QST
DIGITAL EDITION

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May 2021 www.arrl.org
DEVOTED ENTIRELY TO AMATEUR RADIO

A VHF Eco-Rover

QST Reviews

Mobilinkd
TNC3 for APRS

aprs.fi App for iOS

Four State QRP Group
Nouveau 75A QRP
AM Transceiver Kit

Yaesu SCU-LAN10
Remote Control Unit

bhi NES10-2 MK4 DSP
Noise Cancelling Speaker

The Best of the Best

A Superb All-around Wide-Coverage Transceiver

FT-991A 100W
HF/50/144/430MHz TRANSCEIVER

- Includes HF through UHF with one Radio
- Supports SSB/CW/AM/FM and C4FM digital
- IF Roofing Filters produce Excellent Shape Factor
- IF DSP enables Superb Interference Rejection
- Built in Real-Time Spectrum Scope Display
- 3.5-inch TFT Color Touch Panel Display
- 100 Watts (2 Meter & 70 Centimeter: 50 Watts) of Solid Performance

* External Speaker SP-10: Optional

The New Standard High Performance SDR Transceiver

FTDX10 100W
HF/50MHz TRANSCEIVER

* External Speaker SP-30: Optional

- Hybrid SDR Receiver (Narrow Band SDR & Direct Sampling SDR)
- 9MHz Down Conversion Receiver Configuration
- IF Roofing Filters produce Excellent Shape Factor
- IF DSP enables Superb Interference Rejection
- 5-inch TFT Color Touch Panel with 3DSS*1 Visual Display
- Superior Operating Performance by means of the MPVD*3

The World Leading HF Transceiver with Hybrid SDR

In Homage to the Founder of Yaesu – Sako Hasegawa JA1MP

FTDX101MP 200W
HF/50MHz TRANSCEIVER

The Ultimate

FTDX101D 100W
HF/50MHz TRANSCEIVER

- Dual Hybrid SDR Receivers (Narrow Band SDR & Direct Sampling SDR)
- 9MHz Down Conversion Receiver Configuration
- IF Roofing Filters produce Excellent Shape Factor
- VC-Tune (Variable Capacitor Tuning) Signal Peaking
- IF DSP enables Superb Interference Rejection
- 7-inch TFT Color Touch Panel with 3DSS*1 Visual Display
- Superior Operating Performance by means of ABI*2 & MPVD*3

* Microphone M-1: Optional

* Photo shows the FTDX101MP

*1 3DSS: 3-Dimensional Spectrum Stream *2 ABI: Active Band Indicator *3 MPVD: Multi-Purpose VFO Outer Dial

YAESU The radio

YAESU USA
6125 Phyllis Drive, Cypress,
CA 90630 (714) 827-7600

For the latest Yaesu news, visit us on the Internet: **http://www.yaesu.com**

YAESU
The radio

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FM Friendly Digital : AMS (Automatic Mode Select)

System Fusion II Compatible

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- ***New Memory Auto Grouping (MAG) Function***
- ***New Multi-Channel Standby (MCS) Function***
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C4FM/FM 144/430 MHz DUAL BAND
50 W DIGITAL MOBILE TRANSCEIVER

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Automatic Mode Select
microSD Card
C4FM
Clear and Crisp Voice Technology
WIRES-X

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Cushcraft Antennas

R9

80-6 Meters! No Radials!

Cushcraft's world famous R8 now has a big brother!

Big Brother R9 now includes 75/80 Meters for local ragchewing and worldwide low band DX without radials!

It's omni-directional low angle radiation gives you exciting and easy DX on all 9 bands: 75/80, 40, 30, 20, 17, 15, 12, 10 and 6 Meters with low SWR. QSY instantly – no antenna tuner needed.

Use full 1500 Watts SSB/CW when the going gets tough to break through pileups and poor band conditions.

The R9 is super easy to assemble, installs just about anywhere, and its low profile blends inconspicuously into the background in urban and country settings alike.

Compact Footprint: Installs in an area about the size of a child's sandbox – no ground radials to bury with all RF-energized surfaces safely out of reach.

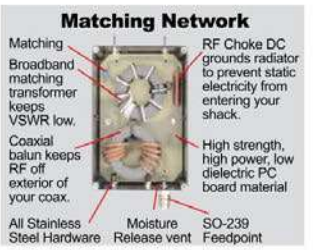
Rugged Construction: Thick fiberglass insulators, all stainless steel hardware and 6063 aircraft-aluminum tubing is double or triple walled at key stress points to handle anything Mother Nature can dish out.

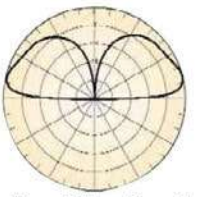
31.5 feet tall, 25 lbs. Mounting mast 1.25 to 2 inches. Wind surface area is 4 square feet.

R8, $599.95. Like R9 antenna but less 75/80 Meters.

R-8TB, $99.95. Tilt-base lets you tilt your antenna up/down easily by yourself to work on.

R-8GK, $79.95. Three-point guy kit for high winds.





Omni-Directional
Low angle radiation gives incredible worldwide DX.

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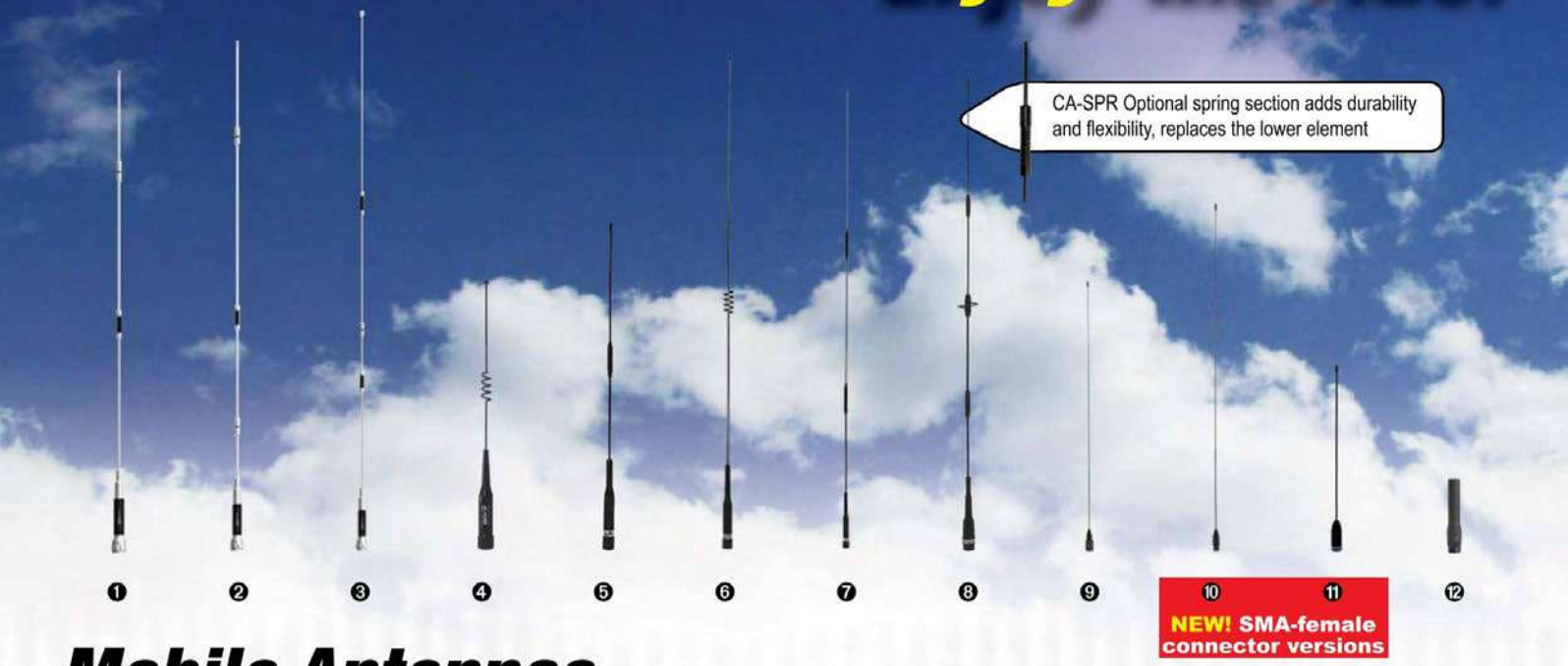
Life is a JOURNEY. Enjoy the ride!



Mobile Antennas

❶ COMET **CSB-750A** DUAL-BAND 2M/440MHz w/FOLD-OVER
2M: 1/2 wave • 440MHz: 5/8 wave x 2 • VSWR: 1.5:1 or less • Length: 42" • Conn: PL-259 • Max. Pwr: 150W

❷ COMET **CSB-770A** DUAL-BAND 2M/440MHz w/FOLD-OVER
2M: 5/8 wave center load • 440MHz: 5/8 wave x 2 center load • VSWR: 1.5:1 or less • Length: 51" • Conn: PL-259 • Max Pwr: 150W

❸ COMET **CSB-790A** DUAL-BAND 2M/440MHz w/FOLD-OVER
2M: 7/8 wave center load • 440MHz: 5/8 wave x 3 center load • VSWR: 1.5:1 or less • Length: 62" • Conn: PL-259 • Max Pwr: 150W

❹ COMET **B-10/B-10NMO** DUAL-BAND 2M/440MHz
2M: 1/4 wave • 440MHz: 1/2 wave • Length: 12" • Conn: B-10 PL-259, B-10NMO - NMO style • Max Pwr: 50W

❺ COMET **SBB-2/SBB-2NMO** DUAL-BAND 2M/440MHz
2M: 1/4 wave • 440MHz: 5/8 wave center load • VSWR: 1.5:1 or less • Length: 18" • Conn: SBB-2 PL-259, SBB-2NMO - MNO style • Max Pwr: 60W

❻ COMET **SBB-5/SBB-5NMO** DUAL-BAND 2M/440MHz w/FOLD-OVER
2M: 1/2 wave • 440MHz: 5/8 wave x 2 • Length: 39" • Conn: SBB-5 PL-259, SBB-5NMO - NMO style • Max Pwr: 120W

❼ COMET **SBB-7/SBB-7NMO** DUAL-BAND 2M/440MHz w/FOLD-OVER
2M: 6/8 wave • 440MHz: 5/8 wave x 3 • Length: 58" • Conn: SBB-7 PL-259, SBB-7NMO - NMO style • Max Pwr: 70W

❽ COMET **CA-2X4SR/CA-2X4SRNMO** WIDE-BAND 140-160MHz 435-465MHz w/FOLD-OVER
2M: 5/8 wave • 440MHz: 5/8 wave x 3 • Length: 40" • Conn: CA-2x4S PL-259, CA-2x4SRNMO NMO style • Max Power: 150W

❾ COMET **BNC-24** DUAL BAND 2M/440MHz HT ANTENNA
RX range: 100-1200MHz • Length: 17" • SuperFlex featherweight whip • Conn: BNC

❿ COMET **SMA-24** NEW! **SMA-24J** DUAL BAND 2M/440MHz HT ANTENNA
RX range: 100-1200MHz • Length: 17" • SuperFlex featherweight whip • Conn: SMA-24: SMA-male / SMA-24J: SMA-female

⓫ COMET **SMA-503** NEW! **SMA-503J** DUAL BAND 2M/440MHz HT ANTENNA
RX range: 100-1200MHz • Length: 8.75" • Conn SMA-503: SMA-male, SMA-503J: SMA-female

⓬ *Maldol* **MH-209, MH-209SMA** DUAL BAND 2M/440MHz HT ANTENNA
Length: 3" • Conn: MH-209 BNC, MH-209SMA: SMA-male • Soft rubber cover, good performance in a small package!

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QST

Contents

May 2021 ♦ Volume 105 ♦ Number 5

Columns

Departments

Digital and Mobile Editions

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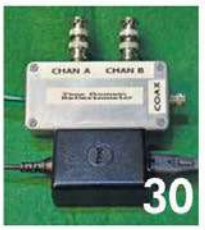
Write for *QST*

www.arrl.org/qst-author-guide
email: **qst@arrl.org**

Our Cover
Electric cars can rove with the best of them — as long as they have the right setup. Wayne Overbeck, N6NB, outfitted his 2020 Chevy Bolt with a microwave toolbox station that covers 6 meters to 10 GHz, so he could get the most out of his VHF expeditions. Read all the details in his article, "Green Roving in a Red Rover," on page 61 of this issue. [Steven Belasco, N1BKB, and Arnold Shatz, N6HC, photo]



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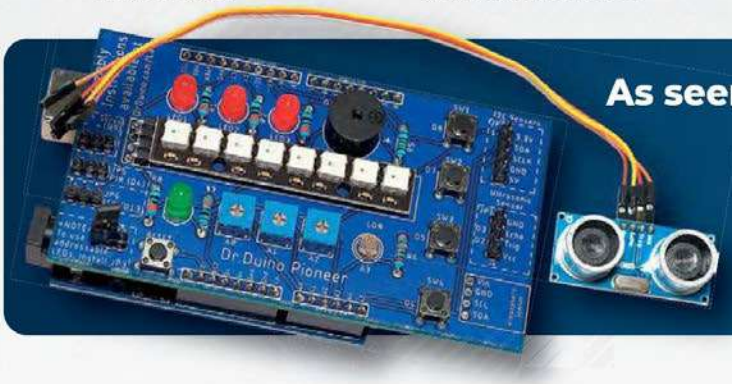

As seen in QST Magazine November 2020
Page 51 Product Review Section

«The Pioneer Edition is an excellent learning platform to begin working with the Arduino»
Revied by Glen Popiel, KW5GP

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DIAMOND ANTENNAS help you get the most out of your on-air experience.

For all your base station and repeater needs, DIAMOND has an antenna that will work for you.

You've tried the rest, now own the best!

X700HNA Special Features:

- Heavy duty fiberglass radomes
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- Overlapping outer shells for added strength
- Stainless steel mounting hardware & radials
- Strong waterproof joint couplings
- Type-N cable connection
- Wideband performance
- Highest gain Dual-band Base Antenna!

Here is a small sample of our wide variety of antennas

Model	Bands	Length Ft.	Max Pwr. Rating	Conn.
Dualband Base Station/Repeater Antennas				
X700HNA (4 section)	2m/70cm	24	200	N
X510HD (3 Section)	2m/70cm	17.2	330/250	UHF or N
X300A (2 Section)	2m/70cm	10	200	UHF or N
X200A (2 Section)	2m/70cm	8.3	200	UHF
X50A (1 Section)	2m/70cm	5.6	200	UHF or N
X30A (1 Section)	2m/70cm	4.5	150	UHF
Monoband Base Station/Repeater Antennas				
F23H (3 Section)	144-174 MHz (W/ Cut Chart)	15	350	UHF
F22A (2 Section)	2m	10.5	200	UHF
CP22E (Aluminum)	2m	8.9	200	UHF
F718A (Coax Element)	70cm	15	250	N
Dualband Mobile Antennas				
SG7900A	2m/70cm	62.2 in.	150	UHF or NMO
SG7500A	2m/70cm	40.6 in.	150	UHF or NMO
NR770H Series	2m/70cm	38.2 in.	200	UHF or NMO
MR77 Series	2m/70cm	20 in.	70	Mag Combo
AZ504FXH	2m/70cm	15.5 in.	50	UHF
AZ504SP	2m/70cm	15.5 in.	50	UHF
NR7900A	2m/70cm	57 in.	300/250	UHF
Monoband Mobile Antennas				
NR22L	2m	96.8 in.	100	UHF
M285	2m	52.4 in.	200	UHF or NMO

RF PARTS™ COMPANY

Diamond Antenna is a division of RF Parts Company

David A. Minster, NA2AA, ARRL Chief Executive Officer, na2aa@arrl.org

Second Century

The "New Normal" for Events

Taking precautions for COVID-19 over the past year has caused significant changes in our lives, not the least of which was the cancellation of in-person hamfests and larger events. We were prevented from congregating for radio club meetings. Even ARRL Field Day was impacted — those group outings we enjoy every year were largely replaced by at-home operating. As a community, we sought ways to adapt so that we could remain connected despite being held apart by restrictions and regulations.

As part of those adaptations, we gained a new term in our vernacular: we "Zoom" with each other. Companies are using Zoom to conduct business. Clubs are using Zoom to conduct meetings and even online hamfests. Analysts and industry pundits are declaring that the acceleration of society into a distanced or remote way of working and interacting is the new normal, and that we should embrace it.

Over the past few months, I've had the opportunity to attend three virtual events: HAM-CON (the Vermont Ham Radio Convention) and Orlando HamCation — which are ordinarily in-person events brought to life by conducting them online — and the QSO Today Virtual Ham Expo, which is purely a virtual event. As the size and sophistication of each event increases, the complexities of, and potential problems with, delivering a seamless, satisfying user experience rise *exponentially*. It is easy to become critical of difficulties and failures of online events like these, but conducting them illustrates how incredibly difficult it is to configure, scale, test, and implement these virtual events.

There have been important lessons learned from conducting these events, including: speakers must not use Wi-Fi or unfamiliar internet connections; speakers must use a camera of good quality; built-in microphones are generally inadequate; live meetings or meetings with live side chats must be moderated by someone other than the presenter, who must be alert to muting attendee microphones during the presentation; the operations of a virtual event must be carefully handled, including emailing/posting links, ensuring mass emails aren't being routed into spam or causing server blacklisting, handling session recording, and more.

If virtual events are so difficult (and in some cases expensive) to conduct, why do organizers do it? For the love of the hobby. For the feeling of community. For the inclusion of many hams, from local to DX, who cannot travel to events. So are virtual events just a fad? A consequence of the times? Or are they the new normal — or, at the very least, a forward-looking way of reimagining amateur radio events? Here's my view:

First and foremost, there is no replacement for being there. One of my greatest joys is to walk a hamfest — the bigger the better — to see equipment, hear the stories, and pick out a gem or two to add to my own station. Seeing an old friend, exchanging a hearty handshake, and catching up is another wonderful by-product of being there.

Though online events and in-person events are two very different beasts, there are best practices that apply to both. In-person events have a limited amount of space for speakers. This forces event organizers to be careful about curating their lineup of speakers. Online events don't have these space restrictions and often book more speakers and sessions than they otherwise would, which can lead to falling into the "just because you can, doesn't mean you should" trap. Online events tend to work harder at having speakers create a script, and fit their presentation to a specific timeframe. Findings from the YouTube community indicate that talks in the 10 – 20 minute range are optimal — a constraint that in-person events could benefit from. Sessions that are more experiential, from kit building to following along with a book, tend to be more popular and easily work in both environments!

The future seems to point to a hybrid model where getting back together in-person is highly desirable, but not at the expense of leaving out those people who — for one reason or another — cannot travel to the event. ARRL will be taking another crack at an online event this month (May 21 – 23) when we host the ARRL at Home event while sitting at home, missing the fun of Dayton Hamvention! We'll be spicing things up with a collection of videos, activities, and perhaps a Sunday raffle.

We hope to see you there! In the meantime, stay radio active! Be a connector! And visit our Ideation page at **www.arrl.org/ideas** to submit ideas for content, products, and more.

David A. Minster, NA2AA
Chief Executive Officer

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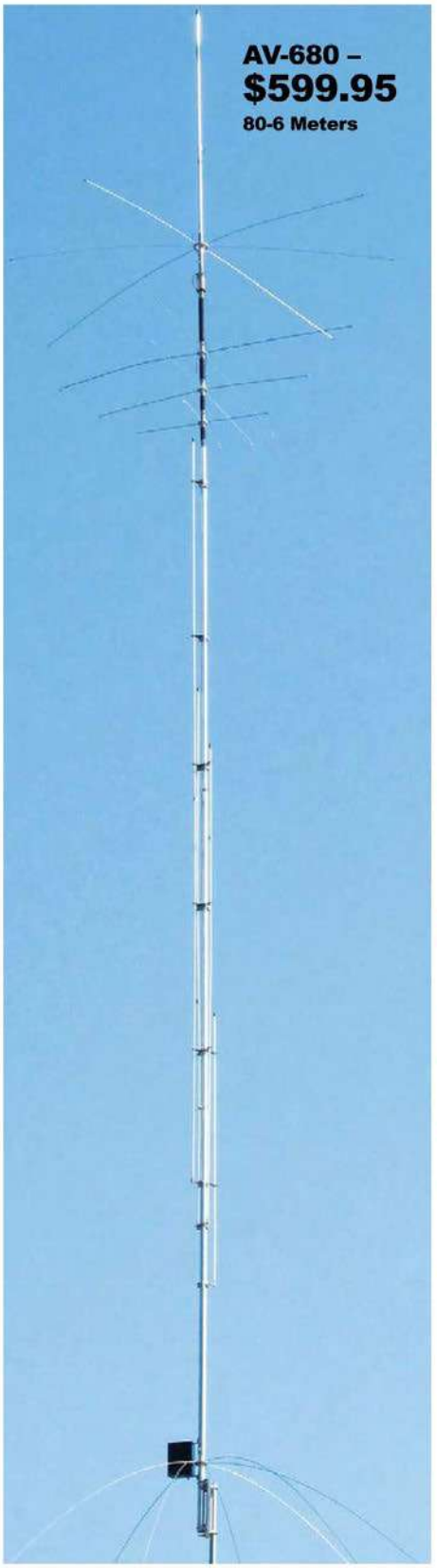

AV-680

80-6 Meters

hy-gain's new AV-680 adds 75/80 Meters with no radials!

Includes 40, 30, 20, 17, 15, 12, 10 and 6 Meters operation with low 17 degree radiation angle and omni-directional world-wide coverage. No ground or radials needed. Handles full 1500 Watts key down continuous for two minutes.

Highly Efficient
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Each band individually tunable
Extra wide low VSWR bandwidth. End fed with broadband matching unit. Single coax cable feed. Automatic bandswitching.

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Built-to-last
High wind survival of 65 mph. Broadband matching unit made from all Teflon® insulated wire. Aircraft quality aluminum tubing, stainless steel hardware.

hy-gain verticals are the best built, best performing and best priced multiband verticals available today.

hy-gain® warranty
Two year limited warranty. All replacement parts in stock.

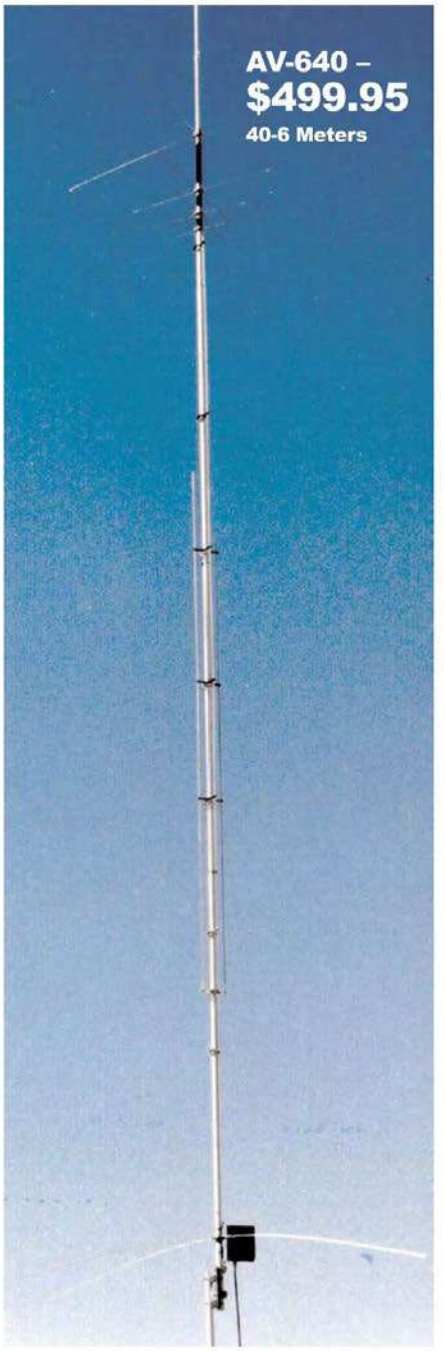
ATB-75, $99.95. Tilt base for hy-gain AV-680/AV-640 and AV-620 verticals.

AGK-8, $79.95. Guy Kit, three point non-conductive guy system for hy-gain AV-680/AV-640 and AV-620 verticals.

AV-640, $499.95. 8 bands: 40, 30, 20, 17, 15, 12, 10, 6 Meters. 25.5 ft., 17.5 lbs.

AV-620, $399.95. 6 bands: 20, 17, 15, 12, 10, 6 Meters. 22.5 ft., 10.5 lbs.

Inside of Matching Unit



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PG50PS Pulse Generator

The PG50PS delivers ultra high (8,000V/uS) slew rate 35ps tr steps. Use it for mm TDR and oscilloscope/amplifier frequency response tests. Apply the step to a scope and the rise-time is measured using the BW=.35/rise-time formula (printed on the case) allowing bandwidth checks to 6GHz.

SALE $775

TDR-Cable Radar®

This time domain reflectometer (TDR) features a fast pulse generator to check transmission lines & cables by analyzing reflections on an oscilloscope. It computes distance to fault (DTF) 2.5 cm - 15km, return loss (RL), velocity factor (Vf) & line loss dB @ 100'. It covers 50 - 600 Ω with 25 ps resolution using isolated samplers and separate (DUT) outputs.

T150 Step Attenuator

Attenuation covers 41dB in 1 dB steps, using Pi-Pad attenuators from DC to 1 GHz. It features a 50 Ω 2W strip line design with UHF switches. Great for ham radio tests of receivers and general signal conditioning.

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SMT Station Monitor

The monitor provides all connections, plus the demodulator, to drive an oscilloscope in XY (drive v. output) mode, resulting in a trapezoid waveform, revealing non-linear operation of a transmitter in real time.

$259

TTG1 Two Tone Generator

The generator has two low distortion (700Hz and 1900Hz) sources to analyze SSB & AM transmitter linearity and overdrive for IMD distortion and harmonic splatter.

$279

DDS-1 Dual Directional Coupler

The coupler measures forward and reflected power with an oscilloscope. The transmitter connects to RF IN, the load connects to RF OUT. When the load absorbs all the energy, virtually no power is reflected, resulting in very little REFL power (SWR 1:1). The FWD port shows power (– 30 dB) to the load

$175

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The sampler inductively samples high power (up to 1.5kW) RF passing from the RF IN to RF OUT ports. The sampled RF is at a calibrated -30 dB level which is compatible with most oscilloscopes for precise measurements based on the displayed waveforms.

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The bridge compares an unknown Z to a reference Z. A test oscillator connects to the RF IN. An oscilloscope connects to the DET OUT. The tested device such as an antenna or coax, connects to the DUT. Equal Z result in essentially zero output and very high RL.

$205

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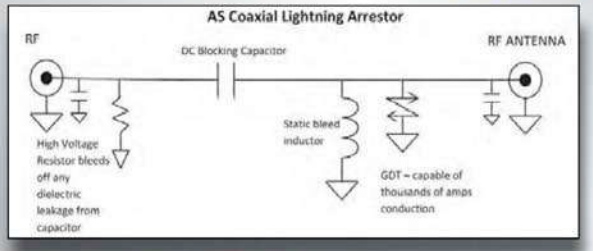

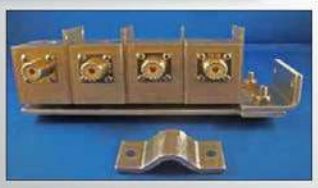

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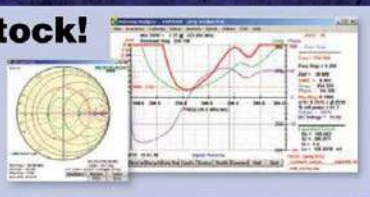

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Member Spotlight

Noji Ratzlaff, KNØJI

Wherever he goes, Noji Ratzlaff, KNØJI, seeks to help connect his community. His interests and hobbies crisscross with radio and public service, spreading awareness of the hobby in his area. Whether that's through emergency preparedness and volunteer work, teaching at his karate studio, or serving as president of his local radio club, Noji keeps busy by staying linked to the people and community around him.

A Technical Mind

Noji was introduced to ham radio by his grandfather, who helped him earn his Novice-class license. However, he lost interest in radio when his grandfather passed away. Years later, a ham he met through his religious group reignited the spark. Noji's wife, Lisa, KR5LYS, also became involved in radio at that time.

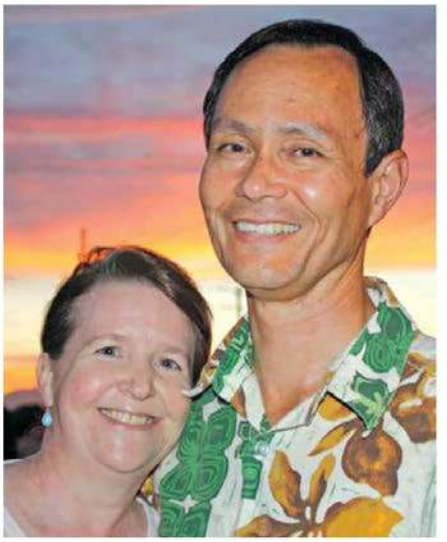
Noji's interest in radio overlaps with his background in electronics. He earned a degree in electrical engineering, which initially led him to work developing programmable arrays like PALs, GALs, and FPGAs. However, he found that software was what truly held his attention, and began working as a software developer. "That was a great move for me," he said, "because subsequent jobs required somebody who could develop software, while having an intimate hardware understanding, especially when it came to embedded systems."

The Radio Community

"My honest favorite aspect of ham radio is helping people," Noji said, whether that's through assisting with antenna installations, programming radios for folks, or teaching radio classes and serving as a Volunteer Examiner (VE). In addition to being a VE, Noji is also a CERT instructor and ARES volunteer. He maintains his own website (**www.noji.com**), which features everything from guides to local restaurants to resources for radio operators. "I love to post stuff on my website," he explained, "especially for new hams, and the ultimate ham radio glossary."

Noji also serves as President of the Utah Valley Amateur Radio Club (UVARC), formed 5 years ago to serve the Utah Valley county. With over 1,500 members, the club is now the largest in the state. In addition to hosting ham radio exam courses and VE sessions, the club participates in lots of events and get-togethers, like swap meets, potluck dinners, hamfests, and weekly nets. They even have special interest nets, like the Ladies' Net, an annual Santa Net, and a New Ham Net. The club earned first-place rankings for Utah in ARRL Field Day 2020 and Winter Field Day 2020.

On weekends during the summer, Noji hikes local mountains while volunteering for the Timpanogos Emergency Response Team. He explained, "Each of us radio people pair up with an EMT and call in to Search and Rescue" to assist injured hikers. "Depending on the situation, we might request a chopper or a posse to come up and carry the patient off the mountain, if we determine they can't make it down on their own."



Noji Ratzlaff, KNØJI, and his wife, Lisa, KR5LYS.

Long-Term Passions

Noji also owns his own karate school, where he's taught since 1997. The school focuses on Shotokan karate and self-defense. Noji's been doing karate since he was 16 years old, and still trains nearly every day, "to keep up with the younger folks." The hobby is his "second-biggest passion, second only to my family." He also enjoys astronomy, Scouting, geocaching, camping, and hiking.

"To me, nothing compares with spending time with my kids, who are grown now," Noji said, "and now with my grandkids." He uses some of that family time to share his passions and pass down his knowledge. He said, "Most of my kids have taken karate from me, and most of my kids are hams too."

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Membership inquiries and general correspondence should be addressed to the administrative headquarters: ARRL, 225 Main St., Newington, Connecticut 06111-1400 USA.

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501-988-2527; **k5ur@arrl.org**

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85 High Street
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Atlantic Division

www.atldiv.org
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P.O. Box 73, Accokeek, MD 20607
301-257-6225; **w3tom@arrl.org**

Vice Director: **Robert B. Famiglio, K3RF**
P.O. Box 9, Media, PA 19063
610-359-7300; **k3rf@arrl.org**

Central Division

www.central.arrl.org
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1150 McKee St., Batavia, IL 60510
630-879-0983; **w9xa@arrl.org**

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www.arrlmidwest.org
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402-421-0840; **k0aiz@arrl.org**

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6 Willarch Rd., Lincoln, MA 01773
781-259-0088; **k1vr@arrl.org**

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Watertown, MA 02472-2875
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www.arrlnwdiv.org
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33643 Burma Rd., Scappoose, OR 97056
503-987-1269; **w7vo@arrl.org**

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509-952-5764; **kb7hdx@arrl.org**

Pacific Division

pacific.arrl.org
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44 Joel Massey Rd., Haines City, FL 33844
407-504-2629; **kg4jsz@arrl.org**

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www.kkn.net/n6aa
Richard J. Norton, N6AA
21290 West Hillside Dr., Topanga, CA 90290
310-455-1138; **n6aa@arrl.org**

Vice Director: **Edward Stearns, AA7A**
7038 E. Aster Dr., Scottsdale, AZ 85254
480-332-8255; **aa7a@arrl.org**

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Eastern Pennsylvania: George Miller, W3GWM, 293 Woods Rd., Wyalusing, PA 18853 570-250-1007; **w3gwm@arrl.org**
Maryland-DC: Marty Pittinger, KB3MXM, 4 Pegram Rd., Owings Mills, MD 21117 410-356-7899; **kb3mxm@arrl.org**
Northern New York: Thomas Dick, KF2GC, 11 Jenkins St., Saranac Lake, NY 12983 518-891-0508; **kf2gc@arrl.org**
Southern New Jersey: Tom Preiser, N2XW, 177 Bowsprit Rd., Manahawkin, NJ, 08050-5001 609-618-0224; **n2xw@arrl.org**
Western New York: Laura Mueller, N2LJM, 2011 E. Main St., Falconer, NY 14733 716-338-3122; **n2ljm@arrl.org**
Western Pennsylvania: Joe Shupienis, W3BC, P.O. Box 73, Falls Creek, PA 15840-0322 814-771-3804; **w3bc@arrl.org**

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Illinois: Thomas Beebe, W9RY, 3540 Market Rd., Marion, IL 62959-8940 618-534-6282; **w9ry@arrl.org**
Indiana: James Merry, Jr., KC9RPX, 7332 W. Mustang Dr., Ellettsville, IN 47429 812-391-2661; **kc9rpx@arrl.org**
Wisconsin: Patrick Moretti, KA1RB, W349S3970 Waterville Rd., Dousman, WI 53118-9786 262-354-2997; **ka1rb@arrl.org**

Dakota Division MN, ND, SD

Minnesota: Bill Mitchell, AE0EE, 2120 Aldrich Ave. S., Apt. 208, Minneapolis, MN 55405 510-529-5658; **ae0ee@arrl.org**
North Dakota: Richard Budd, WØTF, 4951 64th St. NE, York, ND 58386-9304 701-466-2028; **w0tf@arrl.org**
South Dakota: Chris Stallkamp, KIØD, P.O. Box 271, Selby, SD 57472-0271 605-848-3929; **ki0d@arrl.org**

Delta Division AR, LA, MS, TN

Arkansas: James D. Ferguson, Jr., N5LKE, 1500 Lauren Dr., Searcy, AR 72143-8477 501-593-5695; **n5lke@arrl.org**
Louisiana: John Mark Robertson, K5JMR, 201 Madewood Ct., Bossier City, LA 71111-6325 318-572-7917; **k5jmr@arrl.org**
Mississippi: Malcolm Keown, W5XX, 64 Lake Cir. Dr., Vicksburg, MS 39180 601-636-0827; **w5xx@arrl.org**
Tennessee: David Thomas, KM4NYI, 205 Linford Rd., Knoxville, TN 37920 865-654-5489; **km4nyi@arrl.org**

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Kentucky: Steve Morgan, W4NHO, 1124 W. 12th St., Owensboro, KY 42301-2975 270-926-4451; **w4nho@arrl.org**
Michigan: Jim Kvochick, K8JK, 10366 Greystone Ct., Brighton, MI 48114-7650 810-229-5085; **k8jk@arrl.org**
Ohio: Tom Sly, WB8LCD, 1480 Lake Martin Dr., Kent, OH 44240-6260 330-554-4650; **wb8lcd@arrl.org**

Hudson Division ENY, NLI, NNJ

Eastern New York: John K. Fritze, Jr., K2QY, 4 Normanskill Blvd., Delmar, NY 12054-1335401-261-4996; **k2qy@arrl.org**
NYC-Long Island: Jim Mezey, W2KFV, 38 Appletree Ln., Carle Place, NY 11514-1336 516-315-8608; **w2kfv@arrl.org**
Northern New Jersey: Bob Buus, W2OD, 8 Donner St., Holmdel, NJ 07733-2004 732-946-8615; **w2od@arrl.org**

Midwest Division IA, KS, MO, NE

Iowa: Lelia Garner, WAØUIG, 145 Front St., Robins, IA 52328-9718 319-213-3539; **wa0uig@arrl.org**
Kansas: Ronald D. Cowan, KBØDTI, P.O. Box 36, LaCygne, KS 66040 913-757-3758; **kb0dti@arrl.org**
Missouri: Cecil Higgins, ACØHA, 27995 County Rd. 220, Hermitage, MO 65668-8493 417-399-5027; **ac0ha@arrl.org**
Nebraska: Matthew N. Anderson, KAØBOJ, 14300 NW 98th St., Raymond, NE 68428-4254 402-480-5515; **ka0boj@arrl.org**

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Eastern Massachusetts: Tom Walsh, K1TW, 9 Wildwood Dr., Bedford, MA 01730 781-275-5882; **k1tw@arrl.org**
Maine: Robert Gould, N1WJO, 572 Poland Springs Rd., Casco, ME 04015-4016 207-415-5419; **n1wjo@arrl.org**
New Hampshire: John Gotthardt, K1UAF, P.O. Box 2298, Wolfeboro, NH 03894-2298 603-569-3633; **k1uaf@arrl.org**
Rhode Island: Bob Beaudet, W1YRC, 30 Rocky Crest Rd., Cumberland, RI 02864 401-333-2129; **w1yrc@arrl.org**
Vermont: Paul N. Gayet, AA1SU, 11 Cherry St., Essex Junction, VT 05452 802-878-2215; **aa1su@arrl.org**
Western Massachusetts: Raymond Lajoie, KB1LRL, 245 Leominster Rd., Lunenburg, MA 01462-2031 978-549-5507; **kb1lrl@arrl.org**

Northwestern Division AK, EWA, ID, MT, OR, WWA

Alaska: David Stevens, KL7EB, 8521 Golden St., Apt. 4, Anchorage, AK 99502 907-242-6483; **kl7eb@arrl.org**
Eastern Washington: Jack Tiley, AD7FO, 1806 S. Fawn Dr., Spokane Valley, WA 99206-3318 509-951-7214; **ad7fo@arrl.org**
Idaho: Dan Marler, K7REX, 6525 W. Fairfield Ave., Boise, ID 83709 208-914-8939; **k7rex@arrl.org**
Montana: Paul Stiles, KF7SOJ, 5427 Deadwood Dr., Billings, MT 59105 406-671-7092; **kf7soj@arrl.org**
Oregon: David Kidd, KA7OZO, 21760 S. Larkspur Ave., Oregon City, OR 97045-9164 503-320-3484; **ka7ozo@arrl.org**
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Georgia: David Benoist, AG4ZR, 190 Fox Hall Crossing East, Senoia, GA 30276 404-290-0470; **ag4zr@arrl.org**
Northern Florida: Kevin J. Bess, KK4BFN, 908 Flagler Ave., Edgewater, FL 32132-2124 386-547-2838; **kk4bfn@arrl.org**
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Virgin Islands: Fred Kleber, K9VV, P.O. Box 24275, Christiansted, VI 00824-0275 **k9vv@arrl.org**
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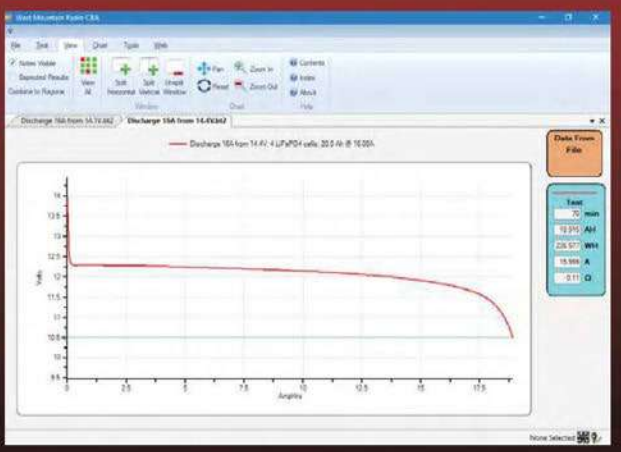

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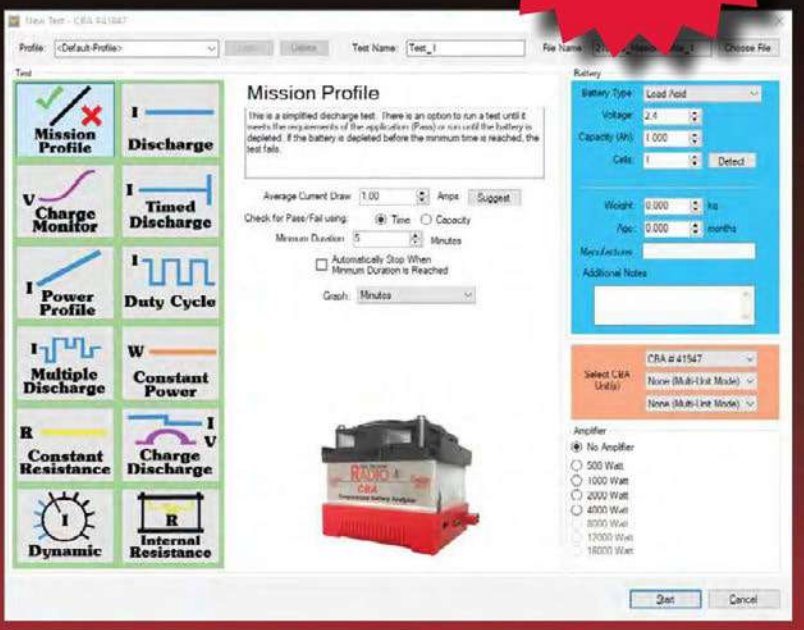

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Up Front

Designing a Fun Foxhunt

Will Holcomb, K4NIO, and his son, Denver, KI4BJY, participated in a foxhunt in Largo, Florida. Will designed a "fox box" with components that could be hidden from the control operator. His goal was to make the activity more fun and challenging, by forcing hunters to sniff out the fox box, rather than have an operator talking into the radio. He built two containers to hold the fox equipment. Both were subdued colors, but clearly marked on the outside with identifying information and Will's cell number. One is a military surplus ammo can, and the other is a PVC pipe.

An Amateur Inspires Local ARES Group

Kelly Stanfield, WØYQG, a visually impaired ham, has been a member of the Benton County (Missouri) Amateur Radio Emergency Service (BC ARES) group since August 2017. Her consistent participation, energetic ham spirit, and willingness to try new things inspired the group to present her with a gift to improve her amateur radio experience. For a visually impaired individual to operate a complex radio, the radio must speak when settings are changed. The Kenwood TS-590s HF radio includes a VGS-1 voice synthesizer board that has this capability, so the BC ARES and Kelly's family raised the funds needed to purchase it, along with a 30 A power supply and a flight case. The group also arranged to install an 80- to 10-meter dipole outside of Kelly's home, with 140 feet of coax, insulators, and PL-259 connectors. The group was able to present the radio to her as a Christmas gift, prior to the COVID-19 pandemic.

▲Craig Martin, KYØO; Kelly Stanfield, WØYQG, and Samantha Henley, KEØLMY, during the presentation of the radio to Kelly (prior to the pandemic).

◀Kelly Stanfield, WØYQG, is introduced to her new radio and flight case.

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Correspondence

Letters from Our Members

Insightful Content on Inclusivity

As someone who's enjoyed the hobby since 1963, I thought that the February 2021 issue contained two insightful articles regarding inclusion in the ham radio community.

In his editorial, "No One Left Behind," ARRL CEO David Minster, NA2AA, provides a good example of a true mentor and discusses inclusion, or lack thereof, in the radio community — a problem seen too often in our hobby. Minster does a nice job presenting possible solutions that can easily be accomplished. I recommend reading his editorial from this issue, as it has some insightful information to help make our community more inclusive.

Additionally, I found that the article, "New Ham Kit: A Way for Clubs to Help Get New Hams on the Air," by Bryan Jackson, W2RBJ, was also an informative read. Jackson looks into the possibilities of why new amateur radio licensees might not stick with the hobby. He shares how the East Greenbush Amateur Radio Association implemented a solution to this concern. As Vice President of the Schoharie County Amateur Radio Association, I liked their idea so much that our club will be developing our own new ham kit for our Volunteer Examiner (VE) team to hand out at exam sessions, and to provide to operators who have recently earned their licenses.

Thomas G. Valosin, WB2KLD
Middleburgh, New York

Remembering an Old Build

Included in the "A Look Back" column in the August 2020 issue was a construction article titled, "The 'Junker' Amplifier," by Lewis McCoy, W1ICP, that originally appeared in the October 1970 issue. This was a linear amplifier using an 813 tube and a TV power transformer, running about 500 W.

This reminded me of a kilowatt linear amplifier I built back then from a *QST* article, using a pair of grounded grid 813s and junk box parts. I built it to only be used on 20 meters (my favorite band). The housing was a copper box from a surplus store. I operated it with a Heathkit HW-32 transceiver, which was also only used for 20 meters. The antenna was a Cushcraft three-element, 20-meter beam on a 60-foot military surplus tower with a Ham-M rotator. I used it with great success for several years.

Sumner Weisman, W1VIV
Framingham, Massachusetts

Positivity on the Bands

I was recently looking through the February 2021 issue, when I noticed the article, "New Ham Kit: A Way for Clubs to Help New Hams Get on the Air" by Bryan Jackson, W2RBJ, about encouraging first-time operators. I completely agree! I strongly doubt that I would've ever touched my Kenwood TH-D74A again had I encountered irritability on the bands.

When I got my Technician-class license, I never once heard a discouraging word on the many repeaters I listened to. Because of this, I was eager to earn my General- and Amateur Extra-class licenses. The fact that I did all that at 13 years old signifies the importance of positive influence!

Maxximus J. Manning, KD2TOR
Middlesex, New York

A Well-Rounded Magazine

The February 2021 issue was great! One of the first columns I read each issue is "Classic Radio." This issue's "Classic Radio" column was written by Dennis Lazar, W4DNN, titled, "The Heathkit DX-40 and Hallicrafters S-38: Faithful Old Friends." It took me back to high school, when my friend and I built a Hallicrafters DX-40 in his basement and used a Hallicrafters S-85 receiver. Soon after he was given a variable frequency oscillator (VFO) as a Christmas gift, allowing us to make even more contacts. The details on tuning and operating were wonderful!

Today, kids get already-built cell phones. When I was a kid, we built our own radios, learning every detail of how they worked along the way. When they worked, we would contact Florida, Texas, and Michigan — we felt like magicians. My mother couldn't understand how we made magic from all the little parts.

Another excellent article in the February 2021 issue was "Create Your Own 1:1 Coax Choke Baluns" by John Portune, W6NBC. In my opinion, this is something everyone needs. He does a great job explaining the problem in detail and what the balun does, as well as explaining how to calculate, design, and build it. He also includes a sample problem to walk you through it step-by-step. My friends and I have made and put up at least nine dipoles, struggling each time. Now we know how to calculate it!

Walter Mellish, KC2KZJ
Livingston, New Jersey

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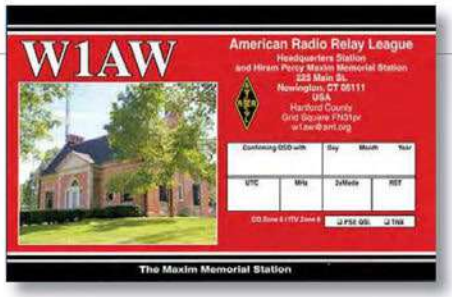

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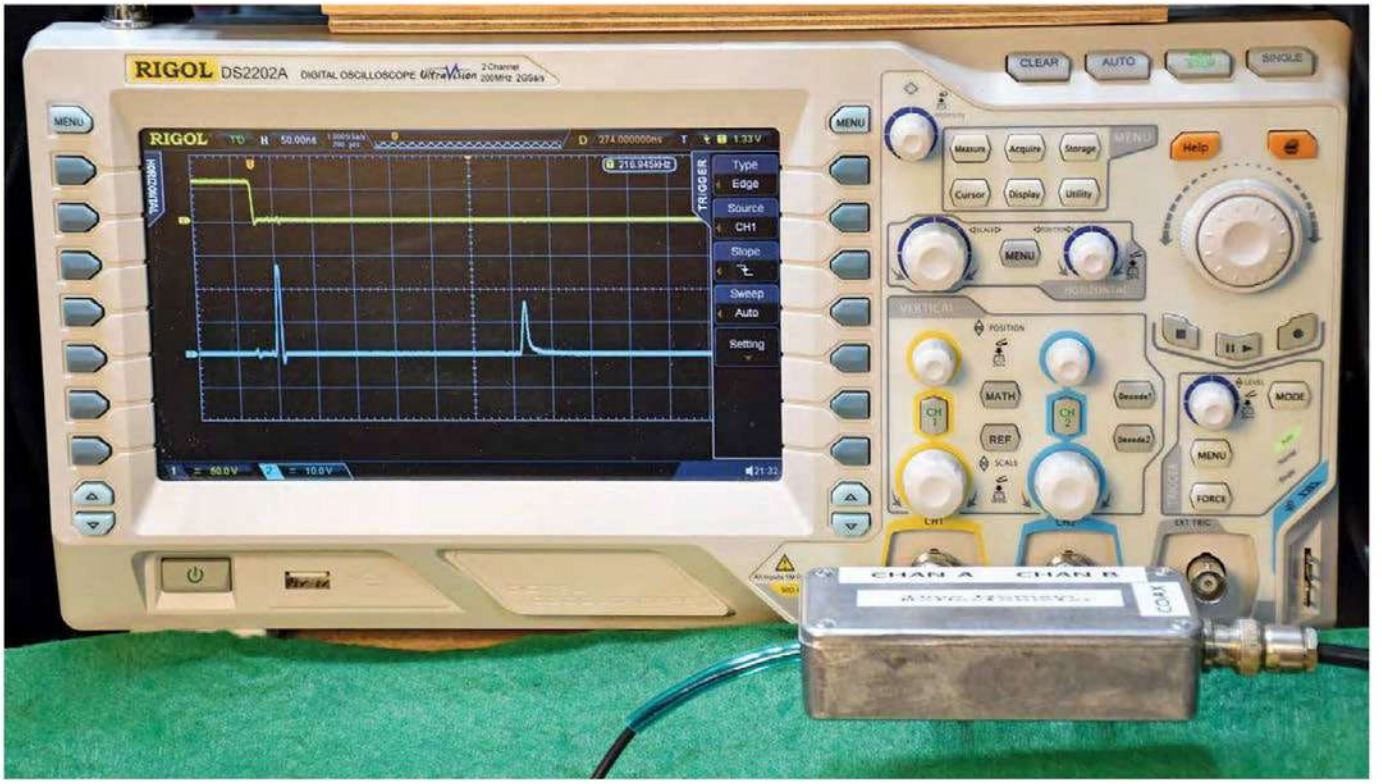


Scavenger Time-Domain Reflectometer Coaxial Cable Tester

Discover coax cable flaws and discontinuities with this pulse generator and an oscilloscope.

Stan Johnson, WØSJ

Of all the methods of testing coaxial cable, I like the time-domain reflectometer (TDR) the most. The operating principle is quite simple. A narrow pulse (here 10 ns) is sent down the coax under test, and the reflections are evaluated on an oscilloscope display. If there are bad connectors or discontinuities in the line, reflected pulses will appear. This pulse generator plus an oscilloscope comprise the TDR seen in the lead photo.

