're building, repairing, aligning or modifying circuits and equipment, then an oscilloscope is going to be *invaluable*. If you read the 'adjustment' section of most radio service manuals, there will usually be a list of the test equipment required to do the job and this will typically include an oscilloscope.

Your choices are broad. You can frequently pick up a decent, simple 10 MHz or 20 MHz CRT-based oscilloscope at a field day or boot sale for well under $50. I've recently seen a nice 50 MHz dual-trace 'scope advertised on the used market for $100.

If you want to pay a bit more, there are any number of used Tektronix or HP instruments (deservedly, legendary brands) around, but keep in mind that these are not always cheap and while they are professional grade instruments that cost tens of thousands in their day, they are getting a bit long in the tooth now. I recently sent a lovely, but ancient, 150 MHz Tektronix oscilloscope to the e-waste graveyard after months of vainly trying to source parts to fix it.

For new oscilloscopes, you will almost certainly be looking at an LCD display (probably in colour) as opposed to a CRT, and almost certainly a digital storage oscilloscope (DSO) as opposed to a purely analogue unit. These offer a wealth of features and can represent very good value. But beware that they have limitations when displaying some complex signals, where analogue instruments do not. Do your research!

When it comes to 'scope probes,

remember that probe bandwidth is important; the probe/s you use must have a bandwidth that at least matches the bandwidth of the 'scope, or better.

One small item that is often neglected is a simple RF probe. These can turn your multimeter or oscilloscope into a very sensitive instrument for detecting small, high frequency signals, and can be invaluable for aligning oscillator and multiplier chains in receivers or transmitters. I scored a nice HP probe for just a few dollars from one of the many buy-sell-swap groups on social media. If you see one, grab it!

Signal generators and noise sources

Just as some sort of power meter is great for checking the output of transmitters, a means of generating a signal is a requirement for checking receivers. The big, old, expensive, rack-mount clunkers that once adorned the shelves of ham shacks seem to have given way these days to tiny little units 'of (insert a country or region) origin'.

While you can't expect a $30 unit from an online auction site to rival the stability or accuracy of a unit made for professional service, for most hams, these little units will almost certainly do the job.

The biggest drawback of inexpensive signal sources is their lack of calibration. Frequency accuracy and stability tends to be quite adequate, but in many instances we need to know exactly how much signal we are pumping into a receiver. Professional units have precision attenuators; even older units that haven't been calibrated for decades will probably still be close to the mark.

If you can find an old step attenuator at a hamfest and have a means of measuring power below the milliwatt range, you could save a bundle. It's worth noting that many of the antenna analysers mentioned earlier include a basic signal generator function. These are often

For constructors, repairer or hardware hackers, there are many inexpensive component testers available these days. These may be complete units, like the L/C meter, or modules and self-assembly kits. Ability to measure parts directly is a great facility.

ideal for simple tests to determine whether your receiver is hearing as it should.

Note that, if you're testing the receiver section of a transceiver, be very careful not to transmit into your signal generator. Doing this has let out a lot of smoke and earned repair technicians a lot of dollars over the years!

In addition to signal generators, broadband RF noise sources are quite widely available. These usually use something like a reverse-biased diode noise source and a load of amplification to produce quite high level and very broadband RF noise, extending from a few MHz up into the GHz range. In conjunction with a spectrum analyser, these noise sources are great for checking filters and so forth. Just don't connect one to an antenna or you might have the neighbours knocking on your door, perhaps followed by a radio inspector!

Spectrum analysers

In the olden days (i.e. the 1970s), the mark of the accomplished amateur was possession of either a receiver with a panoramic adaptor or a spectrum analyser. If you had one or other, or both, you had truly reached the pinnacle and were the envy of other amateurs. Nowadays of course, instead of a blip on a cathode ray tube, just about every modern transceiver comes with a colourful 'waterfall' LCD screen showing exactly what's happening over large slices of spectrum.

With spectrum analysers, we are moving into the realm of specialised RF test equipment. This is the 'nice to have' stuff, but is rarely a genuine requirement for the average amateur.

Unfortunately, some hams get hold of a spectrum analyser and then wonder exactly what to do with it. If you're building transmitters or amplifiers and looking for signal purity then, yes. Personally, I consider a spectrum analyser without a tracking generator as a curiosity only. You can use it to spot spurious emissions, but not a lot else. If you're working with filters, diplexers and the like, then an analyser with a tracking generator is essential. Beyond that, I believe that if you know what a spectrum analyser does, you'll know why you might need one.

Once again, there are some very inexpensive and widely available

This pair of instruments work in conjunction with your PC or laptop to provide a spectrum analyser and tracking signal generator. Specs are more than adequate for ham shack use.

modern alternatives to the old CRT-based instruments that amateurs used to lust over. You can now buy a 'Tiny' spectrum analyser that covers from 100 kHz to 350 MHz. True, it may not be exactly lab-standard or even close to being a calibrated instrument, but it's enough to satisfy your curiosity, fits in your pocket and will set you back under $100.

A step up from the 'Mini' type are those instruments having the RF bits in a separate case and a USB connection to your computer that does all the display and clever bits. These can be quite sophisticated and useful. For example, I have a small pair of instruments made by RF Explorer. These comprise a spectrum analyser and matching signal generator; while they do have an integrated display, they also connect to a computer and software allows just about all the functions of a full-blown analyser, including a tracking generator. I have used this pair to set up the cavity filters on our club VHF repeater with great success.

The next step is the modern, self-contained instrument, usually with a nice colour display and a similar appearance to a modern digital storage oscilloscope. These range in price from a few hundred dollars to many thousands for professional quality, fully-calibrated units.

As for used spectrum analysers? – like the old CRT-based oscilloscopes, these are perhaps getting a bit long in the tooth. If the price is right and you've got the bench real estate in your shack to accommodate a 30-40 kg unit, then by all means go for it.

Radio test sets

Anyone who has ever worked in the radio communications sector will likely be familiar with the all-in-one radio test set. From manufacturers such as Motorola, HP and IFR, these were used everywhere from the workbench to flying around in the back of the radio tech's ute, to balancing on a tuft of grass next to a tower at the top of some mountain.

These workhorse units incorporate a whole range of instruments, from a signal generator to a sensitive receiver, to RF power meter, oscilloscope, even a simple spectrum analyser in some models. With one of these units, a technician could test an entire radio system: receiver sensitivity, audio quality, transmitter power, modulation, practically everything.

Many of these units have found their way into ham shacks. Although long retired from professional use, they remain extremely useful. Be aware though, they can be a bit of a gamble.

Unless you have very deep pockets, used test sets will be the way to go. Expect to pay upwards of $500 for an old, basic set, up to thousands for a more modern unit.

I have an old IFR 1000S in my shack. I chose this deliberately because most of its parts are still easily obtained, meaning I can service it myself. Mechanical parts

The IFR 1000S, typical of the all-in-one radio test sets from the 1980s. This unit gets a lot of use in my shack.

can be hard to come by, but most of the electronics is quite run-of-the-mill. I chose mine because it had been fitted with a new CRT for the oscilloscope/spectrum analyser and the internal power supply had also been refurbished.

Keep in mind that these units are now quite old and may have had quite a rough life in commercial radio servicing. Don't expect them to be trouble-free. Older units like mine have a propensity to let the smoke out of tantalum capacitors, which is spectacular, but usually easily fixed. My unit is predominantly analogue with some TTL and CMOS logic (74-series and 4000-series). More modern units are much more computerised and can be difficult and expensive to maintain if the manufacturer no longer supports the unit.

But wait, there's more!

There's a lot more useful test gear available than can reasonably be covered in this article. A look around on line will yield a plethora of electronic gadgetry. Everything from top-of-the-range professional instruments to little component testers that can cost less than a cup of coffee. It's amazing what's out there these days.

Don't neglect older equipment if it's in decent condition and comes with all its accessories. This HP 410C voltmeter was picked up for a good price and came complete with the AC probe allowing accurate measurement of tiny AC voltages at up to 700 MHz.

Free tools

In wrapping up, it would be remiss not to mention that you may already have access to some test equipment without realising it. This covers such things as web SDR (KiwiSDR) sites online and built-in power/SWR meters in many rigs.

Many modern transceivers incorporate good output power metering, current metering for the finals and even quite decent SWR metering. While limited in comparison to stand-alone instruments, the information your transceiver provides can be a valuable aid to troubleshooting.

Have you ever wondered exactly what sort of signal you're putting to air? Did you know there are many web-accessible receivers all over the world that you can use to listen to your transmissions in real time? Google (that's a *verb*?) KiwiSDR.

Yes, you can look at your signal on a spectrum analyser and view your audio on an oscilloscope, but an actual on-air test can reveal a lot, especially when many remote receivers provide a nice waterfall display. I just wish I could convince some of the 'turn it up to eleven' folk to take advantage of the ability to look at and listen to their own transmissions!

A simple RF probe can turn your multimeter or CRO into a very sensitive instrument for detecting RF; they're invaluable for aligning receivers and transmitters.

Ohm's Law in practice

Figuring out meter shunts and multipliers without fears or tears

Jules Perrin VK3JFP

Sooner or later, you will need to use a panel meter to show current or voltage relating to the working of a circuit or piece of equipment. Here's how to get that meter to show what you want. A practical, everyday use of Ohm's law, explained simply without complex mathematics.

Figure 1. Analogue panel meters come in a variety styles. These are moving coil meters having a pointer that moves over a scale to show a value in response to current flow.

Analogue panel meters are ubiquitous. Square, round and edgewise shapes, as seen in **Figure 1**, meet different needs. Even the march of digital electronics, liquid crystal displays and specialised ICs has not pushed them off the inventories of electronics stores.

The most common analogue panel meter is the moving coil meter (MCM), sometimes known as a moving coil current meter (MCCM) or permanent magnet moving coil meter (PMMC). In some quarters, it's known as a moving coil galvanometer. Never mind the acronyms and multisyllable terms, let's keep it simple.

We can thank a Frenchman, Jacques-Arsène d'Arsonval, for pioneering development of the moving coil meter that first saw the light of day in 1882. Later, many others refined and improved the moving coil meter. For many years, they were called d'Arsonval meters.

Figure 2 illustrates the general makeup of a moving coil meter. A coil of fine, insulated wire is mounted on a shaft between jewelled bearings, sitting within the shaped poles of a permanent magnet. The core within the coil is of soft iron, concentrating the magnetic field. The coil is positioned by 'control' springs that are connected to each end. The current being measured passes through the coil which experiences a twisting force, or torque. The shaped pole pieces provide a radial field through the coil, thus giving constant torque, whatever the coil's position, while the springs oppose the torque. The coil turns by an amount directly related to the current flowing, which the pointer indicates on a scale.

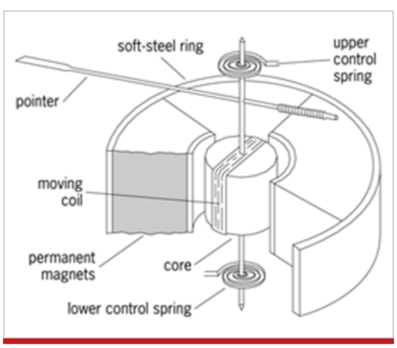


Figure 2. The workings of a moving coil meter, showing all the salient parts.

If you look closely at the square and round meters in **Figure 1**, you can see parts of this marvel of physics and engineering.

Getting to know a meter

The coil in a moving coil meter has a given resistance for its particular design, set out in the maker's or supplier's specifications. The value of that resistance will determine the current at which the pointer reaches full-scale deflection (FSD). The meter in **Figure 3** here, that reads 30 volts FSD, has a specified resistance of 30 kohms. From Ohm's law, the current flowing through the meter at full scale can be found this way:

I meter = E meter / R meter
= 30 / 30,000
= 0.001 amps,
or 1 milliamp (mA)

Now we know that when we are using this meter only 1 mA flows through it when it reads 30 V.

Figure 3. This panel meter is manufactured to read voltage over the range from 0 V to 30 V.

A voltmeter measures the potential difference, or voltage, between two points in a circuit. A current meter measures the current flowing in a circuit. Panel meters are produced to measure one specific current or voltage range.

When circumstances require a different current or voltage to be measured, the meter can be adapted by applying Ohm's law and connecting resistors to change the meter range. The resistors applied are called shunts or multipliers. A shunt is a resistor connected across the meter. A multiplier is a resistor connected in series with the meter.

Behold, the multiplier!

Take the example where we want the meter of **Figure 3** to read 0 to 50 V. Knowing the specifications of the meter, we need to connect a multiplier resistor in series with it, but what value?

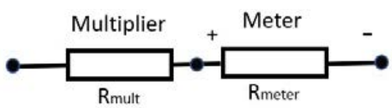


Figure 4. With a multiplier resistor (Rmult) in series with the Figure 3 panel meter, you can have it read to 50 V.

From **Figure 4**, as the meter 'drops' 30 V across its internal resistance at FSD, the multiplier resistor must 'drop' 20 volts. The current flowing at FSD is 1 mA, so the value of Rmult can be found from Ohm's law, like this:

Rmult = 20 V / 0.001 A
= 20,000 ohms, or 20k

In practical terms, you would connect two 10k resistors in series as your multiplier resistance. The meter scale would be recalibrated to read 0 – 50 V.

Figure 5. Common 1 mA FSD panel meters like this can be put to a lot of uses.

Now, the shunt!

With a panel meter like that in **Figure 5**, it may have a specified coil resistance of 1500 ohms. To use this meter to measure 100 mA, you would need to connect a shunt resistor to 'bypass' all but 1 mA of the current, i.e. 99 mA (0.099 amps). **Figure 6** illustrates the principle.

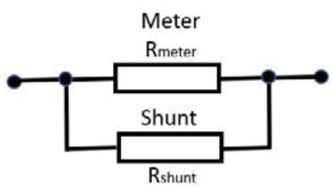


Figure 6. The shunt resistor bypasses an amount of current, effectively increasing the FSD value of the meter.

Emeter = Imeter x Rmeter
= 1/1000 amps x 1500 ohms
= 1.5 volts

Rshunt = 1.5/0.099
= 15.15 ohms

In practical terms, a 15 ohm resistor connected across the meter would do the job.

Read it right

Analogue meters are subject to parallax errors when being read. This is caused by the apparent position of the meter scale relative to the meter pointer, which is slightly above the scale, and the viewing position of the person reading the meter.

To overcome parallax error, the meter must be viewed directly face-on to the scale (90 degrees to the plane of the scale plate).

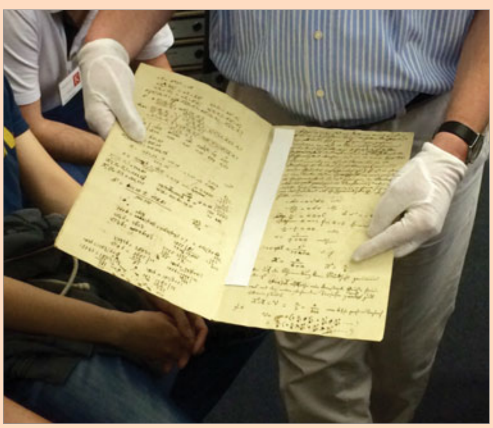
New technology

The continued miniaturisation and lower cost of electronic components and equipment led to better ways to make displays and measurements. In turn, this also led to greater accuracy than achievable with analogue meter scales. Some examples include:

- digital meter displays with back light
- digital multimeters (DMMs) that fit in your pocket
- multimeters with inductance and capacitance functions
- auto-ranging DMMs
- true-RMS reading DMMs.

If you have a topic you would like to nominate to be covered in a future instalment of Newcomers' Notebook, email Jules at jp.bqt@bigpond.net.au

Have fun and stay safe.



It all began here!

The first record of Ohm's law is found in his own lab book, held today at the archives of the **Deutsches Museum** (wikimedia.org), the "German Museum of Masterpieces of Science and Technology" in Munich, Germany. It claims to be the world's largest museum of science and technology.

No bedtime stories here . . .

'Reading' your oscilloscope

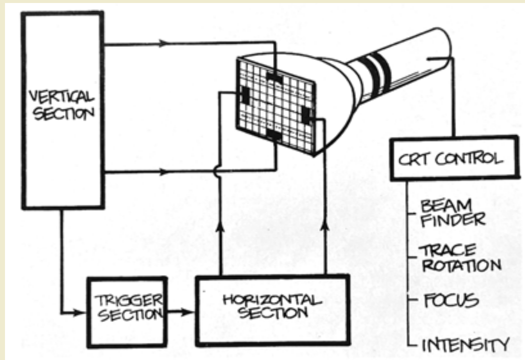
Roger Harrison VK2ZRH

Once you get a stable waveform displayed, here's how to discern its secrets.

So, you've bought yourself, or otherwise acquired, your first oscilloscope. Expectations are high. There's a learning process to go through, and the rewards are great. Undoubtedly, an oscilloscope is truly one of the handiest bits of gear to have. It's many things in one: a signal voltmeter, an analyser, a signal tracer, a frequency meter and period timer, all wrapped up in one convenient box that helps you to visualise, analyse and measure what's happening with a circuit and the equipment of which it is the heart.

Despite the relentless march of digital technology, the analogue cathode ray oscilloscope, or CRO, based on a cathode ray tube (CRT), continues as a mainstay of bench instruments for circuit and equipment development, analysis, service and repair. Curiously, digital instruments with modern liquid crystal or LED displays are also widely referred to as 'CROs'; the term has entered the vernacular, and stuck.

The panel here outlines the basic blocks of every oscilloscope. In this instance, it's a single-channel analogue unit, but two-channel and multi-channel instruments simply have more of the same sections, but the same basic concepts apply. Digital oscilloscopes employ the same concepts of displaying a signal waveform over a span of time but first digitize the signal or signals being examined.



The Cathode Ray Tube (CRT) is central to the display system of analogue oscilloscopes. This diagram` outlines the important blocks that make up a CRO. The CRT at top right creates a beam of electrons that 'write' a spot of light on the fluorescent screen – that end with the X-Y grid on it. Some neat circuitry at top right, beneath the CRT, provides controls for the beam (CRT Control).

To 'draw' the graph of a signal being measured, the signal is applied to the Vertical Section, driving the Y axis of the grid display. Since a CRO is a voltage measuring instrument, signal voltage is shown as amplitude on the display's Y axis.

The Horizontal Section, known as the timebase, sweeps the CRT spot across the screen, from left to right – the X axis. The Trigger Section starts the sweep at defined places of the signal being measured by the Vertical Section. This helps create a stable display by synchronising the sweep to the signal being measured.

Most CROs include an input for a third axis – the Z axis – not shown here for reasons of simplicity. This can have a signal applied to turn on or off the CRT spot, or to set the spot's brightness.

For decades, those CRO makers with at least some smarts have included an **auto** button (or similar) among the controls on their instruments. Its function is to give you a stable display once you connect the instrument's probe to a signal and push the button. Magic! From there, you can twiddle the knobs to your heart's delight to set up the display just the way you want it, knowing that, should you get yourself into trouble, you can always get 'back to taws' by hitting auto.

The graticule

Of key importance in an oscilloscope's display system is the *graticule* – the grid of lines placed across the face of the display. This grid is your prime reference for interpreting what's shown on the screen. With a CRT display, the graticule may be a piece of transparent plastic with the lines scribed on the inside surface placed against the CRT. In upmarket CRTs, the tube is manufactured with a graticule on the CRT's inside surface to eliminate *parallax error* when reading the display.

In the instance where a plastic graticule is placed over the CRT screen, parallax error arises because the trace on the CRT and the graticule are on different planes. If you view the display from an angle slightly off the direct line of sight, the trace will appear a bit displaced from the graticule.

Oscilloscope graticules are usually laid out in an 8 x 10 grid, as shown in **Figure 1**. Each of the vertical and horizontal lines denote major divisions of the display screen. These generally correspond to labelling on the vertical and horizontal section controls that denote, respectively, volts/div and seconds/div.

Where the CRT is of a suitable size, the graticule may actually be scored or ruled at centimetre intervals, in which case the vertical and horizontal controls may be labelled in volts/cm or seconds/cm.

As **Figure 1** illustrates, the graticules on some instruments include marks on the vertical scale for the

10% and 90% amplitude points used to determine the **rise time** of signals; in conjunction with those, dotted or dashed horizontal rules will mark the 0% and 100% amplitude points.

Basic reading rules

Amplitude and time are the two basic parameters you can measure with your oscilloscope. Well, duh! They're the prime characteristics of signals found in electronics and radio communications. Almost every other measurement is based on one of these two fundamental quantities.

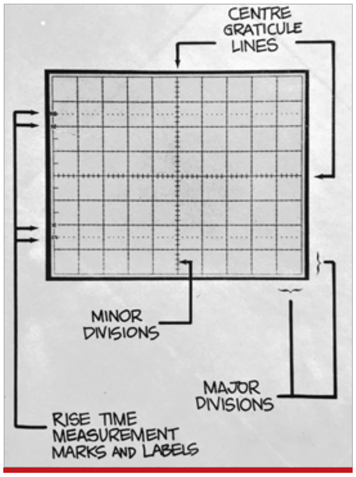


Figure 1. The typical 8 x 10 oscilloscope graticule, illustrating the basic reference marks for 'reading' the displayed waveforms and for taking measurements.

In making either amplitude or time measurements, the prime rule is to **use as much screen area as possible**. The more screen area you use, the better the measurement *resolution*. Use the **centre vertical graticule scale** for *amplitude* and the **centre horizontal scale** for *time* measurements. As you can appreciated from Figure 1, each has five minor graduations and thus less estimation is needed. Even with a dual-channel CRO, the same rules apply: use as much screen area as possible and line up the signals over the centre graticule scales when taking readings.

