QST
DIGITAL EDITION

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QST Reviews

SDRplay RSPdx Software-Defined Receiver

FUNKAMATEUR/SDR-Kits FA-VA5 Vector Antenna Analyzer

Cushcraft AR-2 "Ringo" 2-Meter Antenna

EAntenna DUOSAT Dual-Band Satellite Antenna

YAESU
The radio

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- ***Wide Range RX Coverage : 108 ~ 999.99 MHz***
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50 W DIGITAL MOBILE TRANSCEIVER

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The radio... YAESU

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2kHz RMDR 123dB+
2kHz BDR 150dB+
2kHz 3rd IMDR 110dB+

Ultra Low-Noise Local Oscillator System; 400MHz HRDDS
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2kHz Phase Noise −150dBc/Hz

VC-TUNE (Variable Capacitor Tune) signal peaking

Maximum Attenuation −70dB

3DSS (3-Dimensional Spectrum Stream) visual display
view up to last 25 seconds of band conditions in real time

TX Signal Purity

TX Phase Noise −150dBc/Hz (TX 14MHz 2kHz separation)

* Microphone M-1: Optional

In Homage to the Founder of Yaesu – Sako Hasegawa JA1MP

FTDX101MP 200W
HF/50MHz TRANSCEIVER

- External Power Supply with 3.94" (100mm) Front Speaker, FPS-101 included
- VC-Tune unit × 2 (MAIN and SUB bands) included
- 300Hz Crystal roofing filter (MAIN band) included
- 600Hz Crystal roofing filter (MAIN and SUB bands) included
- 3kHz Crystal roofing filter (MAIN and SUB bands) included

The Ultimate

FTDX101D 100W
HF/50MHz TRANSCEIVER

- VC-Tune unit (MAIN band) included
- 600Hz Crystal roofing filter (MAIN and SUB bands) included
- 3kHz Crystal roofing filter (MAIN and SUB bands) included

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Specifications subject to change without notice. Some accessories and/or options may be standard in certain areas. Frequency coverage may differ in some countries. Check with your local Yaesu Dealer for specific details.

Cushcraft...Keeping You in Touch Around the Globe

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.

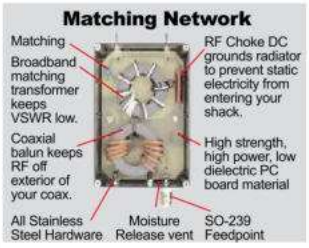
Rugged Construction: Thick fiberglass insulators, all stainless steel hardware and 6063 aircraft-aluminum tubing is double or triple walled at key stress points to handle anything Mother Nature can dish out.

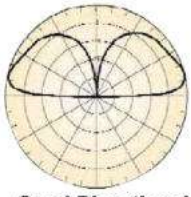
31.5 feet tall, 25 lbs. Mounting mast 1.25 to 2 inches. Wind surface area is 4 square feet.

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

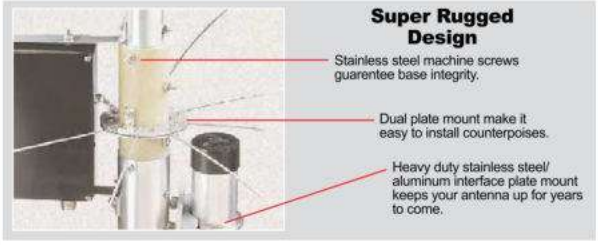
R-8TB, $99.95. Tilt-base lets you tilt your antenna up/down easily by yourself to work on.

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!

CHA-250B - *No Antenna Tuner Needed!*

❶ ❷ ❸ ❹ ❺ ❻ ❼

Base Antennas

❶ C★MET CHA-250B BROADBAND 80M THROUGH 6M VERTICAL ANTENNA

A newly designed broadband vertical with NO GROUND RADIALS. EXTREMELY easy to assemble, requires no tuning or adjustments and VSWR is under 1.5:1 from 3.5-57MHz! • TX: 3.5MHz – 57MHz • RX: 2.0– 90MHz • VSWR is 1.5:1 or less, continuous • Max Power: 250W SSB/125W FM• Impedance: 50 Ohm • Length: 23' 5" • Weight: 7 lbs. 1 oz. • Conn: SO-239 • Mast Req'd: 1" – 2" dia. • Max wind speed: 67MPH

❷ Maldol HVU-8 ULTRA-COMPACT 8 BAND HF/VHF/UHF VERTICAL ANTENNA

80/40/20/15/10/6/2M/70cm Only 1/2 the traditional size and weight of vertical HF antennas, and it includes 2M/70cm! Unique radial system rotates for balcony installations, the radials can all be rotated to one side. • Wavelength: HF and 6M: 1/4 wave • 2M: 1/2 wave • 70cm: Two 5/8waves in phase • Impedance: 50 Ohm • Max Power: HF 200W SSB • 6M–70cm: 150W FM• Conn: SO-239 • Height: Only 8'6" • Weight: 5lbs. 7ozs.

❸ C★MET GP-3 DUAL-BAND 146/446MHZ BASE REPEATER ANTENNA

Wavelength: 146MHz 6/8 wave • 446MHz 5/8 wave x 3 • Max Pwr: 200W • Length: 5'11"• Weight: 2lbs. 9ozs. • Conn: Gold-plated SO-239 • Construction: Single-piece fiberglass

❹ C★MET GP-6 DUAL-BAND 146/446MHZ BASE REPEATER ANTENNA

Wavelength: 146MHz 5/8 wave x 2 • 446MHz 5/8 wave x 5 • Max Pwr: 200W • Length: 10'2"• Weight: 3lbs. 8ozs. • Conn: Gold-plated SO-239 • Construction: Fiberglass, 2 Sections

❺ C★MET GP-9 / GP-9N DUAL-BAND 146/446MHZ BASE REPEATER ANTENNA

BEST SELLER! • Wavelength: 146MHz 5/8 wave x 3 • 446MHz 5/8 wave x 8 • Max Pwr: 200W• Length: 16' 9"" • Weight: 5lbs. 11ozs. • Conn: GP-9 Gold-plated SO-239 • GP-9N Gold-plated N-type female • Construction: Fiberglass, 3 Sections

❻ C★MET CX-333 TRI-BAND 146/220/446MHZ BASE REPEATER ANTENNA

Wavelength: 146MHz 5/8 wave x 2 • 220MHz 5/8 wave x 3• 446MHz 5/8 wave x 5 • Max Pwr: 120W • Length: 10'2" • Weight: 3lbs. 1oz.• Conn: Gold-plated SO-239 • Construction: Fiberglass, 2 Sections

❼ C★MET GP-15 TRI-BAND 52/146/446MHZ BASE REPEATER ANTENNA

Wavelength: 52MHz 5/8 wave • 146MHz 5/8 wave x 2 • 446MHz 5/8 wave x 4 • Max Pwr: 150W • Length: 7'11" • Weight: 3lbs. 1oz. • Conn: Gold-plated SO-239• 2MHz band-width after tuning (6M) • Construction: Single-piece fiberglass

NEW CAA-500MarkII

1.8-500MHz Antenna analyzer

The CAA-500MarkII combines the simplicity and accuracy of an analog instrument, PLUS…a full color LCD graphic display • Resistive (R) and Reactive (X) components of impedance graphed and displayed numerically • SWR readings in both graphic and numerical results.

Operates on 8-16VDC external power, 6 AA Alkaline or NiMH rechargeable cells • Trickle charger built in (only when using NiMH batteries) • Typical battery life: 9 hours of continuous operation • Battery level indicator • Selectable auto power-off time limit preserves battery capacity • SO-239 connector for 1.8-300MHz range • N-female connector for 300-500MHz range

The perfect combination of analog and graphic information, designed in particular for antenna diagnostics and adjustments while on the roof, tower or in the field!

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Shoulder strap included.

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QST

Contents

September 2020 ♦ Volume 104 ♦ Number 9

Columns

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Write for *QST*

www.arrl.org/qst-author-guide
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Our Cover

Experienced hiker Zach Thompson, KM4BLG, understands the struggle of minimizing the weight of his equipment while operating portable. With a lightweight design in mind, he built an antenna mast out of his trekking poles. Read more about it in his article, "Easy to Use Antenna Mast for Portable Operators," on page 36 of this issue.

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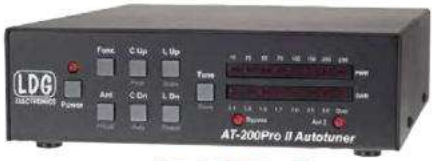

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Tunes 10:1 SWR • Two-Year Warranty • 250W SSB/100W Digital

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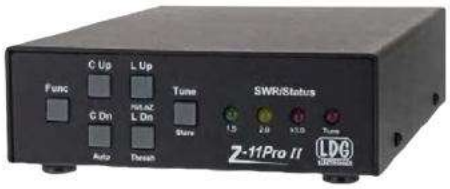
Portable and Desktop Autotuners



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Generic Tuner for HF Radios • Includes Icom Interface Cable • 125W SSB/30W Digital • Other Interface Cables Available @HamGadgets.com

Z-817

FT-817/818 Compatible • Operates on 4-AAs • 20W SSB/5W Digital

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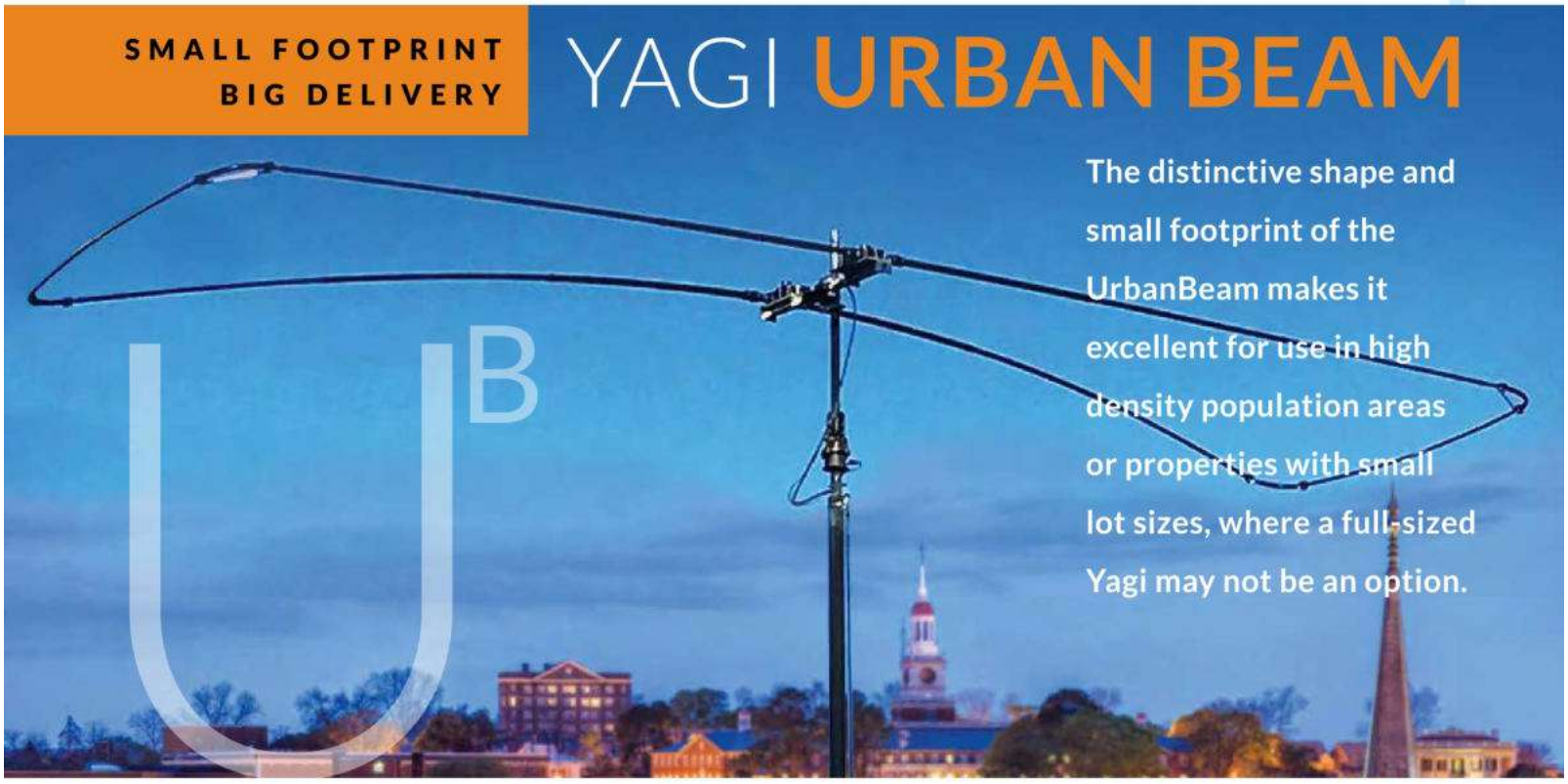
BIG DELIVERY

YAGI URBAN BEAM



The distinctive shape and small footprint of the UrbanBeam makes it excellent for use in high density population areas or properties with small lot sizes, where a full-sized Yagi may not be an option.

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DIAMOND ANTENNA

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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.

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X700HNA Special Features:

- Heavy duty fiberglass radomes
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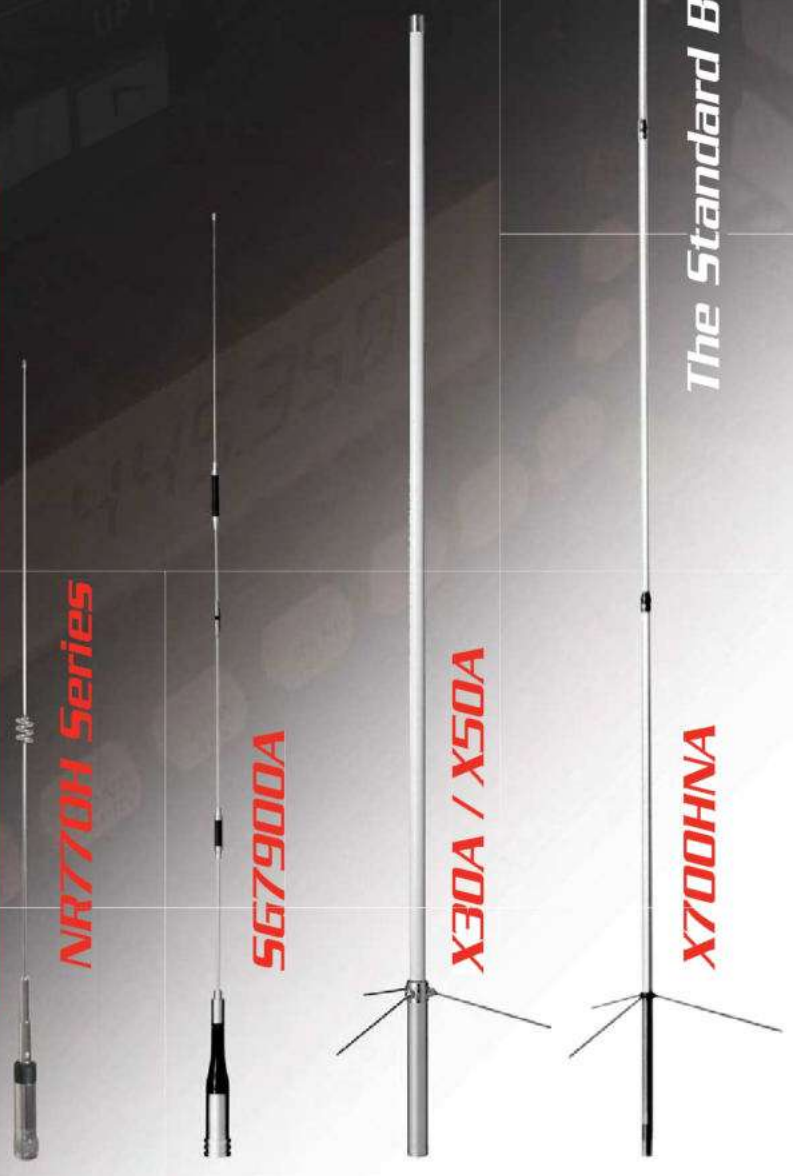
Dualband Base Station/Repeater Antennas				
X700HNA (4 section)	2m/70cm	24	200	N
X510HD (3 Section)	2m/70cm	17.2	330/250	UHF or N
X300A (2 Section)	2m/70cm	10	200	UHF or N
X200A (2 Section)	2m/70cm	8.3	200	UHF
X50A (1 Section)	2m/70cm	5.6	200	UHF or N
X30A (1 Section)	2m/70cm	4.5	150	UHF
Monoband Base 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



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Steve Ford, WB8IMY, wb8imy@arrl.org

Second Century

Moving On

After almost 30 years at ARRL, this is my last issue as the Editor of QST magazine. In a few weeks, I'll be turning in my office keys and strolling across the Headquarters parking lot for the final time. They say your retirement years can be among the happiest, and I'm looking forward to finding out if that is true.

I'm leaving the ARRL publications department, and *QST*, in the skilled hands of Becky Schoenfeld, W1BXY. Her career already spans nearly 30 years and includes employment with some of the giants of publishing, such as McGraw-Hill. We've functioned as an editorial management team for nearly a decade, and it has been a delightful partnership.

Becky has assembled a crew of talented media professionals, some of whom are relatively new to Headquarters, and others who are seasoned veterans. They have ideas and creativity in abundance, and they'll accelerate the modernization process that Becky and I began a few years ago.

That's why it is important for me to take my leave. I'm old school and ARRL urgently needs new school, especially when it comes to media. As a manager, I'm a firm believer in the necessity of stepping aside and making room for fresh perspectives. The tricky part is recognizing when that moment has arrived. I've seen too many people my age who cling to their careers, perhaps hoping for one more flash of glory before winter closes in.

Thanks, but I'll pass. My time is at an end; their time is just beginning. I'll take great pleasure in watching their progress from the sidelines.

I welcome returning to amateur radio as a "civilian," even though the hobby is facing perhaps the most crucial time in its history. Late last year, International Amateur Radio Union President Tim Ellam, VE6SH/G4HUA, poignantly observed that amateur radio had reached "an inflection point." That may be an understatement.

My chosen metaphor to describe the situation is *a perfect storm*. It is a maelstrom of poor HF band conditions, onerous antenna restrictions, escalating threats to our spectrum, indifference and sometimes even hostility from various regulatory bodies, and an aging and increasingly inactive ham population. Add the long-term social and economic impacts of the coronavirus pandemic and the outlook becomes forbidding, to say the least.

Even so, I'm confident ham radio will endure, although it may depart significantly from ham radio as we've known it. This doesn't mean we'll be forced to abandon our rich history, but we will need to accept that the "good old days" are dwindling in our rear-view mirrors. Besides, as Billy Joel sang in "Keeping the Faith" — "The good old days weren't always good and tomorrow ain't as bad as it seems."

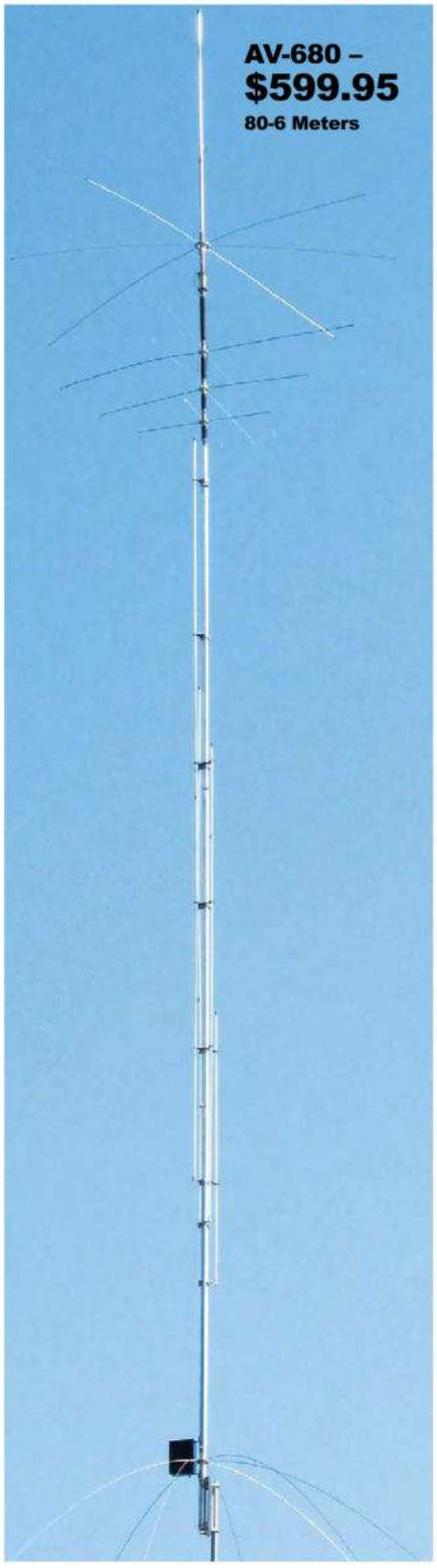
My faith in the future of the hobby was reinforced by an amateur I corresponded with recently. He is 86 years old and just purchased a Raspberry Pi microcomputer that he intends to use to explore HF digital operating. He even signed up for an online course to improve his knowledge of the Linux operating system. This gentleman has no experience with digital modes or computer programming, and he doesn't care — he remains open to change and he is eager for a new challenge. Amateur radio requires many more forward-looking individuals like him, regardless of age.

In whatever way the future unfolds, amateurs can always count on having the ARRL Headquarters staff at their backs. Most of the people at 225 Main Street are invisible to the membership, rarely turning up in the pages of *QST*, yet they create publications and online media, answer telephone calls and emails, process awards, collaborate with industry and the FCC, promote amateur radio to the public, provide ongoing education, and perform countless other tasks to help keep our avocation alive. Some have spent the majority of their working lives at Headquarters even though they could enjoy higher incomes — not to mention milder winters! — elsewhere. They persist because they genuinely believe in ARRL's mission. I count myself lucky to have worked alongside such dedicated individuals. I will miss them all.

73,
Steve Ford, WB8IMY
Editor, QST

The First Choice of Hams Around the World!

hy-gain® Antennas



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
The AV-680 uses quarter wave stubs on 6, 10, 12 and 17 Meters and very efficient end loading coil and capacity hats on 15, 20, 30, 40 and 80 Meters -- no traps. End loading allows efficient operation with a low profile. Resonators are placed in parallel not in series.

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

Sleek and low-profile
Low 2.9 sq. ft. wind surface area. Small footprint for mounting easily on decks, roofs and patios. 26 feet, 18.5 lbs.

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.

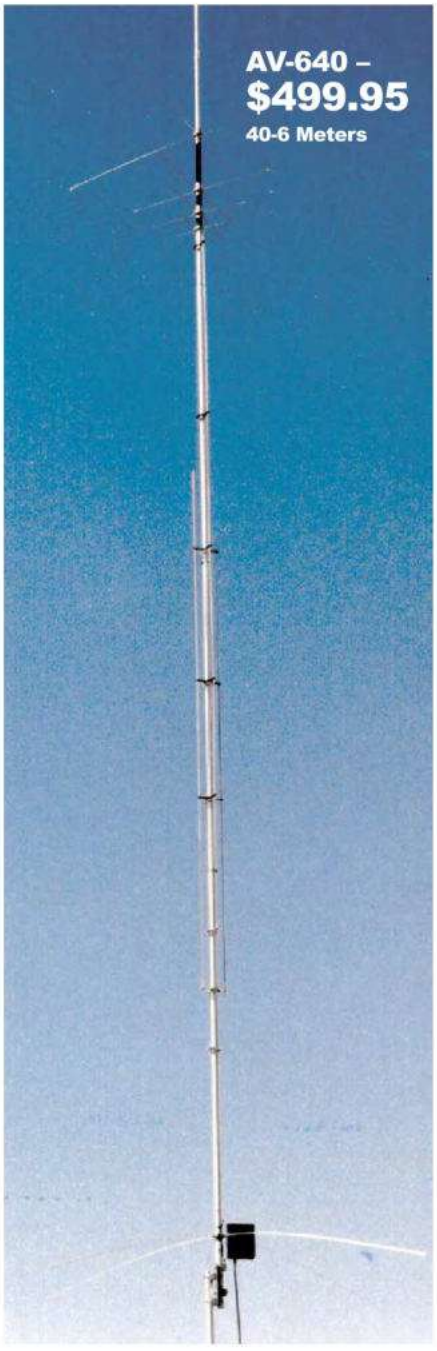
ATB-75, $99.95. Tilt base for hy-gain AV-680/AV-640 and AV-620 verticals.

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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- 80-10 meter*
- Compact & light
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- Quick band change
- Aluminum mast*
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DPM6000 Power Meter

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$895

PG50PS Pulse Generator

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$175

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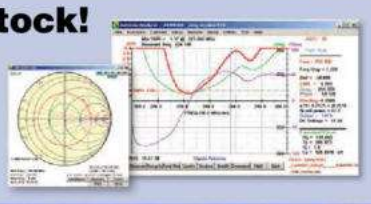

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AS-302, AS-303 Coaxial cable arrestors. DC to 500 MHz. N-type or SO-239 connectors. **AS-300SB** Stacking fixture available. **AS-309H**, ladder line arrestor. All have static bleed function. **AS-8SP**, **AS-12SP** and **AS-16SP** control cable arrestors. Protect your rotator's and other control cables.

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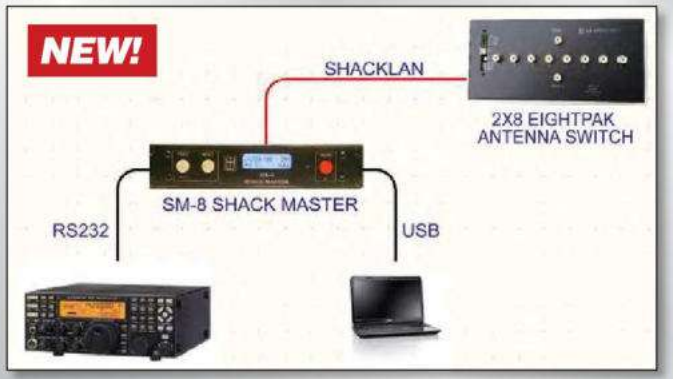
Wiring are simple phone cables that daisy chain to all the devices. Wireless control is also available to your tower-located switches. Call us to learn how to set up simple or complex systems. Below is a simple basic system that can switch antennas as you change bands. We can interface to any radio CAT port, not just RS232.



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Member Spotlight

Pascal Villeneuve, VA2PV

VA2PV is a familiar call sign to many *QST* readers. It belongs to Pascal Villeneuve, a Canadian radio amateur who often reviews new technology for *QST's* "Product Review" column. Pascal has a penchant for innovation, both in his amateur radio activities and his professional life.

Pascal didn't become licensed until early adulthood, but his interest in radio started when he was very young. He was born and raised on a farm and he fondly remembers the ancient RCA receiver that sat in his father's barn office. Pascal often used it to listen to shortwave broadcast stations. He said, "I managed to connect a long-wire antenna and I could receive many signals, but I didn't understand most of them because the broadcasts were in languages other than English or French. No matter; I was hooked!"

Thanks to one of his uncles, Pascal discovered the Citizens Band (CB) during the 1970s. His uncle had a CB transceiver installed in his pickup truck and Pascal listened whenever he had the chance.

One day, Pascal's mother took him on a visit to a man who was tuning the family's piano. As it turned out, the piano tuner was also a ham. Pascal was astonished to see his station and began asking one question after another — so many that his mother finally intervened. That evening, Pascal begged his parents to enroll him in an amateur radio course. They declined, citing the cost of setting up a station and wondering if Pascal might be too young for such things. Amateur radio would have to wait.

Pascal graduated college in 1991 with a degree in Business Administration, but his passion for radio remained. That same year, he began studying for his Basic amateur radio license and soon passed the exam. By early 1992, he had completed all the Canadian ham exams.

Pascal married in 1994 and all was well; he was settling into his career and enjoying amateur radio. However, in the mid '90s, while he was between jobs, his wife suggested that he return to college to study electronics. Pascal agreed and soon earned a new degree with a major in computer electronics. The ink was barely dry on his diploma when he was hired by a large telecommunications company. Pascal has since become the company's senior technical support manager for the business market with expertise in IP networking with technologies such as VoIP, MPLS, PSTN, and more.

Friendship and Technical Challenges

When asked what he enjoys most about ham radio, Pascal quickly replied, "Friendship and technical challenges."

He explained, "I always find myself searching for something new to try. That's the reason I created my website (**www.va2pv.com**) and YouTube channel (**Laboenligne.ca**)." He uses both platforms to share information about his "passion for this wonderful hobby that made me who I am today."

For Pascal, his family is his top priority and his career takes second place. Even so, he still finds time to be heavily involved in amateur radio.

He usually prefers to share his latest discoveries through video. "Everything I try in ham radio I make a video about and I enjoy the technical challenge of making quality videos," he said. "For example, since 2016 I've been producing all my videos in 4K Ultra High Definition. That made the production process somewhat more complex. I even had to build a monster PC just to be able to edit the files!"

The Future of Amateur Radio

When asked if he is optimistic about the future of radio, Pascal said, "If you would have asked me this question 10 years ago, I would have been very pessimistic, but today I think differently. Exciting technologies like digital communications and software-defined radio have brought new blood into the hobby and will continue to do so."

Pascal believes the internet is not a threat to amateur radio, but is instead a valuable resource. "Just look at what YouTube videos have done to educate hams, new and old," he said. "I don't mean just my channel, but all of them. Soon we'll have ARRL's Lifelong Learning program that will also use the internet as an educational tool. In this climate, how can I not be optimistic?"

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Up Front

A Family Affair

In late February, just a few weeks before the COVID-19 lockdowns began, the Southern Peninsula Amateur Radio Club and the Hampton Public Service Team conducted an exam session at the American Red Cross facility in Hampton, Virginia. They had 15 Volunteer Examiners on board with 22 candidates participating. The result was 17 new Technician-class licensees, a new General-class license, a Technician who upgraded to General, and three Generals who upgraded to Amateur Extra class.

Among the new Technicians were nearly all the members of the Hallare family, consisting of Ferdinand, his wife Maila, and their two young daughters, Maxyn and Hally.

A happy family and Volunteer Examiners. In the foreground, from left to right: Maila, KO4CHW; Hally, KO4CHX; Maxyn, KO4CHY; Ferdryx, and Ferdinand, KO4CHZ. In the background, from left to right: Don Stidwell, KE4RMO; Dennis Ricketts, K4DRR; Bob MacLachlan, KE4JDY; Bob Uiterwyk, W3AF; Dave Hewlett, WA4OPE; Tom Hite, AE4TH; Addison Inge, AA4AV; Don Mertz, KJ4MZ, and Ed Shuman, WDØFYV.

Morse Code Can Be Stylish Too

During a stay in a newly built hotel near the Fort Lauderdale, Florida airport, Gene Marcus, W3PM, was surprised to find that Morse code played a significant role in its stylish décor. The Morse code greeting "Gateway to Discovery" appears directly behind the reception desk. It even appears in the distinctive carpeting found throughout the corridors of the hotel.

Code Ninjas

The name of this international company that teaches kids how to write computer code put Mike Lonneke, W4RN, in mind of black-clad assassins descending from the ceiling to smite hams who miscopy Morse code.

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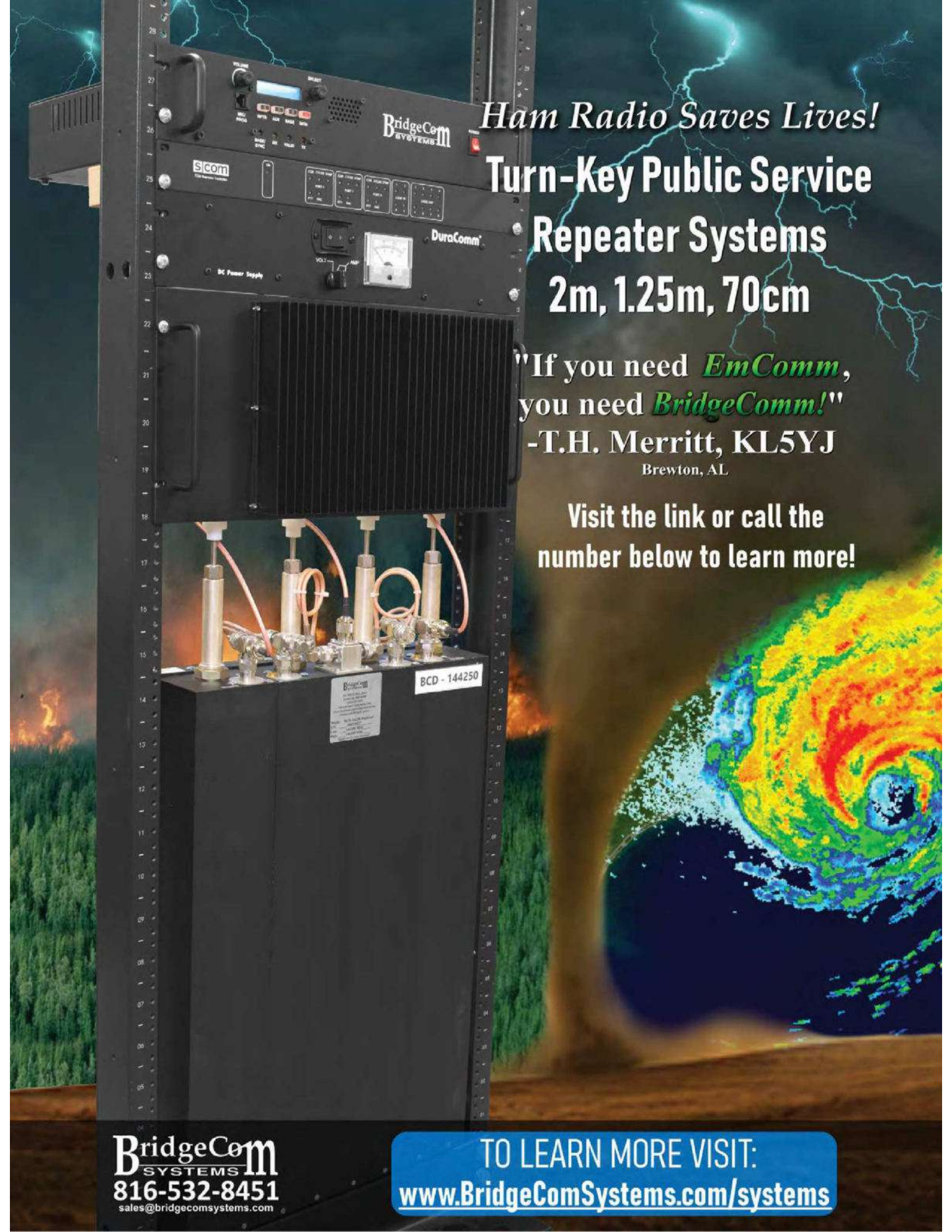
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Correspondence

Letters from Our Members

Telegraph Keys in World War II

I enjoyed Harold Kramer's, WJ1B, excellent "Classic Radio" article in the July 2020 issue of *QST* about military telegraph keys, especially the British Royal Air Force (RAF) "Bathtub" key, of which I have owned a few and know something of their history.