If the coax is terminated with a resistor that matches the impedance of the cable, no reflections will take place, and the scope will display a flat line. If the cable is open at the end, a positive-going pulse will be reflected (see the lower trace in the lead photo). If the coax is shorted at the far end, a negative-going pulse will be reflected.

You can determine the location of flaws by looking at the elapsed time since the pulse was transmitted. If you know the velocity factor of the cable, you can calculate the length. If you know the length of the cable, you can measure the velocity factor. You can also measure the impedance of the cable precisely. You can build a time domain reflectometer pulse generator for your oscilloscope from scavenged parts for less than $20.

If there are bad connectors or discontinuities in the line, reflected pulses will appear.

Finding the Coax Length or Velocity Factor

In Figure 1, the TDR has been connected to a roll of RG223 coax terminated with an open circuit, so the reflected pulse at the right side of the lower trace is positive-going. In the upper left corner, you can see that the ΔX — the roundtrip time between cursors — is $T = \Delta X = 312.0$ ns. It takes 312 ns for the pulse to travel the length of the coax and back again to the TDR pulse generator. According to the spec sheet, the RG223 velocity factor is $v = 0.659$ times the speed of light, $c = 3 \times 10^8$ m/s, so the length, D, of the coax is

$$D = cvT/2 = (3 \times 10^8) \times (0.659) \times (312 \times 10^{-9})/2 = 30.84 \text{ m}$$

We used the pulse roundtrip time $T = \Delta X$, hence the appearance of the division by 2 in the formula. To verify that result, I unrolled the coax and measured the length as $D_M = 30.88$ meters. The difference was just 0.04 meters, or less than 2 inches in approximately 100 feet.

If the length of the coax is known (D_M) and you want to calculate the velocity factor v_c, the formula can be rearranged to

$$v_c = 2D_M/(cT) = 2 \times (30.88)/[(3 \times 10^8) \times (312 \times 10^{-9})]$$

which equals 0.660, which is pretty close to the datasheet nominal value of 0.659.

Finding Coax Cable Impedance

Terminate the coax under test with a good-quality 50 Ω load. In Figure 2, notice the small pulse reflected from the end of the coax. The oscilloscope vertical gain has been magnified to make the pulse more visible. The positive polarity indicates that the 50 Ω termination is a higher impedance than the coax. Replace the 50 Ω load with a small potentiometer and adjust it for a

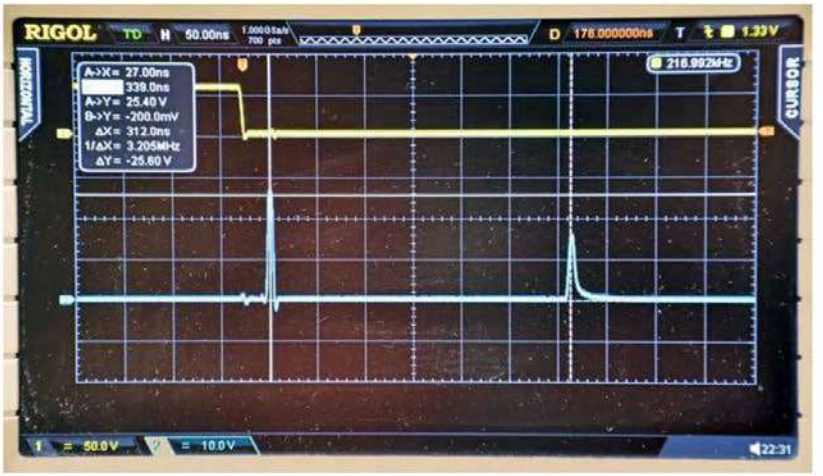


Figure 1 — The TDR lower trace shows a positive-going reflection from an open-circuit termination.

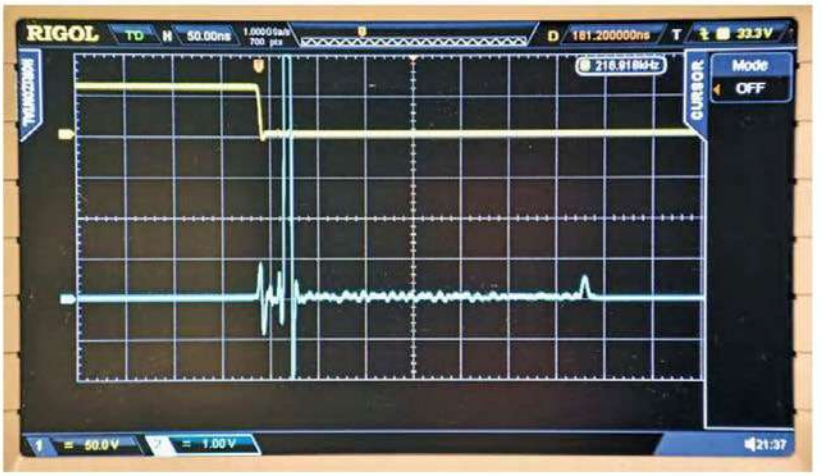


Figure 2 — This vertically expanded trace shows a small reflection from a slightly higher impedance than that of the coax under test.

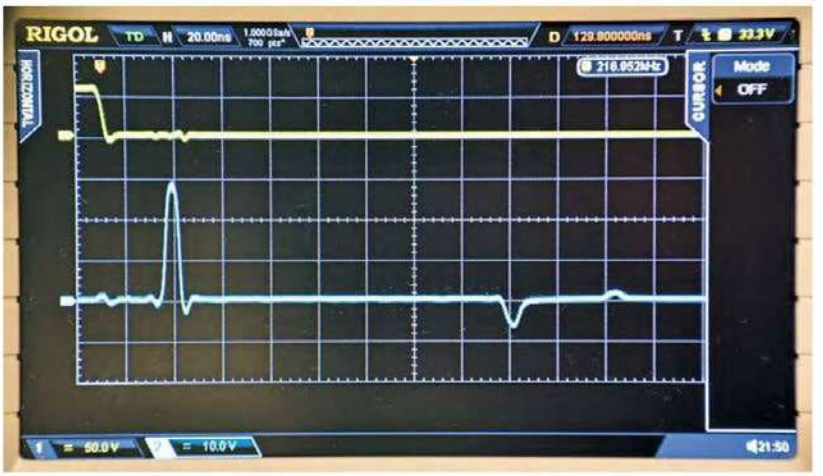


Figure 3 — A reflection is shown from a slightly higher impedance than that of the coax under test, with a lower impedance (negative pulse) at 75% of the coax length.

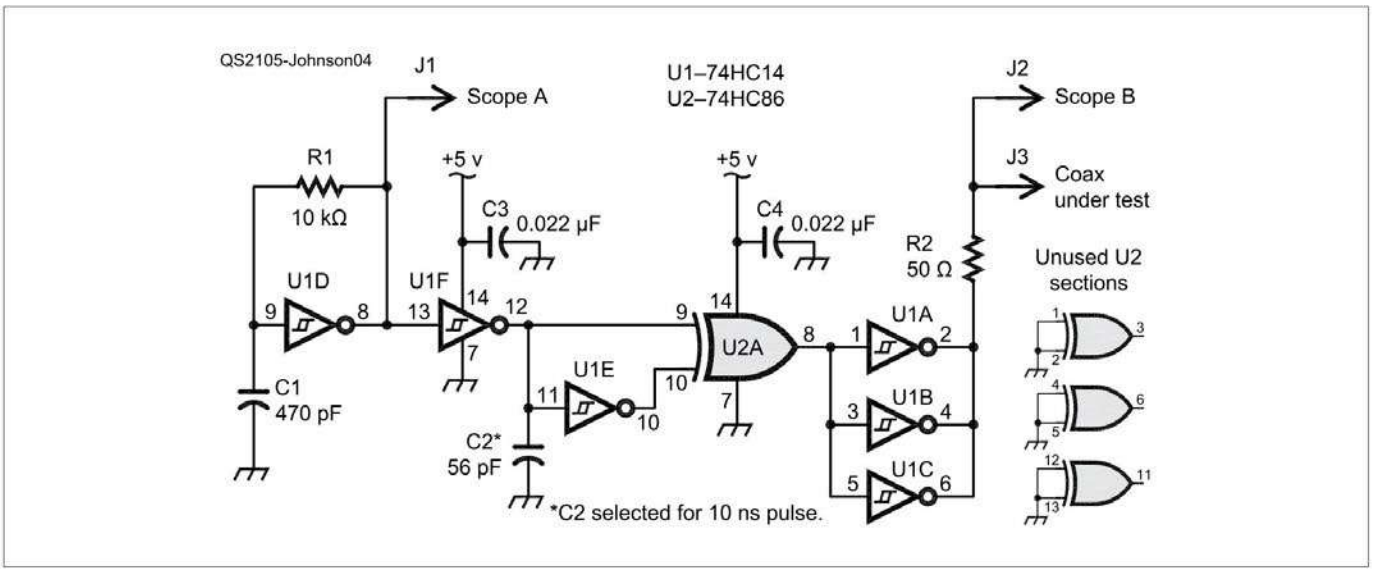


Figure 4 — A schematic diagram shows the TDR pulse generator. It can be constructed from scavenged parts.

C1 — 470 pF capacitor. A larger capacitance value may be used to allow more time between pulses.
C2 — 56 pF capacitor. Select this capacitor for an output pulse that is about 10 ns wide.
C3, C4 — 0.022 µF WIMA capacitors scavenged from my junk box
J1, J2, J3 — Scavenged BNC connectors
R1 — 10 kΩ resistor
R2 — 50 Ω, ¼ W, 1% resistor RC07 type. This resistor must match the impedance of the coax under test. Change this resistor to 75 Ω for testing 75 Ω coax.
U1 — 74HC14 hex inverting Schmitt trigger integrated circuit
U2 — 74HC86 quad two-input exclusive or integrated circuit
PCB scrap — Scavenged from junk box
Standoff posts — Scavenged parts
Power supply — Scavenged 5 V dc wall wart
Aluminum box — Scavenged 4 × 2 × 1 inch box

minimum reflected pulse amplitude. I measured a potentiometer resistance of 47.5 Ω with an ohmmeter. To verify this measurement, I connected a 47.5 Ω 1% resistor in place of the potentiometer to the end of the coax and yes, this coax has an impedance of 47.5 Ω. The data sheet says RG223 has a nominal impedance of 50 Ω.

Finding Problems with Your Coax

A few years ago, the SWR went up on my vertical antenna. After checking everything else, I disconnected the coax from the antenna and attached a 50 Ω load. A TDR measurement revealed that the last 5 feet of coax was bad. I found that a seal had failed, allowing water into the coax. I chopped off the bad coax section, installed a new connector, and it has been working fine ever since.

To demonstrate looking for a flaw in coax, refer to Figure 3, which shows reflections from a **T** connector joining a 13.9-meter cable to a 4.3-meter cable. The far end of the cable is terminated with a 75 Ω load to mark where the end of the cable is on the scope display. The trace represents the 18.2-meter cable. A 50 Ω load resistor is installed on the **T** connector, making the impedance much lower than 50 Ω at that point. A negative pulse is reflected from that discontinuity. Notice that the artificial flaw is about 75% of the way down the coax. Marking the end of the cable in this manner makes flaws much easier to find.

How to Make a TDR

Figure 4 shows the schematic diagram of the TDR pulse generator. The first inverter is used as an oscillator to set the pulse repetition rate at about 200 kHz. The output (Pin 8) feeds connector J1 and a buffer. The buffer output (Pin 12) drives an exclusive or gate input (Pin 9) and an inverter that drives the other exclusive or gate input (Pin 10). The delay introduced by the inverter connected to Pin 10 causes the exclusive or inputs to be different for a very short period of time. The output pulse is buffered by the three inverters (U1) connected in parallel. Select capacitor C2 to produce a pulse that is 10 ns wide at its bottom. On the scope, it should resemble a half-sine wave pulse at 50 MHz.

Connect J1 to the oscilloscope input Channel A (upper trace in all the images). Set the scope to trigger on the negative transition of input A.

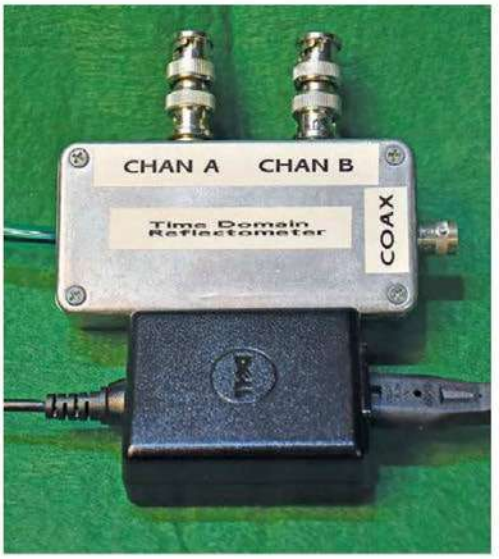


Figure 5 — The TDR pulse generator is in an aluminum housing. The 5 V dc wall wart is shown below the pulse generator.

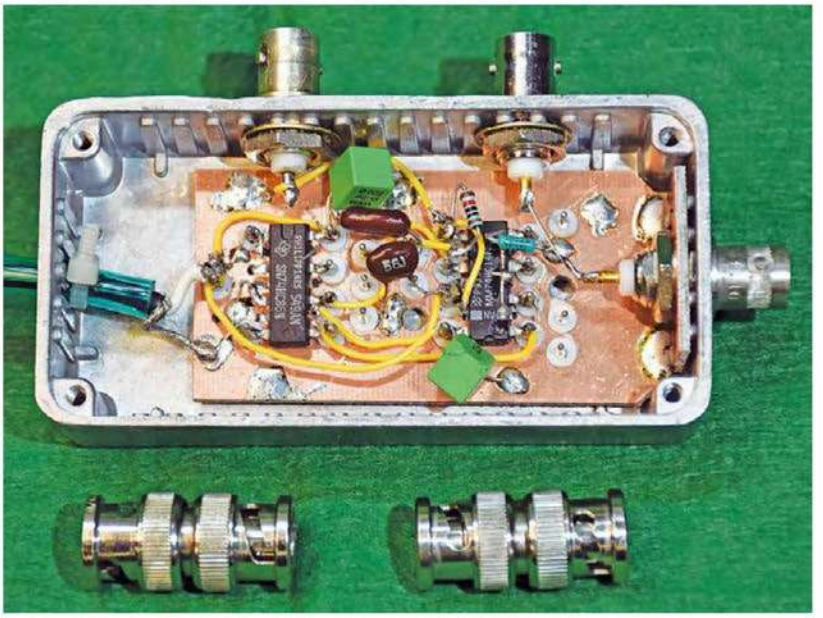


Figure 6 — The "dead bug" construction style of the pulse generator results in the shortest connections between components.

Connect J2 to scope input Channel B (lower trace on all the images). To minimize the capacitive loading, the connection to the scope should be as short as possible. I use BNC double male adapters (see Figures 5 and 6). The coax under test is connected to J3.

Figure 6 shows the internal construction. I wanted the minimum amount of lead inductance and stray capacitance. I placed four standoffs on each side of the two integrated circuits (ICs) with the IC leads soldered directly to the standoffs. I bent three pins vertically on each side of the IC and soldered the wires directly to them in "dead bug, point-to-point" construction style. A scrap of printed circuit board (PCB) material made an excellent ground plane and was soldered directly to PCB material on J3. I intended this construction to be a prototype, but it worked so well that it didn't need further changes.

Conclusion

Yes, you can build a scavenger time-domain reflectometer pulse generator out of new parts, but I doubt that you will achieve the same level of satisfaction. I hope your TDR works as well as mine, and remember to keep scavenging.

Stan Johnson, WØSJ, was first licensed in 1961 and upgraded to an Amateur Extra-class license in 1968. He has a degree in electronics from Iowa State University and a physics degree from the University of Northern Iowa. His career began at Bell Telephone Laboratories near Chicago and ended at the John Deere Product Engineering Center in Iowa as a scientist/engineer. Since retiring in 2001, Stan enjoys building things, mostly out of scavenged junk. You can reach Stan at **w0scavengesjunk@gmail.com**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

Feedback

■ In the March 2021 "Product Review" by Phil Salas, AD5X, of the tinySA Portable Spectrum Analyzer, we noted that the device did not properly display the spectrum of an AM signal. tinySA designer Erik Kaashoek, PDØEK, reports that with updated firmware, it is now possible to display an AM signal correctly. With the new firmware, there is also a built-in measurement function for AM that calculates the modulation depth. For more information, see the supplemental information for this review at **www.arrl.org/qst-in-depth**. Firmware update instructions are available from the tinySA wiki at **tinysa.org/wiki**.

■ In the "Celebrating Our Legacy" column of the April 2021 issue, the photo caption should have read, "Wayne Schonfeld, WA4YDJ, and his father with fellow campers at Camp Albert Butler in 1965." *QST* regrets the error.

High-Efficiency 2 kW Water-Cooled Dummy Load

This dummy load uses RF thick-film resistors and water cooling to permit continuous operation up to 2 kW.

Guenther Knebel, DK6ET

Testing and troubleshooting high-power amplifiers routinely requires a high-power dummy load (see Figure 1). However, dummy loads capable of handling sustained high power are difficult to find. Therefore, I endeavored to develop a dummy load with the following specifications:

1. Power capability of 2 kW continuous
2. Nominal resistance of 50 Ω ± 3%
3. Frequency range up to at least 30 MHz
4. SWR better than 1.05

RF thick-film chip resistors based on beryllium oxide (BeO) technology have excellent thermal performance. These chips typically have a resistance of 50 Ω ± 5%, and continuous power ranges up to

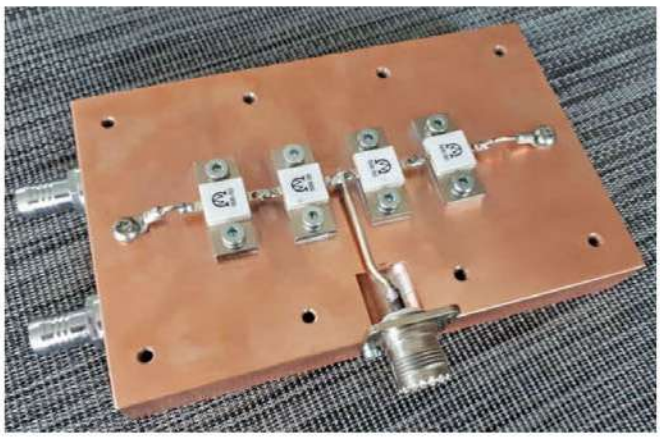


Figure 1 — The dummy load uses four 500 W, thick-film resistors.

1,750 W from –50 to 100 °C (available at **www.barryind.com/flanged_terminations.html**). However, these power levels can only be achieved with a good mechanical and thermal structure. Due to my professional involvement with cooling of sophisticated injection molds, I decided to pursue water cooling for this dummy load. Inexpensive components are available for the construction of a water-cooled dummy load (see my website at **www.nd2x.com/kd5fzx-h2o.html**).

The dummy load and cooling unit design was carried out with 3D CAD modeling (see Figures 2 and 3). Four 500 W chip resistors were mounted on a cooling plate, which consisted of two 160 × 100 × 10 millimeter copper plates (marked in green and dark blue in Figure 2).

A 9-millimeter-wide by 5-millimeter-deep, **U**-shaped channel (see Figure 4) was milled around the chip resistor locations in the top and bottom plates. Eight M4 threaded holes for fastening the chip resistors and ten M4 through-holes were made in the top plate. Then both inner (**U**-channel) sides of the copper plates were face-milled, coated with solder paste, and placed on a hotplate. After the solder began to melt, the copper plates were placed on top of each other. Solder was applied to the 10 through-holes so that the contact surfaces connected securely. This created a closed ring channel with a cross-section of 90 squared millimeters from the two channel halves. After cooling, all six outer sides were milled to size, and then two connectors were inserted for the water connections. A final pressure test showed that all the seams were tight (see Figure 5).

The milled top of the cooling plate was polished and cleaned prior to component mounting. The undersides of the chip resistors were coated with thermal paste and screwed onto the cooling plate with M4 10-millimeter Allen screws, followed by installation of the UHF connector. Next, the thin connection lugs of

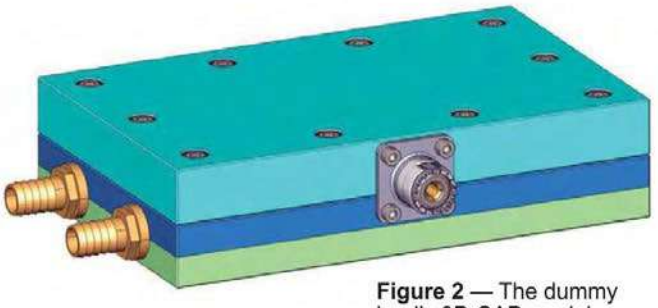


Figure 2 — The dummy load's 3D CAD model.

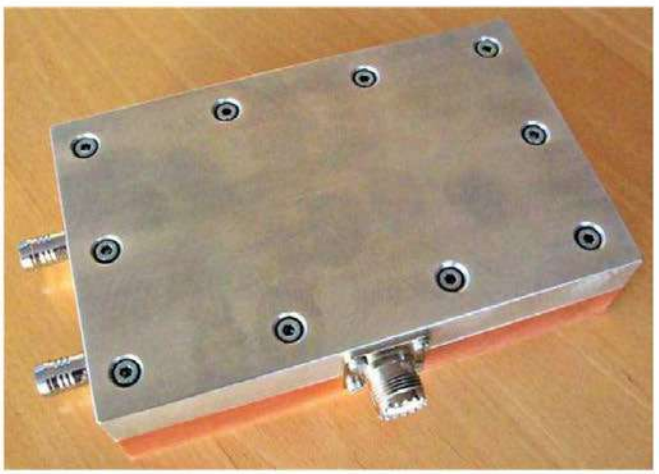


Figure 3 — The completed water-cooled dummy load, with the water intake/exhaust connectors on the left.

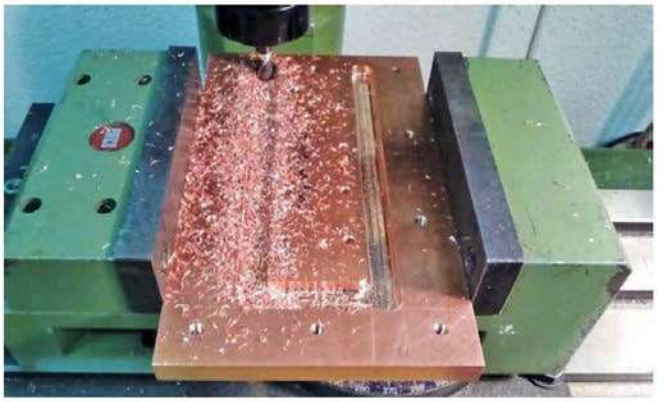


Figure 4 — The milled channel is for water cooling.

Figure 5 — The plates are soldered together.

the resistors were soldered together, and the ends were connected to ground with short wires, as seen in Figure 1. Finally, the aluminum cover plate was screwed on. A milled pocket on the inside of the cover provided space for the chip resistors. This cover provided an RF-tight housing and protection against accidental contact (see Figure 3).

Cooling Unit

The cooling process is shown in Figure 6. Two special 200 × 200 millimeter coolers with filigree copper fin radiators provide efficient heat transfer to the air and make optimal use of the installation space. Both radiators are equipped with thermal sensors for temperature monitoring of the cooling water. The heated water from the dummy load is cooled in the first cooler before it flows through the pump into the second cooler then back into the dummy load.

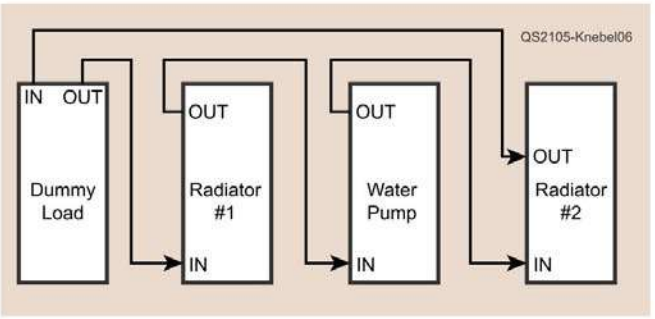


Figure 6 — The water flow is shown during the cooling process.

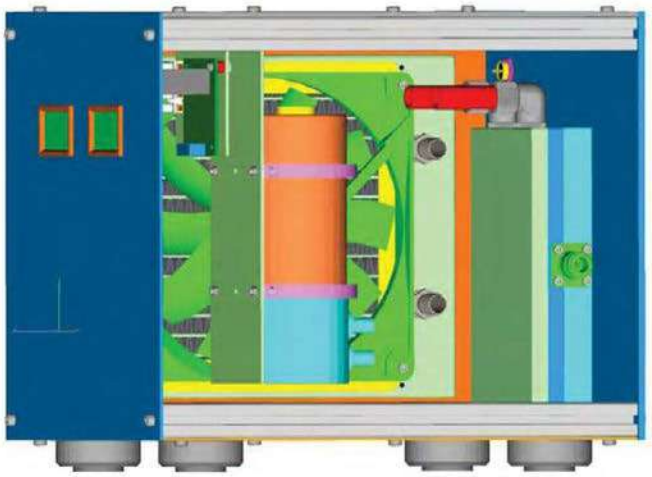


Figure 7 — The final CAD model.

The air required for cooling utilizes two slow-running 180-millimeter fans that draw in air via slots in the base plate. Both 12 V dc fans run continuously from an external power supply. The moving air flows through the high-performance radiators and then back to the outside through slotted side plates. The final CAD model of the cooling unit with the integrated dummy load on the inside of the rear wall was created over several iteration steps (see Figure 7). Attention was paid to a symmetrical arrangement of the cooling components and good accessibility. Aluminum sheets for the cabinet were laser cut, with the necessary data generated directly from the 3D CAD model. This provided mechanically precise parts and a nice appearance. The top cover, a 3-millimeter-thick acrylic panel, allows a look inside the cooling unit and also provides a nice overall impression thanks to the blue LEDs in the two fans (see Figure 8).

Finally, an LCD provides analog and digital information of the water temperature. The LCD is supplied with 5 V dc via a voltage regulator board.

Figure 8 — The completed dummy load.

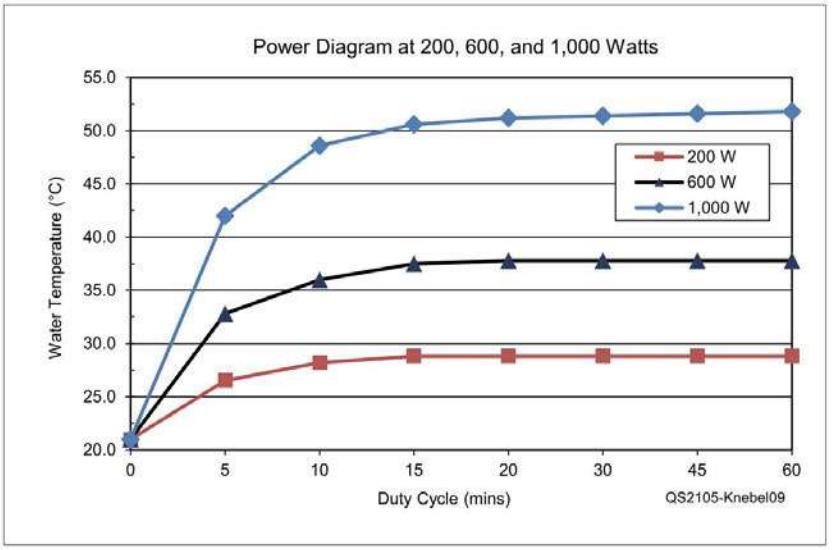


Figure 9 — The water temperature versus time is shown at 200, 600, and 1,000 W.

Measurements

Using an AA-35 ZOOM, the SWR of the completed dummy load was measured at less than 1.05:1 from 1 – 35 MHz. Next, power tests were carried out at 100 W without water cooling to observe the heat transfer from the chip resistors to the heatsink. After 20 minutes, both the chip resistors and the cooling plate became just lukewarm. Then, the cooling unit was connected. With a pump output of 500 liters/hour, approximately 1.5 liters was constantly circulating in the two coolers. Next, the water temperature was measured over periods of 1 hour at 200, 600, and 1,000 W. The results are shown in Figure 9. Incidentally, after 1 hour at 1,000 W, the surface temperature of the copper plate was 65 °C.

Optimization Potential

While this dummy load performance was quite good, there is always room for improvement. In a first optimization phase, an expansion tank with a capacity of approximately 1 liter was placed between the two fans. This provided additional cooling due to the increased water volume of the expansion tank, pump, dummy load, and the two radiators.

In a second iteration, the dummy load was screwed onto the outside of the rear plate. Besides providing easier access to the UHF connector, it also permitted mounting an additional aluminum cooling plate on the inner side of the back plate to enhance heat transfer.

Finally, heat transfer can be further improved by replacing the thermal paste with eutectic alloys made of gallium, indium, and tin. These so-called liquid metals provide extremely high thermal conductivity compared to synthetic polymers. Because the alloy is liquid at room temperature, unevenness can be leveled out much better than with conventional thermal pastes. However, liquid metals are electrically conductive, so care must be taken to ensure short circuits don't occur. Contact with aluminum should also be avoided because gallium attacks the protective oxide layer, and thus leads to embrittlement. Copper or nickel-plated copper surfaces have good long-term stability.

Conclusion

Efficient cooling of high-power chip resistors or LDMOS-FETs can be implemented with water cooling. The main focus must be on constant circulation and a sufficiently large amount of water and large radiators. Additionally, careful design of the cooling channels is required so that the heat is distributed quickly into a sufficiently thick copper plate without creating local hotspots that can destroy a component. I would be happy to provide CAD models to anyone interested in duplicating the high-power dummy load described here.

All photos by the author.

Guenther Knebel, DK6ET, has been an amateur radio operator for almost 50 years. He received his VHF license in 1972, then upgraded to a General and then an Amateur Extra-class license shortly after. He holds a Master's degree in applied physics and received his PhD in pharmaceutical technology in 1982. For more than 30 years, he worked in the biomedical industry, initially as a lab manager, and later as a director of R&D. Now retired, Guenther spends most of his time in 3D CAD mechanical engineering and building his homebrewed equipment. You can contact Guenther at **dk6et@darc.de**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

Product Review

Mobilinkd TNC3 for APRS

Reviewed by Steve Ford, WB8IMY
wb8imy@arrl.net

Many amateurs think of the Automatic Packet Reporting System (APRS®) as a ham network for tracking people, vehicles, and other moving objects. While that is one of its chief uses, APRS is capable of much more. For instance, the world is peppered with APRS-linked weather stations that make environmental data available in near-real time. The network is also capable of text messaging, either station-to-station via RF, or to and from the internet.

To get involved with APRS, you usually need a 2-meter FM transceiver (144.39 MHz is the main APRS frequency) and a packet radio terminal node controller (TNC), which acts as a modem to send and receive data over the air. To display the positions of APRS stations on maps, and to access the network, you also need software on whatever computer is connected to the TNC.

In recent years, some transceiver manufacturers have begun incorporating APRS functionality, including TNCs, in their VHF FM radios. These radios can display a limited amount of APRS information and allow connections to an external computer to make use of specialized APRS software, which usually includes detailed maps (down to street level).

One thing that may stand in your way is if you already have a transceiver you enjoy using that doesn't include APRS features. You would need to track down an external TNC, wire it to your radio, and install APRS software on your station computer. but that approach seems cumbersome and almost antiquated in the era of powerful mobile devices, such as smartphones and tablets. Fortunately, Mobilinkd has created a solution with its TNC3.

A Tiny Wireless TNC

The Mobilinkd TNC3 is small enough to fit in your palm with room to spare (see Figure 1). Within the diminutive package is a TNC capable of operating at 1,200 or 9,600 baud (most APRS activity takes place at 1,200 baud).

Figure 1 — The Mobilinkd TNC3 is extremely compact, and it uses a wireless Bluetooth connection to communicate with your smartphone or tablet.

The TNC3 communicates with your smartphone or tablet using a wireless Bluetooth connection. The connection to your transceiver is made through a cable that carries the transmit audio, receive audio, and transmit/receive switching (PTT). Mobilinkd sells prewired cables for several mobile and handheld transceivers, or you can choose to make your own.

The TNC3 contains a battery that you can recharge through any USB computer connection, or 5 V, USB-style charger. The charger and USB cable are not included but are readily available. Once charged, the battery is good for up to 48 hours of continuous use.

You configure the TNC3 by using one of the free Mobilinkd apps for either iOS (from the Apple App Store) or Android (available from Google Play). It is important to point out that the Mobilinkd apps do not

Bottom Line

When used with a handheld or mobile 2-meter FM transceiver and smartphone or tablet, the Mobilinkd TNC3 offers an affordable path to a full-featured APRS mobile station without the burden of hauling a laptop. Setup is straightforward.

process and display APRS information; they are used strictly for configuring the TNC3. To use the TNC3 for APRS or other packet radio applications, you will need a separate app that can communicate with the TNC3.

My TNC3 Setup

For this review, I chose to create my own TNC3 cable for use with my 2-meter mobile transceiver. The TNC3 port requires a four-section TRRS plug (which Mobilinkd also sells). All I needed to do was create a cable that connects to the appropriate audio input and PTT pins on the transceiver's microphone jack, as well as the radio's external speaker jack. The Mobilinkd manual describes the necessary connections to the TRRS plug.

The Mobilinkd app for iOS allowed me to quickly configure the TNC and test the radio for proper transmit and receive audio levels. When you start the app for the first time, it automatically hunts for the TNC3's Bluetooth signal. The TNC switches on with a single press of the top button, and a blue LED indicates that the Bluetooth link is active. Once the app finds the TNC3, tap the app to select it and pairing takes place quickly.

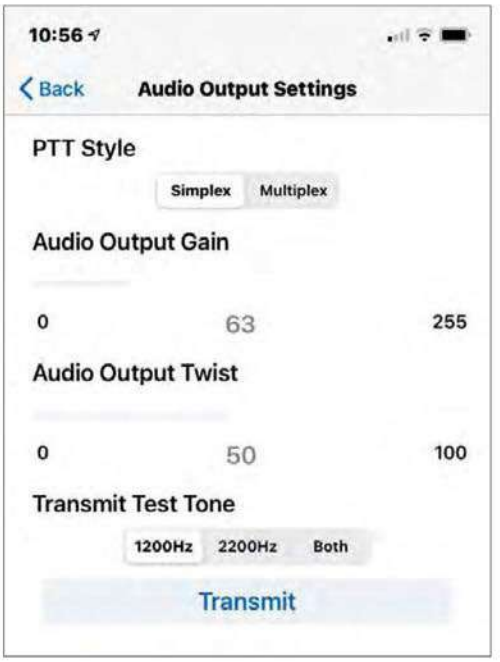


Figure 2 — Setting up transmit audio levels with the Mobilinkd configuration app.

Because I was using an iOS device, I needed an iOS APRS app that was compatible with the TNC3. At the time of this writing, the only one I could find was the *aprs.fi* app in the Apple App Store. It sells for $9.99 and includes some additional features for in-app purchase. For this review, the basic app was all I needed. (See the review of the *aprs.fi* app elsewhere in this issue for more information.) Android users will find similar APRS apps for their devices.

On the Network

I tuned the transceiver to 144.39 MHz and set the squelch wide open, as specified in the downloadable instructions. I adjusted the transceiver volume control and, using the Mobilinkd configuration app, set the TNC3's audio input gain accordingly. I have a fair amount of APRS activity in my area, so it didn't take long to pick up a signal. Each time the TNC3 decodes a packet, its LED flashes green.

Adjusting transmit audio through the app was straightforward. I set the TNC3 audio output levels and then tapped the app's **TRANSMIT** button to test. The TNC3's LED glowed red, and I heard the test signal on a separate receiver. You can select different test tones and then tap the app sliders to adjust the output levels (see Figure 2). You want a signal that is well modulated, but not overmodulated.

With the transceiver fully configured, I saved the configuration and then closed the Mobilinkd app. Next, I brought up the *aprs.fi* app and set it to look for the TNC3 Bluetooth signal. It connected within seconds, and it wasn't long after before I began seeing icons of APRS stations, many of them weather stations, populating the *aprs.fi* map. The app is impressive, and the display is particularly striking when used with the larger screen of a tablet rather than a smartphone.

After monitoring for a while, I had the *aprs.fi* app send a beacon for my position. My transceiver immediately went into the transmit mode and, while watching the raw packet data within the app during receive, I saw my information being relayed to the network. About a minute later, it appeared on the **aprs.fi** website.

One of the most attractive aspects of the TNC3 is its portability. I could toss the radio into my car and, with my smartphone, become a full-featured APRS mobile station, not just another car sending out tracking beacons. This has excellent potential for public service applications where you want full APRS capability without the burden of hauling a laptop. In fact, you could use the TNC3 with nothing more than a handheld transceiver and the mobile smartphone or tablet of your choosing. That would go a long way toward making portable/mobile APRS much easier and affordable. There's an active users' group online at **groups.io/g/mobilinkd**.

Manufacturer: Mobilinkd, **www.mobilinkd.com**. Price: $119.95.

aprs.fi App for iOS

Reviewed by Steve Ford, WB8IMY
wb8imy@arrl.net

The Automatic Packet Reporting System (APRS) is one of amateur radio's digital success stories. Developed more than 20 years ago by Bob Bruninga, WB4APR, it began as a clever means of tracking moving objects using Global Positioning System (GPS) receivers attached to packet radio modems and 2-meter FM transceivers. APRS has since evolved into a global network devoted to tracking, weather monitoring, and message handling.

The radio-based APRS network has thoroughly integrated with the internet. Information passes from one to the other almost seamlessly, and the integration has allowed APRS to offer more functionality than perhaps even Bob himself imagined possible.

The near-universal proliferation of smartphones and tablets has brought APRS to virtually every amateur. Even if you don't own an APRS-capable FM transceiver, there are now apps that will allow you to tap into this vast network. A Wi-Fi or cellular connection is all you need.

Bottom Line

The *aprs.fi* app for iOS is a useful companion to the Mobilinkd TNC3 or other packet modem, or you can use it to view APRS activity around the world via the internet.

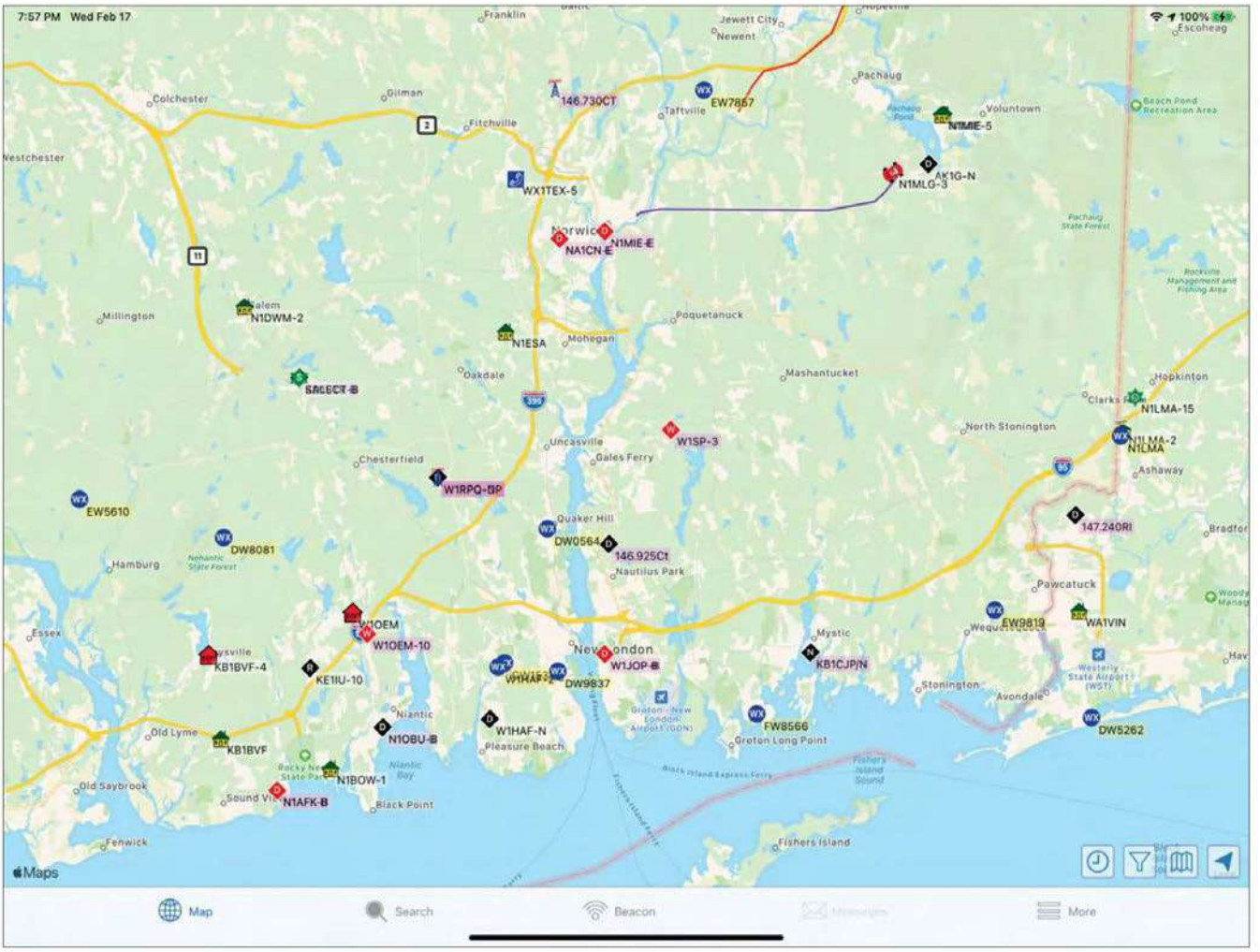


Figure 3 — The *aprs.fi* app displays detailed maps that you can scroll and zoom with finger gestures. Icons represent signals received from mobile and fixed amateur stations, weather stations, and repeaters.

A Mobile APRS App

One of the most popular APRS applications for iOS devices, such as iPhones or iPads, is *aprs.fi*. The app is available for purchase and download from the Apple App Store for $9.99. This is a one-time purchase, although to acquire all the features, you must buy a monthly or yearly subscription. More about this in a moment.

Aprs.fi opens with a detailed map that you can easily scroll and zoom. In fact, you can zoom all the way down to street level. The app will use the GPS receiver in your device to pinpoint your location with a blue icon. It's best to zoom to within 50 miles of your location, if not closer. Otherwise, the app may attempt to populate the map with an overwhelming number of icons, and this will take a while, even with a fast internet connection (see Figure 3).

The app displays some fascinating information that you can view by tapping on an individual station icon. For instance, many weather stations offer data such as wind speed, temperature, and more that *aprs.fi* will display graphically (see Figure 4).

For radio use, the app supports the Mobilinkd TNC3 wireless controller reviewed elsewhere in this issue. It connects to the TNC3 via a Bluetooth link, and the TNC connects to your 2-meter FM transceiver (144.39 MHz is the standard APRS frequency). With *aprs.fi* running the show, you can use the TNC3 to send and receive APRS traffic directly.

Subscription Features

If you don't want to use the Mobilinkd TNC3, *aprs.fi* has its own software-based packet modem that you can use by connecting your tablet or smartphone to your radio with cables, or you can use another interface of your choosing. To unlock the *aprs.fi* app modem, you will need to purchase a $8.49 annual subscription. (If you're just experimenting, you can buy a $2.49 monthly subscription.) Purchasing a subscription also allows you to send and receive APRS text messages via radio or the internet, as well as send position beacons from your device to the internet (think of it as APRS without the radio).

But even if you never attach your mobile device to a transceiver, *aprs.fi* is certainly worth the $9.99 just to watch all the APRS activity around the world.

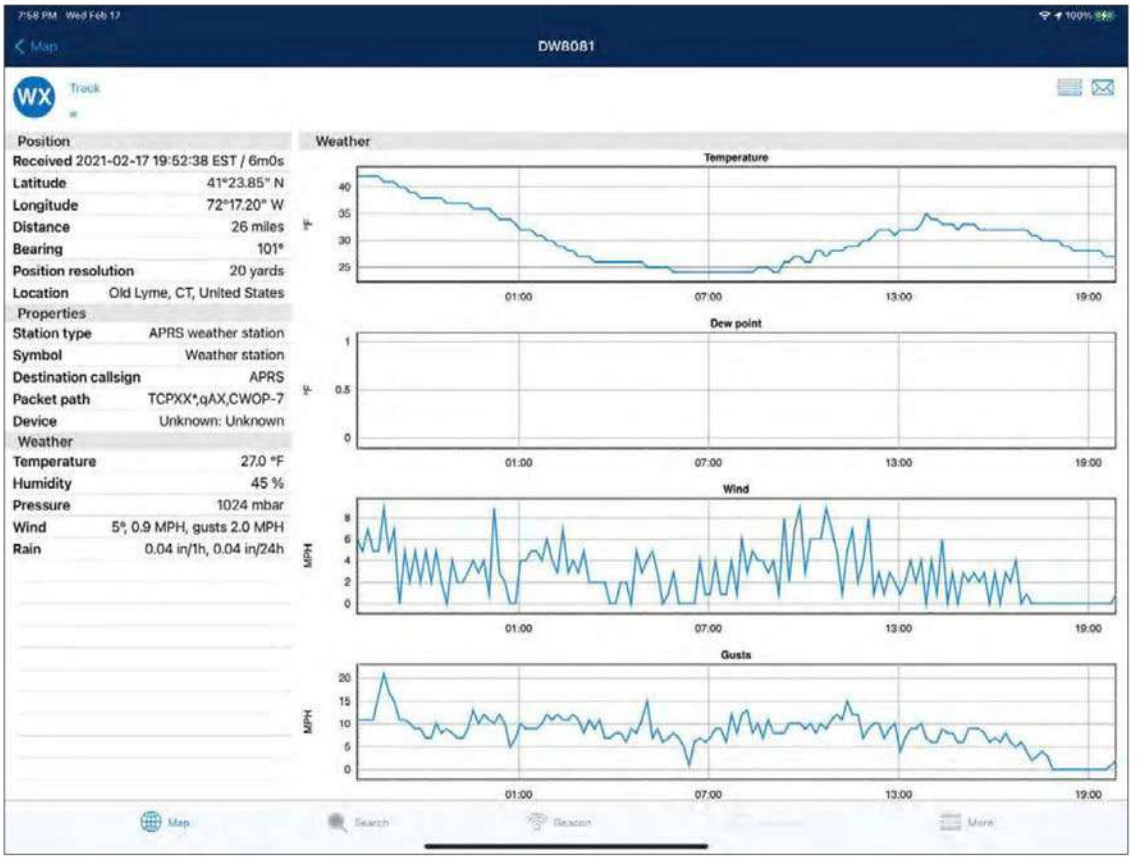


Figure 4 — Tap on a weather station icon, and you'll see the most recent report, often complete with graphs.

Four State QRP Group Nouveau 75A QRP AM Transceiver Kit

Reviewed by Paul Danzer, N1II
n1ii@arrl.net

Several CW transceiver kits are available for the QRP (low-power) operator who wants to build their own. A few operate on SSB and digital modes. For the kit builder who wants something different, check out this microprocessor-based low-power transceiver that uses amplitude modulation (AM) only, and covers the 75-meter band. Designed by David Cripe, NMØS, who has developed several kits offered by the Four State QRP Group, the Nouveau 75A is a replacement for a popular Retro 75 offered years ago by Dave Benson, K1SWL, from Small Wonder Labs. (We reviewed the Retro 75 kit in the October 2010 issue of *QST*.)

Overview

The main circuit board for the Nouveau 75A comes with approximately 80% of the parts pre-installed (these are surface-mounted devices — SMDs). The rest of the components are primarily through-hole components that you install and solder. The board is clearly marked with component designations that correspond to the layout shown in the assembly manual. A pre-assembled four-digit LED frequency display board mounts behind the front panel.

The nominal 5 W carrier output (20 W PEP) is available from approximately 3.6 to 4.0 MHz, although most AM activity takes place in the upper part of the band. Extended receive coverage from 3.0 to 6.2 MHz is available with reduced sensitivity, as shown in Table 1. The unit is powered by 11 to 14 V dc at up to 2.5 A. The kit comes with an enclosure you put together and is complete with a microphone.

A power jack, BNC antenna connector, and power switch are located on the back panel. A microphone jack and microphone gain control are on the left side of the front panel, with the receive audio gain control and encoder to select the frequency on the lower right side of the front panel.

Bottom Line

The Four State QRP Nouveau 75A kit goes together quickly and results in an attractive low-power 75-meter AM transceiver that works well for local and regional contacts.

The Best of Both Worlds — Analog and Digital

The PDF instruction manual is available for download from the Four State QRP Group website. It includes detailed assembly instructions, a schematic diagram and PC board layout, theory of operation, and operating hints.

In a classical AM transmitter, a big and heavy iron core transformer or choke is used to provide amplitude modulation. The Nouveau 75A instead uses a highly efficient class G modulator circuit to provide modulating audio to a class E final amplifier — an IRF510 MOSFET.

The transceiver uses a microcontroller-driven Si5351 phase-locked loop (PLL) for the variable frequency oscillator (VFO). The PLL generates the transmit frequency directly, set by the front-panel rotary encoder and displayed on the LED. In receive, the microcontroller sets the PLL to 5.5 to 6 MHz, with a 2 MHz intermediate frequency (IF). Tuning steps are 1 kHz from 3.5 to 4 MHz, and 5 kHz above and below that range.

The mixing circuit is interesting because the IRF510 final amplifier is also used as the mixer. In the receive mode, dc voltage is removed from the transmitter final amplifier, and the 6 MHz VFO signal is applied to the gate of the IRF510. The MOSFET behaves as a switching mixer and downconverts the 75-meter receive signal to the 2 MHz intermediate frequency, where it is amplified and demodulated. Bandwidth filtering (6 kHz) is provided by three ceramic resonators.

Table 1
Four State QRP Group Nouveau 75A, s/n 0180

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Transmit, 3.605 – 3.995 MHz. Receive, 3.0 to 6.2 MHz.	As specified.
Mode: AM.	As specified.
Power requirements: 11 – 14 V dc. Receive, 120 mA. Transmit, 600 mA unmodulated; typically 2.5 A at peak RF power output.	At 13.8 V dc: Receive, 151 mA (maximum volume), 125 mA (minimum volume). Transmit, 897 mA with unmodulated carrier; 1.92 A at peak RF power output.
AM receiver sensitivity: Not specified.	10 dB (S+N)/N, 1 kHz tone: At 3.88 MHz, 18.8 µV; 3.1 MHz, 19.1 µV; 4 MHz, 29.5 µV; 5 MHz, 43.6 µV; 6.1 MHz, 298 µV.
Audio response at 6 dB points: Not specified.	312 to 2144 Hz (3664 Hz BW).*
RF power output: 5 W carrier, 20 W PEP.	Maximum RF output at 13.8 V dc: 6.6 W carrier, 25.4 W PEP.
Harmonic and spurious suppression: Not specified.	60 dB. Meets FCC requirements for spectral purity.
Transmit intermodulation distortion (IMD): Not specified.	IMD products down 60 dB at 3 kHz from carrier.
Size: 2.2 × 5.3 × 4.5 inches, including protrusions. Weight: 12.8 ounces.	

*Audio filter shaping suggests shallow filter shaping; mid and high frequencies are present but reduced. More test data from the ARRL Lab is available from **www.arrl.org/qst-in-depth**.

Most functions are controlled by the microprocessor. A brief description of the software functions is included in the instruction sheets.