In taking measurements of a signal that has a DC component, the above rules still apply, but the *zero* reference is established as a convenient horizontal graticule line.

For periodic or repetitive waveforms, such as you 'garden variety' sine wave or square waves, a period measurement is always made **between two points that**

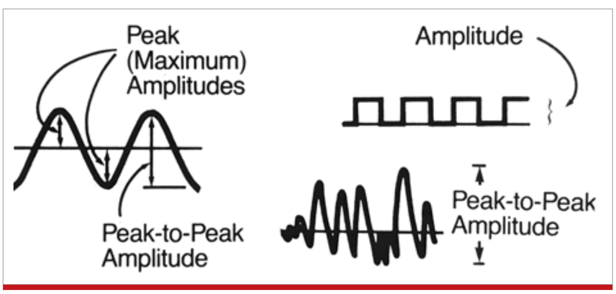


Figure 2. Illustrating the salient amplitude characteristics of both regular and irregular waveforms. These are a measure of the trace's displacement compared with an established reference (typically, 0 V). In some instances, the overall amplitude is of importance, e.g. the peak-to-peak value.

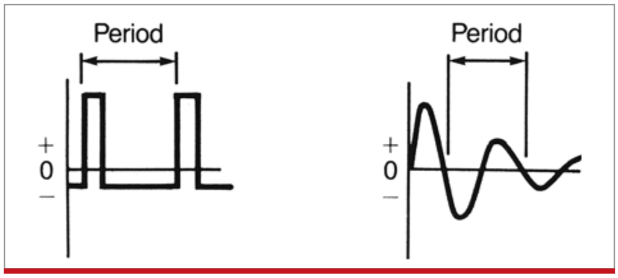


Figure 3. The period of a repetitive waveform is the time required to complete one cycle, taken between points that are on the same place or position on successive cycles.

are at the same place or position on successive cycles.

Voltage and time/period measurements with your CRO are *direct* measurements. You can also calculate *derived* values from these direct measurements of a signal's characteristics. For example, frequency is derived from the period measurement of a repetitive waveform; it is simply the reciprocal of the period:

Frequency = 1/period

If the period is in seconds, the frequency will be in Hertz. When the period is in milliseconds, the frequency is in kilohertz. When it's in microseconds, the frequency is in megahertz. Simples.

Other derived measurements can be made also, particularly when it comes to sine waves. So, time to segue to the sines (it's not a dance).

Reading your sines

A sine wave is the simplest of waveforms you'll meet. Square waves may *look* simple, but are really a complex collection of sine waves. You can use your CRO to read most of a sine wave's characteristics, indeed, *all* of its important ones, with the exceptions of distortion and bandwidth. **Figure 4** shows a sine wave and all its characteristics that can be determined with your CRO.

The peak and peak-to-peak voltages, and the period, can be read directly. The RMS (root-mean-square) value can be derived mathematically from the peak voltage value, as: RMS volts = 0.707 x peak volts.

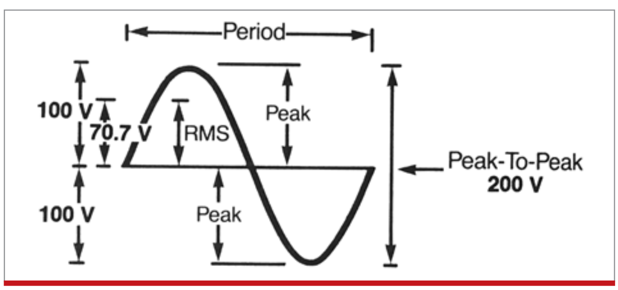


Figure 4. The salient characteristics of a sine wave that you can measure with your CRO, assuming no dc component is present. The RMS voltage value is a derived measurement, using a little maths.

The sine wave signal illustrated in **Figure 4** is conveniently 100 volts amplitude. Hence, the RMS value is 70.7 V. When measuring a signal like this (with care!), you would use a x10 probe and set the vertical sensitivity to 5 V/div, giving an actual scale value of 50 V/div on your graticule. Thus, the signal would occupy four major vertical divisions on the CRO screen.

If this was a 50 Hz sine wave, to display one cycle across the screen, the timebase would be set at 2 ms/div, giving a period of 20 milliseconds across the ten major graticule divisions.

When deriving frequency from a period measurement, better accuracy is obtained by displaying multiple cycles across the screen and then measuring the overall period. A good example is illustrated in **Figure 5**, showing seven cycles of a sine wave in a period of one second. The signal frequency is thus seven times the reciprocal of ('one over') the *total* period of one second – thus, 7 Hz here.

If you display ten cycles of a signal, its frequency would be ten times the total period. The above methodology is a convenient method to remember when reading your oscilloscope.

NB: Illustrations and information relied on here were obtained from the papyrus scrolls of the Harrison family archive, which acknowledged the assistance of Tektronix Australia.

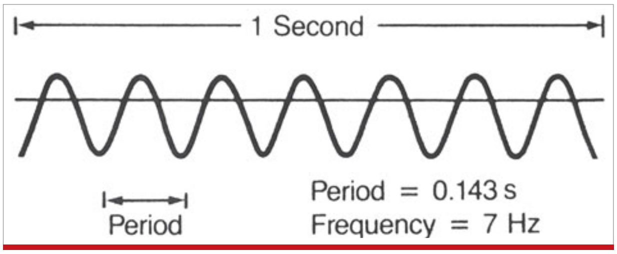


Figure 5. As illustrated here, the frequency of a sine wave may be derived conveniently by displaying a number of cycles across the screen.

Plan ahead

Operate within the band plans: http://www.wia.org.au/members/bandplans/about/

Test Gear Review

Ute-style DMM at a pocket money price

Roger Harrison VK2ZRH

The Digitech QM1321 is a robust, auto-ranging DMM with true-RMS AC measurement at an unpretentious price.

I've seen and used a lot of multimeters during my various careers across manufacturing, RF and electronics product design, science and servicing, technical magazine publishing, and home hobby stuff.

My first multimeter was a volt-ohm meter (VOM) I built myself, with a panel meter and a big, robust, multi-position rotary switch, both re-purposed from ex-defense equipment. I made the chassis, too, featuring a sloping panel. I could measure, within limited ranges and uncertain accuracy, DC volts and current, resistance and continuity. Checking volts or continuity under the dash of the family's FJ Holden was not on. My pocket money saved for a month would not afford a *real* VOM, let alone a vacuum-tube voltmeter (VTVM).

Hurtle through serial careers and where am I at? Well, I still have one or two multimeters. OK, one analogue and one digital. The DMM in my portable toolbox (aka 'Old Yeller') gets used the most. But, but . . I wished Old Yeller, although auto-ranging, did a few more things. Like detect 'live' power cables et al, non-contact. I could retire that bulky pocket-pen tester that's *always* under everything else in the toolbox when needed. And *another* thing: I'd like to identify 'live terminals' with a beep *and* flash without having to look at the instrument; I could retire another old 'pocket' tool. I'd like Old Yeller to hold a reading when I can't watch while measuring something. And frequency measurement; 100 kHz, good, 1 MHz, better.

Lo and behold, along comes this Digitech, with all those like-to-haves wrapped up in a multi-function handheld DMM boasting true-RMS measurement and auto-ranging, plus more besides. Although a bit larger than Old Yeller, the QM1321 fits comfortably in my average-sized hand, even with its high-viz jacket.

The big, robust, multi-position rotary switch fills the panel between the large 4-digit liquid crystal display and the array of four connector jacks. It has OFF positions at each end. You don't have to turn it all the way back when you're finished with the furthest function. Smart. The 4000-count display includes backlighting that turns off automatically after 10 seconds. The digits are 22 mm tall – almost twice that of Old Yeller's (12 mm tall). Easy to read under many different circumstances.

Holding this DMM in either hand, it is well-balanced and I can operate all the pushbuttons with a thumb – and even the range switch – all singlehandedly! The non-contact voltage detection function (NCV) piqued my curiosity. I found it could reliably detect the 15 VDC supply lead to my laptop at 50 mm; likewise for a 240 VAC lead. The LCD shows 1-to-4 dashes for 'field strength' while flashing a LED and beeping. Very handy. The Live Wire check launches the same beep-flash-dash indications, when using the leads to test which terminals in a multi-terminal block have volts applied, for example.

It comes with a multi-function socket that plugs into the pair of jacks on the right. This enables checking junction transistor gain (hFE), both NPN and PNP, and leaded capacitors

This DMM's designers have included many thoughtful touches; the 1-m long test leads have probes with safety collars so your fingers don't slip down, exposing you to danger; the high-viz jacket has collars to store the test probes; the DMM's body has a tilt-stand at the back that swings out to hold it up for convenient viewing, and there's the "off" positions at each end of the range switch. The manual's in English.

The closer

With the variety of included functions (I counted 15), plus true-RMS AC facility, the ability to measure frequency to 10 MHz in seven ranges, plus the 'live wire' checking facilities, makes this a very versatile instrument suited to 'workhorse' usage – akin to a ute – in electrical, electronics and RF applications.

The instrument's strengths are in the attention to key details, along with little ones that are nevertheless significant. Listed at $49.95, the QM1321 is worth close consideration.

[Unit provided by Jaycar].

Fox hunting with Fourier

Can esoteric mathematics help us in fox hunting? You bet!

Eric Heinzle VK5HSE

If you have ever wondered how a Frenchman born in 1768 can be of assistance while you're wandering aimlessly in a paddock holding a directional antenna, read on . . .

First, consider the panel opposite to see how a square wave is made up of a series of sine waves, then come back here and continue. Or, skip that until later, and now continue.

Matters of mixing

When we recall the trigonometric identity:

$$\sin(\mathbf{a})*\sin(\mathbf{b}) = 1/2\cos(\mathbf{a} - \mathbf{b}) - 1/2\cos(\mathbf{a} + \mathbf{b})$$

we can see that multiplying a signal of frequency '**a**' by a signal of frequency '**b**' produces mixing products spaced a frequency '**b**' above and below the fundamental frequency '**a**'.

Knowing that square waves comprise an infinite sum of sine waves of odd harmonics, we see from the trigonometric identity that an infinite number of odd harmonics is produced above and below the signal of frequency '**a**', if '**a**' is multiplied by a square wave of fundamental frequency '**b**'; i.e, by simply turning the signal '**a**' on and off repeatedly, we achieve mixing with an infinite number of harmonics.

Mathematically, we have:

$$\sin(\mathbf{a})*[\sin(\mathbf{b}) + 1/3\sin(3\mathbf{b}) + 1/5\sin(5\mathbf{b}) + \ldots$$

$$= 1/2\cos(\mathbf{a} - \mathbf{b}) - 1/2\cos(\mathbf{a} + \mathbf{b}) + 1/6\cos(\mathbf{a} - 3\mathbf{b}) - 1/6\cos(\mathbf{a} + 3\mathbf{b}) + \ldots \text{etc}$$

A simple way to do this in practice is to use a square wave of fundamental frequency '**b**' to turn on and off a diode – through which we pass the signal frequency of interest '**a**'. Importantly, the amplitude of the n^{th} harmonic is proportional to $1/n$, making the power of the n^{th} harmonic proportional to $1/n^2$. Put another way, the further the mixing product is away from the frequency '**a**', the smaller its amplitude and power.

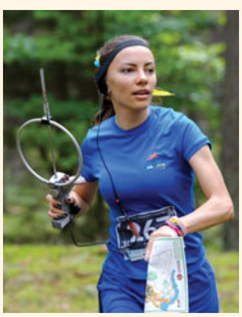
Any deviation from perfect symmetry in a square wave, such as a non-50% duty cycle, will cause some even harmonics. Accordingly, in the real world, sources of square waves will typically produce harmonics at even and odd multiples.

The preceding theory also applies to switch mode power supplies with abrupt transitions in their drive circuits at fundamental frequencies in the LF or MF range. Without adequate shielding and RF suppression, such supplies can be rich sources of harmonics heard in MF and HF receivers.

How this becomes useful in a paddock with tall grass and snakes

When engaged in radio direction finding, your receiver can easily become overloaded by the strength of the desired signal when you're near the transmitter. Switched

Amateur radio 'fox hunting'



For fun outdoors using portable amateur radio technology, one or two sporty-minded hams – the fox or foxes – will hide one or more small transmitters in a defined area, perhaps a suburban park or rural paddock. Participants – the 'hounds' – might participate on-foot or in vehicles, using hand-held or vehicle-mounted receivers and employ radio direction finding techniques with directional antennas to locate the hidden transmitters. Fox hunts are generally arranged as short competitive events, with simple rules and lasting up to 20 minutes to perhaps two hours.

Fox hunting is also known as direction finding (DFing), or amateur radio direction finding (ARDF). In some countries, the activity is called Radio Sport. Visit: https://ardf.org.au/

The transmitters and receivers used operate on designated amateur frequency bands; typically, 3.5-3.8 MHz (aka 80 metres – '80m') in the high frequency (HF) spectrum, and the 144-148 MHz band (aka two metres – '2m') in the very high frequency (VHF) spectrum. Visit: www.foxhunt.com.au; https://vimeo.com/19696729

Joseph Fourier was a mathematician and military engineer, born in France in 1768. He is credited with the fundamental insight that a periodic function (i.e, one that repeats its values at regular intervals) can be represented as a sum of an infinite number of sine and cosine terms. Topically, Fourier has also been ascribed as discovering, almost 200 years ago, how the greenhouse effect works. [https://tinyurl.com/2khaw3br]

Jean-Baptiste Joseph Fourier

For example, a periodic waveform such as a square wave can be represented as a sum of sine waves. In **Figures 1– 7**, we see how successive addition of odd harmonics, of decreasing amplitude to the fundamental sine wave, achieves a better and better approximation to a square wave. In the case of a square wave, each term in the infinite sum is of the form 1/n*sin(n*x).

We apply this insight to radio communications when using circuits that produce a square wave as a source of harmonics. The square wave is equivalent to a fundamental frequency and an infinite number of odd harmonics of decreasing amplitude. These harmonics can be extremely useful.

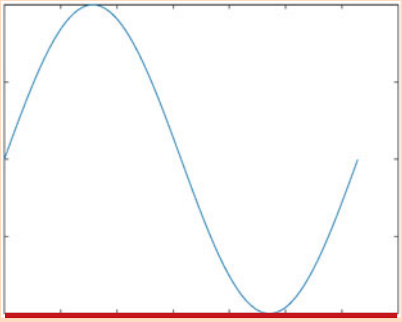


Figure 1: sin(x)

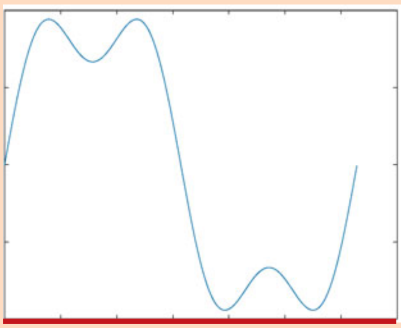


Figure 2: sin(x) + 1/3*sin(3*x)

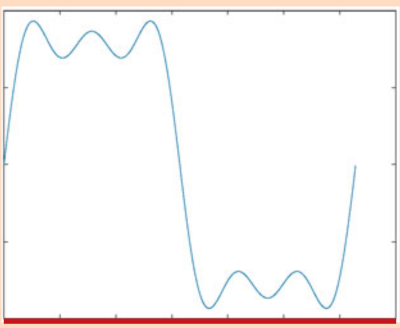


Figure 3: sin(x) + 1/3*sin(3*x) + 1/5*sin(5*x)

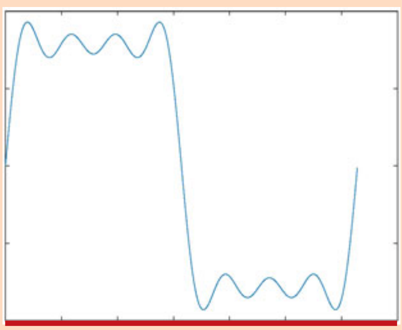


Figure 4: sin(x) + 1/3*sin(3*x) + 1/5*sin(5*x) + 1/7*sin(7*x)

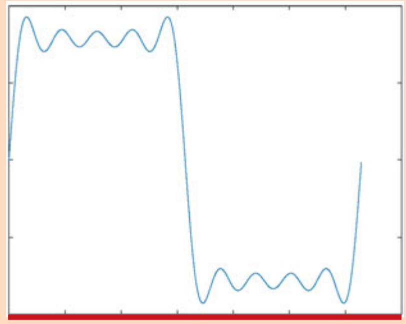


Figure 5: sin(x) + 1/3*sin(3*x) + 1/5*sin(5*x) + 1/7*sin(7*x) + 1/9*sin(9*x)

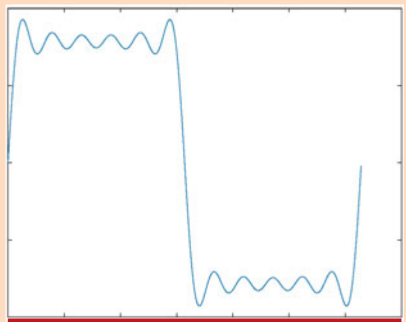


Figure 6: sin(x) + 1/3*sin(3*x) + 1/5*sin(5*x) + 1/7*sin(7*x) + 1/9*sin(9*x) + 1/11*sin(11*x)

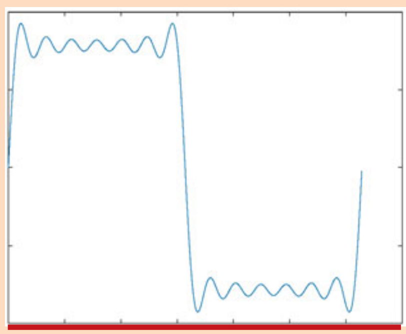


Figure 7: sin(x) + 1/3*sin(3*x) + 1/5*sin(5*x) + 1/7*sin(7*x) + 1/9*sin(9*x) + 1/11*sin(11*x) + 1/13*sin(13*x)

attenuators can struggle to provide sufficient attenuation to prevent overload in the receiver because of interstage coupling. This places a practical limit on the overall amount of switched attenuation possible.

By taking advantage of the harmonically decreasing amplitude and geometrically decreasing power of mixing products, you can more easily achieve arbitrary attenuation of the signal. You do this by tuning the receiver to a suitably attenuated mixing product spaced **n** multiples of the fundamental of the square wave away from the carrier of interest.

Now, imagine you are looking for a weather balloon radiosonde that has landed in hilly terrain with high tension transmission lines, fencing and a mobile phone tower nearby. The local signal from the downed radiosonde will be both powerful and reflecting off multiple metallic structures. Even with a directional antenna, the precise location of the transmitter will be difficult to discern since the receiver will be overloaded, regardless of the direction in which you aim the antenna.

A solution to this problem emerges from Fourier's work, namely, a simple circuit between a directional antenna and the receiver which drives a diode switch with a square wave. By tuning the radio to a suitable mixing product, the signal can be sufficiently attenuated to allow accurate direction finding with the directional antenna.

The Fourier solution

The circuit in Figure 8 is based on a widely used design that runs off a 9 V battery. Following the on/off switch, the battery drives a resistive divider formed by R3 and RV1. A TTL "oscillator in a can," X1, is powered by a 78L05 voltage regulator, U1, and produces a square wave that is AC-coupled by C2 to the midpoint of the resistive divider network.

The signal from the potentiometer tap goes to ground via R2, the signal diode, D1, and R1.

D1 is driven into forward bias when the square wave arriving via RV1 is of sufficient magnitude. When D1 conducts, the antenna signal at BNC1 can pass through to BNC2 and then on to the receiver.

Each mixing product present will be diminished the further away it is from the sum of the fundamental mixing frequency and frequency of the signal of interest. Hence, we have an attenuator.

Hardware

I designed a PCB in "pcb-rnd," an open-source PCB layout editor. I chose the PCB dimensions to fit a standard 83 x 54 x 31 mm project (or jiffy) box (e.g., Jaycar HB6015) leaving room for a 9 V battery.

The PCB outline has notches to accommodate the ribs inside the box. The outline of a PCB is typically defined in a distinct layer in a PCB editor; pcb-rnd allows lines and arcs used on the outline layer, enabling the designer to achieve quite complex outlines.

I designed the PCB for through-hole construction, but it can accommodate SMD components for the signal path C3, D1, and C4. If you are keen to do this, thanks to the additional SMD footprints, pcb-rnd supports multiple fonts; naturally, I added the Klingon word for 'hunter' to the silk screen.

As an experiment, I also placed large, plated holes on the PCB layout for direct attachment of the PCB to the driven element of a Yagi antenna like WA5VJB's 'Cheap Yagi' designs. But I have not tried this in practice.

If you are interested in creating more exotic silk screen artwork or board outlines, you can create these in the free and open-source vector graphics package 'Inkscape,' and export as a pcb-rnd feature with the inkscape2pcb plug-in.

Construction

Make holes in the enclosure to accommodate the slide switch S1, the potentiometer RV1, and for the BNC connectors.