These keys were fitted to British bombers during World War II and were used by RAF wireless officers. They were made from a brown Bakelite material, a precursor to plastic. For Canadian crews, the keys were black. These keys are very rare due to the huge losses of Canadian crews.

The key can be strapped to the operator's leg. Many years ago, I actually used one on a parachute jump. The Bathtub keys weren't used by World War II paratroopers on bombers, unless they were being flown in on gliders or Dakota DC-3s and towed by the bombers to their drop zones.

Doug Goodison, GØLUH
Isleworth, Middlesex, England

Staying Connected During Coronavirus

With any club, keeping a connection to the membership is always a challenge. With radio, it's a bit different, because we "know" a lot of other folks despite never having the chance to meet in person. With the COVID-19 health crisis, face-to-face group meetings have been stopped entirely. I read with interest the article "Online Club Meetings Ease Shelter-in-Place Isolation" by Lee Chambers, KI7SS, and Phil Cornell, W7PLC, in the July issue of *QST*. Our club was among those groups using videoconferencing technology, but we added a twist.

Our repeater club's meeting was scheduled for the end of March and was just not going to happen. We moved instead to a videoconferencing site to host our meeting virtually. To give our club members a chance to practice with the technology, we had them test their connections during our "SUHFARS NothingNet," which runs weekly on Sunday nights on our repeater. We had our quarterly meeting, and all went well, but there was an unintended consequence. Everyone enjoyed the video component so much that they wanted to keep it as a regular feature of the net.

All of our nets since then have included the video component. As an added benefit, this allows members that were out of range of the repeater to virtually join the net. Now, the "video net" starts 30 minutes before our regular net's time and continues after the end of the net, usually for another 30 minutes or so. Sometimes the conversations are technical, and sometimes not, in keeping with the theme of a NothingNet.

Some will say, "But it's not radio." I say instead that it's another dimension we can embrace as part of communications and to add enjoyment to our interactions.

Mike Zyskowski, KD9MZ
Round Lake, Illinois
Life Member

July Cover Art

I very much admired the cover artwork (by Kevin Sterjo) for the July 2020 issue of *QST*. Many years ago, I had the honor of designing the flag for ARRL, so while I'm not a professional artist or illustrator, I know good design when I see it. I particularly like the version of the ARRL logo on the coffee cup in the lower right corner of the cover. It's the best minimalist version of it that I've seen and could almost be a universal emblem for the whole of amateur radio.

Ralph Holberg, N4RX
Mobile, Alabama
Life Member

Send your letters to "Correspondence," ARRL, 225 Main St., Newington, CT 06111. You can also submit letters by fax at 860-594-0259, or via email to **letters@arrl.org**. We read every letter received, but we can only publish a few each month. We reserve the right to edit your letter for clarity, and to fit the available page space. Letters published in "Correspondence" may also appear in other ARRL media. The publishers of *QST* assume no responsibility for statements made by correspondents.

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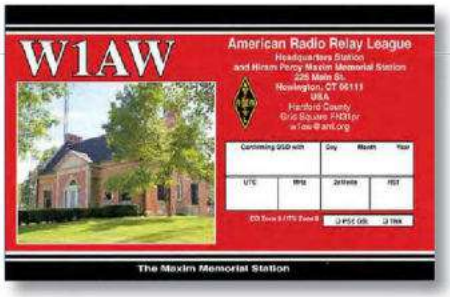
W1AW's QSL File

Every month, W1AW receives hundreds of QSL cards from hams all over the world, confirming contact with the Hiram Percy Maxim Memorial Station at ARRL Headquarters. Maybe you'll recognize an on-air friend — or even yourself — among these recent cards.



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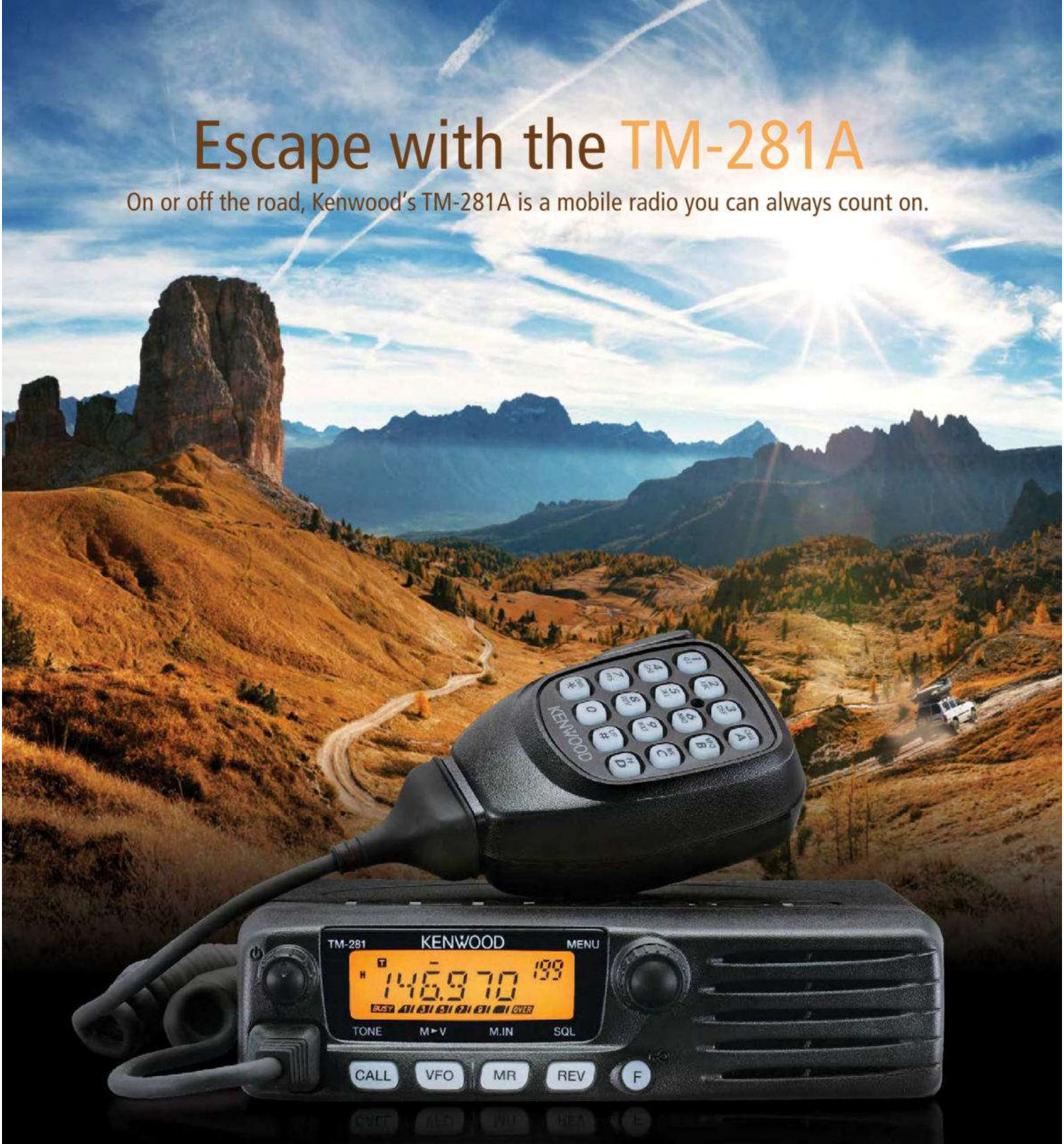

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Build Your Own Optical Encoder

The theory and construction of an inexpensive optical encoder.

Riccardo Gionetti, IØFDH

Not being very satisfied with commercially available mechanical encoders, I decided to build an electro-optical encoder. I used this encoder in an RF generator and in a receiver, but it can have many more applications. And because there are no mechanical contacts, it is very reliable.

Encoder and Circuit Discussion

An electro-opto-mechanical encoder converts the angular position of its shaft into a digital signal by producing pulses from the shaft rotation. As shown in Figure 1, the encoder basically consists of a disk, usually plastic, attached to a rotating shaft, and divided into transparent and dark areas. There is also a pair of

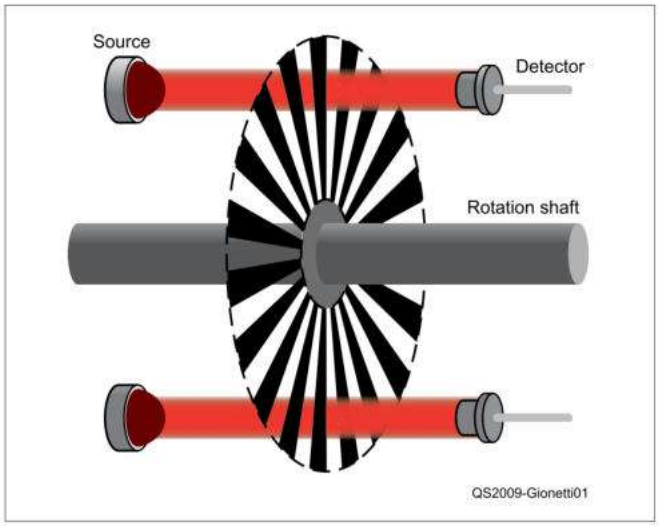

Figure 1 — The rotary encoder working principle.

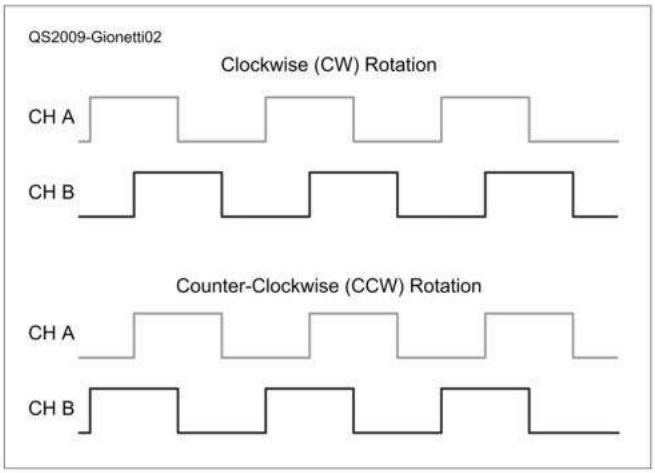

Figure 2 — The clockwise and counterclockwise rotation.

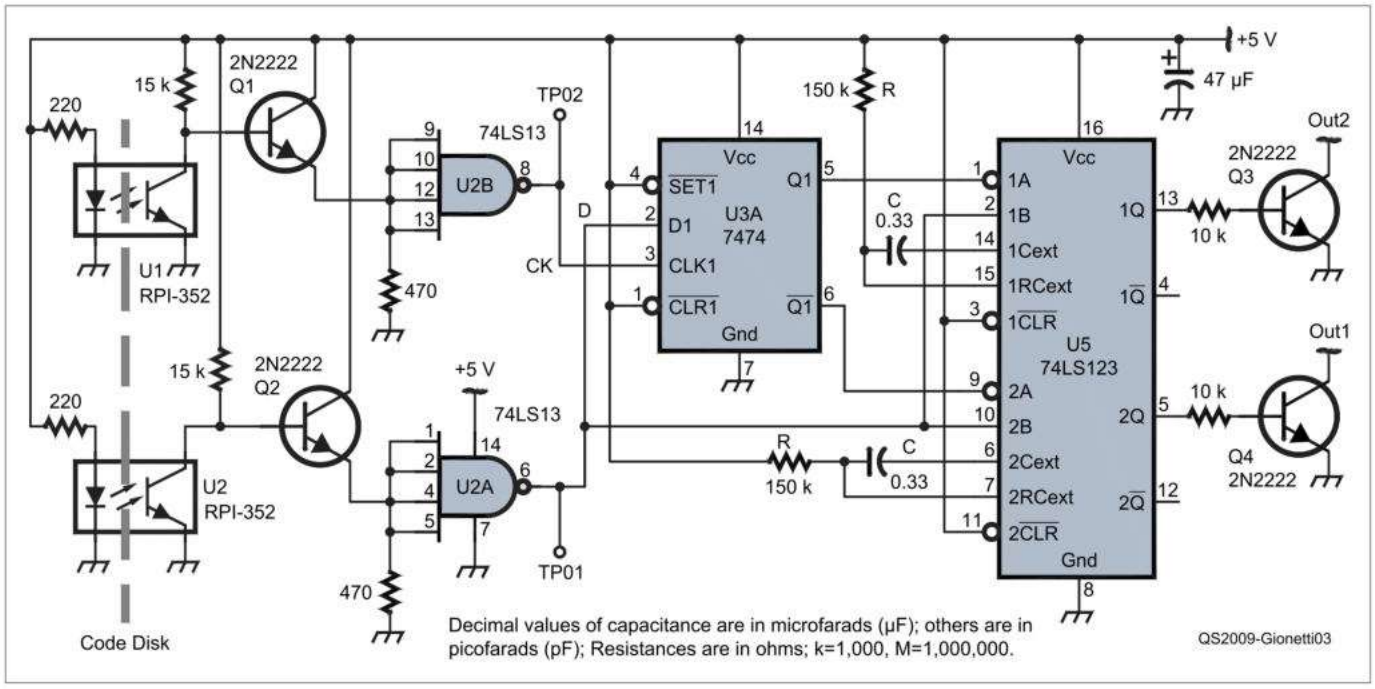

Figure 3 — The schematic diagram.

photo emitters/detectors, which generate the light that passes through the transparent areas of the disk, and it receives the light signal and converts it into voltage pulses. The two photo emitters/detectors are positioned to cause a 90-degree phase difference between the clocks. This phase relationship determines the direction of rotation. Figure 2 shows the output sequences at TP01 (channel A) and TP02 (channel B) in Figure 3. For clockwise rotation, A leads B by 90 degrees. For counterclockwise rotation, A lags B by 90 degrees.

Figure 3 shows how the photo detector outputs connect to a digital board. A Schmitt trigger removes the small linear region between the on and off states of the detectors. By applying channel A to input D, and channel B to the input clock of a 74LS74 D flip-flop, we can determine the sense of encoder rotation. When A leads B, output Q is low. Q becomes high when A lags B (see Figure 4). To have duration pulses independent of the rotation speed of the encoder shaft, the Q and $\overline{Q}$ outputs of the D flip-flop are connected to gates 1A and 2A (Pins 1 and 9) of a 74LS123 dual-monostable multi-vibrator, while the channel B connects to gates 1B and 2B (Pins 2 and 10) of the 74LS123. With this configuration, clockwise rotation activates monostable A, while counterclockwise rotation activates monostable B. The duration of the pulses is determined by the RC time constant (about 15 ms with the values shown). The period depends on the shaft rotation speed.

The Q or $\overline{Q}$ outputs of the monostables are connected to the device to be controlled by open collector transistors. Pull-up resistors (not shown) provide high-state voltage when Q is off, or low-state voltage when Q is on. The open collectors allow interfacing to TTL, TTL LS, CMOS, and HCMOS. Figure 5 shows the CW and the CCW pulses at the open collector outputs.

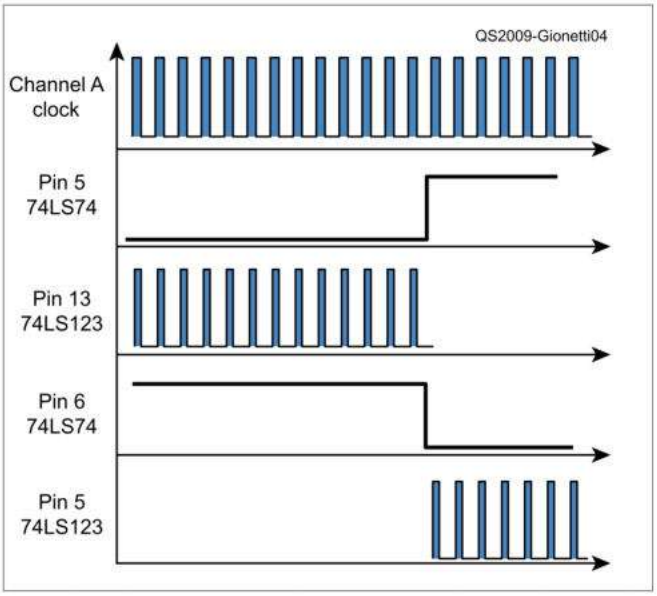

Figure 4 — The encoder output in CW and CCW rotation.

Assembly

Figure 6 shows the necessary mechanical and electrical parts. The threaded collar and brass shaft are from

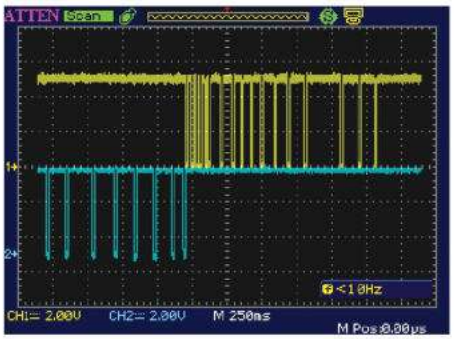

Figure 5 — A view of the CW and CCW pulses at the open collector outputs.

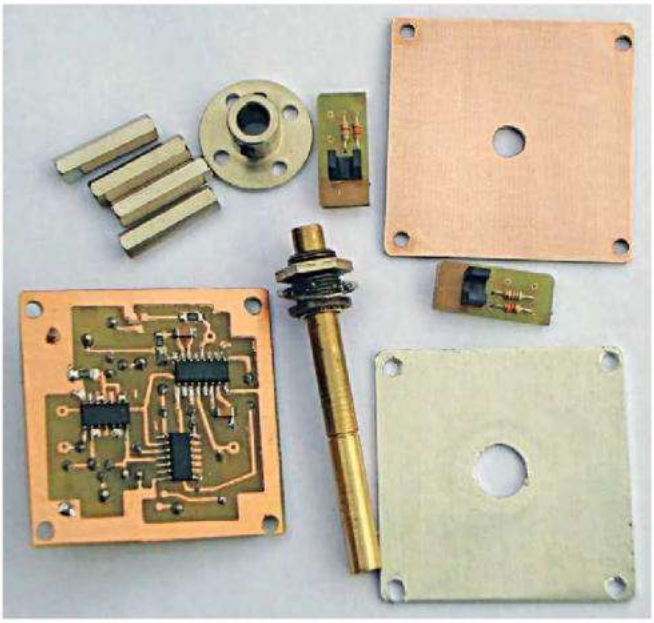

Figure 6 — The encoder's main parts.

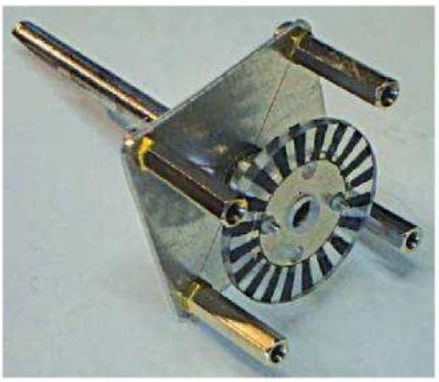

Figure 7 — The code wheel mounted on the shaft.

Figure 8 — The photo interrupter mini-board.

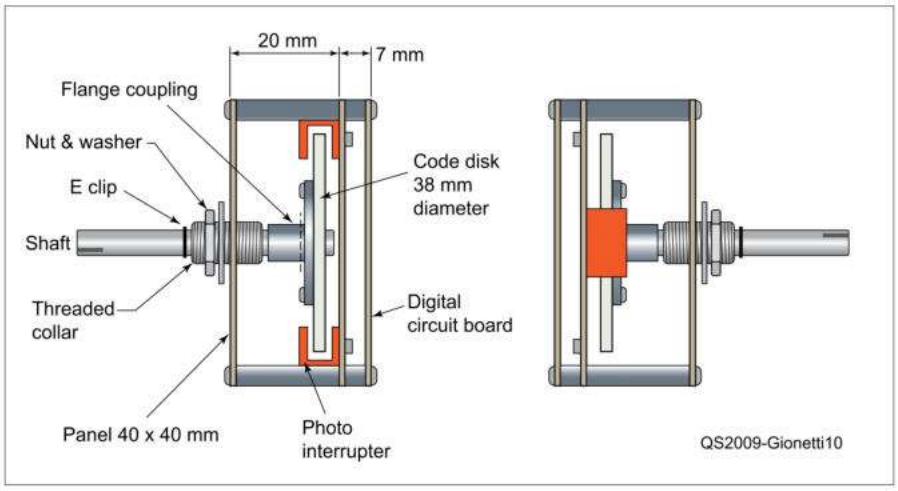

Figure 10 — The mechanical assembly.

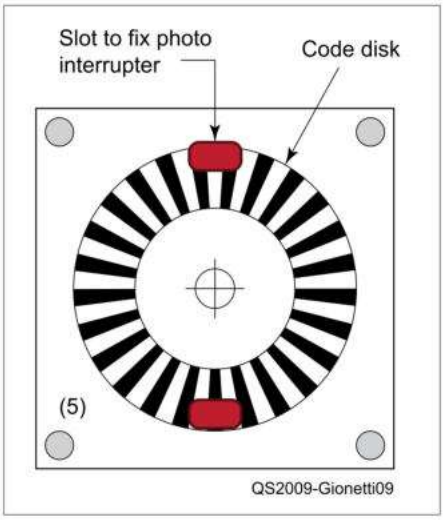

Figure 9 — The code disk.

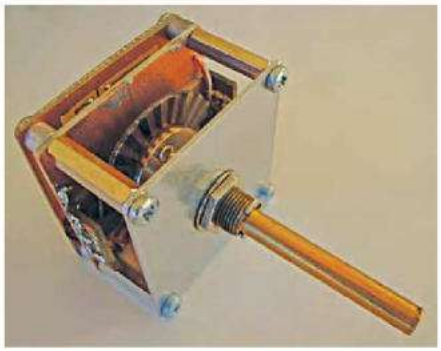

Figure 11 — The assembled encoder.

an old potentiometer. A groove cut in the brass shaft is for a clip to prevent the shaft from coming out of the collar. The flange to which the code disk is attached was purchased on eBay.

The plexiglass encoder disk has a thickness of 1.5 millimeters and a diameter of 38 millimeters. Attached to this disk is a transparent adhesive sheet with the code wheel printed by a laser or inkjet printer. The code wheel has 50 cells, which provides 25 pulses per revolution. The code wheel generator software is available at **https://www.softpedia.com/get/Others/Miscellaneous/Codewheel-Generator.shtml**. Figure 7 shows the assembled 4 × 4 × 3 centimeter encoder. The photo interrupters are soldered on two mini boards (see Figure 8), and are then mounted on a board (see Figure 9) on which two slots provide for their mechanical positioning. Additional assembly detail is shown in Figure 10, and the completed unit is shown in Figure 11.

After mounting the digital card, connect the photo interrupter outputs to the A and B inputs on the digital board. Using a dual-channel oscilloscope, verify that pulses are present at the monostable outputs, as shown in Figure 5. There will be pulses from both monostables, so slightly move either photo interrupter in its slot on the board until you have impulses from only one output when the rotation is in one direction. Reversing the rotation should show pulses on the other output. Now fix the photo interrupter in place with its screw. Your encoder is now ready to use.

All photos by the author.

Licensed since 1974, Riccardo Gionetti, IØFDH, attended the University of Rome "La Sapienza" at G. Marconi Institute and received a degree in Physics with specialization in cybernetics and electronics. He also took technical master courses in radar technology, microwave measurements, EMC, IR sensors, and electronic warfare. Now retired, Riccardo worked for 10 years in telecommunications, and 30 years for the main Italian defense industry. For the last 10 years, he was responsible for applied research and technology for radio frequency sensors. Riccardo has published over 50 technical articles and papers in professional and amateur radio fields, is coauthor of the handbook on *HF Power Linear Amplifier Design*, and he authored a course on "Tactical Radio Communications." You can contact Riccardo at **rgionetti@virgilio.it**.

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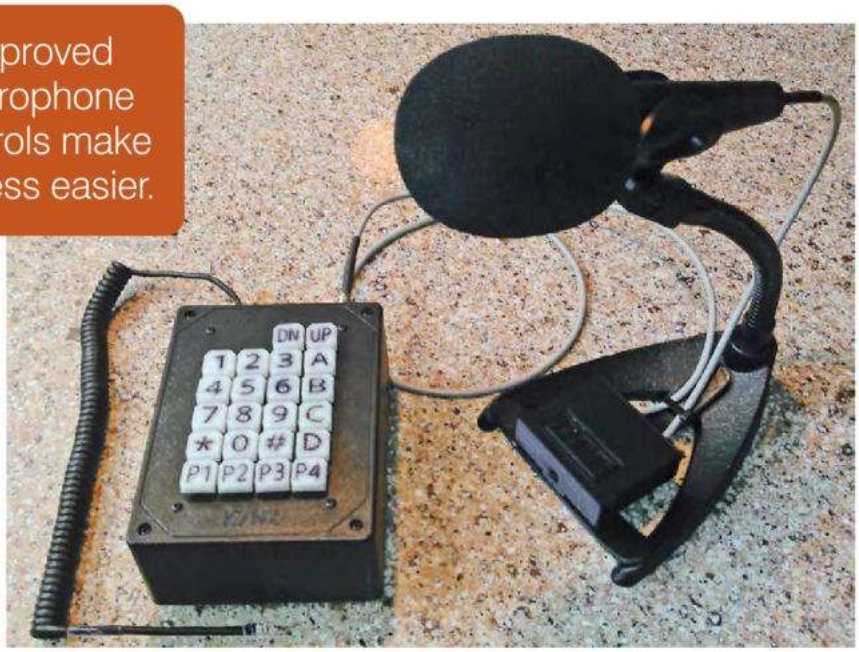
Bigger Buttons are Better

Improved microphone controls make access easier.



Derek Rutz, K7NZ

Having trouble using hand microphones with buttons that are too small and close together can quickly take the fun out of operating. Matt, KF7RM, and I decided to design a low-cost, more-accessible desk microphone using a clone circuit board from a DTMF hand microphone.

PCB Tracing

With the microphone schematic (found online), a volt-ohm meter, and the clone PCB, I identified the push-button swirl pad traces (see Figure 2), and labeled them by row (R1 – R5) and column (C1 – C4). The bottom left portion of each swirl trace provides the supply voltage (V) to each pad. To utilize the existing PCB, it was necessary to parallel these connections. Figure 3 shows the wiring for the switch matrix, and Figure 4 shows the dual-row header connections. The **UP** and **DN** switches, and the Normally Open (**N.O.**) momentary contact switches were paralleled as well. I brought all lines out to a dual-row header connector, which mates with the new keypad assembly.

I removed the electret microphone element and PTT switch from the board to use in a new microphone/PTT assembly. Details are on the *QST* in Depth web page at **www.arrl.org/qst-in-depth**. Solder pad connections for these components were wired to a four-pin connector on the keypad assembly (see Figures 5 and 6).

New Keypad Assembly

We arranged 22 **N.O.** momentary contact DPST pushbutton switches, evenly spaced on a medium-sized proto board and wired them to mimic the original keypad functions. We then wired the connection points (R1 – R5, C1 – C4, and **UP** / **DN**) to a dual-row header to mate with the MH-48 clone PCB. I designed key caps — shown installed on the new control box in the lead photo — using the free online

Figure 1 — Small, closely spaced buttons are difficult to operate with big fingers.

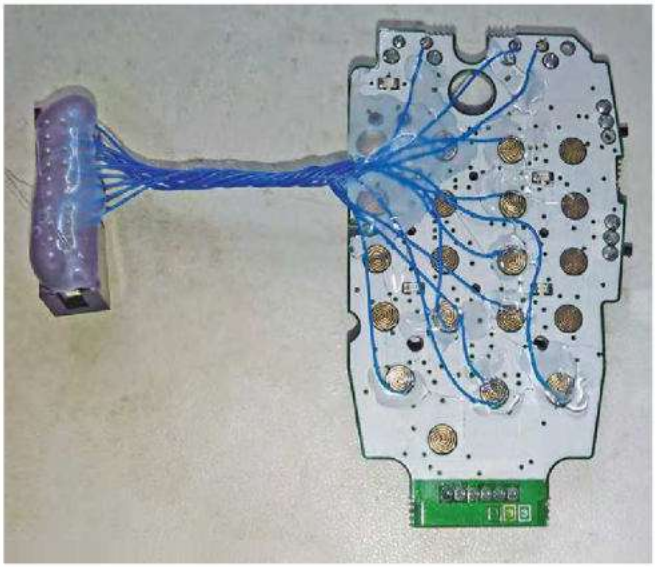


Figure 2 — Connections are soldered to the pushbutton swirl pad traces.

Tinkercad (**www.tinkercad.com**) application. I 3D-printed them using glow-in-the-dark PLA material, then used a black permanent marker to fill in the alphanumeric depressions in the key caps.

I machined the top panel of a Hammond ABS project enclosure to accept the new keypad proto board mounted underneath (see Figure 7). Finally, I machined through-holes in the enclosure to accept

Our purpose was to improve accessibility of the hand microphone controls while keeping costs low.

the six-pin coiled microphone cable and a new four-pin connector for the microphone/PTT assembly. I used hot glue to secure the MH-48 clone PCB and header connector inside the enclosure.

New Microphone/PTT Assembly

Again using the *Tinkercad* application, I fabricated the microphone body clam shells and the top and bottom of the PTT switch enclosures. These details are on the **www.arrl.org/qst-in-depth** web page.

I purchased a microphone desk stand (cast metal base, gooseneck, and microphone clip) online. In order to securely mount the PTT switch assembly to the desk stand, I 3D-printed a **T** bracket and hot glued it to the base. Finally, I glued a PTT switch box to the top of the **T** bracket.

Performance Testing

After verifying that there were no shorts between wires of the six-pin transceiver cable, I connected the

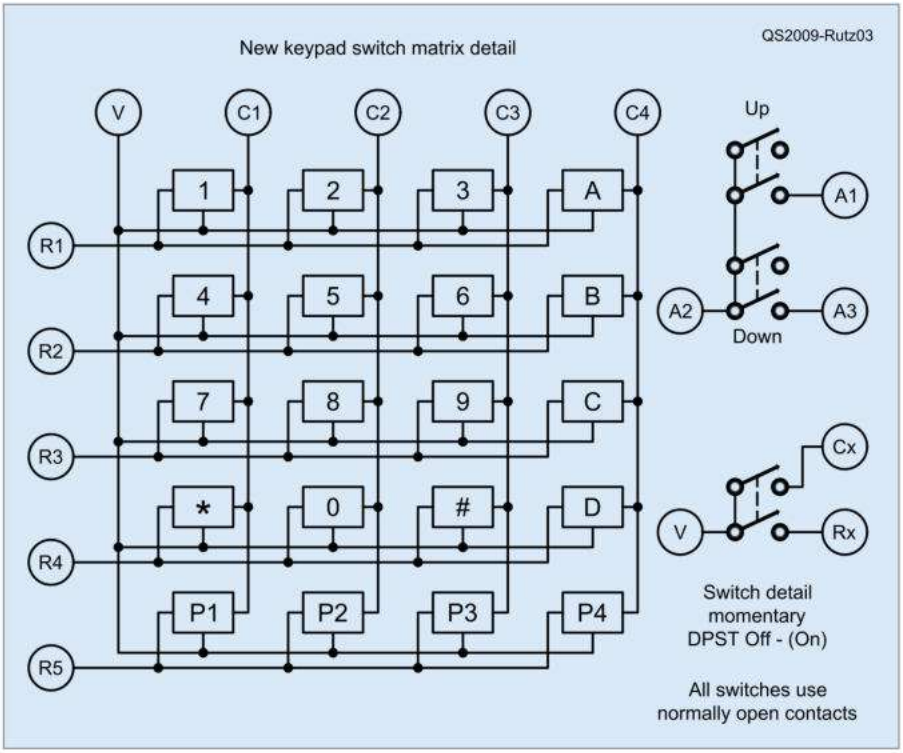


Figure 3 — The schematic of the new keypad switch matrix.