Putting It Together

Upon opening the shipping box, I noticed the contents are packed — really packed. There is probably not a fraction of a cubic inch not filled with the main PC board, display board, two bags of parts, hardware envelope, speaker, microphone, and enclosure pieces. It's helpful to keep the components in the bags they came in. The finished kit is shown in Figure 5.

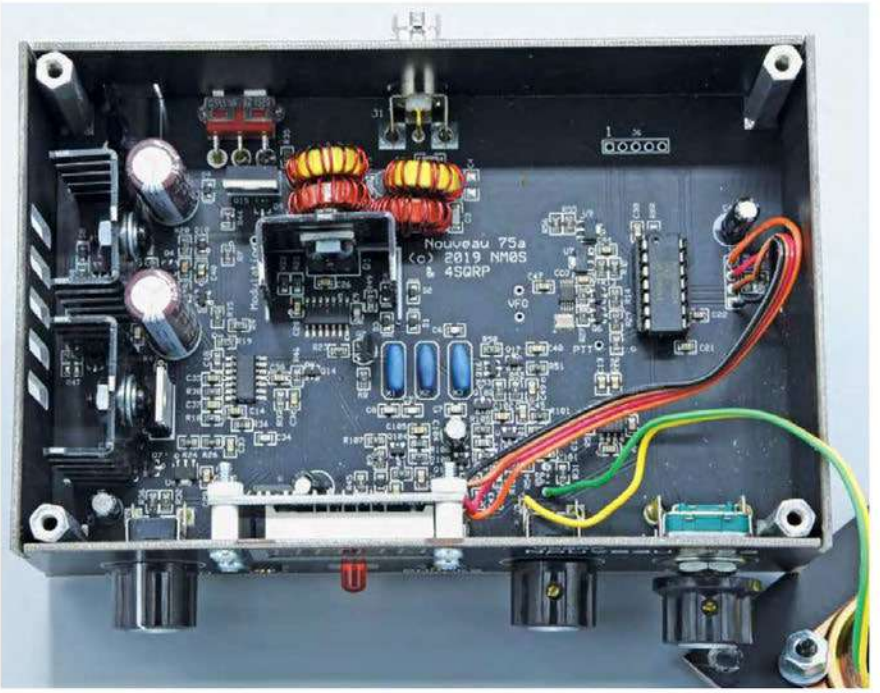


Figure 5 — The finished Nouveau 75A in its case. The four-digit display module is mounted behind the front panel and shows the transmit frequency in 1 kHz increments. A four-conductor cable connects the display to the main board. The speaker mounts to the top cover.

The Four State QRP website includes the PDF of the instruction manual, along with separate PDFs with better-quality versions of the schematic diagram and PC board layout/part placement guide. I found that the labels on the schematic and PC board layout were a bit small when printed on 8.5 × 11 inch paper. For maximum clarity, you may want to view these illustrations on your PC monitor, where you can zoom in.

Following the manual, assembly is fairly straightforward. There are, however, a few things to note.

- Follow the directions very carefully when mounting Q1, Q3, and Q11 with their heatsinks.
- Clear nail polish is included in the list of needed tools, but not used in any of the steps.
- The wire for the toroid inductors is fairly stiff. You might find it easier to wind the toroids from the center. As an example, for 19 turns, place the center of the wire inside the toroid and wind 10 turns on the core in one direction, and wind the remaining nine turns on the rest of the core.

On the Air with the Nouveau 75A

Bob Allison, WB1GCM

After Paul, N1II, finished building the Nouveau 75A kit, I had the opportunity to use it over a weekend. One of my 80-meter antennas is a full-size dipole, with the center only 18 feet above ground. This is used as a one-hopper, near-vertical incidence skywave (NVIS) antenna. Such antennas work great for radiating RF energy straight up, with the refracting signal raining down over a 200-mile circle. This circular pattern has been confirmed with many on-air signal reports. An NVIS antenna can work well with low-power transmissions on the 75/80-meter band, especially just after sunrise and before sunset.

On my operating desk, the Nouveau 75A was completely overshadowed by my classic tube-type Heathkit DX-100 transmitter and Collins R-390 receiver that I often use for operating on 75-meter AM. I connected my antenna and 13.8 V dc power supply to the Nouveau 75A and tuned to the hub of AM operating activity, 3.885 MHz, where I heard a contact in progress. Both stations were quite strong. After listening a while, I politely broke in. Peter, K1PHG, in Brookfield, Connecticut, some 60 miles away, came back and gave a report of S-9 and "sounds okay."

Also on frequency was Brent, W1IA, in Derry, New Hampshire, about 95 miles away. Brent told me my transmit audio was tearing (clipped). This observation confirms the ARRL Lab measurements I made regarding the red LED indicator on the Nouveau 75A's front panel. The LED starts to illuminate when modulation approaches 100%, and talking with the LED fully illuminated when speaking will cause overmodulation. With the level properly adjusted so that the LED only illuminates a little on voice peaks, I received several reports of good audio and plenty of modulation.

I thanked Brent for his help, and then Bruce, W1UJR, in Wiscasset, Maine, called in from 198 miles away. He gave the Nouveau 75A and my low dipole a signal report of S-9 +10 dB. Having built three Nouveau 75A kits, Bruce was enthusiastic about the radio, noting its ease of construction and decent performance. He also confirmed that when using the microphone provided with the kit, the transmit audio consists of mostly mid- and high-frequency audio components. Audio quality enthusiasts take note: there is plenty of room for improvement with other microphones or audio processing devices.

Finally, Steve, KB1VWC, checked in from Falmouth, Massachusetts, 92 miles away with yet another S-9 signal report. After 45 minutes of "kit chat," using only 5 W of RF power output from the Nouveau 75A, it was time to move on. Before I signed off, I couldn't resist switching over to the DX-100 for a signal report. "10 dB over S-9," Steve reported. That's a 10 dB improvement for 200 extra pounds.

In the Lab, I found that the Nouveau 75A is a good candidate for use with a power amplifier, because of its low-transmit phase noise and good transmit intermodulation distortion (IMD) characteristics. Lab measurements indicated that the receiver sensitivity could be better, but there was plenty of signal out of the Nouveau 75A speaker for easy listening during my on-air AM contacts. Audio quality of the speaker is okay, but limited by its small size. I tried it with an external speaker, and found there was plenty of audio, and the sound quality was quite good. In addition to the amateur radio contacts, I used the Nouveau 75A to listen to time station CHU in Ottawa, Ontario, on 3.330 MHz, and WTWW in Nashville, Tennessee, on 5.085 MHz.

- The ribbon wire supplied in the kit I worked on was stranded wire, just a bit too big for the solder holes in the display module and one end of the speaker cable. You might consider substituting your own ribbon cable with a smaller gauge wire.
- Before assembling the enclosure, it's a good idea to power up the finished PC board and check it out.
- The enclosure is made from PC board material, with the front, rear, and side panels tack-soldered to the main PC board. When assembling the case, use both masking tape and rubber bands to hold the sides squarely in place while you solder.
- After assembly, there is a brief procedure to calibrate the receiver frequency setting by using a known signal source, such as a strong shortwave station. This step is important to ensure that the radio transmits and receives on the same frequency.

In Summary

After completing the kit, I sent it to Bob Allison, WB1GCM, in the ARRL Lab for testing. Bob enjoys operating 75-meter AM, and he tried it out (see the sidebar, "On the Air with the Nouveau 75A").

AM operators typically congregate near the high end of 75 meters. Look for stations around 3.885 MHz. Other frequencies may be more popular in your area, so tune around. There's a users' group online at **4sqrp.groups.io/g/N75**.

The Nouveau 75A is a fun little unit. Construction isn't difficult, and the finished unit is attractive and works well. It won't replace your 100 W home-station transceiver, but it is an interesting way to try 75-meter AM.

Manufacturer: Four State QRP Group, **www.4sqrp.com**. Price: $114, plus shipping.

Yaesu SCU-LAN10 Remote Control Unit

Reviewed by Dr. Terry Glagowski, W1TR
w1tr@arrl.net

Remote amateur radio operation has rapidly gained popularity in recent years as broadband internet service has become widely available. Many hams need to live in urban areas, sometimes in apartments or dense housing, where zoning, homeowners' associations (HOAs), or deed restrictions and covenants prevent the use of effective antennas.

One solution is to live in the city, but buy a second home or even just a vacant lot in a rural area where a remote station can be located. This avoids antenna restrictions and usually offers lower received noise levels. Members of a club might join together to create a shared remote station in a good radio location and take turns using it remotely.

To do this, a means of operating the station remotely is needed. The remote operator must be able to control and monitor the transceiver, amplifier, antenna(s), power supplies, accessories, and more. Monitoring of everything is required to make sure that nothing is wrong. Unfortunately, if something happens, it can be a long and expensive trip to fix things.

Overview

The Yaesu SCU-LAN10 Remote Control Unit is an accessory device that currently allows remote operation of the Yaesu FTDX101D, FTDX101MP, and FTDX10 transceivers. By "remote," I mean operation over a local area network (LAN) within a local site (for example, control the radio from another room in the house), *and* operation over a wide area network (WAN) for controlling the radio over the internet from anywhere in the world if the internet performance is adequate.

The SCU-LAN10 is connected to the transceiver by the USB and accessory jack cables, and connected to the LAN via an ethernet RJ-45 connection. The LAN is connected to the internet via a DSL or cable modem or other broadband device. Companion *SCU-LAN10 Remote Control Software* runs on your PC.

Capabilities

The SCU-LAN10 *Operation Manual* describes the capabilities and limitations of the unit.

- Voice operation is supported with either push-to-talk (PTT) or voice-operated transmit (VOX).
- CW operation is limited to receive only.
- Sound card digital modes — such as PSK, RTTY, FT8, or SSTV — are not supported, but perhaps the transceiver audio input and output could be configured to use computer sound card modes, such as FT8 with VOX.
- Remote control of the transceiver power **ON/OFF** switch was not supported in software version 1, but it is supported in version 2, which was released in December 2020.

System Requirements

A computer with Microsoft Windows 8 or 10 (either 32- or 64-bit version) is required. Other requirements include Microsoft .NET Framework 4, an i5 or faster CPU, 4 GB RAM, 10 MB disk space, a LAN port, and audio interfaces to speaker or headphones and microphone. These system requirements are met by most modern computers.

The *SCU-LAN10 Remote Control Software* display on the PC mirrors the TFT color touch panel on the transceiver with 800 × 480 pixel resolution. Nearly every-

Bottom Line

Yaesu's SCU-LAN10 Remote Control Unit adds some remote control functionality to the FTDX101D/MP and FTDX10 transceivers. For transmitting, only voice operation is currently supported, but remote receive is available for other modes. Configuration and setup of the SCU-LAN10 could be less complicated.

thing that is on the transceiver display is available, along with menus to access the transceiver's buttons and knobs. However, only 15 of the transceiver's 37 menu items were available remotely in the software version I used. Six different PC screen layouts are available to show the main and sub receiver controls and spectrum displays.

Setup

The front of the unit is rather simple, including a green LED power indicator, a red **STATUS** LED, and a small **RESET** button. The back of the unit (see Figure 6) is the business end. Left to right, there is a ⅛-inch audio in/out jack that is normally not used, a 13-pin DIN socket, a CAT/RS-232C DB-9 female (not used), a LAN connector, a USB connector, and a 12 V dc power jack. At first glance, one would think there are a lot of connections to be made.

Figure 6 — The rear-panel connections on the SCU-LAN10.

Included in the box is a 13-pin DIN cable that attaches to the SCU-LAN10 and to the 13-pin **ACC** port on the back of the radio, along with two snap-on ferrite cores to be installed on this cable. Also included is a USB-A/USB-B cable used for transmit and receive audio. You will need to supply an ethernet cable to connect to your router.

Before the *SCU-LAN10 Remote Control Software* can be used, the SCU-LAN10 device must be configured and the software must be configured. I have quite a bit of experience with setting up networks and devices, but SCU-LAN10 configuration proved to be a stumbling block for two different hams without that extensive experience who tried to work through the configuration. I've detailed the steps I followed to configure the device and the companion software in a document available for download from **www.arrl.org/qst-in-depth**.

The *SCU-LAN10 Setting Tool* software would benefit by making the configuration and setup of the

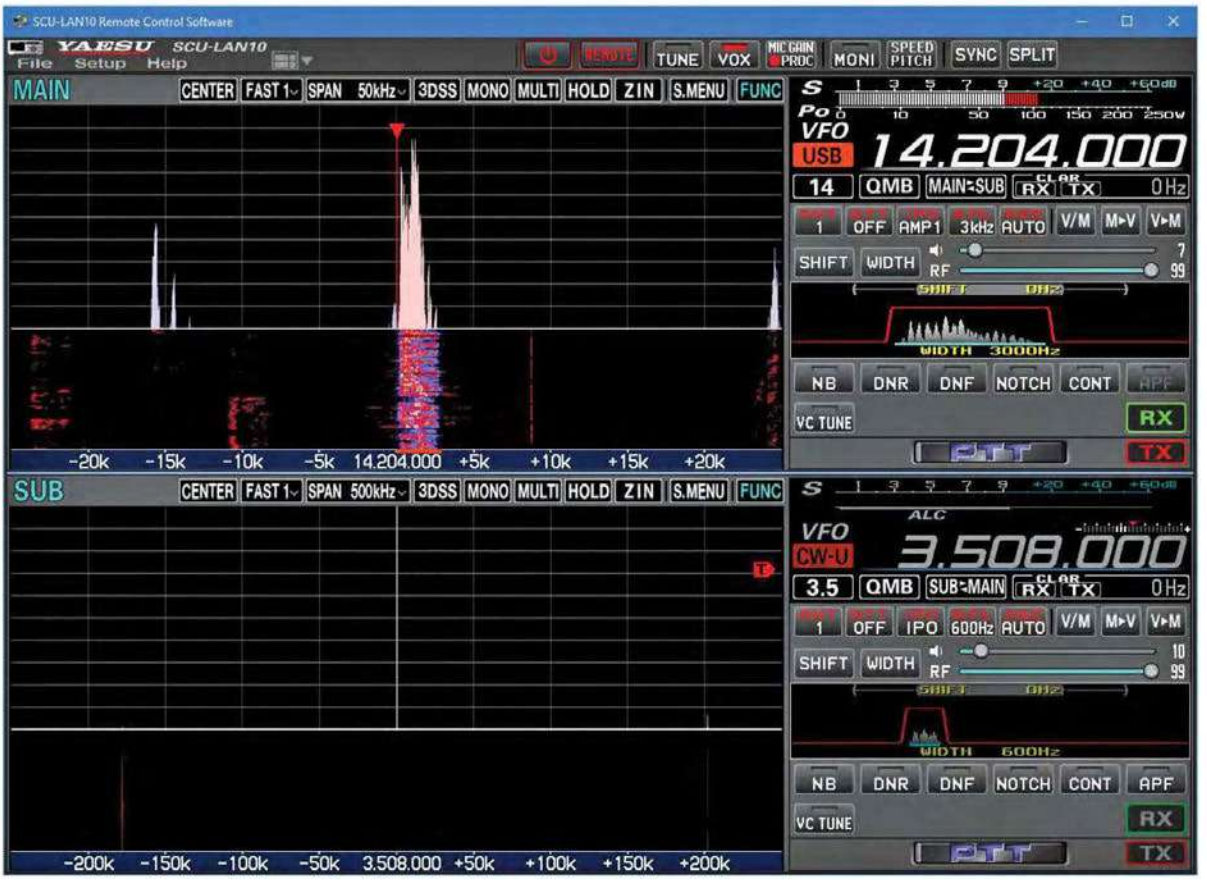


Figure 7 — The transceiver display for the FTDX101MP main and sub receivers, viewed in the Yaesu *SCU-LAN10 Remote Control Software*. Six different window configurations are available, and windows can be resized to suit your preferences.

SCU-LAN10 a bit easier. Because the remote and local ends of the system over the internet are directly connected rather than through a middleman server, there is a need for a static IP address. There is no way around this, but it needs to be made easier.

My suggestion is that a web browser management page be built into the SCU-LAN10 firmware to make it plug-and-play, similar to the Dynamic Host Configuration Protocol (DHCP) capability built into typical consumer LAN/Wi-Fi routers. This would allow easier configuration of the local LAN IP address of the device without connecting a computer directly to the device and temporarily altering the computer IP address.

Controlling the Transceiver

I used the SCU-LAN10 with the FTDX101MP transceiver reviewed in the December 2020 issue of *QST*. Once the SCU-LAN10 is set up and the software configured, start the *SCU-LAN10 Remote Control Software* to activate remote control of the transceiver. If the SCU-LAN10 device and the software are properly configured, clicking the **REMOTE** button will activate the system, and the transceiver control interface will be displayed (see Figure 7). Clicking the **REMOTE** button again will stop operation.

Version 2 of the *SCU-LAN10 Remote Control Software* supports transceiver remote power on/off, whereas Version 1 did not. When **REMOTE** is activated, the power to the transceiver is automatically turned on. The power can be toggled by clicking on the **POWER** icon. Note that if **REMOTE** is deactivated with power on, the transceiver remains on until turned off manually.

Detailed operation of the Yaesu transceiver via the SCU-LAN10 is described in the *SCU-LAN10 Operation Manual*. By using the mouse, you can click on any of the buttons on the PC screen to control the transceiver.

Figure 8 shows the transceiver control area of the main screen. To change frequency, hover the cursor over the MHz, kHz, or Hz part of the frequency display. Use the mouse wheel to change that value. Right click on the frequency display to change the tuning rate. Many other settings, such as antenna selection, filter bandwidth, AGC, preamp/attenuator, noise blanker and noise reduction, are adjustable with a few clicks.

Click on the panadapter display to move to the frequency of a signal. (Click on the virtual carrier frequency for SSB — the lower side for USB or upper side for LSB. Click on the center of the signal for non-SSB modes.) You can also click on the **MODE** button to display the mode choice.

Figure 8 — The *SCU-LAN10 Remote Control Software* controls frequency, mode, filters, noise reduction, AGC settings, and many other transceiver features and functions.

Slider controls are available for audio and RF gain. The spectrum scope display functions are accessed using the **S.MENU** button. The full function menu can be accessed using the **FUNC** button, but choices are limited to 15 of the 37 functions available on the FTDX101MP display (see Figure 9).

On-the-Air Experience

I made a few contacts on 20 meters using the SCU-LAN10 connected to the external IP address of my router, which means it was going out to the internet and returning, instead of directly accessing the LAN inside my home. The PC software worked flawlessly and showed the main and sub receivers with animated views of the meter, panadapter, waterfall, and other scope displays.

The controls responded quickly and positively without latency (delay). I was able to use PTT successfully, but VOX operation did not work until I discovered that the transceiver needed to be set for VOX operation from the rear-panel input instead of the microphone jack. This menu item is not accessible from the remote software screen; it has to be set on the transceiver display. Step-by-step instructions for making the correct settings are included in the document available from **www.arrl.org/qst-in-depth**.

Several of the ARRL Lab staffers connected to this system from their home or the office and were successfully able to view and change the displays and controls, and they used the FTDX101MP to listen and transmit. One of them, with a very limited bandwidth

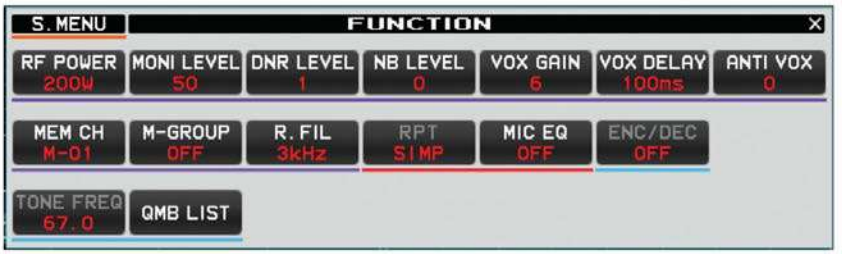


Figure 9 — The onscreen **FUNC** button in the *SCU-LAN10 Remote Control Software* accesses 15 of the 37 menus available on the FTDX101MP's display.

internet connection, was not able to get the scope displays to work and received a network error message, but was otherwise able to operate the radio remotely.

The **HELP** menu on the *SCU-LAN10 Remote Control Software* screen allows access to the installation and operation manuals by opening a PDF. This is very helpful if you are just learning how to use the system or have forgotten one of the finer points of operation.

Summary

The Yaesu SCU-LAN10 is a step in the right direction for compatible Yaesu transceivers. Although the SCU-LAN10 currently offers voice-only operation, a successor product or software version might be able to do more. If a way can be found to route the audio from soundcard application software application to the remote software, audio-based digital operation, such as FT8 or AFSK RTTY, could be carried out.

Additional remote features (such as operation on additional modes, and remote access to more of the transceiver's menu items) would be a benefit for Yaesu transceiver owners. Also, as mentioned previously, configuration and setup of the SCU-LAN10 could be less complicated.

This system does perform as advertised, allowing remote operation of companion transceivers within the limitations specified. I look forward to its evolution.

Manufacturer: Yaesu USA, 6125 Phyllis Dr., Cypress, CA 90630; **www.yaesu.com**. Price: $300.

bhi NES10-2 MK4 DSP Noise Cancelling Speaker

Reviewed by Mark Wilson, K1RO
k1ro@arrl.org

bhi offers a variety of DSP noise cancelling products. The NES10-2 MK4 is the fourth generation of bhi's compact speaker with active DSP features built-in. At about 2.5 × 4.3 × 2.2 inches (height, width, depth) and weighing about 12 ounces, this speaker could fit in just about any mobile or portable station. The NES10-2 MK4 can be used with the power turned off (no amplification or processing). When the power is turned on but the DSP function is turned off, it's a 5 W amplified speaker. Switch on the DSP filtering and you get adjustable noise reduction and automatic reduction of heterodynes or other tones.

Overview

This speaker is designed to connect to a transceiver's external speaker jack via an attached 6-foot cable with a monaural 3.5-millimeter plug. The manual cautions that headphone or line-level audio-output jacks may not provide an audio level high enough to drive the NES10-2 MK4. I found that it worked fine when connected to either the external speaker or headphone jack of my transceiver. Maximum input power is 5 W.

Bottom Line

The compact bhi NES10-2 MK4 DSP noise cancelling speaker effectively reduces noise and eliminates tones. It would be a good add-on to most transceivers, especially ones that don't provide these functions.

The NES10-2 MK4 comes with a mounting bracket and requires 10 – 18 V dc at 500 mA. A 5½ foot long, fused power cable is included. The **OFF/ON/DSP** switch on top powers the speaker and engages the DSP function. An **OUTPUT LEVEL ADJUST** control on the top is used to set the speaker volume to be the same with the power on or off. After the initial adjustment, use the transceiver's volume control during normal operation. The rear-panel **FILTER LEVEL** knob provides DSP level adjustment in eight steps (see Figure 10). There's a 3.5-millimeter monaural jack on the side of the speaker that provides headphone-level audio. The internal speaker is muted when headphones are plugged in.

The NES 10-2 MK4 is specified to reduce noise by 8 to 40 dB, and tones by up to 65 dB. There is no provision to perform the functions separately. An LED at the upper right behind the speaker grille glows red with power applied, and green when DSP is active. An LED on the left side flashes red if the audio input is too high.

Using the DSP Speaker

As mentioned in the instructions, there is a delay and audio click when you first power on the speaker. With DSP activated, in many cases there is a slight delay before the DSP starts processing signals and noise cancellation and tone reduction are applied.

With the processing turned off, the audio from the speaker sounded about the same as from the speaker in my transceiver. With the DSP feature engaged, the manual suggests starting with a **FILTER LEVEL** setting of 6 (30 dB of noise reduction). Depending on how you mount the speaker, you may find it difficult to access the **FILTER LEVEL** knob on the rear panel.

As with most adjustable DSP systems I have used, I found that settings in the mid range offered the best compromise between signal quality and noise elimination. There was still quite a bit of noise present at the lower settings. At the higher levels, I could hear more digital artifacts and distortion. The artifacts were most noticeable with no signals present, or during pauses in the other station's transmissions. With a signal present, the artifacts were much weaker. According to bhi, the DSP noise reduction operates by identifying whether or not speech is present in the signal. The filter level adjusts the amount of noise that passes through with the speech components.

The tone reduction capabilities worked well. It took the processor about a second to eliminate a single tone and slightly longer to eliminate two tones. It worked well with multiple tones of the same amplitude or different amplitudes. Because the tone reduction is not instantaneous, the noise reduction feature can be used with CW signals even though tone reduction cannot be turned off separately. Some DSP systems attack a tone quickly enough to suppress desired CW signals.

Figure 10 — The bhi NES10-2 MK4 rear panel. The knob in the center is for the eight-step **FILTER LEVEL** adjustment.

I didn't experience any RF interference to the speaker while transmitting. The manual includes a section with suggestions on what to do if that happens, including using ferrites on the speaker and power leads or trying a different power supply.

The noise reduction and tone reduction features of the NES10-2 MK4 are similar to those in my transceiver. If you have an older radio with DSP features, or one that does not feature built-in DSP noise and tone reduction, this speaker could make a noticeable improvement in listening comfort.

Manufacturer: bhi Ltd., P.O. Box 318, Burgess Hill, West Sussex RH15 9NR, England; **www.bhi-ltd.com**. US dealers for bhi products: DX Engineering (**www.dxengineering.com**) and GigaParts (**www.gigaparts.com**). Price: $170.

The Best of "The Doctor is In"

While the column undergoes retooling in order to keep bringing you practical technical advice, *QST* presents some of the best questions and answers from past issues, with thanks to the Doctor himself, Joel Hallas, W1ZR.

Q Mike, WA2VQW, asks: I have a 66-foot homebrew vertical monopole with 60 buried radials of random lengths. It is resonant at 3.6 MHz and works well. In the spirit of continuous improvement, I was wondering — if I increased the effective electrical length from ¼ to ⅜ wavelength by adding a capacity hat, would the pattern have a lower elevation pattern as if it were a longer antenna?

A This is an interesting question, because multiple configuration options are often unavailable. To get a handle on the question, I looked at three 80-meter monopole lengths; ¼, ⅜, and ⅝ wavelength, both as full-size vertical monopoles and as top-loaded antennas, with the loading at 64 feet, in the loaded cases.

While many would select the inverted **L**, or perhaps the old shipboard standard flat-top as a simpler way to provide the top loading, I chose an **X** configuration of four equal-length, equally spaced perpendicular horizontal loading wires to avoid the confusion of the directional results of the others due to the horizontally polarized component. The **X** is close to omnidirectional, so the results can be compared directly to those of the ¼-wave monopole.

Figures 1 through 3 show the *EZNEC* elevation pattern of the three full-length antennas, while Figures 4 and 5 show the elevation patterns of top loaded **X** configurations tuned to be resonant at the same frequencies as the ⅜-wave (2.4 MHz) and ⅝-wave (1.45 MHz).[1] The results of the five cases are summarized in Table 1. As noted in the captions, my modeled ground is not as good as your 60-radial system, so your absolute gain should be higher. If you had a perfect ground, it would be around 5 dB higher. Real life will be in between.

To conclude, while the top-loaded configurations add a bit to the intensity of the ¼-wave unloaded monopole, and reduce the peak of the elevation angle a bit, the physical length is clearly the most important consideration — size matters!

[1]Several versions of *EZNEC* antenna modeling software are available from developer Roy Lewallen, W7EL, at **www.eznec.com**.

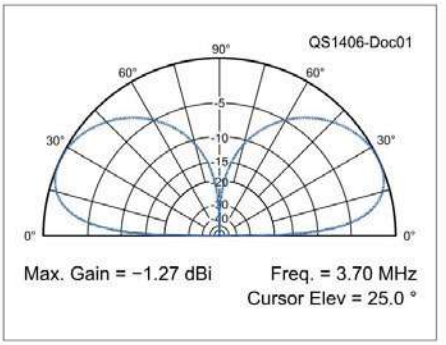


Figure 1 — Elevation pattern of a ¼-wave (64-foot) monopole over a radial field of eight buried ¼-wave radials in typical ground (conductivity 0.005 S/m, dielectric constant 13).

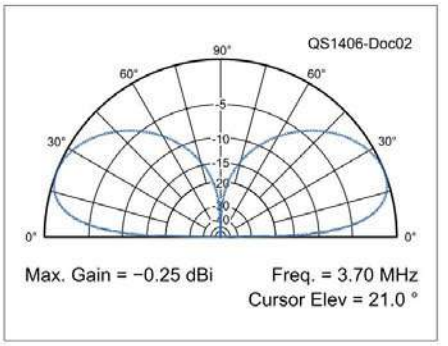


Figure 2 — Elevation pattern of a ⅜-wave (97.5-foot-high) monopole over the same ground system as in Figure 1.

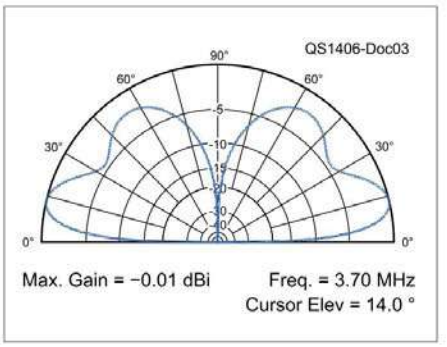


Figure 3 — Elevation pattern of a ⅝-wave (164.5-foot) monopole over the same ground system as in Figure 1.

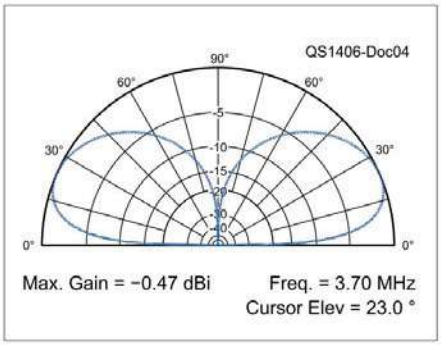


Figure 4 — Elevation pattern of a ⅜-wave electrical length (2.4 MHz resonance) 80-meter monopole formed by adding four perpendicular 12-foot horizontal capacity hat wires on top of the 64-foot monopole over the same ground system as in Figure 1.

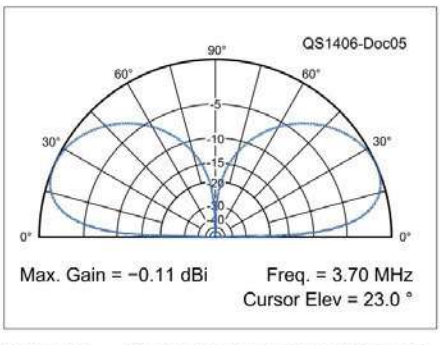


Figure 5 — Similar to Figure 4, but ⅝-wave electrical length (1.45 MHz resonance) 80-meter monopole formed by adding four perpendicular 44-foot horizontal capacity hat wires.

Table 1
Peak Gain and Elevation Angle of Five 80-Meter Monopoles

Configuration	Gain (dBi)	Peak Elevation Angle (°)
¼-wave monopole	–1.27	25
⅜-wave monopole	–0.25	21
⅝-wave monopole	–0.01	14
⅜-wave electrical top-loaded monopole	–0.47	23
⅝-wave electrical top-loaded monopole	–0.11	23

There are other considerations to take into account. First, while the ¼-wave monopole can generally be fed directly with 50 Ω coax, some form of matching network will be required for all other configurations. Matching networks add cost, as well as some loss, probably enough to negate any additional intensity in the loaded cases, although the elevation angle benefit will remain.

On the positive side, a top-loaded configuration, inverted **L**, flat top, or **X**, while not adding a lot to the 80-meter performance, will make the antenna work better on 160 meters, if that's in your plans.

Any of these antennas will provide a good account of themselves on 160 and 80 meters, if used with a good ground radial system and a tuner. The ¼-wave can also work well at low angles on 40 meters. All will work on higher frequency bands as well, but the radiation will tend toward higher elevation angles.

Q Larry, HK2LS, asks: Any idea what I can do to eliminate a noise that I hear throughout the spectrum from 1.8 to 30 MHz? The noise started recently and exists for about 3 days, then goes away only to return later. I don't know if it's an intermodulation product generated in my receiver or a spurious signal from a nearby short-wave broadcaster. If I disconnect the antenna the radio is silent.

A That is a key distinction, because the cure is quite different for the two cases. To find out, insert, say, 10 dB of attenuation in the front end of your receiver (many transceivers can do this with a front-panel button). If the signal is coming from outside on the receive frequency, it will drop by 10 dB, or almost 2 S-units. If it is a third-order intermodulation product generated from off-frequency signals mixing within your receiver, it will drop by 3 × 10 dB or 5 S-units (check your S-meter calibration on a known signal in the same band first).

If it is a signal on your frequency, about the only hope is one of the canceling type noise reduction devices, although you may get some relief by turning your beam to a null in the station's direction. You also could try to identify the signal source and let them know that they appear to have a transmitter problem.

If you are dealing with intermodulation distortion (IMD), and find that at least one of the signal sources is outside of the ham bands, you can keep all out-of-band signals out of your receiver through filtering. There are a couple of possibilities — one is an external band-pass filter, such as the bandswitching unit we reviewed in the June 2013 issue.[2] As noted in that review, the 20-meter filter has 50 dB of out-of-band rejection. You could also try a single band unit, such as we reviewed in June 2012. If you use a linear amplifier, you can put a 100 W filter between the transceiver and the amplifier.

Another possibility that your transceiver can make use of is the Yaesu VRF preselector option. That is really designed to eliminate nearby in-band signals, but it should also reduce the kind of out-of-band signals that will cause IMD. You can buy the unit with a single filter to see if it helps.

The one kind of IMD that none of these will help, and that is hard to track down, is intermodulation occurring in something not related to your receiver. For example, loose gutter connections can act like semiconductor mixers, resulting in undesired products of strong nearby signals that the gutter can radiate toward your antenna.

[2]H. W. Silver, NØAX, "Product Review — Array Solutions AS-419 Switched Band-pass Filters" *QST*, June 2013, pp. 52 – 53.

Do you have a question? Ask the Doctor! Send your questions to "The Doctor," ARRL, 225 Main St., Newington, CT 06111, or email your question to: **doctor@arrl.org**.

Listen to the archives of the *ARRL The Doctor is In* podcast on iTunes, Blubrry, Stitcher, or on the ARRL website at **www.arrl.org/doctor**.

Strays

QST Congratulates…

Bill Talanian, W1UUQ, who was honored to have the Santa Barbara Radio Club's (SBARC) primary communications facility, K6TZ, dedicated to him. The dedication recognized Talanian's efforts as club trustee for over 40 years, during which he forged partnerships with government agencies and helped obtain funding to build the facility. SBARC operates six linked communications sites throughout Santa Barbara County, California, each providing analog and digital amateur capabilities while gathering data for educators, researchers, and public safety groups from sensors, receivers, and webcams.

Technical Correspondence

Arduino Farnsworth Training, FT8 SNR Stats, and an Inexpensive Vacuum Coax Relay

Evaluating Receive Performance with FT8

Prior to the advent of modern digital modes such as FT8, successful communication mostly required signal amplitudes stronger than the received noise level. This relationship can be stated as a ratio of signal to noise (SNR).

One of the interesting aspects of operating FT8 is that stations send and receive objective SNR reports generated by the software. These are expressed in decibels (dB). Some believe that a negative SNR implies the signal is below the noise floor, but this is not the case. Received FT8 reports are referenced to a much wider noise bandwidth (2,500 Hz) than the actual detection bandwidth required to successfully decode the data. The smaller detection bandwidth drives the actual SNR.

Regardless, the SNR information gleaned from FT8 contacts can provide a glimpse of your overall station performance on a given band by comparing many individual reports over time. I reviewed my 160-meter FT8 SNR reports for the October to December 2019 period (see Table 1). As a refresher, a stronger signal has a smaller negative SNR. An SNR of –12 dB is 10 dB stronger than an SNR of –22 dB. Six dB is considered to be one S-unit.

As shown in Table 1, the sent SNR minus received SNR of my most distant contact of 5,024 miles yields +9 dB in the S – R column. I consider this positive 9 dB an indication of a favorable receive situation at my station. This result, along with others at 0 dB and above, are highlighted in green.

Of course, there are any number of variables in play, such as the equipment used at the opposite station, the noise levels at the opposite stations, and so forth. This type of comparison doesn't yield precise results, but it can certainly give you a sense of how well you're doing when it comes to reception. Note the abundance of green highlighting in Table 1, which I take to mean that while my station can always use improvement, on balance it is doing well — at least on 160 meters. I'd encourage others to make similar FT8 comparisons at their stations. — *73, Joe Ostrowski, KI5FJ,* **ki5fj@arrl.net**

Build an Affordable Vacuum Coax Relay

Innovations in DX and Contesting, LLC — a small amateur club of six members — operates an all-band contest station in Greenfield, Indiana. This station has been in operation for more than 10 years and we recently decided that we needed high-quality coax relays so we could safely switch some of our low-band antennas at the power levels generated by our amplifier. The amplifier in question can provide 1,500 W of output power on all bands through 6 meters.

Table 1
Signal-to-Noise Comparisons in Decibels Using FT8 on 160 Meters

Distance (Miles)	Entity	Sent	Received	S – R	Call Sign
5,024	Bulgaria	–12	–21	+09	LZ2WO
4,438	Lithuania	–15	–19	+04	LY1G
4,311	Finland	–14	–21	+07	OG2A
4,177	Germany	–18	–19	+01	DJ4MM
4,168	Balearic Isl	–16	–19	+03	EA6SX
4,165	Sweden	–17	–09	–08	SM2W
3,967	Belgium	–19	–19	+00	ON5CD
3,869	France	–10	–15	+05	F5II
3,862	Netherlands	–15	–16	+01	PA5KM
3,704	Mauritania	–06	–18	+12	5T5PA
3,680	Spain	–13	–15	+02	EA1ALE
3,556	Alaska	–24	–18	–06	WL7SJ
3,541	Scotland	–19	–18	–01	GM3YTS
3,441	Canary Isl	–11	–15	+04	EA8DO
3,329	Ireland	–09	–13	+04	EI4KF
2,788	Azores	–02	–12	+10	CU2AP
2,709	Ecuador	–08	–18	+10	HC2AO
2,550	Brazil	–16	–20	+04	PV8ABA
2,536	Suriname	–05	–12	+07	PZ5RA
2,231	Columbia	–07	–22	+15	HK3W
2,179	Greenland	–19	–06	–13	XP3A
1,944	Panama	–16	–07	–09	HP3AK
1,858	St. Lucia	–20	–01	–19	J68HZ
1,780	Mexico	–22	–10	–12	XE2YWH
1,737	Dominica	–24	–09	–15	J79WTA
1,493	US VI	–13	–15	+02	KP2BH
1,377	Puerto Rico	–08	–09	+01	WP4G
1,333	Dominican Republic	–22	–17	–05	HI8DL
1,250	Haiti	–16	–20	+04	4V1000
1,234	St. Pierre/Miquelon	–12	–04	–08	TO80SP

I've come to consider vacuum relays to be superior to open-contact relays for RF applications. Because their contacts are in a vacuum, arcing is limited. Also, these relays can handle extremely high RF voltages and considerable current.

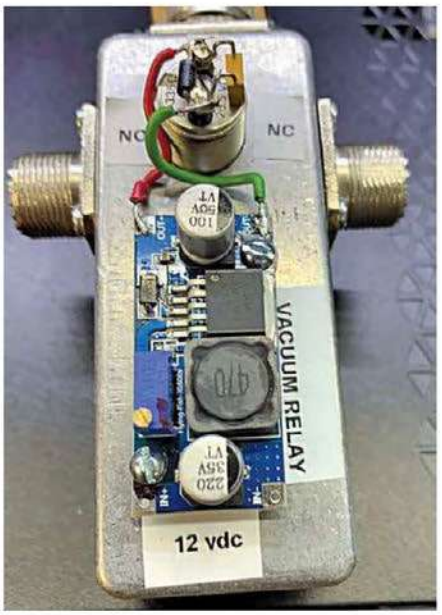


Figure 1 — The homebrew vacuum relay. The boost power converter board is visible atop the lower portion of the enclosure. In this application, it converts 12 V dc to 24 V dc to switch the relay (at the top of the enclosure). [Lyman H. Wolfla II, K9LZJ, photo]

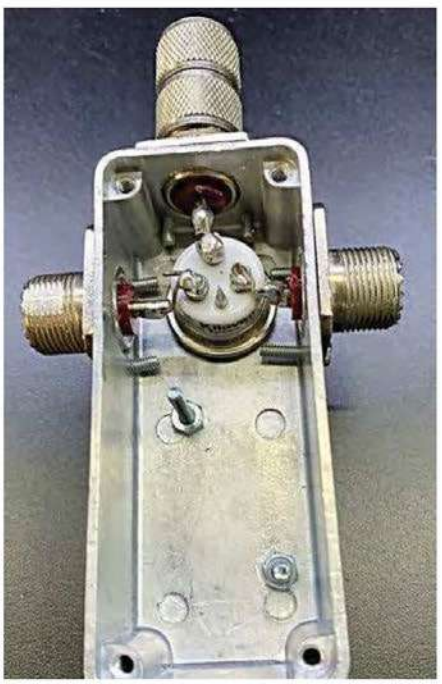


Figure 2 — An interior view of the enclosure, showing how the vacuum relay is attached to the RF ports. [Lyman H. Wolfla II, K9LZJ, photo]

The cost of a good-quality vacuum relay can be substantial, but there are units available on the surplus market at a significant cost savings, typically selling between $30 and $150. I was able to find coax relays that will handle 10,000 V and 8 A for $30 on eBay. However, these low-cost vacuum relays usually have coil voltages of 24 V dc, which tends to limit their use in the amateur world.

A solution presented itself in the form of a device known as a step-up boost power converter, which will take a voltage as low as 4 V dc and raise it to as high as 35 V dc or higher. These can be purchased on **Amazon.com** for less than $10. By using this device, a small aluminum box, and a high-quality vacuum relay, I've been able to build a coax switch with no measurable loss from 160 through 6 meters for under $50 (see Figures 1 and 2).

I've tested these relays with 1,500 W into a dummy load on 160 through 6 meters and saw no change in the SWR readings. Using the boost converter, the relay can be controlled with any dc voltage between 5 and 34 V. In this instance, I set it for 24 V. — *73, Lyman H. Wolfla II, K9LZJ/W9VW,* **hwolfla@gmail.com**

Adding Farnsworth Training to the AK3Y CW Trainer

In my November 2019 *QST* article, "A CW Trainer That Uses Custom Text," I described how to use an Arduino microcontroller to build a CW trainer. My goal was to help hams push the upper limits of their CW speeds by concentrating on decoding whole words and phrases rather than individual characters. According to the feedback I received, the trainer has worked well for that application.

Recently, however, I recognized the need for a modified approach. Our local repeater club initiated a weekly Zoom session to help new hams (or at least those new to CW) learn the code or improve their receiving and sending ability which, in most cases, was limited to around 5 WPM or less.

While the CW trainer described in my article could certainly be used to generate consistent code at slow rates, it was discovered over 70 years ago that transmitting each character at a high speed (for example, 20 WPM), but adjusting the character and word spacings such that the "effective" transmission rate is low (5 WPM), was a much better approach to CW learning. This technique was popularized in the late 1950s by Russ Farnsworth, W6TTB, (SK) whose name has since been associated with this CW training approach.

The C++ code for my CW trainer has now been modified to accommodate the Farnsworth training method. The modified Arduino sketch, *Morse Farnsworth.ino*, as well as new versions of the Morse library (including *Morse2.cpp* and *Morse2.h*) are available to download at **www.arrl.org/qst-in-depth**.

In the new Arduino sketch, you can select the individual character speed (ie, 20 WPM) and select the Farnsworth rate (5 WPM). The intra-character and intra-word spacings are then automatically adjusted to achieve the desired Farnsworth speed while sending individual characters at the higher rate.

To properly compile the new code, make sure to place *Morse2.cpp* and *Morse2.h* in its own folder inside the default library directory for your Arduino's IDE. — *73, Bob Fontana, AK3Y,* **ak3y@arrl.net**

Materials for this column may be sent to ARRL, 225 Main St., Newington, CT 06111; or via email to **tc@arrl.org**. Please include your name, call sign, complete mailing address, daytime telephone number, and email address on all correspondence. Whether you are praising or criticizing a work, please send the author(s) a copy of your comments. The publishers of *QST* assume no responsibility for statements made herein by correspondents.

Hints & Hacks

Sorting Parts with Magnets; Testing for a Hot Chassis; Rear Panel Access, and New Crystals for Old

Magnetic Parts Keeper

When working on radios, there are many covers and enclosures that must be removed to gain access to various circuits. Some are secured with machine screws, while others use sheet metal screws. Still others use various nuts, bolts, and washers. When you start to reassemble the radio, perhaps months later, it's difficult to remember which screw, nut, or bolt goes where.

I have used low-cost, low-strength magnets with great success in this regard. A single magnet is used to hold the fasteners to a specific internal cover, while non-magnetic screws (stainless or brass) can be placed in a metal jar lid with a magnet. The magnet is strong enough to hold the lid to the cover, so there's no question as to what parts go where. The magnets shown in Figure 1 were sold in units of 10 for $1 at a local bargain store. — *73, Al Rabassa, NW2M,* **arabassa@comcast.net**

The Hot Chassis Test

If you have older equipment with two-prong non-polarized ac cords, you could have a dangerous situation on your hands. A quick safety test is to hold a non-contact voltage tester (NCVT) near the metal case with the unit plugged into an active wall outlet. If the NCVT alarms (see Figure 2), the chassis is electrically hot. Try reversing the plug in the outlet and rechecking the chassis with the NCVT. It should indicate that the chassis is safe. You'll find NCVTs for sale online and at hardware outlets for less than $20 – 30.

For a temporary fix, attach a polarized "cheater" plug (see Figure 3), so the unit can only be plugged into an outlet in the correct polarity. Plan on changing to a hardwired polarized cord (or better yet, a three-pronged grounded cord) soon. — *73, Ruth Ring, KJ1V,* **kj1v@arrl.net**

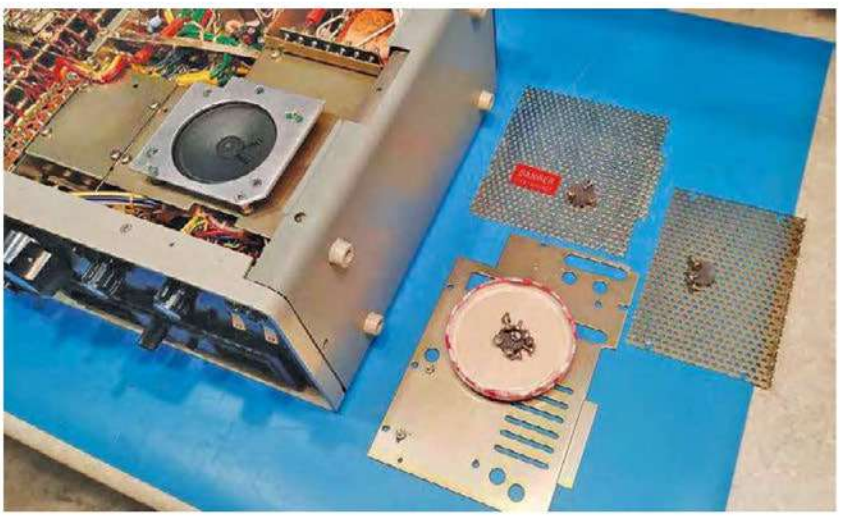


Figure 1 — During disassembly, an inexpensive magnet can keep fasteners attached to the pieces they belong to. [Al Rabassa, NW2M, photo]

Figure 2 — This non-contact voltage tester is glowing red to warn of an electrically hot case. [Ruth Ring, KJ1V, photo]

Figure 3 — A polarized "cheater" plug offers a temporary solution for making sure the equipment can only be plugged into an ac outlet in the correct position. [Ruth Ring, KJ1V, photo]

Figure 4 — A rotating tray is an affordable, easy way to access the rear panels of equipment when necessary. [Roberto Sadkowski, AJ6CY, photo]

Figure 6 — After the components are removed from the old crystal case and replaced with the new crystal, solder the leads of the new crystal to the internal leads of the case. [Joe Scoglio, KA4WJB, photo]

Rotating Heavy Equipment

I recently acquired a 500 W amplifier and antenna tuner. Together they weigh around 40 pounds. The equipment is located on a shelf at about 4 feet high. Every time I needed to add or modify a connection to the back panel, it was a strain to lift the equipment, rotate it, and access the connectors.

I figured a heavy-duty rotating tray (also called a "Lazy Susan") would allow me to rotate the equipment with ease. I found one in an online store that was rated for 150 pounds. The weight is supposed to go in the center of the plate, but it was robust enough to withstand the load even with the weight distributed to its legs. Now I can easily rotate the equipment and reach the back panels when needed. — *73, Roberto Sadkowski, K6KM,* **rsadkowski@gmail.com**

Repurposing Crystals

I enjoy operating several old ham transmitters that require FT-243 style crystals. However, I can never seem to find enough crystals with FT-243 holders at the frequencies I want. I did have some old crystals that weren't at ham frequencies (see Figure 5), so I decided to retrofit their holders with modern crystals at the frequencies I needed.

Figure 5 — Old crystals are available, but most aren't at frequencies within the amateur bands. [Joe Scoglio, KA4WJB, photo]

Figure 7 — The old crystal case is relabelled with the new frequency. [Joe Scoglio, KA4WJB, photo]

The first step is to remove everything from the interior of the old case (see Figure 6). Next, solder the new crystal onto the two internal pins and replace the cover. Finally, relabel the case with the new frequency (see Figure 7). This retains the vintage crystal look while providing crystals at frequencies I need. This approach also saves the trouble of building socket adapters. — *73, Joe Scoglio, KA4WJB,* **ka4wjb@gmail.com**.

"Hints and Hacks" items have not been tested by *QST* or ARRL unless otherwise stated. Although we can't guarantee that a given hint will work for your situation, we make every effort to screen out harmful information. Send technical questions directly to the hint's author.

QST invites you to share your hints with fellow hams. Send them to "Attn: Hints and Hacks" at ARRL Headquarters, 225 Main St., Newington, CT 06111, or via email to **hh@arrl.org**. Please include your name, call sign, complete mailing address, daytime telephone number, and email address on all correspondence. Whether you are praising or criticizing an item, please send the author(s) a copy of your comments.

Feedback

In the "Eclectic Technology" column published in the March 2021 issue of *QST*, we included an image of the *WSJT-X* software application that appeared to show FST activity on 6 meters. Despite the frequency display shown in the image, the activity was actually taking place on the 2200-meter band.

Steve Ford, WB8IMY, wb8imy@arrl.net

Eclectic Technology

CATSync

If you use CAT (computer-aided transceiver) control at your station, you may be interested in a Windows application created by Oscar Diez, DJ0MY.

In previous "Eclectic Technology" columns (and in an episode of the Eclectic Tech podcast), I've discussed the proliferation of web-accessible software-defined receivers. These are radios that individuals — amateur radio operators and otherwise — have established online for anyone to use, free of charge. Depending on the radio, the frequency coverage often ranges from LF to 10 meters, with some including VHF and UHF as well. A typical remote site can accommodate many simultaneous listeners.

There are hundreds of these web radios scattered throughout the world and you can access any of them through websites like WebSDR, at **www.websdr.org**. I enjoy using the remote radios for station tests. It is fascinating to listen to yourself, albeit with a slight delay, from hundreds and even thousands of miles away.

CATSync

With *CATSync*, you might say Oscar has taken the next logical step in remote receiver control. Rather than relying on a keyboard and mouse, the application allows you to link a remote receiver to your own CAT-enabled transceiver. Once a connection is established, when you spin your VFO, the frequency changes at the remote receiver as well. If you switch bands, it follows. If you change modes from, say, CW to SSB, the remote receiver does too.