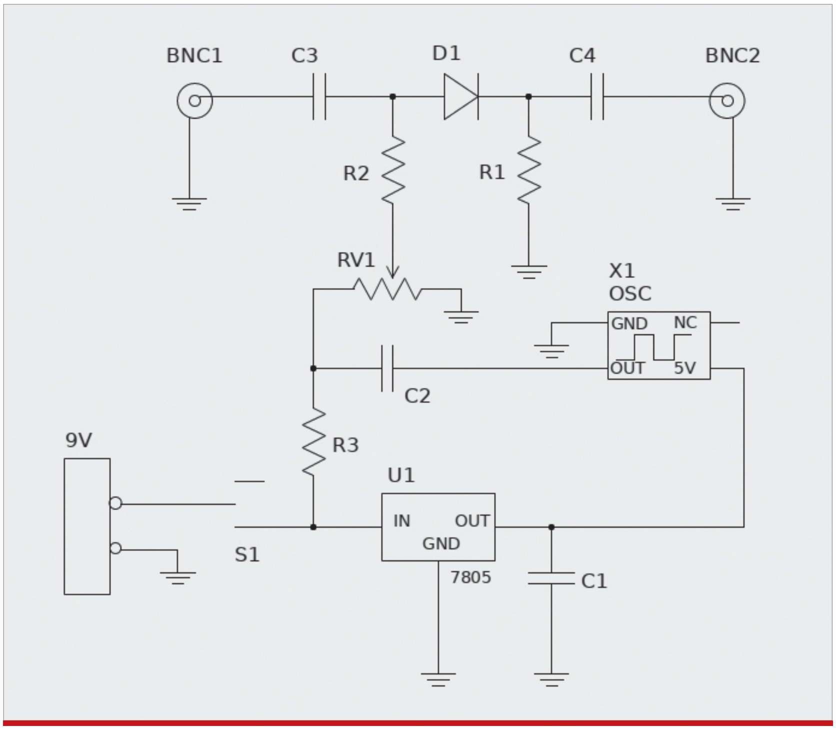


Figure 8: Foxhunt attenuator schematic.

Qty	Name	Type / Value	Part No.
1	TTL Oscillator		X1
1	Diode	1N4148	D1
1	Capacitor	100 nF	C1
1	Capacitor	4n7 (4.7 nF)	C2
2	Capacitor	470 pF	C3, C4
2	Resistor	2k2 (2.2k)	R1, R2
1	Resistor	4k7 (4.7k)	R3
1	Potentiometer	5k	RV1
1	5 V voltage regulator	78L05	U1
1	Slide switch		S1
2	BNC connectors		
1	Case/ enclosure	Jaycar HB6015 or similar	
1	9 V battery and battery lead		
1	Etched PCB		

Parts list.

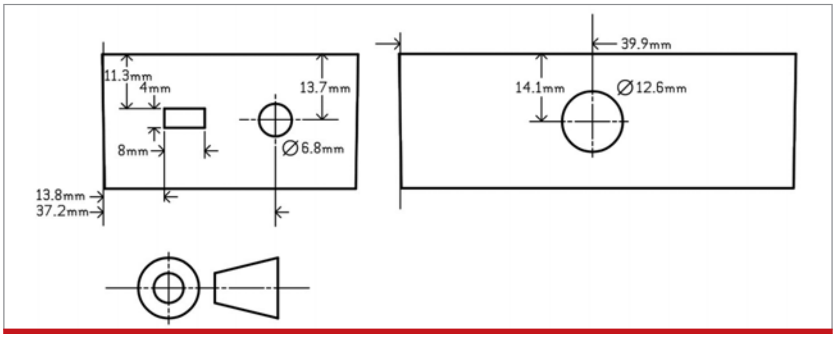


Figure 9: This dimensioned diagram applies to version 1.2 of the board and shows the sizes and locations of the necessary holes in the enclosure.

Insert a battery and put the lid on the project box. It is worth labelling the on and off positions of the switch, to avoid flattening the battery accidentally. [Or perhaps add a flashing LED after the switch – Ed].

You can now test the unit with a receiver by attaching an antenna to the input of the unit and the output to the receiver. Tune 4-8-12 MHz above or below a strong signal.

I tested the prototype unit with a

Note: The enclosure has tapered sides, and distances from the side wall are given at the height of the enclosure.

Solder all the components to the PCB, except the BNC connectors. Take care to ensure the 78L05 has the conventional pinout shown on the PCB, and that the square corner of the oscillator matches the silkscreen markings on the footprint.

I designed the PCB to accept either rectangular full-size, or square half-size oscillator modules. To keep the layout compact when using through-hole components for the signal path, C3 and D1 share a mounting hole and C4 and D1 also share a mounting hole.

Before assembling the unit in the enclosure, you can test the circuit by powering it up and looking for output at the fundamental frequency with either a frequency counter or an HF receiver.

Finally, mount the BNC connectors in the box, with terminals uppermost and mounting washers done up loosely. See **Figure 10.**

Lower the PCB onto the BNC connectors while feeding the potentiometer shaft and switch into their respective enclosure openings. See **Figure 11.** Take care to align the BNC terminals and mounting studs with their respective PCB footprints. Once positioned, solder the BNC pins.

Once assembled, add the potentiometer and tighten its mounting nut, followed by all other washers and all nuts.

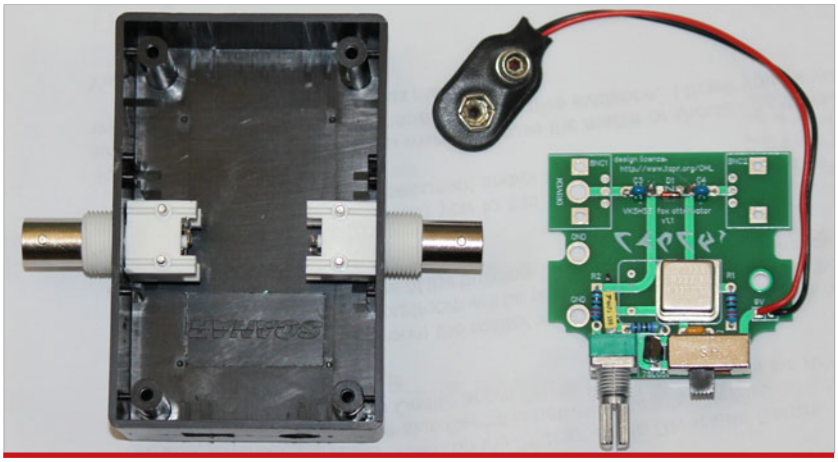


Figure 10: Assembled board without the BNC connectors.

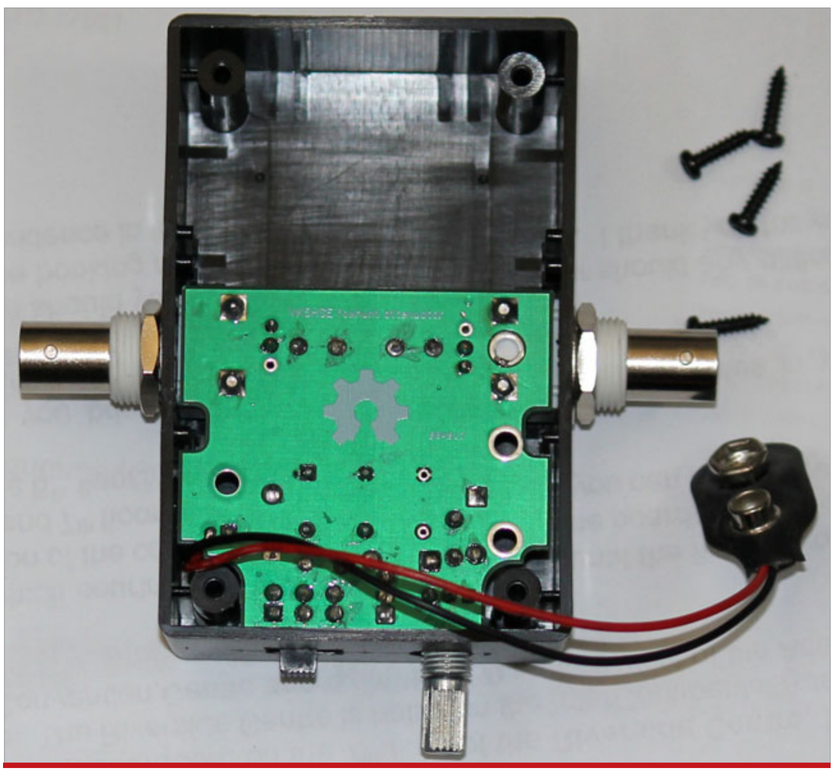


Figure 11: Fit PCB to BNC connectors, pot and switch.

Yaesu FT60 hand-held by tuning in 4 MHz multiples above and below the VK5RAD Sunday morning broadcast on 147.000 MHz.

Concluding remarks

Alternative switches or potentiometers can, of course, be used if you can find space for them within the project box.

The PCB design files are available in the github repository. You can modify them in pcb-rnd if you prefer different footprints. A switched potentiometer could replace the existing slide switch to simplify construction.

The theory of operation also applies to switched mode power supplies (SMPSs). These can employ pulse-width modulation or frequency modulation, with corresponding effects on the radiated spectrum.

Finally, avoid transmitting into the unit, as it may let the magic smoke out. Happy fox hunting!

Sources

Design files for the PCB including Gerber files are available online. The zipped gerber files can be submitted to PCB manufacturers who will typically provide ten boards, including shipping for less than the cost of a takeaway meal; see: https://github.com/erichVK5/frequency-offset-attenuator

- pcb-rnd for PCB design and the dimensional drawings; see: www.repo.hu/projects/pcb-rnd
- lepton-eda for the schematic; see https://github.com/lepton-eda
- gnu octave for the graphs; see https://www.gnu.org/software/octave/index
- GIMP for photo manipulation and editing graphics; see https://www.gimp.org
- inkscape2pcb exporter for Inkscape; see https://inkscape.org/~erichVK5/

Figure 12: Testing the unit. It's tuned to 151 MHz here, 4 MHz above the 147 MHz signal from VK5RAD.

Unravelling the mysteries of connecting radios to antennas

Part 4 Article 2 How to roll-your-own balun / unun

Brian Clarke, VK2GCE
e brlanclarke01@optusnet.com.au

Case 1 - Where you require $Z_0 = 100\ \Omega$

The formula for the Z_0 of two parallel wires is:

$Z_0 = 276 (\log_{10}\{2s / d\}) / \sqrt{\varepsilon}$

where

s = distance between centres

d = diameter of wires

ε = dielectric coefficient of spacing material.

Now, assume air spacing (ε = 1) and substitute the required 100 Ω into the formula:

▶ $100\ \Omega = 276 (\log_{10}\{2s/d\})$

▶ s / d = 1.15; so, we can use almost any two wires, perhaps with a thin sleeve over one of them to achieve the 15% spacing, plied flat together.

Case 2 - Where you require $Z_0 = 36\ \Omega$

The formula for the Impedance of two flat strips laid on top of one another is:

$Z_0 = 377 / \sqrt{\varepsilon}\ [w / s + 2]$ **Kraus** and **Marhefka** (2003:891)

where

s = spacing

w = width

ε = dielectric coefficient of spacing material

or, if w>>s

$Z_0 = 377\ s / (w \sqrt{\varepsilon})$ **Sevick** (1991:4.3)

Now, assume that ε of the separator = 1.44 (for example, one of the plastics), and substitute the required 36 Ω into the formula:

▶ $36\ \Omega = 377 \times s / (w \sqrt{1.44})$ ▶ s / w = 0.115.

So, get two strips of very thin copper 4.42 mm wide (approx 3/16") and roll them with two layers of 0.25 mm (0.010") Mylar® or Teflon® tape. You may even be able to use some powder-coated strip, to achieve the same effect, without the difficulty of holding the two copper strips and the two layers of insulating tape together.

Note: The thickness of the copper strips does not enter into impedance calculations. The cross-sectional area of the strips determines the current limit at LF, but at HF and beyond, the thickness of the strip becomes the limit as the effective current carrying area diminishes with frequency (skin effect). So, you need a thicker strip just to meet plain thermal requirements (see Terman, 1955:22).

How many turns?

Now there is another impedance to consider - the magnetising impedance of the primary winding.

If there are not enough turns, there will be insufficient primary inductance and hence, at the LF end, the core will overheat, resulting in a permanent loss of permeability. If there are too many turns and the current level is maintained:

- you are likely to saturate the core (B = μNI) giving rise to distortion, spurious signals and heating
- you will get reduced transformer action at the HF end because of capacitive coupling between the turns
- you may approach a winding length of λ/2 at some frequency.

Formula for inductance

For this discussion, I have assumed you want to transmit at least 100 W. To keep the balun size reasonable, I have assumed you will use a ferrite core. The inductance to calculate is the magnetising inductance, L_M. For a toroidal core, this is:

$L_M = 0.4 \pi N_P^2 \mu_0 (A_e / I_e) \times 10^{-8}$ Henry **Sevick** (1991:2.2)

where

N_P = number of primary turns - always a whole number for a toroid

μ_0 = initial permeability of the core at the lowest frequency of interest

A_e = the effective cross-sectional area of the core

I_e = the average magnetic path length in the core.

Many texts and core providers reduce this formula to:

$L_M = kA_L N_P^2$ Henry

Where

k = a constant, usually provided by the manufacturer

A_L = the inductance index for a particular core, also provided by the manufacturer.

(See *ARRL Handbook* (1995:4.36); Langford-Smith

(1952:445 and 1960:445); Terman (1955:ch2) and the Amidon information sheet)

The formulae for rod ferrites are much more complex because of the high-reluctance air section in the magnetic path.

The number of turns is a compromise between upper and lower 0.45 dB points. Why 0.45 dB? This represents about 10% losses, which is just about acceptable. It can be shown that (see Appendix 2 for a derivation of this):

$2\ X_M = 3\ Z_{AE}$

When we substitute this in the formula for the number of turns, we get the approximation:

$N_P = \sqrt{(2\ Z_{AE}\ I_e\ 10^{-7} / f\ \mu_0\ A_e)}$

Now, we want high permeability µ0, a large core area Ae, and small core length Ie to give us a small-diameter, squat toroid.

To get a simple formula to use for any combination of frequency, permeability or antenna feed impedance, assume operating at 10 MHz, μ_0 = 100 and Z_{AE} = 50 Ω; then we get:

$N_P = \sqrt{(I_e / A_e)}$

An example

For Z_{AE} = 300 Ω and operating at 1.8 MHz, multiply this approximation by

√ (300 / 50 x 10 / 1.8) = 5.77

just to compensate for the change of frequency and impedance.

If you choose the model FT-240 toroid with A_e = 1.57 cm², and outer diameter = 6.096 cm, then I_e = 14.40 cm.

Thus, I_e / A_e = 9.17 and hence $\sqrt{(I_e / A_e)}$ = 3.03.

So, N_p = 5.77 x 3.03 = 17.47 turns, say 18 (a toroid only permits whole turns).

Another example

Building on what we learned in the previous example, let's say you want to use a bit more power; so, choose a ferrite core with the same dimensions but with an initial permeability μ_0 = 300 to reduce the losses.

If this were to operate at 1.8 MHz and now feed a 50 Ω dipole, then:

N_p = 3.03 [toroid dimensions] x √{(300 / 50) [impedance change] x (100 / 300) [permeability change]}

= 3.03 x √2

= 4.29 turns (use 5 turns)

Choice of ferrite mix

You will recall that inductance L is proportional to N² and µ. As you can see from Figure 14 below, µ is flat up to a knee and then falls off with frequency. Because inductive reactance X_L is proportional to L and frequency (that is, to f, N² and μ_0) then, as the frequency increases falls, and the (f.µ) product remains essentially constant. Thus the reactance X_L of the magnetising inductance becomes proportional to N².

Do not be put off by snake-oil merchants who say you must choose a ferrite that has the frequency range - ask to see the curve of   vs frequency. You can use a ferrite characterised for 10 to 20 MHz (for example, type 61) to well beyond 100 MHz.

Generally, I recommend that you avoid iron powder mixes because they have lower permeability and therefore require more turns, and have a smaller operating frequency range (revisit Figure 13).

Have a careful look at your RF PA design to see if there is any chance of direct current (DC) getting into the transformer primary. If DC flows in these windings, the permeability will fall and heating will occur. When lightning has hit your balun / unun, you can be fairly certain that the safe operating temperature will have been exceeded and you will need to replace the core.

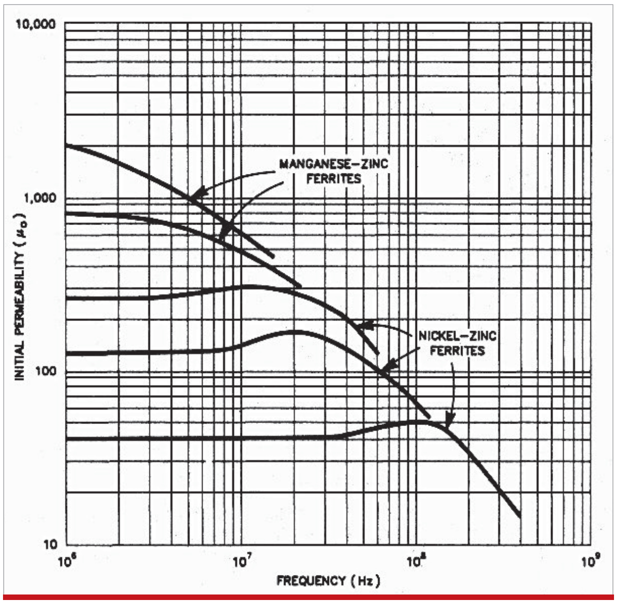


Figure 14: Initial permeability vs frequency for common ferrite cores (Sevick, 1991:3-14).

Power handling

Use the largest cross-section ferrite you can afford in order to keep the power loss per unit volume low; then the temperature rise is unlikely to reduce the permeability. This is always countered by the need to keep the length of windings well below λ/2.

If the temperature of the core regularly exceeds 100°C, choose a larger core and wire size or you will exceed the Curie limit point of the core (around 130°C) and damage it permanently. The higher the initial permeability, the fewer turns required for low frequency performance, the less the inter-turn capacitance, and hence, the better the high frequency performance, and the lower the Ohmic losses. However, it is wise to choose a ferrite whose initial

μ_0 is less than 300 - much more than that and efficiency falls, leading to more heating.

As your operating frequency rises, the current flows more and more on the surface of the wire (see Terman (1955) on skin effect). Heating thus increases, so the safe power input level falls. You can overcome this by using heavier gauge wire or tubing.

Some practical advice:

- If you break a ferrite toroid, use an isocyano-acrylate glue (for example, Super Glue®) to cement all the broken parts together. Ensure that all air gaps have been excluded, so that you do not increase the reluctance of the magnetic circuit. Be careful: isocyano-acrylates degrade with temperature.
- Ferrites are ceramics and so are very good insulators – there is no need to insulate ferrite cores before you wind conductors onto them.

Practical 4:1 baluns

Case 1: 50 Ω to 200 Ω

Let's assume you want to feed an OCF antenna with an RG-58 coaxial feedline. A TL balun design requires a $Z_0 = \sqrt{(50 \times 200)} = 100\ \Omega$. A bifilar-wound coil using 1.0 mm enamelled copper wire on an FT-140-61 ferrite core can achieve that. You will need about 3 m of wire, folded in half.

1. Tie the two wires together, flat, with small cable ties or even Sellotape. Avoid twisting.
2. Feed in 7 or 8 turns to get the LF performance, spaced evenly around one half of the toroidal core to reduce inter-turn capacitance.
3. Tie the winding in place with cable ties.
4. Now wind in, space out and secure exactly the same number of turns as before, on the other half of the core.

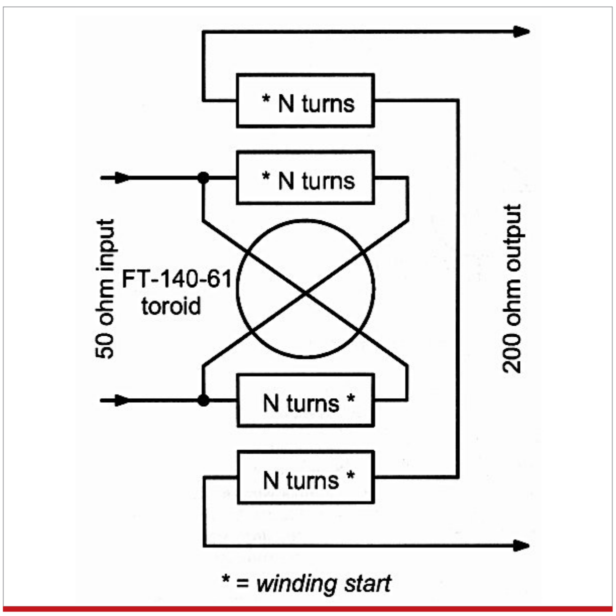


Figure 15: Winding and connection details for a 4:1 balun.

What you have now is two 100 Ω TLs giving two 1:1 transformers.

5. Connect one winding of each pair in parallel to provide the 50 Ω primary. Pay attention to the phasing.
6. Connect the other two windings in series adding to provide the 200 Ω secondary
7. When you are happy with the result, use an isocyano-acrylate cement on the ends of the turns to hold them in place.

See Figure 15 for connection details; the start end of each winding is indicated by an asterisk (*).

You should pay between $12 and $15 for an FT-140-61 toroidal core. Try TTS Systems.

Case 2: 75 Ω to 18.75 Ω

This is the kind of balun you require to feed a three-element Yagi via RG-59 coaxial feedline. Now, the characteristic impedance, Z_0 of the TL winding $= \sqrt{(75 \times 18.75)} = 37.5\ \Omega$. If you look back a little in this Part 4, you will find that strip-line will be suitable for this impedance. When you go through the calculations, you will find that the strip needs to be about 4.5 mm wide. Then follow the rest of the instructions for constructing your stripline TL balun.