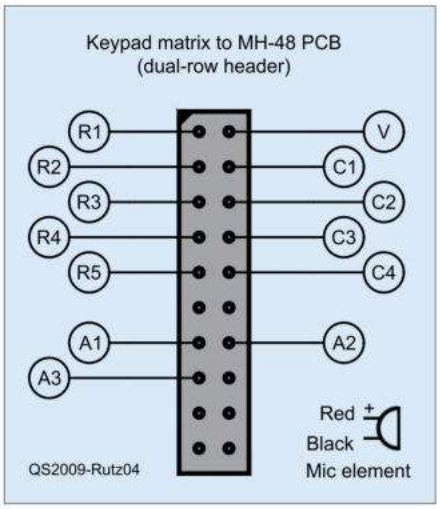


Figure 4 — Dual-row header to keypad matrix wiring.

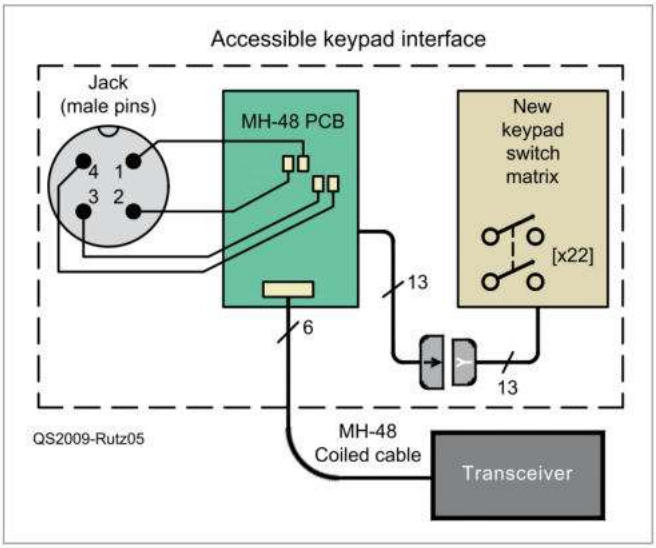


Figure 5 — Interface wiring of the new microphone.

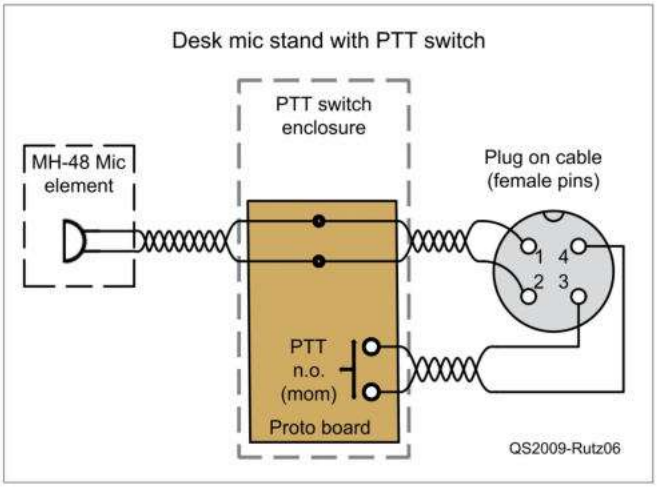


Figure 6 — Wiring of the new desk microphone.

new microphone/PTT assembly to my Yaesu FTM-100D radio. In various modes, I verified that all the keypad switches worked correctly. In both analog and C4FM transmissions, the audio reports were excellent. Life-testing of the switches and PLA components is ongoing.

Figure 8 shows Matt, KF7RM, at his operating position with the new microphone.

Conclusion

For well under $100, I fabricated a more accessible microphone using readily available parts, making the operation of common radio functions easier and more enjoyable. Matt has been using this new accessible replacement for the MH-48 microphone assembly with great success. It is much easier for him to activate the PTT switch, and he can easily see and activate the large DTMF buttons. We hope that this project will inspire fellow hams to develop other accessibility solutions and motivate manufacturers to consider adding accessibility features and options when designing amateur radio gear.

Figure 7 — The clone MH-48 PCB and new wiring, shown inside the new controller housing.

Figure 8 — Radar Matt, KF7RM, with his new microphone.

Photos by the author.

Derek Rutz, K7NZ, has a Bachelor's degree in Electronics Engineering Technology and a Master's degree in Technology Management. He is Product Engineer for a dermatology laser manufacturer. He is also a designer/maker, who built a 3D printer, a four-axis computer numerically controlled mill, and a variety of mechanical and electrical tools. He designs and fabricates custom electronics, enclosures, and miscellaneous components. In the transition to retirement, his focus shifted to amateur radio. Derek received his amateur license in 2018, and he operates from his solar-powered portable station. You can reach Derek at **k7nz@arrl.net**.

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

Easy to Use Antenna Mast for Portable Operators

This portable mast uses your trekking poles and won't break your budget or your back.

Zach Thompson, KM4BLG

With a large portion of hams living in antenna-restricted areas, and with amateur radio equipment becoming more compact and lightweight, many hams are turning to portable operation. What portable operation looks like for you can vary based on your needs, objectives, and budget.

Motivation

A few years ago, I got involved with portable operating through SOTA (Summits on the Air), an awards program that encourages amateur radio operation from the tops of designated mountain peaks. Many of these mountain peaks involve a fair bit of hiking, which adds an additional dynamic to the experience. One major goal for any kind of hiking or backpacking is to minimize the load; equipment that is small and lightweight is necessary for success. Most portable operators use wire antennas because they are affordable, lightweight, compact, and easy to deploy. However, one limitation of wire antennas is the need for some sort of overhead support, such as a tree, tower, pole, or another tall object. Often, there will be few or no suitable supports, or supports might not be conveniently located.

Many portable operators look for solutions on either how to support their existing antenna, or an alternate antenna system that does not require supports. For many, the choice is usually some sort of portable mast system that is comprised of a telescoping pole made of fiberglass or another lightweight material. This works well, but it can be cumbersome because it adds weight to your pack. Also, depending on the mast, it can be frustrating to set up without assistance. As someone who overpacks, I wanted a mast system that would have a minimal impact on my existing setup. The goal of this project was to develop a strong, versatile mast that would utilize mostly components already found in many portable operators' backpacks.

Design Concept

I purchased a pair of aluminum trekking poles for hiking. These are very useful for maintaining balance over rough terrain. As I started to look at portable mast operations, these trekking poles seemed to fit the bill. They are lightweight, rigid, and can support a good amount of weight. Most importantly, I already carry a pair of them on portable expeditions. Each of my trekking poles extends to about 4.5 feet. Placing them vertically end-to-end results in a height of about 9 feet, which is a usable mast height. I then designed a custom coupler to join the trekking poles to each other.

Trials and a Solution

My first tries to design a coupling between two trekking pole tips were 3D printer-based designs. After three unsuccessful iterations, I designed a workable solution, shown in Figure 1.

Figure 1 — A close-up of the center coupling arrangement shows the 3D-printed components at each end of the PVC section. Carabiners attach guy lines to the screw eyes.

Figure 2 — The mast system is shown supporting a twin-lead rollup VHF **J** pole at the 2019 SKYWARN™ Amateur Radio Recognition Day at the Greenville-Spartanburg, South Carolina, National Weather Service office.

The successful approach combines custom 3D-printed couplers with the strength of PVC pipe. I designed a custom adapter that has an inner diameter to match the trekking pole tip, and an outer diameter to match the inside diameter of half-inch PVC pipe. I cut a small section of half-inch PVC pipe and used epoxy to join one of my adapters on each end. In the center, I left room to attach four screw eyes to serve as guying points. This design finally allowed me to have a snug, secure fit, while still having good mechanical strength. I subjected this design to physical testing, and it passed all my tests without cracking or breaking.

Deployment and Use

Deployment of this mast is fairly straightforward. I attached small carabiners to the ends of four 6-foot lengths of elastic shock cord to use for guying (see Figure 1). The carabiners allow for quick and easy deployment and tear down, while the elastic shock cord helps to reduce tangling and provides a small amount of flexibility for strain relief in windy conditions. I used ultralight, unbendable tent stakes to attach the guy cords (see Figure 2). The four guy cords are installed at 90-degree angles from each other. They help to balance opposing forces and keep the mast upright.

Figure 3 — All the needed components, except for the trekking poles, fit in a small bag for easy carrying. The coin is nearly 1 inch in diameter.

One major goal for any kind of hiking or backpacking is to minimize the load; equipment that is small and lightweight is necessary for success.

This structure can support several types of antenna. I have tested it with a twin-lead rollup VHF **J** pole, and an end-fed HF antenna. This mast could also serve as a center support for an inverted-**V** antenna. I clipped or tied all of my antennas to the wrist strap on the top of the trekking pole. All the mast components except for the trekking poles fit in a small bag for easy carrying (see Figure 3).

I chose aluminum trekking poles, so there may be interaction between the antenna and the mast. However, I have not noticed any ill effects. You could choose trekking poles made with a non-conductive material, but this increases the overall cost.

Conclusion

Construction measurements may vary depending on your specific trekking poles, but the overall design concept remains the same. Because many operators already carry many of the materials listed here — trekking poles, rope/cord, and stakes — this mast can be constructed with minimal additional cost or weight. The mast is only 9 feet tall, but it serves my purpose.

All photos by the author.

Zach Thompson, KM4BLG, became interested in amateur radio at 10 years old, when he purchased his first shortwave receiver. Naturally, shortwave listening eventually extended to amateur radio. In 2014, while a senior in high school, he earned his Technician-class license. Zach soon upgraded to the Amateur Extra-class license. He became proficient in CW and has become very active in the AUXCOMM community. His favorite activities include portable operation, antenna construction, and experimenting with assorted digital modes. You can reach Zach at **km4blg@gmail.com**.

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

Steve Ford, WB8IMY, wb8imy@arrl.org

Eclectic Technology

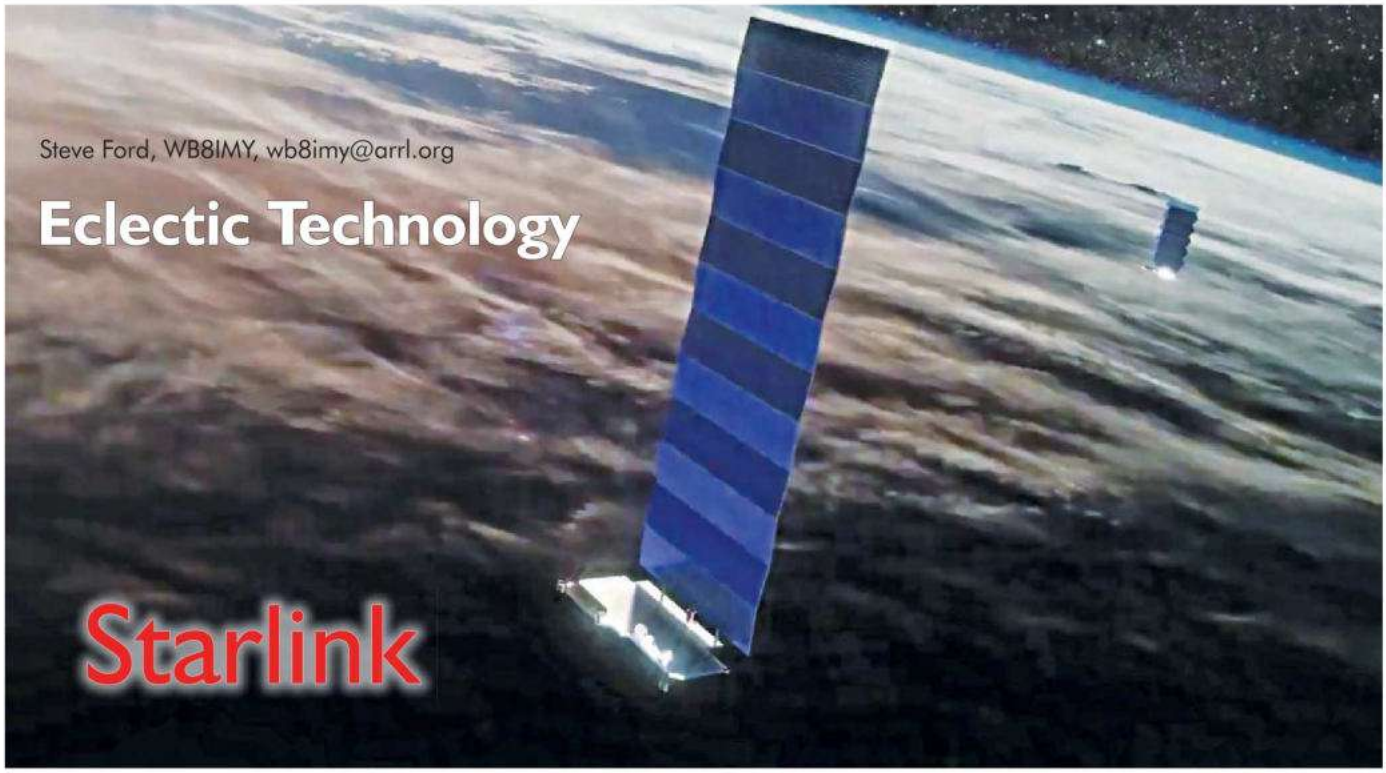


Figure 1 — An artist's conception of a Starlink satellite deploying its solar array.

If you follow space technology news, you'll notice that Starlink is a name that comes up frequently. It is the brainchild of Elon Musk's SpaceX and it promises to deliver high-speed internet access to underserved areas.

Satellite internet isn't new, as HughesNet® and Viasat™ have been doing it for years. However, both services are provided by satellites in geostationary orbits, approximately 22,000 miles above the equator. At that distance, there is a significant amount of latency between the user, the ground gateway, and the satellite — sometimes more than 600 ms. For some internet activities, that isn't a great concern, but for others it can be a deal breaker.

Starlink takes a different approach. Rather than relying on large satellites parked in geostationary orbits, the Starlink network is comprised of thousands of relatively small, 500-pound satellites traveling in low orbits at altitudes between 500 and 800 miles. At those altitudes, the total latency is only 25 to 35 ms, which is comparable with terrestrial internet.

Phased Arrays on the Ku and Ka Bands

As shown in Figure 1, Starlink satellites resemble flat platforms with single vertical solar panels. They use phased array antennas that are electronically "steerable" and operate on the Ku and Ka microwave bands. Depending on the configuration, uplinks and downlinks could occur at frequencies between 18 and 40 GHz.

Each satellite communicates with the ground stations, as well as with each other. Like a terrestrial mesh network, the satellites share data and crosslink dynamically, depending on which satellite has the best link to a customer's ground terminal at any moment.

According to SpaceX, the ground terminal consists of a phased-array antenna system in an enclosure the size of a pizza box. There is no need to aim the antenna; the customer simply places it at a location that has at least a partial view of the sky. The idea is that there will be so many Starlink satellites visible at any given time, the terminal will always be able to uplink and downlink. SpaceX is touting Starlink data rates with this system approaching 1 gigabit per second.

At the time this column was written, SpaceX had already placed hundreds of Starlink satellites in orbit and planned on having nearly 1,000 operational by the end of the year. The long-range goal is to deploy a Starlink fleet numbering close to 10,000. This prospect has generated opposition in the astronomy community, due to the potential for visual interference.

It is worth noting that SpaceX isn't the only player in the low-Earth-orbiting internet marketplace. There is also Telesat, OneWeb, and Project Kuiper, which is Amazon's system. OneWeb filed for Chapter 11 bankruptcy in March during the coronavirus pandemic, so its future is uncertain.

Ham Applications

It will be interesting to see how this technology impacts amateur radio public service activities. You might, for example, see instances where a single Starlink terminal is deployed in a disaster area and then connected to a portable amateur radio mesh network to provide high-speed data and internet linking over wide areas.

Mark J. Wilson, K1RO, k1ro@arrl.org

Product Review

SDRplay RSPdx Software-Defined Receiver

Reviewed by Pascal Villeneuve, VA2PV
va2pv@arrl.net

In recent years, software-defined radio (SDR) technology has become very popular. By transferring processing tasks to software, SDR technology reduces the hardware costs, while often increasing features and performance. It's also easier to upgrade. That's exactly the case with the SDRplay wideband receivers.

This British-based company has been around for a few years. Beginning with the RSP1, all of their product model names have started with RSP, short for Radio Spectrum Processor. In 2016, SDRplay launched the RSP2 and RSP2pro (with metal enclosure), and the RSPdx replaces these receivers. (We reviewed the RSP2pro in the October 2017 issue of *QST*.)

There are many applications for this SDR receiver. It can be used for all-mode listening up to 2 GHz, and it can be used to scan segments of the spectrum. It can be used as a panadapter with your HF transceiver if you have access to IF output signals. You can even use it as a spectrum analyzer with the appropriate software. The SDRplay website features a long list of ham radio, industrial, scientific, and educational application notes.

Overview

The SDRplay RSPdx is a wideband, full-featured, 14-bit SDR that covers the entire RF spectrum from 1 kHz to 2 GHz. Combined with SDRplay's *SDRuno* software, you can monitor up to 10 MHz of spectrum at a time.

The RSPdx shipping box includes only the receiver. You will have to provide a USB cable to connect it to your computer, as well as download the *SDRuno* software and documentation from the SDRplay website.

The RSPdx comes with a metal enclosure. The unit is heavy for its size, and it will stay still on your desk. There are three antenna inputs, an external reference clock input, and a USB connector for the computer connection. Unlike its predecessor, the RSP2, the RSPdx has no external clock output port. If you need a reference clock output, you will have to move up to the top-end SDRplay device, the RSPduo.

The RSPdx front end has been redesigned for better performance at HF and lower frequencies. The preselector filters and notch filter have been improved, attenuator steps have been added, and there's a new HDR (high dynamic range) mode when used with the companion *SDRuno* software. Compared to the RSP2pro, the ARRL Lab measurements show significantly better sensitivity at 630 and 2200 meters, as well as an approximately 15 dB improvement in third-order IMD dynamic range at HF with the RSPdx AGC level adjusted for best dynamic range. The RSPdx also adds an LF/VLF filter for operation below 500 kHz. This should make this device interesting for medium-wave and long-wave DX hunters.

Antenna ports labeled **ANT A** and **ANT B** are SMA female connectors and can be used from 1 kHz to

Bottom Line

The RSPdx is the latest in SDRplay's line of popular wideband SDR receivers. It offers improved low-band performance and will provide many hours of learning and enjoyment.

Table 1
SDRplay RSPdx, s/n not available

Software: SDRuno, v.1.33

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: 1 kHz to 2 GHz.	0.1058 MHz to 2.0001 GHz.
Power requirement: USB power only.	As specified.
Modes of operation: SSB, CW, AM, AM Synchronous, FM, FMN, SWFM (stereo decode), WFM.	As specified.
Receiver	**Receiver Dynamic Testing**
Sensitivity (MDS): Not specified.	Noise floor (MDS), 500 Hz bandwidth. AGC level = 60.† 0.137 MHz, –120 dBm; 0.475 MHz, –116 dBm; 1.8 MHz, –127 dBm; 3.5 MHz, –128 dBm; 14 MHz, –133 dBm; 50 MHz, –136 dBm; 144 MHz, –142 dBm; 223 MHz, –144 dBm; 440 MHz, –144 dBm; 902 MHz, –144 dBm; 1296 MHz, –142 dBm.
Noise figure: 20 dB (2 MHz), 17 dB (12 MHz); 15 dB (40 MHz); 2.1 dB (200 MHz); 6.0 dB (340 MHz); 3.1 dB (660 MHz); 4.4 dB (1.5 GHz); 5.0 dB (1.8 GHz).	14 MHz, 14 dB; 144 MHz, 5 dB; 223, 440, and 902 MHz, 3 dB; 1296 MHz, 5 dB.
AM sensitivity: Not specified.	For 10 dB (S+N/N), 6 kHz BW: 1.020 MHz, 3.83 µV; 3.885 MHz, 4.57 µV; 29.0 MHz, 1.78 µV; 50.4 MHz, 1.84 µV; 120 MHz, 0.68 µV; 144 MHz, 0.70 µV.
FM sensitivity: Not specified.	For 12 dB SINAD, 12 kHz BW: 29 MHz, 0.53 µV; 52 MHz, 0.60 µV; 100 MHz (WBFM), 0.56 µV; 146 MHz, 0.21 µV;162 MHz, 0.20 µV; 223 MHz, 0.16 µV; 440 MHz, 0.16 µV; 902 MHz, 0.18 µV; 1296 MHz, 0.22 µV.
Two-tone, third-order IMD dynamic range: Not specified.	Preamp off: 79 dB at 20, 5, and 2 kHz spacing.†
Second-order intercept point: Not specified.	14 MHz, +37 dBm; 21, 50, 144, and 440 MHz, +35 dBm.
FM adjacent channel selectivity: Not specified.	29 MHz, 48 dB; 52 MHz, 49 dB; 144 MHz, 48 dB; 440 MHz, 49 dB.
FM two-tone, third-order dynamic range: Not specified.	20 kHz spacing: 29 MHz, 48 dB; 52 MHz, 49 dB, 144 MHz, 48 dB.* 440 MHz, 49 dB. 10 MHz spacing: 29 MHz, 83 dB, 52 MHz, 84 dB; 144 MHz, 72 dB; 440 MHz, 75 dB.
Squelch sensitivity: Not specified.	29 MHz, 0.63 µV; 52 MHz, 0.56 µV; 146 MHz, 0.25 µV; 440 MHz, 0.18 µV. SSB, 0.19 µV
DSP noise reduction: Not specified.	15 dB.
Notch filter depth: Not specified.	Auto notch only, 70 dB.
IF/audio response: Not specified.	Range at –6 dB points:** CW (500 Hz BW): 450 – 950 Hz; USB (2.8 kHz BW): 94 – 2796 Hz; LSB (2.4 kHz BW): 94 – 2796 Hz; AM (6 kHz BW): 45 – 2915 Hz.
Signal processing delay time: Not specified.	430 ms.
ADC clip level: Not specified.	At maximum RF gain, 14 MHz, –34 dBm; 50 MHz, –35 dBm, 144 MHz, –56 dBm; 432 MHz, –59 dBm; 1 GHz, –44 dBm.

Size (height, width, depth): 1.0 × 3.6 × 4.6 inches (including protrusions). Weight: 12 ounces.

AGC could not be disabled for blocking and reciprocal mixing dynamic range tests. See "Lab Notes" sidebar.

†AGC level was adjusted to maximize dynamic range performance.
*Measurements were phase noise limited at the value indicated.
**Default values; bandwidth and cutoff frequencies are adjustable.

2 GHz. The BNC socket for the third antenna port (**ANT C**) is for 200 MHz and below. All three antennas are software-selectable.

Software

This receiver needs a computer and software for operation. You can download the Windows-based *SDRuno* software (see Figure 1) from the SDRplay website. The software is free, and it only works with the SDRplay products. The SDRplay website also offers plug-ins to use the RSPdx with third-party software. There are a number of drivers for using various RSP models with Windows, macOS, Android, Linux, and Raspberry Pi platforms.

Figure 1 — SDRplay *SDRuno* software.

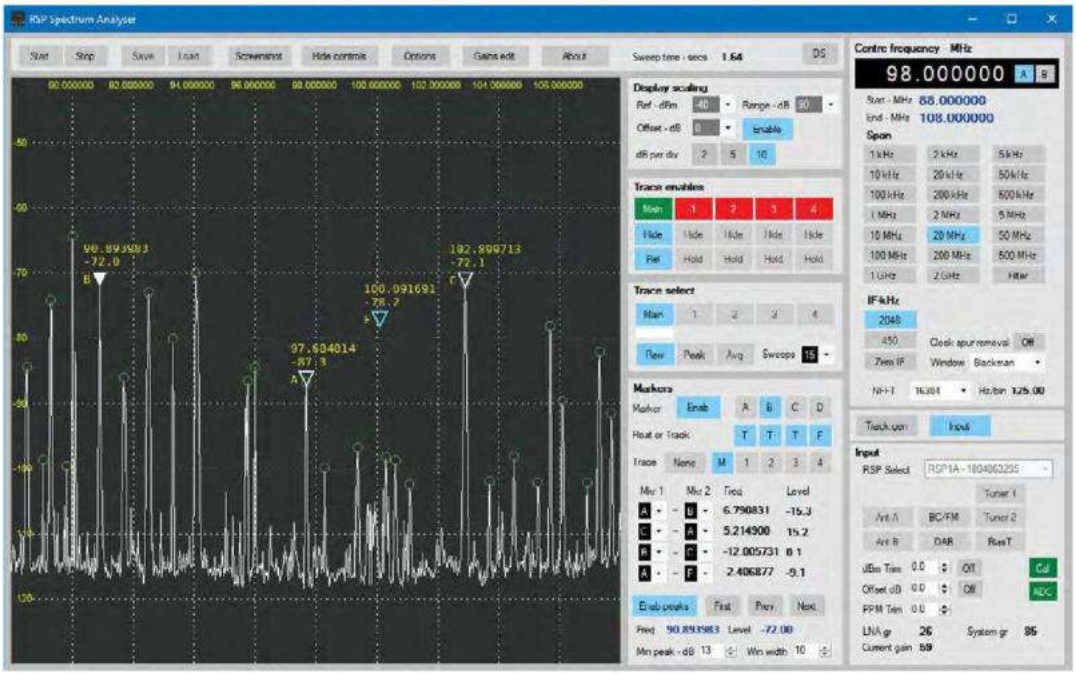


Figure 2 — *RSP Spectrum Analyser* software. [Photo courtesy of SDRplay]

Operation on the Air

During operation, the look and feel of the RSPdx is very similar to the RSP1 and RSP2 receivers, as they all use the *SDRuno* software. Some features are only available if the hardware is compatible. For example, if you have the high-end RSPduo, you can operate two separate receivers on two different antenna ports. On the RSPdx, you will have better low-band filters and performance below 2 MHz, but the software is the same as for the other units.

One feature I find remarkably interesting is the Spectrum Analyzer software for the RSP products that you can download for free from their website as well (see Figure 2). If you add an external reference clock input, you will have a capable piece of workshop equipment for a very low price.

I spent some time listening to signals on the air with the RSPdx and comparing reception to my HF transceivers. Any signals I could hear on my HF trans-

ceivers, I could also hear on the RSPdx. I loved the fact that it can be used as a wideband scanner, for listening on the HF, VHF, or UHF ham bands, or for listening to the many frequencies used by other services.

Lab Notes: SDRplay RSPdx

Bob Allison, WB1GCM,
ARRL Laboratory Assistant Manager

The SDRplay RSPdx has plenty of sensitivity, especially in the VHF and UHF region of the RF spectrum. Though sensitive, the receiver's behavior in the presence of strong signals needs a bit of explanation.

Strong nearby signals may cause a reduction in the speaker volume level while listening to a desired signal (this is called blocking). Overall, the RSPdx exhibits minimal undesirable effects when using a modest antenna system, but you may notice some blocking if signals are strong. For example, an S-7 signal, 20 kHz away, will cause speaker volume to drop by 1 dB. The blocking effect lessens as an offending signal moves away from the desired frequency. For example, an S-9 +20 dB signal 1 MHz away is at the threshold of blocking the desired signal. In the presence of strong adjacent signals, the solution is to adjust the volume appropriately.

The dynamic range measurements we regularly report are made with the receiver AGC turned off. Though the RSPdx can indicate AGC off, the blocking behavior does not change whether the AGC setting is off or on. Because of this effect, I could not measure either blocking gain compression dynamic range or reciprocal mixing dynamic range for the RSPdx. A more detailed explanation is available from **www.arrl.org/qst-in-depth**.

Receive processing delay time (the time between when a signal enters the antenna jack and when it is heard in the speaker) measured 430 milliseconds. If this receiver is paired up with a transmitter, the delay is long enough that you will need to use a separate sidetone for CW operation rather than trying to listen to your own sent CW transmissions.

I found the software operation complicated at first because there are many features, and some are labeled differently than on a typical ham transceiver. I had no difficulty with the most common features, such as mode selection, noise blanker, multiple notch filters, or noise reduction. There is a quick ham band selection that lets you switch easily between bands with the correct default modes.

The first thing you need to master within the *SDRuno* software is the use of preselectors from the **BANDS** menu in the **SDRUNO RX CONTROL** window. There are four band types: Ham Lower, Ham Upper, Broadcast, and the HDR bands for below 2 MHz (see Figure 3). Mastering this menu improves your experience from the start, and you can move on to more complex adjustments.

Where it gets complicated is when you want to fine tune, as there are endless adjustments you can make depending on the receiving conditions. I spent a few minutes talking to Mike Ladd, KD2KOG, who represents SDRplay and provides technical support in the US. He showed me some tricks that helped me to remove unwanted noise using several careful adjustments. For every situation, there is a tool to improve reception or to pull small signals out of the noise by improving the signal-to-noise ratio (SNR). You can find Mike's tips on his YouTube channel at **www.youtube.com/c/SDRplayHamGuides/videos**.

Conclusion

The RSPdx with *SDRuno* software offers a good performing, wideband, multimode receiver at an attractive price. I like the fact that this radio can be used for many applications. For someone newly interested in shortwave listening and ham radio, the SDRplay receivers offer a good starting point. The RSPdx allows someone to check out many aspects of the hobby without breaking the bank. If they do get licensed and move up to a transceiver, the RSPdx will still be useful for general listening/scanning, as a panadapter, or as a spectrum analyzer.

Figure 3 — Preselectors are available for various frequency ranges.

Larger versions of the illustrations in this review are available from **www.arrl.org/qst-in-depth**.

Manufacturer: SDRplay Limited, 21 Lenten St., Alton, Hampshire, GU34 1HG, United Kingdom; **www.sdrplay.com**. Distributed in the United States by Ham Radio Outlet; **www.hamradio.com**. Price: $199.95, including the *SDRuno* software.

FUNKAMATEUR/SDR-Kits FA-VA5 Vector Antenna Analyzer

Reviewed by Phil Salas, AD5X
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The FA-VA5 is a 600 MHz antenna analyzer designed by Michael Knitter, DG5MK, for *FUNKAMATEUR* magazine in Germany. SDR-Kits, a micro business that works closely with *FUNKAMATEUR*, is their approved reseller.

The FA-VA5 is available as either a kit that comes "99% assembled and tested," or as a "self-assembly" kit. The 99%-assembled kit requires soldering the on/off switch, plugging in the LCD/backlight module into the preassembled main PC board, and then installing everything into the enclosure. Rather than a true kit of components, it is more of a sub-assembly kit. (See the sidebar, "Building the FA-VA5 Antenna Analyzer.")

The self-assembly kit includes a preassembled PC board with programmed microcontroller, graphic display including backlight, a USB module, and a specially designed enclosure. The builder solders 12 through-hole parts and does the final assembly. The instructions indicate that this should take less than 3 hours. Instructions for both versions are available online, so you can see what is involved.

Both kits include open/short/load (O/S/L) calibration elements that are usable up to about 100 MHz. A high-quality calibration kit covering up to 600 MHz, with load parameters individually measured, is also available. I recommend purchasing the high-quality calibration kit, as it is inexpensive, and you can take full advantage of the entire 600 MHz range of this instrument. Figure 4 shows the FA-VA5 and optional accessories.

Overview

The FA-VA5 is a single-port vector network analyzer (VNA) that provides signed, complex impedance measurements of RF loads from 10 kHz to 600 MHz with a frequency resolution of 1 Hz. The measurement port is a BNC female connector. A USB A-to-USB Mini A cable is not provided, so you will need to provide one for firmware updates and computer interfacing. A high-quality, full-color *Assembly and Operating Manual* is provided.

Standalone power is provided by two internal AA batteries (not included). A battery voltage reading on the

Figure 4 — The FA-VA5 with optional case, various optional adapters, and the optional high-quality four-piece calibration kit (at the lower left).

Building the VA-FA5 Antenna Analyzer

Before Phil Salas, AD5X, could review the VA-FA5, I needed to build one!

The kit ships from Germany and mine arrived within 10 days after placing the order. I built the version that came 99% assembled and tested, and it isn't a kit in the traditional sense, where you are placing and soldering myriad components. Instead, the VA-FA5 is a modular kit, with most sections already complete. Your task is to install the switches, the multipin header connectors, and a couple of pre-populated circuit boards.

The kit comes with an aluminum enclosure that offers a sizeable cutout for the display. This is the only aspect of the assembly that is a bit tricky. For the display to fit properly within the cutout, you must *carefully* install the multipin header connectors, making sure they are perfectly vertical. The display module plugs into the headers, so if the headers are crooked, the display won't align with the cutout.

The total build time was 30 minutes, ending with the satisfaction of connecting the batteries and seeing the amber screen come to life. — *Steve Ford, WB8IMY*

Bottom Line

The FA-VA5 is an easy-to-use and inexpensive 600 MHz antenna analyzer that will satisfy the needs of most amateurs. The kit goes together quickly.

Table 2
FA-VA5 Manufacturer's Specifications

Measurement frequency range: 0.01 to 600 MHz.
Reference impedance: 25, 50, and 75 Ω (50 Ω default).
Frequency resolution: 1 Hz.
Frequency stability: 0.5 parts per million (ppm).
SWR measurement range: ≤100.
Impedance range: ≤1,000 Ω.
Return Loss Dynamic Range Precise Mode: 80 dB, 0.01 – 200 MHz; 50 dB 200 – 600 MHz. Standard Mode: 75 dB, 0.01 – 200 MHz; 45 dB, 200 – 500 MHz. Fast Mode: 70 dB, 0.01 – 200 MHz; 40 dB, 200 – 600 MHz.
Accuracy: ≤2%, 0.01 – 200 MHz; and Z, <1,000 Ω.
RF output level (square wave, into 50 Ω): Fundamental/3rd harmonic/5th harmonic At 1 MHz: +5.6 dBm / –4 dBm / –8.3 dBm At 200 MHz: +4.5 dBm / –7.2 dBm / –15.3 dBm
Current consumption (lighting off, single frequency, 50 Ω measurement): 38 mA mean, 65 mA peak at 1 MHz; 47 mA mean, 85 mA peak at 200 MHz. Clock: 0.9 µA.
Dimensions: 5 × 3.4 × 0.9 inches. Weight: 10 ounces with battery.

startup display shows the battery status (see Figure 5). When a computer is connected, power is provided though the USB connection.