I know of a few net-control operators who've discovered *CATSync* and use it when they have difficulty hearing distant stations. They'll operate normally with their transceiver, but occasionally switch to a remote receiver to pick up a weaker station they can't otherwise copy.

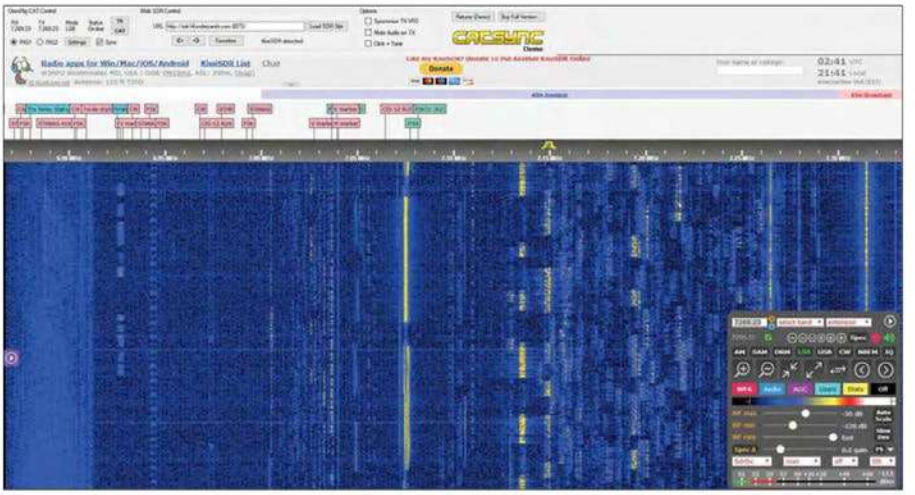


Figure 1 — Listening to 40-meter SSB through the W3HFU receiver in Maryland from my station in Connecticut. Thanks to *CATSync*, when I change the frequency of my transceiver's VFO, the frequency at the W3HFU receiver changes as well.

Installation

If you want to try *CATSync*, the first step is to download and set up the free *Omni-Rig* CAT software, available at **dxatlas.com/omnirig**. On the *Omni-Rig* page, you'll find a lengthy list of supported transceivers.

Once you've confirmed that *Omni-Rig* is working with your transceiver, you can go to the *CATSync* site at **catsyncsdr.wordpress.com** and download the demo version of the program.

CATSync works somewhat like a web browser in that you need to type or paste the address of your chosen receiver into its URL window. For example, you'll find another large list of remote receivers at KiwiSDR at **kiwisdr.com/public**. Choose a receiver and copy its URL into *CATSync*. The application will establish the connection and, if all goes well, the remote receiver interface will appear and will be set to the frequency shown in your transceiver's VFO display (see Figure 1). You should hear the remote audio through your computer speakers at the same time.

As you change frequency or mode at your transceiver, the remote receiver will respond in kind. The reverse is also true; if you change the frequency or mode of the remote receiver, your transceiver will reflect those changes as well.

The click-and-tune functionality of the demo version of *CATSync* is limited to only 3 minutes per session. In the demo version, you may also notice that when you adjust your transceiver VFO, the remote receiver indicates the frequency change, but you still hear only the signals that were present at your initial frequency.

The demo version mainly allows you to verify that *CATSync* is functioning and that commands are being passed back and forth. If you want full functionality, you'll have to purchase the registered version of *CATSync* for 9.95 Euros (US $12.06 when this column was written).

What to Expect During the Rising Years of Solar Cycle 25

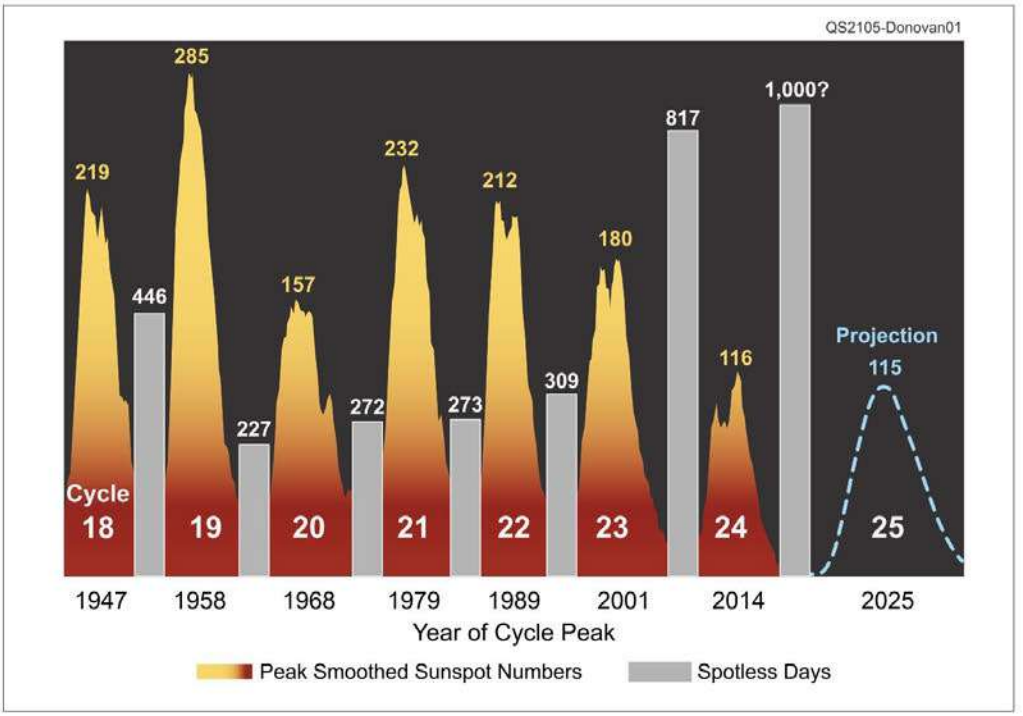
Some predictions for how the next 4 years of the solar cycle will affect HF propagation.

Frank Donovan, W3LPL

Solar Cycle 25 is affecting HF propagation in unexpected ways since we reached the solar minimum of Cycle 24 in December 2019. The next 4 years, which include Cycle 25's rise to solar maximum, will provide many opportunities to enjoy greatly improved HF DX propagation, especially with effective antennas for 30 through 10 meters, which benefit most from increasing sunspot activity.

My own experience on HF began 1 year after Cycle 19's solar maximum in 1958. However, I wasn't able to participate in the best HF propagation in history because I couldn't make contacts beyond a few hundred miles on 80 meters with my 35-foot wire antenna. Listening to the locals snagging DX all over the world on 10 meters convinced me that I, too, could enjoy DXing if I had better antennas. Several local hams helped me erect some simple horizontal dipoles and soon I was making contacts around the globe, earning DXCC in just 1 year.

After experiencing several solar cycles, I began to understand that each one has its own personality, and they always defy prediction. Higher smoothed



Solar cycles since 1945. This chart illustrates downward trends in sunspot activity, upward trends in spotless days, double peaks at solar maximum, and the National Oceanic and Atmospheric Administration's (NOAA) Solar Cycle 25 forecast as a blue dashed line. [Graphic courtesy of the Sunspot Index and Long-term Solar Observations, Royal Observatory of Belgium]

Table 1

Solar Cycle	SSN at 12 Months	SSN at 24 Months	SSN at 36 Months	Months to Solar Max.	Solar Cycle Duration in Years
18	40	112	204	39	10.2
19	33	168	256	47	10.5
20	28	96	134	49	11.4
21	29	99	193	45	10.5
22	45	161	210	38	9.9
23	34	93	143	63	12.3
24	13	42	92	64	11.0

Source: Sunspot Index and Long-term Solar Observations, Royal Observatory of Belgium

Table 2

Solar Max. Year	Solar Min. Year	Spotless Days Between Solar Cycles	Last Month with 10+ Spotless Days Post-Min.
1947	1954	446	8 months
1958	1964	227	9 months
1968	1976	272	8 months
1979	1986	273	5 months
1989	1996	309	11 months
2001	2008	817	18 months
2014	2019	1,000?	14 months so far

Source: Sunspot Index and Long-term Solar Observations, Royal Observatory of Belgium

sunspot numbers (SSNs) indicate improved HF propagation, and a large number of spotless days (with no sunspots at all) often indicate a precursor of a weak solar cycle to follow.

Forecasts and Trends

At least 70 forecasts for Cycle 25 have been published in scientific journals, predicting everything from a very weak to a very strong cycle. The respected National Oceanic and Atmospheric Administration (NOAA) forecast, as well as most other forecasts, anticipates Cycle 25 to be similar to Cycle 24. Referring to Tables 1 and 2, Cycle 24 had low SSNs during its rise to solar maximum compared to other cycles, as evidenced by its SSNs at 12, 24, and 36 months after solar minimum. Cycle 24 took 64 months to reach solar maximum — longer than any cycle since 1945. The sun recently produced more spotless days than usual during the thirteenth and fourteenth months after solar minimum. The Sunspot Index and Long-term Solar Observations (SILSO) World Data Center at the Royal Observatory of Belgium anticipates up to 1,024 spotless days before the transition to Cycle 25 completes, likely before the end of 2021.

A Brief Introduction to Cycle 25

Cycle 25 produced 180 spotless days and some occasional weak sunspots through October 2020. The weak sunspots had little effect on HF DX propagation, as evidenced by the 10.7-centimeter solar flux index (SFI), never exceeding 75 SFI until late October. SFI is the most widely used short-term indicator of increased sunspot activity that improves HF propagation.

Fortuitously, 17 sunspots suddenly appeared in a new solar region just as the November CQ World Wide CW DX Contest began, an exceptionally rare event for the opening year of any solar cycle. The SFI reached 110 during the first day of the contest — the highest in more than 3 years — and stayed above

100 through early December 2020. Enhanced sunspot activity greatly improved propagation throughout the contest, providing worldwide 15-meter propagation from sunrise until sunset, and opening 10 meters to most of the world for many hours during both contest days. Excellent 30- through 10-meter DX propagation occurred for many hours every day until the active region rotated to the back of the sun on December 6. The region again rotated onto the sun's visible disk in late December, enhancing 30- through 12-meter DX propagation for several hours a day through early January 2021. The region made a rare third appearance in late January, but with very low sunspot activity.

A Slow Start in 2021

The SFI hasn't exceeded 78 and has been mostly below 74 since January 6, much lower than the corresponding months of Cycle 24. Only a few weak sunspots having little effect on HF propagation have appeared from early January through at least March 7, 2021. No sunspots showed for 20 days in a row from January 28 to February 17, which was unusual during the corresponding months of any solar cycle.

Cycle 25 sunspots strong enough to improve HF propagation have so far appeared only in the sun's southern hemisphere, a condition known as hemispheric asymmetry, which has caused double peaks during every solar maximum since 1958. Based on similar weak solar cycles, Cycle 25 is likely to rise more rapidly later this year when the more active solar southern hemisphere influences increased sunspot activity in the northern hemisphere.

Improved Propagation This Fall

The bands 160 – 40 meters are likely to remain unchanged, while 30 meters should improve during nighttime hours, as should 20 meters during the hours after sunset. Seventeen meters is likely to greatly improve, while 15 meters is likely to have more frequent excellent DX propagation, interspersed with weaker propagation. DX on 12 and 10 meters will probably remain spotty and unreliable, but look for 6-meter sporadic-E propagation every day during June and July in northern hemisphere temperate zones, owing to infrequent geomagnetic disturbances in the early years of Cycle 25 and low geomagnetic activity typical of June and July.

Improving Propagation in 2022 and Beyond

Improved propagation in 2022 will depend on upward trending sunspot activity during 2021. Propagation improvement during 2023 similarly depends on increasing sunspot activity during 2022. If the SFI persists below 90 through December 2021, then propagation should improve gradually until a solar maximum weaker than Cycle 24's arrives in 2025. If the SFI persists above 100 through December, then propagation is likely to rapidly improve until a solar maximum similar to Cycle 24's arrives in 2025. If the SFI persists above 125 through December, then propagation is likely to improve more rapidly until a solar maximum stronger than Cycle 24's arrives in 2025.

Be Prepared for Cycle 25

Prepare to capitalize on propagation opportunities when they're available. It's crucial to have effective antennas for 30 through 10 meters, the bands that benefit the most from increased sunspot activity. Even simple antennas such as horizontal dipoles can be very effective DX antennas. Learn to use propagation tools such as the Reverse Beacon Network (RBN) that help you identify every DX opportunity, no matter how brief. Proficiency with popular digital modes such as FT8 will greatly add to your DXing success. Most importantly, enjoy the greatly improved DXing opportunities during Cycle 25. They've been a long time coming!

Frank Donovan, W3LPL, began his ham radio journey at 12 years old, during the W1OP/1 Providence Radio Association 1959 ARRL Field Day. His multioperator, multitransmitter DX contest teams have completed more than one million contacts in the CQWW and ARRL DX contests. He retired 10 years ago as a Chief Engineer at General Dynamics, after a 45-year career in electronics and systems engineering. Frank can be reached at **donovanf@erols.com**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

US Amateur Radio Bands

Operator license classes: **E** = Amateur Extra **A** = Advanced **G** = General **T** = Technician **N** = Novice
CW operation is permitted throughout all amateur bands. Except as noted, all frequencies are in megahertz (MHz).

= RTTY, data, phone, image = USB phone, RTTY, data and CW = RTTY and data = phone and image
= SSB phone = CW only

LF – Low Frequency band

2200 Meters (135 kHz) E,A,G

1 W EIRP maximum

135.7 kHz — 137.8 kHz

MF – Medium Frequency bands

630 Meters (472 kHz) E,A,G

5 W EIRP max, except in Alaska within 496 miles of Russia where the limit is **1 W EIRP**

472 kHz — 479 kHz

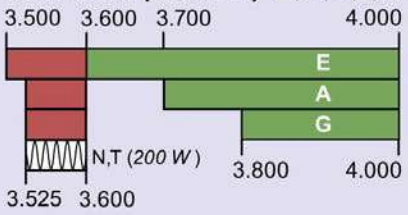
160 Meters (1.8 MHz) E,A,G

1.800 — 1.900 — 2.000 MHz

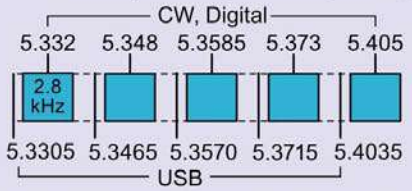
Amateurs wishing to operate on **2200 or 630 meters** must first register with the Utilities Technology Council online at **https://utc.org/plc-database-amateur-notification-process/.** You need only register once for each band.

HF – High Frequency bands

80 Meters (3.5 MHz) E,A,G,T,N

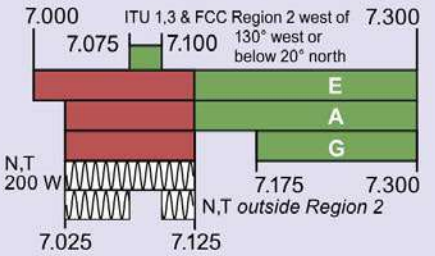


60 Meters (5.3 MHz) E, A, G (100 W)



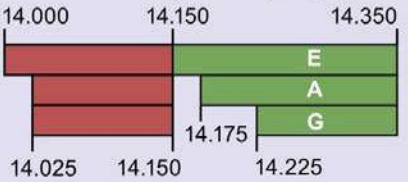
Gen, Adv, and Extra licensees may operate on a secondary basis with a maximum ERP of 100 W maximum.

40 Meters (7 MHz) E,A,G,T,N

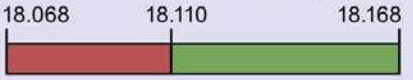


30 Meters (10.1 MHz) E,A,G

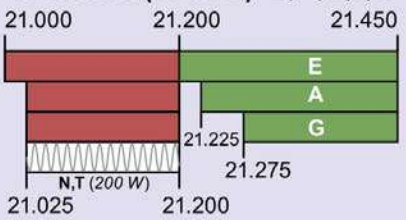
20 Meters (14 MHz) E,A,G



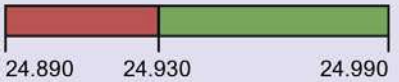
17 Meters (18 MHz) E,A,G



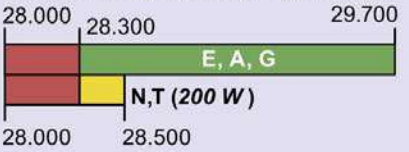
15 Meters (21 MHz) E,A,G,T,N



12 Meters (24 MHz) E,A,G



10 Meters (28 MHz) E,A,G,T,N

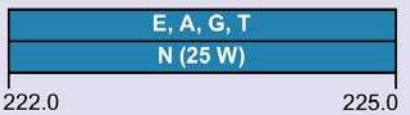


VHF – Very High Frequency bands

6 Meters (50 MHz) E,A,G,T

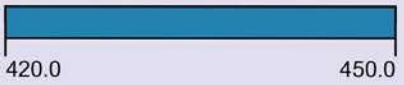
2 Meters (144 MHz) E,A,G,T

1.25 Meters (222 MHz) E,A,G,T,N

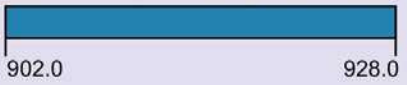


UHF – Ultra High Frequency bands

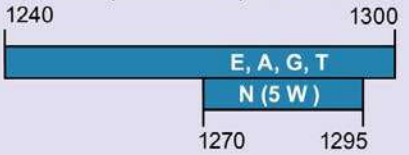
70 cm (420 MHz) E,A,G,T



33 cm (902 MHz) E,A,G,T



23 cm (1240 MHz) E,A,G,T,N



SHF&EHF – Super and Extremely High Frequency bands

All licensees except Novices are authorized all modes on the following frequencies:

2300-2310 MHz	3300-3500 MHz	10.0-10.5 GHz	47.0-47.2 GHz	122.25-123.0 GHz	241-250 GHz
2390-2450 MHz	5650-5925 MHz	24.0-24.25 GHz	76.0-81.0 GHz	134-141 GHz	All above 275 GHz

See www.arrl.org/band-plan for detailed band plans.

OTAbands **rev. 1-22-20**

Green Roving in a Red Rover

My 2020 Chevy Bolt has been outfitted with the same microwave toolbox station used on a gasoline-powered car with a V8 engine. The station covers all bands from 6 meters to 10 GHz.

VHF roving with no carbon footprint.

Wayne Overbeck, N6NB

Though I've roved for a long time, I have to admit that I haven't been very "green" about it for most of that time. Even before roving was recognized as a category in ARRL VHF contests, I was operating portable on mountaintops with cars and trucks that consumed gasoline as if there were an endless supply and spewed out exhaust gases as if air pollution didn't matter.

For years I drove large Ford and Chevy vans and trucks coast-to-coast on amateur radio VHF expeditions, giving little thought to fuel consumption. The most efficient of those vehicles delivered about 14 miles per gallon — even less when towing a tower trailer.

A New Way to Rove

By 2020, electric cars became practical for roving. Tesla's all-electric cars have good reviews for their performance and style. The high-end models have an EPA-rated cruising range of around 400 miles, earning well over 100 MPGe (miles per gallon gasoline equivalent). These cars have no carbon footprint.

This console controls the 10-band toolbox setup on the roof, providing instant band-switching. There's also a transceiver for straight-through operation on 6 meters, 2 meters, and 432 MHz, and acts as the IF for all bands above 902 MHz.

Almost every other manufacturer is rushing to challenge Tesla in the all-electric marketplace, encouraged by state and federal rebate programs and incentives to get people to switch to Earth-friendly cars. There are also ways to recharge these cars using clean electrical power sources.

More than one million all-electric cars have been sold worldwide, and that number is growing rapidly. The big obstacle for most potential electric-car buyers has always been limited range and the difficulty of recharging the main battery away from home. But many manufacturers now offer modestly priced electric cars with a cruising range of well over 200 miles, and there are charging stations along all the major highways. For more information, read *Energy Choices for the Radio Amateur: Your Power Sources in the 21st Century* by Bob Bruninga, WB4APR, available for purchase at **www.arrl.org/shop/Energy-Choices-for-the-Radio-Amateur**.

I decided to purchase a 2020 Chevy Bolt EV Premier with built-in side rails on the roof designed for mounting a platform. I doubt General Motors' target market was hams wanting to mount a 10-band microwave station on the rooftop for roving in VHF contests, but that's what sold me, so I set out to turn it into a rover. It was my project during the start of COVID-19.

Charging and Discharging

The Chevy Bolt is a subcompact crossover vehicle. Its EPA-rated range is 259 miles, but I quickly discovered that by driving conservatively I could make this little car go considerably further than that on one charge. I also found I could bypass all the charging stations (some free, some not) and park in a friend's driveway to recharge more than 225 miles from home as easily as I could recharge at home.

I immediately bought a level 2 EV charger that runs on 220 V and will recharge an electric vehicle (EV) overnight. Note that a qualified electrician may have to adjust the typical household 30 A clothes dryer 220 V circuit (NEMA 10-30). Most level 2 EV chargers are designed to draw 32 A and use a 50 A power plug (NEMA 14-50). The level 1 EV charger that comes with most electric cars will recharge the vehicle on 110 V, but that can take up to 48 hours. If you're on the road and want to recharge in a hurry, there are plenty of level 3 EV chargers in public places. How quickly one of those will recharge your EV depends on the car's built-in, high-voltage charging system. The Chevy Bolt owner's manual says it's possible to recharge to 80% of capacity in less than 1 hour, but I've found that it takes longer (up to 3 hours).

The Chevy Bolt main battery pack is a lithium polymer-based system and isn't lightweight. The one in a 2020 Chevy Bolt is a 66 kW hour, 344 V beast that occupies almost the entire subfloor of the vehicle and weighs about 1,000 pounds. The result is a subcompact SUV that weighs almost 4,000 pounds before amateur radio equipment and antennas are mounted. With that being said, it handles well, has surprising acceleration, and has a relatively high top speed. The center of gravity is

Inside the car is a 10-band station with a Vivaldi antenna that covers 900 MHz through 12 GHz. It includes small power amplifiers for all bands 2.3 GHz and up and has performed well on long paths with only the wideband antenna aimed out a car window on the microwave bands. The radio equipment is powered by two 100 Ah lithium iron phosphate batteries on the floor.

so low that I had no concerns about mounting a platform, an antenna rotator, and a stack of VHF+ antennas on the roof.

When it comes to powering a ham radio station in the car, some hams have used the 12 V auxiliary battery that's there to power accessories. It's recharged from the high-voltage battery, at the price of reduced range. Some amateurs have viewed the main battery as a gigantic portable Hoover Dam for running ham gear during Field Day. You can arrange to monitor the auxiliary battery's voltage as it declines and restart the car to recharge the auxiliary battery every time it gets too low (read "Electric Vehicle Power for ARRL Field Day" by Janelle Brisbine, NØMTI, in the June 2019 issue of *QST* for more information). If you're not far from home or another EV charging point, that will work fine. For a rover on a long trip, however, that's not a good idea. Additionally, don't hook anything up to the auxiliary battery or the high-voltage battery. If anything should go wrong with the car's electrical system, your ham gear will give the dealer an excuse to disallow the warranty.

My solution to power radios, transverters, amplifiers, and a 110 V inverter for an antenna rotator was a pair of 100 Ah, 12 V lithium iron phosphate batteries. They weigh less than half of what you might expect if you've ever lifted a lead-acid automotive battery of the same physical size, and with their built-in battery management system, they're easy and safe to recharge on any 14 V power source. Two of them fit easily on the passenger side floor and can be wired in parallel to run a VHF+ radio station for an entire weekend. They stay over 12 V until they're almost completely discharged and if you run them down, a few hours with an ac powered 12 V supply will recharge them.

Platform Design

The Chevy Bolt's built-in side rails each have four threaded rivets (thread size M6-1.0). I made four brackets of 2-inch aluminum angle stock that are ⅛-inch thick and 175 millimeters long. I mounted stainless U-bolts on the brackets to secure two 1½-inch aluminum 0.058-inch wall tubes that serve as crossbars. Those support the rotator bracket. An antenna rotator is very desirable for aiming highly directional microwave antennas, but it could be omitted by someone intending to use only short VHF antennas and aim them by turning the car.

I wanted to have a platform similar to those on many other vehicles used for VHF+ roving. Over the years, I've built quite a few 10-band rover stations. Seven of them are toolbox stations and all of them can be mounted interchangeably on the rotators on various cars' rooftop platforms. Carrie Tai, W6TAI, used a toolbox station for many years atop an Infiniti FX50 with a 390 hp V8 engine and shocking gasoline consumption numbers. It seemed only fitting to mount that station atop an electric car that uses no gasoline at all.

The Chevy Bolt is also well suited for newer 10-band rover stations where all microwave antennas are mounted atop an equipment console on the passenger seat inside the car with the antennas aimed

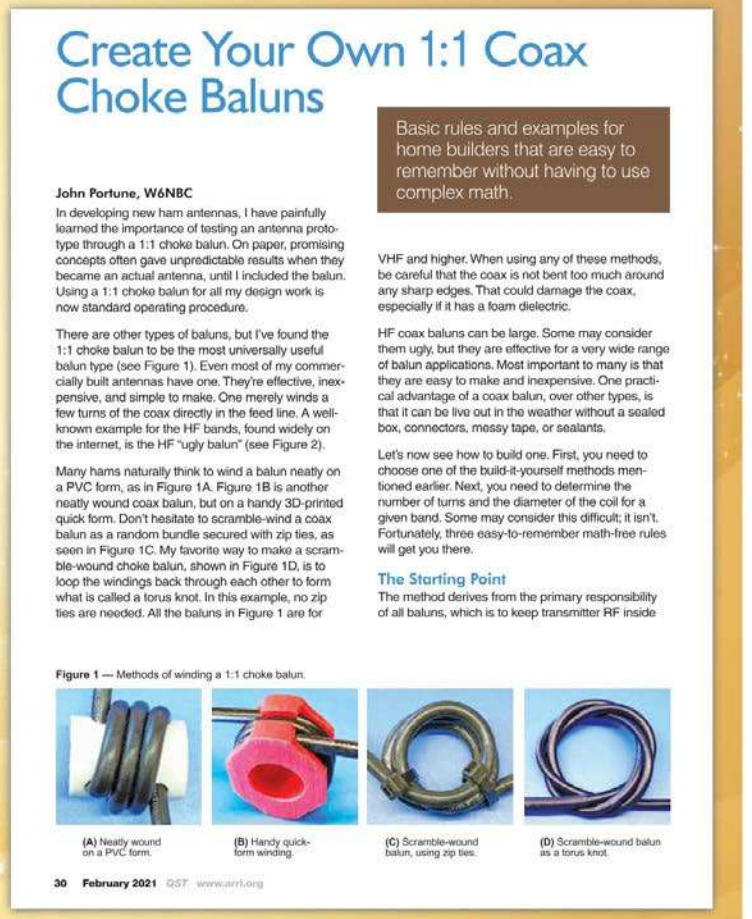
out the passenger window (visit **http://n6nb.com/small_10_band_rovers_with_up_to_seven_transverters.pdf** for more information). Only antennas for bands 6, 2, 222, and 432 go on the roof in that kind of installation. That approach is greener due to less wind load (and less wind noise) on the roof. Some might even skip the rooftop antennas altogether.

Some cars generate enough RF noise that operating mobile in motion can be difficult. To test the Chevy Bolt for that problem, I mounted a motorized multiband mobile antenna on a bracket attached to the roof rail. Noise seemed minimal on 20 and 40 meters, except during the regenerative braking process. Usually outside noise from various sources exceeds noise generated by the car, but when braking was used to help recharge the main battery, several S-units of extra noise appeared (enough to mask weak signals). That problem might be even more severe if a mobile antenna were mounted lower on the car body instead of at roof level.

With or without rooftop antennas, an electric car can do just about everything a gasoline-fueled rover can do, but with zero pollution and dramatically better energy efficiency. With careful route planning, the one remaining drawback of an electric car (delays during recharging) can be overcome as charging stations at travel stops and hotels become more plentiful.

Wayne Overbeck, N6NB, was first licensed in 1957, and has been roving and mountain topping in ARRL VHF contests ever since. He has won at least an ARRL Division-Leader Certificate in a VHF contest in seven different decades (since the 1960s), with one or more national first-place finishes in more than 40 VHF contests, and was the 1980 Radio Amateur of the Year at Dayton Hamvention®. Wayne is a retired attorney and professor of communications at California State University, Fullerton. He holds a PhD from the University of California, Los Angeles, and a JD from Loyola Law School. Wayne is the author of 20 editions of the college textbook, *Major Principles of Media Law*. He can be reached at **woverbeck@fullerton.edu**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.



Create Your Own 1:1 Coax Choke Baluns

Basic rules and examples for home builders that are easy to remember without having to use complex math.

John Portune, W6NBC

In developing new ham antennas, I have painfully learned the importance of testing an antenna prototype through a 1:1 choke balun. On paper, promising concepts often gave unpredictable results when they became an actual antenna, until I included the balun. Using a 1:1 choke balun for all my design work is now standard operating procedure.

There are other types of baluns, but I've found the 1:1 choke balun to be the most universally useful balun type (see Figure 1). Even most of my commercially built antennas have one. They're effective, inexpensive, and simple to make. One merely winds a few turns of the coax directly in the feed line. A well-known example for the HF bands, found widely on the internet, is the HF "ugly balun" (see Figure 2).

Many hams naturally think to wind a balun neatly on a PVC form, as in Figure 1A. Figure 1B is another neatly wound coax balun, but on a handy 3D-printed quick form. Don't hesitate to scramble-wind a coax balun as a random bundle secured with zip ties, as seen in Figure 1C. My favorite way to make a scramble-wound choke balun, shown in Figure 1D, is to loop the windings back through each other to form what is called a torus knot. In this example, no zip ties are needed. All the baluns in Figure 1 are for VHF and higher. When using any of these methods, be careful that the coax is not bent too much around any sharp edges. That could damage the coax, especially if it has a foam dielectric.

HF coax baluns can be large. Some may consider them ugly, but they are effective for a very wide range of balun applications. Most important to many is that they are easy to make and inexpensive. One practical advantage of a coax balun, over other types, is that it can be live out in the weather without a sealed box, connectors, messy tape, or sealants.

Let's now see how to build one. First, you need to choose one of the build-it-yourself methods mentioned earlier. Next, you need to determine the number of turns and the diameter of the coil for a given band. Some may consider this difficult; it isn't. Fortunately, three easy-to-remember math-free rules will get you there.

The Starting Point

The method derives from the primary responsibility of all baluns, which is to keep transmitter RF inside

Figure 1 — Methods of winding a 1:1 choke balun.

(A) Neatly wound on a PVC form. (B) Handy quick-form winding. (C) Scramble-wound balun, using zip ties. (D) Scramble-wound balun as a torus knot.

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The ARRL Ham Radio Equipment Insurance Plan

This policy covers radios and related equipment, with a lower deductible than most homeowners policies.

Jen Glifort, KC1KNL

There are all kinds of ways to lose valuable gear in an instant. ARRL offers a ham radio equipment insurance plan as a benefit to members. Through this insurance, members can cover all of their equipment at a low price and ease their fears.

The insurance coverage available to ARRL members can help safeguard your equipment in the event of theft or damage. [Photo courtesy of Matt Burt, KFØQ]

Tom McDonough, Senior Vice President of Risk Strategies Insurance, Inc., is the broker and administrator for this policy with ARRL. He said, "The equipment insurance policy covers your radio equipment and all related equipment — whether you include computers, portable gear, miscellaneous cables and accessories, handhelds, etc."

The insurance covers mobile and home station equipment from damage by fire, lightning, wind, collisions, theft, and other accidents or natural hazards. It also covers loss or damage to antennas, towers, and rotators.

ARRL Insurance Plan vs. Homeowners Policies

Tom explained how the ARRL insurance plan compares to homeowners policies:

> The premium is based on a rate well below typical homeowners policy rates, and the deductible of $50 to replace and $25 to repair, is far below the deductible on most homeowners policies. Your homeowners policy is protecting you from a major economic loss — such as a fire — to your home. That is why most homeowners policies have minimum deductibles of $500 per claim. You can save premium by having a $1,000 deductible on your homeowners policy, and even more if you raise it to $2,500 or higher. This will save you on premium costs while still protecting you from the catastrophic loss due to a fire or a tree collapse. The downside of that is your radio transceiver or other station equipment can be worth less than the homeowners deductible, and if lightning strikes, burning out the equipment, you could be faced with a significant expense to replace the equipment and get back on the air. Insuring the equipment in the ARRL program will save you premium on your homeowners policy and give you coverage that would not be available under the homeowners policy, because the deductible alone would prevent a covered claim.

The annual premium for this plan is just $1.40 per $100 of replacement cost value (with a minimum premium of $20), whereas other coverage available typically runs from $5 – 8 per $100 of replacement cost value. The plan doesn't cover normal wear and tear on the equipment, dishonest acts by the policyholder, and other similar situations included as exclusions in the policy.

How to Enroll

The ARRL Ham Radio Equipment Insurance Plan is available to all ARRL members who live in the United States. To enroll, visit **www.arrlinsurance.com**, where you can sign up, schedule your equipment, and pay your premium using a credit card or check. Make sure you list all radio equipment in use and its replacement value.

You must notify the plan administrator (Risk Strategies) of new equipment within 60 days of acquisition. With no additional premium, coverage for up to $2,000 of new equipment is included until your next renewal date. For assistance, please call Risk Strategies' toll-free number, 866-819-0209.

Protection begins as soon as the premium is processed. For more information, visit **www.arrl.org/insurance**.

Jen Glifort is the Senior Editor for *QST*. She can be reached at **jglifort@arrl.org**.

Rick Lindquist, WW1ME, ww1me@arrl.org

Happenings

ARRL to Extend Field Day Rule Waivers from 2020, Add Class D and E Power Limit

The COVID-19 pandemic-modified ARRL Field Day rules from 2020 will continue this June with a power limit imposed on Class D (Home Stations) and Class E (Home Stations — Emergency Power) participants. February's news from the ARRL Board's Programs and Services Committee came as many clubs and groups were starting preparations for Field Day in earnest. Field Day 2021 takes place June 26 – 27.

"This early decision should alleviate any hesitancy that radio clubs and individual Field Day participants may have with their planning for the event," said ARRL Contest Program Manager Paul Bourque, N1SFE.

For Field Day 2021, Class D stations may work all other Field Day stations, including other Class D stations, for points. This year, however, Class D and Class E stations will be limited to 150 W PEP output.

For Field Day 2021, an aggregate club score will be published, as was done last year. The aggregate score will be a sum of all individual entries who attributed their score to that of a specific club.

ARRL Field Day is one of the biggest events on the amateur radio calendar. Last summer, a record 10,213 entries were received.

"With the greater flexibility afforded by the rules waivers, individuals and groups will still be able to participate in Field Day, while still staying within any public health recommendations or requirements," Bourque said.

The preferred method of submitting entries after Field Day is via the web applet. The ARRL Field Day rules, found elsewhere in this issue, include instructions on how to submit entries, which must be submitted or postmarked by Tuesday, July 27, 2021.

Innovator Ulrich Rohde, N1UL, Donates Sophisticated Vector Signal Generator to ARRL

ARRL Life Member Ulrich Rohde, N1UL, has donated a Rohde & Schwarz SMBV100A vector signal generator to the ARRL Laboratory. The device offers internal signal generation for all major digital radio standards. "That is absolutely fabulous news and extremely generous," ARRL CEO David Minster, NA2AA, told Rohde.

Ulrich Rohde, N1UL

ARRL Laboratory Manager Ed Hare, W1RFI, said the instrument will be a valuable addition to the Lab's testing capabilities.

"We will be able to do more comprehensive tests on modern radios, almost all of which use software-defined radio technology," Hare said. "We will also be able to add testing of receivers' digital capability. The flexibility of this generator will serve the Laboratory for years to come."

Hare said he was looking forward to learning more about the SMBV100A once it's installed at the Lab. "The potential is really exciting," he said. "As always, we appreciate the support that Ulrich Rohde has given to the Lab over the past several decades."

Rohde said vector signal generators are the logical successors to the older AM/FM modulation-capable signal generators and have practically unlimited capability. "For some of the tests required to characterize a software-defined radio (SDR), we need different test equipment," he said. Rohde noted that the SMBV100A has a built-in arbitrary waveform generator capable of operating up to 6 GHz, with "many complex signals in its library, and also has the familiar AM/FM simple mode."

Going from analog to digital SDRs, large-signal behavior is best determined with special multi-carrier signals, Rohde said. Instead of a two-tone test signal for, say, measuring IF characteristics, the SMBV100A can generate up to 30 discrete tones. Rohde said the SMBV100A can produce any signal "as long as you can describe it mathematically," even an FT8 signal. The bottom line is a more realistic test result.

Dayton Hamvention Announces 2021 Award Winners

Dayton Hamvention® has announced its 2021 award winners. Hamvention Awards Committee Co-Chairs Michael Kalter, W8CI, and Frank Beafore, WS8B, said that despite the COVID-19 pandemic, the Hamvention committee elected to go forward in announcing its selection of outstanding radio amateurs and predicted that Hamvention will return in 2022.

Amateur of the Year

Angel M. Vazquez, Jr., WP3R

Angel M. Vazquez, Jr., WP3R, the head of telescope operations and Puerto Rico Coordination Zone Spectrum Manager for Puerto Rico's famous Arecibo Observatory, was cited as Amateur of the Year for "his unswerving and diligent support of amateur radio throughout the entire territory of Puerto Rico and worldwide."

Vazquez earned his amateur radio license in 1993, and headed the 2010 moonbounce effort from the observatory, as well as multiple special events using the KP4AO club call sign. He enjoys contesting and DXing.

Vazquez helped to provide communication support in the wake of Hurricane Maria. He was named Amateur of the Year in Puerto Rico in 2018 and received the Yasme Excellence Award in 2019. He's also a Volunteer Examiner and inaugurated the first virtual/online bilingual testing program as part of the Greater Los Angeles Amateur Radio Group (GLAARG) VEC.

Technical Achievement

Tamitha Skov, WX6SWW, is well-known as the Space Weather Woman. A credentialed space weather forecaster, Skov's forecasting work is widely known on social media and has been featured in several publications, as well as on TV. Skov said she specifically got her ham license in 2018 to better understand and serve the needs of the amateur radio community. She has taught at Contest University and delivered presentations for ARRL, Dayton Hamvention, and amateur radio clubs around the world.

Tamitha Skov, WX6SWW

Professionally, Skov is a research scientist for The Aerospace Corporation. She also teaches the art of space weather forecasting to meteorologists at Millersville University and is working with ARRL and HamSCI to create educational materials.

Special Achievement

Wesley Lamboley, W3WL

Wesley Lamboley, W3WL, was nominated by his peers for his lifelong, high-energy support of the science and art of amateur radio. "Not only has he supported youth coaching, membership recruiting, and technical problem assistance, he always does it with a smile and great humor," the awards committee said. Lamboley spent 40 years in the aerospace industry as a technical writer, electrical and systems engineer, and manager. Introduced to amateur radio in 1955 when a friend invited him to Field Day, Lamboley credits ham radio for much of his success.

"Many mentors helped me and I try to pay it forward as best I can, especially for young people," he said.

Club of the Year

The Hamvention Awards Committee named the ARRL-affiliated Vienna Wireless Society (VWS), K4HTA, in Virginia as the Club of the Year. The committee shared that VWS's 280 members focus on youth education and public service, and promote the growth of ham radio. The club is now the largest and most active in the Washington, DC, area.

"Our priorities are fostering a fun and inclusive environment, building camaraderie, and focusing on the key areas of service, education, and communication," VWS said. The club offers licensing classes, workshops, and four educational programs a month at its meetings, and these are archived for broader use. Their annual Winterfest is host to the ARRL Virginia Section Convention. The Vienna Wireless Society operates two repeaters in the DC area and actively supports public service communications.

Eight Incumbent Section Managers Begin New Terms

Eight incumbent ARRL Section Managers who were unopposed for re-election in the 2020 – 2021 winter election cycle began new terms on April 1. They are Rick Paquette, W7RAP (Arizona); James Ferguson, N5LKE (Arkansas); Lelia Garner, WAØUIG (Iowa); Steve Morgan, W4NHO (Kentucky); Malcolm Keown, W5XX (Mississippi); Paul Stiles, KF7SOJ (Montana); Steven Lott Smith, KG5VK (North Texas), and Rick Breininger, N1TEK (Wyoming).

Because no nominating petitions were received from the Orange Section by the December 4, 2020, deadline, candidates for the office of Orange Section Manager will be re-solicited. Notices will appear in the April and May issues of *QST* to elicit candidates for an 18-month term starting on October 1. Veteran Orange Section Manager Carl Gardenias, WU6D, decided not to run for another term after serving since 2003.

ARISS Ham Station in Columbus Module is Once Again Operational

Roughly 6 weeks after going silent following a spacewalk that installed new antenna cabling, the Amateur Radio on the International Space Station (ARISS) ham station in the Columbus module is once again operational. The Columbus station, which typically uses the call sign NA1SS, is the primary ARISS amateur radio station used for school contacts and other activities. A January 27 spacewalk replaced a coax feed line installed 11 years ago with another built by the European Space Agency (ESA) and Airbus.

While the specific cause of the problem has not yet been determined, a March 13 spacewalk that restored the antenna cabling to its original configuration provided the solution. The ARISS work was appended to the to-do list for astronauts Mike Hopkins, KF5LJG, and Victor Glover, KI5BKC, to complete.

"On behalf of the ARISS international team, our heartfelt thanks to all who helped ARISS work through the cable anomaly investigation, troubleshooting, and ultimate repair," ARISS International Chair Frank Bauer, KA3HDO, said. Bauer praised NASA, the ESA, Airbus, and ARISS-Russia lead Sergey Samburov, RV3DR.

During the weekend spacewalk, Hopkins swapped out a cable for the Bartolomeo commercial payload-handling platform that had been installed in series with the ARISS VHF-UHF antenna feed line, returning the ARISS system to its pre-January 27 configuration. Hopkins raised a question concerning a sharp bend in the cable near a connector, but no further adjustments were possible.

On March 14, ARISS was able to confirm the operation's success when Automatic Packet Reporting System (APRS) signals on 145.825 MHz were heard in California, Utah, and Idaho as the ISS passed overhead. ARISS team member Christy Hunter, KB6LTY, was able to digipeat through NA1SS during the pass. With additional confirmation from stations in South America and the Middle East, ARISS declared the radio system operational again.

Section Manager Nomination Notice

To all ARRL members in Colorado, Eastern Washington, Georgia, Los Angeles, Sacramento Valley, San Francisco, South Texas, West Virginia, and Western Washington: You are hereby solicited for nominating petitions pursuant to an election for Section Manager (SM). Incumbents are listed on page 16 of this issue.

To be valid, a petition must contain the signatures of five or more full ARRL members residing in the Sections concerned. It is advisable to have a few more than five signatures on each petition. A sample nomination form is available on the ARRL website at **www.arrl.org/section-terms-nomination-information**. Nominating petitions may be made by facsimile or electronic transmission of images, provided that upon request by the Field Services Manager, the original documents are received by the manager within 7 days of the request. It is acceptable to submit signatures that have been sent via email or mail under the following guidelines: The petition copies must be made from the original form supplied by ARRL or downloaded from the ARRL website. The form must be exactly the same on both sides (i.e., autobiographical information should appear exactly the same on all copies). All forms/copies must be submitted together.

Candidates may use any of the available electronic signature platforms such as DocuSign, HelloSign, and Signed PDF. Candidates who use an electronic signature platform to be nominated, as described above, do not have to send in original paper copies of the nominating documents. The packet that is sent to ARRL Headquarters must be complete. Multiple files or emails for a single petition will not be accepted.

We suggest the following format:

(Place and Date)

Field Services Manager, ARRL
225 Main St.
Newington, CT 06111

We, the undersigned full members of the _____ ARRL Section of the _____ Division, hereby nominate _____ as candidate for Section Manager of this Section for the next 2-year term of office.

(Signature _____ Call Sign ____ City ___ ZIP ____)

Any candidate for the office of Section Manager must be a resident of the Section, an amateur radio licensee of Technician class or higher, and a full member of the League for a continuous term of at least 2 years immediately preceding receipt of a nominating petition. Petitions must be received at Headquarters by 4 PM Eastern Time on June 4, 2021. If more than one member is nominated in a single Section, ballots will be mailed from Headquarters no later than July 1, 2021, to full members of record as of June 4, 2021 which is the closing date for nominations. Returns will be counted August 24, 2021. Section Managers elected as a result of the above procedure will take office October 1, 2021.

If only one valid petition is received from a Section, that nominee shall be declared elected without opposition for a 2-year term beginning October 1, 2021. If no petitions are received from a Section by the specified closing date, such Section will be resolicited in the October *QST*. A Section Manager elected through the resolicitation will serve a term of 18 months. A Section Manager vacancy occurring between elections is filled through appointment by the Field Services Manager. — *Bart Jahnke, W9JJ, Field Services & Radiosport Department Manager*

SM Nomination Petition Resolicitation

Because no nomination petitions were received for the Orange Section Manager election by the nomination deadline of December 4, 2020, nominations are hereby resolicited. See the above for details.

Rick Palm, K1CE, k1ce@arrl.net

Public Service

Military Auxiliary Radio System (MARS) Update

The US Department of Defense (DOD) sponsors the Military Auxiliary Radio System, or MARS. MARS is managed and operated in two programs, one by the US Army and the other by the US Air Force. MARS recruits talented amateur radio operators to communicate in and support military radio networks (with assignments outside of the HF bands) to provide backup and augmentation of military communications.

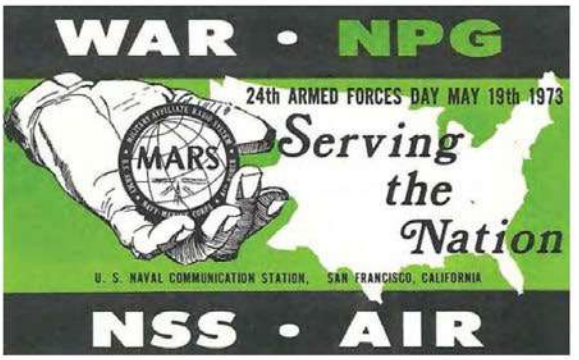
MARS has changed dramatically over the years. Many older *QST* readers may remember the popular phone patch operations in the '60s, arranged and conducted for troops in Vietnam and their families back home. Today, MARS amateur radio operators still operate a phone patch network supporting Air Force aircraft (and sometimes Army maneuver units), but they also train to support complex communications tasking, which could involve major disasters and even cybersecurity breaches. It supports US National Guard training and operations, as well as the Department of Homeland Security SHAred RESources (SHARES) HF Radio Program. MARS members operate their radio stations on the same net with military and government stations promoting interoperability.

The Army MARS is headquartered at Fort Huachuca, Arizona, and the Air Force MARS is headquartered at the Scott Air Force Base in St. Clair County, Illinois.

MARS History

MARS evolved from the original Army Amateur Radio System, established in 1925. The Army and Air Force MARS headquarters stations were operated from the Pentagon during the 1950s and 1960s. The military call sign of the Army MARS station was WAR, and its FCC call sign for the amateur bands was K4USA. The Air Force MARS call sign was AIR, with an amateur radio call sign of K4AF.

During the '60s, Air Force MARS member and US Senator Barry Goldwater, K7UGA/AFC6BC, operated his Phoenix, Arizona, station to conduct thousands of phone patches from service personnel in Southeastern Asia to loved ones back home. The Army phone patch program in Vietnam started with six stations and was completed in 1969, with 47 MARS stations in seven nets that conducted more than 42,000 phone patches each month.



A Military Auxiliary Radio System (MARS) QSL card from 1973.

In 1948, the Army and Air Force established the Military Amateur Radio System, later renaming it the Military Affiliate Radio System. In 1962, Navy-Marine Corps MARS was launched, creating a joint service program. In 1997, Army MARS and Air Force MARS inaugurated on-the-air interoperability. In 2009, the program was renamed the Military Auxiliary Radio System. In 2011, Air Force MARS established the National Military Support Network, and the Army MARS runs the National Support Network, which provides communications support for the DOD, Department of Homeland Security, and military and Army National Guard units.

To learn more about the history of MARS, you can purchase *Army MARS at 90*, by William C. Sexton, N1IN/AARIFP (SK), available at **www.amazon.com/Army-MARS-at-William-Sexton/dp/1329964322**.

Upcoming Exercises

MARS officials have announced dates for this year during which MARS members will operate on 60 meters for interoperability with the amateur radio community. At 60 meters, amateurs are permitted to operate on five discrete frequency channels. Because the Amateur Radio Service is a secondary user (government users hold primary status on 60 meters), we're required to yield to the primary users. Please review ARRL best practices prior to operating on the 60-meter channels (**www.arrl.org/files/file/Regulatory/Recommended_Practices_Version_6_5.pdf**).

Some of the dates coincide with quarterly DOD Communications Exercises (COMEX). All exercises begin on channel 1 as the initial calling channel, and move to other 60-meter working channels as indicated. MARS members will perform technical and essential complex mission tasks that are critical for accomplishment of the MARS mission.

"In addition to voice calls, I want to introduce passing [General Message] ICS 213-formatted messages in voice and digital modes to enhance the overall interop experience," US Army MARS Chief Paul English, WD8DBY, said. He explained that the exercises will "yield the frequencies to other scheduled exercises or mission activations, which may be called by other agencies for interop support" for scenarios such as hurricanes and wildfires. "We regularly instruct MARS members to work cooperatively with the amateur radio community during the use of the 60-meter interop channels," English said. "We will continue to track our 60-meter usage and activities, and plan to provide a quarterly usage report of 60-meter interoperability activities."

During October 2019, corresponding with the ARRL Simulated Emergency Test (SET), MARS members continued promoting interoperability with the ARES® (Amateur Radio Emergency Service) community. From November 2 – 17, the MARS organization executed DOD Communications Exercise (COMEX) 19-4. MARS members used the exercise for further training and refining their operator skills to provide situational awareness, such as county status reports and weather observations. The exercise culminated on November 16 with military stations sending M110 messages to the amateur community on 60-meter channel 1.

This year's Annual Armed Forces Day Crossband Test with amateur radio operators will take place from May 7 – 8. A complete list of stations, call signs, frequencies, times, and mode of operation will be published by April 20, and will be available at **www.dodmars.org**.

Other MARS News

The DOD is now regularly broadcasting messages on WWV at 10 minutes past the hour, and WWVH at 50 minutes past the hour. These messages cover topics such as significant events in military history; HF tips, tricks, and techniques, and upcoming HF exercises. During each broadcast, listeners are provided a URL and asked to take a listener survey. The survey results are periodically shared with WWV/H personnel and their headquarters at the National Institute of Standards and Technology (NIST).

Joining MARS

There are stringent qualification and training requirements for membership in MARS. For example, section (f) of the Army MARS application states that applicants must have "unrestricted access to a radio system consisting of a transmitter and receiver (or transceiver), antenna, modem, computer equipment, and associated software. This system must be capable of operating on all radio frequencies between 2 and 30 MHz in accordance with NTIA [National Telecommunications and Information Administration *Manual of Regulations and Procedures for Radio Frequency Management*] technical standards, with an output power of at least 100 W in order to communicate effectively over long distances." Adding that "the system shall use single sideband as described in *MIL–STD–188–141* and the serial phase key-shifting data mode described in *MIL–STD–188–110A*. 'Unrestricted access' means the individual may use the radio system on demand and as required to support MARS activities without conditions."

For more information about Army MARS, please email **paul.a.english.civ@mail.mil** and for Air Force MARS information, contact **join@afmars-mil.us**.

Field Organization Reports

February 2021

Public Service Honor Roll

This listing recognizes radio amateurs whose public service performance during the month indicated 70 or more points in six categories. Details on the program can be found at **www.arrl.org/public-service-honor-roll**.