An Uda-Yagi antenna for 40-m is out of the question for most of us living in built-up areas. How about a 20-m beam? The lowest operating frequency in this band is 14.00 MHz. How many turns should there be on a core such as FT-140-61, whose permeability is 125?

Recall we arrived at the formula $Np = \sqrt{(I_e / A_e)}$ when operating at 10 MHz with $\mu = 100$ and $Z_{AE} = 50\ \Omega$.

If you use the FT-140-61 core, $I_e / A_e = 11.19$. Correcting for the different permeability and frequency:

$N_P = \sqrt{(I_e / A_e)(100 / 125)(75 / 50)(10 / 14)}$.

Note: I have used 75 Ω impedance for calculating magnetising inductance because the primary that supplies the magnetising current, is a 75 Ω TL.

So, $N_P = \sqrt{(11.19 \times (0.8 \times 1.5 \times 0.70))} = 3.10$; so, wind 4 turns.

You could use the same wiring layout as for the previous balun and so follow the same construction steps, this time with four turns of your strip-line on each half of the toroid. The parallel connections go to the 18.75 Ω antenna and the series connections to the 75 Ω coaxial feedline.

If you live outside built-up conurbations, because of the effort required to make a strip-line transmission line, you might consider the possibility of a 40-m beam. Think big!

So, now if you wind 5 turns instead of 4, the lower 0.45 dB point will be about 5.4 MHz. Such a design would perform quite satisfactorily from 7 MHz to 70 MHz.

For complete balun kits, try https://www.ttssystems.com.au/?s=balun+kit

What if there is a mismatch?

Recall from the Part 1 material (*Amateur Radio* Vol 89, Issue 3) that antenna impedance varies with frequency.

So, if the characteristic impedance of the balun is **greater than** optimum for your operating frequency, you now know that:

- the resistive part of Z_{IN} increases slightly with frequency and Z_{AE}
- the reactive part of Z_{IN} is positive and increases with frequency and Z_{OUT}

And, if the characteristic impedance is **less than** optimum for your frequency:

- the resistive part of Z_{IN} decreases greatly with frequency and Z_{OUT}
- the reactive part of Z_{IN} is negative and its magnitude increases with frequency and Z_{OUT}.

Of course, these generalisations apply with limitations – antennas are not just simple combinations of R, L and C. Look back at the impedance spiral in Part 1.

Summary on baluns

Here are the main considerations when designing and constructing baluns / ununs:

1. Frequency range – with a ferrite core, the whole of the amateur HF spectrum (possibly to 6-m) can be covered by one balun
2. Impedances – operate at constant impedance, in and out, whenever possible, though going too high is better than too low
3. Matching – the output impedance should match the downstream device to meet the Jacobi criterion
4. Turns ratio and impedance ratio - there are problems with power bandwidth when you attempt high impedance ratios
5. Transmission line impedance for matching input to output – the geometric mean formula
6. Magnetising flux – the number of turns required to get the appropriate flux
7. Construction materials and methods
8. Power handling capability.

References

Iron-powder and ferrite coil forms (2001) Amidon Associates, Costa Mesa
ARRL Handbook (2005) ARRL, CT

Kraus, John D and **Marhefka**, Ronald J (2003) *Antennas for all applications*, McGraw-Hill, Boston

Langford-Smith, Fritz (1960) *Radio Designer's Handbook*, Illiffe, London, or the 1952 edition, accessible at *https://tinyurl.com/yuk45x3r*

Sevick, Jerry (1991) *Transmission line transformers*, ARRL, CT

Terman, Frederick Emmons (1955) *Electronic and Radio Engineering*, McGraw-Hill, NY

Appendix 2

Balun design – calculation of the minimum LF inductance (Sevick, 1991:2-3)

This derivation of the relationship between the magnetising reactance X_M and the source impedance R_G for a nominated operating bandwidth, relates to the earlier discussion on balun design under the heading, 'Formula for inductance'.

All power amplifiers have an internal resistance, R_G that we try to match to our antenna impedance Z_{AE}, if we believe we need to meet the Jacobi requirements for maximum power transfer from generator to load. Figure 16 represents an LF model of an antenna connected in parallel with the magnetising inductance of the balun / unun primary. The implied inductance of the antenna, unless of greater length than (2n+1)λ/4, will be quite small.

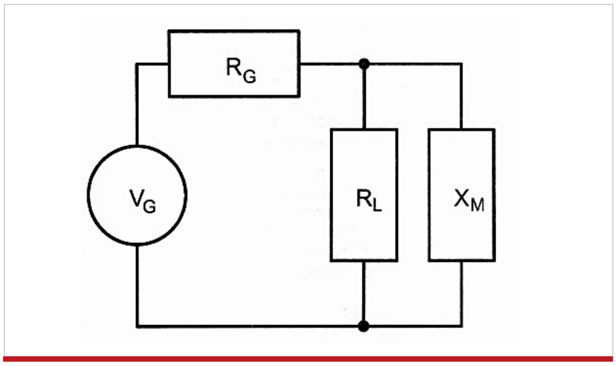


Figure 16: LF model of antenna radiation resistance, R_L connected to the magnetising inductance of the balun / unun primary, X_M.

When the Jacobi condition is met, $R_L = R_G$, and so, $E_{RL} = E_G / 2$. The maximum power available to the load is therefore:

$P_{AVAIL} = (E_G / 2)^2 / 4 R_G$

The equation for LF performance can be written as:

$P_{AVAIL} / P_{OUT} = (R_G^2 + 4 X_M^2) / 4 X_M^2$

where $X_M = 2\pi f L_M$ (recall: L_M is the magnetising inductance of the primary of our balun / unun).

While it is usual to measure the frequency response in audio circuits at the -3 dB points, that represents a 50% loss in a power device (most humans can detect a 3 dB change in sound level). For the balun, our design target is a 10% loss, corresponding to 0.45 dB. This means an efficiency, η of 0.9 or 90%, equivalent to a VSWR of 2:1; to obtain this result from the above formula:

$4 X_M^2 = 0.9 (R_G^2 + 4 X_M^2)$

Solving this, we get

$2 X_M = 3 R_G$

Note: The Jacobi theorem demonstrates that maximum power transfer occurs when the load and what feeds it have the same impedance; however, maximum power transfer results in 50% of the power going to the load and the other 50% going to what feeds the load. Some of us do not adhere slavishly to the Jacobi shibboleth because we want higher overall system efficiency, η, than 50%.

Disregarding Jacobi is exactly what you do when you connect a loudspeaker, say 8 Ω nominal impedance, to an audio amplifier whose output impedance is around 0.2 Ω, and you want a high damping factor. The beauty of this approach is that loudspeaker impedance is complex in the mathematical sense, and varies considerably with frequency; so, driving with a very low impedance amplifier virtually prevents unwanted loudspeaker resonances from 'colouring' the audio produced.

Electricity distribution authorities aim much higher than 99% overall system efficiency. Just think how much energy would be wasted in providing us with electricity if half the energy generated were thrown away, and our electricity generation systems therefore needed to be twice as large.

If you get all upset about the implied VSWR on a TL, the main cause of emf and current nodes and antinodes is a mismatch between the antenna feed-point impedance and the characteristic impedance of the TL, Z_0.

Silent Key Mike Subocz VK3AVV

Mike VK3AVV particularly enjoyed VHF-UHF field day contesting.

On January 5th, 2022, Mike Subocz VK3AVV, VK3JV, AI7MS became a silent key and a great loss to the amateur radio community at 84 years young.

Mike was best known for his contest work in the development of the VKContest Log (VKCL) program which has assisted contesters both in Australia and further afield in improving their contest logging skills.

Mike was born in 1937 in Byelorussia, now known as Belarus, and was the eldest of two children.

In 1949, after the deprivations of WW2 in which nearly one quarter of the Byelorussian citizens lost their lives, Mike's family emigrated to Australia. Being 12 years old at the time, meant that Mike was relatively fluent in the Belarusian language, which he was able to use in later life to represent the small Belarusian community in Melbourne and Australia.

Mike settled well into his new environment, was successful at school and eventually gained a Bachelor of Engineering (Electrical) Degree at the University of Melbourne and later, a Master of Engineering Science at Monash University.

After graduating, he worked overseas for a while before returning to Melbourne in 1973 and settling down with his wife Norma. A son, Craig, followed in 1978.

Mike worked for the Telecom Research Laboratories in Clayton in the Engineering Section until retirement around 1995.

Mike's wife Norma, sadly passed away in 1994 and in 1998 Mike found his second life partner in Tamara (Tammy), and a second family in Tony, Anita and later, a number of grandchildren and step-grandchildren.

In 1998, Mike and his family were able to spend some enjoyable time back in Belarus – no doubt the trip brought back all sorts of memories for him.

Mike's passions were church, grandkids, amateur radio, computer programming, F1 motor race attendance, nature study and the Saab Car Club and its activities. Wherever Mike was, his trusty Nikon camera would be there as well, recording events for posterity.

Involvement in the Belarusian Autocephalous Orthodox Church (BAOC) in Yarraville took up much of his time in retirement and he worked tirelessly for the Church community in many and varied capacities. With his knowledge of the Belarusian language, Mike was able to represent the BAOC in Church forums and the BAOC diaspora in the United States.

Mike had the radio callsigns VK3AVV, VK3JV and AI7MS, and was a member of the Wireless Institute of Australia and the Eastern & Mountain District Radio Club (EMDRC) in Melbourne.

Amateur radio was with Mike for many, many years. In fact, I recently spoke with two amateurs who had worked with Mike at the Telstra Research laboratories in the 1990s. They had only kind words to say about Mike, who was described as a gentleman by all who worked with him. Apparently, with a difficult to pronounce surname of Subocz, Mike was always affectionately known as Mr Shoebox!

Mike always liked to compete in amateur radio contests where one tried to contact as many people as possible in a short time.

In the early 2000s, Mike, using his computer programming skills, decided to create a special program called VKCL (or VK Contest Log), which could be used by other amateurs to assist them in keeping a record of their contacts in the various competitions.

Over the period 2002 to 2021, Mike developed, modified and updated the program in response to requests from fellow amateurs, both in Australia and around the world. The latest version, which he released just last August, 2021, was version 4.15.

Mike also loved to try out his program himself under competition conditions. He never missed an opportunity to travel with a small group of fellow amateurs from the EMDRC to various mountain tops three weekends per year, in November, January and March.

Mike was a member of the EMDRC club for at least 25 years and, only last year, was honored with Life Membership of the club – something he was immensely proud of. The citation for his Life Membership: was as follows:

> "Mike has been a long-term and valuable member of the club contesting team, especially as the six meter operator. His computer contest logger, VKCL, which he has developed from the ground up, has contributed greatly to the club's success in the VHF/UHF and John Moyle Field Days. Mike's ability to upgrade and refine the logger program so that all operators are fully networked together has been especially appreciated.
>
> This, however, is but one aspect of Mike's work, as his VKCL contest logger is now the "go to" program for hundreds of Australian, New Zealand and many international contesters, based on the reputation that the program has always been field-tested by the club team, as a great endorsement for the club.
>
> Furthermore, Mike has been able to develop and provide a computerized log checking process which has assisted the various contest managers and even provided feedback to the individual contesters as to their logging performance and errors.
>
> Mike's determination to provide such a vital piece of computing expertise to the EMDRC and the amateur world deserves to be recognized fully by our members."

When Mike's passing was posted on Facebook pages relating to amateur radio, the outpouring of positive comments about people's interactions with Mike over the years was overwhelming.

Mike was a kind, thoughtful and generous person who will be sorely missed by all those amateurs who came in contact with him over the many years. He leaves a large gap in the Australian and New Zealand contesting scene.

The Subocz family would like to thank the many amateurs who have sent their condolences.

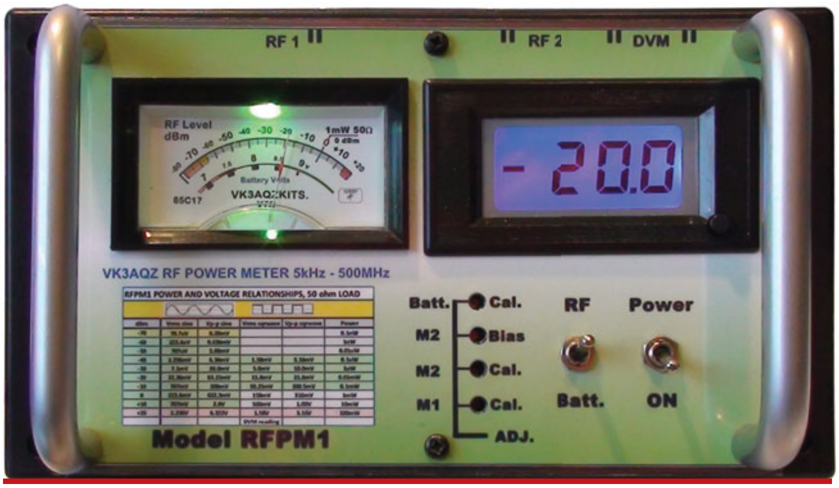
Contributed by Peter Forbes VK3QI

The VK3AQZ wide range RF power meter project

Part 1

Luigi Destefano VK3AQZ

Featuring analogue and digital displays, it measures from +20 to below -70 dBm with +/-1 dB accuracy, over 5 kHz to 500 MHz



This versatile instrument is a valuable tool for tune-up, test and development applications. The key to its range and accuracy is the 'RF head' (shown below) housing a log-amp/detector IC and linked by a shielded cable.

An instrument to measure radiofrequency (RF) power with a reasonable degree of accuracy over a wide frequency range is a valuable tool for radio amateurs, RF technicians, electronics hobbyists and students.

The main reason for the development of this power meter was to enable the design and testing of amateur radio receivers and transmitters without needing to buy an expensive commercial instrument. Performance of homebrew equipment can be developed or tuned-up and improved if an accurate means of measuring RF levels is available.

A number of publications have appeared using the low-cost, but reasonably accurate, Analog Devices AD8307 logarithmic amplifier/detector IC. It converts amplitude variations of an RF input voltage to a DC output voltage that varies according to the logarithm of the input voltage value changes. It does this from near DC to over 500 MHz with a reasonably high degree of accuracy (+/-1dB) over a 92 dB input range. A logarithmic relationship between input and output means that a simple linear display device can be used to obtain input signal level changes directly in decibels.

The AD8307 datasheet contains additional information about the IC, including a comprehensive discussion on the theory of log amplifiers. Please refer to the datasheets for further information, available online here: www.analog.com/en/products/ad8307.html

Design decisions

A simple but effective use of the AD8307 to measure RF power was published in QST, June 2001 pp 38-43, by Wes Hayward and Bob Larkin, titled *"Simple RF-Power Measurement"*. [1]

Following that article, quite a number of circuits and adaptations of the original design were published in various magazines and on websites. Some articles showed minor additions and others added complexity. Some used microprocessors or computers to provide displays of the resulting measurement of RF voltage and power in a 50 ohm load.

An RF power meter is most likely used on an intermittent basis by radio amateurs and hobbyists, but RF design engineers would use one constantly in the laboratory. With this in mind, the design I finally

A metal enclosure is essential for the instrument's RF head shielding.

settled on had to be as low a cost as possible, easy to construct, minimal use of complex integrated circuits, and simple to align and easy to use.

Portability and battery operation were also desirable features, particularly for the measurement of RF field strengths around an amateur station antenna.

In the initial stages, various published circuits were tried, many failed to meet the above requirements. Eventually, the design chosen was a variation of the original QST one. This used a simple analogue meter movement and a chart to convert the AD8307 output to a power reading.

After building and using the various designs, it became evident that the analogue meter was a very important part of the design when adjusting tuned circuits. However, a digital display was also useful for measuring amplifier and filter responses. A modification by Bob Kopski in an article titled *"An Advanced VHF Wattmeter"* published in QEX for May/June 2002, added a simple LCD meter to provide 1 dB/mV readout. This was found to be quite a simple but effective solution. [3]

So, the final design includes both an analogue readout and a simple digital readout.

During the evaluation of various circuits with digital displays, it was found that some of the designs using microprocessors were unsatisfactory. Some produced jumps in the reading at various levels, while others just hung if the signal amplitude varied suddenly. Some computer versions simply failed to work on my PC, or just gave incorrect answers due to rather poor software implementation of the analogue-to-digital (A-D) conversion. An annoying aspect was the response time of the designs.

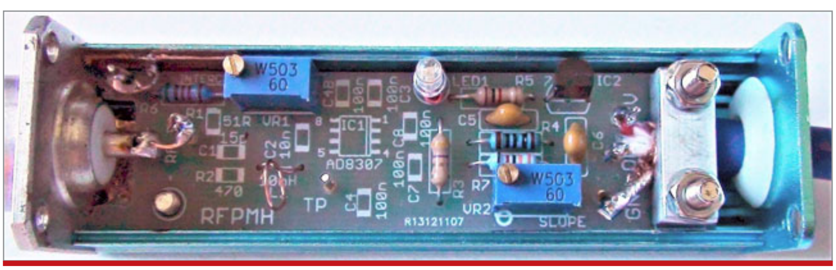
The simple LCD meter has a reasonably quick update time that can show small variations in level due to movement of test leads and so on. However, in the case of some microprocessor designs, the software was either too slow or smoothed so as to avoid these fluctuations. Side-by-side measurements confirmed the problem, hence the reason for avoiding some of these software derived A-D solutions. Further, some designs gave readouts to two decimal points of a dB when the overall accuracy of the chip is considerably less than that!

As a result of these tests, a low-cost 200 mV meter was finally chosen as the digital display portion of the RF power meter.

Commercially available, low-cost LCD voltmeters have well established, bug free, and smooth hardware A-D converters, low power consumption, and generally low spurious RF emissions.

In the latter case, it was found that some LED-type meters produced considerable RF emissions that proved quite difficult to reduce. Similarly, some of the microprocessor designs were also unsatisfactory due to high levels of radiated RF. The detector probe for this project is very sensitive to RF in its immediate vicinity.

The RF signals emitted by some of the devices I tested were so high that the dynamic range of the meter was reduced significantly. It took considerable shielding and effort to reduce such noise. On the other hand, the LCD versions were considerably less noisy.



Inside the RF head. Components are placed on both top and bottom of the PC board.

Printed circuit layouts

Images of PCB layouts and overlays are available for download from the WIA website. These were created with the free version of Autodesk Eagle. Download the artwork from: www.wia.org.au/members/armag/2022/march/

Presenting – the RFPM1

The final design of the RFPM1 power meter comprises a shielded metal-cased RF detector head containing the AD8307 chip (the RFPMH) connected to a separate meter unit containing the analogue and digital displays, buffering, and power supply circuitry (the RFPMM).

Frequency of operation is from 5 kHz to 500 MHz. The AD8307 IC has a falling response around the 300 MHz to 500 MHz region. In order to flatten the response out to 500 MHz, the RF head includes a simple RLC input network that reduces low frequency signals by around 3-4 dB. The QST design incorporated this addition. [1]

Because of the addition of the input RLC network, the sensitivity is also reduced by around the same amount. So, with the RLC network, the overall input power range is from -70 dBm to around +16 dBm. The input impedance is 50 ohms, set by a terminating resistor in the RF head.

The RFPM1 has provision for two switched RF detector heads, a facility I found useful for measuring inputs and outputs as well as front-to-back ratio measurements on antennae.

The cable between the RF detector head and the meter unit carries only DC signals, so ordinary shielded audio cable can be used.

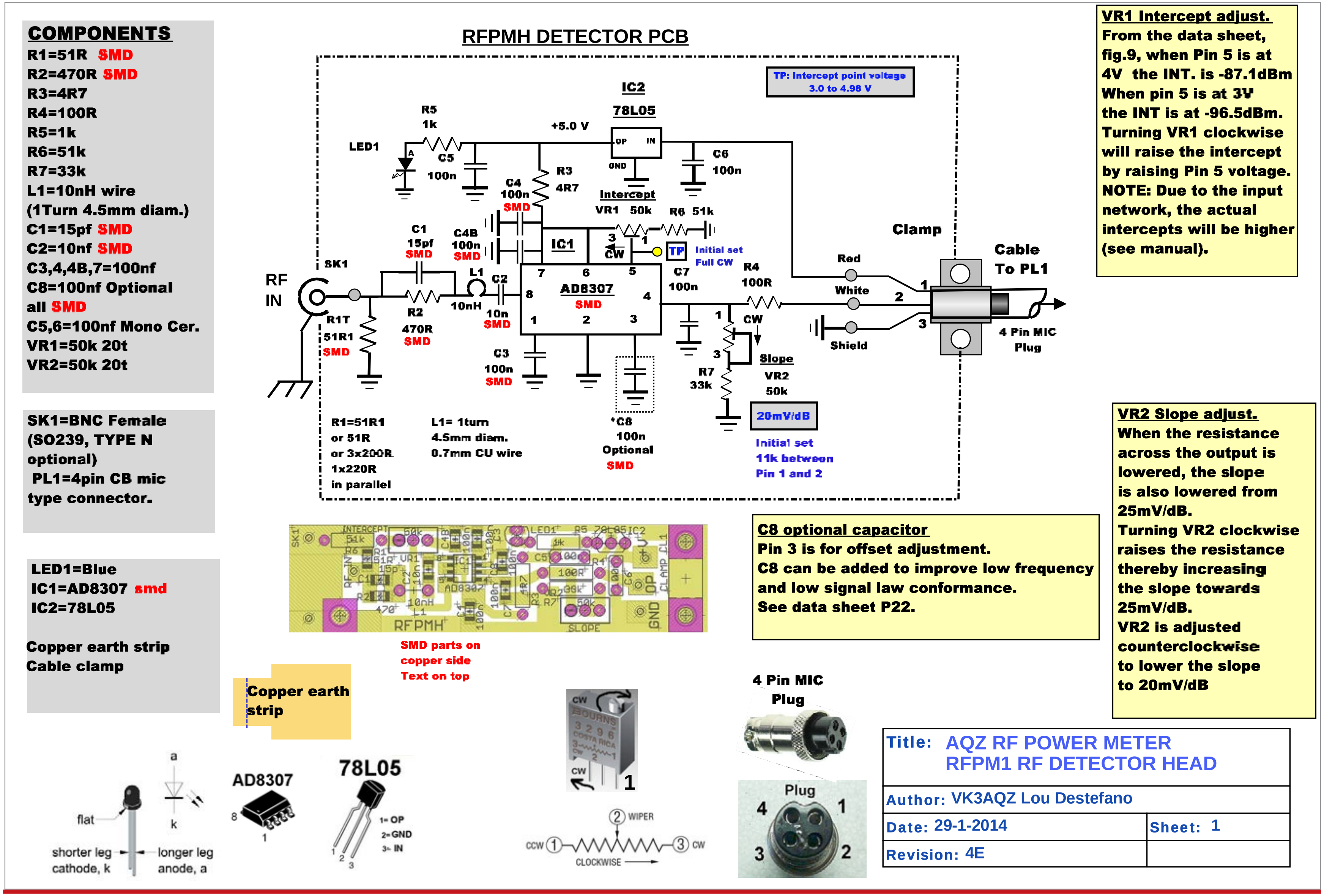


Figure 1. The RF detector head circuit – RFPMH – and PC board layout (the latter can be downloaded from the WIA website).