The FA-VA5 also includes a real-time clock with backup capacitor and an audible buzzer to aid in making SWR adjustments. You can select single-frequency or multi-frequency modes. All information is displayed on a 1.4 × 2.5 inch backlit orange monochrome screen. Table 2 summarizes the analyzer's specified performance.

Testing

The first thing I did with the finished FA-VA5 was to run through the full O/S/L calibration. This took about 25 minutes, which was a good time for me to scan the manual to get a feel for operating the unit. Next, I checked the FA-VA5 master TCXO (temperature-controlled crystal oscillator) against my frequency counter and found it to be within 10 Hz. If you have a highly accurate frequency counter, you can adjust the TCXO to within 1 Hz under the **CORRECTION FREQUENCY** menu item. The fundamental frequency output level is approximately +5 dBm over the full frequency range. There is a **FREQUENCY GENERATOR** mode that is useful for a variety of testing purposes, but keep in mind that the output waveform is a square wave rich in harmonics. With a 200 MHz signal from the FA-VA5, the third harmonic at 600 MHz is about 13 dB below the fundamental, and the fifth harmonic at 1 GHz is about 19 dB down. (A spectral plot of the output and larger versions of the screen captures shown later in this review are available online from **www.arrl.org/qst-in-depth**.)

Table 3
FA-VA5 Measured Open Circuit Impedance

Frequency (MHz)	Output (Z) (Ω)	Frequency (MHz)	Output (Z) (Ω)
1.8	>10,000	50	>1,900
3.5	>10,000	146	>680
7	>10,000	222	>450
14	>6,600	440	>280
28	>3,300		

Figure 5 — FA-VA5 startup screen, along with an interior view of the completed kit.

Next, I recorded the open-circuit output impedance as measured by the FA-VA5. This gives an indication of the impedance magnitude you can accurately measure as a function of frequency. The results are tabulated in Table 3.

For the all-important SWR testing, I first checked the FA-VA5 against a precision 50 Ω load and found it to display a worst case 1.03:1 SWR at 440 MHz. Next, I tested it against shorted and open microwave attenuators of 5 dB (1.92:1 SWR), 3 dB (3.01:1 SWR), 2 dB (4.42:1 SWR), and 1 dB (8.7:1 SWR). This test shows both low-impedance (shorted) and high-impedance (open) measurements for the same SWR. Because the attenuators are not perfect (especially due to open-circuit stray capacitance at higher frequencies), I also measured them on my Array Solutions VNAuhf

Table 4
FA-VA5 Resistive Load Measurements

FA-VA5 compared to Array Solutions VNAuhf

Load (SWR)	1.9:1	3:1	4.4:1	8.7:1
Frequency	---- Measurement with FA-VA5/VNAuhf -----			
(MHz)	VA5/uhf	VA5/uhf	VA5/uhf	VA5/uhf
1.8 (Short)	1.8/1.8	2.6/2.6	4.6/4.5	10.7/11.0
1.8 (Open)	2.2/2.2	3.4/3.4	5.2/5.3	8.0/7.9
3.5 (Short)	1.8/1.8	2.6/2.6	4.6/4.5	10.7/11.0
3.5 (Open)	2.2/2.2	3.4/3.4	5.3/5.3	8.0/7.9
7 (Short)	1.8/1.8	2.6/2.6	5.6/4.5	10.6/10.9
7 (Open)	2.2/2.2	3.4/3.4	5.3/5.3	8.0/7.9
14 (Short)	1.8/1.8	2.6/2.6	4.5/4.5	10.5/10.9
14 (Open)	2.2/2.2	3.4/3.4	5.3/5.3	8.0/7.9
28 (Short)	1.8/1.8	2.6/2.6	4.5/4.4	10.3/10.7
28 (Open)	2.2/2.2	3.4/3.4	5.3/5.2	8.0/7.9
50 (Short)	1.8/1.9	2.6/2.6	4.6/4.4	10.4/10.6
50 (Open)	2.1/2.2	3.4/3.4	5.3/5.2	8.1/7.9
146 (Short)	1.8/1.9	2.6/2.7	4.4/4.6	9.1/10.5
146 (Open)	2.1/2.0	3.4/3.3	5.4/5.1	8.7/8.2
222 (Short)	1.9/2.0	2.6/2.7	4.2/4.8	8.0/10.1
222 (Open)	2.1/1.9	3.4/3.3	5.3/4.8	9.3/8.3
440 (Short)	1.6/2.0	2.4/2.9	4.4/5.2	5.0/9.5
440 (Open)	2.2/1.9	3.6/3.0	4.2/4.5	11.1/8.1

vector network analyzer for comparison. As shown in Table 4, the FA-VA5 SWR readings compare quite favorably to the VNAuhf readings, though measurements diverged a bit with the low-impedance 8.7 SWR load at 440 MHz.

For my final accuracy tests, I used series R-C (resistive-capacitive) complex loads with an SWR of approximately 2:1 at 50 MHz, 146 MHz, and 222 MHz. Table 5 shows the FA-VA5 versus the VNAuhf measurements. As you can see, the FA-VA5 provides almost identical SWR measurements, and the series R-C measurements are close as well.

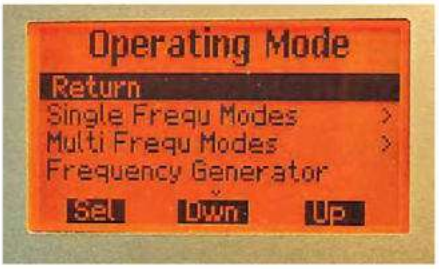

Figure 6 — FA-VA5 Operating Mode menu.

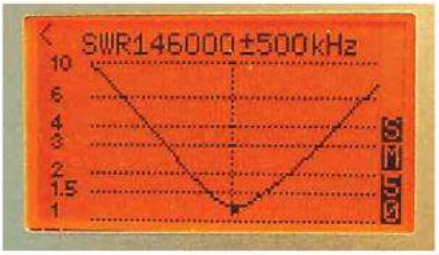

Figure 7 — SWR plot of 2-meter band-pass filter.

Using the FA-VA5

Prior to using the FA-VA5, check online for firmware updates (**www.dg5mk.de/pages/downloads.php**). YouTube videos at **www.sdr-kits.net/VA5_Page** show how to download and install the firmware.

The FA-VA5 has just an on/off switch and three push-buttons. However, operation is quite intuitive as DG5MK was clever in the use of the buttons. When turned on, the FA-VA5 briefly displays the software version and the battery voltage, and then reverts to the last measurement menu used. A long press of the left button takes you to the **OPERATING MODE** menu, shown in Figure 6, where you can select measurement modes, the frequency generator, LCR (inductance, capacitance, resistance) measurements, and setup parameters.

SINGLE FREQUENCY mode measurements include SWR, impedance, return loss, and the SWR buzzer if

Table 5
FA-VA5 Complex Load Measurements

FA-VA5 compared to Array Solutions VNAuhf measurements of SWR and series resistance/capacitance

Frequency	---------- FA-VA5 ----------				---------- VNAuhf ----------			
MHz)	SWR	[Z]	Z	Cs	SWR	[Z]	Z	Cs
50	1.98	56.9 Ω	46.2 –*j*33.3 Ω	96 pF	1.95	57.95 Ω	47.5 –*j*33 Ω	96 pF
146	1.85	51.2 Ω	42.9 –*j*28 Ω	39 pF	1.81	53.3 Ω	45.2 –*j*28.3 Ω	39 pF
222	1.81	47.3 Ω	40.1 –*j*25.1 Ω	29 pF	1.74	49.2 Ω	42.5 –*j*24.7 Ω	29 pF

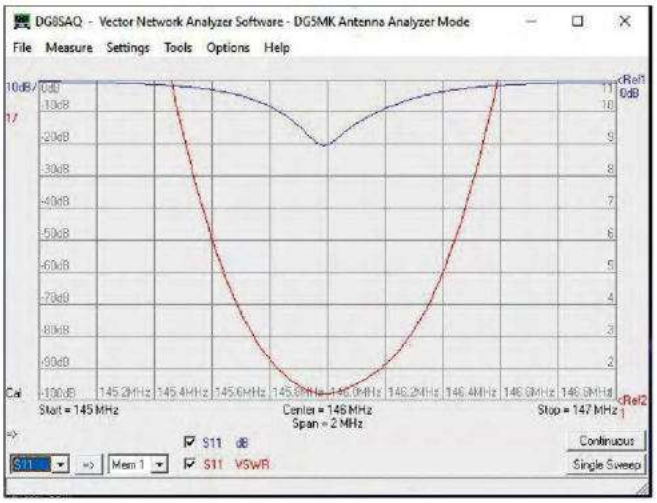

Figure 8 —SWR and return loss sweep of the 2-meter band-pass filter from Figure 7 viewed in the DG8SAQ *VNWA* software.

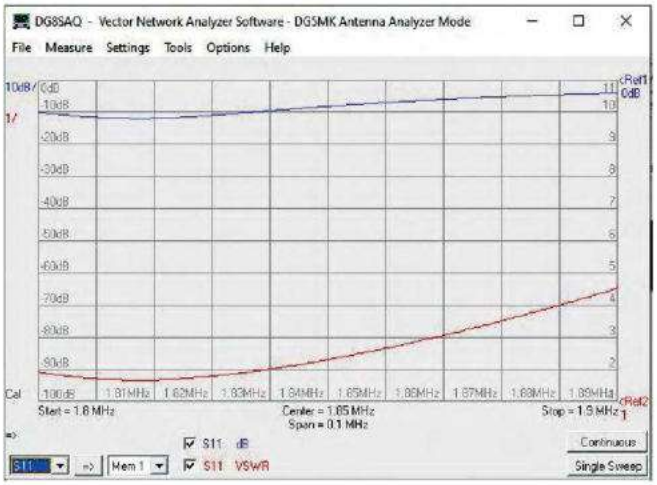

Figure 9 — SWR and return loss sweep of author's 160-meter antenna viewed in the DG8SAQ *VNWA* software.

desired. With the SWR buzzer, the beeping rate increases as the SWR decreases, making it easy to adjust an antenna while just listening to the beeps. The measuring frequency is easily changed with the left button (which selects the frequency digit to change) and the middle and right buttons (which increment or decrement the selected digit).

The **MULTI FREQUENCY** mode displays a five-band bar graph (frequencies are programmable), or sweeps of SWR or impedance, or a Smith chart display. The sweep modes can be set as either a single sweep or a continuous sweep. The left button selects the center frequency, swept bandwidth, and marker settings. The middle and right buttons permit adjusting the settings. Figure 7 shows an SWR scan of a 2-meter band-pass filter.

Additionally, up to 10 screen views can be saved for future display, and 16 data sets can be saved for exporting to a PC for documentation purposes.

Computer Interface

The FA-VA5 can be used with DG8SAQ *VNWA* PC software. On the SDR-Kits website, there are Windows and Linux installation packages, documentation in several languages, and tutorials.

VNWA is a powerful and easy-to-use software package that permits display and control of the FA-VA5 over its full 600 MHz frequency range. The software is free, and no license code is required if the DG5MK Antenna Analyzer option is selected during software setup. Figure 8 shows a *VNWA* SWR and return loss scan of the 2-meter band-pass filter shown in Figure 7. Figure 9 is a scan of SWR and return loss with my 160-meter antenna.

Conclusion

The FA-VA5 kit is yet another option for those who want an antenna analyzer. For $200, you get an accurate instrument that covers up to 600 MHz. You can investigate the FA-VA5 further by viewing the documentation and tutorials from the SDR-Kits website. Additional information and help is available on the FA-VA5 user group at **groups.io/g/fa-va5-users/topics**.

Manufacturer: FUNKAMATEUR, **www.box73.de**. Available from SDR-Kits, **www.sdr-kits.net/VA5_Page**. Approximate prices: 99% Assembled and Tested FA-VA5 Kit, $190; Self-Assembly Kit, $170; 600 MHz three-piece (BNC male) calibration kit, $15; 600 MHz four-piece (BNC male/female) calibration kit, $20; BNC male-to-type N female adapter, $5; padded case for FA-VA, loads, and adapters, $13. Exact prices depend on the current dollar/Euro exchange rate.

Cushcraft AR-2 "Ringo" 2-Meter Antenna

Reviewed by Joel R. Hallas, W1ZR
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The Cushcraft AR-2 "Ringo" is a home-station ½-wave, end-fed vertical antenna designed for the 2-meter amateur band. It can also be tuned to the commercial or marine frequencies within the 135 to 180 MHz range, using dimensions provided. Other versions include the AR-6 (6 meters), AR-10 (10 meters), and AR-450 (70 centimeters), as well as the larger Ringo Ranger II series (for example, the ARX-2), and even a dual-band version, the AR-270.

The antenna reviewed here, the original AR-2 Ringo designed by Cushcraft founder Les Cushman, W1BX, was first advertised in *QST* back in the 1970s. The antenna is enduringly popular among 2-meter FM operators, and we thought it would be worth a look at the current version.

Assembling the AR-2

The AR-2 is a straightforward design, with fairly easy final assembly required. Much of the antenna is preassembled, as shown in Figure 10. If fully preassembled, the matching ring would require a larger box, but if left to the user to assemble, it is a fairly straightforward task. In addition, the two sections of the element must be connected using the supplied strap-type tubing clamp. It took less than an hour to put it all together. The two-sheet instructions are well illustrated and, while not quite step-by-step, are easy to follow.

Figure 10 — The AR-2 comes partly assembled with some final assembly required — mainly assembling the pieces of the base matching ring.

The only assembly discontinuities were that one ⅝-inch-long and two ⅜-inch-long 8-32 machine screws were specified, but I received three screws that were ⅝-inch length. I just used them anyway, without any problems. I also received far more #8 lockwashers than specified, but managed to use them all up on connections that didn't specify them. Better too many than too few in most cases.

Bottom Line

The venerable Cushcraft AR-2 Ringo provides a low-impact 2-meter base-station antenna that performs as expected, extending range well beyond what an indoor antenna can do.

Tuning the AR-2

There are just two adjustments that must be made to set the AR-2 to operate on the desired frequencies. The instructions specify the monopole length versus frequency in 5 MHz increments. I set the length to the 38.5 inches specified for 145 MHz and found it worked fine across the 2-meter FM portion of the band. Once set, it will cover the whole 2-meter FM band with a low SWR — 1.4:1 at 145 MHz, rising to 2:1 at 147.5 MHz.

The connection from the feed to the matching ring should be set for minimum SWR across the band, and I found that it's not an especially critical adjustment. For my adjustments, I elevated the antenna using the mast I purchased for the installation, to get the antenna near-field above my test position (see Figure 11).

While there is a lot of ring tubing, the connecting rod can only reach a limited region of the ring without distorting its shape. Not surprisingly, the best match occurred with the connecting rod in the location to which it fit best. I placed marking-pen indications every ½ inch or so on the ring within the connection region, so I could keep track of the locations I had tried. While adjustment with an antenna analyzer or SWR meter is strongly suggested, I expect that if test equipment were not available, the AR-2 would work reasonably well if the rod were just connected to the ring opposite the feed location.

◀ **Figure 11** — The completed antenna AR-2 temporarily positioned for adjustment on top of a 1.25-inch aluminum TV mast section.

▼ **Figure 12** — The author's son-in-law, Michael Phillis, finalizes the installation of the AR-2 on top of a 6-foot mast attached to a TV antenna-designed chimney mount. [Katie Phillis, photo]

Installation

The AR-2 is light, and at 38.5 inches tall it doesn't provide much wind load, so any of the typical light-duty TV antenna mounts should be suitable. I used a two-strap chimney mount that was left over from a previous antenna test, and that was begging to be put to use.

Because Nancy, W1NCY, forbade me to climb on the roof, I enlisted my son-in-law Michael Phillis, who runs his own audio system installation and operation company (Performance Audio in Westport, Connecticut), but is familiar with antenna installations as well. The installation was quite straightforward and was completed in just a few minutes (see Figure 12).

On the Air

Wiring the antenna to the station (Nancy's kitchen 2-meter transceiver) was straightforward and went together without a hitch. A coaxial cable that was prepositioned between the joists and extended through a wall plate was put to its intended use, and I connected it to the basement coax run from the antenna.

Not surprisingly, the antenna offers much more consistent results than the horizontal Yagi we previously used. In addition to very solid signals to and from all desired regional repeaters, I am now also bringing up repeaters on the same frequency pair in southern New Jersey, perhaps 60 miles away. Setting up the tone-squelch for the desired local repeaters solved that problem.

Manufacturer: Cushcraft Amateur Radio Antennas, 300 Industrial Park Rd., Starkville, MS 39759. **www.cushcraftamateur.com**. Price $80.

EAntenna DUOSAT Dual-Band Satellite Antenna

Reviewed by Steve Ford, WB8IMY
wb8imy@arrl.net

Amateurs who enjoy operating satellites from portable stations tend to pick dual-band (145 and 435 MHz) directional antennas that offer sufficient gain while being light enough for handheld use. There are two models from other manufacturers that have been popular for a number of years, but EAntenna has introduced another contender: the DUOSAT.

DUOSAT's design takes a slightly different approach compared to its competitors. It combines two loop-fed array (or LFA) Yagis on a single boom rather than the common arrangement of using dual Yagis with dipoles as their driven elements. In the DUOSAT, the driven elements for 2 meters and 70 centimeters are both full-wave rectangular loops in-line between the parasitic elements. The DUOSAT offers a total of three elements on 2 meters and five elements on 70 centimeters. Each driven element is attached to a separate short feed line, which is terminated in a PL-259 connector.

If you are using the DUOSAT with a transceiver that has separate 2-meter and 70-centimeter antenna ports, all you have to do is run two feed lines to the antenna and connect through two female/female couplers. For this review, I was using a dual-band FM mobile transceiver with only one antenna port, so I connected the two DUOSAT feed lines to an MFJ-916B diplexer and ran a single cable back to the radio.

Assembling the DUOSAT

The DUOSAT arrives in a long, narrow box containing the aluminum elements and stainless-steel hardware. The parts bag includes a small Allen wrench.

The assembly instructions for the DUOSAT are in both English and Spanish, but the English translation is somewhat fractured and requires careful interpretation. There are no step-by-step assembly instructions. Instead, you must use the antenna diagrams as guides to install the elements in their correct positions. For example, it is obvious from the diagram that the longest 2-meter element, the reflector, must be installed at the rear of the boom.

The boom is pre-drilled with holes to accommodate the elements and to allow insertion of the bolts and nuts used to hold them in place. The Allen wrench does a decent job for this task; although, I found that I

Bottom Line

The EAntenna DUOSAT is a rugged, well-designed antenna. If you don't mind the lengthy assembly time, the DUOSAT is excellent for portable operating, whether it's satellite or terrestrial.

still had to tighten all the nuts with a wrench to keep the elements from wobbling slightly.

The driven element loops include end sections that slide in and out, not unlike trombones (see Figure 13). A total of eight hose clamps apply the necessary pressure to keep them firmly in place.

I needed about an hour to assemble the DUOSAT. Much of this time was spent making sure I had the elements in their proper places, installing the nuts and bolts, and so on. The DUOSAT is portable in the sense that it is lightweight (only 22 ounces) and just 46 inches wide at its widest point, but this is not an antenna that you can throw together in a few minutes. If you plan to keep the DUOSAT disassembled until you intend to use it, include about an hour's worth of assembly time before it's ready. Repeated assembly will no doubt reduce the time as you become more familiar with the antenna.

Adjusted and On the Air

When assembling the DUOSAT, you'll notice that each "trombone" section is marked with black horizonal lines. These lines indicate the default positions when you slide the sections into the driven elements and tighten the hose clamps. By loosening the clamps and moving the sections, you can adjust for the lowest SWR on each band.

I settled for the default positions and swept the DUOSAT with an antenna analyzer. I was pleasantly surprised to see a 1.5:1 SWR at 145.800 MHz and a 1.3:1 SWR at 435 MHz — perfect for satellite operating. The 2:1 SWR bandwidth on 2 meters ranged from 144.070 to 146.600 MHz; on 70 centimeters it was 430.200 to 440.000 MHz. The default settings were perfect for my purposes, so no slider adjustments were necessary.

With a 25-foot low-loss feed line attached to the diplexer, I tried the DUOSAT with my dual-band mobile transceiver during an AMSAT-OSCAR 91 pass. It was a relatively low-elevation pass with a peak at 30 degrees above my local horizon, so I thought it might offer a worthy challenge.

With the DUOSAT in hand, I started hearing strong signals from the satellite when it was barely above the trees. Within minutes OSCAR 91 was approaching 30 degrees, and the FM signals were full quieting. I quickly worked several stations and received excellent reports before the satellite disappeared over the horizon.

Figure 13 — In this close-up view, you can see the separate feed lines attached to the driven loop elements. You can also see the sliding end sections and hose clamps.

Although the DUOSAT is intended for satellite use, it can function just as well for terrestrial operating. I made some slight adjustments to raise the low-SWR points higher in the bands and then took the antenna to a nearby hill. The performance was impressive. I made simplex contacts out to about 40 miles on both bands.

Manufacturer: EAntenna; **www.eantenna.es**. Distributed in the United States by DX Engineering; **www.dxengineering.com**. $169.99.

Joel R. Hallas, W1ZR, w1zr@arrl.org

The Doctor is In

There's Always Some Way to Have an Antenna

Q Foster, K5FEK, asks: I'm in a neighborhood where I can't have any visible antennas. I have a fair-sized attic, so I can run any number of wires around inside, but I have some concerns.

- **I have a very heavy clay-shingled roof — it withstood 150 MPH winds from Hurricane Irma and barely groaned. Can I get a decent HF signal out from underneath it?**
- **All kinds of wiring and foil HVAC ducting run parallel to any antenna or feed line configuration I can have. They would all be as close as 6 inches and no farther than 3 feet to anything I put there. What are my hazards concerning RFI, both inbound and outbound?**
- **I have many walls that use metal two-by-fours as framing members. Are they usable as a ground or a counterpoise? I have no idea how they are connected together.**

A That sounds like a real challenge! I don't know anything about the RF properties of clay, but I would guess it wouldn't be too much of a problem compared to all the other issues you raise. While anything is worth a try, having antennas 6 inches from other wires is asking for all kinds of trouble with RFI in both directions, not to mention soaking up a lot of your signal. I am guessing that most of your wiring and ducts are near the attic floor. If so, is the area near the peak of the roof clear? If it is, an antenna could be put there, perhaps with wire ends bent down along the roofline at the ends. Otherwise, I'd look into outdoor possibilities.

One possibility is using antennas that can't be seen, perhaps made from very thin wire or an inverted V antenna, hidden under the roof overhangs at the ends of the house. Flagpoles are a popular solution and are generally protected by federal and state laws. These can be made into clever vertical multiband monopoles — check the *QST* archives for examples. Another possibility is an antenna that looks like something else. I reviewed an interesting portable vertical dipole that I think could also be used as a hanger for plants and perhaps bird feeders as a partial disguise. See the "Short Takes" column in the November 2008 issue of *QST* for that review. That antenna, the Trans-World Adventurer (see Figure 1) is now sold by DX Engineering, which offers several models (**www.dxengineering.com**).

Figure 1 — W1ZR adjusting the Transworld Adventurer antenna. This is a possible solution for antenna-restricted areas, because it can be easily moved, disguised, or broken down when not in use. [Nancy Hallas, W1NCY, photo]

Q Bill, K2MYQ asks: Do center-fed dipoles for any given frequency have a performance advantage over end-fed or off-center-fed dipoles cut for the same frequencies?

A An ideal electrical ½-wave-long antenna will have the same voltage and current distribution, independent of the method of feeding it. That assumes that the current is applied only to the antenna, as would be the case if center fed by a properly balanced transmission line.

In real life, however, it's more complicated. It's difficult to actually get such a nice current distribution even with a center-fed arrangement, and much more difficult (but not impossible) with other feed mechanisms. Often,

some of the antenna current ends up on the outside of the coax shield, or as common-mode current on a balanced line. In that case, the transmission line becomes part of the antenna and contributes to the antenna pattern, often as a vertically polarized fraction of the antenna radiation. Note that if in the clear, this may result in radiation in helpful directions, so it's not all bad news. But it could be detrimental if it continues into the house.

Q Mark, KG1Q, asks: What do you feel is the best way to have resonance on both 75 and 80 meters with a single antenna? For example, resonance near 3.5 MHz and 3.9 MHz with a single dipole.

A Unfortunately, 80 and 75 meters are too close together in frequency for some common band-sharing arrangements to work. For example, a pair of parallel-connected dipoles, one cut for each subband and spaced at a reasonable distance, work about the same as a parallel connection with each dipole the same length.

Using two parallel dipoles cut for midband is a possibility, although the spacing needs to be pretty wide. With a spacing of 10 feet at the ends, the SWR will be within about 3:1 from 3.5 to 4 MHz, with the wires cut about 4 feet shorter than required for resonance of a single dipole. Parallel-connected but perpendicularly oriented dipoles, one cut for 80 and the other for 75, can provide 3.5 to 4 MHz coverage with less than a 2:1 SWR.

There have been some clever wideband designs published in *QST* over the years that can do a nice job across all of 80/75 meters. See WA4DRU's broadband 80-meter cage antenna (as used at W1AW) in the December 1980 issue of *QST*. Frank Witt's, AI1H, use of multiple transmission lines as transformers is described in the September 1993 issue. Rudy Severns', N6LF, three-wire window-line-fed dipole is explained in *QST*'s July 1995 issue. Any of these provide a good wideband dipole solution.

Q Barry, WA2WAO, asks: I plan to put an HF vertical in my back yard, to be driven by a maximum of 100 W. I'm getting mixed answers on the question of whether or not I need a balun in my feed line. Some say I would if I were running 500 W or more. What is your recommendation?

A It's not really a power issue, although higher power does tend to magnify any problems. A balun is needed to properly transition between a balanced load, such as a center-fed dipole, and an unbalanced system, such as coaxial transmission line. Without a balun, some of the antenna current ends up as common-mode current on the transmission line, reducing the radiation to the desired destination. In your case, both the antenna system and the transmission line are unbalanced, so no balun is required.

What may be required here instead is a common-mode choke. It is often the case that the antenna will couple RF onto the shield of the coax as it winds its way through the radial field. The problem then is that the RF continues down the shield and enters the house, where it can cause RFI problems with your equipment, as well as other household systems. It also works the other way — RFI from your washing machine, or other household devices, can get picked up on the shield and work its way back to the antenna and into your transceiver.

This usually doesn't happen if the coax is buried well below the surface (only use direct-burial rated coax for this). If the coax is exposed, it will terminate RF fields from the antenna, just as the radials do. The best solution in that case is to insert a common-mode choke on the coax at, or just beyond, the radial field. In this way, the coax shield between the antenna and choke will act like an additional radial.

The common-mode choke doesn't need to be as complicated or expensive as a balun. It can simply be the same coax coiled around a piece of PVC tubing (diameter and turn count depend on band) or a dozen ferrite beads (mix dependent on frequency) on the coax.

Q Marcus, KI6WDX, asks: There is plenty of literature about placing an isolator or a common-mode choke in line with the coax feed for HF antennas, but I have never seen any articles or references for such an arrangement for use with either VHF or UHF antennas. Why is that?

A Common-mode chokes are most needed for the case in which one part of a balanced antenna, typically one half of a center-fed dipole, is connected directly to the shield of the coax. While this is common in HF, most well-designed VHF/UHF antennas are designed to present an unbalanced load to the coax, thereby avoiding the issue.

You can, however, still have problems with directly coupling from the antenna to the shield, but that is generally easier to avoid with VHF/UHF antennas due to their size.

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**.

Hints & Hacks

Guarding Against Polarity Reversal; Strengthening a Coaxial Switch, and Sharing a CI-V Control Line

Polarity Protection

If you plug in and unplug equipment often enough from a power supply (like when transferring base station equipment to the car, Field Day, or a vacation setup), eventually some piece of equipment will get plugged in with the wrong (aka reverse) polarity.

In some cases, the manufacturer has added a bit of protection right inside the equipment with a diode in series with the power line (see Figure 1) or across the supply lines (as shown in Figure 2) to keep it from going up in smoke. The circuit in Figure 1 will make the radio appear "dead" with no further explanation, while the circuit in Figure 2 will cause the radio's fuse to blow. Neither of these techniques are done universally, and if a schematic from the radio is not available, you're pretty much relying on luck that protective circuitry was built into your equipment.

While the standard approaches are the easiest and least expensive ways to add protection, they fall a bit short. If a device doesn't power up due to power cables being plugged into the supply with reverse polarity and we don't realize what happened, we lose valuable time looking for the problem.

If we build our own protection circuit, we can go a step further. By using a bridge rectifier wired as shown in Figure 3, a polarity reversal at the power supply still results in the correct voltage polarity applied to the radio. The trick here is that this bridge rectifier should be installed directly and permanently into a radio or circuit, so if wires get mixed up it won't be between the protection circuit and downstream circuitry.

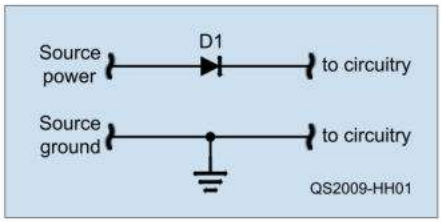


Figure 1 — Some reverse-polarity protection circuits use a diode in series with the power line.

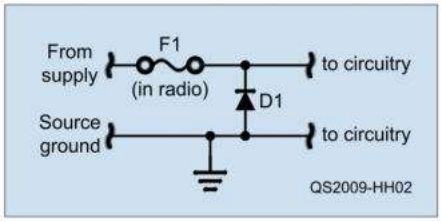


Figure 2 — Another protection approach uses a diode across the supply lines, along with a fuse.

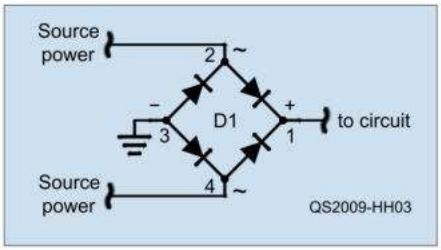


Figure 3 — By using a bridge rectifier, a polarity reversal at the power supply still results in the correct voltage polarity applied to the radio.

You also need to consider the current draw of what you're powering. For example, what's the maximum current that will pass through the protection diodes? In the case of a 100 W transceiver, we could be looking at as much as 25 A in full-output, key-down mode. Even with low-power circuits, there is still the in-rush current to consider and this current can be higher than the operating current. So whatever approach you use, make sure the diodes are selected accordingly, and even attached to heatsinks if necessary.

— 73, Klaus Spies, WB9YBM, **wb9ybm1@yahoo.com**

MFJ-1702 Coaxial Switch Modification

I recently discovered a problem with my MFJ Enterprises MFJ-1702 coaxial switch. The connection to the incoming coax connection was intermittent, resulting in poor receive and likely poor transmitting as well. After opening it up, I discovered that the port 1 and 2 contacts were bent and not making a decent connection with the common port. The common port's contact had become twisted and the switched contacts were barely connecting. The small set screw holding the common port in place had also gotten loose, allowing the connector to twist.

To fix these issues, I started by removing the common port. This involved loosening the set screw and removing the connector. With the common connector out of the way, I gained access to the port 1 and 2 contacts (see Figure 4).

Figure 4 — The MFJ-1702 coaxial switch has a common port switched between two separate ports. [Clint Millett, VE3CMQ, photo]

Figure 5 — A rubber O-ring washer across the connections increases the holding tension. [Clint Millett, VE3CMQ, photo]

I placed a rubber O-ring washer with a 7/16-inch inside diameter (a 3/8-inch ring should work as well) across these connections and then reinstalled the common port, making sure that the contact was square with the common port pin. I also checked that the set screw was firmly in place so this connector couldn't move.

I checked the operation of the switch and found it to be much better than before. The contacts made a firm and complete connection because the O-ring created additional pressure for the contacts without overstressing the contact leaves (see Figure 5).

This modification only took a few minutes, cost almost nothing, and would likely work on similar switches. Note, however, that performing this modification may violate the manufacturer's warranty, so don't attempt the modification unless you're sure the warranty has expired.
— 73, Clint Millett, VE3CMQ,
ve3cmq@secrs.com

An Inexpensive CI-V Splitter

As a fan of computer control for rigs, I need at least two CI-V control ports for the logging software I use with my Icom IC-706 transceiver. I reasoned that if the only two connections to the rig I need are serial and ground, then an audio cable splitter should suffice. Splitters also function as signal combiners. The two former input ports are isolated from each other, so neither logging program will be affected by commands the other sends.