656
WA7PTM

445
WA3EZN

434
W7PAT

410
N9VC

324
KK6GXG

320
ND8W

318
KE8BYC

302
KD2LPM

280
KE8KOC

264
WA2CCN

260
KW9EMG

243
W0PZD

215
AB8MW

195
AD3J

190
KM8V

180
KB8RCR

170
AC8NP

164
AC8CM

161
WB6UZX

155
W2PH
AI9F
K0RCJ

154
W9RY

145
W4DNA
W9GRG

142
N8CY

140
W7EES
W8MAL
WB9QPM
K4IWW

138
KD0HHN

135
N4CNX

130
AC0KQ
N1LL
WK4WC
N5MKY
KD8ZCM

125
W4CMH
AG9G
WB9WKO

124
K8RDN

123
W8IM

120
WA4VGZ
WC4FSU
K9LGU
KC9FXE

W0LAW
KA9QWC
KC8WH
K3JL
NA7G
N7IE

116
KD2IWN

115
W2DW
K1XFC

114
KD2GRS

113
KC8YVF

111
AB8M

110
W1KX
WA3QLW
WB8YLO
KA9MZJ
KI7TIG
K6HTN
K8BKM
WB8TQZ
WF2Y
WS4P

108
W9EEU
K2TV

105
W2PAX
K8MDA
N2WGF

103
K7OED

100
WB4RJW
KZ8Q
KN9P
NX9K
AC8RV

WB8SIQ
K8RC
KV8Z
KB2YAA
KB3YRU

99
WA1URS

97
KB1NMO

96
WD8USA

93
WB8YYS

92
K9GDF
W4TTO
K1STM

90
KM4WHO
KB9GO
N2LC
K8KRA
KB8HJJ
KA1G
KL7RF
N8MRS
AA3N
W7PHX
N4ZM
K2EAG
W2JPS
WB8WKQ
K8ED
K3MIY
WX2DX

89
K1HEJ

84
KB8PGW

83
WV5Q

82
AB9ZA

81
W9BGJ
N3KRX
N6IET
WB8R

80
AJ7B
KR4ST
K0WAV
KF7GC
AA7BM
KG7QWR
KJ7BHO
KB3MXK
W2ZXN

77
KN4AAG

76
N8CJS
W5XX

75
N3JET

74
K3AUX
W8DW

73
KC1FLU
KU1U
KD8UOT
KD8KBX

72
K4FHR
K6RAU

71
KB0DTI

70
AD4DO

Section Traffic Manager Reports

The following Section Traffic Managers reported: AK, AR, AZ, CO, CT, DE, EB, EMA, ENY, EPA, IN, KS, KY, LA, LAX, MDC, ME, MI, MN, MO, MS, MT, NC, ND, NE, NFL, NLI, NM, NNJ, NTX, OH, OR, SC, SFL, SJV, TN, UT, WCF, WI, WMA, WNY, WPA, WTX, WV, WWA, WY.

Section Emergency Coordinator Reports

The following Section Emergency Coordinators reported: ENY, IN, KY, MDC, ME, MI, MO, MS, ND, NLI, NM, NNJ, NV, OH, OR, ORG, PAC, SCV, SFL, SD, SJV, SNJ, STX, TN, VI, WCF, WPA, WY.

Brass Pounders League

The BPL is open to all amateurs in the US, Canada, and US possessions who report to their SMs a total of 500 or more points or a sum of 100 or more origination and delivery points for any calendar month. Messages must be handled on amateur radio frequencies within 48 hours of receipt in standard ARRL radiogram format. Call signs of qualifiers and their monthly BPL total points follow.

KY2D 1,516, NX9K 1,365, K6HTN 1,131, WB9WKO 883, N9CK 840, N1IQI 553, KW1U 551, KK3F 525.

Bruce Draper, AA5B, aa5b.corral@gmail.com

Contest Corral

May 2021

Check for updates and a downloadable PDF version online at **www.arrl.org/contest-calendar**.
Refer to the contest websites for full rules, scoring information, operating periods or time limits, and log submission information.

Start - Finish Date-Time		Date-Time		Bands	Contest Name	Mode	Exchange	Sponsor's Website
1	0000	2	1600	50, 144	Araucaria World Wide VHF Contest	CW Ph	RS(T), 6-char grid square	avhfc.com/rules/en.pdf
1	0001	2	2359	28	10-10 International Spring Contest, CW	CW	Name, mbr or "0," SPC	www.ten-ten.org
1	0300	1	0859	3.5-28	RCC Cup	CW Ph	RS(T), mbr or ITU zone	rcccup.ru
1	0800	1	1400	Above 902	Microwave Spring Sprint	CW Ph Dig	6-char grid square	sites.google.com/site/springvhfupsprints
1	1200	2	1159	3.5-28	ARI International DX Contest	CW Ph Dig	RS(T), Italian province or serial	ari.it/en/contest-hf
1	1200	2	1200	3.5-144	F9AA Cup, Digi	Dig	RST, serial	www.site.urc.asso.fr
1	1300	1	1900	3.5-28	AGCW QRP/QRP Party	CW	RST, serial, Class (A/B)	alt.agcw.de/index.php/en
1	1300	2	0700	1.8-28	7th Call Area QSO Party	CW Ph	RS(T), 5-letter state/county code or SPC	7qp.org
1	1500	2	0300	1.8-28	Indiana QSO Party	CW Ph	RS(T), county or SPC	hdxcc.org/inqp/rules.html
1	1600	1	1800	3.5-28	FISTS Saturday Sprint	CW	RST, SPC, name, mbr or "0"	fistsna.org/operating.html#sprints
1	1700	2	2359	1.8-VHF	Delaware QSO Party	CW Ph	RS(T), county or SPC	www.fsarc.org/qsoparty
1	2000	2	2359	3.5-28	New England QSO Party	CW Ph Dig	RS(T), W1 county/state or SPC	www.neqp.org/rules.html
3	0000	3	0100	1.8-14	K1USN Slow Speed Test	CW	Name, SPC at 20 WPM max	www.k1usn.com/sst.html
3	1630	3	1729	3.5, 7	OK1WC Memorial (MWC)	CW	RST, serial	memorial-ok1wc.cz
4	0100	4	0159	1.8-50	Worldwide Sideband Activity Contest	Ph	RS, age group (OM, YL, or Youth)	wwsac.com/rules.html
4	0100	4	0300	3.5-28	ARS Spartan Sprint	CW	RST, SPC, power	arsqrp.blogspot.com
4	1700	4	1900	3.5-14	RTTYops Weeksprint	Dig	Other's call, your call, serial, name	rttyops.wordpress.com
4	2300	5	0300	All	MIE 33 Contest	CW Ph	RS(T), age	www.ztv.ne.jp/isoda/33
5	1300	5	1400	1.8-28	CWops Mini-CWT Test	CW	Name, mbr or SPC	cwops.org
5	1700	5	2000	144	VHF-UHF FT8 Activity Contest	Dig	4-char grid square	ft8activity.eu/index.php/en
5	1900	5	2000	1.8-28	CWops Mini-CWT Test	CW	Name, mbr or SPC	cwops.org
5	1900	5	2030	3.5-14	RSGB FT4 Contest Series	Dig	4-char grid square	www.rsgbcc.org/hf
6	0300	6	0400	1.8-28	CWops Mini-CWT Test	CW	Name, mbr or SPC	cwops.org
6	1700	6	1900	3.5-14	RTTYops Weeksprint	Dig	Other's call, your call, serial, name	rttyops.wordpress.com
6	1700	6	2100	28	NRAU 10-Meter Activity Contest	CW Ph Dig	RS(T), 6-char grid square	nrrlcontest.no
6	1900	6	2100	1.8-50	SKCC Sprint Europe	CW	RST, SPC, Name, mbr or "none"	www.skccgroup.com
7	0145	7	0215	1.8-21	NCCC RTTY Sprint	Dig	Serial, name, QTH	www.ncccsprint.com
7	0230	7	0300	1.8-21	NCCC Sprint	CW	Serial, name, QTH	www.ncccsprint.com
7	2000	7	2100	1.8-14	K1USN Slow Speed Test	CW	Name, SPC, 20 WPM max	www.k1usn.com/sst.html
8	0001	9	2359	3.5-144	Day of the YLs Contest	CW Ph	RS(T), YL/OM	ka1uln.blogspot.com
8	0500	9	1100	50-1296	SARL VHF/UHF Digital Contest	Dig	RST, 6-char grid locator	www.sarl.org.za
8	1200	9	1159	1.8-28	CQ-M International DX Contest	CW Ph	RS(T), serial	cqm.srr.ru/en-rules
8	1200	9	1200	3.5-28	VOLTA WW RTTY Contest	Dig	RST, serial, CQ zone	www.contestvolta.com
8	1200	9	2359	1.8-50	SKCC Weekend Sprintathon	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
8	1400	9	0200	3.5-144	Arkansas QSO Party	CW Ph	RS(T), AR county or SPC	www.arkqp.com
8	2300	9	0300	50	50 MHz Spring Sprint	CW Ph Dig	4-char grid square	sites.google.com/site/springvhfupsprints
9	1000	9	1400	7	WAB 7 MHz Phone/CW	CW Ph	RS, serial, WAB square or country	wab.intermip.net/Contests.php
10	0000	10	0200	1.8-28	4 States QRP Grp Second Sunday Sprint	CW Ph	RS(T), SPC, mbr or power	www.4sqrp.com
10	1900	10	2030	3.5	RSGB 80-Meter Club Championship, SSB	Ph	RS, serial	www.rsgbcc.org/hf
12	1700	12	2000	432	VHF-UHF FT8 Activity Contest	Dig	4-char grid square	ft8activity.eu/index.php/en
13	1600	13	2200	3.5, 7	QRP Minimal Art Session	CW	RST, class, number of components	qrpcc.de/contestrules
15	0800	16	1100	3.5	NZART Sangster Shield Contest	CW	RST, serial, branch (if any)	nzart.org.nz/activities/contests
15	1200	16	1200	1.8-28	His Majesty King of Spain Contest, CW	CW	RST, EA province or serial	concursos.ure.es/en
15	1600	15	2159	1.8-50	Feld Hell Sprint	Dig	RST, mbr, SPC, grid	sites.google.com/site/feldhellclub
16	2100	16	2300	3.5-28	FISTS Sunday Sprint	CW	RST, SPC, name, mbr or "0"	fistsna.org
16	2300	17	0100	1.8-28	Run for the Bacon QRP Contest	CW	RST, SPC, mbr or power	qrpcontest.com/pigrun
19	1900	19	2030	3.5	RSGB 80-Meter Club Championship, Data	Dig	RST, serial	www.rsgbcc.org/hf
20	0030	20	0230	3.5-14	NAQCC CW Sprint	CW	RST, SPC, mbr or power	naqcc.info
21	1200	21	2359	3.5-28	Hamvention QSO Party	CW Ph	RS(T), first year attended Hamvention	wwrof.org
22	1200	23	1200	3.5-28	EU PSK DX Contest	Dig	RST, EU area code or serial	eupsk.club
22	2100	23	0200	3.5	Baltic Contest	CW Ph	RS(T), serial	lrsf.lt/en/balticcontestrules
24	0000	24	0100	1.8-28	QRP ARCI Hootowl Sprint	CW	RST, SPC, mbr or power	qrparci.org/contest
26	0000	26	0200	1.8-50	SKCC Sprint	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
27	1900	27	2030	3.5	RSGB 80-Meter Club Championship, CW	CW	RST, serial	www.rsgbcc.org/hf
29	0000	29	2359	1.8-50	Feld Hell Sprint	Dig	RST, mbr, SPC, grid	sites.google.com/site/feldhellclub
29	0000	30	2359	1.8-28	CQ WW WPX Contest, CW	CW	RST, serial	www.cqwpx.com

There are a number of weekly contests not included in the table above. For more info, visit: **www.qrpfoxhunt.org**, **www.ncccsprint.com**, and **www.cwops.org**. All dates refer to UTC and may be different from calendar dates in North America. Contests are not conducted on the 60-, 30-, 17-, or 12-meter bands. Mbr = Membership number. Serial = Sequential number of the contact. SPC = State, Province, DXCC Entity. XE = Mexican state. Listings in blue indicate contests sponsored by ARRL or *NCJ*. The latest time to make a valid contest QSO is the minute listed in the "Finish Time" column. *Data for Contest Corral is maintained on the WA7BNM Contest Calendar at* **www.contestcalendar.com** *and is extracted for publication in* QST *2 months prior to the month of the contest. ARRL gratefully acknowledges the support of Bruce Horn, WA7BNM, in providing this service.*

FIELD DAY 2021

The largest on-air event returns June 26 – 27, 2021.

1800 UTC Saturday, June 26 through 1759 UTC Sunday, June 27.

Bands and Modes: Participants may only operate on the 160-, 80-, 40-, 20-, 15-, and 10-meter HF bands, and may use all bands 50 MHz and above using phone, CW, and/or digital modes.

Setup: Class A and B stations that wish to operate for only 24 hours may begin their setup at 0000 UTC on the Friday (Thursday afternoon or evening local time) preceding the ARRL Field Day period. Cumulative setup time for those stations may not exceed a total of 24 hours. Class A and B stations that wish to operate the full 27-hour Field Day period may not begin setup until 1800 UTC on Saturday.

Reporting Your Score: All entries must be received at ARRL HQ no later than Tuesday, July 27, 2021. Participants are strongly encouraged to use the online ARRL Field Day score reporting system at **www.field-day.arrl.org**. Online entrants will receive an email confirmation that their entry was accepted, as well as 50 bonus points for submitting their score electronically.

2021 Rules Waivers: The 2020 Field Day rules waivers have been extended to 2021: Class D stations can work other Class D stations for points. As with last year, participants operating from their home stations can contribute their scores to that of their club's aggregate score, which will be published in *QST*.

In addition, a new rule waiver has been added for 2021: Class D and Class E stations are limited to 150 W peak envelope power (PEP) transmitter output.

Let everyone know where you'll be for Field Day by using the Field Day Locator at **www.arrl.org/field-day-locator**. It can also be used to find a nearby Field Day site, or an operation to join if you're travelling out of town.

Other bonus point options are available, including newer additions like the social media bonus. Groups (not individuals) who actively promote their Field Day event on a social media platform (such as Facebook, Instagram, or Twitter) earn 100 bonus points. Use the hashtag **#ARRLFD** to share your plans and tips for a successful Field Day.

Participants should download and review the material found in the 2021 Field Day packet (including information about available bonus points), at **www.arrl.org/field-day**. Email any questions to **fdinfo@arrl.org**.

Curt Laumann, K7ZOO, set up his 2020 ARRL Field Day station just outside of Sonoita, Arizona, powered entirely by solar power. In the foreground are his 2-meter and 70-centimeter Lindenblad antennas, which he used for satellite contacts. [Curt Laumann, K7ZOO, photo]

Rick Rosen, K1DS, rick1ds@hotmail.com

2020 ARRL International EME Contest

Last year's EME Contest 2.3 GHz and up weekend was held September 12 – 13. The 50 – 1296 MHz weekends took place October 10 – 11 and November 28 – 29.

Multioperator Scores by Category

Call Sign	Score	QSOs	Mults
Multioperator, CW/Phone Only, All Band			
SP6JLW	724,500	115	63
Multioperator, CW/Phone Only, 432 MHz			
SP9KDA	8,400	14	6
Multioperator, CW/Phone Only, 1.22 GHz			
9A5AA	90,300	43	21
F6KRK	15,000	15	10
Multioperator, All Mode, All Band			
RA3EME	6,253,000	370	169
K2UYH	2,406,900	213	113
NC1I	1,178,000	155	76
OH1LRY	660,800	118	56
OZ9KY	436,800	84	52
LU1CGB	380,000	76	50
W4ZST	135,300	41	33
Multioperator, All Mode, 144 MHz			
S51ZO	1,102,200	167	66
KG6NUB	825,300	131	63
W9VW	262,200	69	38
F6HEO	176,700	57	31
LZ1KU	37,400	22	17
BY2HIT	100	1	1
Multioperator, All Mode, 432 MHz			
S51LF	186,000	62	30
VE3MIS	23,800	17	14
Multioperator, All Mode, 1.2 GHz			
W6YX	576,300	113	51
IK5VLS	466,200	111	42
VA7MM	316,000	79	40
KØPRT	90,000	36	25
UA6AH	74,100	39	19
Multioperator, All Mode, 24 GHz			
OK1KIR	2,800	7	4

Single Operator Scores by Category

Call Sign	Score	QSOs	Mults
Single Operator, CW/Phone Only, All Band			
G3LTF	958,500	135	71
KL6M	522,000	90	58
OK1CA	482,300	91	53
WA6PY	260,000	65	40
F2CT	255,000	75	34
SP3XBO	213,500	61	35
IK3COJ	6,300	9	7
JJ1NNJ	4,000	8	5
Single Operator, CW/Phone Only, 432 MHz			
DL9KR	25,200	21	12
DL8UCC	8,000	10	8
DL6SH	6,600	11	6
GØJLO	5,600	8	7
JA9BOH	3,600	6	6
F6HLC	2,500	5	5
Single Operator, CW/Phone Only, 1.2 GHz			
DG5CST	468,000	104	45
G4CCH	392,000	98	40
OZ4MM	336,000	96	35
DLØSHF	316,800	88	36
OK1CS	244,200	74	33
OK1KKD	192,000	64	30
W4OP	192,000	64	30
LZ2US	180,000	60	30
I1NDP	140,000	56	25
IK1FJI	114,400	52	22
F5KUG	86,000	43	20
JH1KRC	83,600	38	22
F6ETI	70,200	39	18
WK9P	41,600	26	16
N4PZ	36,000	24	15
DJ3JJ	12,800	16	8
WB2BYP	5,600	8	7
Single Operator, All Mode, All Band			
UA3PTW	6,673,600	388	172
LZ1DX	1,240,200	159	78
YL2GD	710,400	111	64
JA6AHB	657,200	106	62
PA2CHR	591,700	97	61
ES3RF	550,000	100	55
UA4AQL	547,200	96	57
NØAKC	489,500	89	55
DL4DTU	470,400	96	49
KD2LGX	448,200	83	54
PA3DZL	423,200	92	46
W1PV	421,800	74	57
WA3RGQ	347,600	79	44
N1AV	277,200	66	42
AI1K	258,300	63	41
KNØWS	255,600	71	36
4Z5CP	225,700	61	37
UB4UAA	216,600	57	38
K4EME	188,700	51	37
DJ3AK	133,300	43	31
JJ3JHP	133,300	43	31
N8AM	123,200	44	28
W5LUA	103,600	37	28
PE1LWT	87,400	38	23
KO4MA	78,200	34	23
W2LPL	60,900	29	21
W3CJK	53,200	28	19
HI8DL	41,400	23	18
KC2HFQ	40,000	25	16
W1FKF	26,600	19	14
F1IOZ	22,400	16	14
UT2EG	22,100	17	13
R6CS	19,800	18	11
UA3TCF	13,000	13	10
YL2FZ	8,800	11	8
K1DS	6,400	8	8
JE1TNL	4,800	8	6
JA4UMN	900	3	3
Single Operator, All Mode, 50 MHz			
NØTB	57,500	25	23
KJ9I	400	2	2
Single Operator, All Mode, 144 MHz			
PA5Y	2,244,000	264	85
RX1AS	2,219,900	281	79
OK1DIX	1,872,000	234	80
WA1NPZ	1,074,400	158	68
IW4ARD	966,400	151	64
N7NW	851,500	131	65
WB9UWA	705,600	126	56
OH2LHE	689,000	130	53
K1DG	535,600	103	52
R3PA	534,100	109	49
I2FAK	526,400	94	56
G8RWG	420,000	100	42
AB1OC	312,400	71	44
DF2ZC	301,500	67	45
N1DPM	296,400	78	38
IK2DDR	272,000	68	40
K6KLY	262,500	75	35
W6TCP	243,600	58	42
AG4W	188,800	59	32
HG5BMU	186,000	62	30
7K3LGC	179,200	56	32
UA1OEJ	166,400	52	32
UT5ST	166,400	52	32
KØTPP	156,400	46	34
JP3EXR	155,000	50	31
RN6MA	129,600	48	27
LZ1DP	117,600	49	24
UT9UR	113,400	42	27
K7MAC	106,600	41	26
TI1K	83,600	38	22
TA1D	77,000	35	22
UA9YJM	73,500	35	21
IU4FKR	68,200	31	22
UA6ACF	67,200	32	21
RZ6DD	48,000	30	16
KA1W	40,000	25	16
UA6BAC	39,000	26	15
ON4KHG	37,500	25	15
RV3YM	33,600	21	16
WA3QPX	33,000	22	15
UT5IG	32,200	23	14
R9WL	28,600	22	13
BA4SI	26,600	19	14
LZ2FO	23,400	18	13
NH6Y	22,400	16	14
KD7UO	20,400	17	12
EW7T	18,000	18	10
YU7MS	16,800	14	12
TA2NC	14,400	16	9
ND4X	14,300	13	11
JHØWJF	13,000	13	10
RA6C	11,700	13	9
YO6XK	11,700	13	9
WDØE	9,900	11	9
G8TTI	9,000	10	9
PA5MS	9,000	10	9
W8TN	9,000	10	9
KG7P	6,300	9	7
KU8L	4,900	7	7
VE2PN	4,900	7	7
UA6LCN	4,800	8	6
LA3TK	4,200	7	6
PE1ITR	4,200	7	6
W5GLD	3,600	6	6
R3UG	2,000	5	4
JG2TSL	1,200	4	3
OK1BRT	900	3	3
VA2WA	600	3	2
RM5P	400	2	2
UA9CCL	400	2	2
DL/HB9HBK	200	2	1
SP2ERZ	200	2	1
BV3UF	100	1	1
JA1DYB	100	1	1
K7KMR	100	1	1
LU2FGL	100	1	1
N2AMC	100	1	1
RV1CB	100	1	1
SP2HHX	100	1	1
VE6XH	100	1	1
YB2MDU	100	1	1
Single Operator, All Mode, 222 MHz			
WA4NJP	4,900	7	7
K7ULS	2,500	5	5
Single Operator, All Mode, 432 MHz			
DL7APV	1,388,800	217	64
UT5DL	489,600	102	48
SM7THS	217,600	64	34
VK4EME	82,500	33	25
OK1TEH	81,600	34	24
RD3FD	62,700	33	19
VK2CMP	24,700	19	13
DK1KW	17,000	17	10
YO2NAA	15,000	15	10
GW3TKH	9,900	11	9
SM5EPO	3,500	7	5
MØABA	3,000	6	5
F4VTP	2,500	5	5
N1QG	2,500	5	5
YO2LSP	2,500	5	5
AE6EQ	1,600	4	4
DG7YBN	400	2	2
JRØWFY	400	2	2
JK1BLA	100	1	1
K9PW	100	1	1
N5HX	100	1	1
NY2NY	100	1	1
OH3DP	100	1	1
UR7IM	100	1	1
UR7IMM	100	1	1
W5RZ	100	1	1
Single Operator, All Mode, 1.2 GHz			
OK2DL	974,400	168	58
DF3RU	726,100	137	53
DL3EBJ	680,000	136	50
PA3FXB	655,000	131	50
RA3AUB	632,100	129	49
DL7UDA	576,000	120	48
OK1DFC	541,200	123	44
KA1GT	488,800	104	47
RA4HL	432,600	103	42
N5BF	361,200	86	42
PAØPLY	352,000	88	40
IK2MMB	347,100	89	39
RD4D	311,500	89	35
SP5GDM	308,000	77	40
SM5DGX	221,000	65	34
DF2GB	211,200	64	33
I5YDI	195,000	65	30
AA4MD	192,000	60	32
KD3UY	182,900	59	31
UA9FAD	151,200	54	28
YO2LEL	137,800	53	26
UA4LCF	135,200	52	26
WA3GFZ	121,800	42	29
AA6I	113,400	42	27
CX2SC	112,800	47	24
RX6AIA	66,300	39	17
IØNAA	58,800	28	21
FR5DN	57,000	38	15
OK1YK	48,000	32	15
ES6FX	46,800	26	18
LZ4OC	46,400	29	16
KB7Q	45,900	27	17
RA2FGG	45,000	30	15
RD9SAC	43,400	31	14
JA4LJB	39,000	26	15
DL1SUZ	31,200	24	13
CE3VRT	26,600	19	14
W3HMS	24,700	19	13
WA2FGK	18,000	15	12
SV1CAL	13,600	17	8
VK6KCC	12,800	16	8
OK1USW	12,000	15	8
W6TOD	5,600	8	7
OK1IL	2,500	5	5
UA1CCU	2,000	5	4
LA2IMA	1,600	4	4
RW4HW	900	3	3
Single Operator, All Mode, 2.3 GHz			
DL1EMA	3,000	6	5
K3WM	400	2	2
Single Operator, All Mode, 10 GHz			
W3SZ	34,500	23	15
OK2AQ	30,400	19	16
OZ1FF	26,600	19	14
IW2FZR	18,000	15	12

Total Reported QSOs by Mode

Digital	10,101
CW/Phone	2,860
Total	12,961

Total Reported QSOs by Band

50 MHz	27	3.4 GHz	13
144 MHz	5,217	5.7 GHz	77
222 MHz	15	10 GHz	176
432 MHz	1,443	24 GHz	8
1296 MHz	5,732	Total	12,961
2.3 GHz	253		

Read the full results of the contest online at **http://contests.arrl.org**.

This year's 2021 International EME Contest weekends are scheduled for October 23 – 24 (2.3 GHz and up weekend), as well as November 20 – 21 and December 18 – 19 (50 – 1296 MHz weekends).

Kelly Taylor, VE4XT, ve4xt@mymts.net

2020 ARRL November Sweepstakes — CW

Last year's ARRL November Sweepstakes (CW weekend) was held November 7 – 9, 2020.

Plaque Sponsors

ARRL is pleased to award a Sweepstakes Plaque to the Overall and Division Leaders in each category, thanks to Icom America, clubs, and individuals who sponsor these awards. For more information on plaque sponsorship or to order a duplicate plaque, contact the ARRL Contest Program at 860-594-0232 or **contests@arrl.org**. Plaques cost $80, which includes all shipping charges.

Winner	Division	Category	Sponsor
N9RV	Overall	Single Operator High Power	Trey Garlough, N5KO
N4OGW	Overall	Single Operator Low Power	Radiosport Manitoba — VE4VV Memorial
VY2ZM	Overall	Single Operator QRP	Icom America
VE5MX	Overall	Single Operator Unlimited High Power	Icom America
N4ZZ	Overall	Single Operator Unlimited Low Power	Icom America
NØUR	Overall	Single Operator Unlimited QRP	Icom America
ND7K	Overall	Multioperator High Power	Icom America
W8TK	Overall	Multioperator Low Power	Icom America
KØHC (WØBH, op)	Overall	School Club	Icom America
AA3B	Atlantic	Single Operator High Power	Icom America
K3UA	Atlantic	Single Operator Low Power	John Thompson, K3MD
W2GD	Atlantic	Single Operator QRP	Icom America
K3MM	Atlantic	Single Operator Unlimited High Power	Icom America
W2FU (N2ZN, op)	Atlantic	Single Operator Unlimited Low Power	Icom America
KO3T	Atlantic	Single Operator Unlimited QRP	Icom America
NG3R	Atlantic	Multioperator High Power	Icom America
W9RE	Central	Single Operator High Power	Society of Midwest Contesters
N9JF	Central	Single Operator Low Power	Society of Midwest Contesters
K9ZO	Central	Single Operator QRP	Icom America
K9CT	Central	Single Operator Unlimited High Power	Society of Midwest Contesters
N9CO	Central	Single Operator Unlimited Low Power	Society of Midwest Contesters
WE9V	Central	Single Operator Unlimited QRP	Icom America
W9YK	Central	Multioperator High Power	Icom America
N9MT	Central	Multioperator Low Power	Icom America
K9IU (K7JOE, op)	Central	School Club	Icom America
WDØT	Dakota	Single Operator High Power	Minnesota Wireless Assn. — In memory of Tod Olson, KØTO
NAØN (@WØZT)	Dakota	Single Operator Low Power	Minnesota Wireless Assn.
KEØTT	Dakota	Single Operator QRP	Icom America
KTØA	Dakota	Single Operator Unlimited High Power	Minnesota Wireless Assn. — In memory of Jim Dokmo, KØFVF
K7BG	Dakota	Single Operator Unlimited Low Power	Minnesota Wireless Assn.
NØUR	Dakota	Single Operator Unlimited QRP	Icom America
KØHB	Dakota	Multioperator High Power	Icom America
KØEJ	Delta	Single Operator High Power	Icom America
N4OGW	Delta	Single Operator Low Power	Icom America
N5IB	Delta	Single Operator QRP	Icom America
N4DW	Delta	Single Operator Unlimited High Power	Icom America
N4ZZ	Delta	Single Operator Unlimited Low Power	Icom America
N6MA	Delta	Single Operator Unlimited QRP	Icom America
W5GAD	Delta	Multioperator Low Power	Icom America
K8MP	Great Lakes	Single Operator High Power	Icom America
W8CAR	Great Lakes	Single Operator Low Power	Icom America
K8BKM	Great Lakes	Single Operator QRP	Icom America
N4QS	Great Lakes	Single Operator Unlimited High Power	Icom America
K8BL	Great Lakes	Single Operator Unlimited Low Power	Icom America
K8ZT	Great Lakes	Single Operator Unlimited QRP	Icom America
W8EDU (AD8Y, op)	Great Lakes	School Club	Icom America
N2NT (N2NC, op)	Hudson	Single Operator High Power	Icom America
KU2M	Hudson	Single Operator Low Power	Icom America
KR2Q	Hudson	Single Operator QRP	Icom America
KD2RD	Hudson	Single Operator Unlimited High Power	Icom America
K2TW	Hudson	Single Operator Unlimited Low Power	John Thompson, K3MD
WA2JQK	Hudson	Multioperator High Power	Icom America
NJ1F	Hudson	Multioperator Low Power	Icom America
W2KGY	Hudson	School Club	Icom America
NØAX	Midwest	Single Operator High Power	Icom America
NØAC	Midwest	Single Operator Low Power	Icom America
NIØC	Midwest	Single Operator QRP	Icom America
NØXR (@NØNI)	Midwest	Single Operator Unlimited High Power	Icom America
KØVBU	Midwest	Single Operator Unlimited Low Power	Icom America
ABØS	Midwest	Multioperator High Power	Icom America
KØHC (WØBH, op)	Midwest	School Club	Icom America
K5ZD	New England	Single Operator High Power	Icom America
K1XM	New England	Single Operator Low Power	Icom America
W1XX	New England	Single Operator QRP	Icom America
W1SJ	New England	Single Operator Unlimited High Power	Icom America
KB1W	New England	Single Operator Unlimited Low Power	Icom America
K1RX	New England	Multioperator High Power	Icom America
W1FM	New England	Multioperator Low Power	Icom America
N9RV	Northwestern	Single Operator High Power	Icom America
WJ9B	Northwestern	Single Operator Low Power	Icom America
W7YAQ	Northwestern	Single Operator QRP	Icom America
K7RL	Northwestern	Single Operator Unlimited High Power	Icom America
K4XU	Northwestern	Single Operator Unlimited Low Power	Icom America
N7TL	Northwestern	Multioperator Low Power	Icom America
N6TV	Pacific	Single Operator High Power	Icom America
KH6CJJ	Pacific	Single Operator Low Power	Icom America
W6JTI	Pacific	Single Operator QRP	Icom America
KX7M	Pacific	Single Operator Unlimited High Power	Icom America
K7XC	Pacific	Single Operator Unlimited Low Power	Icom America
K6MI	Pacific	Single Operator Unlimited QRP	Icom America
K6TD	Pacific	Multioperator High Power	Icom America
K4ZW	Roanoke	Single Operator High Power	Potomac Valley Radio Club
K4OAQ	Roanoke	Single Operator Low Power	Icom America
AD8J	Roanoke	Single Operator QRP	Icom America
W4NF	Roanoke	Single Operator Unlimited High Power	Icom America
N1WR	Roanoke	Single Operator Unlimited Low Power	Icom America
W4TG	Roanoke	Multioperator Low Power	Icom America
K5TA	Rocky Mountain	Single Operator High Power	Icom America
N4VI	Rocky Mountain	Single Operator Low Power	Icom America
KØAV	Rocky Mountain	Single Operator QRP	Icom America
KØEU	Rocky Mountain	Single Operator Unlimited High Power	Icom America
WØZA	Rocky Mountain	Single Operator Unlimited Low Power	Icom America
WC7S	Rocky Mountain	Single Operator Unlimited QRP	Icom America
KØRF	Rocky Mountain	Multioperator High Power	Icom America
KK5OV	Rocky Mountain	Multioperator Low Power	Icom America
KP2M (KT3Y, op)	Southeastern	Single Operator High Power	Icom America
NP4Z	Southeastern	Single Operator Low Power	Icom America
K3TW	Southeastern	Single Operator QRP	Icom America
N4BP	Southeastern	Single Operator Unlimited High Power	Icom America
N4KH	Southeastern	Single Operator Unlimited Low Power	Icom America
W4THI	Southeastern	Multioperator High Power	Icom America
NP4DX	Southeastern	Multioperator Low Power	Icom America
K6LA	Southwestern	Single Operator High Power	Icom America
W6AYC	Southwestern	Single Operator Low Power	Icom America
N7IR	Southwestern	Single Operator QRP	Icom America
N5ZO	Southwestern	Single Operator Unlimited High Power	Icom America
N6CY	Southwestern	Single Operator Unlimited Low Power	Icom America
ND7K	Southwestern	Multioperator High Power	Icom America
W8TK	Southwestern	Multioperator Low Power	Icom America
K7UAZ (KG6T, op)	Southwestern	School Club	Icom America
NR5M (K5GA, op)	West Gulf	Single Operator High Power	Icom America
WD5K	West Gulf	Single Operator Low Power	Icom America
KJ5Y (KJØD, op)	West Gulf	Single Operator QRP	Icom America
K5RT	West Gulf	Single Operator Unlimited High Power	Icom America
WA8ZBT	West Gulf	Single Operator Unlimited Low Power	Icom America
WDØGTY	West Gulf	Multioperator Low Power	Icom America
VA7RR	Canada	Single Operator High Power	Icom America
VE5SF	Canada	Single Operator Low Power	Icom America
VY2ZM	Canada	Single Operator QRP	Icom America
VE5MX	Canada	Single Operator Unlimited High Power	Icom America
VA2WA	Canada	Single Operator Unlimited Low Power	Icom America
VA7DZ	Canada	Multioperator Low Power	Icom America

Top Ten

Single Operator, High Power

N9RV	244,776
W7RM (N6TR, op)	234,696
KP2M (KT3Y, op)	231,072
K5ZD	223,944
NR5M (K5GA, op)	220,416
N5RZ	219,784
W9RE	212,148
AA3B	211,650
N2NT (N2NC, op)	209,832
N2IC	209,326

Single Operator, Low Power

N4OGW	190,176
WJ9B	186,086
NP4Z	168,156
W6AYC	167,826
N5EE	166,830
NA0N (@W0ZT)	166,296
K3UA	160,392
K2PO	156,948
K1XM	154,214
NO6T (VE4EA, op)	153,216

Single Operator, QRP

VY2ZM	162,524
W2GD	126,160
VE3VN	104,632
N7IR	103,584
K0AV	95,256
K9ZO	92,824
K8BKM	92,332
W6JTI	90,364
KR2Q	85,440
W6YX (N7MH, op)	81,000

Single Operator Unlimited, High Power

VE5MX	237,888
K0EU	232,680
N5ZO	224,784
K9CT	215,040
K6LL	209,832
K7RL	203,516
KX7M	197,208
K3MM	196,392
WD6T (@N6RO)	195,720
KD4D	194,712

Single Operator Unlimited, Low Power

N4ZZ	191,352
VA2WA	180,774
K4XU	168,168
W9SN	162,624
W2FU (N2ZN, op)	158,696
N9CO	150,728
K2TW	147,906
W0ZA	136,566
VE3YT	135,954
K0VBU	134,644

Single Operator Unlimited, QRP

N0UR	78,560
WE9V	60,640
WC7S	45,752
N6MA	44,198
K6MI	22,940
KO3T	16,200
N3BNA	9,568
K8ZT	3,150
K6CTA	360
AG4CC	180

Multioperator, Single Transmitter, High Power

ND7K	246,792
K0RF	225,456
AB0S	202,188
K8IA	198,912
KY7M	196,728
NG3R	194,552
K0HB	124,832
K1RX	116,640
K3CCR	104,912
K6TD	88,644

Multioperator, Single Transmitter, Low Power

W8TK	175,896
NP4DX	159,526
N7TY	149,016
W1FM	86,592
W4TG	79,056
VA7DZ	69,916
W5GAD	62,550
WD0GTY	46,980
N9MT	24,080
K4MM	22,880

School Club

K0HC	148,176
K9IU	87,648
K7UAZ	57,996
W9JWC	32,200
W2KGY	252
W8EDU	98

Division Winners

Single Operator, High Power

Atlantic	AA3B	211,650
Central	W9RE	212,148
Dakota	WD0T	203,184
Delta	K0EJ	195,382
Great Lakes	K8MP	125,296
Hudson	N2NT (N2NC, op)	209,832
Midwest	N0AX	196,212
New England	K5ZD	223,944
Northwestern	N9RV	244,776
Pacific	N6TV	208,444
Roanoke	K4ZW	194,054
Rocky Mountain	K5TA	197,064
Southeastern	KP2M (KT3Y, op)	231,072
Southwestern	K6LA	208,994
West Gulf	NR5M (K5GA, op)	220,416
Canada	VA7RR	206,136

Single Operator, Low Power

Atlantic	K3UA	160,392
Central	N9JF	127,264
Dakota	NA0N (@W0ZT)	166,296
Delta	N4OGW	190,176
Great Lakes	W8CAR	151,724
Hudson	KU2M	100,440
Midwest	N0AC	128,740
New England	K1XM	154,214
Northwestern	WJ9B	186,086
Pacific	KH6CJJ	79,948
Roanoke	K4OAQ	125,296
Rocky Mountain	N4VI	65,440
Southeastern	NP4Z	168,156
Southwestern	W6AYC	167,826
West Gulf	WD5K	115,038
Canada	VE5SF	124,832

Single Operator, QRP

Atlantic	W2GD	126,160
Central	K9ZO	92,824
Dakota	KE0TT	54,668
Delta	N5IB	27,648
Great Lakes	K8BKM	92,332
Hudson	KR2Q	85,440
Midwest	NI0C	15,376
New England	W1XX	76,156
Northwestern	W7YAQ	71,680
Pacific	W6JTI	90,364
Roanoke	AD8J	64,476
Rocky Mountain	K0AV	95,256
Southeastern	K3TW	63,990
Southwestern	N7IR	103,584
West Gulf	KJ5Y (KJ0D, op)	32,802
Canada	VY2ZM	162,524

Single Operator Unlimited, High Power

Atlantic	K3MM	196,392
Central	K9CT	215,040
Dakota	KT0A	149,076
Delta	N4DW	140,768
Great Lakes	N4QS	183,098
Hudson	KD2RD	150,230
Midwest	N0XR (@N0NI)	181,604
New England	W1SJ	177,620
Northwestern	K7RL	203,516
Pacific	KX7M	197,208
Roanoke	W4NF	173,636
Rocky Mountain	K0EU	232,680
Southeastern	N4BP	181,936
Southwestern	N5ZO	224,784
West Gulf	K5RT	190,900
Canada	VE5MX	237,888

Single Operator Unlimited, Low Power

Atlantic	W2FU (N2ZN, op)	158,696
Central	N9CO	150,728
Dakota	K7BG	133,962
Delta	N4ZZ	191,352
Great Lakes	K8BL	126,160
Hudson	K2TW	147,906
Midwest	K0VBU	134,644
New England	KB1W	112,548
Northwestern	K4XU	168,168
Pacific	K7XC	103,252
Roanoke	N1WR	96,924
Rocky Mountain	W0ZA	136,566
Southeastern	N4KH	115,370
Southwestern	N6CY	113,544
West Gulf	WA8ZBT	76,916
Canada	VA2WA	180,774

Single Operator Unlimited, QRP

Atlantic	KO3T	16,200
Central	WE9V	60,640
Dakota	N0UR	78,560
Delta	N6MA	44,198
Great Lakes	K8ZT	3,150
Pacific	K6MI	22,940
Rocky Mountain	WC7S	45,752

Multioperator, Single Transmitter, High Power

Atlantic	NG3R	194,552
Central	W9YK	56,480
Dakota	K0HB	124,832
Hudson	WA2JQK	29,394
Midwest	AB0S	202,188
New England	K1RX	116,640
Pacific	K6TD	88,644
Rocky Mountain	K0RF	225,456
Southeastern	W4THI	25,760
Southwestern	ND7K	246,792

Multioperator, Single Transmitter, Low Power

Central	N9MT	24,080
Delta	W5GAD	62,550
Hudson	NJ1F	6,110
New England	W1FM	86,592
Northwestern	N7TL	2,250
Roanoke	W4TG	79,056
Rocky Mountain	KK5OV	10,848
Southeastern	NP4DX	159,526
Southwestern	W8TK	175,896
West Gulf	WD0GTY	46,980
Canada	VA7DZ	69,916

School Club

Central	K9IU	87,648
Great Lakes	W8EDU	98
Hudson	W2KGY	252
Midwest	K0HC	148,176
Southwestern	K7UAZ	57,996

Todd Bendtsen, VE5MX, built a two-tower contest station a few miles from his home in Weyburn, Saskatchewan, incorporating homebrewed Yagi antennas. [Todd Bendtsen, VE5MX, photo]

Full Results Online

You can read the full results of the contest online at **http://contests.arrl.org**. You'll find detailed analysis and more play-by-play, along with the full line scores. Improve your results by studying your log-checking report, too.

The 2021 ARRL November Sweepstakes (CW weekend) will be held November 6 – 8, 2021.

The 2021 ARRL June VHF Contest

1800 UTC Saturday, June 12 – 0259 UTC Monday, June 14

The June VHF Contest is right around the corner! The late-spring weather brings enhanced tropospheric ducting and meteor scatter. Plus, it's the peak of sporadic-E season. Take advantage of these propagation enhancements and have some fun on the VHF and UHF bands. With several different categories to participate in, there's something to match your favorite style of operating.

Here are some things to remember for this contest:

- The exchange is simple: Just the Maidenhead grid square you're operating from. For more information on grid squares, visit **www.arrl.org/grid-squares**.
- Assistance is permitted in all ARRL VHF Contests — so you can make announcements or chat with others about your contest activity (as long as the contact is completed over the air).
- Log submissions: Upload your Cabrillo log file to the contest web app at **http://contest-log-submission.arrl.org**. Paper logs can be mailed to ARRL – June VHF Contest, 225 Main St., Newington, CT 06111.
- Ten-day deadline: all logs must be uploaded or postmarked no later than 0259 UTC, June 24.
- Share your photos and VHF contest stories to the ARRL Contest Soapbox page at **http://contests.arrl.org/contestsoapbox.php**.

John Edwards, KB4BKV, and his son, Jason, operated from the northwest corner of grid square FM19 in western Pennsylvania during the 2020 ARRL June VHF Contest. John reported that the weather was perfect, and 6 meters kept them busy during the event. [John Edwards, KB4BKV, photo]

Complete rules can be found at www.arrl.org/june-vhf

June 2021 Kids Day

1800 UTC – 2359 UTC Saturday, June 19, 2021

The third Saturday in June is the time to encourage youngsters to get on the air and share in the excitement and fun that amateur radio can provide!

Sponsored by the Boring (Oregon) Amateur Radio Club, this event has a simple exchange suitable for a younger operator: first name, age, location, and favorite color. After that, the contact can be as long or short as each participant likes.

Kids Day is the perfect opportunity for you or your club to open your shack doors and invite kids over to discover what amateur radio is all about.

Complete rules and downloadable certificates of participation can be found at www.arrl.org/kids-day

Madison Frazier operated during the ARRL January 2021 Kids Day alongside her father, Aaron Frazier, KE8LVA. Madison reported that she made over 70 contacts on 80 and 40 meters and is looking forward to participating again in June. [Aaron Frazier, KE8LVA, photo]

W1AW Schedule

PAC	MTN	CENT	EAST	UTC	MON	TUE	WED	THU	FRI
6 AM	7 AM	8 AM	9 AM	1300		FAST CODE	SLOW CODE	FAST CODE	SLOW CODE
7 AM-1 PM	8 AM-2 PM	9 AM-3 PM	10 AM-4 PM	1400-1600 1700-1945	VISITING OPERATOR TIME (12 PM-1 PM CLOSED FOR LUNCH)				
1 PM	2 PM	3 PM	4 PM	2000	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE
2 PM	3 PM	4 PM	5 PM	2100	CODE BULLETIN				
3 PM	4 PM	5 PM	6 PM	2200	DIGITAL BULLETIN				
4 PM	5 PM	6 PM	7 PM	2300	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE
5 PM	6 PM	7 PM	8 PM	0000	CODE BULLETIN				
6 PM	7 PM	8 PM	9 PM	0100	DIGITAL BULLETIN				
6^{45} PM	7^{45} PM	8^{45} PM	9^{45} PM	0145	VOICE BULLETIN				
7 PM	8 PM	9 PM	10 PM	0200	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE
8 PM	9 PM	10 PM	11 PM	0300	CODE BULLETIN				

W1AW's schedule is at the same local time throughout the year. From the second Sunday in March to the first Sunday in November, UTC = Eastern US time + 4 hours. For the rest of the year, UTC = Eastern US time + 5 hours.

♦ Morse code transmissions: Frequencies are 1.8025, 3.5815, 7.0475, 14.0475, 18.0975, 21.0675, 28.0675, 50.350, and 147.555 MHz.

Slow Code = practice sent at 5, 7½, 10, 13, and 15 WPM.

Fast Code = practice sent at 35, 30, 25, 20, 15, 13, and 10 WPM.

Code bulletins are sent at 18 WPM.

For more information, visit us at
www.arrl.org/w1aw

♦ W1AW Qualifying Runs are sent on the same frequencies as the Morse code transmissions. West Coast qualifying runs are transmitted by various West Coast stations on CW frequencies that are normally used by W1AW, in addition to 3590 kHz, at various times. Underline 1 minute of the highest speed you copied, certify that your copy was made without aid, and send it to ARRL for grading. Please include your name, call sign (if any), and complete mailing address. Fees: $10 for a certificate, $7.50 for endorsements.

♦ Digital transmissions: Frequencies are 3.5975, 7.095, 14.095, 18.1025, 21.095, 28.095, 50.350, and 147.555 MHz.

Bulletins are sent using 45.45-baud Baudot, PSK31 in BPSK mode, and MFSK16 on a daily revolving schedule.

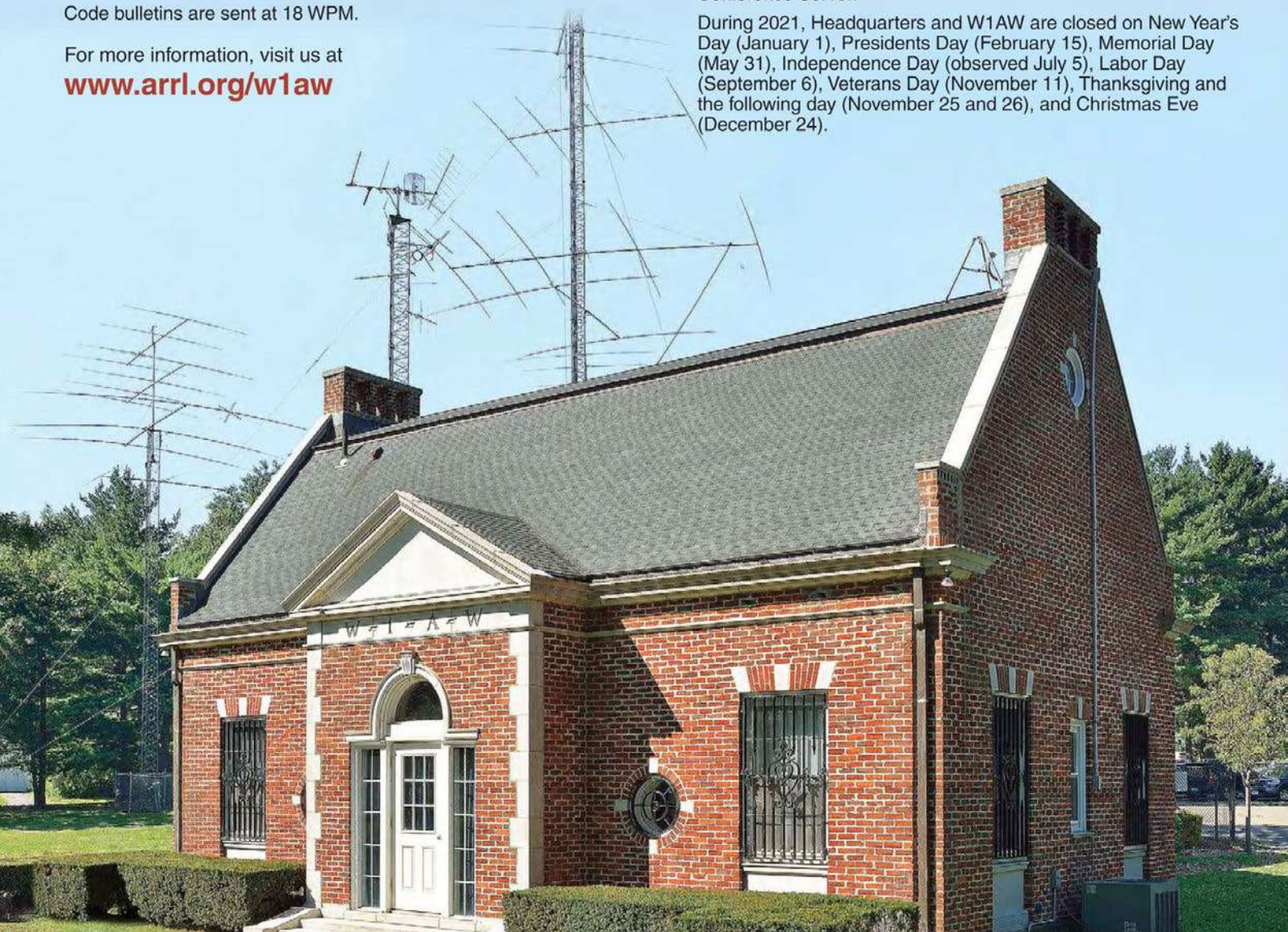
Keplerian elements for many amateur satellites will be sent on the regular digital frequencies on Tuesdays and Fridays at 6:30 PM Eastern time using Baudot and PSK31.

♦ Voice transmissions: Frequencies are 1.855, 3.99, 7.29, 14.29, 18.16, 21.39, 28.59, 50.350, and 147.555 MHz. Voice transmissions on 7.290 MHz are in AM double sideband, full carrier.

♦ Notes: On Fridays, UTC, a DX bulletin replaces the regular bulletins. W1AW is open to visitors 10 AM to noon and 1 PM to 3:45 PM Monday through Friday. FCC-licensed amateurs may operate the station during that time. Be sure to bring a reference copy of your current FCC amateur license. In a communication emergency, monitor W1AW for special bulletins as follows: voice on the hour, teleprinter at 15 minutes past the hour, and CW on the half hour.

W1AW code practice and CW/digital/phone bulletin transmission audio is also available real-time via the *EchoLink Conference Server* W1AWBDCT. The conference server runs concurrently with the regularly scheduled station transmissions. The W1AW Qualifying Run texts can also be copied via the EchoLink Conference Server.