The use of a long audio cable simplifies the measurement of antenna front-to-back ratios, or in situations remote from the meter unit.

The RF head

The circuit of the RF head is shown in **Figure 1**. The input circuit contains a 51.1 ohm 1% terminating resistor in parallel with the input network. R2, C1 and L1 form a high frequency boost network that helps to flatten the UHF response of the unit.

The input impedance of the AD8307 is 1100 ohms in parallel with 1.4 pF. The 470 ohm resistor, R2, in conjunction with the input resistance of 1100 ohms forms a simple voltage divider that serves to lower the sensitivity at low frequencies. C1 starts to bypass R2 at UHF and, in conjunction with L1, forms a small UHF-boost circuit, thereby flattening the overall response of the RF head.

The AD8307 IC is a surface mount version, as are a number of components connected to it. The surface mount components offer better performance at UHF. The surface mount version of the AD8307 is also considerably lower in cost and more readily available than the 8-pin DIL version.

In addition, double-sided PC board was tried, but the groundplane turned out to be one large UHF bypass capacitor resulting in poor UHF performance. Some may wonder about this as it is common to use double-sided material for RF circuits. The original QST design used 'air supported' wiring as this was found to produce better UHF performance. So, the RFPMH PCB is single-sided, which appears to be a good compromise between ease of construction and performance.

The use of surface mount components requires some care in assembly; I used 1206-size components that are not too difficult to mount.

Referring to the AD8307 datasheet, the intercept point and slope can be adjusted by the addition of some variable resistors. The data sheet has comprehensive information explaining the concepts of the device's intercept point and slope.

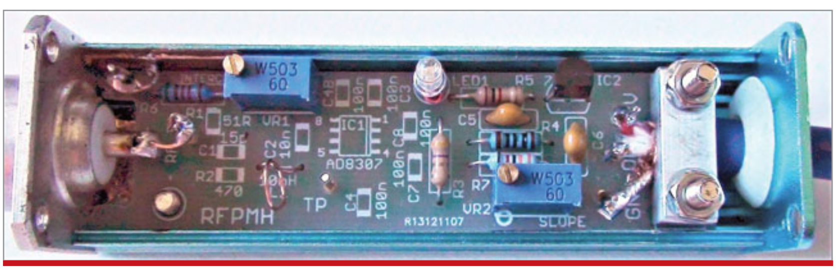
VR1 is a 20-turn trimpot used to set the intercept point. VR1 varies the voltage on pin 5 from around 3 V to 4.99 V. Referring to the AD8307 datasheet, the graph in Figure 9 represents an intercept point variation, at 10 MHz, from -96.5 dBm at 3 V to -82.9 dBm at 4.99 V.

However, in this design, the inclusion of the input UHF boost circuit causes the intercept point to shift. Measurements taken on the prototype indicated that, at an input level of -20 dBm, the DC output voltage was around 1.3 V, as against the published value of around 1.7 V. In other words, the traces on the Figure 9 datasheet graph all fell by around 0.4 V. This was for a voltage of 4.0 V on pin 5.

In the RFPM1, the intercept is normally set to give the lowest reading with a 50 ohm termination across the input. However, some users may require a different intercept point, depending on the application. For this reason, the trimpot can be adjusted through a small hole in the RF head enclosure.

There is a spread in characteristics between individual chips and the boost component values, resulting in different DC outputs for a given input level. The intercept adjustment can be used to help match two RF heads to the one meter unit. Initial setting for VR1 is fully clockwise. Measurements on two prototype probes show the variation in intercept points.

VR2 is also a 20-turn trimpot that can be used to adjust the slope of the log output. Without VR2, the nominal slope is 25 mV/dB. The slope for the RFPM1 is adjusted for 20 mV/dB, simplifying the meter circuitry, and matching some of the other designs published.



RF head internal view, again. Note the two trimpots for intercept and slope adjustment, VR1 at top left and VR2 at lower right. L1, part of the UHF boost circuit – a small loop of wire, can be seen below VR1.

References

1 W. Hayward, W7ZOI, and R. Larkin, W7PUA, "Simple RF Power Measurement," QST, June 2001, pp 38-43. https://tinyurl.com/2p8dzbnr
2 R. Kopski. K3NHI. "A Simple RF Power Calibrator" QEX, Jan/Feb 2004 pp 51-54
3 R. Kopski, K3NHI, "An Advanced VHF Wattmeter," QEX, May/Jun 2002, pp 3-8.
4 Analogue Devices website: www.analog.com/en/index.html

AD8307 data:

www.analog.com/en/products/ad8307.html

Some AD applications documents:

https://tinyurl.com/38ww93hc
https://tinyurl.com/mr45hyck

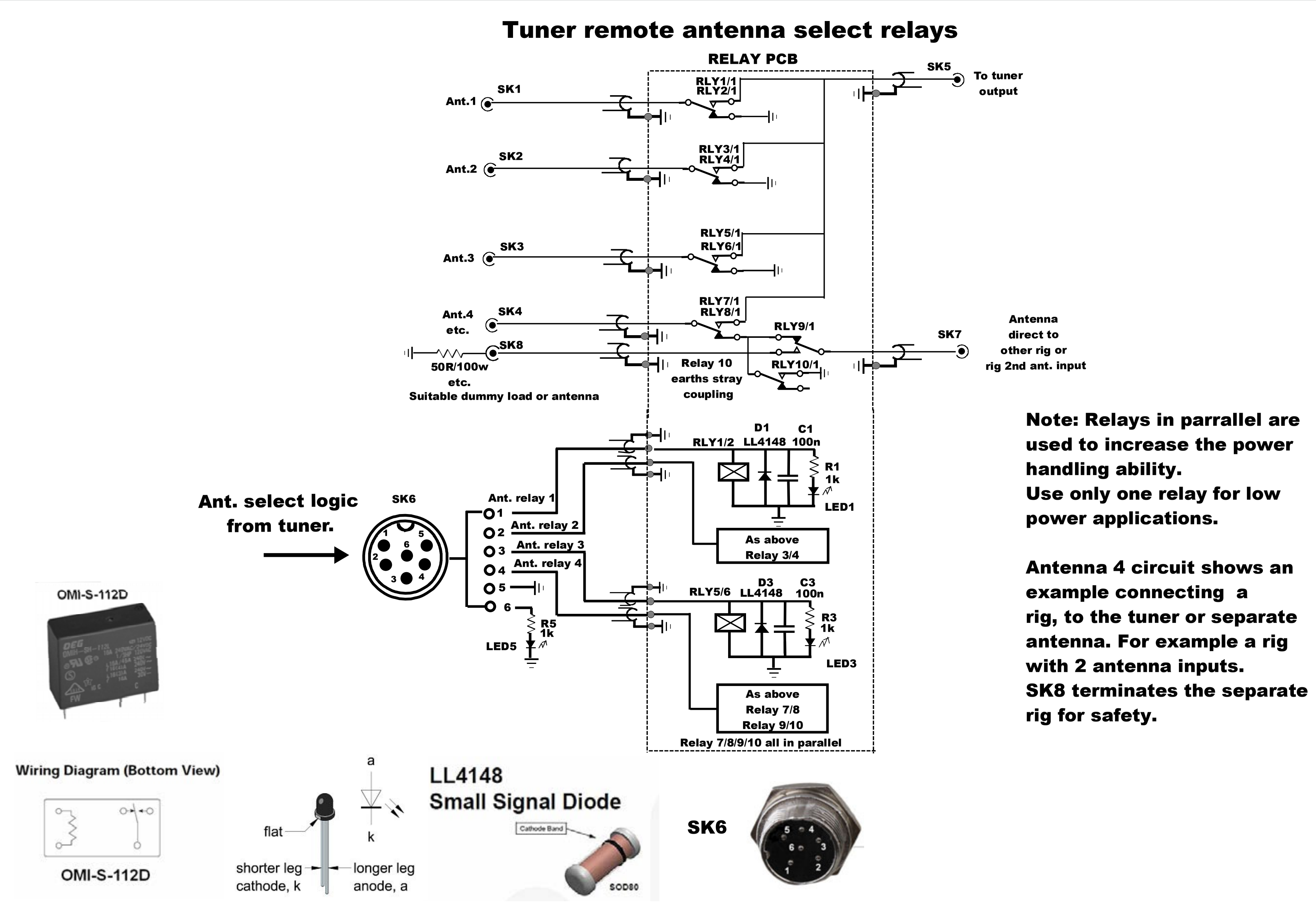


Figure 17. Circuit of the remote antenna select switch seems deceptively simple, but includes a number of useful functions with the 4th antenna circuit – involving SK4-SK7-SK8.

The VK3AQZ HF antenna tuner project

Part 3 Fifth and final article of Lou's ATU project

Luigi Destefano VK3AQZ

Part 3: The antenna switch

The antenna switch is outside my house and is controlled by a shielded 6-core cable by the ATU processor. The circuit is in **Figure 17**. The relays are housed in a diecast box with the connectors all mounted on the down-facing side of the case to minimise moisture ingress. **Photo 3A1** shows an internal view.

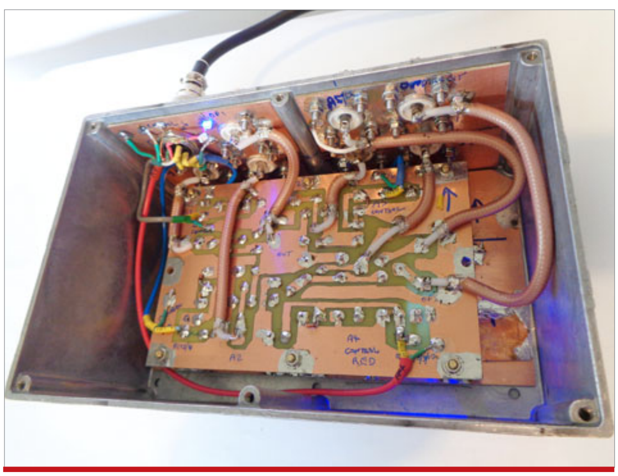


Photo 3A1. Inside view of the antenna switch. Note the routing of the RG-142 coax for the RF connections.

Photo 3A3. Top-down view of the antenna switch, highlighting placement of all the sockets on one side of the diecast box.

I used RG-142 coax for the RF connections. I soldered the braid directly to the ground areas of the PCB. The PCB with the relays is mounted upside down in the case using pillars soldered to the PCB base. Connections from the sockets to the relays are made directly to the copper side.

The relays have been laid out in a square pattern with the switched outputs all meeting in a central area. I did this to obtain the shortest RF output path.

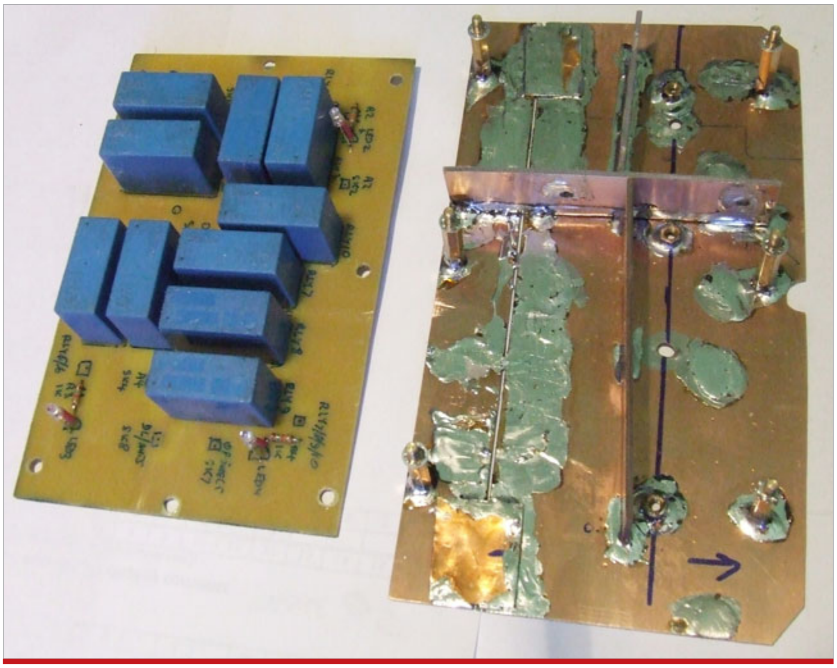


Photo 3A2. Showing how I located the relays to place the outputs centrally on the PCB. Small scraps of PCB are soldered in place vertically to shield the antenna / relay sections.

Photo 3A2 shows the location of the relays with the outputs in the centre of the PCB, and also shows the base made from scrap pieces of PCB material. I used small pieces of PCB placed vertically to act as shields between the four antenna-relay sections. **Photo 3A3** shows an external view.

Each antenna is switched by two OMI-S-112-D general purpose 10 A relays. I wired two relays in parallel to increase the power handling to, say, 400 W. One of the four circuits is different from the other three. The first three antenna relay pairs are wired so that the normally closed (NC) contacts ground the antennae that have not been selected.

The fourth antenna circuit is slightly different. When it is not selected, it is connected by a separate coax to a separate rig, or a rig with a second antenna connector. That connection bypasses the tuner and other switching. It is a direct feed to antenna 4.

However, when antenna 4 is selected, the particular rig connected to it is switched to a dummy load, or a 50 Ω antenna. That 4th antenna may be an antenna not normally needing to be fed from the tuner, such as a 28 MHz or 50 MHz beam, or vertical, or a special function load. This is just a precaution to make sure the rig sees a proper load if accidently put into transmit.

There is also a fourth relay that is used to ground the relay arms connecting the signal relays. This reduces unwanted stray coupling between the circuits. In all, there are four relays associated with the fourth circuit. This extra circuit is just something I wanted to have so I could effectively have two paths to the antennae outside. Please note that the control signals feed the relays via shielded cable.

I did some quick tests on leakage between the various ports. I found that, below 30 MHz, the drop in signal between any input and the selected output to be less than 0.1 dB, and around 0.1 dB at 30 MHz. The test level was 0 dBm.

I used my Leader signal generator for these tests; it does not have a resistive 50 output impedance. I inserted a good 50 20 dB pad between the generator and the antenna switcher and the attenuation fell to the figures quoted. I found that, at frequencies below 21 MHz, the leakage from the other antenna inputs varied from -70 dB to around -60 dB; at 30 MHz it had risen to around -50 dB.

Conclusion

As far as testing and alignment goes, it should be pretty straight forward. You may want to put a capacitance meter across the capacitor circuit board before attaching the inductor PCB. Toggle the relays and see if the capacitance changes are relatively smooth in steps of 5 pF, or thereabouts.

Also do a similar test on the inductor PCB. You may find that, at the major code changes, such as going from seven active relays to only one (code change from 127 to 128), that the step is not 0.1 uH. The reason for that is the stray inductance change caused by going from seven active relays, down to just one.

The resulting inductance change is probably a lot more than the nominal 0.1 uH. In most cases that may not cause too much of a problem. However, if you have an antenna that matches near that value, then you may want to trim some of the coils a bit. It will most likely require the next coil in the sequence to lose or add some wire. The same applies to the variable C. This problem becomes worse at higher frequencies. So, please bear that in mind when stepping up and down in L and C values.

After a short period of use, I noticed one of the inductance steps was greater than expected. This turned out to be a faulty opto-coupler. Up to now, I have had no further failures. Because of this, I now recommend the LEDs across the relay coils be made visible somewhere in the case, or on the front panel, so that you can check that they are all being activated.

If you go ahead and build the SWR and power meter section, you will need to calibrate and set up the AD8307 detectors and calibrate the Stockton bridge outputs. For

The ATU and antenna switch in use in my shack.

that you will need a signal with two accurately known levels for setting the slope, and an accurately known power level to set the dBm calibration.

You could use your HF transceiver because most will have a reasonable power indication of 10 W and 100 W levels on the inbuilt meters. Also, most rigs have an inbuilt SWR meter you can use instead of one in the rig switch. Use a frequency of around 7 MHz because the bridge is quite good at that frequency. Above 21 MHz, the response of the Stockton bridge will most likely start to fall off.

If you use larger cores than the FT50s, core saturation at the higher powers and frequency will be less. **Photos 3A4** shows the ATU and remote rig switch together on my bench.

Both the remote rig and the remote antenna selectors can be used without the processor. You can use a single-pole four-position switch for antenna selection, and a single-pole five-position switch for the rig switch with SWR and power meter. Use a small 12 V supply to feed the switch poles. They can make convenient shack accessories in their own right.

If you are only going to run low power (say, less than 25 W), you can use smaller 2 A relays and smaller coils. They can be air-wound, slug-tuned types as seen on older radios, and smaller toroids. The capacitors can have a lower voltage rating, and you can use small trimmers, such as mica, beehive, and air-spaced types. With no remote rig or antenna switching, a smaller display or none, you can use a smaller case. Just something to think about.

Acknowledgement

I have a handy little device attached to my IC-706 called a "Tunemate", made by Owen Duffy VK2OMD. I connect this little device to the tuner socket on the IC-706 to fool it into thinking that there is an ICOM tuner attached. When I push the tune button, the rig transmits a 10 W carrier for 18 seconds, or shorter if the tune button is pushed again. A very convenient and safe way of setting up the tuner.

ERRATA

Editing during production introduced some unfortunate errors in Part 2, Fourth article last issue, Vol. 90, Issue 1, pp 22-32.

Page 23, column 2, paragraph 1. The first sentence should read: The relays are switched by the main tuning unit via the shielded 6-core cable.

Page 24, paragraph 1. The first sentence should read: The relays I use here are different from the ones in the tuning unit.

Page 24, paragraph 3. The first sentence should read: The type used in the tuning unit have the moving pole at the opposite end of the case, away from the NO and NC contacts.

Page 28, column 1, 5th line from bottom. The last sentence in this paragraph should read: So, on position 1, only the relays are active since they are driven by the signal voltages from the tuning unit.

We apologise to the author, Lou Destefano, and readers for this lapse.

VHF/UHF - An Expanding World

David K Minchin VK5KK
e david@vk5kk.com

This month's column focusses first on 10 GHz with a report from Rex VK7MO on the VK–ZL opening in January 2022, plus details of Richard VK7ZBX's portable 10 GHz EME station; and in keeping with the general theme on 'measurement' in this issue, part 6 of my construction series looks at noise figure comparisons on 10 GHz equipment over the past 30 years.

VK7 to ZL Opening on 10 GHz and some thoughts on ducting propagation

This piece compiled by Rex Moncur VK7MO, Roger Rehr W3SZ, Roger Corbett ZL3RC, and Richard Howlett VK7ZBX.

We previously reported on the first 10 GHZ QSOs from VK to ZL over a path of around 2000 km between VK7MO and ZL3RC in the summers of 2019-20 and 2020-21 (AR, Vol.88, No. 2, 2020). VK7MO and ZL3RC repeated this on 22 January 2022, with VK7ZBX making his first long distance 10 GHz QSO to ZL3RC. Comparative tests were made on 1296 MHz. Propagation was present for over 5 hours from 0116 to 0556 UTC on 22 January 2022.

VK7MO operated from his home location at 320 metres and VK7ZBX operated portable at 676 metres just 4 km further back, thus the paths were almost identical other than the operating height. Having two stations operating at different heights provided the opportunity to learn some more about ducting.

VK7ZBX received twice as many decodes as VK7MO and after taking account of system performance and lower absorption at the height of VK7ZBX, he received on average 9 dB stronger signals on the common decodes.

Analysis of high-resolution radiosonde data shows there was a very strong duct at the Tasmanian end, but this was well above the operating heights of both VK7MO and VK7ZBX and unlikely to be the cause of the propagation. However, there was a moderate duct at the height of VK7ZBX and a weak duct at the height of VK7MO which might explain the propagation. Our preliminary view is that weak ducts that show up in the high-resolution radiosonde data that we previously ignored, might be important for understanding ducting propagation.