I bought an audio splitter (see Figure 6) from a local store (a headphone splitter would work) and plugged my two CI-V control interfaces into the splitter's two output ports. I then connected the splitter to the rig's CI-V plug and powered on the station PC. Both programs immediately began to track the radio's frequency, mode, and band as if there were only one cable connected. I could find no changes in performance from the original setup. This should work with any splitter, whether mono or stereo, and any rig that uses a 1/8-inch plug for CI-V.
— 73, Max Hochschild, AC1MX,
ac1mx@outlook.com

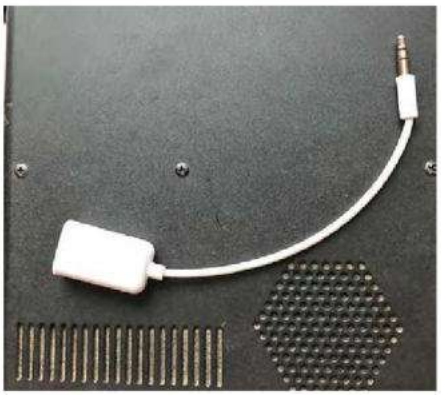


Figure 6 — An ordinary headphone audio splitter can be used to share a single CI-V control port on an Icom transceiver with two software applications. [Max Hochschild, AC1MX, photo]

"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.

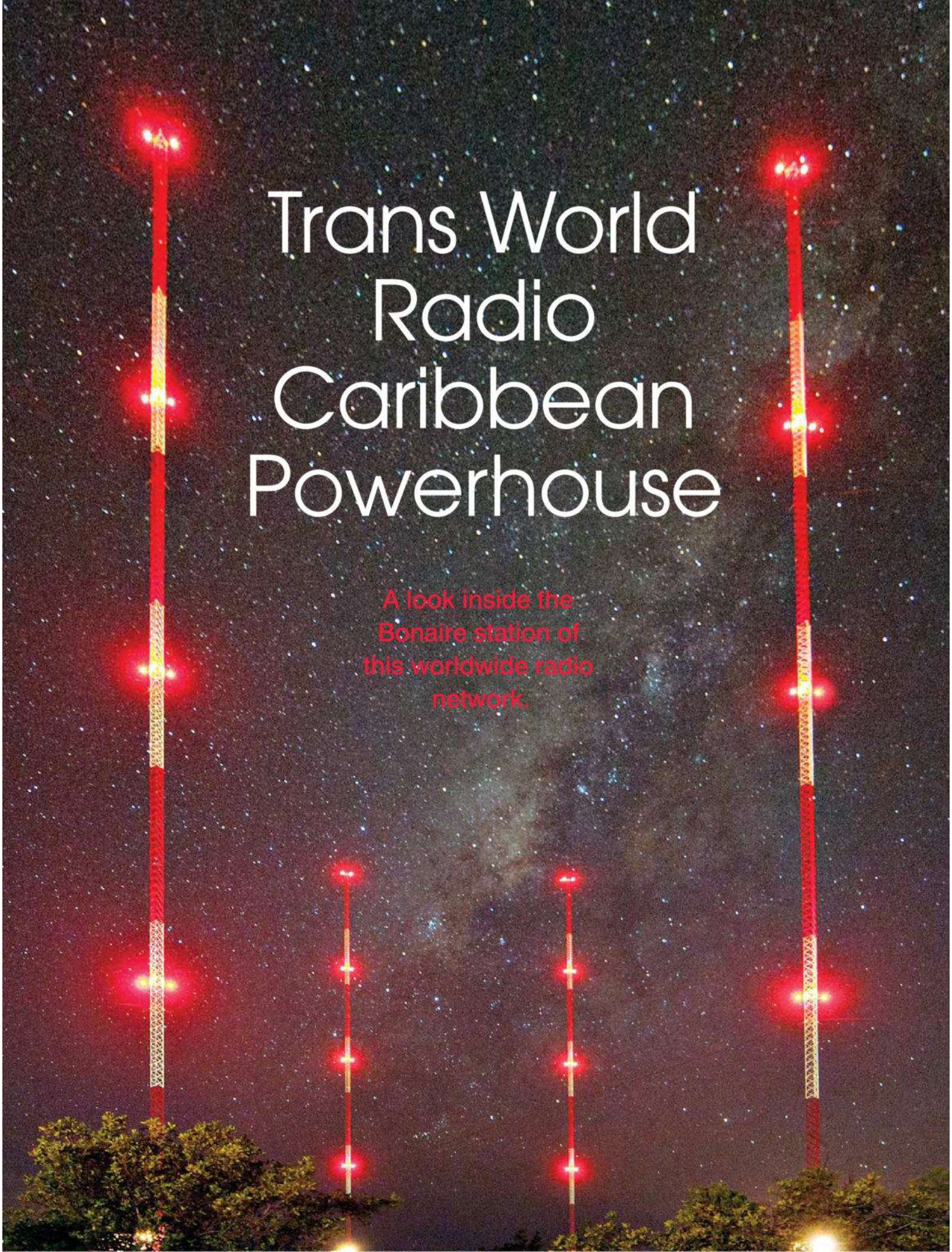
Strays

QST Congratulates...

Oliver Lee, WØLCI, of Delta, Colorado, for celebrating his 100th birthday on June 21 and receiving the ARRL Centurion Award.

Oliver was first licensed in 1935, when he joined the Colorado National Guard during high school, serving as their radio operator. He enlisted in the Navy after the Pearl Harbor bombing and served for 26 years in the field of communications at home and abroad, as an electronics officer on carriers and as Chief Radio Technician at naval facilities in Japan, Guam, and the Philippines. He is a member of the Montrose Amateur Radio Club and is still active on the air.

Montrose Amateur Radio Club President Kathy Joslin, KK6RNV, presented Oliver Lee, WØLCI, with the ARRL Centurion Award. [Stan Joslin, WØLQ, photo]



Trans World Radio Caribbean Powerhouse

A look inside the Bonaire station of this worldwide radio network.

Andy Corbin, W4KDN

Recently, I visited Bonaire, an island about 50 miles off the coast of Venezuela, to tour the studio and operations building of Trans World Radio (TWR). TWR has transmitters all over the globe, broadcasting to 190 countries. The first TWR transmitter was an army surplus transmitter in Morocco in the early 1950s, with coverage in Spain. In 1964, the Bonaire site went on the air with 500 kW.

My tour guide, TWR Assistant Director Brad Swanson, began the tour in one of the many production studios with sound-absorbing materials, as well as heavy double doors to eliminate outside noise. When the facility was built in the late 1960s, they would heat piles of sand over a fire to eliminate moisture, then pour it into the core between the double-row block walls to dampen any outside noise.

A Transmitter Upgrade

In the engineering room, we saw a large transmitter tube on the floor. This was the final tube out of the Radio Netherlands transmitter, decommissioned in 2012, located on the northern end of Bonaire. I was able to pick it up, and it weighed about 35 pounds.

Andy Corbin, W4KDN, holding a decommissioned Radio Netherlands transmitter tube. [Andy Corbin, W4KDN, photo]

While visiting the transmitter site, I learned that TWR recently installed a 440 kW transmitter and their station broadcasts on 800 kHz AM. They also have a small FM station on the north end of the island. They have four ⅜-wavelength towers that are 461 feet high, configured in a rectangle. Some high-power AM stations use open-wire feeders to deliver their signal to the antennas, but TWR uses a coaxial feed line, which is about 4 – 6 inches in diameter.

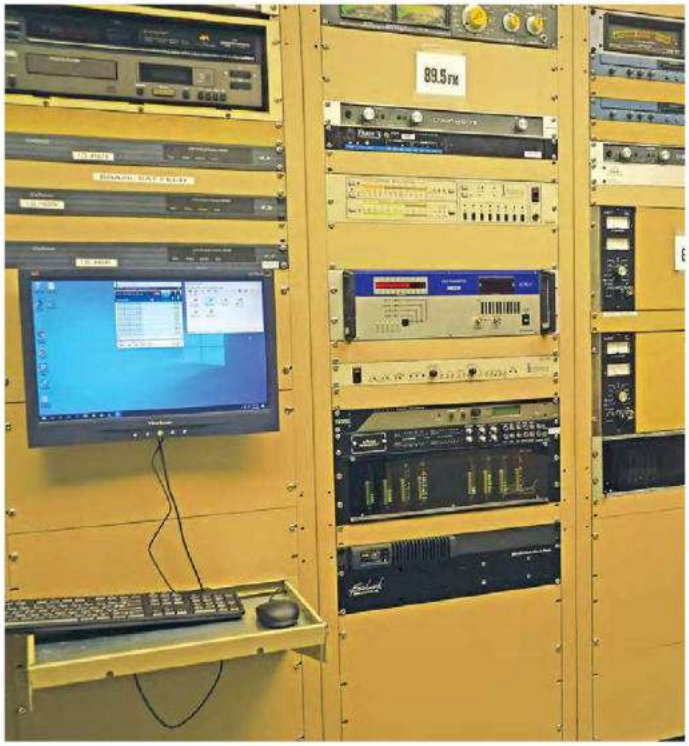
Inside the transmitter room was the former 100 kW transmitter, which was taken out of service when the new 440 kW transmitter was installed. I was surprised about the absence of tubes at that power level. Both transmitters, built by Nautel, have solid-state modules that can be hot swapped in and out of the main unit. The modules for the 100 kW transmitter, while similar in appearance, are not compatible with the 440 kW transmitter.

Two lightning corona discharge balls, used as lightning arrestors, placed at the base of the tower. [Andy Corbin, W4KDN, photo]

A lightning corona discharge ball that had been hit by lightning. [Andy Corbin, W4KDN, photo]

The Bonaire station's four ⅜-wavelength towers. At 461 feet high, they light the night sky. [TWR Assistant Director Brad Swanson, photo]

The transmitter room at the Bonaire station. [Andy Corbin, W4KDN, photo]



The TWR Bonaire station's engineering room. [Andy Corbin, W4KDN, photo]

Lightning Preparedness

In another room of the transmitter building, we saw a metal sphere with holes in it. It was a lightning corona discharge ball that had been used as a lightning arrestor at the base of the tower — this piece had been hit by lightning. Two of these balls get placed at the base of the tower. One is attached to the tower, while the other is on the ground, with a 1 – 2 inch gap between them. When lightning strikes, it arcs over from the tower ball and is transferred to the ground ball, where it's redirected to the ground.

Signal Patterns

In the phasor room, the towers are connected to barrel-sized inductors and capacitors housed in a large Faraday cage. The phasors are used to adjust the pattern of the transmitted signal. TWR's pattern (for example, northwest or southeast) differs depending on the time of day. Finally, they have an almost omnidirectional pattern, which is run at lower power.

Our final stop on the tour was a building with one of the four antenna tuning units (ATUs). Similar to the phasor room, it contained large inductors and capacitors in a Faraday cage.

Conclusion

It was fascinating to see behind the scenes of this massive station. I really enjoyed my trip to Bonaire and my tour of the TWR location. I'd recommend it to any hams who find themselves in the area.

Andy Corbin, W4KDN, is a retired police lieutenant. He has been licensed since 1977 and holds an Amateur Extra-class license, as well as a General Radiotelephone Operators License with a Ship Radar Endorsement. Andy can be reached at **nitespark@cox.net**.

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

Augment Your ARES® Mission with FirstNet®

How to include this communications platform in your public service toolbox.

Randy Richmond, W7HMT

In March 2018, the Nationwide Public Safety Broadband Network known as First Responder Network Authority, in contract with AT&T, was launched as FirstNet®, the first nationwide 4G LTE communications platform dedicated for public safety's wireless broadband needs. The 2012 Spectrum Act, which funded FirstNet, sallows the dedicated band on the 700 MHz spectrum to be shared with second responders (extended primary status), such as people in healthcare, utilities, transportation, and supporting volunteer groups, including the Amateur Radio Emergency Service (ARES®). Here's how ARES members can apply for a subscription to FirstNet and use this tool for public service applications.

FirstNet vs. Commercial Cellular

FirstNet differs from commercial cellular carriers in the US because it offers the following:

- 20 MHz of dedicated 700 MHz spectrum, known as Band 14. Band 14 is a nationwide, high-quality spectrum provided by FirstNet to extend the coverage and capacity available to public safety users on its communication platform.
- Access to AT&T's existing commercial spectrum where Band 14 has not yet been deployed, or for additional coverage and capacity.
- Traffic priority for FirstNet first responder subscribers over commercial and consumer traffic on all of the above spectrum, without having to invoke Wireless Priority Service (WPS) codes. A subscriber vetting process helps ensure the pool of qualified users doesn't overly dilute priority access.
- A planned dedicated multicast IP network separate from AT&T's commercial unicast IP network, which can efficiently support group communications.
- Dedicated sales and support teams.
- Access to FirstNet Ready® devices and FirstNet-approved applications that include Band 14 capabilities and meet FirstNet's rigorous security, relevancy, and data privacy standards.

Advantages for ARES

ARES Cellular Use

ARES members know that in disasters, both cellular and public safety land mobile radio (LMR) networks can go down. One of the benefits of the Amateur Radio Service is that network-independent, ad-hoc stations can quickly be set up and get on the air to communi-cate inside and outside the impacted region. Although ARES is capable of operating with no functional cellular network, there are times when cellular capabilities, if available, are useful.

ARES training (such as EC-001: Introduction to Emergency Communication) notes specific instances where cellular service can aid the ARES mission, such as passing private information or large amounts of data (except for limited availability on HamWAN — 4G LTE exceeds the data rate of all other amateur radio modes).

Another example is the ability to communicate directly with served agencies. Phone calls between designated served agency management and ARES team members have always been desirable, particularly as a primary activation method. But ARES members seldom have the ability to participate in group two-way communications with their served agency, because they don't usually get permission to use an agency's Part 90 LMR system. FirstNet offers several certified broadband push-to-talk (PTT) apps that can be used to bridge served agency personnel and ARES team members on a common platform.

Common situational awareness and field reporting applications (such as *WebEOC*) between ARES teams and served agencies can also be integrated. Such situational awareness can include sending photos and real-time video.

Improving Cellular Resiliency

In many recent natural disasters, cellular service has been severely impacted. In light of FirstNet's mission, public safety departments have access to a nationwide dedicated fleet of 76 FirstNet deployable assets, such as Flying Cell on Wings (COWs) and Satellite Cell on Light Trucks (SatCOLTs), that can quickly be deployed during disasters.

Additionally, public safety agencies will be able to tap into the AT&T fleet of 300+ assets when available. The FirstNet platform is being built to help provide first responders with a solution that's more available and reliable than existing commercial networks. In addition to Band 14, AT&T continually assesses opportunities to harden critical sites important to public safety. These include sites in regions vulnerable to natural hazards like hurricanes, floods, and extreme temperatures.

Solving Cellular Congestion

Although cellular networks may go down during major natural disasters, there are many other ARES deployment scenarios in which cellular coverage is fully or partially maintained (for example, large special events and less severe disasters). Often the problem with cellular networks in these types of scenarios is that they're congested with traffic, which makes them an unreliable resource, except for special users who have access to a Wireless Priority Service (WPS). ARES members with FirstNet extended primary service receive priority network access and data prioritization, giving them continuous data priority across voice and data. When needed, first responders can "uplift" extended primary users, giving them even higher priority levels and preemption capabilities. This priority works on both AT&T's commercial bands as well as the dedicated Band 14. This priority applies to both voice and data (valuable for Broadband PTT, situational awareness, and field reporting apps).

Randy Richmond's, W7HMT, Sonim XP8 FirstNet-ready device.

The Future of FirstNet

FirstNet is not the only national public safety broadband network (NPSBN) in development. A number of other nations are actively pursuing it as well, including the UK, Canada, Australia, South Korea, France, Belgium, Germany, and Norway. Because of the global demand for mission-critical broadband, the global cellular standards body known as the 3rd Generation Partnership Project (**www.3GPP.org**), has been developing a series of open standards called Mission Critical PTT, Mission Critical Video, and Mission Critical Data (abbreviated as MCX). These capabilities can be added to both 4G and future 5G networks. Virtually every NPSBN globally has plans to adopt this suite of standards (and many commercial carriers plan to adopt it as well to retain their public safety customers). FirstNet just recently launched a service based on MCX, called FirstNet-PTT.

Another standard emerging from 3GPP is for a Mission Critical Interworking Function (IWF), which enables LMR networks to be integrated with MCX to enable interoperability between PTT users on both LMR and NPSBNs. FirstNet has plans to introduce this in the near future.

Hybrid radios that can operate both LMR and FirstNet and are upgradable to MCX are already available from several Part 90 LMR manufacturers, offering public safety users a single device that can make the best use of both networks.

As the MCX ecosystem expands, this promises to become a valuable tool to maximize real-time communications, situational awareness, and field reporting for all first, second, and volunteer responders.

Communicating Directly with Served Agencies

One of the valuable apps accessible to all subscribers through the FirstNet App Catalog is FirstNet Assist. ARES FirstNet subscribers using this app can view all mutual aid events within their proximity and request elevated priority access to FirstNet for the duration of the incident. FirstNet Push-to-Talk was launched in March 2020 (see the sidebar, "The Future of FirstNet"), and many public safety agencies have plans to use it to interoperate with and augment their LMR systems, further enabling them to communicate with their served agencies.

Subscribing to FirstNet

Given these advantages, I found it useful as an ARES member to have a FirstNet subscription, and the price was comparable to my existing AT&T consumer service. Although I don't work for a first or second responder agency, I recently obtained a FirstNet subscription based on my ARES membership. My process for subscribing may not be the same for all ARES members. If you're interested in subscribing, have your agency contact an AT&T FirstNet solutions consultant at **FirstNet.com**, through the "Contact Us" page.

After contacting FirstNet support, I went to the lead of our ARES team's served agency, who wrote a letter requesting that I be allowed to obtain a FirstNet subscription to aid with emergency communications for the agency. With this, FirstNet provided me with an online account profile and authorization code. I then went to my local AT&T store to obtain a subscriber-paid FirstNet subscription. I brought my FirstNet-ready smartphone. Because Band 14 is relatively new, not all handsets support it (visit **www.firstnet.com/devices** for a selection of compatible devices and accessories). In less than an hour, I left the store with a FirstNet subscription (see Figure 1).

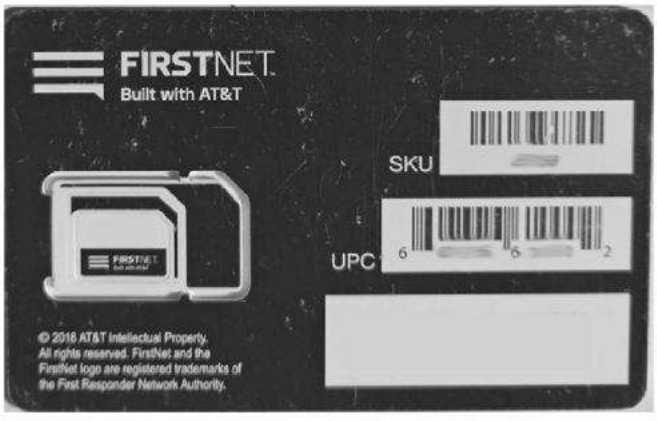


Figure 1 — FirstNet subscribers receive a black FirstNet SIM card from AT&T.

Subsequently, I installed the FirstNet Assist app, which simplifies obtaining support and enables me to see first responder mutual-aid incidents within my proximity. I also now have access to the FirstNet App Catalog, which shows an extensive list of FirstNet Reviewed and Certified situational awareness and broadband PTT apps, some of which my served agency may use in the future.

Conclusion

Given the fact that FirstNet, like existing cellular networks, is subject to impairment during disasters, there remains a need for a resiliency that only amateur radio can provide. Nonetheless, FirstNet can be another valuable resource in the ARES toolkit, to help provide communications in times of disaster.

The L3Harris XL-200 hybrid LMR/LTE radio.

All photos by the author.

Randy Richmond, W7HMT, is the Planning Coordinator for the North Bend, Washington, ARES Team (NBAT). He's also the Standards and Regulatory Specialist at Zetron, Inc., a company that manufactures consoles for public safety dispatch centers. Randy can be reached at **w7hmt@arrl.net**.

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

Amateur Radio Disability Access

Helpful tools and assistive technology solutions from a ham who has ALS.

Figure 1 — The left and right clicks on the Docooler PCsensor USB 2 Foot Switch Control Keyboard.

Steve Appleyard, G3PND

In the latter half of 2017, I began to develop a weakness in my left arm, and in January 2018, I was diagnosed with ALS (Lou Gehrig's disease). The weakness progressed, extending to my right arm and both hands, and increasingly affected my ability to operate my radios. I've explored and implemented methods of mitigating this increasing level of disability, as they may assist with a wide range of conditions.

Using a Keyboard

In many cases, you can work around the need to use a keyboard by using the dictation facility now available on most computers, tablets, and phones. I use this function to send many of my emails. Still, there are many times when I need access to a keyboard function, like when I'm entering details into a log. Fortunately, a solution is now available in the form of an onscreen keyboard provided by Windows 10. You simply move the cursor over the keyboard with the mouse and left-click keys to type. You can access the onscreen keyboard by going to **SETTINGS**, then **EASE OF ACCESS**, **KEYBOARD**, **ONSCREEN KEYBOARD**. It can also be turned on and off using the Windows key + **Ctrl** + **O**.

Hands-Free Mouse Usage

Using the onscreen keyboard requires the ability to move a mouse and to left and right click. When I first discovered the onscreen keyboard, I could readily move the mouse and type at a decent speed, further enhanced by an excellent predictive text function. As my condition has progressed, I've needed to adopt additional measures. The first was simply to use the mouse on a lower table in front of my radio and computer. Currently, I can still move the mouse on this table, albeit in a much more limited way, but I'm no longer able to left and right click. Fortunately, I've found an effective solution for this, using a double foot switch keyboard, specifically the Docooler PCsensor USB 2 Foot Switch Control Keyboard, which I found on Amazon (see Figure 1). The associated downloadable software allows you to assign any keyboard functions to the switches, including left and right mouse clicks, which you can then operate with your feet (visit **www.pcsensor.com/usb-foot-switch.html** to download the software).

I also found *Camera Mouse*, which is a free software that utilizes a webcam to track the movement of your head to control the position of the cursor (**www.cameramouse.org**). The only hardware you need to use this is a webcam. I've set up *Camera Mouse* on both of my desktop computers and they work well, particularly when you tweak the settings for your desired response.

Radio Operation

My radio is a Yaesu FT-1000MP, interfaced to my computer with a *micro*HAM microKEYER II, providing full computer-aided transceiver (CAT) control, with CW and RTTY/PSK operation in conjunction with *N1MM Logger+* software (see Figure 2).

Basic operation of the radio is carried out using *N1MM Logger+* for selecting the mode (CW/SSB/PSK/digital), selection of the band and the filter, and tuning the radio via the band map and entry windows. SSB and digital operation is pretty straightforward. I use a push-to-talk (PTT) footswitch for SSB and onscreen keyboard/camera mouse with the two mouse footswitches for digital. Sending Morse code is a little more complex.

Sending Morse Code

The method I use for CW operation depends on the type of contact I'm making — contesting; a quick, basic exchange, or a longer chat.

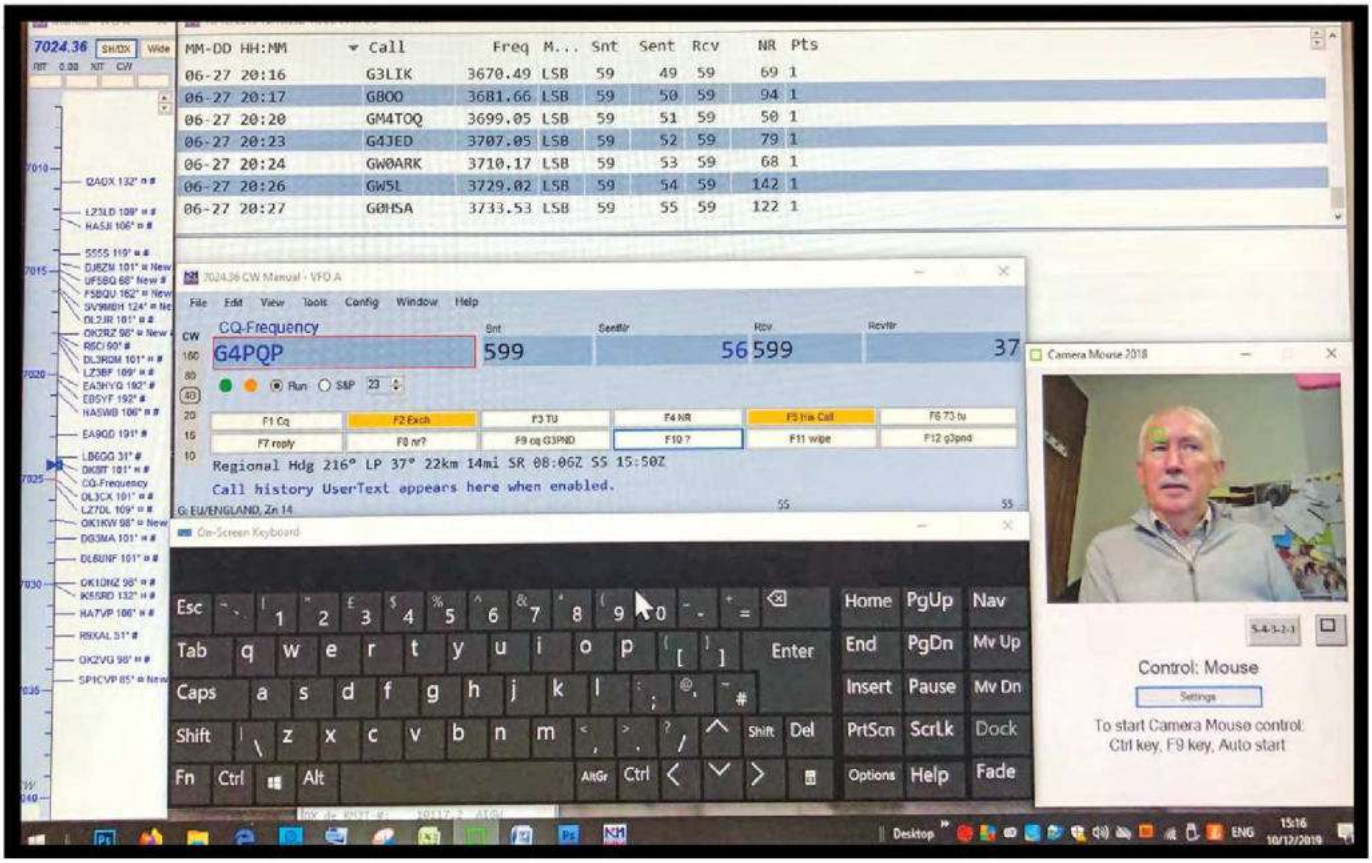


Figure 2 — The Windows 10 onscreen keyboard, the *Camera Mouse* software (at right), and *N1MM Logger+*. In the *Camera Mouse* software, the cursor follows a selected facial feature as you move your head. Here the green tracking square is locked onto my right eyebrow.

Contesting

Contesting is the simplest of the three forms of contact. In the past, I would have operated in run mode, however, I now find that I can't enter call signs and serial numbers fast enough. I now use the "search and pounce" method, using the band map to tune the radio, which gives me as much time as I need.

Quick Contacts

I use the *N1MM Logger+* macros with customized preset messages as the basis of my contact. Each macro function can contain up to 255 characters. I always instigate the contact with calling CQ, rather than responding to one, so I control the contact's format and duration. I use the *N1MM Logger+* general log, listed as "DX" in the log drop-down menu. This gives additional name and comment windows. I use the comment windows for sharing my location. I've also noted my condition on my **QRZ.com** page to explain any perceived differences in the way I communicate.

Longer Contacts

I have two methods of generating spontaneous Morse code for longer contacts. The first method is to use *N1MM Logger+*'s built-in keyer function (window/CW key). Whatever I type, using the onscreen keyboard with the mouse or camera mouse and footswitch, is sent as Morse code.

My second method is more innovative, using a piece of hardware specially designed and built by my friend Bruce Ashdown, G4KZT, which he calls the "SAYMORSE CW keyer." You speak the Morse code into the built-in microphone. The circuitry includes audio amplification and a Schmitt trigger to produce a 0 and 1 output, which can be plugged directly into the radio's key jack in place of the Morse key.

A previous version of this article appeared in the March 2020 issue of RadCom.

All photos by the author.

Steve Appleyard, G3PND, was first licensed as a radio amateur in 1961, while studying electronic engineering. He pursued a career in the electronics industry, designing marine navigation and communication equipment. He is now retired. Steve edited the book *International Antennas*, published in 2017 by ARRL and the Radio Society of Great Britain (RSGB). He also wrote the first chapter, "Using the Reverse Beacon Network to Test Antennas." He is co-author of *Getting Started In EME*, published in 2019 by the RSGB. He can be reached at **sfappleyard@btinternet.com**.

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

2020 Simulated Emergency Test

Test your readiness on October 3 – 4, 2020.

Steve Ewald, WV1X

ARRL's 2020 Simulated Emergency Test (SET) will take place October 3 and 4. This nationwide exercise is the chance to test your personal emergency operating skills and the readiness of your communications equipment in a simulated emergency-like deployment. In consideration of the COVID-19 pandemic, everyone who participates in the SET must follow Center for Disease Control (CDC) and local health department guidelines by staying home if you can, maintaining safe distances when around people, and following recommended cleaning and disinfecting practices at all times. For more information, visit **www.cdc.gov/coronavirus/2019-ncov**.

Ed Compos, K5CRQ, (left) and Bart Pickens, N5TWB, (right) served as net control operators from the Tulsa County Emergency Operations Center during the 2019 SET in Tulsa County, Oklahoma. [Paul Teel, WB5ANX, photo]

ARRL Field Organization leaders at the Section and local levels, and many other volunteers that are active in public service and emergency communications, are developing simulated emergency-like scenarios in consultation with a variety of agencies and organizations for whom radio amateurs are known to provide service during emergencies. ARRL's Amateur Radio Emergency Service (ARES®), the National Traffic System (NTS), the Radio Amateur Civil Emergency Service (RACES), SKYWARN™, Community Emergency Response Team (CERT), the Salvation Army Team Emergency Radio Network (SATERN), and other allied groups and public service-oriented radio amateurs are among those who are eligible to participate in the simulated exercise and to practice emergency operation plans, nets, and procedures.

Visit **www.arrl.org/served-agencies-and-partners** for more information on ARRL's served agencies and partners.

The 2020 ARRL SET offers the chance to reach out to these partners to establish or review plans and develop working relationships.

National Preparedness Month

National Preparedness Month is in September, and is a nationwide effort to encourage everyone to take steps to prepare for emergencies in their homes, workplaces, schools, and communities. We encourage you to consider this year's Simulated Emergency Test and all preparations for it as a demonstration of amateur radio's readiness. More information on National Preparedness Month can be found at **www.ready.gov**.

SET to Go!

ARRL Field Organization leaders have the option of conducting their local or Section-wide SET on another weekend besides October 3 and 4. 2020 SETs should be conducted no later than the end of the fall season or calendar year.

To find out how to be involved in this year's SET, please contact your local ARRL Emergency Coordinator or Net Manager. Contact your local club or other area clubs to find out who the Emergency Coordinator is and/or where the nearest ARES or NTS nets meet. In addition, refer to the ARRL Section web pages at **www.arrl.org/groups/sections**.

Guidelines and specific SET reporting forms for the ARRL Section and Field Organization leaders are posted at **www.arrl.org/public-service-field-services-forms**. If you're in charge of reporting this year's SET activity on behalf of your group, download the forms, fill them out as appropriate, and return them to **sewald@arrl.org** at ARRL Headquarters.

Rick Lindquist, WW1ME, ww1me@arrl.org

Happenings

ARRL to Hold 2021 National Convention at Orlando HamCation®

Orlando HamCation® will host the 2021 ARRL National Convention (**http://www.arrl.org/arrl-expo**) in Orlando, Florida, February 11 – 14. The convention will mark the 75th anniversary of HamCation — one of the largest annual ham radio gatherings. The convention theme, "reDiscover Radio," is a rallying call for radio amateurs committed to developing knowledge and skills in radio technology and communication.

The convention kicks off on Thursday, February 11, with a series of day-long ARRL Training Tracks and a National Convention luncheon. Registration will open in the fall. HamCation will host the rest of the convention Friday – Sunday, February 12 – 14, at the Central Florida Fairgrounds & Expo Park in Orlando. The *ARRL Events* app will help attendees navigate HamCation from a smartphone or tablet to find exhibitors, forum schedules, and affiliated events.

HamCation is sponsored by the ARRL-affiliated Orlando Amateur Radio Club (OARC) and supported by volunteers from radio clubs throughout the region. Michael Cauley, W4MCA, is Orlando HamCation's general chairman. This year, an estimated 24,200 people attended all 3 days of the event.

Details on tickets and information about forums, exhibits (including information for vendors and tailgaters), testing, travel, and preferred hotels with special rates will appear on the HamCation website, at **www.hamcation.com**.

Online ticket sales are under way. Tickets purchased (postmarked) by December 1, 2020, cost $15 and are valid for all 3 days.

ARRL Illinois Section Has a New Section Manager

Thomas Beebe, W9RY, was appointed as the Illinois Section Manager (SM), effective July 1, succeeding Ron Morgan, AD9I, who stepped down due to health concerns that became apparent just as he was ready to start a new term. Morgan was re-elected in the spring Section Manager election cycle and had served as SM since February 2017. Beebe, who lives in Marion, will fulfill the 2-year term that extends through June 30, 2022.

Beebe was one of three candidates who ran for the post in the spring SM election. He has served as an Assistant Section Manager, Official Emergency Station, and a Field Instructor and Field Examiner. Beebe has been a ham for more than 50 years.

ARRL Radiosport and Field Services Manager Bart Jahnke, W9JJ, made the appointment after consulting with ARRL Central Division Director Kermit Carlson, W9XA.