During 2021, Headquarters and W1AW are closed on New Year's Day (January 1), Presidents Day (February 15), Memorial Day (May 31), Independence Day (observed July 5), Labor Day (September 6), Veterans Day (November 11), Thanksgiving and the following day (November 25 and 26), and Christmas Eve (December 24).



Bernie McClenny, W3UR, w3ur@arrl.org

QSL Manager to the World — Joseph L. Arcure, Jr., W3HNK

Joseph L. Arcure, Jr., W3HNK, has been a QSL manager for over 6 decades. Anyone who has a DX QSL card collection no doubt has received a QSL from W3HNK, who has managed the QSLing duties of hundreds of DX stations. This month, we take a look at the life of "the ultimate QSL manager."

The World's Most Recognized QSL Manager

Joe was born on Christmas Day 1933 in Scranton, Pennsylvania. When Joe was 17 years old, he joined the United States National Guard. Shortly afterward, the Korean War broke out and President Truman federalized the National Guard into the Army. During Joe's physical, it was discovered he had pulmonary tuberculosis, which booted him out on medical grounds when they gave him a 4-F card. Over the next year, Joe was in bed resting.

Introduction to Amateur Radio

His father, Joe Sr., a banker, enrolled Joe Jr. in a course in radio repairs. At this time, Joe knew nothing about amateur radio, but he got a quick introduction. The first thing he built was a superheterodyne receiver, and the person he made contact with was W3QVQ, who he located about a half-mile away. Joe was licensed in 1956 as WN3HNK.

About a year later, Joe's Novice license was about to expire, so he and his wife, Esther, went to New York City's FCC building, near "Radio Row," where he took his General license exam. He entered the testing room, intimidated by the rows of desks, each with a headset for taking the Morse code test. Moments after the code test began, with 13 words per minute, Joe's pencil broke, and he was forced to hand in a nearly blank test. Disappointed, he met up with Esther and told her what happened with the broken pencil. She responded, "I didn't drive all these miles through the Pocono Mountains and take a subway to find out you broke a pencil."

Joe Arcure, W3HNK, at his circa-1960 station on CW. [Paul Arcure, photo]

QSL Managers Joe Arcure, W3HNK, and Bob Schenck, N2OO, at one of the hospitality suites after the 2013 Dayton DX Dinner. [Bob Schenck, N2OO, photo]

Joe went back up and took the code test again, along with the written exam. He was successful and became W3HNK.

Joe's first station was from World Radio Laboratories, with a 40-meter folded dipole made out of TV ribbon. Joe has since set up his current station at the Hilltop Transmitting Association club station, about 6 miles from his home.

Becoming a DXer and QSL Manager

The DX bug hit him in 1957, with his activity on CW and AM, and like many of his friends, he eventually switched to SSB. In August 1963, Joe made a contact with George Baillie, ZE4JS (now Z24S), in the then-DXCC country of Southern Rhodesia (now called Zimbabwe). Wanting to confirm the contact from a country Joe had never worked before, he sent George an SASE (self-addressed, stamped envelope) with US postage. Thankfully, George sent back a QSL with Rhodesian postage and a note asking Joe to be his QSL manager. At the time, Joe did not know what a QSL manager was. But after reading George's letter, he agreed, and this was the first of many hundreds of stations for which W3HNK would act as QSL manager.

Over the years, many DX stations wrote to Joe, asking him to be their QSL manager. He never turned anyone away and always paid for the QSL cards. Joe used the presses at W9SKR (for over 40 years), W4MPY, and LZ1JZ, and now, he uses UX5UO. In 1979, Joseph L. Arcure, Jr., W3HNK, was inducted into the CQ DX Hall of Fame.

Being a QSL manager, Joe receives mail from all over the globe. As a boy, he used to collect stamps, but because he no longer does, Joe sends them to a ham in Florida who collects them.

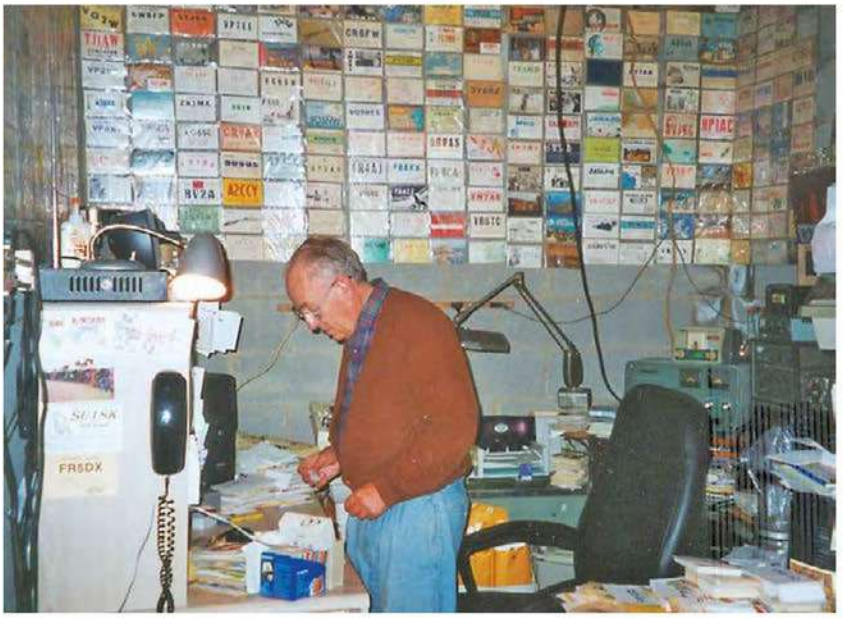
Other End of the Pileup

Joe has been on a few of his own DXpeditions, including PJ8AR on Sint Maarten, VP2VY in the British Virgin Islands, FG0AFC/FS7 on the French side of St. Marten, VP2EY in Anguilla, and VP5/W3HNK from the Turks and Caicos Islands.

On his first operation as PJ8AR, Joe recalled making a contact with a station in Australia (VK), and the man called him a bootlegger, as there was no such prefix as PJ8. Joe explained that the PJ8 prefix was used for visitors and PJ7 for locals on Sint Maarten. The man did not believe him until Joe made another contact with him during the CQ World Wide DX (SSB) Contest. Joe told the Australian ham, "I wouldn't be down here spending all my money and doing something illegal."

The DXer

W3HNK has 336 current countries confirmed in the ARRL DXCC Mixed standings, missing BS7 — Scarborough Reef, BV9 — Pratas, P5 — North Korea, and Z6 — Kosovo. For his all-time list, Joe has confirmed 362. Joe came close, but he missed making a contact with North Korea via Edishir, P5/4L4FN. Ed was very strong one night on 10 meters on SSB. Joe fired up his SB220 and Yaesu, but moments later, he received a phone call from his neighbor complaining about the interference. Two weeks later, Ed was booted out of the country.



Joe keeping busy organizing clients' information at W3HNK. [Paul Arcure, photo]

Joe's favorite mode is CW, and his favorite band is 15 meters, because it reminds him of his days as a Novice licensee and how good conditions were as he worked DX. He remembered back then, there was a problem with televisions being built with 21 MC IFs, which caused lots of TVI problems.

Wrap-Up

My first W3HNK QSL card was for a confirmation with YS1RRD (now YS1RR). It should be noted that Joe does not make money as a QSL manager. He fronts the money for the QSL cards for each of the stations he manages, and then any donations from DX stations are used to purchase future QSLs and for QSLs going to the bureau. Thank you, Joe, for your many years of giving back to the hobby and for all those QSLs. Until next month, see you in the pileups! — *Bernie, W3UR*

Strays

MARCO

The Medical Amateur Radio Council (MARCO) has devoted space in the February 2021 issue of their *Aether* newsletter to keep members informed about the best sources of pandemic information. Readers can view or download the issue at **https://marco-ltd.org/aether-newsletter-february-edition**.

QST Congratulates...

The Ogden (Utah) Amateur Radio Club (OARC), which is celebrating 100 years as an organized club in May 2021. Club President Dave Mamanakis, KD7GR, and Centennial Committee Chairman Gil Leonard, NG7IL, are directing the planning for the club's centennial year, including a special event station in May at the "Golden Spike" railroad commemoration at Promontory Point in Utah. Visit **www.ogdenarc.org** for more information.

Jon Jones, NØJK, n0jk@arrl.org

The World Above 50 MHz

New Zealand to North America February Opening

The Super Bowl was not the only extravaganza on Sunday, February 7, 2021. A major opening took place on 6 meters from New Zealand to North America. Sporadic E began early on Sunday morning on 50 MHz, with the first sporadic-E spots appearing around 1500Z from VE1 to W2. From Kansas, I, NØJK (EM28), had intense E_s to Texas and worked N5NA (DM92) and K5TDA (DM80) around 1625Z. The E_s faded by 1730Z in the Midwest, but continued along the East Coast all day. Around 2100z, the E_s became stronger and spread southwest from New England to the Gulf Coast and Mexico.

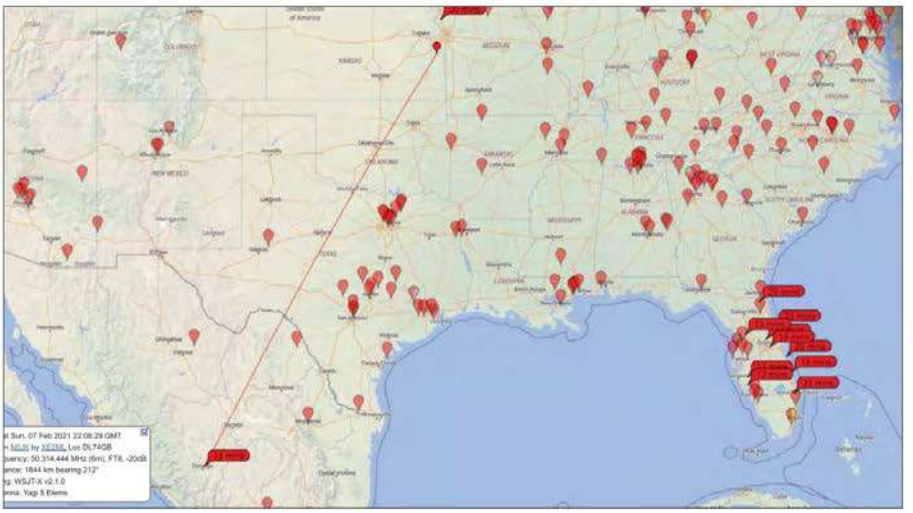


Figure 1 — A PSK Reporter map, showing the 6-meter flags from February 7, 2021. The line shows the contact between XE2ML and NØJK. [Image courtesy of **pskreporter.info/pskmap**]

At 2123Z, K1TOL (FN44) spotted ZL3NW (RE66), over 15,000 kilometers away. ZL3NW then spotted a number of New England stations on FT8, including W1VD, WA1EAZ, K1SIX, K1KA, and others. XE2OR (DL98) worked N2CG (FN20) at 2128Z. At 2239Z, W5LDA (EM15) in Oklahoma copied ZL1RS on FT8. ZL1RS (RF64) copied W5LDA on three consecutive sequences at +2, +7, –3, then he was gone. They did not complete a contact.

Stations from Mexico were strong into Kansas at this time, and John, KFØM (EM17), worked several. I decoded Martin, XE2ML (DL74), working WZ1V (FN31) at 2214Z, then I worked Martin a few minutes later at 2216Z (see Figure 1). I saw K1SIX (FN43) and AC4TO (EM70) at the same time in the Band Activity window. At 2240Z, VA1WV (FN75) heard XE2ML, and WA1EAZ (FN42) made a contact with Martin. Tim, WW1L (FN54), said, "The band is full of North American stations. Some [were] very strong."

The opening from North America to New Zealand faded by 2300Z. The E_s continued across North America until almost 0400Z. It was a remarkably strong and long-lasting E_s opening for the month of February. It was much like summertime openings. The extensive E_s allowed links to form extending to TEP (trans-equatorial propagation), then across the Pacific Ocean to New Zealand. The solar flux was only 73, far too low for F2 propagation from North America to Oceania.

On the Bands

50 MHz. Sporadic E took place on February 2, and I copied XE1FAS, XE2YWH, and made completed contacts with WA2VJL (EL06) at 2351Z with a "–08 report." I ran 10 W from a venerable MFJ-9406 on FT8 to a ¼-wave whip on his car. Al, WA2VJL, made 58 contacts on 6 meters that evening, mostly to W4, W8, and W9. On February 4, Larry, NØLL (EM09), worked XE2ML (DL74). I decoded N7WB/P (DM51), XE2OR (DL98), and KØJY (DM68). VK3OER (QF23) spotted KØTPP (EM48) at 0036Z on FT8 (see Figure 2).

Ron, K3FR (FM18), noted an opening on February 13 to Florida. NØLL worked W7OJT (DM24) and WØXR (DM22) on MSK144 meteor scatter on February 21.

222 MHz. Charlie, NØAKC, and Ray, WA4NJP, ran an experiment on February 28, 2021, on 222 MHz EME (Earth-moon-Earth) with the new *WSJT-X* Q65 mode. They called it the "How Low Can You Go Experiment."

They used Ray's 28-foot dish and 350 W, Charlie's 7-wavelength-long pair of M^2 antennas (23 elements, see Figure 3), and a KW SSPA. Ray and Charlie completed a contact on JT65. They had limited experience with the new Q65 mode. Charlie had made one EME contact on the mode, while Ray had never attempted one.

Figure 2 — Larry's, NØLL, VHF array. [Larry Lambert, NØLL, photo]

Figure 3 — Charlie Betz's, NØAKC, 222 MHz EME array. It is a combined 222 MHz/432 MHz array with two Yagis on 222 MHz and four on 432 MHz. [Charlie Betz, NØAKC, photo]

Running Q65-60A (60-second T/R sequences, 1.67 Hz spacing, 108 Hz width), the two completed a contact. Charlie said they "tried reducing power to see how low [they] could go and still work each other."

At 100 W output, they could both copy each other and still had a visible trace on the waterfall. They continued to reduce power, and eventually they made a complete contact with each running only 25 W. At that point, neither were able to see a visible trace on the waterfall; however, *WSJT-X* was still able to find the signals. Charlie said, "To be fair, Ray's big dish probably helped quite a bit, especially with the fact that he can rotate polarity. My antennas are fixed horizontally." Ray said Charlie's signal peaked when the dish was rotated to a 60-degree polarity. Charlie concluded, "It does make me wonder just what might be possible with other low-power stations via EME."

This was only one experiment, but it does show that the new Q65 mode does indeed work very well. (See the sidebar, "Recommended Q65 Submodes" for a list of modes that are known to be effective for specific applications.)

Recommended Q65 Submodes

- Standard ionospheric scatter on 50 MHz: 30A
- QRP ionospheric scatter on 50 MHz: 120E
- Ionospheric scatter on 144 MHz: 60C
- Tropo-scatter and rain-scatter at 10 GHz: 60D
- Small-dish EME, 10 and 24 GHz: 120E
- Other EME: 50, 144, 222 MHz MHz 60A; 432 MHz 60B; 1296 MHz: 60C; 10 GHz: 60D. From *Quick-Start Guide to Q65* by Joe Taylor, K1JT.

After Charlie and Ray completed their Q65 experiment, they went back to JT65 at 25 W to see if it would work, but they couldn't hear each other.

432 MHz and up. Jimmy, K5IM (EM20), found strong winter tropo across southern Texas on February 9 ahead of the historic winter snow storm that came through a few days later. He heard the NN5DX/b on 902.362 MHz at 1600Z. He then worked NN5DX (DM80) on 222, 432, 902, and 1296 MHz on SSB and CW. On 432 MHz, signals were S9 +20 dB. He also worked K5TRA (EM10) on 902 and 1296 MHz SSB.

Here and There

There was daily activity with Q65 on 6 meters in February. With sporadic E and tropo picking up in May, questions arise on whether Q65 will be used on sporadic E on 6 meters, whether tropo will be on 2 meters and up, and whether it will replace FT8. Regarding Q65, Hasan, NØAN, said it "may may be more fruitful to complete a scheduled contact for a difficult multiplier."

Maty Weinberg, KB1EIB, events@arrl.org; www.arrl.org/special-event-stations

Special Event Stations

Working special event stations is an enjoyable way to help commemorate history. Many provide a special QSL card or certificate!

Through Dec. 31, 0000Z – 2359Z, all calls, all areas. VE2GT and VE2NCG. **Quebec Parks on the Air (QCPOTA).** Certificate. *This is an operating event. See website for details.* **qcpota.ca**

Apr. 18 – Apr 19, 1300Z – 0400Z, W7W, Rochester, NY. W2JLD/ Special event coordinator. **World Amateur Radio Day**. EchoLink *ROC-HAM* CONFERENCE 531091 AllStar 2585, 47620, 53130. QSL. John Derycke, W2JLD, 85 Amherst St. #2, Rochester, NY 14607. **w2jld2@gmail.com**

Apr. 24, 1300Z – 1900Z, W1M, Russell, MA. Western Massachusetts Council BSA. **Woronoko Heights Outdoor Adventure**. 14.290 14.060 10.115 7.190. QSL. Tom Barker, 329 Faraway Rd., Whitefield, NH 03598. *Operating from the Horace Moses Scout Reservation.*

Apr. 24, 1400Z – 1930Z, W1BSA, Fall River, MA. USTNE NE1PL. **W1BSA Birthday of Scouting Event**. 14.259. QSL. Rick Emord, 135 Wareham St., Middleboro, MA 02346. *See website for up-to-date information.* **www.ne1pl.org**

May 7 – May 8, 1600Z – 2000Z, various call signs, Fort Huachuca, AZ. US Department of Defense. **Armed Forces Day Crossband Test**. USB 5330.5 14438.5 14383.5 13164; FM 2484. QSL. Station contacted. *Military stations will transmit on DOD frequencies and announce the amateur frequency they are monitoring. A complete list of participating stations, modes, frequencies, and times will be available after April 19, 2021. See website for details.* **dodmars.org**

May 7 – May 10, 1500Z – 2300Z, W7G, Corinne, UT. Ogden Amateur Radio Club, W7SU. **Golden Spike Special Event — W7G**. 14.255 7.235 7.074 7.040. QSL. Ogden Amateur Radio Club (OARC) — W7SU, P.O. Box 3353, Ogden, UT 84409. **www.w7g.org** *or* **ogdenarc.org**

May 8, 1600Z – 2300Z, NI6IW, San Diego, CA. USS *Midway* (CV-41) Museum Ship. **Battle of Coral Sea**. 7.250 14.320 14.070 (PSK31) D-STAR via PAPA System repeaters. QSL. USS *Midway* CV-41 COMEDTRA NI6IW, 910 N. Harbor Dr., San Diego, CA 92101.

May 9 – May 15, 0000Z – 2359Z, K3FBI/Ø through 9, Quantico, VA. FBI Amateur Radio Association. **National Police Week — Honoring Our Fallen Heroes**. 14.275 14.074 7.275 7.074; all bands, all modes. Certificate & QSL. Jay Chamberlain, NS4J, 27 Fox Run Ln., Fredericksburg, VA 22405. **www.qrz.com/db/k3fbi**

May 11 – May 12, 1500Z – 0200Z, WØCGM, Dundas, MN. South East Metro Amateur Radio Club. **Minnesota Birthday Bash**. 7.250. Certificate. SEMARC, 1655 68th St. W., Inver Grove Heights, MN 55077. **www.semarc.org**

May 15, 1200Z – 2200Z, W8TFC, Richwood, WV. The Family Center Amateur Radio Club. **82nd Annual Ramp Festival**. 444.450 14.250 7.250 3.850. Certificate. Wally Howerton, WA8LLY, 144 Chief Red Eyes Tr., P.O. Box 85, Richwood, WV 26261. *Certificates will automatically be completed and emailed if operator is listed in* **qrz.com**. **walter.howerton@frontier.com** *or* **thefamilycenterofrichwoodwv.com/Ham/default.html**

May 15, 1300Z – 1900Z, W1M, Russell, MA. Western Massachusetts Council BSA. **Woronoko Heights Outdoor Adventure**. 14.290 14.060 10.115 7.190. QSL. Tom Barker, 329 Faraway Rd., Whitefield, NH 03598. *Operating from Moses Scout Reservation.*

May 15 – May 23, 1500Z – 2300Z, W7SU/1ØØ, Ogden, UT. Ogden Amateur Radio Club. **Centennial Celebration.** 14.255 7.235 7.074 7.040. QSL. Ogden Amateur Radio Club — W7SU/1ØØ, P.O. Box 3353, Ogden, UT 84409. **www.qrz.com/db/w7su/100** *or* **ogdenarc.org/100**

May 22 – May 23, 1600Z – 1800Z, K7SWI, Nampa, ID. South West Idaho Amateur Radio Club. **Chicken Dinner Road**. 146.52 14.250 7.250 3.850. Certificate & QSL.* South West Idaho ARC, K7SWI, 323 W. Dewey Ave., Nampa, ID 83686-6638. **www.facebook.com/groups/SouthWestIdahoARC**

May 27 – Jun 1, 0000Z – 2359Z, W2F, Brooklyn, NY. James Gallo. **Fleet Week NYC**. 14.340. QSL. James Gallo, 149 Marine Ave., Brooklyn, NY 11209.

May 28 – May 31, 1800Z – 1800Z, W3M, State College, PA. Nittany Amateur Radio Club. **Birthplace of Memorial Day**. 7.195. QSL. W3M, Nittany Amateur Radio Club, P.O. Box 614, State College, PA 16801. **www.qrz.com/db/w3m**

May 28 – May 31, 1800Z – 2359Z, KØS, Springfield, MO. NØEW. **KØS Strange Antenna Challenge**. 28.500 14.310 7.200 3.900. QSL. Erik Weaver, 4857 E. Farm Rd. 136, Springfield, MO 65809. *Anyone may operate, just add /KØS to your call sign; /KØS station is responsible for their own QSL. The Strange Antenna Challenge is to utilize antennas* not *made of normal antenna materials.* **erikeweaver@gmail.com**

May 29, 1300Z – 2200Z, W2A, Christiansburg, VA. New River Valley Amateur Radio Club. **World War II Hero Audie Murphy**. 14.262 7.262 3.860. QSL. Danny Wylam, 710 McDaniel Dr., Christiansburg, VA 24073. *Operating from Brush Mountain on the Appalachian Trail, near the crash site.* **dannywylam@gmail.com**

Certificates and QSL cards: To obtain a certificate from any of the special event stations offering them, send your QSO information along with a 9 × 12 inch self-addressed, stamped envelope (three units of postage) to the address listed in the announcement. To receive a special event QSL card (when offered), be sure to include a self-addressed, stamped business envelope along with your QSL card and QSO information. *Note: Some clubs may ask for a nominal fee to cover the cost of the certificate or QSL. Request will be made on air during the event or on the club's website.

Special Events Announcements: For items to be listed in this column, use the ARRL Special Events Listing Form at **www.arrl.org/special-events-application**.

Submissions must be received by ARRL HQ no later than the 1st of the second month preceding the publication date; a special event listing for **August** *QST* would have to be received by **June 1**. In addition to being listed in *QST*, your event will be listed on the ARRL Web Special Events page. ARRL reserves the right to exclude events of a commercial or political nature.

Steve Ewald, WV1X, sewald@arrl.org; www.arrl.org/hamfests-and-conventions-calendar

Convention and Hamfest Calendar

A = AUCTION
D = DEALERS / VENDORS
F = FLEA MARKET
H = HANDICAP ACCESS
Q = FIELD CHECKING OF QSL CARDS
R = REFRESHMENTS
S = SEMINARS / PRESENTATIONS
T = TAILGATING
V = VE SESSIONS

Abbreviations

Spr = Sponsor
TI = Talk-in frequency
Adm = Admission

Arizona (Sierra Vista) — May 1 T V
7 AM – noon. *Spr:* Cochise ARA. Cochise ARA Building, 2756 S. Moson Rd. *TI:* 146.76 – (162.2 Hz). *Adm:* free. **www.k7rdg.org**

Connecticut (Goshen) — May 22 D F H R T V
8 AM – noon. *Spr:* Southern Berkshire ARC. Goshen Fairgrounds, 116 Old Middle St. (CT Rte. 63). *TI:* 147.285 + (77.0 Hz). *Adm:* $5. **www.sberk.org**

Iowa (Mason City) — June 5 D F H Q R S V
9 AM – 2 PM. *Spr:* Northland Amateur Communications Group. Music Man Square, 308 S. Pennsylvania Ave. *TI:* 442.275 + (100 Hz). *Adm:* $5, door $7. **www.ke0pou.com/nrr**

Michigan (Hudsonville) — June 5 F H T V
8 AM – noon. *Spr:* Independent Repeater Association. Hudsonville Fairgrounds, 5235 Park Ave. *TI:* 147.16 + (94.8 Hz). *Adm:* $8. **www.w8ira.org**

New Jersey (Succasunna) — May 15 D F H Q T
8 AM. *Spr:* Splitrock ARA. Horseshoe Lake Park, 72 Eyland Ave. *TI:* 146.985 + (131.8 Hz). *Adm:* $7. **www.splitrockara.org**

New Mexico (Clovis) — May 29 F H R S T V
8:30 AM – 4 PM. *Spr:* Eastern New Mexico ARC. Trinity Lutheran Church, 1705 W. 21st St. *TI:* 443.450 (131.8 Hz). *Adm:* none. **www.ka5b.org**

Ohio (Wauseon) — June 5 D F H R V
8 AM – 1 PM. *Spr:* Fulton County ARC. Roth Family Woodlot, 105 Hill Ave. *TI:* 147.195 +. *Adm: $5.* **www.k8bxq.org/hamfest**

To All Event Sponsors

Before making a final decision on a date for your event, you are encouraged to check the Hamfest and Convention Database (**www.arrl.org/hamfests-and-conventions-calendar**) for events that may already be scheduled in your area on that date. You are also encouraged to register your event with HQ as far in advance as your planning permits. See **www.arrl.org/hamfest-convention-application** for an online registration form. Dates may be recorded up to 2 years in advance.

Events that are sanctioned by ARRL receive special benefits, including an announcement in these listings and online. Sanctioned conventions are also listed in *The ARRL Letter.* In addition, events receive donated ARRL prize certificates and handouts. Once the form has been submitted, your ARRL Director will decide whether to approve the date and provide ARRL sanction.

The deadline for receipt of items for this column is the **1st of the second month preceding publication date**. For example, your information must arrive at HQ by **June 1** to be listed in the **August** issue. Information in this column is accurate as of our deadline; contact the sponsor or check the sponsor's website for possible late changes, driving directions, and other event details. Please note that postal regulations prohibit mention in *QST* of games of chance, such as raffles or bingo.

Promoting your event is guaranteed to increase attendance. As an approved event sponsor, you are entitled to special discounted rates on *QST* display advertising and ARRL web banner advertising. Call ARRL's toll-free number at 1-800-243-7768, or email **ads@arrl.org**.

Strays

AF4K Crystals to Reopen

Steve Johnson, WD8DAS, has purchased the AF4K Crystals business and will return it to service. For almost 20 years, AF4K Crystals was a source of vintage and modern radio crystals for ham radio and electronics projects. For more information, visit the new website at **www.af4k-crystals.com**.

MATPARC Donates Nearly $10,000 to Youth in STEM

On March 4, 2021, in their final act as a club, the Metro Atlanta Telephone Pioneers Amateur Radio Club (MATPARC) donated nearly $10,000 to the North Fulton Amateur Radio League's Youth, Education, Scholarship, and Associated Fund. MATPARC formerly focused on mentoring new hams, making use of a complete ham station in the AT&T building (where many club members worked). As membership dwindled and AT&T vacated the building, the club decided to sell any remaining equipment and donate the funds to support young people engaging with radio and STEM subjects.

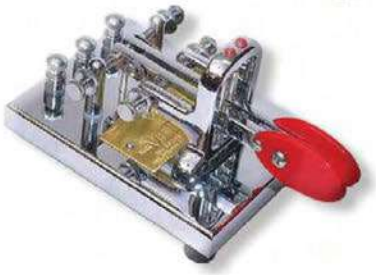
The Bolingbrook Health and Welfare Net

The Bolingbrook Amateur Radio Society (BARS) in Chicago established a nightly health and welfare net to keep area hams in contact with one another during the pandemic. Each night has a regular net control operator, and there is usually a question to help prompt discussion. The BARS linked repeater system is 147.330 MHz with + offset 107.2 Hz CTCSS and 443.525 MHz with + offset 114.8 Hz CTCSS. The repeater can also be found on EchoLink at K9BAR-R. The net is at 1930 Central Time every day. Visit **www.k9bar.org** for more information.

Certificate of Code Proficiency

Recipients

Sponsored by
VIBROPLEX
www.vibroplex.com



This month, ARRL recognizes merit and progress in Morse code proficiency on the part of the following individuals, who have achieved proficiency at the following rates, in words per minute.

December 2020

Robert C. Dupuis, K7CJN	10
Bobby P. Hargrave, KN4UCN	10
Robert T. Marston, AA6XE	10
Jason G. Warren, WE8L	10
Steve M. Kuzyszyn, KB2WQ	15
Nyles McKeithan, KS4S	15
David J. Warwick, K4DJW	15
David Loveridge, AC9TA	20
Nelson F. Mikeska, Jr., KI5JF	20

January 2021

Rene M. Beland, KE8NPD	10
Victor Denisov, N6DVS	10
Dale L. Martin, KG5U	10
Michael M. Piehl, K7LNT	10
David J. Redanz, N9HX	10
Frances R. Rogers, AC3GH	10
Burton D. Wizeman, K4SRQ	10
Norman R. Cox, KE0ZT	15
Clifford P. Culpepper, W4VN	15
Justin C. Jackson, Jr., WB4ABY	15
Kenneth A. Knox, KD2KEH	15
Robert T. Marston, AA6XE	15
Dale L. Martin, KG5U	15
Frances R. Rogers, AC3GH	15
Glenn E. Sigler, N8IJY	15
Galen L. Babcock, Sr., AG5LS	20
Edward G. Corbett, AA1ZX	20
Leonard G. Crispino, WB2MJH	20
Nyles McKeithan, KS4S	20
Dennis G. Martin, WA2USA	25
Robert S. Zarges, Jr., K2MZ	25
Robert S. Zarges, Jr., K2MZ	30
Frank P. Arciuolo, W1ZAH	35
Lahra "Flip" Svare, KT9X	35

February 2021

Kevin M. Brouelette, AJ6EE	10
Alton R. DeWeese, Jr., N4IDH	10
Michael L. Jones, KG6UBG	10
Daniel Lasorso, KD8OFT	10
Lawrence A. Lisle, K9KZT	10
James P. Long, N9EET	10
Kenneth L. Powell, KG4LLQ	10
Thomas S. Watson, W5ZBT	10
William N. Massie, AA8KY	15
Matthew J. Mikolay	15

March 2021

David A. Hewitt, WA9AVZ	10
Thomas P. Stelmach, NØQBX	10

Congratulations to all the recipients.

May 2021 W1AW Qualifying Runs

W1AW, the Hiram Percy Maxim Memorial Station at ARRL Headquarters in Newington, Connecticut, transmits Morse code Qualifying Runs to assist ham radio operators in increasing and perfecting their proficiency in Morse code. Amateur radio operators can earn a Certificate of Code Proficiency or endorsements by listening to W1AW Qualifying Runs.

May Qualifying Runs will be transmitted by W1AW in Newington, Connecticut at the times shown at 1.802.5, 3.581.5, 7.047.5, 14.047.5, 18.097.5, 21.067.5, 28.067.5, 50.350, and 147.555 MHz. The West Coast Qualifying Runs are tentatively scheduled to be transmitted by K9JM on Wednesday, May 26 at 9 PM PDT (0400 UTC on May 27) on 3590 and 7047.5 kHz. Unless indicated otherwise, sending speeds are from 10 to 35 WPM.

Amateur radio operators who participate in Qualifying Runs may submit proof of 1 minute of the highest speed they have copied in the hope of qualifying for the Certificate of Code Proficiency, or an endorsement to their existing certificate.

Legibly copy at least 1 minute of text by hand, and mail the sheet to: W1AW Qualifying Runs, 225 Main St., Newington, CT USA 06111.

Include $10 (check or money order) if this is a submission for your initial Code Proficiency certificate; $7.50 if you are applying for an endorsement (available for speeds up to 40 WPM). Your test will be checked against the actual transmissions to determine if you have qualified.

Members of the North Fulton (Georgia) Amateur Radio League (**https://nfarl.org/**) are offering to subsidize the total cost of a Code Proficiency certificate or endorsement submission for any individual age 21 years and younger, and who reside in either the US or Canada. Participants who wish to make use of this offer should indicate on their qualifying run submissions they are age 21 or younger, and certify as such via their signature. Eligible participants are not required to send any fee with their Code Proficiency submissions.

For more information about Qualifying Runs, please visit **www.arrl.org/qualifying-run-schedule**.

For information about how to qualify for the Certificate of Code Proficiency, please visit **www.arrl.org/code-proficiency-certificate**.

W1AW Code Proficiency Schedule — May 2021
(All times are in Eastern Daylight Time)

Monday	Tuesday	Wednesday	Thursday	Friday
5/3 4 PM – 2000Z 10 – 35 WPM	**5/4** 7 PM – 2300Z 35 – 10 WPM		**5/6** 10 PM – 0200Z **(5/7 – UTC)** 10 – 40 WPM	**5/7** 9 AM – 1300Z 10 – 35 WPM
	5/11 4 PM – 2000Z 10 – 35 WPM	**5/12** 7 PM – 2300Z 10 – 40 WPM	**5/13** 9 AM – 1300Z 35 – 10 WPM	**5/14** 10 PM – 0200Z **(5/15 – UTC)** 10 – 35 WPM
	5/18 9 AM – 1300Z 10 – 35 WPM	**5/19** 10 PM – 0200Z **(5/20 – UTC)** 35 – 10 WPM	**5/20** 7 PM – 2300Z 10 – 35 WPM	**5/21** 4 PM – 2000Z 10 – 40 WPM
		5/26 9 AM – 1300Z 35 – 10 WPM	**5/27** 4 PM – 2000Z 35 – 10 WPM	**5/28** 7 PM – 2300Z 10 – 35 WPM

Melissa Stemmer, KA7CLO, mstemmer@arrl.org

At the Foundation

The ARRL Foundation's Annual Board Meeting was held on January 27, 2021. Atlantic Division Director Tom Abernethy, W3TOM; Delta Division Director David Norris, K5UZ, and Brian Mileshosky, N5ZGT, were re-elected to the ARRL Foundation Board for a 3-year term by the ARRL Board of Directors at their January 15 – 16, 2021 Annual Meeting. Dr. David Woolweaver, K5RAV; Tim Duffy, K3LR; Jim Fenstermaker, K9JF; Ria Jairam, N2RJ; Rick Niswander, K7GM; Dick Norton, N6AA, and Mike Ritz, W7VO, remain on the ARRL Foundation Board to complete their terms. During the ARRL Foundation Annual Meeting,

Dr. Woolweaver was re-elected as President, Mileshosky was re-elected as Vice President, Niswander was re-elected as Treasurer, and Melissa Stemmer, KA7CLO, was elected as Secretary.

Dr. Woolweaver appointed Fenstermaker to serve as the Scholarship Committee Chair, with Abernethy, Duffy, Jairam, Norris, and Ritz also serving. Dr. Woolweaver appointed Mileshosky to serve as the Grants Committee Chair, with Norton and Dr. Woolweaver also serving.

The Foundation Board unanimously approved Ellwood ("Woody") Brem, K3YV, as the recipient of the 2020 Bill Orr, W6SAI, Technical Writing Award for his March 2020 *QST* article, "'Leaky' Antenna Switches," as recommended by the *QST* editorial staff.

The ARRL Foundation Scholarship Committee is in the process of reviewing applications for the 2021 Scholarship Awards. Recipients will be announced in May 2021.

Volunteer Monitor Program Reports

The Volunteer Monitor (VM) Program is a joint initiative between ARRL and the FCC to enhance compliance in the Amateur Radio Service.

In January 2021, Volunteer Monitors reported 2,277 hours monitoring the HF frequencies and 2,162 hours monitoring VHF frequencies and above.

The Volunteer Monitor Program Administrator issued 12 Advisory Notices. An Advisory Notice is an attempt to resolve rule violation issues informally before FCC intervention:

- Operators in Milwaukee, Wisconsin; Centralia, Washington; Edmond, Oklahoma; Fontana, California, and Orleans, Massachusetts, received Advisories concerning operation outside their license class.
- An operator in Thorn Hill, Tennessee, received an Advisory concerning interference.
- An operator in Ridgely, Tennessee, received an Advisory regarding excessive bandwidth.
- Operators in Miami, Florida; Friendly, West Virginia; Collinsville, Illinois, and Keansburg, New Jersey, received Advisories concerning station ID issues.
- An operator in Philadelphia, Pennsylvania, received an Advisory regarding improper use of a linear amplifier.

The Volunteer Monitor Program Administrator had two meetings in January with FCC Enforcement Bureau personnel.

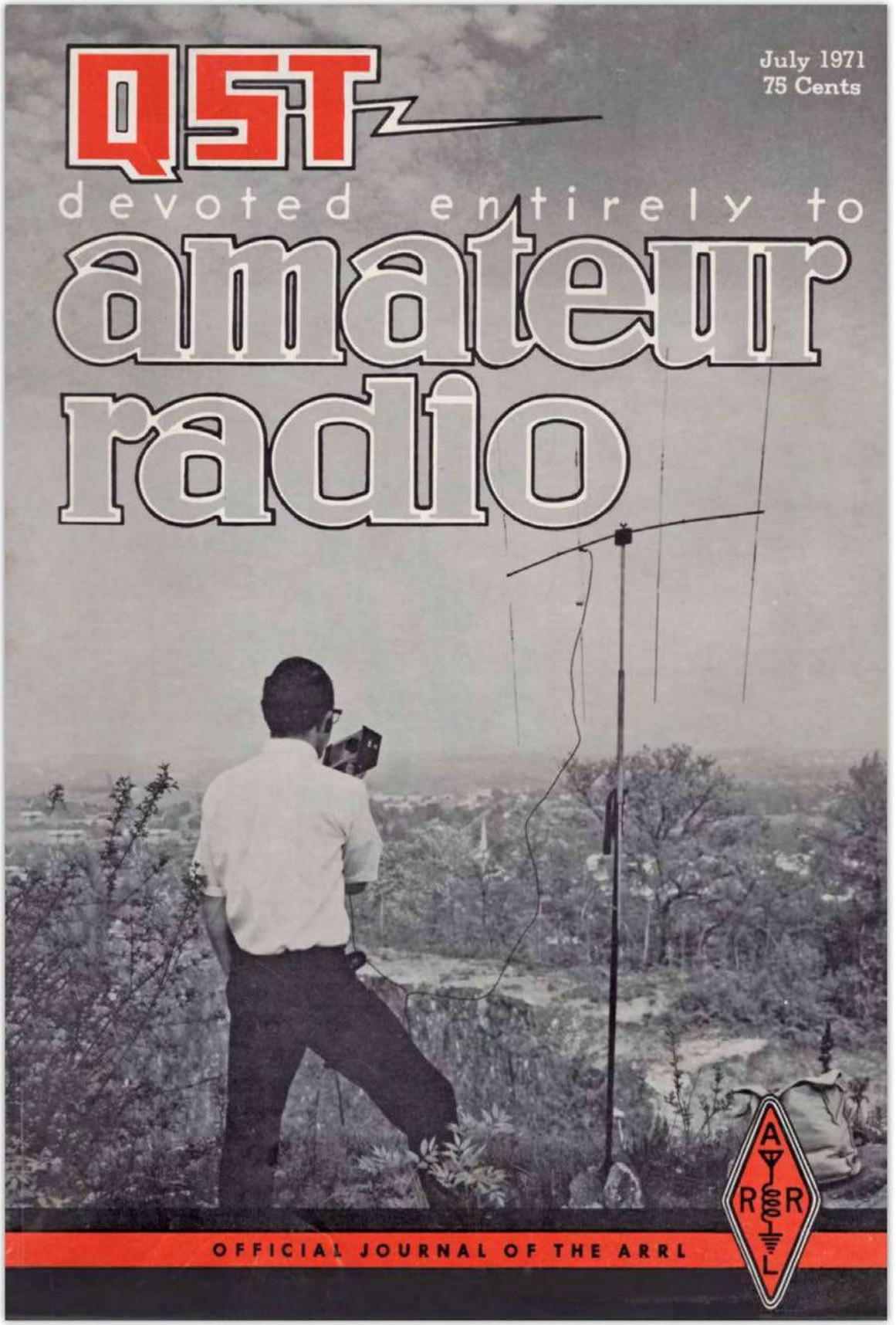
In February 2021 (as of the date of this writing), Volunteer Monitors reported 1,762 hours monitoring the HF frequencies and 2,158 hours monitoring VHF frequencies and above.

The Volunteer Monitor Program Administrator issued 10 Advisory Notices. An Advisory Notice is an attempt to resolve rule violation issues informally before FCC intervention.

- Operators in Holdenville, Oklahoma; Luzerne, Michigan; Miami, Florida, and Merrick, New York, received Advisories concerning operation outside their license class.
- Operators in Magalia, California; Jefferson, Georgia, and Redway, California, received Advisories concerning interference to repeater systems and HF net operations.
- An operator in Mansfield, Arkansas, received an Advisory regarding failure to ID.
- An operator in Charlottesville, Virginia, received an Advisory concerning improper bandwidth resulting in interference.
- A desert racing association in Odessa, Texas, received a warning about the use of amateur 2-meter frequencies for racing events.

The Volunteer Monitor Program Administrator had two meetings with FCC Enforcement Bureau personnel. — *Thanks to Riley Hollingsworth, K4ZDH, Volunteer Monitor Program Administrator*

A Look Back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July 1971
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ARRL

Two-Toter

A Lightweight Portable Beam for Two Meters

BY E. LAIRD CAMPBELL,* WICUT

ALMOST ANY part of the USA or Canada is now within the range of a repeater, so the chance for reliable communications in any territory under almost any condition is now a reality. With the advent of hand-held and battery-portable 2-meter transceivers, there is still an opportunity for participation and fun by the vhf man interested in portable work or mountain-topping . . . whether it's camping, or an afternoon hike to the hills.

Within the "normal" range of a repeater, a simple whip antenna will probably do the job. But for tripping fringe and over-the-hill repeaters, long-haul direct operation, or for some added directivity in a repeater-saturated area, a beam antenna can be very useful. Of course, if the antenna is to be transported by hand, it should be as light in weight as possible. The antenna described here fits all of the above criteria.

The Package

The portable antenna consists of a 4-element parasitic array with 0.2-wavelength element spacing. The elements are cut for the center of the 2-meter band. The driven element is gamma-matched and fed with 52-ohm coax feedline. Included in the package is a short wooden mast which can be attached to any available structure at the site; the antenna could also be hand-held. Whether the support be an old tree branch, ice axe, or alpenstock, the mast need not be more than a wavelength or so above the ground if the shot to the distant repeater or station is clear of local obstructions. Theoretical gain of this beam is slightly over 8 dB, referenced to a half-wave dipole.

* Managing Editor, *QST*.

Although the longest piece in the erected antenna is about 50 inches, the broken-down antenna package is about 13 inches long, 2 inches wide, and weighs about 14 oz (see Table 1). The boom, elements, and mast are actually sections of aluminum and wood that screw or push together. The antenna and mast can be assembled in approximately 2 1/2 minutes (if the Beaufort number is less than 2!).

Except for the driven element, each element consists of three sections of 1/8-inch aluminum rod held together with threaded unions. Aluminum welding rod works fine here, but use the hardest grade. Threaded 6-32 to 6-32 unions (A in Fig. 1) can be made by drilling and tapping short sections of 1/4-inch rod, if you can't come up with something at a hardware store. Cut the elements to length as indicated in Fig. 1. Thread (6-32) the proper ends (for example, the reflector would have one 13.3-inch rod threaded at both ends, and two 13.3-inch rods threaded at one end only).

In Fig. 1, note that except for the driven element the center rod of each element has a collet swaged to it. This is a cheap and easy way to prevent the rods from slipping through the oversize holes in the boom after the antenna is assembled. Since, in my case, the antenna is always used for

Anyone for a game of Pick Up Sticks? The longest piece in the package is about 13 inches and they all weigh in at 14 oz. If everything goes okay, the antenna can be assembled in a few minutes.

July 1971

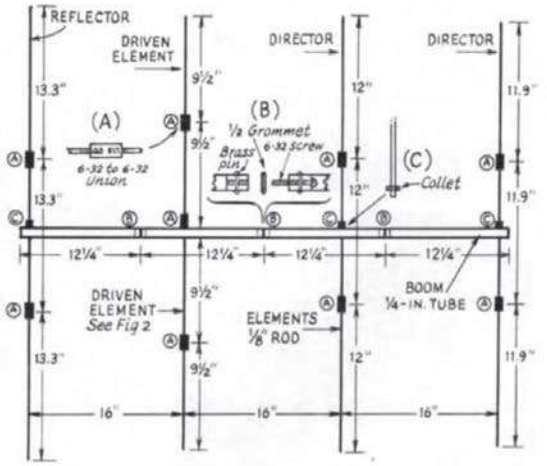


Fig. 1 — Dimensions and details of the 2-meter beam.

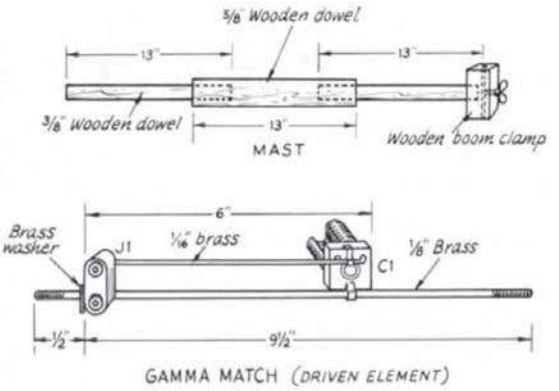


Fig. 2 — The wooden mast and driven element.

vertical polarization, gravity holds the elements in position; the collets prevent them from sliding all the way through. I made my collets from sections sawed from an old volume-control shaft. The original shaft was hollow and the rings slid easily over the elements. A whack with a hammer swages the collet fast to the element.

The driven element is a four-piece affair and is similar to the other elements except for the gamma section, shown in Fig. 2. A 1/8-inch and 1/16-inch brass rod is used here because it is easier to solder to brass than it is to aluminum. Again, a welding supply shop is a good source of material (or a model airplane supply store).

The gamma capacitor, C1, is soldered to both the large and small rods. For added gamma-rod support, bend a 90-degree radius at the end of the small rod and plug it into the hole in the ceramic frame of the capacitor. Now solder the capacitor tabs to the rods. You might notice that the gamma capacitor is mounted in a rather unorthodox fashion; that is, it is usually connected at the point where the feedline is attached, rather than at the point where the gamma rod connects to the driven element. However, it works fine as shown and gives spacing and support to the outer limits of the gamma rod.

The feed line is connected to a ceramic crystal socket which also acts as a support spacer for the gamma rod. An old crystal holder or a plug made for the socket is used to connect the feedline to the antenna.

Note the brass washer (Fig. 2) is soldered to the 1/8-inch brass rod. This forms a seat to hold the rod against the boom. The rod element is held there by a union from the other side of the boom (no collet required here).

The Boom

Four 12 1/2-inch sections of 1/4-inch aluminum tubing make up the boom. The sections are fastened together by 6-32 threaded "plugs" (B in Fig. 1) at the section ends. The plugs are forced inside the tubing ends. Even though the forced fit may be tight, the joints will get sloppy with use, so it is necessary to pin the plugs with brass brads or nails. Peen both ends of the nail for a snug fit.

Notice that with each pair of mating plugs, one plug contains a 1-inch 6-32 brass machine screw. Thread the screw through the plug before the plug is inserted in the boom tube. The brass nail will hold the screw fast so that when the boom pieces are mated the screw won't slip loose.

One half of a small rubber grommet is placed between the mating boom sections. Use an old razor blade to cut a grommet in half. Trim off the center piece of rubber so that both sides of the finished piece are flat and parallel. Push the half-grommet over the thread of the machine screw where it will stay put. The purpose of the grommet is to allow element alignment. The grommet allows 30 or 40 degrees of twist while maintaining a relatively tight connection between boom sections. By the way, don't drill holes in the boom sections for the elements until you have assembled the complete boom and all the sections are nearly tight. Drill the 1/8-inch element holes parallel to each other.

The gamma section of the driven element. The feed line attaches to the socket at the left.

Close-up of two boom sections (top). The rubber grommet gives a tight fit between sections and makes it possible to twist the sections for element alignment. Element pieces are joined with a threaded union (bottom). Note the dabs of paint to identify the proper matching sections.

The Mast and the Boom Clamp

Ordinary wooden dowels make up the mast. Any number of sections can be used to get the desired height, although mast material can probably be found at the operating site. My 40-inch mast is a 5/8-inch diameter dowel drilled at each end to accept 3/8-inch diameter dowels in a slip fit. The boom clamp is also wood, drilled to take the 3/8 dowel and 1/4-inch boom. Some kind of a boom clamp is necessary; the one shown in Fig. 2 works fine. A threaded chunk of brass (or a large nut) is cemented and then hammered into the wood. A threaded wing screw is finger-tightened against the boom.

Now Take to the Hills

This little antenna project can be put together in an evening or two. There are probably many refinements that could be made to improve the mechanical stability of the beam. The presentation here is simply an idea article for "Mod" I!

To allow easy assembly, color-code each adjacent joint of the boom and elements. Model airplane dope works nicely. Have the XYL make you a canvas tote bag (or get a telephoto lens bag at your photographic supply house) to fit the knocked-down antenna. Keep a handful of rubber bands or some twine in the bag for use in attaching the mast to whatever stanchion is available at the site. Try to keep the mast "nonferrous" within a half wavelength or so of the antenna in order to reduce losses and pattern distortion.

The feedline used is the miniature type, RG-174/U. Don't worry about attenuation in the cable for short lengths. A ten-foot length will only introduce about 0.4-dB loss. RG-58/U is less lossy, but it is larger, heavier, and difficult to wind into a small bundle.

Now take to the hills and have some fun! Remember, using this antenna effectively makes your peanut-whistle rig 6 times stronger than it would be with a whip, plus some added selectivity to boot. Who knows, with a lucky opening, you might even work a G, a KH6, a . . . QST

Table I
Antenna Weight

Item	*Weight (oz)*
4-element beam	7.0
40-inch wooden mast	3.5
Feedline and connectors	1.5
Tote bag	1.5
Rubber bands	.5
Total	14.0

Parts List

4 – 1/4-inch aluminum tubes, 12.25 inches long.
3 – 1/8-inch aluminum rods, 13.3 inches long.
3 – 1/8-inch aluminum rods, 12.0 inches long.
3 – 1/8-inch aluminum rods, 11.9 inches long.
3 – 1/8-inch aluminum rods, 9.5 inches long.
1 – 1/8-inch brass rod, 10 inches long.
1 – 1/16-inch brass rod, 6.25 inches long.
9 – 6-32 to 6-32 unions (A in Fig. 1).
6 – 6-32 1/4-inch "plugs" (B in Fig. 1).
3 – 1/8-inch ID collets (C in Fig. 1).
3 – 6-32 machine screws 1 inch long.
2 – Rubber grommets, 1/8-inch hole.
1 – Brass washer, 1/8-inch hole.
2 – 3/8-inch wooden dowels, 13 inches long.
1 – 5/8-inch wooden dowel, 13 inches long.
1 – Wooden boom clamp.
1 – Ceramic crystal socket.
1 – Plug to fit above socket.
1 – Connector to fit equipment.
1 – Hank of RG-174/U miniature coaxial cable.
1 – Handful of rubber bands.
1 – Canvas tote bag with draw string.