W3SZ has developed a video method of displaying the rays that propagate in ducts, based on high resolution radiosonde data, and this shows the impact of these very weak ducts at the Tasmanian end (see Section 4 below).

1. **Hepburn Chart for the day of the tests.** We were alerted to the possibility of propagation by the Hepburn charts indicating that best propagation would be around 0600 UTC on 22 January (**Figure 1**).

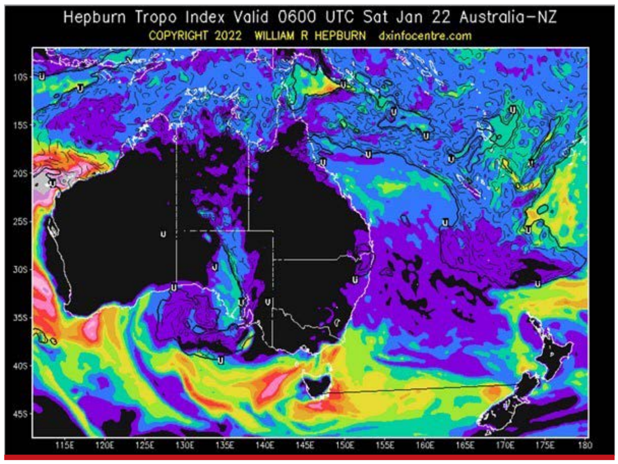


Figure 1. Hepburn chart indicating potential propagation at 0600 UTC on 22 January 2022. The black lime between Tasmania and the South Island of New Zealand is the path involved.

2. **Locations, Equipment, System Performance and Best Signals:**

- VK7MO: Lat -42.907763°, Lon 147.303996°, Altitude 320 metres, Path length to ZL3RC, 1972 km
- VK7ZBX: Lat -42.917237°, Lon 147.250739°, Altitude 676 meters, Path Length to ZL3RC, 1976 km
- ZL3RC: Lat -42.089234°, Lon 171.347699°171.347699°, Altitude 100 metres
- VK7MO: 10 GHz, 77 cm dish and 60 watts. 1296 MHz, 37 element Yagi and 120 watts. Both bands fully GPSDO locked.
- VK7ZBX: 10 GHz, 60 cm dish and 30 watts. 1296 MHz 19 element Yagi and 10 watts. Both bands fully GPSDO locked.
- ZL3RC: 10 GHz, 113 cm dish and 60 watts. 1296 MHz, 60 element Yagi and 15 watts. Transverters GPSDO locked but not the 144 MHz IF.

The Q65-60B mode, tone spacing 3.3 Hz was used for both 10.368 GHz and 1296 MHz.

Freq (MHz)	10.368	10.368	1296	1296	10.368	10.368	1296	1296
RX	VK7MO	VK7ZBX	VK7MO	VKZBX	ZL3RC	ZL3RC	ZL3RC	ZL3RC
TX	ZL3RC	ZL3RC	ZL3RC	ZL3RC	VK7MO	VK7ZBX	VK7MO	VK7ZBX
System Perform' (dB)	292	290	251	247	292	287	260	246
Best Signal (WSJT S/N)	-20	-7	-15	-21	-18	-25	-6	-18

Figure 2. System performance and best signals received by each of the stations involved.

At 10 GHz, the system performance (**Figure 2**) is around 290 dB and similar to that required for EME (288 dB for the Moon at perigee). This is confirmed by the fact that the same equipment has been used for EME.

At 1296 MHz, our system performance (**Figure 2**) is some 40 dB lower due, primarily, to much lower antenna gains. Despite the lower system performance, signal levels are in the same ballpark. Factors that explain this are higher absorption at 10 GHz, around 25 dB, and what is called free space attenuation, which relates to reduced receive antenna capture area at higher frequencies, 18 dB. Against this, the narrower beamwidths used at 10 GHz more effectively couple into the narrow ducts and can provide around 10 dB advantage. [1]

The above implies a difference of about 33 dB in favour of 1296 MHz, which is in the ballpark of offsetting the 40 dB reduction in system performance. While we cannot expect high levels of accuracy from such limited results, the ballpark evidence is that the losses in the duct do not vary significantly between 1296 MHz and 10 GHz.

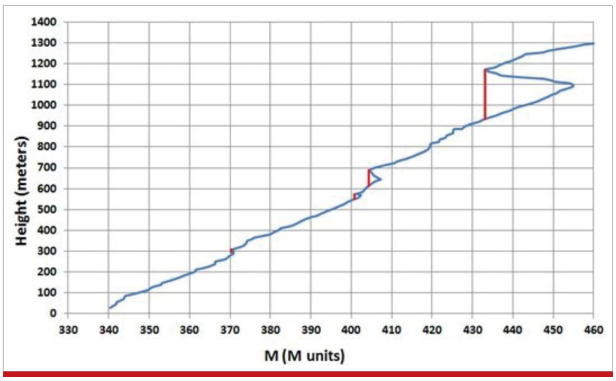


Figure 3. Modified Refractive Index Gradient for the Hobart end of the path at 00Z on 22 January just prior to propagation occurring. Red lines indicate ducts.

3. **High Resolution Radiosonde data.** High resolution radiosonde data has become available from the University of Wyoming over the last few years at the following URL: https://tinyurl.com/2p8a6zks

Figure 3 is an example of the modified refractive index gradient derived from high resolution radiosonde data at the Hobart end just prior to these tests. While there is a strong duct between 920 and 1180 metres, there is also a weak duct at around 320 meters, where VK7MO was operating, and a moderate duct at 676 metres, where VK7ZBX was operating. We are of the opinion that this high-resolution data might give useful insights into ducting and is well worth investigation during ducting events. Unfortunately, there are no radiosonde sites close to where ZL3RC was operating.

4. **Ray Tracing.** The following URLs give examples of W3SZ's ray tracing videos for the Hobart end of the path at 00Z, just before our on-air testing and at 12Z, some seven hours after our on-air testing was completed.

   https://w3sz.com/Hobart-00Z-22-Jan-2022.mp4

   https://w3sz.com/Hobart-12Z-22-Jan-2022.mp4

The ray tracing is done at 0.1-degree intervals for ray take-off angles ranging from -0.6 degrees to +0.6 degrees from horizontal at each level, for transmitter heights ranging from 10 meters to 1500 meters, to show how the number of rays propagated within the duct varies with height for a given refractive index/height profile. The heights of VK7MO and VK7ZBX are marked by blue and red horizontal lines respectively.

The example at 00Z shows only one ray trace at the height of VK7MO but more propagated rays near the height of VK7ZBX and many more at heights of approximately 1000 meters. A greater number of rays present for a given height in the video, indicating duct propagation over a larger range of incident angles. The presence of numerous rays at several adjacent heights in the video are both associated with the presence of a stronger duct and are also associated with the presence of stronger signals propagating to the other end of the duct.

5. Signal spreading and QSB at 10 GHz. We conducted limited tests with single tones that are useful to determine spreading and the rate and magnitude of QSB. **Figure 4** shows an example of a

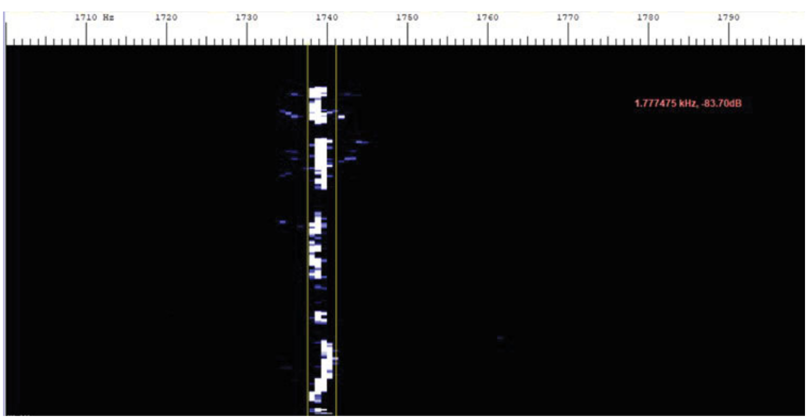


Figure 4. A 60-second period of a single tone on 10 GHz shows almost all the energy constrained within 3.3 Hz, shown by the added yellow lines. The gaps in the signal demonstrate that there is deep and rapid QSB.

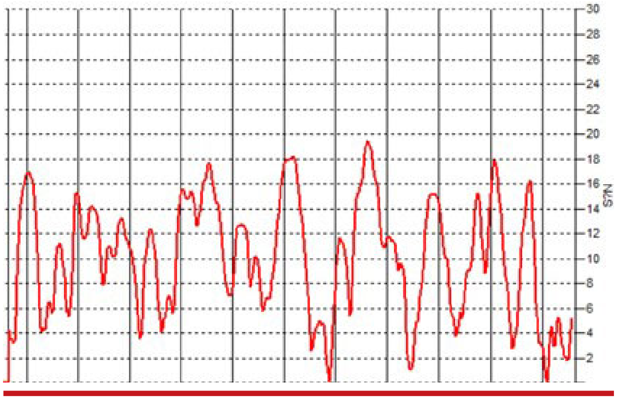


Figure 5. The same file used for Figure 4 shows that the amplitude variations are up to 20 dB, with significant variations in less than a second. Vertical lines are 5-sec intervals.

single tone with all the energy constrained within a few Hz indicating that the Q65-60B sub-mode with 3.3 Hz tone spacing should be viable.

Q65, with its heavy forward error correction, is a very effective mode for coping with the sort of QSB shown in **Figure 5**. This opens the question as to whether shorter periods, such as 15 seconds, might be useful as one then has four times as many opportunities to achieve a decode.

6. Conclusions and Comments.

1/ The opening in January 2022 continues a sequence of six long distance (around 2000 km-plus) 10 GHz openings between either VK6 and VK7 or from VK to ZL each summer. In every case where the Hepburn charts suggested propagation and we were in a position to try, 10 GHz QSOs were completed.

2/ Keys to 10 GHz success are EME-capable portable stations that are GPSDO locked, combined with the means to point accurately at both ends.

3/ The 15-second period Q65-15A is worth testing for 10 GHz ducting.

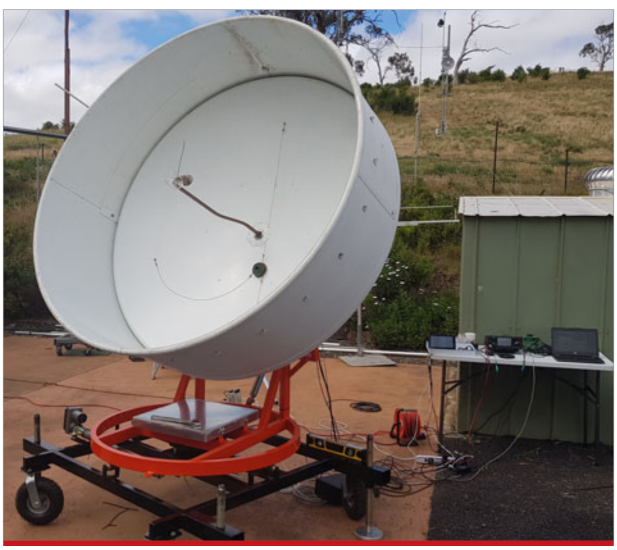


Photo 1. Richard VK7ZBX's 1.8 metre portable EME station.

4/ High Resolution radiosonde data suggests that small ducts that we previously ignored may play a part in these long-distance openings.

5/ VK7ZBX's 9 dB improvement compared to VK7MO suggests that it is worth optimising station height to that of the duct.

10 GHz Portable EME

Richard VK7ZBX reports:

"The project started almost five years ago after a demo of 10 GHz EME at our local club Radio and Electronics Club of Southern Tasmania (REAST) by Rex VK7MO. Like many there, I was pretty impressed at seeing echoes come from the moon on any frequency, let alone 10 GHz! After watching the precision of the process, one thing struck me that it would be super cool to have a dish that would automatically track the moon and hence make things a little less hectic during operation.

"Murray VK7ZMS and I spent quite some time discussing various mechanical solutions and decided that yep, we are in. Spoke to Rex, and after a few sobering comments about being aware this is a minimum or no compromise path and it would not be either cheap, or easy. So, the next day a 1.8 metre Mitec dish showed up at my work with the comments, 'Here you go; this will get you started.'

"Many options for rotation and elevation were contemplated and tried, with linear actuators winning out for both AZ and elevation. I did have ideas of tracking satellites but then decided that it was primarily an EME system. So, having the ability to track moonrise and moonset was most important, so the linear actuator would be fine.

"Position reporting is done with a US Digital absolute encoder for AZ; an absolute inclinometer from US digital keeps track of elevation. The AZ encoder is coupled direct to the AZ axis 1:1 with a coupler to allow for not being aligned 100%.

"The linear actuators are natively 36 V, but I drive them with PWM boards at 24 V that seems to work nicely. I have tinkered with a few tracking systems,

Photo 2: Richard VK7ZBX's 20 W 10 GHz transverter mounted on the rear of the 1.8 m dish.

there are so many great options out there.

"It was pretty dam nice to have the first contact on the system with Rex VK7MO a distance of 22 km as the crow flies, but over a 730,000 km signal path.

"System details: Kuhne G4 3cm Transverter, Kuhne waveguide preamp, WR75 waveguide switch, 20 W SSPA courtesy of Jac PA3DZL and his group, 1.8M Mitec prime focus dish. Seeing 12dB of sun noise.

Attached rifle scope is very handy. It is aimed by peaking on Sun noise then adjusting the riflescope. This is great to be able to add visual tracking to keep an eye on the automatic system. As the system is portable, one can't be certain the vertical axis is 100% perpendicular, so small «tweaks» will be required.

"Looking forward to getting a few stations in the log."

Construction Series Part 6: Noise figure measurement on 10 GHz

Measuring noise figure (NF) of any receive system is important for weak signal work but difficult to achieve without access to calibrated NF meter and noise source. Most amateur operators resort to comparative A-vs-B testing, or just rely on a manufacturer's specification sheet. Importantly, it is the system NF we need to measure and not just the noise figure of the front-end device. Minimising losses in front of that expensive LNA is just as important as ensuring there is sufficient gain to mask noise in the following stages in a complete system.

For EME, Sun (and Moon) noise is good way to check and optimise a system, provided you have everything close to working to start with. On 10 GHz, an optimum system can just detect Moon noise on a 900 mm dish, a 1.2 m dish should see around 0.5 dB of Moon noise, or > 9 dB Sun noise.

There are a number of articles on how to construct a noise meter, the most popular are by Charlie VK3NX and Michael DB6NT (who copied Charlie!). These meters are basically a broadband (2-4 MHz) TRF receiver on the IF of a transverter with a logarithmic detector coupled via audio stage(s) with some averaging/damping to a meter. The meter can be set down to 1 dB full scale to show minor changes in noise.

Once you can hear Moon noise, then you have reached your signal receiving capacity, although having more Moon noise does make the Moon easier to track! If you can't hear Moon noise, then you can still use the Moon noise meter with another noise source to optimise your systems, albeit in a comparative way.

Just for the exercise, I thought I would compare the noise figure of a collection of 10 GHz transverters I have used since 1992 that are still in use directly or as loan units for field days. The older transverters were mostly optimised using "amateur methods", i.e., measuring quieting on a CW carrier on FM, or Sun noise and an AC voltmeter.

Noise Figure	Preamp	Transverter	Year
0.64 dB	X-LNA (NE3515S02)	Kuhne MKU10G3 (NE32584 FE)	2018
1.07 dB	DG0VE (NE32584)	VK3XDK Mk2 (NE32584 FE)	2014
1.12 dB	None	Kuhne MKU10G3 (NE32584 FE)	2015
1.37 dB	WB5LUA (AT13135)	DB6NT Mk1 #1 (MGF1303 FE)	1992
2.8 dB	None	DB6NT Mk1 #2 (MGF1303 FE)	1995
6.25 dB	None	W1GHZ Pipecap (NLB310 FE)	2016

Figure 6. 10 GHz noise figure measurement results.

The more recent EME transverters and LNAs have been checked on NF measuring equipment, usually to debug coax relays, waveguide transitions and cheap SMA connectors! Testing was done using a Hewlett-Packard HP 8970A noise figure meter with an Eaton 7616 1-to-12.4 GHz noise source (~15 dB). Results can be found in **Figure 6**, including the year, the transverter, the type of transverter and the front-end device. Three preamps were used in the tests; for two of these, there was a 'with' or 'without' test.

Not surprisingly the X-LNA (a PA0 project) in front of the MKU10G3 transverter had the best NF at 0.64 dB (**Photo 3**), the same transverter with a Kuhne preamp measured 0.72 dB (not included in the table). The kit built MKU10G3 transverter was 1.12 dB, an excellent result. The DG0VE preamp in front of the VK3XDK Mk2 transverter was the best general performer. This combination is installed on a patch panel with a 4 Watt PA that has been to Europe a few times, the best DX it has worked is 750 km on forward scatter on the patch!

Maybe the biggest surprise was the old DB6NT Mk1 + WB5LUA ATF13135 preamp system from 1992, with 1.37 dB NF (**Photo 4**). Both were built using PCBs that we etched on Rogers 5880 Teflon back in the VK5 ESC days.

This transverter more recently was installed at VK5AKM's, at 14 metres (above ground), as a home system. Most notable DX was copying Derek VK6DZ on 10 GHz JT4f in 2013 before anyone else did just on its patch antenna! Before that, the same transverter/preamp in a different box and crystal local oscillator copied Wally VK6KZ in 1994. Unfortunately, it was only one-way, maybe partly explained by the difference in receive systems! The bare DB6NT Mk1 with 2.8 dB NF was optimised for NF at the time. This probably is more typical of that era.

The last transverter tested was the popular W1GHZ Simple (Pipe cap/MMIC) transverter from 2016 at 6.25 dB NF. The gain of this transverter was also the lowest (11 dB). Paul did not quote a NF for this transverter. The devices are capable of better NF but, as discussed in the article, the significant loss of FR4 glass fibre at 10 GHz is the main limiter.

I'd previously tried this transverter on the 1.8 metre EME system with the X-LNA preamp and found Moon noise was lower than the old DB6NT transverter that I usually use for the noise system. After measuring its

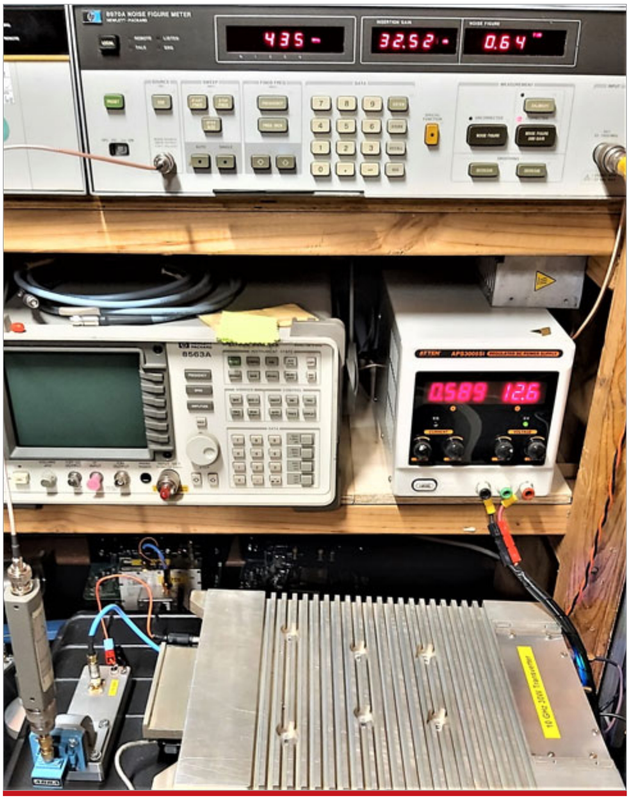


Photo 3 (left). G3 10 GHz Trx + PA0 X-LNA EME system, NF = 0.65 dB.

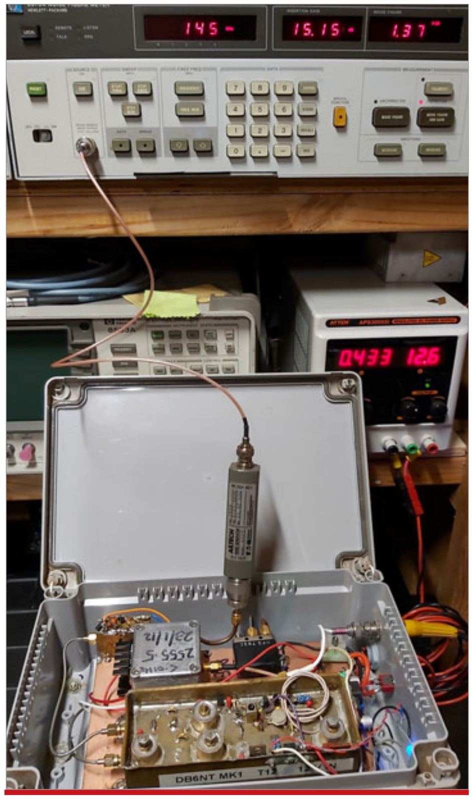


Photo 4 (right). MK1 DB6NT Trx + ATF13135 LNA from 1992, NF = 1.37 dB!

actual noise figure, it is clear from calculations it would need significant gain in front of it to be anywhere near the other units.