Visalia DX Convention Refashioned as Two Virtual Events for 2021

There will be a Virtual Visalia in 2021. Organizers announced in June that the newly renamed International DX and Contesting Convention (IDXCC) in Visalia, California, will span two weekends next April. Each will be a "unique 3-day event" without duplication. Registration will begin early next year. The former International DX Convention was canceled in March, due to the COVID-19 pandemic. Visalia sponsors said the event's new name better reflects what the convention has become over the years — a gathering of avid DXers and contesters from around the US and the world. Sponsors said the challenge for planning next year's event was whether to prepare for an in-person convention or a virtual gathering.

"Everyone wants to hold out hope for a face-to-face meeting next year, but after consultation with a few medical experts, epidemiologists, and longtime attendees of IDXCC, we have concluded that for 2021, the right choice — and the safest choice — is to have a virtual convention instead of an in-person meeting," said an announcement on the IDXCC website.

Visalia Part 1 will take place on April 16 – 18, 2021, and Part 2 on April 23 – 25. The program will include forums, technical talks, DXpedition reports, and award presentations. Visalia 2021 co-chairs John Miller, K6MM, and Rich Seifert, KE1B, invite questions and suggestions via email to **info@dxconvention.com**. See **www.dxconvention.com** for more information.

Rescued Radio Amateur Says, "Ham Radio Saved My Life"

Alden Sumner Jones IV, KC1JWR, of Bennington, Vermont, is thankful for amateur radio, after suffering a medical incident and losing consciousness on June 15 while hiking with others along a remote section of the Long Trail, not far from his home. An EMT from Appalachian Mountain Rescue (AMR), who was hiking nearby, saw Jones pass out, but was unable to connect with 911 via his cell phone. Jones, 41, regained consciousness and was successful using his handheld radio to contact Ron Wonderlick, AG1W, via the Northern Berkshire Amateur Radio Club's K1FFK repeater on Mount Greylock. Wonderlick initiated what turned into an 8-hour effort to get Jones off the trail and to a medical facility, acting as a relay among Jones, emergency crews, and other agencies involved. As the *Bennington Banner* reported, "The Vermont State Police also received assistance from several licensed amateur radio operators who helped facilitate communications, greatly assisting in the rescue."

Matthew Sacco, KC1JPU, headed to a rescue staging area, and when he could not make it into the repeater, he employed some ham radio ingenuity. He fashioned a J-pole antenna from some window line he had on hand, casting it into a tree using a fishing pole. It worked, and an individual on site was able to obtain an accurate location for Jones using the GPS on his cell phone.

Rescuers could not reach Jones using an all-terrain vehicle, so arrangements were made to have a search-and-rescue crew from New York retrieve Jones by helicopter. Amateur radio participants were able to relay critical information, including an accurate location, as preparations continued.

Jones, meanwhile, took advantage of his time with the EMT and other rescuers to talk up amateur radio and explain how to get licensed. According to one account, rescuers were having trouble making contact with the helicopter, so Jones loaned them a better antenna he happened to have. During his flight to a hospital in Albany, New York, Jones again leveraged the occasion to promote amateur radio to the helicopter pilot and crew.

"Ham radio saved my life last night, and I am very thankful for how everyone helped me," Jones said afterward.

A helicopter-supported litter carries Alden Sumner Jones IV, KC1JWR, to safety. [Vermont State Police photo via the *Bennington Banner*]

Dayton Hamvention® Announces New Chair, Assistant Chair for 2021 Show

Rick Allnutt, WS8G

The Dayton Amateur Radio Association (DARA) has appointed Rick Allnutt, WS8G, as the General Chair for Dayton Hamvention® 2021, heading a team of about 750 volunteers. An ARRL Life Member and a ham since 1982, Allnutt, who served as Assistant General Chair with outgoing General Chair Jack Gerbs, WB8SCT, has been a Hamvention volunteer for the past decade.

"Hamvention is very important in my experience of amateur radio," Allnutt said. "I am honored to serve as the General Chair of the Dayton Hamvention."

Tapped as Assistant General Chair is Jim Storms, AB8YK, a past president, vice president, and secretary of the SouthWest Ohio DX Association. He has been DARA's vice president and Hamvention advance registration chair for 3 years and is cofounder, director, and trip team leader of the Dave Kalter Memorial Youth DX Adventure.

The DARA Board expressed its gratitude to Gerbs for his service to Hamvention and DARA. Hamvention 2021 will take place May 21 – 23.

Prominent Radio Amateur Helps to Lead US Convalescent Plasma COVID-19 Expanded Access Study

Well-known contester, DXer, and *National Contest Journal* (*NCJ*) Editor Scott Wright, KØMD, has substantially stepped back from ham radio to offer his expertise to the US convalescent plasma COVID-19 Expanded Access Program (**www.uscovidplasma.org**). The study began in early April under the leadership of Principal Investigator Dr. Michael Joyner, MD, of the Mayo Clinic; Dr. Peter Marks, MD, PhD — who is AB3XC — and Dr. Nicole Verdun, MD, of the US Food and Drug Administration; Dr. Arturo Casavedall, MD, PhD, of Johns Hopkins University, and Wright, who is with the Mayo Clinic.

The US government-supported study collects and provides blood plasma from recovered COVID-19 patients, which contains antibodies that may help fight the disease. The Mayo Clinic is the lead institution for the program.

"The US Convalescent Plasma Expanded Access Program is a collaborative project between the US government and the Mayo Clinic

Scott Wright, KØMD

to provide access to convalescent plasma for patients in the US who are hospitalized with COVID-19," Wright told ARRL. "My role was to organize the infrastructure and the research approach, and to help lead the set-up of the data collection and of the web-site teams, while overseeing the study conduct and regulatory compliance."

A June 18 *Washington Post* article reported, "A large study of 20,000 hospitalized COVID-19 patients who received transfusions of blood plasma from people who recovered found the treatment was safe and suggests giving it to people early in the disease may be beneficial." The safety study was published in the *Mayo Clinic Proceedings*. An initial safety report on 5,000 patients appeared in May in the *Journal of Clinical Investigation*.

Wright said most scientific studies of this magnitude take months to a year with planning and execution to get under way. In this case, the study team went from zero to 60 in a few short weeks. "We started in less than a week. Most studies recruit 2,500 – 5,000 patients," Wright said. "We have recruited over 30,000 patients in 10 weeks, exceeding all expectations."

Hospitals in all 50 states and several US territories are participating, Wright said, and more than 8,000 physician-scientists are working with the team as investigators at their hospitals. Wright's study responsibilities, which are on top of his regular day job, have required him to work daily, including weekends, since April. "It has been intense," he said.

In Brief...

- The ARRL Foundation has awarded $3,000 to the Open Research Institute (ORI). The grant will be applied to Phase 1 of the Digital Multiplex Transponder research and development program. ORI is an IRS 501(c)(3) organization dedicated to open-source research and development in amateur radio (**www.openresearch.institute**). This grant will allow hardware prototypes for broadband microwave digital satellite payloads to proceed more rapidly. An independent IRS 501(c)(3) entity, the ARRL Foundation administers programs to support the amateur radio community, including scholarships for higher education, award grants for amateur radio projects, and special amateur radio program grants for The Victor C. Clark Youth Incentive Program and The Jesse A. Bieberman Meritorious Membership Program.
- The Yasme Foundation (**www.yasme.org**) has announced a supporting grant to establish Reverse Beacon Network (RBN) nodes in Algeria, Tunisia, and Libya. The project will be carried out by youth members of Amateurs Radio Algeriens and the Association des Radio Amateurs Tunisiens radio clubs. Build-out of these nodes will increase RBN presence in Africa for both the amateur and scientific communities. The RBN is a network of global software-defined radio (SDR) receivers that monitors amateur radio bands and reports CW, RTTY, and FT8 signals to a central database (visit **www.reversebeacon.net** for more information). — *Thanks to the Yasme Foundation*

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.

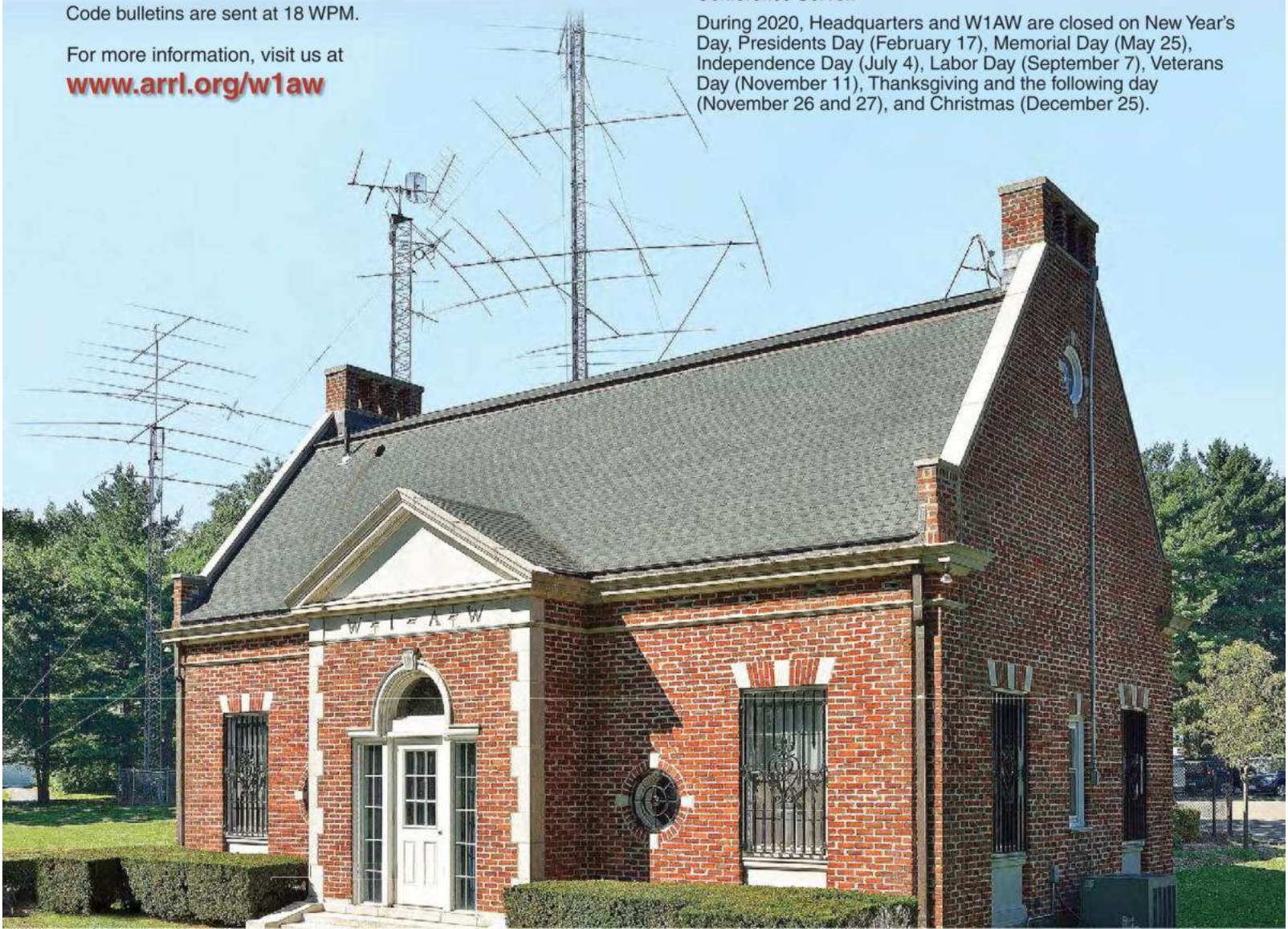
Keplerian elements for many amateur satellites will be sent on the regular digital frequencies on Tuesdays and Fridays at 6:30 PM Eastern time using Baudot and PSK31.

♦ 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 your current FCC amateur license or a photocopy. 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.

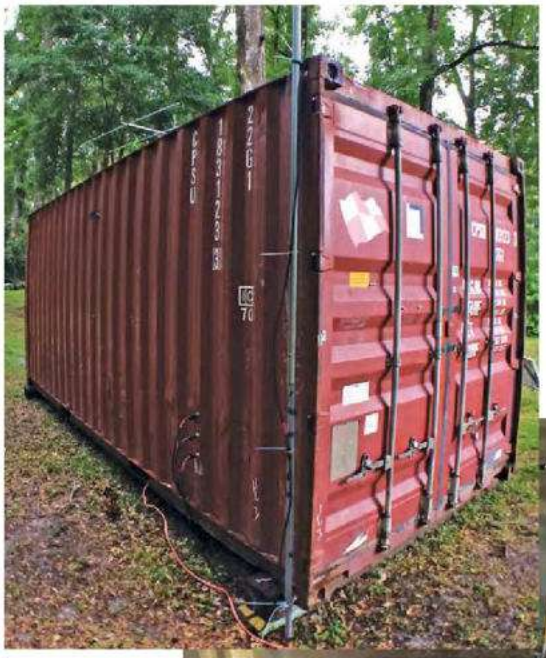
During 2020, Headquarters and W1AW are closed on New Year's Day, Presidents Day (February 17), Memorial Day (May 25), Independence Day (July 4), Labor Day (September 7), Veterans Day (November 11), Thanksgiving and the following day (November 26 and 27), and Christmas (December 25).



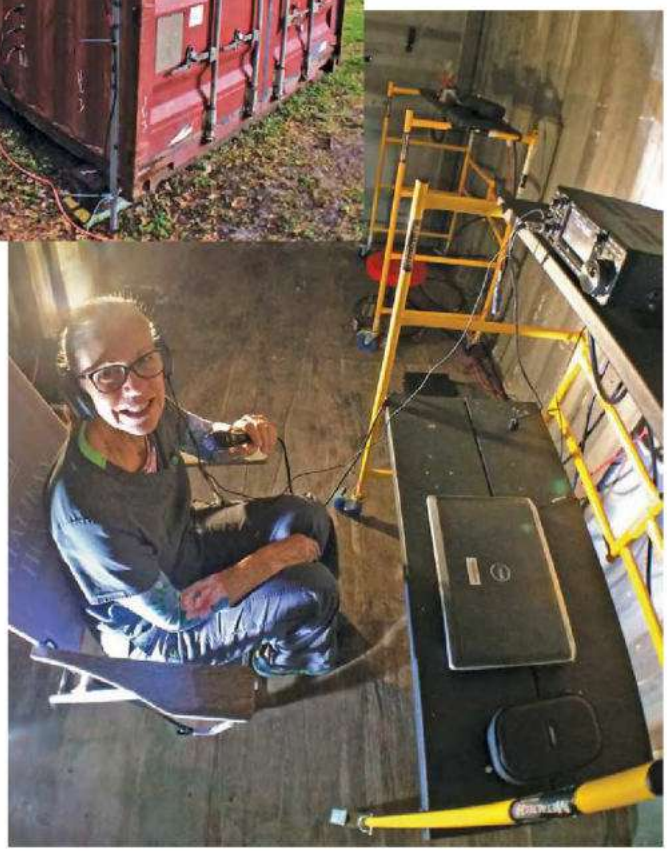
Rick Palm, K1CE, K1CE@arrl.net

Public Service

Shipping Containers for Sheltering Stations and Operators at Deployment Sites



◀ A sheltered station operations center made from a shipping container.



▼ The interior of the shipping container, with my guest operator Sandy Tan, set up for 2020 ARRL Field Day.

Space for operators is often limited at American Red Cross shelters, Salvation Army canteens, emergency operations centers, incident command posts, hospitals, etc. Traditional solutions include the recreational vehicle (RV) that can readily be driven to an assigned deployment site and quickly set up with radios, antennas, and ancillary gear. But the average RV doesn't yield much usable space for radio operators and can be expensive. And sometimes it can be difficult for RVs to travel safely and efficiently on suboptimal road conditions or during storms.

An Alternative Solution

I experimented with another solution — a shipping container. I purchased a medium-sized unit at 8 × 20 feet, yielding 160 square feet of floor space, however, many sizes are available. From the floor to the ceiling is 10 feet, yielding a total of 1,600 cubic feet, leaving plenty of space for my VHF and HF station positions, work bench, battery-charging shelf, floor-mounted floodlights, toolboxes, and milk crates full of cables, wires, and connectors.

Local dealers purchase retired shipping containers from major international shippers at large seaports at wholesale. The dealer then sells them on a retail basis to local customers for storage, homes, or in my case, a ham shack.

The containers are manufactured with heavy steel (mine weighs 5,000 pounds) and their original purpose was to securely protect and hold goods stacked on large cargo ships for transport around the world. They can be repurposed as hard shelters for operators and gear on a deployment against bad weather, such as hurricanes and tornadoes with flying debris. (My container is rated for winds of 150 MPH.) I paid $2,200 plus $125 for delivery, setup, and leveling. An average RV can potentially cost much more.

The containers can be moved, but not quickly during a disaster. Amateur Radio Emergency Service (ARES) operators and other groups may want to consider preplacing them in semi-permanent locations (with approval and advanced planning from property owners or managers) where they perform radio-communication services on a regular basis for drills, public events, emergencies, and disasters. For example, such containers could be placed in the back corners of school parking lots that serve as American Red Cross shelters and emergency operations centers (EOCs).

Containers can be securely locked. They may even offer a Faraday cage effect, reducing RF noise from the myriad of other radio services likely operating in proximity, although the downside might be loss of cell phone and Wi-Fi signals. Test them before use in an emergency — outside antennas may be required. My cell phone and Wi-Fi had no coverage from inside the shipping container with the doors closed, but worked fine with the doors open (my home router is 150 feet away).

Radio Installation Ideas

For years, I've used Metaltech's Mobile Scaffolding Jobsite Series™ mini-scaffolding for mounting my radios and peripherals, with excellent results. On wheels, my operating platforms turn easily for repositioning and yield quick and easy access to the radios' rear panels. (Visit **www.metaltech.co/products/4-high-portable-scaffold** for the model I use.) I moved my scaffolds into the shipping container, placed the shelves with radios already mounted, and plugged in my accessories. I drilled three holes through the container's corrugated wall and mounted bulkhead SO-239 connectors for my HF antenna, 6-meter beam, and 2-meter beam.

For ac power, I ran a 150-foot heavy duty extension cord from my house (ac wiring should be rated for the maximum anticipated requirement). I supplemented my ac power options by acquiring a high-quality 2,800 W gas-powered generator designed for use with sensitive electronics. Do not run a generator inside the container, as the carbon monoxide can be fatal.

For dc power other than my power supply, I placed my two 12 V, 31 Ah sealed lead acid batteries parallel on the floor of the container, along with their solar charge controller. Consider putting foam insulation on the walls to deaden sound, minimizing the echo chamber effect.

Container Safety

Ground the container and your equipment. Ensure ventilation with holes and screened windows (the seller can install windows for a nominal fee). Use an industrial fan for more ventilation and convection cooling.

Close the heavy steel doors by using a bar or lock with a chain from the inside during a storm. To protect yourself from accidentally getting locked in from the outside, place a padlock through one or both outside door lock holes to prevent the doors from being completely closed. However, lock the doors when the container is not in use. Place signs on the sides of the container stating, "Keep Off," "Danger High Voltage," or similar. If you have an implanted medical device, consult with your doctor for any safety requirements before operating inside the container.

Conclusion

The shipping container offers a semi-permanent, secure sheltered operating facility for sites where hams may be deployed on a regular basis. Make a professional proposal for permission to place your container and be prepared to discuss liability issues with the property's agency-owner to be served.

Setting up and outfitting a container would make a great club or ARES project. Visit **www.tigercontainers.com/blog/used-shipping-containers-look-buying** for more information.

Field Organization Reports

June 2020

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**.

710
KD8TTE

475
WA3EZN

445
N9VC

425
W7PAT

367
WA7PTM

291
KD2LPM

272
KE8BYC

265
K1REZ
KE8KOC

260
KD2NMG

255
ND8W

249
AL0Y

220
W3GWM
N8SY

219
KT2D

210
AD8CM

205
WB9WKO

199
KK4PUX

185
KW9EMG
N1LL
WM2C

183
W9RY

180
WA2CCN

175
WS6P
AF4NC

170
W8DJG
AC8RV
W4DNA

167
N3KRX

165
KB3YRU

160
W2PH
WB7OSC
K9LGU

156
N2WGF
WA2BSS

153
KY2MMM

150
KK3F

145
WD8USA

140
AA3N
K4IWW
WO2H

137
KB8RCR

135
W4CMH
AC0KQ
W3YVQ
N5MKY

130
WA4VGZ
WB9QPM
KC9FXE
N2JBA
K8AMH
W8IM
KW1U

129
W4INK

127
K4VWK

126
W7EES

125
KC8WH

122
K9ILJ

120
W4NWT
WC4FSU
W0LAW
AG9G
K8MDA
WK4WC
K3JL
AD3J
KA9QWC
K0IBS
KY2D

119
KA8ZGY

117
AI9F
K3FAZ

115
KF5OMH
N1TF
N1PZP

112
KB0DTI

110
W1KX
WA3QLW
KO4OL
KA9MZJ
K6HTN
K2TV
WB8YLO
KA5AZK
KE5YTA
KF5IOU
N1IQI
KD2JKV
W1RVY
K3IN
WB8TQZ

108
KD8ZCM

107
AC8NP

106
KT4WX

105
KC8YVF

103
KV8Z
AB1AV

102
W2CTG
KD2GXL
WV5Q

101
WB8YYS

100
W2PAX
WB4RJW
KZ8Q
NX9K
KN9P
WB8SIQ
K3RC
KG5NNA
N1LAH
WA1MXT
KA2GQQ
KB2QO
N3RB
AA3SB
WB3FTQ
K8ED

97
KE1ML

96
K1HEJ

95
W9EEU
K1XFC

94
W4TTO
K9DUR
AB3WG

91
N2DW
KC1HHO
K1STM

90
AD4DO
KM4WHO
N6IET
KD8UUB
K8KRA
WB8HJJ
KA1G
KL7RF

AB9ZA
K3MIY
N2TSO
WD8DHC
WD0BFO
KB4CAU
KC1KVY
WA1LPM
NB0Z
K2MJF
KA2HZP
W3CJD
WB8WKQ

89
K9GDF

88
N3SW
K8RDN

87
K0FBS
K2IE

86
KA0DBK

85
W9BGJ
W1INC
KB1NAL

84
K6JT

83
NI2W

81
WW3S

80
WB4ZDU
W3ZR
N8MRS
KN4AAG
WB8R

79
KB1NMO

76
W5XX

75
KD2GRS
KC1MSN

70
K6RAU
K2KNB

The following stations qualified for PSHR in previous months but were not reported in this column: (May) K1REZ 170, AB1AV, N1PZP 105, WA1MXT 100, WV5Q 89, K1CFI 82, W5XX 76. (Apr.) AB1AV, K1UAF 110, N1PZP 109, WA1MXT 100, W1INC 90, K1CFI 88. (Mar.) AB1AV, K1UAF 110, WA1MXT 100, N1PZP 93, W1INC 84. (Feb.) N1PZP 124, K1UAF 110, AB1AV 106, K1CFI 86, W1INC 81. (Jan.) N1PZP 245, K1UAF 110, AB1AV 95, K1CFI 90, W1INC 79. (Dec. 2019) K1UAF 110, N1PZP 100, AB1AV 99, K1CFI 80.

Section Traffic Manager Reports

The following Section Traffic Managers reported: AK, AL, AR, CO, CT, DE, EMA, ENY, EPA, IL, IN, KS, KY, LA, LAX, ME, MI, MN, MS, MT, NC, ND, NE, NFL, NH, NLI, NM, NNJ, NTX, NV, OH, OR, SFL, SJV, TN, VA, WCF, WI, WMA, WPA, WTX, WV, WY.

Section Emergency Coordinator Reports

The following Section Emergency Coordinators reported: AR, CT, DE, ENY, EPA, ID, IN, KY, LA, MDC, ME, MI, MN, MO, MS, ND, NLI, NM, NNJ, NV, OH, OR, SFL, SJV, SNJ, STX, TN, VI, VT, 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.

KK3F 2,507, NX9K 1,338, K6HTN 1,146, WB9WKO 885, KE5YTA 837, KW1U 804, N1IQI 644.

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

Contest Corral — September 2020

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
2	1700	2	2000	144	VHF-UHF FT8 Activity Contest	Dig	4-char grid square	ft8activity.eu/index.php/en
2	2000	2	2100	3.5	UKEICC 80-Meter Contest	Ph	4-char grid square	ukeicc.com/80m-rules.php
2	2300	4	2300	3.5-28	G3ZQS Memorial Straight Key Contest	CW	RST, SPC, name, mbr or power	www.fistsna.org
3	1700	3	2100	28	NRAU 10-Meter Activity Contest	CW Ph Dig	RS(T), 6-char grid square	nrau.net/activity-contests
3	1900	3	2100	1.8-50	SKCC Sprint Europe	CW	RST, SPC, name, mbr or power	www.skccgroup.com
5	0000	5	2359	1.8-28	CWOps CW Open	CW	Serial, name	cwops.org/cwops-tests
5	0000	6	2359	3.5-28	All Asian DX Contest, Phone	Ph	RS, 2-digit age	www.jarl.org/English
5	0600	5	0800	7,14	Wake-Up! QRP Sprint	CW	RST, serial, suffix of previous QSO	qrp.ru/contest/wakeup
5	1300	6	0400	1.8-UHF	Colorado QSO Party	CW Ph Dig	Name, CO county or SPC	ppraa.org/coqp
5	1300	6	1259	1.8-28	IARU Region 1 Field Day, SSB	Ph	RST, serial	darc.de/der-club/referate/conteste
5	1300	6	1300	3.5-28	RSGB SSB Field Day	Ph	RS, serial	www.rsgbcc.org/hf
5	1400	6	1400	145	IARU Region 1 145 MHz Contest	CW Ph Dig	RS(T), serial, 6-char grid	iaru-r1.org/on-the-air
5	1600	5	1900	7	AGCW Straight Key Party	CW	RST, serial, class, name, age	agcw.org/index.php/en
5	2000	6	2000	3.5	PODXS 070 Club Jay Hudak Memorial 80-Meter Sprint	Dig	RST, SPC	www.podxs070.com
6	1000	6	1400	144	WAB 144 MHz QRO Phone	Ph	RS, serial, WAB square or country	wab.intermip.net
6	1800	7	0300	1.8-UHF	Tennessee QSO Party	CW Ph Dig	RS(T), TN county or SPC	tnqp.org/rules
7	1900	7	2030	3.5	RSGB 80-Meter Autumn Series, SSB	Ph	RS, serial	www.rsgbcc.org/hf
7	2300	8	0300	1.8-50	MI QRP Labor Day CW Sprint	CW	RST, SPC, mbr or power	miqrp.net/contest
8	0100	8	0300	3.5-28	ARS Spartan Sprint	CW	RST, SPC, power	arsqrp.blogspot.com
9	1700	9	2000	432	VHF-UHF FT8 Activity Contest	Dig	4-char grid square	ft8activity.eu/index.php/en
12	0000	12	2359	3.5-28	Russian RTTY WW Contest	Dig	RST, oblast or CQ zone	qrz.ru/contest/detail/93
12	0000	13	2359	2.3 GHz +	ARRL EME Contest	CW Ph Dig	Signal report	www.arrl.org/eme-contest
12	0000	13	2359	3.5-28	WAE DX Contest, SSB	Ph	RS, serial	darc.de/der-club/referate/conteste
12	1000	13	1000	1.8-28	SARL Field Day Contest	CW Ph Dig	RS(T), number of xmitrs, category, province or "DX"	www.sarl.org.za
12	1200	13	2359	1.8-50	SKCC Weekend Sprintathon	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
12	1400	12	2200	3.5-28	Ohio State Parks on the Air	Ph	Park abbreviation or "OH" or SPC	ospota.org
12	1400	13	2000	1.8-UHF	Texas QSO Party	CW Ph Dig	RS(T), TX county or SPC	www.txqp.net
12	1500	13	0300	3.5-28	Alabama QSO Party	CW Ph	RS(T), AL county or SPC	alabamaqsoparty.org
12	1500	13	0959	3.5-28	Russian Cup Digital Contest	Dig	Serial, 4-char grid square	qrz.ru/contest/detail/86.html
12	1800	14	0300	50 +	ARRL September VHF Contest	CW Ph Dig	4-char grid square	www.arrl.org/september-vhf
13	0000	13	0400	3.5-14	North American Sprint, CW	CW	Other station's call, your call, serial, name, SPC	ncjweb.com
14	0000	14	0200	1.8-28	4 States QRP Group Second Sunday Sprint	CW Ph	RS(T), SPC, mbr or power	www.4sqrp.com
16	1900	16	2030	3.5	RSGB 80-Meter Autumn Series, CW	CW	RST, serial	www.rsgbcc.org/hf
17	0030	17	0230	3.5-14	NAQCC CW Sprint	CW	RST, SPC, mbr or power	naqcc.info/contests.html
17	1930	17	2059	3.5	BCC QSO Party	CW Ph Dig	RS(T), T-shirt size	bavarian-contest-club.de/2326
18	2100	18	2359	3.5	AGB NEMIGA Contest	CW Ph Dig	RST, serial, mbr (if any)	ev5agb.com/index_eng.html
19	0000	19	2359	1.8-VHF	FOC QSO Party	CW	RST, name, mbr (if any)	g4foc.org/qsoparty
19	0000	20	2359	1.8-UHF	Collegiate QSO Party	CW Ph Dig	School name, RS(T), operating class	collegiateqsoparty.com
19	0600	20	2359	10 GHz +	ARRL 10 GHz and Up Contest	CW Ph Dig	6-char maidenhead locator	www.arrl.org/10-ghz-up
19	1200	20	0800	50,70, 144,432, 1296	SARL VHF/UHF Digital Contest	Dig	RST, 6-char grid locator	www.sarl.org.za
19	1200	20	1200	3.5-28	Scandinavian Activity Contest, CW	CW	RST, serial	sactest.net/blog
19	1200	20	1200	1.8-28	All Africa International DX Contest	CW Ph Dig	RS(T), serial	www.sarl.org.za
19	1400	20	0200	1.8-UHF	Iowa QSO Party	CW Ph Dig	RS(T), IA county or SPC	www.w0yl.com/IAQP
19	1500	19	2100	1.8-28	QRP Afield	CW Ph Dig	RS(T), SPC, mbr or power	newenglandqrp.org/qrp-afield-2018
19	1600	19	2300	3.5-144	Wisconsin Parks on the Air	Ph	WI park abbreviation or SPC	wipota.com
19	1600	20	0359	3.5-28	New Jersey QSO Party	CW Ph Dig	RS(T), NJ county or SPC	k2td-bcrc.org/njqp
19	1600	20	2200	1.8-UHF	New Hampshire QSO Party	CW Ph Dig	RS(T), NH county or SPC	w1wqm.org/nhqso
19	1600	20	2359	1.8-144	Washington State Salmon Run	CW Ph Dig	RS(T), WA county or SPC	wwdxc.org/salmonrun
19	1800	19	1959	1.8-50	Feld Hell Sprint	Dig	RST, mbr, SPC, grid	sites.google.com/site/feldhellclub
20	0000	20	0400	3.5-14	North American Sprint, RTTY	Dig	Other station's call, your call, serial, name, SPC	ncjweb.com
20	1700	20	2059	3.5-28	BARTG Sprint 75	Dig	Serial	bartg.org.uk
20	2300	21	0100	1.8-28	Run for the Bacon QRP Contest	CW	RST, SPC, mbr or power	qrpcontest.com/pigrun
21	1900	21	2300	144	144 MHz Fall Sprint	CW Ph Dig	4-char grid square	svhfs.org
23	0000	23	0200	1.8-28	SKCC Sprint	CW	RST, SPC, name, mbr or power	skccgroup.com
24	1900	24	2030	3.5	RSGB 80-Meter Autumn Series, Data	Dig	RST, serial	rsgbcc.org/hf
26	0000	27	2359	3.5-28	CQ Worldwide DX Contest, RTTY	Dig	RST, CQ zone, US state or VE area (if US/VE)	www.cqwwrtty.com
26	1200	27	1200	1.8-28	Maine QSO Party	CW Ph	RS(T), ME county or SPC	ws1sm.com/MEQP.html
26	1400	26	1800	144, 432	AGCW VHF/UHF Contest	CW	RST, serial, power, 6-char grid	agcw.org/index.php/en
28	1900	28	2030	3.5	RSGB FT4 Contest Series	Dig	4-char grid square	www.rsgbcc.org/hf
29	1900	29	2300	222	222 MHz Fall Sprint	CW Ph Dig	4-char grid square	svhfs.org
30	2000	30	2100	3.5	UKEICC 80-Meter Contest	CW	4-char grid square	ukeicc.com/80m-rules.php

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. 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.*

Chris Tate, N6WM, n6wm@largeradio.org

2020 ARRL International DX Phone Contest Results

This year's ARRL DX Phone Contest was held March 7 – 8, 2020.