Hints and Kinks For the Experimenter

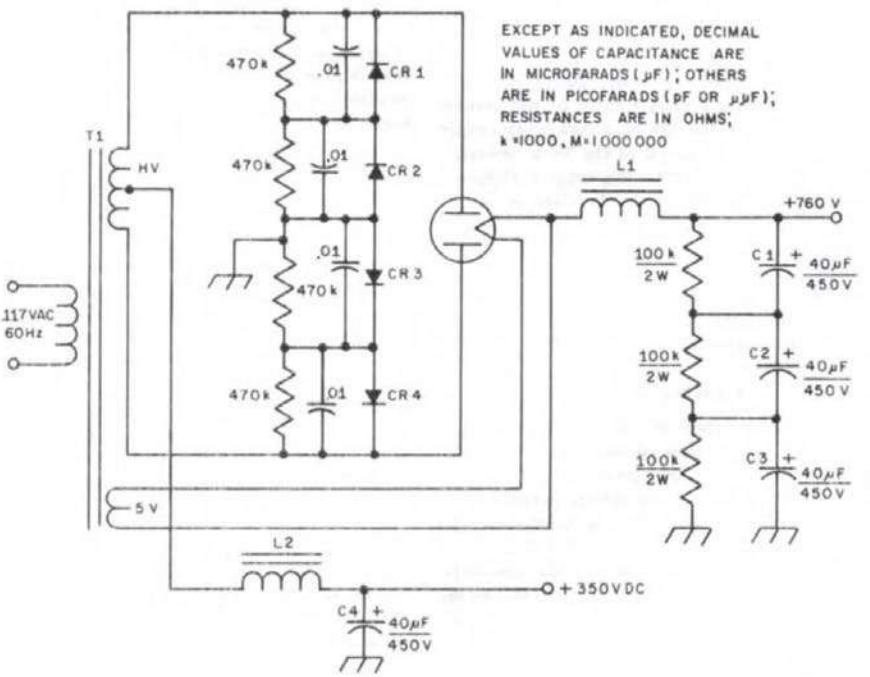
WOODEN HANDLE FOR EASIER BAND-SWITCH OPERATIONS

Recently I purchased some new gear, but because of my arthritis I was unable to operate the band switch. Al Roach, W6JUK, made up a little handle with a wooden grip which allows me to turn the switches in my station very easily. Outdoor-indoor carpeting is used on the front of the handle to protect the panels. – *Nick Hauck, K6QPE*

INCREASED VOLTAGE FOR TV-TYPE POWER SUPPLIES

Novice operator WN4SCF was running 40 watts with a junk-box rig consisting of a 6AG7 and an 807. The power supply used a TV transformer and a 5U4 rectifier. Since we wanted a Novice gallon, keeping within the tradition of building from the junk box, we decided to install a series of diodes in a bridge circuit across the 5U4 plate terminals on the tube socket. The addition of the diodes increased the plate voltage to 900 without a load, so a choke was installed to keep the capacitors from charging to the peak voltage supplied by the transformer. Using a 2-H choke, we reduced the voltage to 760. The modified power supply allowed us to load the amplifier stage to 75 watts input. – *Gerald L. Collins, W8BQE, and Frank Kendall, WN4SCF*

Circuit diagram for increasing the voltage of a tube-type full-wave rectifier power supply.
C1-C4, incl. – 40-μF, 450-V, electrolytic.
CR1-CR4, incl. – 600-PRV, 1-A silicon rectifier.
L1, L2 – 2-H filter choke, TV replacement type.
T1 – TV transformer. ▼



ELIMINATING TUBE NOISE IN THE HALLICRAFTERS HT-37

When operating break-in cw while using a TR switch, a noise is generated within the HT-37, under key-up conditions, which can create a "hash" in the receiver. A relatively simple modification, passed along to me by Jim Ricks, W9TO, takes care of the problem nicely. Although I have not personally tried this modification with the HT-32, it should work equally well.

Disconnect the grounded end of R26 (15,000-ohm, 1/2-watt resistor) and reconnect it to the keying line which is connected to one end of R72 (4700-ohm, 1/2-watt resistor). The keying line at R72 is on the side *opposite* R71 (10,000-ohm, 1/2-watt resistor). These resistors are mounted on a terminal strip on the underside of the chassis. After the modification is completed, set the bias voltage as prescribed in the instruction manual. – *Bill Bryant, W4UX*

A HANDY NAME PLATE

Shown in the photograph is a name plate I made from a piece of scrap aluminum and bulletin board letters. The letters are available from many stationery stores for about 10 cents each. – *Robert M. Patton, WA3HOW*

The handy name plate

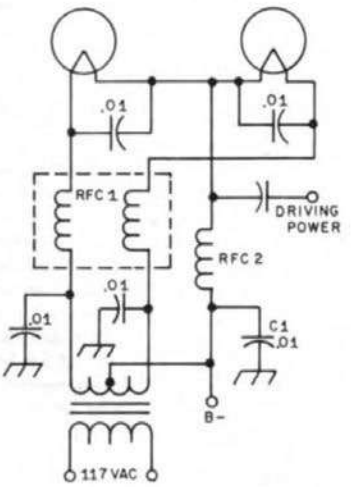
HEAT REDUCTION IN AMATEUR TRANSMITTERS

Excessive heat is sometimes a problem in amateur gear. It becomes acute if the unit is placed in a position which restricts the air circulation. An easy solution is to place a small fan, such as a Rotron Whisper Fan, on top of the cabinet over the final amplifier compartment. The fan will pull out hot air and bring in cool air from underneath the cabinet. This system is especially helpful when used with TV sweep-tube amplifiers.

A Venturi type of fan has a supporting structure around the fan blades. This serves as a place to mount small rubber feet to protect the top of the cabinet. – *Paul Kent, WAØUPD*

SERIES CONNECTION OF FILAMENTS IN GROUNDED-GRID AMPLIFIERS

When two identical high-power tube filaments are connected in series, the filament voltage may not split equally since there are some differences in the warm-up time. One of the tubes may heat faster than the other, resulting in a greater voltage drop across that tube's filaments. The increased voltage will heat it further and the added heat will increase the resistance. The hotter tube will receive the higher voltage. In my amplifier, a pair of 4-250s, one tube received 9 volts while the other received 1 volt.



Circuit diagram for series connecting the filaments. Component designations are for text reference.

Connecting the filament transformer center tap to the point where the tubes are joined together will eliminate the problem because each tube is fed independently. In the grounded-grid configuration, the circuit shown can be used. The only additional part required is RFC2, which is similar to RFC1. The new choke could be wound on a separate piece of ferrite rod, or the original choke could be rewound with three conductors instead of two. Of course the cold end of this new choke must be properly bypassed with a capacitor (C1 in the circuit shown). – *Leonard Lehmann, WB2GTU*

INSULATION FOR HOMEMADE TRANSFORMERS

For insulation between layers of turns in a homemade transformer, the plastic bags used for roasting meats, manufactured by Reynolds Metals Company, work well. The trade name is "Brown-In-Bag" and the material is slightly over .001 inch thick. Of course, the material will withstand high temperatures. No tests have been made to determine the voltage breakdown point, but I have used this material successfully with transformers up to 750 volts rms. – *W. Vollkommer, W2HO*

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Celebrating Our Legacy

Discovering Radio at 8 Years Old

While exploring the family attic at 8 years old in 1949, I found a large, ornate, wood-encased Zenith radio, which had been inoperative for years. I plugged it in and hit the back of the chassis with a broom. I heard music! I've been hooked on amateur radio ever since.

While I experimented with electrical and electronic devices over the following years, it wasn't until 1960 that I earned my first ham radio license. I first got on the air with a well-used Johnson Viking Challenger and Hallicrafters SX-24 Skyrider Defiant. Soon after, I upgraded to my Technician-class license. My first phone radio was the Heathkit HW-29, also known as the Benton Harbor Lunchbox.

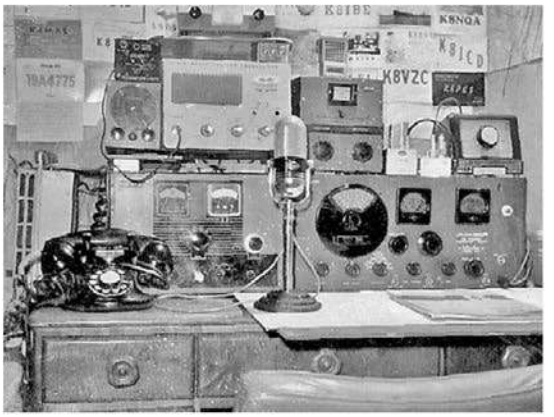
During my late teenage years, I put together a mega station in my parents' basement, building a four-channel, 1,000 W based amplifier for the 6-meter band. The power supply featured a "power peg" power line step-down transformer, which had once been attached to a telephone pole. I ran it backwards: 120 V in and 3,500 V out. The big mercury-vapor rectifier tubes really put on a light show when I transmitted.

With the Vietnam War draft looming, I volunteered to join the US Coast Guard. I graduated from electronics school, served for 4 years as an electronics technician, and upgraded to my General-class license. Electronics technicians needed to learn how to repair anything from radios to radar and sonar. I became an expert in air-search radar and cryptography.

A high point for me was operating for a year from the Loran transmitting station on Biorka Island, Alaska. From this isolated Aleutian island, my only connection with civilization was ham radio. A local CW net got me hooked on increasing my Morse code speed. It resulted in a lifelong love of the original digital mode. I've seen online that my old call sign, KL7FSX, is still listed as the activator on Islands on the Air (IOTA) for Biorka Island, and that a few of my old QSL cards are for sale as historic antiques on eBay and a few other websites.

Over the years, I've always stayed on the air in one form or another, including Summits on the Air (SOTA), CW, building radios, and more. My favorite radio is my old Drake TR-4. Coupled with an Ameritron AL-811 amplifier, I can work the world.

Dennis J. Lazar, W4DNN
Port Charlotte, Florida



Dennis J. Lazar's, W4DNN, station in the early '60s, as he transitioned from Novice to Technician.

Shortwave Listening Changed My Life

During the late '50s, I discovered shortwave listening (SWL) and got hooked listening to news broadcasts and other information from foreign countries. During the summer of 1957, I was given an old Farnsworth AM Tabletop radio in a brown Bakelite case. The radio had a small slide switch on the rear chassis that opened my world to SWL. I soon had a long wire antenna strung from my bedroom window to a tree in our backyard.

One evening, my SWL was interrupted by a high signal that wiped out the entire band. The next morning, I discovered a large three-element beam in my neighbor's backyard. The antenna belonged to a youth about my age, who invited me to see his ham radio station. That first meeting grew into a lifelong friendship.

After high school, I worked in the radio industry as a DJ and news announcer at several radio stations in Pittsburgh, Pennsylvania, and earned my General-class license along the way. Soon after, I received my draft notice and was eventually sent to US Naval Radio School. Because I was sending and receiving faster than what was required to graduate, I received a travel order to San Juan, Puerto Rico, for my ship assignment, after only 6 weeks of school.

Some of my greatest memories of my Navy duty were when I received permission to bring my radio aboard during a Mediterranean cruise. I operated during my off-duty hours and ran phone patches from the port of Naples, Italy, during Christmas in 1966, and made contact with two Antarctic bases.

When my 6 years in the Navy were up, I returned to Pittsburgh, married my high school sweetheart, and took a job in sales instead of broadcast radio.

My sales territory grew to cover the states of Washington, Oregon, Idaho, Montana, Wyoming, and Alaska, presenting a great opportunity for mobile HF operations. I quickly amassed counties toward the County Hunter of the Year Award, Worked All States (WAS), and worked DX from my car in the evenings.

Ham radio opened up a new world for me — I've traveled to all 50 US states and 30 foreign countries. I now have my Amateur Extra-class license, am a Volunteer Examiner, and act as liaison to the county Red Cross for emergency communications. Looking back, it all started with a shortwave radio and a chance meeting with a ham radio operator that went on to change my life.

Ed McLaughlin, W6OLA
Kennewick, Washington

Send reminiscences of your early days in radio to "Celebrating Our Legacy," ARRL, 225 Main St., Newington, CT 06111 or **celebrate@arrl.org**. Submissions selected for publication will be edited for space and clarity. Material published in "Celebrating Our Legacy" may also appear in other ARRL media. The publishers of *QST* assume no responsibility for statements made in this column.

George Misic, KE8RN, ke8rn@comcast.net

Classic Radio

Novice Receivers from the 1960s

Several manufacturers of amateur radio equipment offered low-cost receivers aimed at Novice-class licensees. Here is a collection of 1960s-era receivers priced at or below $100, primarily designed for beginners.

Hallicrafters

Hallicrafters, like others, built a line of low-cost receivers that were often used by Novices and beginners. The low end was known as the Sky Buddy series, starting in 1935 as the model 5-T long before the Novice-class license. The better-known S-19 and S-19R (see Figure 1) versions came out in 1938 and 1939, respectively, and both still more than a decade before the Novice license. The well-known S-38 series appeared right after World War II in 1946 for $40 assembled (the S-38 family was never sold as a kit) and later versions remained on the market until 1961, and it only rose in price to $55. The S-119 Sky Buddy II became available in 1959, and it was sold as a kit for $40 and assembled for $50. The S-119 only received 535 kHz to 16.4 MHz on three bands, so it did not cover the popular Novice band on 15 meters. The S-120 was a low-cost receiver made in the US, using four tubes for $60 in 1960 to 1963. In 1969, the S-120A from Japan entered the market and remained available until 1971 for $60. It was a solid-state receiver.

In 1960, Hallicrafters sought to directly address the Novice market with the SX-140 receiver covering the 80/75-, 40-, 20-, 15-, 10-, and 6-meter bands. The SX-140 addressed new Technician-class licensees by covering the 6-meter band, the Novice bands on 80, 40, and 15 meters, and the popular bands on 20 meters and 10 meters. The SX-140 initially cost $95 when first sold, and by 1965, it cost $140.

Conar

Conar offered the model-500 Novice receiver as part of their National Radio Institute Novice amateur radio training course in the mid-1960s. The receiver covered all of the 80/75-, 40-, and 15-meter ham bands. The receiver used four tubes and had a built-in speaker. The tubes were a 6BE6 converter, a 6BZ6 first intermediate frequency (IF), a 6U8 second IF and BFO, and a 6U8 audio amplifier and audio output stage. The receiver used a power transformer with a silicon diode to rectify the ac power. The unit also used an antenna trimmer to peak the input with the antenna that the operator chose to use.

Heathkit

Heathkit offered many low-cost receivers, starting in 1949 with the AR-1 receiver, which was transformer powered and covered up to 35.0 MHz. It required modifications to be able to receive CW. It was followed in 1953 by the AR-2, which covered up to 35.0 MHz and came with a BFO for CW. The third receiver in this series was the AR-3 (see Figure 2). It was available from 1955 to 1961. Like the other two receivers, it was transformer powered, but the cabinet was optional. They all came with a speaker; the AR-3 was the first of the family to have a dial light.

Other low-cost Heathkit receivers include the GR-54 kit released in 1966 for $85, the GR-64 kit released in 1964 for $38, the GR-81 released in 1962 for $23, the GR-91 released

Figure 1 — Hallicrafters S-19R was originally introduced in 1939. [Photo courtesy of **universal-radio.com**]

Figure 2 — The Heathkit AR-3 was originally released in 1955. [Photo courtesy of **universal-radio.com**]

in 1961 for $40 in kit form, the solid-state SW-717 released in 1972 for $70, and the amateur band-only HR-10 released in 1961 for $75 in kit form. Of the low-cost Heathkits, only the GR-81 and GR-91 lacked a power transformer for user safety because of the risk of a hot chassis causing ac shock. The HR-10 was a major step up in performance over the other receivers listed. It had seven tubes, but unlike the others, it lacked a built-in speaker.

Allied Radio Knight Kits

Heathkit's primary competitor in the 1960s was the Knight Kit line from the Allied Radio Company, located in Chicago, Illinois. They sold kit-form receivers in 1957, starting with the Space Spanner receiver for only $16. The receiver was a hot-chassis, three-tube regenerative design, but it came with a cabinet and a built-in speaker. For a bit more, the Space Master also premiered in 1957 for $25 in kit form. It only had two tubes, but it used a power transformer. It was also a regenerative design.

In 1961, the more impressive-looking R-55 receiver became available for $60. It became the R-55A in 1965, and the name held until 1968 with few changes at the same price. This receiver was a superheterodyne with six tubes and a power transformer.

RadioShack

RadioShack built a few low-cost receivers using the Realistic trade name. The DX-75 was sold from 1965 to 1966 for $70. It used four tubes but had a power transformer and silicon diode rectifiers. The band spread was not calibrated for the amateur bands. It just read from 0 to 100. The DX-100, which was on the market from 1981 to 1984, and the DX-120 Star Patrol, which was on the market from 1970 to 1971, were both solid state. The DX-100 cost $100, but it had a built-in speaker and a ceramic IF filter. The DX-120 was only $70 and did not have calibrated band spread, but it did use a field-effect transistor (FET) RF amplifier.

National

National made two inexpensive, but functional, receivers: the SW-54, available from 1950 to 1957, and the NC-60 (see Figure 3), available from 1957 to 1964. Both receivers were hot-chassis designs made with five tubes, a 12BE6 converter (mixer-oscillator), a 12BA6 IF amplifier and BFO, a 12AV6 detector and first audio, a 50C5 audio output stage, and a 35Z5 or 35W4 rectifier. The NC-77X was very similar to the NC-60, but with a new case, and the NC-77XW in a walnut wooden case. In my opinion, the SW-54 and the NC-60 are a step above many similar five-tube ac/dc receivers. Although the band spread did not have calibrations other than a 0 to 100 scale, the owner's manual for the NC-77X and NC-77XW had a chart to provide ham radio and SWL band calibrations.

Eico

Eico mainly made test instruments, Novice-class transmitters, and other kits, but they also made an entry-level receiver called the 711 Space Ranger (see Figure 4), first introduced in 1967. The receiver was sold wired and ready to use for $70 or as a kit for $50. The 711 covered 0.55 to 30 MHz and included an S-Meter (only functional on AM), a built-in speaker, an uncalibrated band-spread control, and a ¼-inch headphone jack.

Hammarlund and RME

Hammarlund and RME did not enter the $100-and-under market; the lowest cost Hammarlund after the beginning of the Novice-class license was the HQ-100 general-coverage receiver with amateur band spread in 1956 for $169. RME had no low-cost receivers when the Novice license became available.

Figure 3 — The National NC-60 was originally from 1957. [Photo courtesy of **universal-radio.com**]

Figure 4 — The Eico 711 Space Ranger was originally released in 1967. [Richard Post, KB8TAD, photo]

Al Brogdon, W1AB

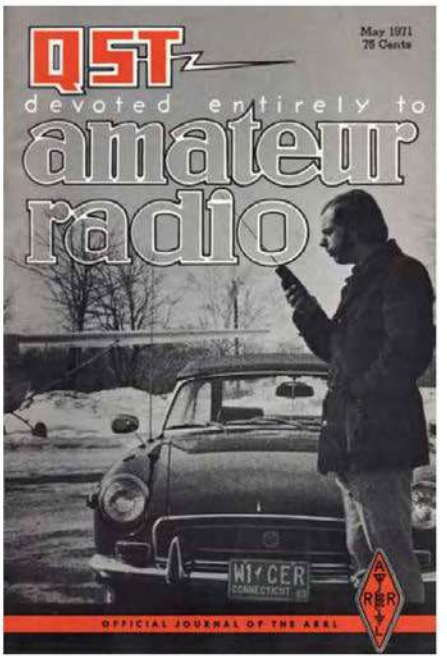
100, 50, and 25 Years Ago

May 1921

- The cover photo is of operator 1HX, with her headphones on.
- The editorial, "Another Poindexter Bill," reports that Senator Poindexter introduced a bill that would put amateur radio stations under the control of the US Navy, which has attempted to close down ham radio in the past.
- The editor's note in "The Antenna," by John C. Stroebel, Jr., 8ZW, comments that "We do not know nearly as much about what is good aerial design as we do about the design of the rest of our apparatus," and highly recommends reading the article.
- "The Resonant Converter," by Walter S. Lemmon, describes the device he developed, and has used for some time, to produce the desired high musical tones in his transmitter.

May 1971

- The cover photo shows Dave DeMaw, WN1LZQ, listening to a 2-meter repeater using a handheld receiver.
- The editorial uses humor to point out how the ARRL Board listens to the (widely) divergent views on the various issues in ham radio at its meetings, and strives to reach the best decisions.
- Kenneth Macleish, W7TX; Henry O. Pattison, W7EFV, and Roy C. Hejhall, K7QWR, present "The Rec/Counter," a compact counter built with three integrated circuits that show you the frequency of an incoming signal.
- In "An FM Listener's Potpourri," Douglas Blakeslee, W1KLK, discusses various aspects of listening to ham FM signals to help the ham FM newbie.
- Jerry Hall, K1PLP, and Gus M. Wilson, W1NPC, explain "A Single-Band Converter" that can be built to tune any of the HF ham bands with its output at 1600 kHz.
- James Lawson, W2PV, shares "Simple Arrays of Vertical Antenna Elements" and their optimization using computer antenna modeling.
- Gary O. White, WA4UNW, built "The RTL-1 RTTY Converter" using resistor-transistor logic.
- Lewis McCoy, W1ICP, discusses "Some Plain Facts About Antennas, Feeders, and Transmatches."
- In "Phone Patching and the Telephone Network," George P. Schleicher, W9NLT, explains some of the fine points of telephone transmission to help get the best quality with your ham phone patches.



May 1996

- The cover photo shows Mark Gummer's, N2IQU, 48-foot EME dish that he assembled from government-surplus scrap, in order to create a powerful presence on 144, 432, and 1296 MHz EME.
- The editorial asks, "Is There a Spectrum Shortage?" and reports on the four en banc meetings of the FCC Commissioners.
- In "Up Front in *QST*," Sam Garshofsky, W2PWF, shares two photos of the B-29 World War II bomber, *Sentimental Journey*, which he saw in the Pima Air Museum in Tucson, Arizona. Underneath the aircraft's nose is the Federal Aviation Administration (FAA) registration number, K4OK.
- In "Ill Winds Blow," Jerry Herman, N3BDW, and Rick Palm, K1CE, review the 1995 hurricane season and the communications assistance provided by hams.
- Bill Carver, K6OLG, shares "A High-Performance AGC/IF Subsystem," to help hams reach exceptional receiver performance.
- "Computer Control for Ramsey's FX-146 and FX-440 Transceivers," by Richard Kowalsky, N7RAY, and Mike Jamieson, KB7QCQ, reports on the addition of a small microprocessor to those radios to "hot rod" their performance.
- In "Hamming in the Kyrgyz Republic," Drew O. McDaniel, W8MHV, shares how he overcame official and practical obstacles to operate from the former Soviet Republic during his travels.

Silent Keys

It is with deep regret that we record the passing of these radio amateurs:

• N1BPX **Marble**, Chester B., Ashland, MA
• KB1CD **Calandrello**, Nicola A., Andover, MA
N1CEB **Ryan**, James F., Westport, CT
N1EDN **Douglas**, Charles J., "Sonny," Woburn, MA
K1EE **Eckelmeyer**, Edward H., III, Skillman, NJ
N1ELK **Ouderkirk**, John T. "Oudi," Jr., Westerly, RI
K1EYG **Rodzen**, Henry J., Fall River, MA
• N1ILB **Case**, Stuart, Mystic, CT
• KC1M **Mick**, James L., Kansas City, MO
♦W1MA **Lajoie**, Edward V., Marstons Mills, MA
♦K1MW **Wood**, Mike, Louisburg, NC
K1PO **Brackett**, Peter O., Indialantic, FL
N1RJ **Johnson**, Roger D., Limington, ME
N1RZE **Bonfoey**, Gene R., Cornville, AZ
NC1T **Bowser**, Frank, Meredith, NH
KA1TKS **Dole**, Roger W., Hermon, ME
N1VOA **Smith**, Nancy, Wareham, MA
• N1VPA **O'Flahaven**, William M., West Palm Beach, FL
N1WVU **St. Clair**, Charles "Mike," Rosedale, IN
K1YLD **Sanders**, Scott G., Colchester, VT
KA1YVU **Jarrett**, Arthur E., Pittsburg, NH
WA2ADZ **De Monstoy**, Herman L., Painted Post, NY
KA2BCF **Toussaint**, Richard, Medina, NY
W2BP **Glatz**, Lauretta A., Granville, NY
K2BPK **Freeman**, Dennis L., Tucson, AZ
W2CCY **Schaible**, Clifford W., Morristown, NJ
KX2D **Guthrie**, John J., Hamilton, NJ
• KG2DR **Briggs**, George R., Phoenix, AZ
WA2HBA **Marande**, Dennis J., Toms River, NJ
N2IF **Killops**, Robert J., Monroe Township, NJ
W2IOT **Onyskin**, Alexander, Huntington, NY
• WA2JQL **Semersky**, Michael, Cary, NC
KC2KI **Glenn**, Pete, Whiting, NJ
• WA2NAJ **Vanca**, Amelia E., Binghamton, NY
N2PCB **Ortiz**, Charles, Sebring, FL
♦K2PPO **Webb**, Norman J., Baldwinsville, NY
W2QXA **Landers**, Maurice K. "Doc," Utica, NY
W2RMB **Burkhart**, Rodger M., Rochester, NY
K2UTI **Apple**, Richard M., Schenectady, NY
N2WDY **Hoefinger**, Robert, Middle Grove, NY
AB3AS **Fisher**, Britton A., Charlotte Hall, MD
N3AVR **Tonecha**, John C., New Stanton, PA
W3BIR **Roberts**, Barbara, Davidsonville, MD
WA3CEJ **Goelz**, Chuck, Harleysville, PA
KW3F **Brown**, Robert C., Lansdale, PA
N3GWN **Ceccoli**, Frederick, Jr., Wilkes-Barre, PA
W3HBM **Kidder**, George W., III, Bar Harbor, ME
• W3IUZ **Anthony**, Constantine A. "Gus," Ocean City, MD
K3OIU **Haden**, Robert E., Irwin, PA
KB3PDT **Rogers**, Frank A., Peyton, CO
N3PED **Lahr**, Lawrence W., Berwick, PA
K3PXC **Miller**, Dale E., Manchester, PA
KC3RA **McCarter**, Stephen L., Hebron, MD
W3SDZ **Michael**, Victor A., Muncy, PA
WA3TIG **Izzo**, Carmine M., Cleona, PA
♦W3VUH **Snyder**, Robert F., Frederick, MD
K4AHK **Harding**, William K., Jr., Matthews, NC
N4AVV **Gurkin**, William H., Myrtle Beach, SC
W4BUR **Burnett**, Joseph D., Jr., Middleburg, FL
NU4C **Milward**, Paul E., Ormond Beach, FL
K4CKQ **Klapheke**, Thomas G., Fort Wayne, IN
W4FQT **Baddley**, Benny H., Oakton, VA
KA4GCW **Lowndes**, Thomas, III, Milledgeville, GA
N4GZS **Sherman**, Peter C., Matthews, NC
KB4HHX **Johnson**, Kay G., Del Rio, TN
KV4J **Friederich**, Rudolf J., Knoxville, TN
KD4JNZ **Rybolt**, Frances J., Kinston, NC
KG4LAG **Neff**, June M., Vine Grove, KY
K4LIQ **Sachse**, Glen W., Yorktown, VA
KE4LYG **Meade**, Jeffrey L., Ruther Glen, VA
♦KJ4MP **Howard**, Dwaine H., Hartselle, AL
W4MRX **Bollenbacher**, Robert A., Wilmington, NC
KJ4MTX **Bangs**, Benny N., Piedmont, AL
• WA4MYN **Du Bose**, James E., Knoxville, TN
W4NE **Webb**, John "Ted," Greenville, SC
♦• W4NHL **Lauritsen**, Neil H., Sr., Clearwater, FL
KE4PBY **Glass**, Eula M., Georgetown, KY
K4PXP **Cullars**, Walter L., Bradenton, FL
♦KE4RFT **Lewis**, Thomas C., Nashville, TN
W4RIQ **Whisnant**, Joe E., Lenoir City, TN
KU4SA **Chilcote**, Ned T., Jacksonville, NC
KI4SII **Henderson**, Powell G., Deltona, FL
N4SOR **Kidd**, David E., Front Royal, VA
W4TWZ **Willoughby**, Larry P., Greensboro, NC
N4TZH **Drennon**, Donald P., Sunrise, FL
WB4UTH **Buchanan**, Robert H., Jr., Columbia, SC
KB4WCX **Carpenter**, Louise T., Ocala, FL
KM4WJT **Stinson**, William D., Rock Hill, SC
KS4WX **Jenkins**, Herndon "Hank," Big Canoe, GA
N4XML **Gagliardi**, Bob, Myrtle Beach, SC
KQ4YZ **Livatino**, Louis M., Jacksonville, FL
N5BNX **Davis**, Robert L., Lamesa, TX
♦W5EMS **Saunders**, Charles H., Louisville, MS
NN5G **Kelly**, Paul, Jr., Oklahoma City, OK
N5GH **Hancock**, George A., Sr., Florence, MS
KG5KWC **Reese**, Louis M,. Sr., New Orleans, LA
K5MVS **Winkle**, Jerry H., La Grande, OR
N5NGC **Trahant**, Jude H., Sr., Kenner, LA
WB5NOG **Clahsen**, Hans, Sierra Vista, AZ
KB5NTF **Reed**, Oscar "Russell," Sr., Winona, MS
KC5RXO **Short**, Kelly L., Clyde, TX
♦W5RXU **Temple**, Dale E., North Little Rock, AR
KA5TFJ **Stevens**, George, Tipton, OK
N5VYS **Weathers**, Obie D., Jr., San Antonio, TX
N5XQK **Rentfro**, Johnny E., Bartlesville, OK
W5ZNX **Garrett**, Donald F., Warner Robins, GA
K5ZR **McCain**, Robert G., Dallas, TX
KI6BIQ **Hester**, John B., Eugene, OR
AG6CQ **Gordon**, Al, Hermosa Beach, CA
AB6ER **Seitz**, Lee K., Lomita, CA
W6IS **Slitzky**, Irving, Springfield, MA
WA6OYL **Fastenau**, Charles W., Merced, CA
N6PI **Dickinson**, Jack A., Santa Barbara, CA
♦KA6R **Wilbanks**, James B., III, Bossier City, LA
WA6RTP **Johnson**, Kenneth J., Eureka, CA
• WB6SBE **Pyzak**, Edward A., Gilroy, CA
KA6WBH **Ball**, Christine F., Lompoc, CA
N6ZAI **McComas**, Scott A., Oxnard, CA
KB7BWD **Brayton**, Edward C., Basin, WY
W7DJB **Burnett**, Lowell J., San Diego, CA
♦N7FD **Cole**, James L., Stuart, FL
• KC7HHR **Bettis**, Oliver L., Blackfoot, ID
AD7HR **Rennie**, Charles A., Jr., Clarkdale, AZ
K7IYN **Scott**, Gene E., Yakima, WA
N7OJ **McCaffrey**, Bruce I., Poulsbo, WA
KD7RPP **Enriquez**, Miguel A., Tucson, AZ
WA7RYV **Bird**, David P., Moore, ID
WB7SCD **Leffler**, Paul C., Beaver Dam, AZ
AG7VY **Zuckerman**, Marc, Las Vegas, NV
N7XN **La Belle**, John "Dale," Bremerton, WA
WA8AJI **Miller**, Walter E., Cincinnati, OH
AF8B **Norman**, Donald E., Elyria, OH
KA8BFT **Kelleher**, William B., Toledo, OH
KD8ECW **Lambright**, Mark D., Byron Center, MI
♦W8FUP **Grossoehme**, Floyd, Cincinnati, OH
W8GPA **Rupert**, John P., Jackson, OH
KG8HF **Scott**, Larry D., West Portsmouth, OH
KE8HJA **Fritz**, Donald R., Dearborn Heights, MI
W8HO **Benson**, Randall J., Xenia, OH
W8LZW **Curtis**, Ronald W., Dayton, OH
N8MFN **Collier**, Rick, Batavia, OH
N8NW **Lawrence**, Harley, Homosassa, FL
WA8PLR **McGuire**, Patrick T., Georgetown, TX
♦WB8RUW **Dittiacur**, Dennis F., Westerville, OH
W8UBC **Norris**, Carl Tommy, Sr., Iowa City, IA
♦N9AXJ **Incarnato**, Lauren R., Loudon, TN
KA9CVI **Clouse**, Rollie E., Marion, IN
WA9ENO **Haase**, John F., West Melbourne, FL
• KB9ENX **Ashleman**, George G., Oswego, IL
AB9EY **Hundt**, Lester C., Milwaukee, WI
K9FPA **Schupp**, George E., Princeton, IN
KB9HQX **Shank**, Stephen M., Richmond, IN
N9JNN **Niles**, John N., Janesville, WI
N9JQH **Frank**, J. Thomas, Indianapolis, IN
N9LCF **Diehl**, Gene A., Fremont, IN
♦K9LI **Glick**, Donald L., Grabill, IN
N9LTD **Mullenix**, David J., Fircrest, WA
♦KA9NPT **James**, Steve, Marengo, IL
KT9O **Osborn**, Ted H., Rosedale, IN
N9TDB **Becker**, Michael G., Milwaukee, WI
W9TRG **Greene**, Terry R., Plymouth, IN
W9WY **Gianotti**, John L., Saint John, IN
WBØACX **Wiles**, John M., Andover, KS
KCØAN **Matthews**, Stephen C., McKinney, TX
KØCS **Gecewicz**, Steve P., Parker, CO
KDØEII **Donahoe**, William J., III, Saint Louis, MO
WAØFII **Jones**, Robert G., Atlantic, IA
WØFRS **Osterloh**, Warren R., Atlanta, GA
KCØGFJ **Lilleston**, Donald L., Paola, KS
• KCØIOQ **Graham**, Linda S., Greenwood, NE
WBØJD **Downie**, James "Jim," Aberdeen, SD
♦WBØLBL **Johns**, H. C., Longmont, CO
WØRAA **Thompson**, Richard L., Colorado Springs, CO
KØREV **Bradt**, Lawrence N., Jackson, MO
WBØRIW **Miller**, Cecil J., Wichita, KS
♦WØSWK **Figgins**, Dorothy M., Las Cruces, NM
NIØW **Michalski**, David J. "Cy," Clear Lake, MN
WBØWGT **Haddock**, Alvin D., Bayfield, CO
VE3CJG **Campbell**, Glen D., Belleville, ON, Canada
VE3FOI **Digweed**, David J., Vineland, ON, Canada
DF5DP **Notthoff**, Norbert, Herne, Germany

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• Former call sign

For information on how to list a Silent Key in *QST*, please visit **www.arrl.org/silent-key-submission-guidelines**.

Note: Silent Key reports must confirm the death by one of the following means: a copy of a newspaper obituary notice, a copy of the death certificate, or a letter from the family lawyer or the executor. Please be sure to include the amateur's name, address, and call sign. Allow several months for the listing to appear in this column.

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• VHF/UHF/1.2GHz • Direct Sampling Now Enters the VHF/UHF Arena • 4.3" Touch Screen Color TFT LCD • Real-Time, High-Speed Spectrum Scope & Waterfall Display • Smooth Satellite Operation

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• 1.2kHz "Optimum" roofing filter • New local oscillator design • Improved phase noise • Improved spectrum scope • Dual scope function • Enhanced mouse operation for spectrum scope

IC-7300 | *HF/50MHz Transceiver*

• RF Direct Sampling System • New "IP+" Function • Class Leading RMDR and Phase Noise Characteristics • 15 Discrete Band-Pass Filters • Built-In Automatic Antenna Tuner

IC-7610 | HF/50 MHz *All Mode Transceiver*

• Large 7-inch color display with high resolution real-time spectrum scope and waterfall • Independent direct sampling receivers capable of receiving two bands/two modes simultaneously

IC-718 | *HF Transceiver*

• 160-10M** • 100W • 12V operation • Simple to use • CW Keyer Built-in • One touch band switching • Direct frequency input • VOX Built-in • Band stacking register • IF shift • 101 memories

IC-705 | HF/50/144/430 MHz *All Mode Transceiver*

• RF Direct Sampling • Real-Time Spectrum Scope and Waterfall Display • Large Color Touch Screen • Supports QRP/QRPp • Bluetooth® and Wireless LAN Built-in

IC-7100 | *All Mode Transceiver*

• HF/50/144/430/440 MHz Multi-band, Multi-mode, IF DSP • D-STAR DV Mode (Digital Voice + Data) • Intuitive Touch Screen Interface • Built-in RTTY Functions

IC-2730A | *VHF/UHF Dual Band Transceiver*

• VHF/VHF, UHF/UHF simultaneous receive • 50 watts of output on VHF and UHF • Optional VS-3 Bluetooth® headset • Easy-to-See large white backlight LCD • Controller attachment to the main Unit

ID-5100A Deluxe

VHF/UHF Dual Band Digital Transceiver

• Analog FM/D-Star DV Mode • SD Card Slot for Voice & Data Storage • 50W Output on VHF/UHF Bands • Integrated GPS Receiver • AM Airband Dualwatch

ID-4100A | *VHF/UHF Dual Band Digital Xcvr*

• Compact, Detachable Controller for Flexible Installation • DV/FM Near Repeater Search Function • Apps for iOS™ and Android™ devices • Wireless Operation with VS-3 & UT-137 Bluetooth® Headset & Module • MicroSD Card Slot

IC-V86 | *VHF 7W HT*

• 7W OutputPower Plus New Antenna Provides 1.5 Times More Coverage • More Audio, 1500 mW Audio Output • IP54 & MIL-STD 810G–Rugged Design Against Dust & Water • 19 Hours of Long Lasting Battery Life • 200 Memory Channels, 1 Call Channel & 6 Scan Edges

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FTDX101MP | *200W HF/50MHz Transceiver*

• Hybrid SDR Configuration • Unparalleled 70 dB Max. Attenuation VC-Tune • New Generation Scope Display 3DSS • ABI (Active Band Indicator) & MPVD (Multi-Purpose VFO Outer Dial) • PC Remote Control Software to Expand the Operating Range • Includes External Power With Matching Front Speaker

FTDX10 | *HF/50MHz 100 W SDR Transceiver*

• Narrow Band and Direct Sampling SDR • Down Conversion, 9MHz IF Roofing Filters Produce Excellent Shape Factor • 5" Full-Color Touch Panel w/3D Spectrum Stream • High Speed Auto Antenna Tuner • Microphone Amplifier w/3-Stage Parametric Equalizer • Remote Operation w/optional LAN Unit (SCU-LAN10)

FT-991A | *HF/VHF/UHF All ModeTransceiver*

Real-time Spectrum Scope with Automatic Scope Control • Multi-color waterfall display • State of the art 32-bit Digital Signal Processing System • 3kHz Roofing Filter for enhanced performance • 3.5 Inch Full Color TFT USB Capable • Internal Automatic Antenna Tuner • High Accuracy TCXO

FTDX101D | *HF + 6M Transceiver*

• Narrow Band SDR & Direct Sampling SDR • Crystal Roofing Filters Phenomenal Multi-Signal Receiving Characteristics • Unparalleled - 70dB Maximum Attenuation VC-Tune • 15 Separate (HAM 10 + GEN 5) Powerful Band Pass Filters • New Generation Scope Displays 3-Dimensional Spectrum Stream

FT-891 | *HF+50 MHz All Mode Mobile Transceiver*

Rugged Construction in an Ultra Compact Body • Stable 100 Watt Output with Efficient Dual Internal Fans • 32-Bit IF DSP Provides Effective and Optimized QRM Rejection • Large Dot Matrix LCD Display with Quick Spectrum Scope • USB Port Allows Connection to a PC with a Single Cable • CAT Control, PTT/RTTY Control

FTM-300DR | *C4FM/FM 144/430MHz Dual Band*

• 50W Reliable Output Power • Real Dual Band Operation (V+V, U+U, V+U, U+V) • 2-inch High-Res Full Color TFT Display • Band Scope • Built-in Bluetooth • WiRES-X Portable Digital Node/Fixed Node with HRI-200

FT-2980R | *Heavy-Duty 80W 2M FM Transceiver*

• Massive heatsink guarantees 80 watts of solid RF power • Loud 3 watts of audio output for noisy environments • Large 6 digit backlit LCD display for excellent visibility • 200 memory channels for serious users

FT-818ND | *HF/6M/2M/440 All Mode Portable Xcvr*

• Ultra-Compact/Portable • Multi-Color Easy to See LCD • 208 Memory Channels/10 Memory Groups • Built-in Electronic Keyer • Internal Battery Operation Capability • Two Antenna Connectors • Built-in High Stability Oscillator ±0.5 ppm

FTM-400XD | *2M/440 Mobile*

• Color display-green, blue, orange, purple, gray • GPS/APRS • Packet 1200/9600 bd ready • Spectrum scope • Bluetooth • MicroSD slot • 500 memory per band

FT-70DR *C4FM/FM 144/430MHz Xcvr*

• System Fusion Compatible • Large Front Speaker delivers 700 mW of Loud Audio Output • Automatic Mode Select detects C4FM or Fm Analog and Switches Accordingly • Huge 1,105 Channel Memory Capacity • External DC Jack for DC Supply and Battery Charging

FT-3DR *C4FM/FM 144/430 MHz Xcvr*

• High Res Full-Color Touch Screen TFT LCD Display • Easy Hands-Free Operation w/Built-In Bluetooth Unit • Built-In High Precision GPS Antenna • 1200/9600bps APRS Data Communications • Simultaneous C4FM/C4FM Standby • Micro SD Card Slot

FT-65R | *144/430 MHz Transceiver*

Compact Commercial Grade Rugged Design • Large Front Speaker Delivers 1W of Powerful Clear Audio • 5 Watts of Reliable RF Power Within a compact Body • 3.5-Hour Rapid Charger Included • Large White LED Flashlight, Alarm and Quick Home Channel Access

FT-60R | *2M/440 5W HT*

• Wide receiver coverage • AM air band receive • 1000 memory channels w/alpha labels • Huge LCD display • Rugged die-cast, water resistant case • NOAA severe weather alert with alert scan

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IC-7300
HF / 6M SDR Transceiver

IC-7610
HF / 6M SDR Transceiver

If you think the crickets chirping is CQ in morse code and frogs in the distance are working down a pileup, it is time to get out and enjoy one of Icom's fabulous SDR rigs!

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hy-gain® HF Rotators

HAM-IV – $709.95

The Most Popular Rotator in the World!

For medium communications arrays up to 15 square feet wind load area. Has 5-second brake delay, Test/Calibrate function. Low temperature grease permits normal operation down to -30 degrees F. Alloy ring gear gives extra strength up to 100,000 PSI for maximum reliability. *Precision* indicator potentiometer. Ferrite beads reduce RF susceptibility. Cinch plug plus 8-pin plug at control box. Dual 98 ball bearing race for load bearing strength and electric locking steel wedge brake prevents wind induced movement. North/South center of rotation scale on meter, low voltage control, max mast $2^{1}/_{16}$".

HAM-VI – $809.95 with DCU-2

HAM-VII – $959.95 with DCU-3

HAM IV and HAM V Rotator Specifications	
Wind Load Capacity (inside tower)	15 square feet
Wind Load (w/mast adapter)	**7.5 square feet**
Turning Power	800 in.-lbs.
Brake Power	**5000 in.-lbs.**
Brake Construction	Electric Wedge
Bearing Assembly	**Dual race/96 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	26 lbs.
Effective Moment (in tower)	**2800 ft.-lbs**

TAILTWISTER SERIES II – $869.95

For Large Medium Antenna Arrays up to 20 sq. ft. wind load.

Has 5-second brake delay, Test/Calibrate functions. Low temp grease, tough alloy ring gear, indicator potentiometer, ferrite beads on potentiometer wires, weatherproof AMP connectors plus 8-pin plug at control box, triple bearing race with 138 ball bearings for large load bearing, electric locking steel wedge brake, North/South center of rotation scale meter, low voltage control, $2^{1}/_{16}$" max mast. **MSHD, $139.95**. Above tower heavy duty mast support. T2X, HAM-IV, HAM-V, HAM-VI. Accepts $1^{7}/_{8}$-$2^{5}/_{8}$" OD.

T-2XD2 – $979.95 with DCU-2

T-2XD3 – $1039.95 with DCU-3

TAILTWISTER Rotator Specifications	
Wind Load Capacity (inside tower)	20 square feet
Wind Load (w/mast adapter)	**10 square feet**
Turning Power	1000 in.-lbs.
Brake Power	**9000 in.-lbs.**
Brake Construction	Electric Wedge
Bearing Assembly	**Triple race/138 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	31 lbs.
Effective Moment (in tower)	**3400 ft.-lbs**

CD-45II – $499.95

For antenna arrays up to 8.5 sq. feet mounted inside tower or 5 sq. ft. with mast adapter.

Low temperature grease good to -30 F degrees. New Test/Calibrate function. Bell rotator design gives total weather protection, dual 58 ball bearing race gives proven support. Die-cast ring gear, stamped steel gear drive, heavy duty, trouble free gear train, North center scale, lighted directional indicator, 8-pin plug/socket on control unit, snap-action control switches, low voltage control, safe operation, takes maximum mast size to $2^{1}/_{16}$ inches. MSLD light duty lower mast support included.

CD-45D2 – $599.95 with DCU-2

CD-45D3 – $659.95 with DCU-3

CD-45II Rotator Specifications	
Wind Load Capacity (inside tower)	8.5 square feet
Wind Load (w/mast adapter)	**5.0 square feet**
Turning Power	600 in.-lbs.
Brake Power	**800 in.-lbs.**
Brake Construction	Disc Brake
Bearing Assembly	**Dual race/48 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	22 lbs.
Effective Moment (in tower)	**1200 ft.-lbs**

New!

Hy-Gain Programmable DCU-3 Digital Rotator Controller

DCU-3 – $499.95

Hy-gain DCU-3 Digital Controller lets you program 6 beam headings! Gives you full automatic or manual control of your hy-gain HAM or Tailtwister Rotators.

Press a memory button or dial in your beam heading or let *Ham Radio Deluxe* (or other) take control. Your antenna auto rotates precisely and safely to your DX.

DCU-3 automatically jogs your antenna free and safely unlocks it before rotating begins (*great for older rotators with "sticky" brakes*) then turns off your motor before reaching its final heading. Your antenna gently coasts to a stop before the brake re-locks -- greatly reducing damaging overshoots and extending rotator life.

Simply press *Left* and *Right* buttons for full manual control and fine tuning.

Bright blue LCD shows current, dialed in and computer controlled beam headings in one degree increments and your call.

Calibrate lets you accurately match your display to your true beam heading. Has USB/RS-232 ports for computer control. Adjustable LCD sleep time. Field upgradeable firmware. 8.5Wx4.3H x9D".

110 VAC. Order DCU-3X for 220 VAC.

DCU-2 Digital Rotator Controller – $459.95
Like DCU-3, but less programmable memories. 110 VAC. Order **DCU-2X**, for 220 VAC.

AR-40 – $399.95

For compact antenna arrays and large FM/TV up to 3.0 square feet wind load area.

Dual 12 ball bearing race. Automatic position sensor never needs resetting. Fully automatic control -- just dial and touch for any desired location. Solid state, low voltage control, safe and silent operation. $2^{1}/_{16}$ inch maximum mast size. MSLD light duty lower mast support included.

AR-40 Rotator Specifications	
Wind Load Capacity (inside tower)	3.0 square feet
Wind Load (w/mast adapter)	**1.5 square feet**
Turning Power	350 in.-lbs.
Brake Power	**450 in.-lbs.**
Brake Construction	Disc Brake
Bearing Assembly	**Dual race/12 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**5**
Shipping Weight	14 lbs.
Effective Moment (in tower)	**300 ft.-lbs**

Replace your Yaesu Rotator Controller

YRC-1 – $369.95

Hy-gain YRC-1 -- more features, more robust, far less prone to lightning damage. Costs less than repairing!

Easy-to-use -- dial in your beam heading and tap GOTO button. Exclusive 180 degree *AutoReversal*™ for fast longpath operation. All DCU-2 features. Bright blue LCD shows current, dialed-in, computer controlled beam headings, call. USB port for computer control. Extra heavy-duty AC power supply. Fast variable DC motor minimizes overshoot. Intuitive menu. Field upgradeable. For Yaesu G-800/1000/2800/G450/650. AC or DC motors.

YRC-3, $449.95. Like YRC-1 and adds 6 memories.

AR-500 Rotator/Controller – $169.95

UHF/VHF/6-Meter, MFJ-1886 Rotator/Controller and Remote. For use of small VHF/UHF, 6M, TV, FM, the MFJ-1886 wide band receiving loop and other light-weight ham antennas. Rotator is built in a weather-proof one piece cast aluminum housing with precision all metal gears, steel thrust bearings and automatic braking. Includes rotator, controller, remote, clamps, and all hardware.AR-500 remembers up to 12 directions even after a power outage! Use remote control or direct console. Displays location and relative position.

hy-gain® Antennas, Rotators & Towers 308 Industrial Pk Rd, Starkville, MS 39759 USA
Sales/Tech: (662) 323-9538 ■ **FAX:** (662) 323-5803 Open 8-4:30 CST, Mon.-Fri.

MFJ Power Supplies

World's best and largest selection of clean, no RF hash, no RFI power supplies designed specifically for ultra-reliable ham radio communications

No Matter What™ Warranty
Every MFJ tuner is protected by MFJ's famous one year **No Matter What™** limited warranty. We will repair or replace your MFJ tuner (at our option) for a full year.

75-Amps, $289.95

MFJ-4275MV high-current switching power supply gives 75A max/70A continuous. Great for ALS-500M amplifier. Adjustable output 4-16 VDC. 110/220 VAC. Binding posts, quick connects, *PowerPoles*™, cigarette lighter socket on front. Battery charger gives charging current of 20A max, 5A continuous. 9¾W x 5½H x 9½D". Only 10.5 lbs.

MFJ-4230MV $99.95 30 Amp, 4-16 Volts Adjustable, Volt/Amp Meter, 5W x 2½H x 6D"

Ham Radio's Best Seller!

MFJ-4230MV is ham radio's best selling and most compact switching power supply – just 5W x 2½H x 6 D" and 3 lbs. Takes up little room at your operating position and perfect for home station, Field Day, DXpeditions, camping, hiking, or for your next business trip or vacation.

MFJ-4230MV gives 25 Amps continuously or 30 Amps surge at 13.8 VDC. Voltage is front-panel adjustable from 4 to 16 VDC.

Add a pair of *PowerPoles*™

MFJ-4230MVP, $119.95. *PowerPoles*™ on back.

MFJ-4230MPF, $109.95. *PowerPoles*™ on front.

MFJ-4230DMP, $159.95. Same as MFJ-4230MVP but has bright orange LCD digital volt/amp display.

Selectable input voltage of 120 or 240 VAC at 47-63 Hz lets you carry it with you and use it worldwide.

Front-panel rocker switch lets you choose Amp or Volt meter for continuous monitoring. Cool operation with excellent 75% efficiency. Extra low ripple and noise is less than 100 mV.

It's quiet! Continuous air-flow gently cools the power supply and a heat sensor increases the fan speed if the temperature rises above 70 degrees celsius.

Over-voltage and over-current protection fully protects your transceiver and has ALARM LED. DC output is 5-way binding posts on the back so you can power your HF, VHF, UHF transceiver and accessories with ease.

45-Amps, $169.95

MFJ-4245MV Switching power supply gives 45A surge/40A continuous. 9-15 VDC out. 85-260 VAC in. Low ripple, highly regulated. 5-way posts, cig lighter, quick connects. 5 lbs., 7½W x 4¾H x 9D".