Hopefully, the NF tests are of some use. I've done a few checks on random preamps made from old Ku-Band LNBs, or cut from surplus microwave equipment. Even the old Qualcomm converter 10 GHz units aren't too shabby (2-3 dB NF) and the 3-stage LNA can achieve < 2 dB NF with some work. Next issue, we will get back into SDR looking at emerging projects.

What happened 20 years ago

Continuing the series, the lead article from my March 2002 column was entitled "New National 24 GHz record". Russell VK3ZQB reports:

> "The cool summer that prevails over Southern Australia has not produced significant amounts of tropospheric propagation so far this year, but there are occasions when there is just enough to be useful. This was the case on the morning of the 26th January when I was lucky enough to work Colin VK5DK on 24 GHz. We had been watching a small duct that existed between Mount Gambier and Port Fairy that was exhibiting intense ducting on 144 MHz, 432 MHz and 1296 MHz. We had speculated that it was strong enough to make solid contacts on 10 GHz but were a little uncertain about the duct supporting 24 GHz.
>
> "Colin went to The Bluff, a high spot west of Mount Gambier while I travelled to Mt Warrnambool near Panmure, east of Warrnambool. It was late in the morning before the fog started to lift and we established contact on 10 GHz about 2230 UTC. The signal on 10 GHz was very strong and we decided to have a look on 24 GHz. At first, we could hear nothing, but then about 2253 UTC, Colin heard my keyer very faintly. We persisted, by 2334 UTC 25th January, the visibility had improved, and we could hear each other's keyer at 5-3 with QSB. We had a contact on voice and exchanged reports setting a new national, VK3 and VK5 distance record for 24 GHz.
>
> "We watched signals on 24 GHz for another hour, but they did not get any stronger. Deep fades with peaks of S3 was the best, with conditions deteriorating as the day progressed."

This national 24 GHz record remained for some years until broken by VK3HZ/VK7MO. It remains the VK5 state record to this day.

In closing

Feel free to drop me a line if you have something to report or describe 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.

73s
David VK5KK

Reference

1. Hatfield NTIA-Report-81-69 *"The Role of Elevated Ducting for Radio Service and Interference Fields"* Page 14.

Meteor Scatter Report

Dr Kevin Johnston VK4UH
e vk4uh@wia.org.au

This Issue: More software upgrades; Meteor Scatter operation during VHF Contests; forthcoming events and showers; Meteor Scatter activity schedules.

Software upgrades

Development of WSJT-X continues at a rapid pace. The latest and current General Release of the free software is now up to version WSJT-X 2.5.4 (released Jan 3, 2022).

As with earlier revisions, much of the recent update work has been to enhance operation of Q65 and MAP65 modes. MSK144 mode, the "standard" for meteor scatter operation, remains fully functional. As always, the advice is to read through the release notes of all upgrade versions before using them on-air.

New software versions and User Guides can be downloaded from the usual source: https://physics.priceton.edu/pulsar/k1jt/wsjtx.html

Meteor Scatter operation during VHF contests

In Europe and North America, where the population density of meteor scatter operators is much higher, there are several annual contests and sprints specifically for MS operation. Some better-known examples include the MMMonVHF/DUBUS "144 MHz Meteor Scatter Sprint Contest" managed by PA4EME and The Bavarian Contest Club "BCC Meteor Scatter Contest". Currently, there are no MS specific competition or contest events here in Region 3.

It is, however, both possible and acceptable to use MS as another mode of propagation to make VHF contacts and score points in established Australian contests, including the WIA VHF/UHF Field Days, the John Moyle Memorial Field Day Contest, and the Ross Hull Memorial VHF/UHF Contest (marathon).

It is apparent that a proportion of VHF contest operators do not support the use of digital modes in Australian contests. Some, very strongly. The reasons are varied but concern has been expressed that the use of digital modes skew the results achieved between those who are set up for digital operation and those who are not.

The evidence, however, suggests that digital operation on the VHF bands, mirroring the results on lower bands, is becoming more popular and widespread during both normal and contest operations for all the same reasons – longer range during periods of poor propagation and contacts achieved with smaller stations and lower power.

Whatever view is held, the fact is that digital contacts, which would include those used on meteor scatter, are formally recognised and accepted as valid in all three of the contests listed above.

In former years, the VHF Field Days, for example, did not recognise digital contacts as valid at all, followed by a period where they were recognised but only in a separate entry category. Currently, all three contests accept digital contacts and all now have very similar requirements in terms of contest exchanges and logging.

Despite being valid, the proportion of VHF digital contest contacts remains low. Of those contacts claimed, the majority have been via tropospheric or sporadic E propagation using "slow" digital modes, including JT65, FT8, QRA64, and more recently, Q65. The number of stations operating via meteor scatter with fast modes during Field Days, including FSK441 and MSK144, has been extremely low.

Why has this been the case? There are a number of possible reasons. As touched on before, a proportion of operators do not approve of or support digital operation during contests. Some operators perhaps may not be familiar with either meteor scatter propagation or digital operation.

Also, 'digital capability' while portable requires additional equipment, including more computers, interfaces and the facility for time synchronisation, to be taken out. Further, the QSO rate of digital contest exchanges, particularly with MS, where a single contact might take 10 minutes or longer to complete, is very slow compared to phone or even CW operation. Many might not consider this worth the effort involved.

One other significant disincentive to digital contest operation has been the difficulty of achieving the required contest exchanges when using some of the current digital modes. All three contests currently have identical exchange requirements for both digital and non-digital contacts.

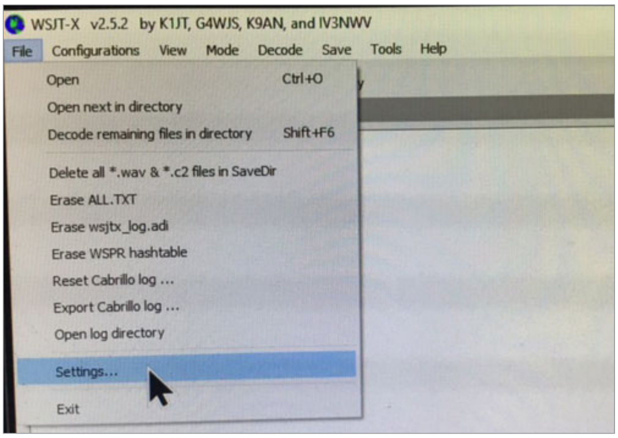
For a valid contact, all require the two-way exchange of callsigns, including /P for portable operation, the two-way exchange of signal reports, the two-way exchange of a 6-figure (Maidenhead) grid locator and the two-way exchange of an "unpredictable" serial number.

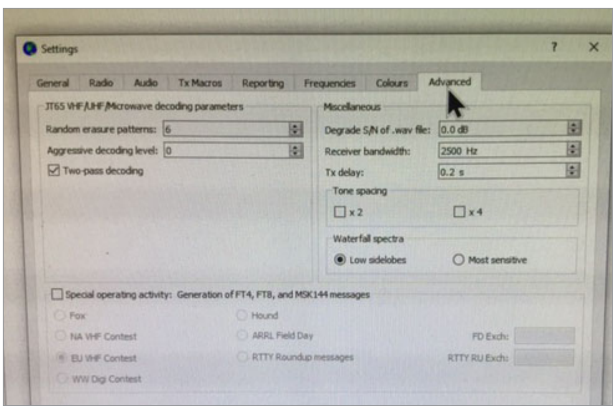
Both MSK144, the commonest MS digital mode, and FT8 – arguably the commonest digital mode used during VHF tropo and Es propagation – employ highly structured and very inflexible formats in their message strings that were not directly compatible with these contest reporting requirements.

While it has always been possible in both digital modes to customise a message to exchange a serial number or a full six-figure grid reference, in practice this was difficult, frustrating and slow, and required a high degree of familiarity with the software plus a lot of manual entry for every step. This situation has now changed. Current versions of WSJT-X now include new contest facilities that overcomes these issues completely.

Access to these facilities are via the main pull-down menu:

<FILE – SETTINGS – ADVANCED>

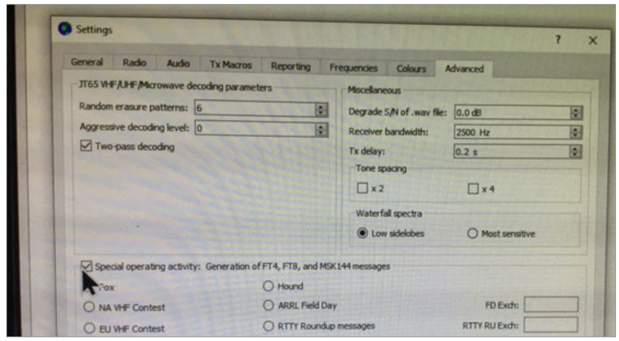


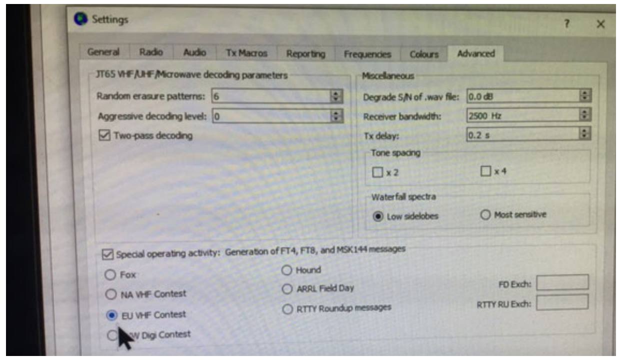


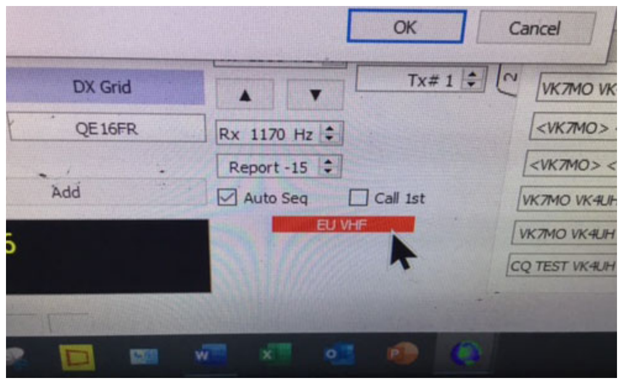
then checking the box in the lower half of the panel marked

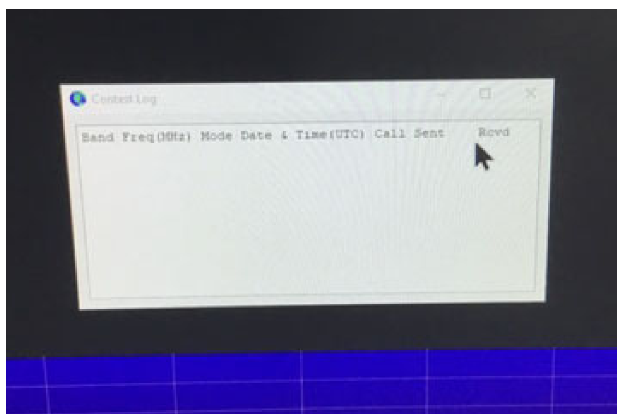
<Special Operating Activity : Generation of FT4, FT8 and MSK144 messages>

This panel gives access to a number of facilities, including Fox and Hound operation, and message formats for a number of specific contests. There is no specific option for any Australian contest. However, selection of the **<EU VHF Contest>** will provide all of the contest exchanges and gridsquares in the appropriate format.









When correctly set up, the **"EU VHF"** panel is illuminated in RED on the main computer screen and the contest appropriate exchanges appear in the standard messages Tx1 – Tx 6.

An additional contest log panel is activated on the screen and the transmitted serial numbers are automatically incremented after each contest contact is logged provided that the <**Auto-Sequence**> option is selected.

Setting up WSJT-X in this format will make achieving contest contacts via meteor scatter both simple and straightforward. While it is true that meteor scatter contacts will normally take much longer than via virtually all other modes of propagation, it is almost always present if enough patience is employed. The contacts are accepted in our contests and achieved distances may extend out to over 2000 km, with the score to match, **even when the bands appear dead**. At the end of the day "points are points".

Clearly, MS contest operation and calls cannot be run on the same focus frequencies as phone/CW. The practice of the contest group I compete with is to use the standard MS focus frequencies, i.e. 144.230 and 50.230 MHz.

Forthcoming meteor showers

The next significant shower events will be the Lyrids at the end of April (22nd peak). This shower is induced by debris from comet C/1861 G1 (Thatcher). Predicted ZHR is 18/hour.

Weekend meteor scatter activity sessions

The weekend MS activity sessions run on Saturday and Sunday mornings from before dawn (around 20:00 UTC or earlier) until propagation fails.

- Focus frequencies: 2m 144.230 MHz, 6m 50.230 MHz
- Current preferred mode MSK144 Version 2.0, running 15 second periods.

In VK, we have a well-established protocol for which call areas use which transmission period during these weekend activity periods:

- Southerly stations (VK1,3,5,7) ALWAYS run 1st period beaming North.
- Northerly stations (VK4) ALWAYS run 2nd period beaming South.
- Stations in the middle call-areas – VK2 and VK1 – change period, depending on the day.
- Saturday run 2nd period beaming South.
- Sunday run 1st period beaming North.

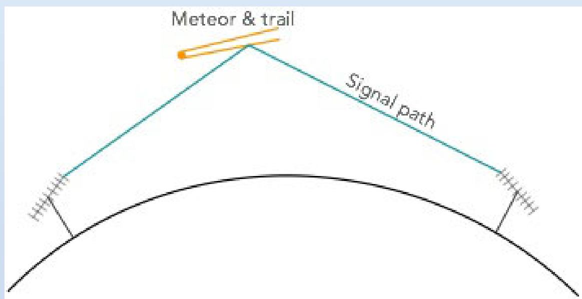
Register with VK-ZL Meteor Scatter Facebook Page (closed group of AR operators) for up to the minute advice and information.

Meteor Scatter operators are encouraged to monitor and post on the VK-Spotter site during the activity sessions

Next edition

A planning guide and diary for Meteor Shower operation through the year.

Contributions for this column are as always welcome. Please e-mail to: vk4uh@wia.org.au



EXPLAINER

Meteor scatter communications relies on the fact that many tiny meteors continually enter the Earth's atmosphere and burn up at heights between 85 and 120 km, leaving short-lived trails of ionisation behind them. These trails can be used to "reflect" radio signals that, although weak and short-lived, are used by operators to establish brief communications paths between radio stations that may be 100s of km, up to 2200 km, apart.

SOTA & Parks

Allen Harvie VK3ARH
e vk3arh@wia.org.au

	Association	Launched	Activations	Total Summits	Unactivated
VK3	Victoria	1-Feb-12	6702	701	251
VK5	South Australia	1-Oct-12	931	346	271
VK1	Australian Capital Territory	1-Feb-13	1780	48	3
VK9	Australian Islands	1-May-13	18	7	5
VK2	NSW	1-Sep-13	3659	1218	741
VK4	Queensland	1-Sep-13	326	1383	1314
VK8	Northern Territory	1-Mar-14	13	246	240
VK6	WA	1-Sep-14	208	259	227
VK7	Tasmania	1-Oct-14	485	796	658

Basic statistics of the nine Australian SOTA associations, in date order of launching.

Summits on the Air (SOTA) is an award scheme for radio amateurs and shortwave listeners that encourages portable operation in mountainous areas. The original SOTA concept was devised by John Linville G3WGV and launched 2002. SOTA is now fully operational in 195 active associations across the world. Each country has its own Associations, each of which defines the recognised SOTA summits within that Association. Given the size of Australia, we have associations based on states, with each coming online individually. SOTA launched in Australia in February 2012 with VK3 being the first Australian association listed. SOTA was not the first award scheme for amateurs wishing to take their radios into the field. National parks have been a favourite place to operate, avoiding radiofrequency interference (RFI) noise and enjoying the Australian bush.

VK3 has the 'Victorian National Parks Award' since the 1970s that became the 'Keith Roget Memorial National Parks Award (KRMNPA) in the 1980s.

VK5 gained the South Australia National Parks and Conservation Parks Award (SANPCPA) in April 2014. Then, Paul Simmonds VK5PAS rolled out World Wide Flora & Fauna (WWFF) across the country in December 2014.

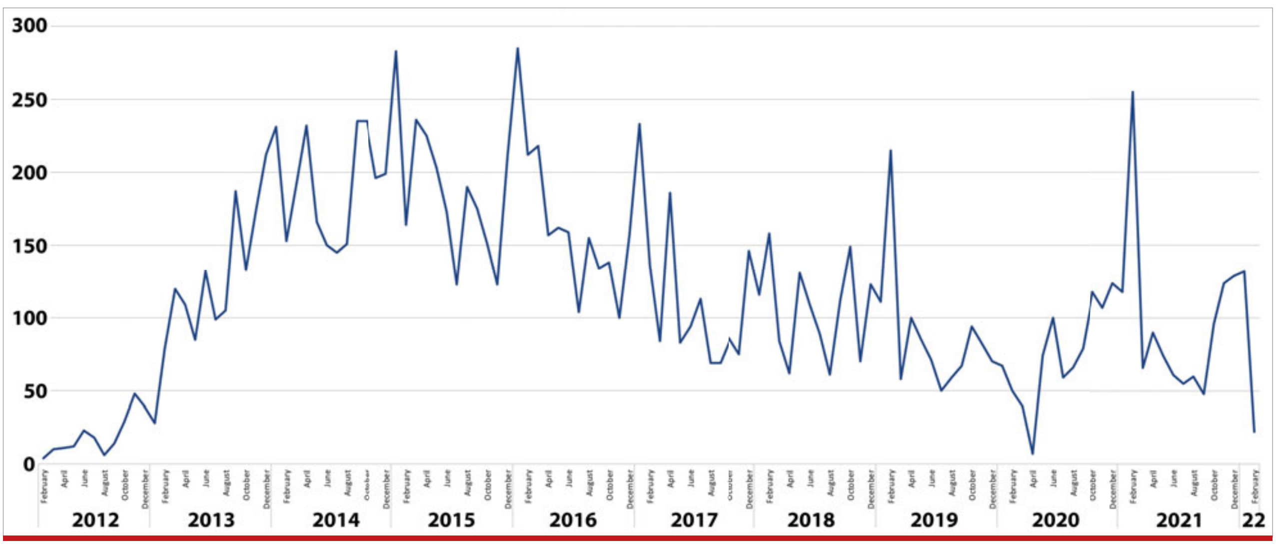
As I was collecting stats, the number of sites that have still not been activated attracted interest. I attribute the uptake of VK3 sites due to their locations being close to built-up areas and the [relatively] large amateur population.

Terrain, activator population and distances involved are factors for the high un-activated states of VK4 and VK7. Sites listed for VK9 are remote; I can personally attest to the effort involved in access and the challenges to gain contacts.

VK2 is another story. The cluster of high-point summits where VK3 and VK2 share a border (the Alpine National Park and Kosciuszko National Park, respectively) shows a lower uptake of summits in VK2. This is not due to the ability of VK2 operators to access the areas. Those that I know are highly skilled and respectful of conditions. However, activations are impeded by the restrictive practice of NSW National Parks & Wildlife Service (NPWS) as compared to Parks Victoria, which operates a policy of having its parks open, seasonal closures aside, and available all year round.

10 years of VK3 SOTA

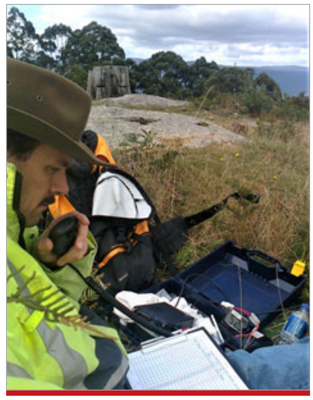
It took 10 years from the launch of SOTA in the UK until the first VK association was launched. This was not due to lack of interest. Paul VK3IH raised the topic in the May 2008 issue of Amateur Radio with an article promoting SOTA, but it then took another four years to launch.



Total SOTA activations of all VK associations since the scheme's inception in 2012. The impact of the pandemic since 2019 is clear. Yet, despite the volatility brought on by serial lockdowns, the trend across 2020 to early 2022 is clearly rising despite the early-2021 spike.

Each association must have a list of qualifying summits prepared and submitted. Summits are not picked on a whim, they must have sufficient topographic prominence. To qualify, a summit must have minimum prominence of 150 metres. Identifying, verifying then preparing the data for verification of suitable summits is a time-consuming task that requires an interest in both radio and hiking. Along comes Wayne VK3WAM. After spending weeks studying contours and spot heights on topographical maps and consulting Google maps (flooding), he prepared and submitted the initial list and supporting documentation for VK3. Bingo, just like that, SOTA is alive Downunder!

Ron Cook VK3AFW in June 2012, with that era's typical equipment.



Peter Frazer VK3ZPF on Mount Beenak, 2012, with Yaesu FT-817 and paper log.

Once launched, the scheme took off like a rocket, slowing to a stable level even with COVID-19 restrictions.

Wayne Merry VK3WAM gained first activation followed by Matt Schnizer K0MOS, then Peter Fraser VK3ZPF. It then took only 21 months for our first Mountain Goat, Wayne Merry VK3WAM. Given the effort Wayne put into getting SOTA operational and the pace that he activated, the trophy was well-deserved.