John Bayne, KK9A, returned to Aruba for the first time since dismantling his own station there in 2011, and operated as P4ØA using the P49Y/P4ØL contest station for the 2020 ARRL International DX Phone Contest. John took the top spot in the DX Single Operator, Low Power category. [John Bayne, KK9A, photo]

The antenna farm at Rolandas Jokubauskas's, LY4A, station in Lithuania. Using his impressive contest station during the 2020 ARRL International DX Phone Contest, he secured a top 10 finish in the Single Operator, High Power category. [Rolandas Jokubauskas, LY4A, photo]

Affiliated Club Competition

Club	Score	Entries
Unlimited		
Frankford Radio Club	203,256,891	221
Yankee Clipper Contest Club	158,730,147	200
Potomac Valley Radio Club	125,333,460	207
Contest Club Ontario	40,659,135	70
Society of Midwest Contesters	32,984,049	101
Florida Contest Group	30,949,245	78
Arizona Outlaws Contest Club	25,176,708	67
Southern California Contest Club	23,722,218	65
Northern California Contest Club	18,854,454	64
Minnesota Wireless Assn.	17,091,219	97
Medium		
North Coast Contesters	21,503,790	17
Central Texas DX and Contest Club	19,301,061	40
Mad River Radio Club	14,020,425	31
Tennessee Contest Group	11,265,297	36
Hudson Valley Contesters and DXers	9,781,866	41
DFW Contest Group	9,759,267	30
Alabama Contest Group	9,166,704	25
Order of Boiled Owls of New York	8,940,084	13
Willamette Valley DX Club	8,421,534	29
Western Washington DX Club	7,912,608	24
Carolina DX Assn.	7,783,647	27
CTRI Contest Group	6,785,190	12
Niagara Frontier Radiosport	6,481,446	16
Grand Mesa Contesters of Colorado	6,456,495	29
Kentucky Contest Group	5,778,519	21
Northeast Wisconsin DX Assn.	5,721,366	9
Big Sky Contesters	5,591,079	12
Mother Lode DX/Contest Club	4,280,343	18
South East Contest Club	4,255,203	25
Bay Area DXers	3,154,776	11
North Texas Contest Club	2,889,171	10
Orca DX and Contest Club	2,460,033	16
Texas DX Society	2,131,746	11
Maritime Contest Club	2,131,734	5
Kansas City Contest Club	2,108,571	6
Northeast Maryland Amateur Radio Contest Society	1,811,289	13
Louisiana Contest Club	1,569,771	5
Rochester (NY) DX Assn.	1,388,301	15
Georgia Contest Group	1,382,631	5
Radiosport Manitoba	1,370,157	3
Metro DX Club	1,183,590	11
Great Places Contest Club	775,908	5
Portage County ARS	767,865	4
Port Lavaca ARC	767,283	6
Mississippi Valley DX/Contest Club	564,918	7
South Jersey Radio Assn.	528,999	8
Spokane DX Assn.	528,216	11
Pacific Northwest VHF Society	528,192	3
Skyview Radio Society	498,135	7
Driftless Zone Contesters	472,020	4
Swamp Fox Contest Group	442,386	4
North Carolina DX and Contest Club	423,990	3
New Providence ARC	393,882	8
599 DX Assn.	356,076	3
West Park Radiops	250,671	8
Great South Bay ARC	167,529	5
Arkansas DX Assn.	155,613	3
Silver Comet Amateur Radio Society	83,211	5
Burlington County Radio Club	12,804	3
Local		
Iowa DX and Contest Club	4,833,270	4
Central Virginia Contest Club	4,357,428	10
The Villages ARC	2,671,632	8
Murgas ARC	1,603,776	6
Bristol (TN) ARC	834,723	9
Hilltop Transmitting Assn.	606,072	7
Meriden ARC	362,826	3
Silver Springs Radio Club	202,287	4
Redwood Empire DX Assn.	195,909	4
Milford (OH) ARC	76,455	3
North Fulton ARL	71,316	4
Sterling Park ARC	12,657	3

The next ARRL International DX Phone Contest will be held March 6 – 7, 2021.

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.

Top Ten — US and Canada

Single Operator, High Power

VY2ZM	3,563,388
NR3X (N4YDU, op)	3,071,232
VY2TT	2,815,005
CF3A (VE3AT, op)	2,663,592
N1UR	2,596,770
W9RE	2,249,208
K4AB	1,749,468
K3ZO	1,592,748
N9RV	1,366,854
NA8V	1,277,760

Single Operator, Low Power

N4TZ	660,630
K5KU	480,447
AD5A	452,160
NT6Q (N5ZO, op)	423,864
K5FUV	369,720
N1DD	318,852
W7RM (K2PO, op)	317,628
KE3X	292,992
W6DVS	285,735
K3SU	273,321

Single Operator, QRP

WE6EZ	79,968
K3TW	41,976
W6QU (W8QZA, op)	28,638
AG4ZL	8,232
KA6PNL	8,178
N3CI	6,804
WX2N	6,660
K1MTD	4,935
K2MIJ	3,564
W7BAK	2,697

Single Operator Unlimited, High Power

AA1K	2,647,890
NC1I (K9PW, op)	2,400,930
K1KI (KM1P, op)	2,397,933
K3WW	2,355,723
N3RD	2,274,300
N3RS	2,096,766
W3UA	2,071,197
AA3B	2,051,148
K5TR	2,030,145
K1RX	1,914,528

Single Operator Unlimited, Low Power

NN1C	1,397,955
VA3DF	805,140
NY6DX	593,460
KS1J	500,712
N2SQW	418,902
WA1FCN	417,750
W3KB	401,622
W9XT	375,708
W1SIP	342,720
WO1N	330,270

Single Operator Unlimited, QRP

K8ZT	48,618
K7SS	16,830
K2GMY	6,480
W8IQ	1,872
KJ5T	330
NRØQ	243
K6CTA	3

Single Operator, 160 Meters

W2MF	10,920
AG4W	7,788
VE3PN	5,760
WB4WXE	3,456
VA3SK	1,656
W8KA	330
NØUY	75

Single Operator, 80 Meters

W3BGN	55,278
K8UR	47,064
W3NO	35,697
KK6ZM	35,460
WD6T (@N6RO)	28,362
KA1IS	26,733
NØOK	23,364
K5KJ	19,440
VE9ML	16,686
W9JOE	13,833

Single Operator, 40 Meters

W7WA	250,290
KT3RR	31,086
K2UR	30,552
KD4RH	25,668
W2AAB	24,960
WB8YYY	22,326
WA8RCN	18,900
WDØBGZ	13,356
K3HW	13,350
WA3FAE	12,054

Single Operator, 20 Meters

W2RE	866,520
VE3DZ	504,561
N7TU (K2SS, op)	337,584
WØEWD	249,705
AA6AA	200,178
K8LX	155,682
AB4B	154,755
K8FF	152,844
W1AVK	80,136
KØBBB	70,227

Single Operator, 15 Meters

K5RX	28,302
K1KNQ	14,715
N6WM	14,040
NCØB	10,605
WB2AMU	8,280
AJ6T	6,231
KX2S	5,880
W2NPT (W3EH, op)	5,301
AD4L	4,263
WD5DJW	2,898

Single Operator, 10 Meters

W5PR	1,404
W4DD	864
N4TUT	486
K4WI	378

Multioperator, Single Transmitter, High Power

NV9L	2,309,568
K3ND	1,412,403
K2LE	1,410,870
W3MF	1,096,704
K3MD	1,012,500
N7NR	964,275
W8PR	954,018
W3LL	806,031
N3XF	761,001
WT3Q	753,480

Multioperator, Single Transmitter, Low Power

N1SOH	361,440
NM1C	276,024
VD1TP	237,300
N8YXR	227,520
KJ3T	182,214
AB5J	65,238
WA1F	59,169
K9IU	48,654
K2AA	40,290
NJ1F	23,814

Multioperator, Two Transmitter

N1MM	2,508,768
K8AZ	1,989,504
K2AX	1,545,372
W2CG	1,541,904
W5WZ	1,360,176
KA1ZD	1,331,388
K3MTR	1,165,920
KT7E	1,034,343
WB2P	821,712
W1QK	709,275

Multioperator, Multitransmitter

K3LR	7,332,930
W3LPL	6,326,451
K1TTT	3,478,596
NE3F	1,335,180
W1CSM	783,144
K5LRW	46,866

Top Ten — DX

Single Operator, High Power

TI7W (N6MJ, op)	7,611,516
8P5A	6,287,502
V47T	5,762,700
NP2P (N2TTA, op)	3,740,076
TO5A (F5VHJ, op)	3,177,291
KP3MM	2,868,624
KH6LC (N6TJ, op)	2,781,360
ZF5T	2,463,912
KL7RA (KLØR, op)	1,848,384
EA8RM	1,762,344

Single Operator, Low Power

P40A (KK9A, op)	4,035,720
VP2MMF (K1XX, op)	3,342,993
KP3DX (NP4Z, op)	2,675,970
WP3R	1,579,662
V31MA	1,064,460
KP4PR	1,026,195
KH6CJJ	942,033
PJ7AA (AA9A, op)	675,132
TI2OY	548,100
IW1FRU	431,748

Single Operator, QRP

LZ9W (LZ1UQ, op)	117,549
HA1DAE	41,205
F5BEG	24,924
JH7UJU	11,592
JA6GCE	9,840
JQ1NGT	6,018
DF5RF	4,131
IK2JTS	3,744
9A5VS	3,564
IW2NRI	2,709

Single Operator Unlimited, High Power

KP2M (N2TK, op)	4,222,245
PT5J (PP5JR, op)	3,947,010
DL6FBL	2,912,760
V26M (N3AD, op)	2,696,493
EA7X	2,600,250
ZW5B (PY2KC, op)	2,444,400
OM2VL	1,783,449
9AØBB (9A3XV, op)	1,606,554
9A5Y (9A3LG, op)	1,595,715
LY4A	1,412,445

Single Operator Unlimited, Low Power

VP9I (K3SW, op)	1,629,360
S52NR	582,180
HK4GOO	491,526
9Z4Y	342,030
HIØLT (KC1XX, op)	338,082
PT7ZT	167,940
PR5K (PY5FO, op)	123,093
PY2ZR	100,320
PY2CX	94,122
PS8HF	83,520

Single Operator Unlimited, QRP

PY2XC	47,088
OK2FD	21,420
PV8AZ	9,576
DJ1XT	2,100
JK1TCV	2,040
MM3AWD	969
R7FO	882
YC2VOC	126
BA4TB	18

Single Operator, 160 Meters

I5JVA	23,760
SN7D (SQ7D, op)	11,253
LU8DPM	5,859
LY7Z	3,135
YO3APJ	3,021
RTØF	1,554
HC5DX	1,092
WL7N	264
SP3GTS	147

Single Operator, 80 Meters

XE2X	201,780
F6KHM (F4DXW, op)	159,384
EA5KA	153,120
MI5K (MIØSLE, op)	119,556
TI2CC	110,040
TM9R	106,947
II9P (IT9EQO, op)	99,468
I4AVG	92,196
HB9CXZ	90,552
HG1S (HA1TJ, op)	80,850

Single Operator, 40 Meters

CR6T (CT1ESV, op)	451,794
LX2ØI (F4HWS, op)	420,918
I4VEQ	381,006
S51YI	290,055
ED1R (EC1KR, op)	232,290
OM2KI	225,000
SN3A (SP3GEM, op)	220,590
YTØA (YT7WM, op)	218,340
EA5Z	215,238
CR6K (CT1CJJ, op)	208,449

Single Operator, 20 Meters

FY5FY	578,829
D4Z	555,768
PYØF (PT2IC, op)	360,006
S5ØR	332,568
PV2P	311,220
HA8JV	285,324
IR6T (IK6JNH, op)	282,162
YT1X	279,990
IR1G (IT9RGY, op)	270,474
S57AL	259,677

Single Operator, 15 Meters

FY5KE (F1HAR, op)	358,380
PX2A (PY2PT, op)	328,689
CV7S	307,449
KP4RV	225,888
LW7DX	182,526
PY5WW	134,577
LU1DK	117,978
PP5JN	96,030
PY2UD	90,630
LU9VD (LU9VEA, op)	68,952

Single Operator, 10 Meters

PY2TMV	5,859
CA4PSH	5,151
PU5FJR	4,914
PU2SDX	2,832
PU2WDX	2,736
PU2UAF	2,091
PU1JSV	1,248
PU5DUD	1,215
PU5BOY	552
PU5DEH	450

Multioperator, Single Transmitter, High Power

ZF1A	6,404,508
J68HZ	6,210,894
TOØA	5,360,952
H33K	4,144,608
KH7M	3,368,418
TO3Z	3,309,600
IR4M	2,970,768
IO5O	2,414,475
4A7S	2,316,762
J68SS	2,048,634

Multioperator, Single Transmitter, Low Power

VP5M	3,290,130
HCØT	1,917,480
HI3LT	1,794,288
C6ATF	1,215,081
C6ANM	642,270
LU2EE	134,805
V47P	125,334
PY1NX	63,756
EA2RCA	9,504
JK2VOC	7,584

Multioperator, Two Transmitter

PJ4G	8,094,204
HQ9X	6,030,822
M6T	2,228,373
EI9E	1,418,112
RW7K	1,303,848
HG7T	913,323
JH8YOH	439,200
C37N	236,940
IQ8UW	7,875

Multioperator, Multitransmitter

PJ2T	7,052,760
9A1A	3,611,376
HCØE	1,224,990
JA3YBK	849,537
LN8W	771,786
IU6HPN	630

Sponsored Plaque Winners

Thanks to the generous support of numerous clubs and individuals, we are pleased to list the winners of the sponsored International DX Phone Contest plaques below. For more information on plaque sponsorship or to order a duplicate plaque, contact ARRL Contest Branch Manager Paul Bourque, N1SFE, at 860-594-0232 or **contests@arrl.org**. Plaques cost $80, which includes all shipping charges.

Winner	Plaque Category	Plaque Sponsor
W5PR	W/VE 28 MHz Phone	Jeff Stuparits, W4DD
8P5A	North America Single Operator, High Power CW	Potomac Valley Radio Club
PY2UDB	World 28 MHz CW	Jeff Stupartis, W4DD
KH6LC (N6TJ, op)	Oceania Single Operator, High Power Phone	Albert Crespo, F5VHJ — In memory of Carl Cook, AI6V
KP2M (N2TK, op)	World Single Operator Unlimited, High Power Phone	Charles Dietz, W5PR
ZF1A	North America Multioperator, Single Transmitter, High Power Phone	Nick Lash, K9KLR
W9RE	Central Division Single Operator, High Power Phone	Society of Midwest Contesters
N4TZ	Central Division Single Operator, Low Power Phone	Society of Midwest Contesters
AA9A	Central Division Multioperator, Single Transmitter CW	Society of Midwest Contesters
T32AZ	Oceania 3.5 MHz Phone	Burton M. Parmeter, KG7MD, Memorial Award
N4TZ	Central Division Single Operator, Low Power CW	Society of Midwest Contesters
AA9A (N9UA, op)	Central Division Single Operator Unlimited, High Power Phone	Society of Midwest Contesters
W9XT	Central Division Single Operator Unlimited, Low Power Phone	Society of Midwest Contesters
WB9Z	Central Division Single Operator Unlimited, High Power CW	Society of Midwest Contesters
W9XT	Central Division Single Operator Unlimited, Low Power CW	Society of Midwest Contesters

Division Winners

Single Operator, High Power

Atlantic	K3ZO	1,592,748
Central	W9RE	2,249,208
Dakota	KØJJR	172,674
Delta	AC4G	412,764
Great Lakes	NA8V	1,277,760
Hudson	W2XL	318,636
Midwest	NØUU	28,140
New England	NR3X (N4YDU, op)	3,071,232
Northwestern	N9RV	1,366,854
Pacific	W6YX (N7MH, op)	1,012,206
Roanoke	KA8Q	301,140
Rocky Mountain	N2IC	920,580
Southeastern	K4AB	1,749,468
Southwestern	W6AFA	457,776
West Gulf	K5WA	896,448
Canada	VY2ZM	3,563,388

Single Operator, Low Power

Atlantic	KE3X	292,992
Central	N4TZ	660,630
Dakota	NGØC	129,480
Delta	K5KU	480,447
Great Lakes	N8GLS	264,735
Hudson	N2HMM	138,138
Midwest	NØYO	77,760
New England	N1DD	318,852
Northwestern	W7RM (K2PO, op)	317,628
Pacific	W6US	78,648
Roanoke	W6DVS	285,735
Rocky Mountain	WA2JQZ	23,562
Southeastern	WW4XX (LZ4AX, op)	174,084
Southwestern	NT6Q (N5ZO, op)	423,864
West Gulf	AD5A	452,160
Canada	VA1SEA	179,580

Single Operator, QRP

Delta	N5MZX	2,520
Hudson	WX2N	6,660
New England	K1MTD	4,935
Northwestern	N7JI	1,044
Roanoke	AG4ZL	8,232
Southeastern	K3TW	41,976
Southwestern	W6QU (W8QZA, op)	28,638
West Gulf	WE6EZ	79,968

Single Operator Unlimited, High Power

Atlantic	AA1K	2,647,890
Central	AA9A (N9UA, op)	1,523,520
Dakota	WAØMHJ	342,528
Delta	WV4P	621,432
Great Lakes	W8MJ	1,232,640
Hudson	KF2O	853,470
Midwest	KØVXU	324,198
New England	NC1I (K9PW, op)	2,400,930
Northwestern	K7RL	1,605,120
Pacific	K6RC	309,042
Roanoke	N4RV	1,137,150
Rocky Mountain	KØRF	1,477,074
Southeastern	K1MM	1,797,780
Southwestern	N6RV	565,110
West Gulf	K5TR	2,030,145
Canada	VE5MX	934,212

Single Operator Unlimited, Low Power

Atlantic	W3KB	401,622
Central	W9XT	375,708
Dakota	NØUR	160,776
Delta	KB5QR	7,020
Great Lakes	WB8WKQ	306,270
Hudson	NY6DX	593,460
Midwest	AAØAI	130,524
New England	NN1C	1,397,955
Northwestern	WZ8T	161,586
Pacific	KL7HQR/W6	38,982
Roanoke	WT8WV	129,360
Rocky Mountain	AD1C	94,470
Southeastern	WA1FCN	417,750
Southwestern	KF7DUR	45,978
West Gulf	N5DO	223,650
Canada	VA3DF	805,140

Single Operator Unlimited, QRP

Great Lakes	K8ZT	48,618
Midwest	NRØQ	243
Northwestern	K7SS	16,830
Pacific	K2GMY	6,480
West Gulf	KJ5T	330

Single Operator, 160 Meters

Atlantic	W2MF	10,920
Dakota	NØUY	75
Southeastern	AG4W	7,788
Southwestern	W8KA	330
Canada	VE3PN	5,760

Single Operator, 80 Meters

Atlantic	W3BGN	55,278
Central	W9JOE	13,833
Dakota	NØOK	23,364
New England	KA1IS	26,733
Northwestern	KK6ZM	35,460
Pacific	WD6T (@N6RO)	28,362
Roanoke	K8UR	47,064
Southeastern	K4RZR	810
West Gulf	K5KJ	19,440
Canada	VE9ML	16,686

Single Operator, 40 Meters

Atlantic	KT3RR	31,086
Central	K2UR	30,552
Great Lakes	WA8RCN	18,900
Hudson	W2AAB	24,960
Midwest	WDØBGZ	13,356
New England	KC1IMK	126
Northwestern	W7WA	250,290
Pacific	WA6SSO	420
Roanoke	KD4RH	25,668
Southeastern	NS4T	4,224
Southwestern	N7RK	4,050
West Gulf	KI5EBJ	3
Canada	VE4VJR	1,764

Single Operator, 20 Meters

Atlantic	AI3Q	50,850
Central	W9ILY	64,242
Dakota	KØBBB	70,227
Delta	KB8VND	7,182
Great Lakes	K8LX	155,682
Hudson	W2GFV	12,558
Midwest	WØEWD	249,705
New England	W2RE	866,520
Northwestern	KI7DG	9,450
Pacific	AA6AA	200,178
Roanoke	N4GVW	390
Rocky Mountain	WAØPFC	1,680
Southeastern	AB4B	154,755
Southwestern	N7TU (K2SS, op)	337,584
West Gulf	W1JCW	45,630
Canada	VE3DZ	504,561

Single Operator, 15 Meters

Atlantic	KX2S	5,880
Central	WB9HFK	2,016
Delta	AJ6T	6,231
Great Lakes	N8PPF	714
Hudson	WB2AMU	8,280
Midwest	ADØH	2,706
New England	W1CEK	3
Pacific	N6WM	14,040
Roanoke	AD4L	4,263
Rocky Mountain	NCØB	10,605
Southeastern	K1KNQ	14,715
Southwestern	N6RM	882
West Gulf	K5RX	28,302
Canada	VE2NCG	396

Single Operator, 10 Meters

Southeastern	W4DD	864
West Gulf	W5PR	1,404

Multioperator, Single Transmitter, High Power

Atlantic	K3ND	1,412,403
Central	NV9L	2,309,568
Dakota	NRØT	87,543
Great Lakes	W8PR	954,018
Hudson	WU2X	258,063
New England	K2LE	1,410,870
Northwestern	W7VO	222,264
Pacific	NW6P	595,392
Southeastern	K2DM	537,768
Southwestern	N7NR	964,275
Canada	VA2UR	402,570

Multioperator, Single Transmitter, Low Power

Atlantic	K2AA	40,290
Central	K9IU	48,654
Dakota	NDØC	8,832
Great Lakes	N8YXR	227,520
Hudson	NJ1F	23,814
New England	N1SOH	361,440
Northwestern	W7JCR	36
Southeastern	KJ3T	182,214
Southwestern	WA6SUN	168
West Gulf	AB5J	65,238
Canada	VD1TP	237,300

Multioperator, Two Transmitter

Atlantic	K2AX	1,545,372
Delta	W5WZ	1,360,176
Great Lakes	K8AZ	1,989,504
Hudson	W2CG	1,541,904
Midwest	NØMA	97,497
New England	N1MM	2,508,768
Northwestern	KT7E	1,034,343
Pacific	W6WB	145,089
Southeastern	K4VQ	277,887
West Gulf	N5AA	109,926
Canada	VE6FI	643,914

Multioperator, Multitransmitter

Atlantic	K3LR	7,332,930
New England	K1TTT	3,478,596
Rocky Mountain	K5LRW	46,866

Continental Winners

Africa

Single Operator, High Power	EA8RM	1,762,344
Single Operator, Low Power	EA8AUW	203,610
Single Operator Unlimited, High Power	ED8M (EA8DIG, op)	195,552
Single Operator Unlimited, Low Power	EF8O (EA8OM, op)	6,660
Single Operator, 20 Meters	D4Z	555,768
Single Operator, 15 Meters	EA8DED	46,569

Asia

Single Operator, High Power	JA2AXB	132,933
Single Operator, Low Power	JH1EAQ	103,095
Single Operator, QRP	JH7UJU	11,592
Single Operator Unlimited, High Power	JA0FVU	55,980
Single Operator Unlimited, Low Power	JA6WFM	21,450
Single Operator Unlimited, QRP	JK1TCV	2,040
Single Operator, 160 Meters	RT0F	1,554
Single Operator, 80 Meters	JA0JHA	50,544
Single Operator, 40 Meters	RA9V	3,780
Single Operator, 20 Meters	JA7NVF	122,472
Multioperator, Single Transmitter, High Power	JH4UYB	701,244
Multioperator, Single Transmitter, Low Power	JK2VOC	7,584
Multioperator, Two Transmitter	JH8YOH	439,200
Multioperator, Multitransmitter	JA3YBK	849,537

Europe

Single Operator, High Power	IR2Q (IK2PFL, op)	1,688,460
Single Operator, Low Power	IW1FRU	431,748
Single Operator, QRP	LZ9W (LZ1UQ, op)	117,549
Single Operator Unlimited, High Power	DL6FBL	2,912,760
Single Operator Unlimited, Low Power	S52NR	582,180
Single Operator Unlimited, QRP	OK2FD	21,420
Single Operator, 160 Meters	I5JVA	23,760
Single Operator, 80 Meters	F6KHM (F4DXW, op)	159,384
Single Operator, 40 Meters	CR6T (CT1ESV, op)	451,794
Single Operator, 20 Meters	S50R	332,568
Single Operator, 15 Meters	EC5K	38,760
Multioperator, Single Transmitter, High Power	IR4M	2,970,768
Multioperator, Single Transmitter, Low Power	EA2RCA	9,504
Multioperator, Two Transmitter	M6T	2,228,373
Multioperator, Multitransmitter	9A1A	3,611,376

North America

Single Operator, High Power	TI7W (N6MJ, op)	7,611,516
Single Operator, Low Power	VP2MMF (K1XX, op)	3,342,993
Single Operator Unlimited, High Power	KP2M (N2TK, op)	4,222,245
Single Operator Unlimited, Low Power	VP9I (K3SW, op)	1,629,360
Single Operator, 160 Meters	WL7N	264
Single Operator, 80 Meters	XE2X	201,780
Single Operator, 40 Meters	CM2XN	160,911
Single Operator, 20 Meters	WP4SD	145,962
Single Operator, 15 Meters	KP4RV	225,888
Multioperator, Single Transmitter, High Power	ZF1A	6,404,508
Multioperator, Single Transmitter, Low Power	VP5M	3,290,130
Multioperator, Two Transmitter	HQ9X	6,030,822

Oceania

Single Operator, High Power	KH6LC (N6TJ, op)	2,781,360
Single Operator, Low Power	KH6CJJ	942,033
Single Operator, QRP	VK4FOMP	960
Single Operator Unlimited, High Power	VK4QH	144,336
Single Operator Unlimited, Low Power	YE8XBN	3,120
Single Operator Unlimited, QRP	YC2VOC	126
Single Operator, 80 Meters	T32AZ	19,656
Single Operator, 40 Meters	VK3GK	69,795
Single Operator, 20 Meters	DX7EVM (DU7OK, op)	4,347
Multioperator, Single Transmitter, High Power	KH7M	3,368,418
Multioperator, Single Transmitter, Low Power	DX4EVM	1,440

South America

Single Operator, High Power	CE3CT	759,015
Single Operator, Low Power	P40A (KK9A, op)	4,035,720
Single Operator, QRP	PY2BN	540
Single Operator Unlimited, High Power	PT5J (PP5JR, op)	3,947,010
Single Operator Unlimited, Low Power	HK4GOO	491,526
Single Operator Unlimited, QRP	PY2XC	47,088
Single Operator, 160 Meters	LU8DPM	5,859
Single Operator, 80 Meters	PX2B (PY2LED, op)	58,320
Single Operator, 40 Meters	LU5FC	161,820
Single Operator, 20 Meters	FY5FY	578,829
Single Operator, 15 Meters	FY5KE (F1HAR, op)	358,380
Single Operator, 10 Meters	PY2TMV	5,859
Multioperator, Single Transmitter, High Power	OA4O	1,222,404
Multioperator, Single Transmitter, Low Power	HC0T	1,917,480
Multioperator, Two Transmitter	PJ4G	8,094,204
Multioperator, Multitransmitter	PJ2T	7,052,760

All ARRL members can now enjoy the digital edition of *QEX* as a member benefit. Coming up in the September/October 2020 and future *QEX* issues are articles and technical notes on a range of amateur radio topics. These are at the top of the queue.

- André Champel, F5SQ, alerts us in his Technical Note of a fire hazard in using window transmission line.
- Gwyn Griffiths, G3ZIL; Rob Robinett, AI6VN, and Glenn Elmore, N6GN, estimate LF and HF band noise while acquiring WSPR spots.
- Carl Luetzelschwab, K9LA, comments in a Technical Note on extending the matching range of an 80-meter antenna.
- Eric Nichols, KL7AJ, in the second installment of his Essay Series, discusses setting up a home electrical engineering lab.
- John Post, KA5GSQ, generates and receives single-sideband signals using GNU radio companion.
- Grant Saviers, KZ1W, and Rob Fanfant, N7QT, report on their H40TT "suitcase" DXpedition to Pigeon Island, Temotu Province.

QEX, a forum for the free exchange of ideas among communications experimenters, is edited by Kazimierz "Kai" Siwiak, KE4PT, (**ksiwiak@arrl.org**) and is published bimonthly. All ARRL members can enjoy the digital edition as a member benefit. The *printed edition* annual subscription rate (six issues per year) for members and non-members in the United States is $29. First-class delivery in the US is available at an annual rate of $40. For international subscribers, including those in Canada and Mexico, *QEX* can be delivered by airmail for $35 annually, see **www.arrl.org/qex**.

Would you like to write for *QEX*? We pay $50 per published page for full articles and *QEX* Technical Notes. Get more information and an Author Guide at **www.arrl.org/qex-author-guide**. If you prefer postal mail, send a business-size self-addressed, stamped (US postage) envelope to: *QEX* Author Guide, c/o Maty Weinberg, ARRL, 225 Main St., Newington, CT 06111.

The 2020 Collegiate QSO Party

0000 UTC Saturday, September 19 – 2359 UTC Sunday, September 20

The Collegiate QSO Party returns for its third year! This event has become a mainstay of the ARRL Collegiate Amateur Radio Initiative (CARI), and celebrates students, faculty, staff, and alumni of college- and university-based amateur radio clubs around the world.

Any licensed amateur is encouraged to participate in the event to contact schools and individuals. Points are awarded for number of contacts, with multipliers for working alumni from your school and contacting collegiate clubs around the world. Bonus points are even awarded for contacting your alma mater's club!

The event also seeks to provide positive community engagement for the start of the academic year. College and university clubs can earn bonuses for engaging administration, operating on campus, and promoting the event with social media.

Awards cover the event's five operating classes, ranging from individuals and non-collegiate clubs to faculty and alumni. The exchange is simple: call sign, school identifier, RST, and operating class.

Support collegiate clubs on social media during the event with **#collegiateQSOparty**. If you are interested in getting involved in the ARRL Collegiate Amateur Radio Initiative, check out **www.arrl.org/wewantu**.

Complete rules, suggested bands, sample QSO script, and log submission information can be found at **http://collegiateqsoparty.com**. For any questions, please email **andy@gatorradio.org** or **tony@kd8rtt.com**.

Congratulations

June 2020
QST Cover Plaque Award Winner

Mike Bryce
WB8VGE

Mike's article, "Battery Sizing for Portable Operation," offered valuable information, not only for ARRL Field Day, but for portable operating in general. Thanks to Mike's advice, readers will be able to avoid unpleasant surprises!

QST Cover Plaque Awards are given to the author or authors of the most popular article in each issue. *You* choose the winners by casting your vote online at

www.arrl.org/cover-plaque-poll

Log in now and pick your favorite article in this issue!

Battery Sizing for Portable Operation

How to choose the right battery capacity for portable and ARRL Field Day operating.

Mike Bryce, WB8VGE

Portable HF operation is on fire right now. It seems like everyone is putting signals out from parks, lighthouses, and just about every hilltop or mountaintop in between. The lead photo shows my portable HF station set up along the Ohio Erie Canal. I carried this HF station via bicycle for a mile or so. A 7.5 Ah battery powers my Icom IC-703. Power is the fundamental requirement for all communications, and when you're operating portable, you need to bring your own. How much power you need depends on many factors.

Sizing by the Numbers

Determining how much battery capacity you need is a simple math problem. Let's use the popular Icom IC-7300 transceiver as an example. According to its specification sheet, the 7300 draws 0.9 to 1.25 A on receive. Let's call this 1 A for our normal listening volume. Transmit current could be as high as 21 A. That's our baseline.

How long you plan to operate, the duty factor and duty cycle of your transmitter, and the mode you'll be operating are all important information. You need all these factors to produce an accurate battery sizing profile. Of course, your mileage will vary.

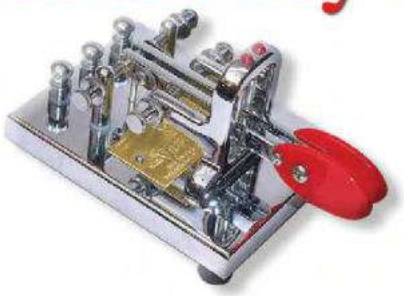
Operation while just chatting (or "ragchewing") is normally a 50% duty cycle — half the time you're listening and the other half you're transmitting. Contest operation can drastically change the transmit-receive duty cycle.

30 June 2020 *QST* www.arrl.org

Certificate of Code Proficiency

Recipients

Sponsored by VIBROPLEX
www.vibroplex.com



This month, ARRL and Vibroplex recognize 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.

March 2020

Joseph S. Kennedy, WQ6Q	10

May 2020

Kirk S. Goddard, AG7YM	10
James Joseph Goudy, NØJG	10
Randy E. Prescher, AC9WR	10
William A. Riches, WA2DVU	10
Gregory S. Weiler, K3MGQ	10
Benjamin M. Cahill, III, AC2YD	15
Benjamin M. Cahill, III, AC2YD	20
Richard E. DuBroff, W9XW	20
Ralph L. Irons, N4RLI	25
William J. Wrbican, K3QP	30
Philippe Givet, F5IYJ	35
Jay P. Jenkins, WE2KEY	35

June 2020

Michael P. Essi, K8WZY	10
Richard J. Gibilisco, NEØJ	10
Kenneth A. Knox, KD2KEH	10
Mark A. Rollings, N5JJC	10
Byron L. Smith, W9ELM	10
Gary G. Swenson, KA2HAN	10
Christopher H. Tenev, K2QFA	10
Richard W. Candelent, KE1RC	15
John M. Carlson, KØHD	15
Maynard L. Denny, K4WMT	15
Steven K. Jenkins, W4MGT	15
Colin K. Phoon, AE3A	15
Maynard L. Denny, K4WMT	20
Ronald J. Hollas, K8RJH	20
Steven K. Jenkins, W4MGT	20
Garth R. Kennedy, W9KJ	20
Juan P. Munoz, KC2FKM	20
Robin L. Zinsmaster, N6PHP	20
Leland R. Bond, N7KC	25
Ronald J. Hollas, K8RJH	25
Murray A. Scott, KE8UM	25
Jay P. Jenkins, WE2KEY	40

July 2020

Garth R. Kennedy, W9KJ	25

Congratulations to all the recipients.

September 2020 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.

September 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 will be transmitted by K6KPH on Saturday, September 26 at 2 PM PDT (2100 UTC) on 3581.5, 7047.5, 14047.5, 18097.5 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.