35-Amps, $149.95

MFJ-4235MV switching power supply gives 35A surge and 30A continuous. 4-16 VDC with 1% voltage regulation. < 9 mV peak-to-peak ripple. AC input 90-125 or 200-240V. 7W x 4¼H x 8¾D", 4 lbs.

35-Amps, $169.95

MFJ-4035MV *19.2 lb. transformer* delivers 35A max, 30A continuous. 1-14 VDC out, 110 VAC in. Highly regulated, 1% load regulation. 1 mV ripple. 5-way binding posts, quick connects. 9½W x 6H x 9¾".

15-Amps, $79.95

MFJ-4115 Tiny! 17A surge, 15A cont. 13.8 VDC. 110/ 220 VAC. 3¾W x 2¼H x7 ¾D", 1.5 lb. 5-way posts. Switcher.
MFJ-4215MV, $79.95. 4-16 VDC, 15A surge, 13A cont., backlit volt/amp meters. 90-125V/200-240 VAC. Switcher.

25-Amps, $119.95

MFJ-4225MV Switching power supply gives 25A surge, 22A continuous. Adjustable 9-15 VDC output, 85-260 AC input. Large 3" dual Amp/Volt meters, Binding posts, Cigarette lighter socket. 3.7 lbs. 5¼W x 4½H x 6D inches.

25-Amps, $99.95

MFJ-4125 gives 25A surge, 22A continuous. 13.8 VDC switching power supply has 5-way binding posts on front panel and quick connects on back. 3.5 lbs. Super compact 5½W x 2½H x 5¾D inches fits anywhere.

25-Amps, $109.95

MFJ-4125P gives 25A surge, 22A continuous. 13.8 VDC switching power supply front has 2 pair of *Anderson PowerPoles*™ and 5-way binding posts on front. Quick connects on back. 3.5 lbs. Super compact 5½W x 2½H x 5¾D".

28-Amps, $99.95

MFJ-4128 28A surge, 25A cont. at 13.8 VDC. AC input voltage 85-135/170-260 VAC. 5-way binding posts, cigarette lighter socket, 7W x 2¼H x 7½D", 4 lbs.
MFJ-4218MV, $119.95. 0-24 VDC, 18A@13.8/9A@24 VDC. Backlit V/A meter. 110/220 VAC.

MFJ *PowerPole*™ Splitters

MFJ-1104, $54.95. *PowerPole*™ Splitter. 30 Amp fused input. Outputs fused at 25, 10, 5A. Open fuse indicator. 2¾W x 3¼H x 1½D".

MFJ-1107, $59.95. 40 Amp fused binding posts input. 4 fused *PowerPole*™ outputs. Two 2.1 mm center positive power jacks.

MFJ-1106, $49.95. One in, six out *PowerPoles*™ 30A total. 7 sets mating connectors included.

MFJ High Current DC Multi-Outlet Strips

Power multiple transceivers/accessories from a single DC power supply

MFJ-1118, $99.95. Power two HF and/or VHF rigs and six accessories from rig's 12VDC supply. 35A high-current and 15A accessory binding posts, Voltmeter, on/off switch. Master fuse, RF bypass.

MFJ-1116, $69.95. Like MFJ-1118 but 15A total, 8 pairs 5-way posts. "On" LED, 0-25 VDC voltmeter.

MFJ-1112, $54.95. Like MFJ-1116 but 6 pairs 5-way binding posts, no meter or switch. 12½W x 2¾H x 2½D".

MFJ-1117, $79.95. High-current. Powers four HF/VHF radios simultaneously -- two at 35A each and two at 35A combined. 8W x 2H x 3D".

MFJ-1129, $139.95. 10 outlets. Installed fuses: two 1A, three 5A, three 10A, two 25A, one 40A. Outlets 1, 2, 4-8 are PowerPoles™. Outlet 3 is a 35A high current binding post, outlet 9, 10 are 15A binding posts. On/off switch, 0-25 VDC voltmeter. 12½W x 1¼H".

MFJ-1128, $129.95. 12 fused *PowerPoles*™: three 1A, four 5A, four 10A, one 25A, one 40A. Switch. Meter.

MFJ-1126, $99.95. 8 fused *PowerPoles*™: One 1A, three 5A, two 10A, one 25A, one 40A. Switch. Voltmeter. 9W x 1¼H x 2¾D".

MFJ-1124, $79.95. Four pairs 35A *PowerPoles*™, two pairs 35A high current binding posts.

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MFJ_4230MV_110414_QST_090619DS

Show your excitement for CYCLE 25

Cycle 25 T-Shirt

These comfortable t-shirts featuring the ARRL Diamond and Cycle 25 on the front left chest and a large imprint of the colorful, eye-catching ARRL Cycle 25 logo on the back. A perfect addition to your ham radio wardrobe!

Cycle 25 Cappuccino/Soup Mug

These oversized versatile, durable ceramic mugs are for more than just cappuccino or your favorite soup. Featuring ARRL Cycle 25 artwork on both sides, the bowl-shaped design stylishly holds 18 ounces.

Cycle 25 Flying Disc

Our dog-safe neon-orange flying disc is a fun way to celebrate Cycle 25 with your canine or human friends at the beach, park, or in your backyard.

Cycle 25 Hat

Our casual, golden yellow Cycle 25 hat is sure to be a warm-weather favorite!

Shop Cycle 25 products online at arrl.org/shop.

ARRL
the national association for amateur radio®

MFJ G5RV Antennas

Operate all bands 10 through 160 Meters with a single wire antenna!

***The famous** G5RV antenna is the most popular ham radio antenna in the world!*

It's an efficient, *all* band 102 foot long antenna – shorter than an 80 Meter dipole. Has 32.5 foot ladder line matching section ending in SO-239 connector for your coax feedline.

MFJ-1778
$69.95

Use horizontally or as Inverted Vee or Sloper with just one support. 1500 Watts.

Operate all bands 80-10 Meters with an antenna tuner and even 160M with ground.

Fully assembled with *ceramic* end and fiberglass center insulators. *Hang and Play*™ – add coax, rope to hang and you're on air!

MFJ-1778M, $59.95. *Half-size,* 52 foot *G5RV JUNIOR for limited space.* 40-10 Meters with tuner. Full 1500 Watts.

MFJ All Band Classic Doublet

MFJ 102 foot *all band* doublet covers 160-6 Meters with balanced line tuner. Super strong custom fiberglass center insulator relieves stress on 100 foot ladder line. *Glazed ceramic* end insulators. 1500 Watts.

MFJ-1777
$79.95

RF Isolator

MFJ-915 *RF Isolator* prevents unwanted RF from traveling on the outside of your coax shield into your transceiver. This unwanted RF can cause painful RF "bites" when you touch your microphone or volume control, cause your display or settings to go crazy, lock up your transceiver or turn off your power supply. In mobile installations, stray RF could cause your car to do funny things even blow your car computer. Clear up these problems, plug an MFJ-915 between your antenna and transceiver. 1.8-30 MHz, 1500 Watts. 5 x 2 inches.

MFJ-915
$39.95

MFJ-919, $69.95. 4:1 current balun,1.5 kW.
MFJ-913, $39.95. 4:1 balun, 300 Watts.

True 1:1 Current

Balun & Center Insulator

True 1:1 *Current Balun/Center Insulator* forces equal radiator currents in dipoles for true dipole radiation pattern. Reduces coax radiation and field pattern distortion – your signal goes where *you* want it. Reduces TVI, RFI and RF hot spots. *Don't build a dipole without one!* 50 hi-permeability ferrite beads on high quality RG-303 *Teflon®* coax and *Teflon®* SO-239. 1.5kW 1.8-30 MHz. Stainless steel hardware. 14 gauge stranded copper wire is *directly* connected to your antenna. 5 x 2 inches. Heavy duty weather housing.

MFJ-918
$39.95

2-Position Antenna Switch

MFJ-1702C, $49.95. 2-position antenna switch, lightning surge protection, center ground. SO-239s.

Lightning surge protectors

MFJ-270, $24.95. 400W. **MFJ-272, $34.95.** 1500 W. Gas discharge tube shunts 5000 amps peak.< 0.1 dB loss. 1 GHz. SO-239s.

MFJ-16C06, $9.45. 6-pack *glazed ceramic* end/center ant. insulators.

MFJ-16B01, $24.95. Molded high strength center insulator. SO-239.

MFJ-16D01, $9.95. 450 Ohm fiberglass end/center insulator with ladder line stress relief and SO-239 mount.

MFJ-18H100, $44.95. 100 feet, 450 Ohm ladder line, 18 gauge copper clad.

80-10 Meter End-Fed Half Wave antenna

Cover all bands with one single wire and no tuner!

MFJ-1982HP
$109.95

No tuner needed!
All band 80-10M EFHW antenna

Get-on-the air on all bands 80-10 Meters with just one wire and one support (pole or tree) and no tuner or long counterpoise.

Installs anywhere in minutes! Rugged *insulated*-wire radiator prevents detuning when contacting limbs/branches. "*No-snag*" end insulator slides over branches, leaves.

Toss over a high limb for inverted-V or sloper or go vertical with an inverted-L.

Dark jacketed wire is virtually invisible – *don't let antenna restrictions keep you off the air!* Great for emergencies.

EFHWs naturally resonate on the 1/2-wave fundamental frequency and odd/even harmonics. Covers 80/40/30/20/17/15/12/10 Meters without traps, stubs or resonators.

Broad-band matching transformer at feed point gives SWR so low you may never need a tuner. Compensating inductor optimizes SWR. 800 Watts SSB/CW. 132 feet jacketed antenna wire.

MFJ-1984HP, $89.95. Like MFJ-1982HP but 40-10M. 66 feet jacketed wire.

See *www.mfjenterprises.com* for 30 Watt QRP and 300 Watt models.

Dual Band Dipoles

MFJ-17758, $99.95. Operate 80/40 Meters with a short 85 foot dipole. Full-size on 40 Meters with ultra-efficient end-loading on 80 Meters. 1500 Watts. Super-strong custom molded center insulator with SO-239 connector and hang hole. Ceramic end insulators. 7-strand, 14 gauge hard copper wire. No tuner needed!

MFJ-17758
$109.95
80/40 Meters

MFJ-17754, $69.95. Like MFJ-17758 but is only 42 feet. Operate 40/20 Meters. Full-size on 20 Meters, ultra-efficient endloading on 40 Meters. 1500 Watts.

Single Band Dipoles

Ultra high quality center fed dipoles give years of troublefree service. Custom injection-molded UV resistant center insulator has built-in SO-239 and hanging hole. Glazed ceramic end insulators. 7-strand, 14-gauge hard copper antenna wire. 1500 Watts. Use horizontally or as sloper or inverted vee. Simply cut to length with provided cutting chart.

MFJ-1779A
$79.95
160M, 265 ft.

MFJ-1779B
$59.95
80-40M, 135 ft

MFJ-1779C
$39.95
20-6M, 35 ft.

OCFD Dipoles

MFJ-2012
$89.95
1500 Watts

MFJ-2010
$69.95
300 Watts

No tuner needed!
MFJ *Off-Center Fed Dipoles* use MFJ's exclusive *ExactRatio*™ RF broadband transformer to give low SWR and maximum bandwidth on 40/20/10/6 Meters. A Guanella current balun kills feedline radiation, pattern distortion, SWR shifts, RFI and noise pickup. Install anywhere and get the same predictable performance regardless of feedline length. You get ground reinforced gain over verticals. Use horizontally, inverted vee, sloper. 98% efficient, 14 gauge, 7-strand copper wire, ceramic end insulators.

MFJ Enterprises, Inc. 300 Industrial Pk Rd, Starkville, MS 39759
Phone: (662) 323-5869 ■ **Tech Help:** (662) 323-0549 ■ **FAX:** (662) 323-6551 8-4:30 CST, Mon.-Fri.

MFJ *Magnetic Loop* Antennas

MFJ 36-inch magnetic loop antenna lets you operate 7 to 22 MHz or 10 to 30 MHz continuously -- including the WARC and MARS bands! Easily handles a full 150 Watts on SSB/CW/Digital for any transceiver.

Ideal for limited space. Apartments, small lots, motor homes, attics, trailers.

Work exciting DX with low angle radiation and local close-in contacts with high angle radiation when mounted vertically.

Super easy-to-use! MFJ remote control auto tunes to your desired band. Fast/slow tune buttons, Cross-Needle SWR/Wattmeter lets you quickly tune to your exact frequency. No control cable needed.

***World's** most efficient small loop antenna has all welded construction, welded butterfly capacitor with no rotating contacts, large 1.050 inch diameter aluminum radiator -- gives you highest possible efficiency.*

Every capacitor plate is welded for extremely low loss and polished to prevent high voltage arcing. Nylon bearing, anti-backlash mechanism, limit switches, continuous no-step DC motor gives smooth precision tuning. Heavy-duty ABS plastic housing has ultraviolet inhibitor protection.

MFJ-1782, $459.95. Like MFJ-1786 but has fast/slow tune manual control.

MFJ-1780, $369.95. 20-10 Meters, 150 Watt *Portable* *24x24x24" box fan loop with carry handle.* Fast/slow tune control. *See QST July 2019.*

***New* 40-15M and 30-10M 300W *High Efficiency* Welded Loop Antennas**

Carry it anywhere! Easy carry handle, fold-out feet, tripod mount bracket. Portable, lightweight 36x36x4". Deluxe semi-auto controller with SWR/Wattmeter, no control line needed. Welded Low loss *butterfly* air-variable capacitor. 300W SSB.

MFJ-1784, $699.95. 40-15 Meters.
MFJ-1783, $649.95. 30-10 Meters.

Build your own Mag loop!

Motorized Butterfly Capacitors

Super low loss butterfly capacitors, no rotating contacts, all plates welded with no mechanical electrical contacts. Anti-backlash mechanism. DC motor with gear reduction box. Handles at least 150 Watts SSB/CW/Digital.

1. p/n: 282-1786, $189.95. 11-128 pF.
2. p/n: 282-1788, $249.95. 15-260 pF.
3. p/n: 80-1786-2SM, $249.95. Auto band selecting remote controller with SWR/Wattmeter.
4. p/n: 80-1782-2, $79.95. Manual remote control, fast/slow tune buttons.

Butterfly Capacitors

5. MFJ-19, $79.95. 12-67 pF.
6. MFJ-23, $109.95. 18-136pF.
7. p/n: 729-0142, $19.95. 6:1 vernier gear reduction drive for loop tuning capacitor.
8. 36-inch Aluminum Circular Loop with Integrated welded capacitor and mast mounting brackets
p/n: 10-1786-11, $129.95. 1.05 inch OD heavy duty tubing.

MFJ Magnetic Loop Tuners, 150 Watts

Turns wire or coax into a small, high efficiency multi-band transmitting magnetic loop antenna!

Work the world 3.5 to 30 MHz with a *full 150 Watts* SSB/CW/Digital. No ground, radials or counterpoises needed.

New larger matching capacitor is 313 pF. Increases matching range. Butterfly capacitor has no rotating contacts.

Very quiet receiving antenna -- you'll hardly notice static crashes. High-Q reduces QRM, overloading, harmonics. Perfect for apartments, antenna restricted areas and portable operation.

A 13' wire loop covers 30-20 Meters (4' for 17-10M; 7' for 20-15M; 28' for 60-40M; 50' for 80M). Tune *any* shape loop -- circle, square, rectangle, *etc.*

A wire length gives about 1.5 to 1 frequency range (i.e.7-10, 18-28 MHz).

Easy-Carry handle. Mount for PVC Cross loop support on cabinet top. Included tripod/mast mount.

A. MFJ-936C, $349.95. Antenna current meter, Cross-Needle SWR/Wattmeter. 9¼Wx5½Hx9½D".

B. MFJ-935C, $299.95. Antenna current meter. 6¼Wx5½Hx9½D".

C. MFJ-933C, $249.95. 6¼Wx5½Hx9½D".

MFJ Low-Noise Receiving Mag Loop

Clearly hear signals 50 KHz to 30 MHz you never knew existed. Power line noise and static disappears. Rotating MFJ-1886 eliminates interfering signals or greatly peaks desired signals. Excellent antenna and preamplifier balance gives deep null. Gives excellent strong and weak signal performance without overload. Fully protected state-of-the-art push-pull Gali MMICs preamplifier gives you high dynamic range, low IMD and 25 dB of low noise gain. Use inside or outside.

QRP Mag Loop Tuner

MFJ-9232
$69.95

Turns wire around a bookcase, window, tree, etc. *into a small, high efficiency transmitting loop antenna!* Operate 40-10 Meters with included flexible wire loop (80/60 Meters with your bigger loop). No counterpoises, radials, ground needed. 25 Watts. Very quiet reception. Hi-Q reduces QRM, overload, harmonics. Great for apartments, antenna restrictions, portable ops.

VIDEOS: https://m.youtube.com/results?search_query=MFJ-9232

Antenna Rotator

Perfect for magnetic loops, VHF/UHF, small HF beams, TV, FM antennas. Weather-proof cast aluminum housing with precision all metal gears, steel thrust bearings and automatic braking. Includes rotator, controller, remote control, clamps, hardware. 12 Memories. Digital display. 110/220 VAC.

$169.95

MFJ Tripods/Masts

Strong, black *steel* triangular braced base. Non-skid feet, strong mast locks.
MFJ-1919, $109.95, Supports 100 lbs. Extends a *whopping* 7.8 ft. Base spreads up to 4.8 sq. ft. 1.4" dia. mast. Collapses to 54" by 6" diameter. 9¾ lbs.
MFJ-1919EX, $179.95. Tripod *plus* mast. 18' extended. 5' collapsed. 1/8" wall, 3/4" dia. top, 1½" dia. bottom.15 lbs.
MFJ-1918, $69.95, 6'extended. 38" collapsed, 6¾ lbs.
MFJ-1918EX, $109.95. Small tripod with extension mast. 9½', 3.8 ft. collapsed. ¾"top, 1" bottom. 6.5 lbs.

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Introducing the

ARRL Field Day 2021 Collection

ARRL Field Day is the most popular on-the-air operating event in amateur radio. Gear up and get in on the fun – ARRL Field Day shirts, hats, tumblers, mugs, notebooks, pins, patches, and more are available at **www.arrl.org/shop/FieldDay** (while supplies last).

Keep it casual with these classic t-shirts featuring the 2021 Field Day logo, a must-have for your wardrobe!

ARRL Field Day is June 26 - 27.

For more information visit:
www.arrl.org/shop/FieldDay

ARRL the national association for amateur radio®

MFJ *Cobweb* Antenna

6-Bands: 20/17/15/12/10/6 M...Outstanding Performance!

Restricted space spoiling your operating fun? MFJ Cobweb puts your call back on the map!

This six-band (20, 17, 15, 12, 10, 6 Meters) full half-wave *Cobweb Antenna* is perfect for restricted space or portable operation. Sky-gray fiberglass spreaders and *nearly invisible* wire elements (flat 9 x 9 x 1/2 feet square. 8 pounds), blend in with your surroundings while standing tough against nasty weather.

Outstanding performance! Horizontally polarized for less local noise pickup plus solid gain over verticals will allow you to work DX easily – even on QRP. Omni-directional. No radials needed! Works great at low heights. Low SWR is due to MFJ's exclusive *Spider-Match*™ broadband network. Use lightweight TV hardware to mount on your chimney, balcony, mast.

Low in cost, but big on performance. MFJ *Cobweb Antenna* turns your space problem into a stack of QSL cards from far away places.

MFJ-1836HK34, $139.95. Add-on kit adds 40/30 Meters to MFJ-1835/1835H and MFJ-1836/MFJ-1836H cobweb antennas.

MFJ-1838
$459.95

40-6 METER Cobweb Super Heavy-Duty, 1.5 kW

New! Super heavy-duty 40-6 Meter Cobweb Antenna. Built to survive harsh northern winters, heavy snow, ice and strong winds – has super-strong large diameter fiberglass and heavy-duty 14 gauge stranded hard copper wire. 8-bands: 40, 30, 20, 17, 15, 12, 10, 6 Meters, 1500 Watts. Turning radius: 12 feet, 23 lbs.

MFJ 20/17/15/12/10/6 Meter *Hexbeam*

New MFJ HexBeams deliver solid gain and directivity on 20/17/15/12/10/6 Meters with two elements on each band.

MFJ uses an updated G3TXQ element configuration for excellent gain, improved bandwidth, superior front-to-back ratio and low SWR!

MFJ takes the HexBeam`s unique balanced-tension framework to a new level with rugged mounting hardware, exceptionally durable spreaders and sliding antenna-wire guides – designed to ensure years of reliable service.

MFJ-1846, $559.95. 6 Bands: 20/17/15/12/10/ 6M, 2-elements per band, full 1500W. 25 lbs. 11 ft.turning radius.

MFJ-1848, $779.95. 8 Bands: 20/17/15/12/10/ 6M, 2-elements per band; 40/30M, single elements, full 1500W. 28 lbs. 14 ft. turning radius.

www.mfjenterprises.com

3-Element Hexbeam

MFJ-1856 is ***six*** individually stacked monoband yagis!

6 Bands: 20/17/15/12/10/6M. Full 1500 Watts.

Three *full-size* elements on each band gives high gain, high front-to-back ratio and wide bandwidth. Works great at 20 feet. 30lbs. 17 feet turning radius. Ideal for a small rotator like hy-gain's CD-45II, $449.95.

MFJ Isolator and 1:1 Balun

MFJ-915, $39.95 Stop *RF* traveling down coax line, painful RF "bites" and erratic operation. 1.5 kW 1.8-60 MHz. 2W x 5H". SO-239s.

MFJ-918, $39.95 True 1:1 Current balun & center insulator forces equal antenna currents in dipole elements.

MFJ Dry Dummy Load

MFJ-260C, $49.95. Air-cooled, 300 Watt dry dummy load with a noninductive resistor in a perforated metal housing. SO-239 connector. Full load 30 seconds. Silk-screened derating curve to 5 minutes. SWR below 1.1:1 to 30 MHz, 1.5:1 from 30 to 650 MHz.

MFJ 2-Pos. Antenna Switch

MFJ-1702C, $49.95. 2-position antenna switch has center ground, auto grounding of unused position, handles 2.5 kW PEP and works to over 500 MHz. Lightning surge protection. Quality SO-239 connectors, heavy duty diecast.

MFJ-1704, $109.95. Like MFJ-1702C but has 4 positions.

MFJ G5RV Antenna

MFJ-1778, $69.95. G5RV antenna covers 160-10 Meters with antenna tuner. 102 ft. long. Inverted vee or sloper. Use on 160 Meters as Marconi. 1500 Watts. Super-strong fiberglass center/feed-point insulators. Glazed ceramic end insulators. Hand-soldered. Add coax, some rope and you're *on the air!*

MFJ Enterprises, Inc. 300 Industrial Pk Rd, Starkville, MS 39759
Phone: (662) 323-5869 ■ **Tech Help:** (662) 323-0549 ■ **FAX:** (662) 323-6551 8-4:30 CST, Mon.-Fri.

MFJ_1836_021417_QST_110819DS

MFJ Weather-Proof Window Feedthrough Panels

Weather-proof window feedthrough panels bring coax, balanced lines, HF/VHF/UHF antennas, random wire antennas, ground, rotator/antenna switch cables and DC/AC power into your hamshack without drilling through walls!

MFJ Weather-Proof Window Feedthrough Panels mount in your window sill. Lets you bring all your antenna connections into your hamshack without drilling holes through walls.

Simply place in window sill and close window. One cut customizes it for any window up to 48 inches. Use horizontally or vertically. Connectors are mounted on inside/outside stainless steel plates and attached to a 4 foot long, 3 1/2 inch high, 3/4 inch thick pressure-treated wood panel.

Real Western Red Cedar wood is naturally resistant to rot, decay and insects -- lasts longer, maintenance-free. Pitch and resin free for a wide range of beautiful finishes or leave it in its naturally beautiful raw finish. Edges sealed by weather-stripping. Seals and insulates against all weather conditions. Includes window locking rod.

Inside/outside stainless steel plates ground all coax shields. Stainless steel ground post brings ground in.

MFJ-4603 Universal Window Feedthrough Panel

MFJ-4603
$109.95

Four 50 Ohm Teflon® SO-239 coax connectors lets you feed HF/VHF/UHF antennas at full legal power limit.

A 50 Ohm Teflon® coax N-connector lets you use any antenna up to 11 GHz, including 450 MHz, UHF, satellite, moon bounce and 2.4/5.8 GHz Wi-Fi antennas.

A 75 Ohm, 1 GHz F-connector makes it easy to bring in television, Satellite, HD, cable TV and FM radio signals.

A pair of high-voltage ceramic feedthru insulators lets you bring in 450/300 Ohm balanced lines directly to your antenna tuner.

Has random/longwire antenna ceramic feedthru insulator.

5-way binding posts lets you supply 50 Volts/15 Amps DC/AC power to your outside antenna tuners/relays/switches.

Stainless ground post brings in ground connection, bonds inside/outside stainless steel panels together and drains away static charges.

MFJ's exclusive Adaptive Cable Feedthru™ lets you bring in rotator/antenna switch cable, etc. without removing connectors (up to 1 1/4 X 1 5/8 in). Adapts to virtually any cable size. Seals out rain, snow, adverse weather.

3 Coax, Balanced Line, Random Wire

Best Seller! 3 Teflon® coax connectors for HF/VHF UHF antennas. Separate high voltage ceramic feed-thru insulators for balanced lines and longwire/random wire, Stainless steel ground post.

MFJ-4602
$79.95

6 Coax

6 high quality Teflon® coax connectors for HF/VHF/UHF antennas. Stainless steel ground post. Full 1500 Watt legal limit.

MFJ-4601
$69.95

4 Balanced Line, 2 Coax

4 pairs of high-voltage ceramic feed-thru insulators for balanced lines and 2 coax connectors.

MFJ-4600
$89.95

5 Cables, any-size

5 Adaptive Cable Feedthrus™. Pass any cable with connector: 2 cables with large connectors up to 1 1/4 x 1 5/8 inches and 3 cables with UHF/N size coax connectors. Seals out weather.

MFJ-4604
$114.95

All-Purpose FeedThru/CableThru™

Stacks MFJ-4603 and MFJ-4604! Gives you every possible cable connection you'll ever need through your window without drilling holes in wall – including UHF, N and F coax connectors, balanced lines, random wire, ground, DC/AC power and cables of any size for rotators, antenna switches, etc.

MFJ-4605
$179.95

Bring cables through the eave of your house

MFJ-4616
shown with standard full size vent (not included) it replaces. For 6 Cables
$34.95

MFJ-4613
shown with standard half size vent (not included) it replaces. For 3 Cables
$19.95

Replace your standard air vents on the eave/sofitt of your house with these MFJ AdaptiveCable™ Air Vent Plates and...

Bring in coax, rotator, antenna switch, power cables, etc. with connectors up to 1 1/4 x 1 5/8 inches!

Sliding plates and rubber grommets adjust for virtually any cable size to seal out adverse weather, insects and varmints. Use existing vent hole, mounting screws and screw holes.

AdaptiveCable™ Wall Plates

MFJ-4614
For 4 Cables
$44.95

Bring nearly any cable -- rotator, antenna switch, coax, DC/ AC power, etc. -- through walls without removing connectors (up to 1 1/4x1 5/8 inches). Sliding plates and rubber grommets adjust hole size to weather-seal virtually any size cable.

Includes stainless steel plates for each side of wall, sliding plates, rubber grommets, weather stripping and screws.

MFJ-4612
For 2 Cables
$34.95

MFJ-4611
For 1 Cable
$19.95

Free Dealer/Catalog/ Manuals/Instructions – Visit: www.mfjenterprises.com or call toll-free 800-647-1800

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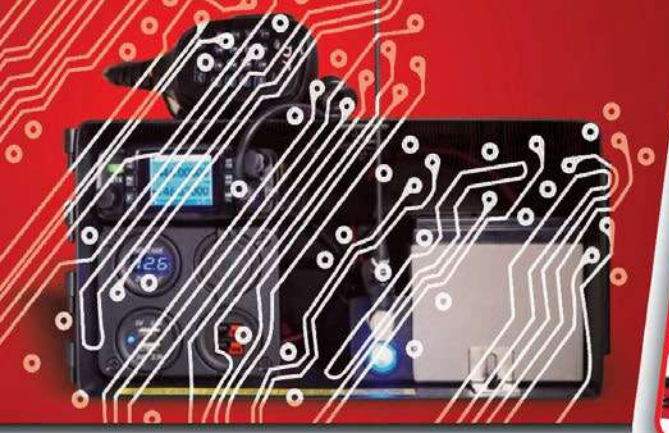
Quicksilver Radio

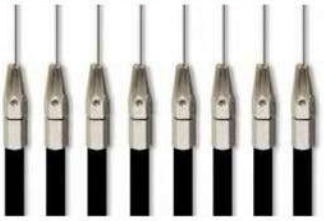
HAMMO-CAN™ Go Box

A complete VHF-UHF station in a can. Get them with or without radios. Check out our large assortment of parts if you want to build your own!



Ultimate Crimp Kit™

Quickstick™



"Hamstick" style mobile antenna. Available from **6M to 75M**. Made in the USA

DC Power Cables

Test Equipment

Powerpoles & DC Connectors

FREE SHIPPING on all orders over $73.00 to any United States address.

HybridDX™ HF antenna. Get on 6M to 160M in less than 80 ft.

Connectors & Adapters

Play-Series™ System

Modular system with meters, usb, powerpoles, switches and more.

In these tough times, we're here to help you with Quality, Service & Value!

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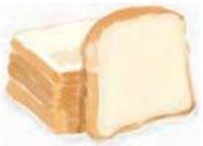

"Best thing since sliced bread!"

More hams use MFJ analyzers than all others in the world!

MFJ-269D . . . 280 KHz - 230 MHz plus 415-470 MHz, 12-bit A/D

New and improved. Now covers 280 KHz to 230 MHz and 415 to 470 MHz and 2200 Meter band!

Instantly gives you a complete picture of your antenna.

Read SWR, return loss, reflect-ion coefficient, match efficiency at any frequency simultaneously.

Read Complex Impedance (100 KHz to 230 MHz) as series equivalent resistance and reactance (Rs+jXs) or as magnitude (Z) and phase (degrees). Also reads parallel equivalent resistance and reactance (Rp+jXp).

Determine velocity factor, coax loss in dB, length of coax and *distance to short or open in feet (it's like a built-in TDR).*

Coax Calculator™ calculates coax line length in feet given degrees and vice versa for any frequency, velocity factor.

New! MFJ-269D **$419.95**

Measure SWR and loss of coax with *any* characteristic impedance (280 KHz to 230 MHz) from 10 to over 600 Ohms.

Measures inductance in uH and capacitance in pF at RF frequencies, 100 KHz to 230 MHz.

High contrast LCD gives precision readings and two side-by-side analog meters make antenna adjustments smooth and easy.

12-bit A/D converter gives much better accuracy and resolution than common 8-bits -- *MFJ-269D exclusive!*

Built-in frequency counter, battery saver, low battery warning, Ni-Mh/NiCd charge circuit. 4Wx2Dx6¾", 2 lbs. Use ten aA batteries or 110 VAC with MFJ-1312D, $19.95.

MFJ-269DPRO™ SWR Analyzer

MFJ-269DPro, $459.95. Like MFJ-269D, but UHF range covers ***430 to 520 MHz***. For commercial work.

MFJ-259D . . . World's Most Popular Antenna Analyzer!

New!

MFJ-259D **$319.95** ***New and improved, now covers 280 KHz-230 MHz!***

***World** famous* MFJ-259D gives you a complete picture of your antenna's SWR and Complex Impedance.

MFJ-259D is a complete ham radio test station including frequency counter, RF signal generator, *SWR Analyzer™*, RF Resistance/ Reactance Analyzer, Coax Analyzer, Capacitance/ Inductance Meter and more!

Read Complex Impedance as series resistance and reactance (R+jX) or as magnitude (Z) and phase (degrees).

Determine velocity factor, coax cable loss in dB, length of coax and distance to short/open.

Read SWR, return loss and reflection coefficient at any frequency simultaneously.

Read inductance (uH) and capacitance (pF) at RF frequencies.

Large easy-to-read two line LCD screen and side-by-side meters clearly display your information.

Built-in frequency counter, Ni-MH/Ni-CD charger circuit, battery saver, low battery warning, smooth reduction drive tuning.

Super easy-to-use! Just set the bandswitch and tune the dial -- just like your transceiver. SWR, Complex impedance displayed instantly!

Fully portable, take it anywhere -- remote sites, up towers, on DX-peditions. Use 10 AA or Ni-Cad or Ni-MH batteries (not included) or 110 VAC with MFJ-1312D, $19.95. Rugged metal cabinet, 4x2x6¾". **MFJ-249D, $299.95.**

MFJ-249D does everything MFJ-259D does with digital display only.

MFJ-223 1-60 MHz Color Graphic VNA Analyzer

This *pocket-sized wonder* breaks the mold for analyzer design with user-friendly convenience, top notch accuracy, and a vivid TFT multi-color display. Don't let the size fool you, it's packed with VNA features and performance you need!

MFJ-223 **$319.95**

- **Single-frequency** and *swept-frequency* operation
- **Truly accurate** SWR, R, X, and Z measurements
- **Seamless DDS** coverage, 100-Hz resolution from 1-60 MHz
- **Smooth "skip-free"** encoder tunes fast or slow without missing a step
- **Powerful +5-dBm** stimulus generator
- **Field-strength meter**
- **DDS generator** precision signal source
- **Vivid 1600-pixel/inch** color graphics on a 2x2 inch non-glare TFT screen

MFJ-225 1.5-180 MHz *continuous* Two-Port Graphic Analyzer

Out in the field, the MFJ-225 is a compact completely *self-contained handheld graphing analyzer.* On the bench it becomes a full-fledged two-port (S21) desktop machine when teamed up with your PC. Using powerful IG-miniVNA freeware, you'll run de-tailed data analysis and print out stunning color-graphic plots to document your work! Built-in back-lighted *3-inch LCD graphic* display. Make fine adjustments using full-screen easy-to-view SWR bargraph, capture vivid swept displays for SWR, impedance, re-turn loss, phase angle, more. DDS generator.

MFJ-225 **$339.95**

SWR Analyzer Accessories

A. MFJ-29D/MFJ-39D, $24.95. Carrying Pouch for MFJ-259D/269D.

B. MFJ-92AA10, $29.95. 10-Pack 2500 mAh Ni-MH Supercells.

C. MFJ-66, $24.95. Dip coils, set of two covers 1.8-230 MHz.

D. MFJ-731, $99.95. Tunable Analyzer Filter, 1.8-30 MHz, for strong RF fields.

E. MFJ-917, $29.95. 1:1 Current balun for SWR Analyzers to test balanced line antennas, other loads.

F. MFJ-7737, $5.95. PL-259 to BNC Female.

G. MFJ-7727, $5.95. PL-259 to SMA Female.

H. MFJ-5510, $9.95.12VDC cigarette lighter adapter.

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Add shipping. Prices and specifications subject to change. (c) 2021 MFJ Enterprises, Inc.

• 1 Year No Matter What™ warranty • 30 day money back guarantee (less s/h) on orders direct from MFJ

made in USA

MFJ...the World Leader in Ham Radio Accessories!

MFJ 1500 Watt Remote Auto Tuner

Place this MFJ-998RT remote tuner at your antenna to match high SWR antennas/long coaxes -- greatly reduce losses for high efficiency

. . . Match 12-1600 Ohms, 1.5 kW, SSB/CW/Digital, 1.8-30 MHz . . . Match coax/wire antennas . . . Weather-sealed . . . Remotely powered thru coax . . . Amplifier, radio, tuner protection . . . Output static/lightning protection . . . StickyTune™ always tunes when power folds back . . . DC power jack . . .

MFJ-998RT
$869.95

Bottom Chassis

Inside View

Tune your antenna at your antenna

Get greatly reduced losses and high efficiencies with long coax runs and high SWR antennas with this new MFJ-998RT 1.5 kW Remote Antenna Tuner.

Weather-Sealed

A tough, durable weather-sealed ABS cabinet with over-lapping lips, sealing gasket and stainless steel chassis protects the MFJ-998RT from all kinds of weather.

No Power Cable Needed!

No power cable needed -- remotely powered through coax. Includes MFJ-4117 Bias-Tee with on/off switch for station end of coax. Has 12 VDC jack for power cable, if desired.

Fully Protected

MFJ exclusive algorithms protect your tuner, radio and RF power amplifier from damage.

Automatic inductor and capacitor limiting prevents tuning extreme loads which can destroy your tuner.

Your tuner will not tune if more than 75 Watts with SWR greater than 3:1 is applied or if more than 125 Watts is applied.

Tuner output is static electricity and lightning induced surge protected.

MFJ exclusive StickyTune™

Very high SWR can fold back transmitter power and prevent tuning caused by extreme differences in loads (example: changing bands and other conditions).

But MFJ exclusive StickyTune™ always tunes with a simple on/off power cycle and re-transmit.

Tunes Coax fed and Wire Antennas

Tunes both coax fed and wire antennas. Has ceramic feed-through insulator for wire antennas. 2 kV Teflon® insulated SO-239 – prevents arcing from high SWR.

High Power, Highly Efficient

A highly efficient L-network matches 6-1600 Ohms at full 1500 Watts legal limit SSB/CW and Digital, 1.8 to 30 MHz with Hi-Q Ls, Cs.

MFJ-998RT Learns as you Operate

As you operate, the MFJ-998RT automatically tunes for minimum SWR and remembers your frequency and tuner settings. The next time you operate on that frequency and antenna, its tuner solution is restored in milliseconds and you're ready to operate!

Highly Intelligent, Ultra-fast Tuning

MFJ InstantRecall™ recalls stored tuning solutions from 10,000 memories. For new frequencies, MFJ Intelli-Tune™ measures your antenna impedance and instantly determines the correct matching components. If antenna impedances cannot be measured, MFJ AdaptiveSearch™ searches only the relevant components that can match your antenna giving you ultra-fast tuning.

Field upgradeable firmware. Requires 12-15 VDC at 1.4 Amps maximum or 110 VAC with optional **MFJ-1316, $29.95**. Weighs 9.5 lbs. $13\frac{1}{4}$W x $6\frac{3}{4}$H x $17\frac{1}{2}$D inches.

600W Remote IntelliTuner™

MFJ-994BRT – perfect for 600 Watt SSB/CW amplifiers like Ameritron's AL-811/ ALS-600/ALS-500M. Matches 12-800 Ohms. Coax/wire antennas, 1.8-30 MHz. Fully weather-sealed for outdoor use. Remotely powered through coax. Tough, durable, built-to-last cabinet, $9\frac{1}{4}$W x 3H x $14\frac{1}{4}$D inches, 4 lbs. Includes MFJ-4117 BiasTee Power Injector.

MFJ-994BRT
$459.95

200W Remote IntelliTuner™

MFJ-926B, 200 Watts SSB/CW/Digital, 6-1600 Ohms, Coax/wire antennas, 1.8-30 MHz. Includes BiasTee.

MFJ-926B $329.95

300W Remote IntelliTuner™

MFJ-993BRT handles 300 Watts SSB/CW and digital.Has extra-wide 6-1600 Ohm impedances. Coax/ wire antennas, 1.8-30 MHz. Fully weather-sealed for remote outdoor or marine use. Remotely powered through coax. Tough, durable, built-to-last cabinet measures $9\frac{1}{4}$W x 3H x $14\frac{1}{4}$D inches. Weighs just 4 pounds. Includes MFJ-4117 BiasTee Power Injector.

MFJ-993BRT
$339.95

MFJ No Matter What™ Warranty

One year **No Matter What**™ Warranty
30 Day Money Back Guarentee
(less s/h) on orders direct from MFJ.

160-6 Meters 43 foot Vertical Antenna

Operate all bands 160-6 Meters at full 1500 Watts with this self-supporting, 43 foot high performance vertical! Assembles in less than an hour. Low profile blends in with sky and trees -- barely see it. Entire length radiates. Exceptional low angle DX performance on 160-20 Meters and very good performance on 17-6 Meters. Telescope it shorter for more effective low angle radiation on 17-6 M if desired. One of these wide range MFJ automatic tuners at the antenna easily matches all bands 160-6 Meters. There's no physical tuning adjustments on the antenna -- you simply put it up! Requires ground system, at least one radial, more the better. Includes balun and base mount. **MFJ-1932, $44.95**. All band ground radial system.

MFJ-2990
$399.95

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MFJ Tuners

New, Improved MFJ-989D 1500 Watt legal limit Antenna Tuner

World's most popular 1500 Watt Legal Limit Tuner just got better -- much better -- gives you more for your money!

New, improved MFJ-989D legal limit antenna tuner gives you better efficiency, lower losses and a new true peak reading meter. It easily handles full 1500 Watts SSB/CW, 1.8 to 30 MHz, including MARS/WARC bands.

New, dual 500 pF air variable capacitors give you twice the capacitance for more efficient operation on 160 and 80 Meters.

New, improved AirCore™ Roller Inductor gives you lower losses, higher Q and handles more power more efficiently.

New, TrueActive™ peak reading Cross-Needle SWR/Wattmeter lets you read true peak power on all modes.

MFJ-989D $469.95

Includes six position ceramic antenna switch, 50 Ohm dummy load, indestructible multi-color Lexan front panel with detailed logging scales and legends.

The MFJ-989D uses the superb time-tested T-Network. It has the widest matching range and is the easiest to use of all matching networks. Now with MFJ's new 500 pF air variable capacitors and new low loss roller inductor, it easily handles higher power much more efficiently.

New, high voltage current balun lets you tune balanced lines at high power with no worries.

New, crank knob lets you reset your roller inductor quickly, smoothly and accurately.

New, larger 2-inch diameter capacitor knobs with easy-to-see dials make tuning much easier.

New, cabinet maintains components' high-Q. Generous air vents keep components cool. $12^{7}/_{8}$W x 6H x $11^{5}/_{8}$D inches.

No Matter What™ Warranty

Every MFJ tuner is protected by MFJ's famous one year **No Matter What™** limited warranty. We will repair or replace your MFJ tuner (at our option) for a full year.

More hams use MFJ tuners than all other tuners in the world!

MFJ-986 Two knob Differential-T™

MFJ-986 $419.95

Two knob tuning (differential capacitor and AirCore™ roller inductor) makes tuning foolproof and easier than ever. Gives minimum SWR at only one setting. Handles 3 kW PEP SSB amplifier input power (1.5 KW output). Gear-driven turns counter, lighted peak/average Cross- Needle SWR/Wattmeter, antenna switch, balun. 1.8 to 30 MHz. 15W x $4^{1}/_{2}$H x $10^{3}/_{4}$D in.

MFJ-962D compact kW Tuner

MFJ-962D $359.95

A few more dollars steps you up to a KW tuner for an amp later. Handles 1.5 kW PEP SSB amplifier input power (800W output). Ideal for Ameritron's AL-811H! AirCore™ roller inductor, gear-driven turns counter, pk/avg lighted Cross-Needle SWR/Wattmeter, antenna switch, balun, Lexan front, 1.8-30MHz. $10^{7}/_{8}$W x $10^{3}/_{4}$H x $4^{1}/_{2}$D in.

MFJ-969 300W Roller Inductor Tuner

Superb, AirCore™ Roller Inductor tuning. Covers 6 Meters thru 160 Meters! 300 Watts PEP SSB. Active true peak reading lighted Cross-Needle SWR Wattmeter, QRM-Free PreTune™, antenna switch, dummy load, 4:1 balun, Lexan front panel. $10^{1}/_{2}$W x $3^{1}/_{2}$H x $9^{1}/_{2}$D inches.

MFJ-969 $259.95

MFJ-949E deluxe 300 Watt Tuner

More hams use MFJ-949s than any other antenna tuner in the world! Handles 300 Watts Full 1.8 to 30 MHz coverage, custom inductor switch, 1000 Volt tuning capacitors, full size peak/average lighted Cross-Needle SWR/Wattmeter, 8 position antenna switch, dummy load, QRM-Free PreTune™, scratch proof Lexan front panel. $10^{5}/_{8}$W x $3^{1}/_{2}$H x 7D inches. **MFJ-948, $179.95.** Economy version of MFJ-949E, less dummy load, Lexan front panel.

MFJ-949E $219.95

MFJ-941E Super Value Tuner

Most for your money! 300 Watts PEP, 1.8-30 MHZ, lighted Cross-Needle SWR/Wattmeter, 8 position antenna switch, 4:1 balun, 1000 volt capacitors, Lexan front panel. $10^{1}/_{2}$W x $2^{1}/_{2}$H x 7D in. **MFJ-941EK, $139.95.** Tuner Kit -- Build your own!

MFJ-941E $169.95

MFJ-945E HF/6M mobile Tuner

Extends your mobile antenna bandwidth so you don't have to stop, go outside and adjust your antenna. Tiny 8W x 2H x 6D in. Lighted Cross-Needle SWR/Wattmeter. Lamp and bypass switches. Covers 1.8-30 MHz and 6 Meters. 300 Watts PEP. **MFJ-20, $9.95**, mobile mount.

MFJ-945E $159.95

MFJ-971 portable/QRP Tuner

Tunes coax, balanced lines, random wire 1.8-30 MHz. Cross-Needle Meter. SWR, 30/300 or 6 Watt QRP ranges. Matches popular MFJ transceivers. Tiny $6^{1}/_{2}$W x $2^{1}/_{2}$H x 6D in.

MFJ-971 $149.95

MFJ-901B smallest Versa Tuner

MFJ's smallest (5W x 2H x 6D in.) and most affordable wide range 200 Watt PEP Versa tuner. Covers 1.8 to 30 MHz. Great for matching solid state rigs to linear amps.

MFJ-901B $119.95

MFJ-902B Tiny Travel Tuner

Tiny $4^{1}/_{2}$W x $2^{1}/_{4}$H x 3D inches, full 150 Watts, 80-6 Meters, has tuner bypass switch, for coax/random wire. **MFJ-904H, $169.95**. Same but adds Cross-needle SWR/Wattmeter and 4:1 balun for balanced lines. $7^{1}/_{4}$W x $2^{3}/_{4}$H x $2^{3}/_{4}$D inches.

MFJ-902B $129.95

MFJ-16010 random wire Tuner

Operate all bands anywhere with MFJ's reversible L-network. Turns random wire into powerful transmitting antenna. 1.8-30 MHz. 200 Watts PEP. Tiny 4W x 2H x 3D in.

MFJ-16010 $79.95

MFJ-9201 QRPocket™ Tuner

80-10 Meters, 25 Watts. 12 position inductor, tune/bypass switch, wide-range T-network, BNCs. 4W x $2^{5}/_{8}$H x $1^{1}/_{2}$D inches. **MFJ-9201, $49.95**

MFJ-9201 $54.95

MFJ-921/924 VHF/UHF Tuners

MFJ-921 covers 2 Meters/220 MHz. **MFJ-924** covers 440 MHz. SWR/Wattmeter. 8W x $2^{1}/_{2}$H x 3D in.

MFJ-921/924 $109.95

MFJ-931 Artificial RF Ground

Eliminates RF hot spots, RF feedback, TVI/RFI, weak signals caused by poor RF grounding. Creates artificial RF ground or electrically places far away RF ground directly at rig. **MFJ-934, $249.95**, Artificial ground/300 Watt Tuner/Cross-Needle SWR/Wattmeter.

MFJ-931 $129.95

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Phone: (662) 323-5869 ■ **Tech Help:** (662) 323-0549 ■ **FAX:** (662) 323-6551 8-4:30 CST, Mon.-Fri.

MFJ_989D_MFJ-986_100708_QST_092019DS

MFJ QRP!

QRPocket™ Loop Antenna Tuner

MFJ-9232
$69.95

Drape a wire around a bookcase, window, tree or other object and attach both ends to this *MFJ QRPocket™ Loop Antenna Tuner. It instantly turns into a small, high efficiency multi-band transmitting loop antenna!*

Operate 40-10 Meters with included flexible wire loop (80/60 Meters with your bigger loop). No ground, radials or counterpoises needed. 25 Watts.

It's a very quiet receiving antenna. Its hi-Q reduces QRM, overload, harmonics.

Perfect for apartments, antenna restricted areas and portable operation. Tune *any* shape loop -- circle, square, rectangle, *etc.*

Adjust tuning and matching capacitors for minimum SWR and operate.

BNC for transmitter, wing nut posts for loop wire. Tiny 2¼Wx4Hx2¼D inches.

MFJ-9234, $69.95. Like MFJ-9232 but connects directly to your transceiver SO-239 antenna connector.

VIDEOS: https://m.youtube.com/results?search_query=MFJ-9232

QRP Antenna Tuner

MFJ-9201, $59.95. *Tunes any antenna* 80-10 Meters, 25 W. 12-position hi-Q inductor, tune/bypass, variable antenna and transmitting matching capacitors, BNC connectors. Tiny 4Wx2⅝Hx1½D inches -- MFJ-9201, rig and antennas easily fit into a backpack or briefcase for vacation, SOTA, hikes, etc.

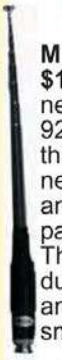
MFJ *Walk-About* 80-6M Antenna

MFJ-1899T, $99.95. Perfect for QRP radios like FT-817, KX3, Xiegu, others. Covers *all* bands 80-6 Meters including WARC. Ten section telescoping whip (52" extended, 7" collapsed). 12" base loading coil with *Wander Lead*. Whip/coil unscrews for easy storage. 25Watts. BNC.

MFJ-7703, $8.95, BNC/PL-259 elbow.

MFJ-7760, $5.95. BNC/BNC elbow.

MFJ Single Band *Walk-Abouts*



Each is 51 inches extended and collapses to 5.5 inches. Handles 25 Watts. BNC.

MFJ-1806T (6M) $34.95
MFJ-1810T (10M) $34.95
MFJ-1812T (12M) $34.95
MFJ-1815T (15M) $34.95
MFJ-1817T (17M) $34.95
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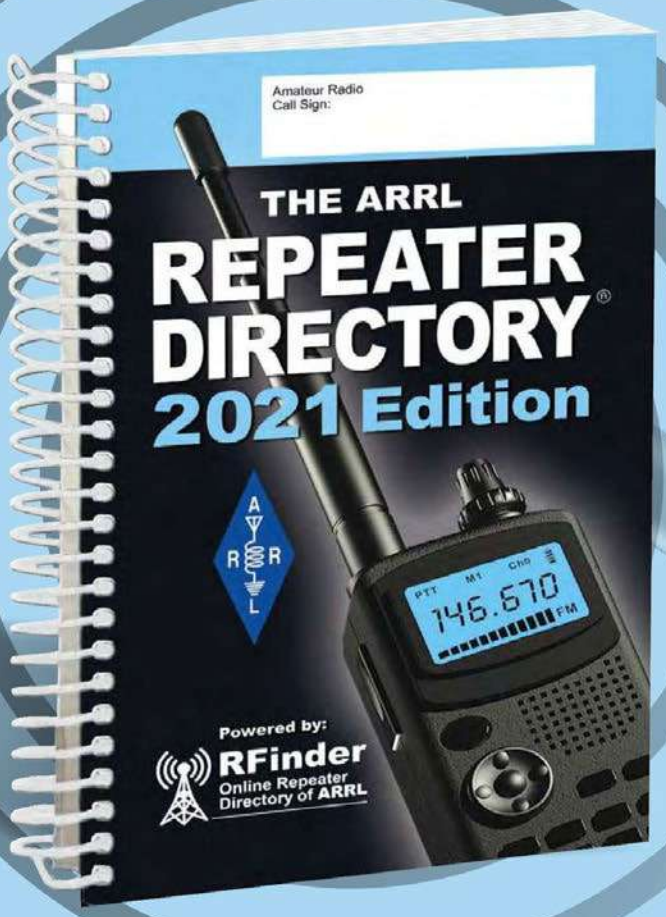

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