Thanks to Andrew Ryan VK3ARR for dipping into the SOTA databases, we can have a closer look at VK3. In the past 10 years, there were:

- 6691 activations of VK3 summits
- 57,632 chases of VK3 summits
- 10,361 summit-to-summit (S2S) contacts (QSOs) worked from a VK3 summit
- The most popular band was 7 MHz, with 61,181 contacts (QSOs), more than 10 times that for the next most popular band – 14MHz, with 5,207 QSOs.
- The most popular transmission mode for activators is SSB (single sideband) with 64,286 QSOs, while Morse (CW) comes second, despite the valiant efforts of one individual, with 8,838 QSOs.
- 171 individual activators have activated a VK3 summit; of these, 36 have only activated a single summit; 18 people have more than 100 activations completed, while one, Peter Freeman VK3PF, has scored more than 500 activations!

There was still more to do with bringing the rest of VK online. Not just ensuring the summit lists were accurate, but recruiting regional managers and ensuring the supporting documentation is available; can't have an award scheme without rules.

Andrew VK3ARR and Peter VK3PF completed a second revision of VK3 summits, adding more, while a small army of keen players mapped and submitted summits to bring the rest of VK online. Since the initial mapping, Andrew VK3ARR and his team have automated the process still requiring manual verifications, but drastically reducing the time to bring associations to bear.

The march of technology

Over the last 10 years, the equipment has been refined. The first photo here shows Ron VK3AFW on Mount William (VK3/VS-001). First contact was with Wayne VK3WAM/p on Mount Richie (VK3/VC-003). Ron's equipment included a Yaesu FT817, an MFJ-971 'QRP' tuner, a G5RV doublet antenna, a 7 Ah sealed lead-acid 'gel cell' battery, and a paper logbook.

Peter VK3ZPF on Mount Beenak (VK3/VC-016) also sported a Yaesu FT-817, gel cell and paper log. The FT-817 was the 'radio of the day' and is still deployed by many operators.

As radios shrank, the Elecraft KX series, with inbuilt tuners and batteries are very popular, as well as the micro KD1JV, uSDX rigs, as well as the likes of Xiegu*, are replacing bulky equipment. The use of gel cells has declined with lightweight LiPo batteries the go, and the use of computer (tablet/cellphone) based logging becoming the norm.

Hats off to those involved in the mapping and who have taken a regional manager role, including Ian VK5CZ, Bernard VK2IB, Andrew VK1DA/2UH, Ian VK1DI, Bruce VK1HBB, Wayne VK3WAM, Peter VK3PF, Andrew VK3ARR, Dave VK4DD, Kimberly VK2KMI, Grant VK4JAZ, Warren VK3BYD and Glenn VK3YY. All were involved; I'm sure I missed at least one Andrew.

Happy 10 years SOTA! It has certainly generated challenges, taken us to places we would have never gone otherwise, and kept many of us fitter than without it. SOTA is a lot of fun and it's brought me a lot of pleasure over the years.

See you for another 10.
73 & 44
Allen VK3ARH

* Check out our review of the Xiegu G90 rig in Vol. 89, 2021, Issue 5, at: https://tinyurl.com/2vhmwjxx

ALARA

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

In the ALARA Newsletter (#171) of October 2019, President Linda VK7QP announced the start of the ALARA Grants Scheme with the following words:

> "ALARA wants to ensure that getting an amateur licence remains affordable. This is one of the issues that came out of the survey that was conducted last year. I am pleased to announce that ALARA has developed a grant scheme which covers half the costs of any YL getting a licence. There are also funds available for ladies wishing to upgrade their licence. Applications are now open for grants. The scheme works on a refund basis. To apply for a grant, keep your receipts and submit them once you have obtained your licence or completed your upgrade qualifications. Full details are available on the ALARA website https://alara.org.au/ "

Nine family callsigns! Back row: Paul McMahon VK3DIP, Kimberley McMahon VK3FHQT, Peter McMahon VK3FLIP, Matthew Griffin VK3FMJG, Nicole Griffin VK3FXYL and John Griffin VK3CU. Front Row: Brenda McMahon VK3QT, Brenda Edmonds VK3KT (SK) and Victoria Griffin VK3LT (SK). NB: callsign details as at July 2006.

Three generations of Edmonds family YLs. Back row: Kimberley (Kim) VK3FHQT and Nicole VK3FXYL. Front row: Brenda VK3QT, Brenda VK3KT (SK) and Vicki VK3LT.

So, if your New Year's Resolution was to finally get your licence this year, why not take advantage of our Grants' scheme and as a bonus we will give you a year's free membership to ALARA.

By sheer coincidence, in this issue we talk about two very different but notable families. In both cases, the senior YLs (Mums) have made a substantial contribution to amateur radio, as have their OMs.

Victoria (Vicki) VK3LT (SK)

It is with regret that we report that Vicki Griffin (née Edmonds) VK3LT has become a silent key. Although not an ALARA Member, Vicki was a member of the notable Edmonds family. Her mother, Brenda VK3KT (SK), was the WIA Education Coordinator for many years and her father, John VK3AFU (SK), served as the WIA Historian during the 1990s.

John and Brenda had four Children; Charles VK3CLE, Vicki VK3LT, Alex VK3BQN and Brenda (Jnr) VK3QT. Brenda VK3QT married Paul VK3DIP and Vicki married John VK3CU. Both marriages produced two children, a boy and a girl, who have also gone on to gain their licences. Matthew VK3FMJG and Nicole VK3FXYL are the children of Vicki and John; and Kim VK3FHQT and Peter VK3FLIP are the children of Brenda (jnr) and Paul.

Sadly, Vicki passed away in November 2021, after a 20-month battle with cancer. She was first licensed in 1977, and by 1979 had gained her full licence as VK3BNK. Before Vicki's illness and recent Covid lockdowns in Victoria, she and John had gained a lot of pleasure out of WWFF and SOTA activities.

Our sympathies go to husband John VK3CU, children Nicole and Matthew, and to the extended family.

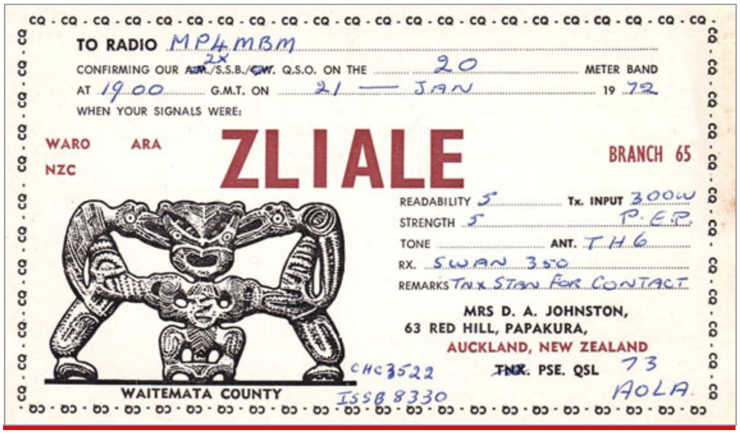
QSL cards' stories

Back in the middle of last year, I received an email from my friend Angie G0CCI, whom I sponsored into ALARA. Someone had approached her and husband Nigel GU4IJF, with a parcel of QSL cards. The person making the donation had been told that they were both amateurs and might know someone who would be interested in the cards.

Angie, seeing a handful of VK and ZL cards, asked me if I knew anyone in VK and ZL who would be pleased to have them. She knew that I was the ALARA Historian, and I said that the WIA's Historian was interested in the Australian cards for the Institute's collection. I also said that I would contact a friend in New Zealand and see whether they would like the ZL cards.

The cards duly arrived and amongst them were cards for Aola ZL1ALE (SK), her OM Dave ZL1AMN (SK) and their daughter Carol ZL1AJL. Aola and Carol were both ALARA Members for many years, up until around 2015.

Aola ZL1ALE (SK) and Dave ZL1AMN (SK).



Aola's distinctive QSL card featuring a Maori insignia.

I then discovered this significant information in the ALARA Archives about Aola and Dave: they were both inducted into the New Zealand DX Hall of Fame! Here is Aola's 2010 Citation:

Aola B. Johnston ZL1ALE

> The election of Aola Johnson ZL1ALE as the 5th inductee to the NZ DX Hall of Fame recognizes Aola's extraordinary and unselfish contribution to the sport of Amateur Radio DXing in New Zealand. Aola's Dxpedition exploits around the Pacific with her husband Dave over many decades has enabled a generation of amateur radio operators world-wide to obtain that elusive new country with a YL operator. Aola has operated as A35YL, ZK2YL, 5W1BY and others. Her personal achievement in the ARRL DXCC program is outstanding with 349 entities credited.

At the time, she was the only lady in New Zealand on the ARRL DXCC Honour Roll. Aola was a member of WARO, CLARA, YLRL, ALARA, BYLARA, and YLISB.

And the Citation for Dave ZL1AMN (Aola's OM) reads:

Dave A. Johnston ZL1AMN

> The election of Dave Johnston as the 4th inductee to the NZ DX Hall of Fame recognizes Dave's extraordinary and unselfish contribution to the sport of Amateur Radio DXing in New Zealand. His DXpedition exploits around the Pacific over many decades as ZL1AA/K, ZK2DJ, A35DJ, 5W1CA are legendary and he has enabled a generation of amateur radio operators worldwide to obtain that elusive new country. His personal achievement in the ARRL DXCC program with Honour Roll on Phone with 350 entities is outstanding. Dave's contribution to Dxing internationally has been immense by way of the ANZA Net anchor man for many years. Dave is the NZ co-coordinator for ITHE, the International Tour Host Exchange organisation which assists amateurs with accommodation when traveling around the World.

Dave was a great supporter of WARO and ALARA and was Net control for the YL 222 Net for many years.

Monday night ALARA nets

And finally, a reminder about our nets on Monday evenings. Skeds are on the ALARA Conference site on Echolink on the 1st and 3rd Mondays of the month; all others are on 3625 kHz. We talk about anything and everything, and would love to have you join us.

DX Awards

Marc Hillman VK3OHM/VK3IP

Below are listed all New DX Awards issued from 2021-12-15 to 2022-02-10

To use the online award system, go to: www.wia.org.au/members/wiadxawards/about/ To use the online award system, go to: *www.wia.org.au/members/wiadxawards/about/*

New awards

Antarctic

#	Call	Name	Mode
129	VK6OZ	Stephen Hill	Open
130	VK6OZ	Stephen Hill	Digital

DXCC Multi-band (5)

#	Call	Name	Mode	Band	Count
149	DM1HR	Hans-Rainer Langner	Open	40-20-17-15-12m	606

DXCC Multi-band (7)

#	Call	Name	Mode	Band	Count
77	DD0VU	Jens Knoepchen	Digital	80-40-30-20-17-15-10m	1130
78	VK3NX	Charlie Kahwagi	Open	80-40-30-20-17-15-12m	796
79	VK3NX	Charlie Kahwagi	Digital	80-40-30-20-17-15-12m	765
80	VK5GR	Grant Willis	Open	80-40-30-20-17-15-12m	1278
81	VK3MH	Brendan Bryant	Open	80-40-30-20-17-15-12m	1198
82	VK3VT	Greg Williams	Open	40-30-20-17-15-12-10m	1232
83	VK3MH	Brendan Bryant	Digital	80-40-30-20-17-15-12m	1138
84	VK3KJ	Scott Williams	Digital	80-40-30-20-17-15-10m	1213
85	VK3KJ	Scott Williams	Open	80-40-30-20-17-15-10m	1229
86	VK6DW	Ian Cook	Digital	40-30-20-17-15-12-10m	956
87	VK5GR	Grant Willis	Digital	80-40-30-20-17-15-12m	1203

DXCC Multi-band (8)

#	Call	Name	Mode	Band	Count
44	VK5BC	Brian Cleland	Digital	80-40-30-20-17-15-12-10m	1288
45	VK2PW	Adam McCarthy	Open	80-40-30-20-17-15-12-10m	1219
46	VK3NX	Charlie Kahwagi	Open	80-40-30-20-17-15-12-10m	896
47	VK2PW	Adam McCarthy	Digital	80-40-30-20-17-15-12-10m	1114
48	VK3MH	Brendan Bryant	Open	80-40-30-20-17-15-12-10m	1306
49	VK3KJ	Scott Williams	Digital	80-40-30-20-17-15-12-10m	1322
50	VK3KJ	Scott Williams	Open	80-40-30-20-17-15-12-10m	1338
51	VK6OZ	Stephen Hill	Open	80-40-30-20-17-15-12-10m	1150
52	VK6OZ	Stephen Hill	Digital	80-40-30-20-17-15-12-10m	1145
53	VK3NX	Charlie Kahwagi	Digital	80-40-30-20-17-15-12-10m	870
54	VK3MH	Brendan Bryant	Digital	80-40-30-20-17-15-12-10m	1238
55	VK5GR	Grant Willis	Open	80-40-30-20-17-15-12-10m	1388

DXCC Multi-mode (Digital)

#	Call	Name	Count
146	VK6OZ	Stephen Hill	219

DXCC Multi-mode (Open)

#	Call	Name	Count
525	VK2BV	Waverley Amateur Radio Society	100
526	VK5VC	Charles McEachern	100
527	VK4KX	Bernard Terry	130
528	VK6OZ	Stephen Hill	221
529	VK2DG	Cameron Grambau	160
530	VK5BJE	Maurice Dawes	104

DXCC Multi-mode (Phone)

#	Call	Name	Count
648	VK4KX	Bernard Terry	130

DXCC Single-band

#	Call	Name	Mode	Band	Count
992	DD0VU	Jens Knoepchen	CW	40m	102
993	DD0VU	Jens Knoepchen	Digital	10m	104
994	VK3NX	Charlie Kahwagi	Open	12m	100
995	VK3NX	Charlie Kahwagi	Digital	12m	100
996	VK5BC	Brian Cleland	Digital	10m	109
997	VK5GR	Grant Willis	Open	12m	100
998	VK2PW	Adam McCarthy	Open	10m	107
999	VK3MH	Brendan Bryant	Open	12m	109
1000	VK3NX	Charlie Kahwagi	Open	10m	100
1001	VK2PW	Adam McCarthy	Digital	10m	104
1002	VK3MH	Brendan Bryant	Digital	12m	102
1003	VK3MH	Brendan Bryant	Open	10m	101
1004	VK6SJ	Stephen Kennedy	Open	40m	100
1005	DM1HR	Hans-Rainer Langner	Digital	12m	108
1006	DM1HR	Hans-Rainer Langner	Open	40m	102
1007	DM1HR	Hans-Rainer Langner	Open	20m	138
1008	DM1HR	Hans-Rainer Langner	Open	17m	133
1009	DM1HR	Hans-Rainer Langner	Open	12m	109
1010	VK6OZ	Stephen Hill	Open	80m	112
1011	VK6OZ	Stephen Hill	Open	40m	157
1012	VK6OZ	Stephen Hill	Open	30m	160
1013	VK6OZ	Stephen Hill	Open	20m	200
1014	VK6OZ	Stephen Hill	Open	17m	162
1015	VK6OZ	Stephen Hill	Open	15m	149
1016	VK6OZ	Stephen Hill	Open	12m	109
1017	VK6OZ	Stephen Hill	Open	10m	101
1018	VK3NX	Charlie Kahwagi	Digital	10m	100
1019	VK3MH	Brendan Bryant	Digital	10m	100
1020	VK6DW	Ian Cook	Digital	10m	100
1021	VK6DW	Ian Cook	Digital	12m	109
1022	VK5GR	Grant Willis	Digital	12m	103
1023	VK5GR	Grant Willis	Open	10m	100
1024	VK2DG	Cameron Grambau	Digital	20m	111
1025	VK2DG	Cameron Grambau	Open	20m	115

Grid Square

#	Call	Name	Mode	Band	Count
592	VK4CAG	Graeme Dowse	CW	HF	251
593	VK3NX	Charlie Kahwagi	Phone	HF	271
594	VK3NX	Charlie Kahwagi	CW	HF	172
595	DM1HR	Hans-Rainer Langner	CW	HF	112
596	VK6OZ	Stephen Hill	Open	HF	1587
597	VK6OZ	Stephen Hill	Phone	HF	180
598	VK6OZ	Stephen Hill	Digital	HF	1580

Islands of Australia

#	Call	Name	Count
19	VK6EH	Wayne Johnson	21

Oceania

#	Call	Name	Count
71	VK5SA	Chris Levingston	53
72	VK4KX	Bernard Terry	29
73	VK3VT	Greg Williams	57
74	VK6OZ	Stephen Hill	31

VHF Century Club

#	Call	Name	Mode	Band
166	VK3KTT	Steven Barr	Digital	6m

Worked All VK Call Areas HF

#	Call	Name	Mode
2435	VK3FZ	Roger Stafford	Phone
2436	VK6OZ	Stephen Hill	Open
2437	VK6OZ	Stephen Hill	Digital

Silent Key Doug Menneke VK2ZMP

Doug Menneke VK2ZMP became a silent key in the early hours of Tuesday 5th October 2021, following a short bout of pneumonia. He was 79.

Doug was a foundation and Life Member of Wagga Amateur Radio Club and, I believe, a WIA member from at least 1969. Peter VK8ZZ fondly remembers he and Doug heading off to attend many of the WIA NSW Division AGMs down in Sydney. Apparently, they used to make a good weekend of it.

Doug worked as an electrician for the Department of Civil Aviation, gaining his amateur licence in 1969 and, from that time on, was a tireless worker for the Wagga Club.

He was very involved with WICEN (Wireless Institute Civil Emergency Network) in the early years. Doug was one of two local coordinators and, during the big floods of the mid-1970s, was very active assisting the local Civil Defence group with communications using amateur radio as the radio services for the Civil Defence were very primitive.

Doug was an avid experimenter and builder of gear. In fact, to quote Dilbert – "He had the Knack!" He could and did turn his hand to almost anything electrical or mechanical and in later years became very interested in steam engines and did a lot of work for the model engineers.

Working with the late Sid Ward VK2SW, he was instrumental in setting up and building much of the original repeater system, cavities and antennas for the Wagga Club.

He was very active on 2m SSB and made many long-distance contacts all over southeast Australia, as well as contacts through some of the early OSCAR series of orbiting satellites. Much of that work was done using homebuilt transverters that used a HF radio as an IF, generally on 28 MHz. He later progressed (as many of us did) to commercially made gear. All his antennas were homebuilt and worked amazingly well.

Doug had a great sense of humour, with influences from Monty Python, Fawlty Towers and The Goons. In later years, he could always be found at the clubrooms for smoko on a Saturday morning, and after gaining life membership, always ensured there was a bun for morning tea.

We extend our condolences to his family and friends. Farewell and 73 "Doogles", may you rest in peace.

John Eyles VK2YW

Hamads

FOR SALE – NSW

WARS Anderson Powerpole DC Distribution Box KIT $45. This is a Kit of the Waverley Amateur Radio Society. The Kit includes all the parts needed to make one DC power distribution box, in a supplied 3D Printed Case. Many kits are available. An upgrade to include 3-USB ports is available. Check it out in the store.

Postage is a flat $9.30 anywhere in Australia. Sorry we don't ship internationally. The case is made with PETG or ABS, both tough and durable materials that withstand up to about 80 deg C (PETG) or 100 deg C (ABS).

The Kit includes 7 Anderson Powerpole connectors and a voltmeter that fits inside the case. Note that this is still all in kit form, soldering and assembly are required and you may need something to hold the meter in place, screws, or glue. Check out the youtube video description.
Link to Store: https://vk2bv.org/home/projects/powerpole-distribution-box/ or email treasurer@vk2bv.org

Icom M710 HF radio for Ham and Marine frequencies $500.

This unit was recently removed from a sailing vessel which is owned by an Amateur Radio Operator and was used on Amateur Bands as well as Marine Bands. It was installed in a protected location and is therefore in excellent condition. Comes complete with original microphone, mounting bracket and manual. The M710 supports an AH4 or AT130 (Marine version of AH4) tuner. Shipping at purchaser's expense.

Feel free to email questions to manalisailing@gmail.com. Contact Erwin tel: 0418 485 949

FOR SALE – VIC

NBS TILT OVER TOWER $1300 neg

Comes with two tower lengths 5m and 3m. Included is a rotator " Emotator Model 502xx " . Approx 15m of antenna cable and approx 10 mtrs of 7-core rotator cable. (Will not separate). Pickup from Narre Warren North 3804.

Contact John VK3CVF tel: +61404098634

About Hamads

- Also available online: www.hamads.com.au
- Free service. Online Hamads are also published in *AR*.
- If you want to advertise in AR, please submit your copy by email (MUCH PREFERRED), or if written and mailed please print carefully and clearly, use upper AND lower case.
- Deceased estates Hamads will be published in full, even if some items are not radio equipment.
- WIA policy recommends that the serial number of all equipment for sale should be included.
- QTHR means the address is correct in the ACMA Register of Radio Licences: https://web.acma.gov.au/rrl/register_search.main_page
- Ordinary Hamads from those who are deemed to be in general electronics retail and wholesale distributive trades should be certified as referring only to private articles, not being re-sold for merchandising purposes.
- For commercial advertising, contact editor@wia.org.au
- Copy must be received by the deadline on page 3 of each issue of *AR*.
- Clearly label For Sale and Wanted items. Include name, address STD telephone number and WIA membership number.

'Hamads'
editor@wia.org.au

TRADE PRACTICES ACT
It is impossible for us to ensure that the advertisements submitted for publication comply with the Trade Practices Act 1974. Therefore, advertisers will appreciate the absolute need for them to ensure that the provisions of the Act are strictly complied with.

VICTORIAN CONSUMER AFFAIRS ACT
Advertisements with only a PO Box number address cannot be accepted without the addition of the business address of the box-holder or seller of the goods.

ADVERTISERS INDEX

Volume 90 Number 2 2022 Print Post Approved PP100007960

Endnotes