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 — September 2020
(All times in Eastern Daylight Time)

Monday	Tuesday	Wednesday	Thursday	Friday
	9/1 7 PM – 2300Z 35 – 10 WPM		**9/3** 10 PM – 0200Z **(9/4 – UTC)** 10 – 40 WPM	**9/4** 9 AM – 1300Z 10 – 35 WPM
Labor Day	**9/8** 4 PM – 2000Z 10 – 35 WPM	**9/9** 7 PM – 2300Z 10 – 40 WPM	**9/10** 9 AM – 1300Z 35 – 10 WPM	**9/11** 10 PM – 0200Z **(9/12 – UTC)** 10 – 35 WPM
	9/15 9 AM – 1300Z 10 – 35 WPM	**9/16** 10 PM – 0200Z **(9/17 – UTC)** 35 – 10 WPM	**9/17** 7 PM – 2300Z 10 – 35 WPM	**9/18** 4 PM – 2000Z 10 – 40 WPM
9/21 10 PM – 0200Z **(9/22 – UTC)** 10 – 40 WPM		**9/23** 9 AM – 1300Z 35 – 10 WPM	**9/24** 4 PM – 2000Z 35 – 10 WPM	**9/25** 7 PM – 2300Z 10 – 35 WPM

Bernie McClenny, W3UR, w3ur@arrl.org

How's DX?

A Tribute to a DX Contact

Due to the current travel restrictions caused by the pandemic, DXpeditions are on hold. Many of us are spending lots of time at home, and getting on the air allows us to connect with people in far-off places and maintain a relationship with the outside world. I'm always grateful to ham radio for helping me reach people around the globe, but especially now, when travel isn't an option. There's something special about being able to get on the radio and have a conversation with someone in another country, who I'd never meet otherwise. I'd like to take a moment to look back at my first DX contact, and consider the people we connect with behind the radios.

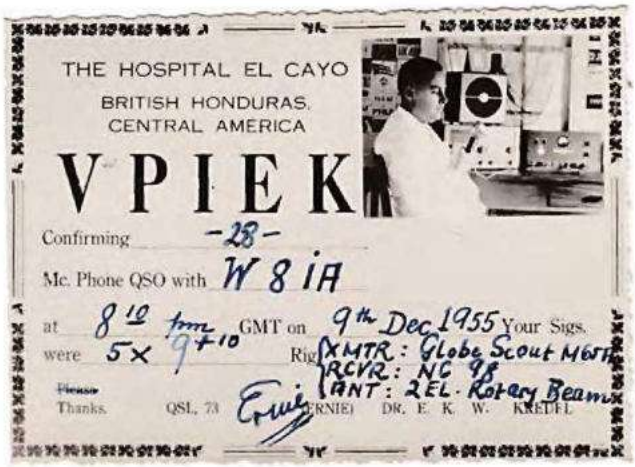


Figure 1 — A QSL card from VP1EK. [Ernie Kredel, KZ5EK, photo]

My First DX Contact

Several weeks after my first ham radio contact — at the age of 13 in 1977 — I found myself working Dr. Ernst Kredel, KZ5EK, in Balboa, Canal Zone, Panama. It was on 15 meters on December 10, 1977. Ernie was on SSB in the 15-meter band. In those days, US Novice stations could only transmit on CW on 80, 40, 15, and 10 meters. He was talking with another station, so I waited until he was done and then called him on CW. Ernie came back to me, giving a signal report. After finishing the contact, I immediately looked him up in the callbook and mailed him a QSL card. Ernie sent a card back with a note "vy psed to be ur First DX And to confirm vy fb mixed mode QSO."

Born on May 16, 1922, Ernie K. W. Kredel lived in Julich, near the triangle border of Belgium, the Netherlands, and Germany. Before World War II, he was enrolled at the University of Freiburg, studying medicine. He was called into the military in the medical field, continuing his education until the end of the war. One of his locations was the occupied island of Guernsey, where he met his English wife. He later graduated and worked for several years in England.

During the 1950s, Ernie was working in El Cayo, British Honduras (now Belize), where he made friends with a missionary who was an amateur radio operator. Ernie became interested in amateur radio and was licensed as VP1EK (see Figure 1). His station was very simple. He used a dipole and was active on 20-meter CW and SSB. He was happy to be able to use his new hobby to talk to stations in Germany, near his childhood home.

Ultimately, Ernie wanted to go to the US, but his medical credentials were not adequate, so he needed to take a post-graduate course and pass an exam. After that, he worked for the Panama Canal administration as a medical officer. At that time, the Canal Zone was a US territory and had separate DXCC status. While there, Ernie was licensed as KZ5EK and was able to set up a decent station with a beam, allowing him to work stations all around the world (including me). On October 1, 1979, the Canal Zone no longer existed as part of the Torrijos-Carter Treaties and was deleted off of the DXCC current list of countries. This meant that my first non-US country worked was also my first to be deleted.

Ernie eventually moved to North Carolina and then on to Mount Dora, Florida, where he was once again able to put up a beam and talk to amateur radio operators in and around where he grew up. Around 2014, Ernie moved back to his country of origin, living in Hamburg. I was saddened to find out that Ernie passed away on February 13, 2017. He was 94.

COVID-19 Disruptions

As mentioned in last month's column, DXpeditions, IOTA activations, and contest travel plans continue to be affected by the coronavirus. With that in mind, I'm not going to be giving as many details about upcoming operations, but rather just brief mentions. It may be best for the foreseeable future to keep your eyes on your favorite daily or weekly DX outlets, as they will have a better amount of time to react to the changing world we now see ourselves in.

Upcoming DX Operations

Mike, W1SRR, is being deployed to Guantanamo Bay as of mid-June. On his way there, at his first intermediate stop, he had to go into restrictions on movement (ROM), and quarantine for 2 weeks. He was hopeful to be on the island by mid-July, with plans to stay in GTMO for "a minimum of 9 months." Once there, he'll be spending free time exercising, doing water sports, and enjoying ham radio as KG4MA. He also expects to get his VEC to help some other service members earn their ham licenses. Listen for Mike on SSB and the digital modes, with some work to be done on CW. Mike is well aware of the need for KG4 on 6 meters (for more info, check his QRZ page at **www.qrz.com/db/kg4ma**).

John, W5JON, had to postpone his June trip to his vacation home in Calypso Bay, St. Kitts. He's now scheduled to be back at V47JA from August 22 to September 5. John has a 6-meter beacon on the mountain, signing V47JA/B on 50.053 MHz.

Hans-Martin, DK2HM, is hoping to spend a holiday-style operation from Easter Island, as XR0YHM, from August 27 to September 7. Some will remember his March 2019 operation from Rarotonga Island as E51HMK. Once in Pascua, he'll be active on SSB and digital modes on 80 through 10 meters (see his QRZ page for updates, at **www.qrz.com/db/xr0yhm**).

A Polish DXpedition team, including SP3CYY, SP3GEM, SP6EQZ, SP6IXF, SP9FOW, and SP9RCL, are hoping to be on Easter Island operating with special call XRØYSP from September 15 – 30. Check **www.qrz.com/db/xr0ysp** for the latest updates.

DXCC Conventions

The W8DXCC that was scheduled for August 29, running in conjunction with the Milford Amateur Radio Hamfest in Owensville, Ohio, has been canceled.

W9DXCC — held in the Chicago, Illinois, area every September — has been canceled this year (see **www.w9dxcc.com** for more info). W4DXCC in Pigeon Forge, Tennessee has also been canceled.

Skipping ahead to April 2021, the International DX Convention, which in recent years has been held in Visalia, California, is going virtual. Part one will take place April 16 – 18 and part two April 23 – 25. Details can be found at **www.dxconvention.com**. Before the Virtual International DX Convention, Jim, N6TJ, and Dick, N6AA, noted the important social aspect of the annual gathering and have put one together for the month prior to the online event. This event is scheduled for March 19 – 21, 2021. For more details, contact Jim at **n6tj@sbcglobal.net**.

Wrap-Up

That's all for this month. A special thanks to AJ8B, DK2HM, N6TJ, W1SRR (KG4MA), and W5JON (V47JA) for helping to make this month's column possible. If you have any DX or IOTA news, or photos or club newsletters, please send them to **bernie@dailydx.com**. Until next month, see you in the pileups! — *Bernie, W3UR*

Jon Jones, NØJK, n0jk@arrl.org

The World Above 50 MHz

The FT8 One-and-Done Phenomenon

It's common to see only one or two FT8 decodes from both DX and stateside stations, followed by no further reception. A few explanations of this could be a fixed E_s cloud bubbling above (and then below) the MUF, or a moving cloud. The "one-and-done" phenomenon is where you see one or perhaps two decodes from a station, and then they are gone. Many operators have noted this, and it appears on DX Cluster spots as well. So many operators wonder what is involved.

Walt, AJ6T, mentions E_s clouds right at the MUF. Other possibilities include E_s cloud movement. A small cloud moves across the path from you to a distant station at a 90-degree angle. It is briefly in position to support propagation, then continues drifting and then no propagation. Meteor scatter is another consideration. A meteor burns up in the right place to raise the MUF above 50 MHz. Once the ionization decays, the MUF drops.

This effect can be observed during a major meteor shower, such as the Geminids or Perseids. Stations pop in for a decode or two, then they are gone. MSK144 is able to utilize meteor bursts more efficiently for communication, as is SSB. FT8 sequences are 15 seconds each, with a repeat starting 30 seconds after the start of the first. Thus, MSK144 or SSB can take advantage of one-and-done propagation — sometimes to successfully complete a contact. FT4 may also be useful, due to the shorter sequences. Joe Taylor, K1JT, reported on the *WSJT-X* Development Group reflector that on June 7, he made 39 DX contacts using the FT4 mode on 50.318 MHz in just 44 minutes.

On the Bands

50 MHz. Adrian, VE7NZ, mentioned he worked Europe on May 31. June started off with a bang. Lee, KX4TT (EL87), worked several European stations, including UR0MC on June 1. K6QXY worked ON4GG, F1IXQ, and G8BCG around 1528Z. Congratulations to W6TOD (DM15), who logged PA4VHF for his 100th DXCC entity on June 1. On June 3, Lloyd, K2KJ/1 (FN55), worked into W4. There was a big opening from Japan to W4 on the evening of June 3. From Utah, K7ULS/P (DN41) worked YS1AG and Japan. AA0MZ (EM29) logged a contact with KO6FE in rare grid CN71. On June 4, K7ULS added HC5VF, and on June 5, he logged 9H1TX and other European stations.

Rich, K1HTV (FM18), found a good European opening on June 7. The next day, Rich logged OD5KU for his 163rd 6-meter DXCC entity. Rich noted that, by end of day on June 8, he'd made contacts with 51 DX stations in 21 countries. Mario, K2ZD, logged TA1BM on June 8. On June 9, Bob, K2DRH (EN41), put Nicholas, TT8SN, in the log.

On June 9, Mario worked TT8SN for his 213th DXCC entity. K1HTV heard KH6CJJ on Maui. I, NØJK, caught one decode of KH6CJJ sending "73" to AD6D at 2337Z. Rich worked NH6Y (BL10). John, KF0M (EM17), worked KH6U for his 49th state on 6 meters during this opening. From Maui, Kent, KH6CJJ, says he runs 175 W to a four-element Yagi up 35 feet and made 65 stateside contacts that day.

On June 11, WA2GFN worked VE2CSI (FO60) on SSB. Dave, NM5Z, made a 6-meter contact with KH6U in Hawaii on June 12, at 2039Z. Jay, N1AV (DM43), also worked Hawaii, adding BA4SAI, HL3GOB, and HL2DAA on June 12. From northern California, Fred, K6IJ, worked KH6, W4, XE, PV8, and HK on June 12. During the ARRL June

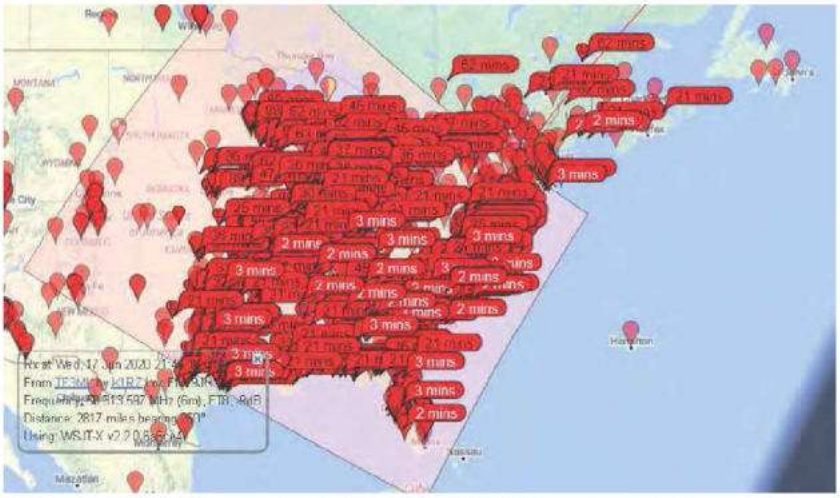


Figure 1 — The PSK report for FT8 reception of TF3ML on June 17, 2020, on 50 MHz. Stations are seen across the entire eastern half of North America.

VHF Contest, KFØM worked several stations in Japan. K1HTV worked 17 DXCC countries during the contest, including SØWS in southern Sudan.

On June 16, K1TOL, WW1L, and N2QT (FM07) worked several stations in Kazakhstan. From Wichita, Kansas, John, KFØM, made contacts with eight European stations. Lou, WØFK, in St. Louis (EM48), worked four new European countries. He noted that there are many operators home during the COVID-19 pandemic, who were able to take advantage of the great conditions, which he called "a ray of sunshine in an otherwise awful year."

TF3ML in Iceland had a big opening to the eastern half of North America on the afternoon of June 17 (see Figure 1). I even copied TF3ML on a mobile whip. John, KFØM (EM17), said TF3ML peaked to "+20" and worked him at 2133z. Meanwhile, Rich, K1HTV, found good conditions to Ecuador. Rich worked 5 HC stations between 2325 – 2330Z on FT8 using "TX2" to expedite the contacts.

On June 18, Trent, N4DTF (EM55), worked KØLU (DN86) on SSB. K7ULS worked LB9RE for a new country. Pat, K7LNP (DN30), worked G4AMT, F6HRP, and OH3SR (KP21). He used an Icom IC-7300 transceiver and an M2 three-element Yagi. On June 19, Frank, W3LPL, in Maryland worked 75 stations in Japan using FT8 from 2130 – 2340Z. W3ATV (FN20) managed to work JG1TSG, while using only 200 W to a 40-meter dipole. Jose, N4BAA, in Indiana worked Japan and HL3GOB with only 80 W. On June 20, KØBJ (DM99) received ZF1EJ on MSK144, possibly via sporadic E. K7ULS found P43A and more stations in Japan on June 21 and in Europe on June 22. K1AV logged KL7HBK for his 50th state on 6 meters on June 23. Hasan, NØAN (EN22), worked 14 stations in Japan on June 25. He uses a five-element LFA Yagi at 60 feet.

On the Sunday afternoon of ARRL Field Day, Bob, WBØNRV (EM17), said, "I called CQ once on FT8, and my screen turned red with stations calling from Japan." He worked 24 stations. Larry, NØLL, went on grid expedition to grid DN90, and he managed to work JF8QNF (QN02) in Japan and decoded JR6EZE and HL3GOB before it started hailing (see Figures 2 and 3).

144 MHz. On Friday, May 29, an extensive sporadic-E opening took place in Europe. D4VHF was heard by SP5XMU in Poland at a distance of 5,600 kilometers. D4VHF worked DL5MCG on FT8 at 1531Z. This opening may have been a combination of tropospheric propagation from Cape Verde with sporadic-E links. On June 10, K7ULS/P (DN41) worked K7EME (DM42) on tropo using JT65. On June 13, N1AV (DM43) worked W5CMP (EM12) on E_s with 90 W and an "18XXX" Yagi. On June 25, Sam, K5SW (EM25), worked K5HCS (EM20) on tropo.

▼ **Figure 2** — Larry, NØLL, used a five-element Yagi during his grid expedition. [Larry Lambert, NØLL, photo]

◀ **Figure 3** — Larry's, NØLL, grid expedition was interrupted with golf ball-sized hail. [Larry Lambert, NØLL, photo]

Here and There

Lance, W7GJ, reported, "Because of the ongoing COVID-19 pandemic, we regret that the W7GJ 6-meter EME DXpedition to FO/A and FO/M and the KB7Q 2-meter EME DXpedition to FO/M must be delayed until 2021." The approximate dates for the new DXpeditions: FO/A (6 meters only) on October 15 – 24, 2021; FO/M (TX7MB on 2 and 6 meters) on October 26 to November 4, 2021.

The August 2020 "World Above 50 MHz" column was missing a citation for the study conducted by the *WSJT-X* development team: S. Franke, K9AN; D. Hill, AA5AU; E. Muns, WØYK; I. Saje, S52D, and J. Taylor, K1JT, "Digital Contesting," *NCJ*, May/June 2020, p. 29.

Special Event Stations

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

Because of the COVID-19 pandemic, many organizations are canceling or rescheduling events. This is the information we had at the time we went to press. We suggest you contact the event organizer to confirm. — *Ed.*

Through Dec. 31, 0000Z – 2359Z, W5YD, Mississippi State, MS. W5YD Mississippi State University Amateur Radio Club. **W5YD Centennial Celebration**. 80, 40, 20, and 17 meters. QSL. Mississippi State University Amateur Radio Club, Dept. of Physics & Astronomy, P.O. Box 5167, Mississippi State, MS 39762-5167. **www.w5yd.org.msstate.edu**

Through Dec. 31, 0000Z – 2359Z, various calls, various cities, IA. Great River Amateur Radio Club. **Iowa State Parks On-the-Air Centennial Celebration**. All bands, all frequencies, as available. Certificate & QSL. IASPOTA-2020, c/o Great River Amateur Radio Club, P.O. Box 1384, Dubuque, IA 52004. *Members will operate with their own call signs from state parks throughout Iowa. Operating as time permits, mostly weekends. QSL for contact; certificate for five parks. See website for complete information.* **www.w0dbq.org/iaspota**

Aug. 12, 1500Z – 1900Z, WØOEL, Fayette, IA. Rural Iowa and Buchanan County Amateur Radio Clubs. **Iowa State Parks On-the-Air Centennial — Fort Atkinson**. 14.240 7.240. Certificate & QSL. Great River Amateur Radio Club, P.O. Box 1384, Dubuque, IA 52004. *QSL for contact; certificate for five parks. See website for complete information.* **www.w0dbq.org/rule** *or* **https://www.w0oel.com**

Aug. 12 – Aug. 24, 0000Z – 0000Z, W9I, Springfield, IL. Sangamon Valley Radio Club. **2020 Illinois State Fair**. 14.250 7.150. QSL. J. Mitch Hopper, K9ZXO, 536 E. Mill St., Rochester, IL 62563. **www.svrc.org**

Aug. 28 – Aug. 30, 2300Z – 2359Z, K5R, Mandeville, LA. KD5PCK. **15th Anniversary of Hurricanes Katrina and Rita**. 40, 20, and 17 meters, General portion. Certificate. Scott Hernandez, 957 Nancy St., Mandeville, LA 70448. *See website for operation and certificate information.* **www.qrz.com/db/k5r** *or* **https://www.facebook.com/groups/katrina5rita**

Aug. 29 – Sep. 7, 0000Z – 2359Z, W3B, Sharon, PA. Mercer County Amateur Radio Club. **Buhl Day, 105th Anniversary of Buhl Farm Park**. 145.350 14.240 7.185 DSTAR Reflector 63C. QSL. Mercer County Amateur Radio Club, P.O. Box 996, Sharon, PA 16146. *Operating at various times as conditions permit. We will also be providing communications for a half marathon. Check website for scheduled times of W3B operation.* **www.qrz.com/db/w3b** *or* **www.w3lif.org**

Aug. 29 – Sep. 7, 0900Z – 0900Z, W8S, Vermontville, MI. Rodney L. Harmon. **100th Vermontville TWP Fire and EMS Association Annual Dance**. 446.000 MHZ PL 74.4 Hz; 145.560 MHz; 147.080 MHz PL 103.5 Hz IRLP Node #4868. Certificate. Rodney L. Harmon, WK8H, 172 E. Second St., Vermontville, MI 49096-9455. *This event has been rescheduled from June 27, 2020 due to the COVID-19 pandemic.* **wk8h_michigan@att.net**

Sep. 2 – Sep. 17, 1800Z – 2359Z, W2V, Ansonia, CT. VOA Radio Club. **75th Anniversary of the Victory Over Japan Ending World War II**. 21.345 14.345 7.245 3.845. QSL. Dave Arruzza, 32 Benz St., Ansonia, CT 06401. **www.qrz.com/db/w2v** *or* **w2v.se@yahoo.com**

Sep. 5 – Sep. 7, 1800Z – 1800Z, K7RDG, Sierra Vista, AZ. Cochise Amateur Radio Association. **Return to Paradise**. 14.285 14.070 7.255 3.890. Certificate. Cochise ARA, P.O. Box 1855, Sierra Vista, AZ 85636-1855. *Operating from the ghost town of Paradise, AZ.* **www.k7rdg.org**

Sep. 5 – Sep. 8, 0030Z – 0100Z, W4NYR, Shelby, NC. Shelby Amateur Radio Club. **Shelby Hamfest At Home Edition**. 14.260 7.260 146.880/no tone 14.060. QSL. Shelby ARC Special Event, P.O. Box 2206, Shelby, NC 28151-2206. **www.shelbyarc.org**

Sep. 9 – Sep. 18, 0000Z – 2359Z, K4D, Carribelle, FL. K5TEN. **Dog Island IOTA DXpedition NA-085 K4D**. 14.275 14.074 7.190 7.074. QSL. Bruce Brady, K5TEN, 208 Mt. Tabor Rd., Hot Springs National Park, AR 71913. *Rare IOTA island, rare grid square, and rare county (NA-085), EL79, Franklin County. Rescheduled from June due to COVID-19.* **k5ten@aol.com**

Sep. 12, 1400Z – 2100Z, W4CA, Roanoke, VA. Roanoke Valley Amateur Radio Club. **Blue Ridge Bonanza**.14.245 7.245. QSL. Roanoke Valley ARC, P.O. Box 2002, Roanoke, VA 24009. **www.w4ca.com**

Sep. 12, 1600Z – 2300Z, NI6IW, San Diego, CA. USS *Midway* (CV-41) Museum Ship. **Commissioning of the USS *Midway* September 1945**. 14.320 7.250; 14.070 (PSK31); D-STAR on various reflectors. QSL. USS *Midway* Museum Ship (COMEDTRA), 910 N. Harbor Dr., San Diego, CA 92101.

Sep. 12 – Sep. 13, 1400Z – 2200Z, WBØSFT/KCØVYS, Overland Park, KS. William Becknell Santa Fe Trail Heritage Days. **4th Annual William Becknell Heritage Days Special Event — Founder of the Santa Fe Trail**. 21.365 14.265 7.265 3.865 1.830; SSB CW FT8. Certificate & QSL. *On the trail 1 × 1 calls, WØB through W9B, and Parks on the Air (K-4579) activation. See website for event details, and how to receive a certificate and/or QSL.* **www.wb0sft.org**

Sep. 12 – Sep. 20, 0000Z – 2359Z, W6JBT, San Bernardino, CA. Citrus Belt Amateur Radio Club. **21st Annual Route 66 On the Air**. 28.466 14.266 7.266 3.866. Certificate & QSL. Citrus Belt Amateur Radio Club, P.O. Box 3788, San Bernardino, CA 92413. *Using 1 × 1 W6-prefix special event call signs, 21 stations, two of them rovers, will operate in or around the major cities along Route 66 from Santa Monica, California to Chicago, Illinois. Radio amateurs driving on Route 66 may take part in the event by using the designation "mobile 66" or "/66" after their call signs. Each participating club will issue its own commemorative QSL card to celebrate this event. Certificates and other items are available. See website for rules and information.* **www.w6jbt.org**

Sep. 12 – Sep. 20, 0000Z – 2359Z, W6H, Rio Rancho, NM. Albuquerque DX Association. **Route 66 On the Air**. 14.266 14.033 7.266 7.033. Certificate & QSL. Bill Mader, 4701

Sombrerete Rd. SE, Rio Rancho, NM 87124. *See website for certificates, frequencies and other information.* **w6jbt.org**, **www.qrz.com/db/w6h** *or* **https://groups.io/g/adxa**

Sep. 12 – Sep. 20, 0000Z – 2359Z, W6L, Tulsa, OK. Tulsa Amateur Radio Club. **Route 66 On the Air**. 14.266. QSL. Tulsa Amateur Radio Club, P.O. Box 4283, Tulsa, OK 74159. *See website for certificates, frequencies and other information.* **w6jbt.org**. **www.w5ias.com**

Sep. 12 – Sep. 22, 0000Z – 2359Z, K4MIA, Loxahatchee, FL. PBSE. **National POW MIA Recognition Day**. 28.400 18.150 14.265 7.195; various digital modes. QSL. Michael Bald, 6758 Hall Blvd., Loxahatchee, FL 33470. *Sister stations K4MIA/5, K4MIA/7, and K4MIA/8 will be in operation on some days. See website for a copy of this year's QSL and additional information. Please take time to remember our POWs and MIAs as well as their families.* **www.qrz.com/db/k4mia**

Sep. 16 – Sep. 18, 0000Z – 0000Z, W8AL, Canton, OH. Canton Amateur Radio Club. **National Football League Centennial Celebration**. 14.300 14.030 7.250 7.030 3.950 3.530; watch for FT8 as well; BM DMR 313989. Certificate. Canton ARC W8AL, c/o Justin W8JKC, P.O. Box 8673, Canton, OH 44711-8673. **www.w8al.org**

Sep. 16 – Sep. 25, 0400Z – 2359Z, W3L, Harleysville, PA. WV2M. **The Saving of the Liberty Bell**. 14.074 14.030 7.074 7.030; modes are SSB, CW, and FT8 (primary mode is FT8). QSL. Frank Gallo, 106 Tweed Way, Harleysville, PA 19438. **www.w3l.info**

Sep. 19, 1100Z – 2300Z, W9ZL, Appleton, WI. Fox Cities Amateur Radio Club. **Wisconsin Parks on the Air**. 21.350 14.260 7.220 3.850. Certificate. Kenneth Ross, P.O. Box 2346, Appleton, WI 54912. **wipota.com** *or* **www.fcarc.club**

Sep. 19, 1300Z – 1900Z, W1M, Russell, MA. Western Mass Council BSA. **Woronoako Heights Outdoor Adventure/ Scout Camps on the Air**. 14.290 14.060 10.115 7.190. QSL. Tom Barker, 329 Faraway Rd., Whitefield, NH 03598. *Manual logging as well as eQSL will be used.*

Sep. 26, 1200Z – 2200Z, K1SV, North Bennington, VT. Southern Vermont Amateur Radio Club. **Covered Bridge Special Event**. 28.333 14.318 7.245 146.520. QSL. Charles Watson, Jr., 1071 East Rd., Bennington, VT 05201. **www.sovarc.org**

Sep. 26, 1200Z – 2300Z, KØA, Inver Grove Heights, MN. South Metro Amateur Radio Club. **US Airmail Beacon System, 100th Anniversary**. 14.250 7.074 7.040; CW, SSB, and FT8. Certificate. Downloadable, see website. **www.semarc.org**

Sep. 26, 1700Z – 2200Z, K4S, Somerset, KY. Lake Cumberland Amateur Radio Association. **Somernites Cruise 20th Season**. 14.268 7.238. QSL. Lake Cumberland Amateur Radio Association, 600 S. Highway 837, Nancy, KY 42544. **www.lcara.net**

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**. A plain-text version of the form is available at that site. You may also request a copy by mail or email. Off-line completed forms can be mailed, faxed (Attn: Special Events), or emailed.

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 **December** *QST* would have to be received by **October 1**. In addition to being listed in *QST*, your event will be listed on the ARRL Web Special Events page. Note: All received events are acknowledged. If you do not receive an acknowledgement within a few days, please contact us. ARRL reserves the right to exclude events of a commercial or political nature.

You can view all received Special Events at **www.arrl.org/special-event-stations**.

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

Because of the COVID-19 pandemic, many organizations are canceling or rescheduling events. This is the information we had at the time we went to press. We suggest you contact the event organizer to confirm. — *Ed.*

Alabama (Chickasaw) — Oct. 3 D H R S V
8 AM – 2 PM. *Spr:* Deep South ARC. J.C. Davis Auditorium, 400 Grand Ave. *TI:* 146.745. *Adm:* $5. **www.k4dsr.com**

Arizona (Tucson) — Sep. 26 D F H Q R T V
7 – 11 AM. *Spr:* Radio Society of Tucson, K7RST. Target Shopping Plaza North End Parking Lot, 9615 Old Spanish Trail. *TI:* 145.25 (156.7 Hz). *Adm:* Free. **www.k7rst.org/index.html**

California (Lincoln) — Sep. 19 D F H R V
7 AM – noon. *Spr:* Western Placer ARC. McBean Park, 65 McBean Park Dr. *TI:* 147.3 (67 Hz). *Adm:* Free.

California (Northridge) — Oct. 10 D H R S V
9 AM – 1 PM. *Spr:* So. CA Preparedness Foundation. Northridge Fashion Square NW Lot. *TI:* None. *Adm:* Free. **www.valleydisasterfair.com**

Georgia (Dalton) — Sep. 12 F T
Ends at noon. *Spr:* Dalton ARC. Prater's Mill, 5845 SR-2. *TI:* 145.230 (141.3 Hz) *Adm:* Free. **www.w4drc.com**

Iowa (Columbus Junction) — Oct. 4 D F H R S T V
7 AM – 2 PM. *Spr:* Muscatine ARC, Washington Area ARC. Louisa County Fairgrounds, 101 Fairground Rd. *TI:* 146.985 (192.8 Hz). *Adm:* $8. **www.muscatineARC.org/se-ia-hamfest**

Kansas (Wichita) — Oct. 3 D F H R S V
8 AM – 1 PM. *Spr:* Valley Center ARC. RiverWalk Church of Christ, 225 N. Waco Ave. *TI:* 146.94 (103.5 Hz). *Adm:* $5. **www.varc.org**

Kentucky (Shepherdsville) — Sep. 12 D F H Q R S T V
8 AM – 2 PM. *Spr:* Greater Louisville Hamfest Association, Inc. Paroquet Springs Conference Center, 395 Paroquet Springs Dr. *TI:* 146.7, 443.7 (79.7 Hz). *Adm:* Advance $6, door $8 (cash only). **www.louisvillehamfest.com**

Louisiana (Slidell) — Oct. 9 – 10 D F H R S V
Friday 2 – 5 PM, Saturday 8 AM – 2 PM. *Spr:* Ozone ARC. Slidell Auditorium, 2056 2nd St. *TI:* 147.27 (114.8 Hz). *Adm:* $5. **www.w5sla.net**

Michigan (Adrian) — Sep. 20 D F H R T V
8 AM. *Spr:* Adrian ARC. Lenawee County Airport, 2651 W. Cadmus Rd. *TI:* 145.37 (85.4 Hz). *Adm:* $5. **www.w8tqe.com**

Michigan (Wyoming) — Sep. 12 D F H Q R T V
8 AM – 1 PM. *Spr:* Grand Rapids ARA. HSB, Inc., 5625 Burlingame Ave. SW. *TI:* 147.26 (94.8 Hz). *Adm:* 6. **www.w8dc.org**

Minnesota (Carlton) — Sep. 26 D F H Q R V
9 AM – 1 PM. *Spr:* ARAC. Four Seasons Event Center, 90 Chestnut Ave. *TI:* 146.94 (103.5 Hz). *Adm:* $7. **www.thearac.org**

Minnesota (Cologne) — Sep. 19 D F H Q R S V
8 AM – noon. *Spr:* SMARTS Radio Club. Cologne Community Center, 1211 Village Pkwy. *TI:* 147.165. *Adm:* $10. **www.smartsfest.org**

Minnesota (Plymouth) — Sep. 29 R T
7 AM – noon. *Spr:* Twin City FM Club. West Medicine Lake Community Club, 1705 Forestview Ln. *TI:* 146.76 (114.8 Hz). *Adm:* Buyers $5, sellers $10. **www.tcfmc.org**

New Jersey (Tinton Falls) — Sep. 26 D F H Q R V
8 AM – noon. *Spr:* KJI Electronics. MOESC Parking Lot, 100 Tornillo Way. *TI:* 147.045 (67 Hz). *Adm:* $5. **www.gsara.club**

New Jersey (Township of Washington) — Oct. 10 D H Q R T V
8 AM – 1 PM. *Spr:* Bergen ARA. Westwood Regional Jr./Sr. High School, 701 Ridgewood Rd. *TI:* 146.79 (141.3 Hz). *Adm:* $5. **www.bara.org**

New York (Ballston Spa) — Sep. 27 D F H R S T V
7 AM – 2 PM. *Spr:* Saratoga County ARA. Saratoga County Fairgrounds, 162 Prospect St. *TI:* 147, 147.24 (91.5 Hz). *Adm:* $6. **www.k2dll.org**

New York (Lancaster) — Sep. 12 D F H R T
7:30 AM. *Spr:* Lancaster ARC. Bowen Road Grove, 3845 Bowen Rd. *TI:* 147.255 (107.2 Hz). *Adm:* $8. **www.w2so.org**

New York (Middletown) — Oct. 4 D F H Q R T V
8 AM – 12:30 PM. *Spr:* Orange County ARC. Town of Wallkill Community Center, 2 Wes Warren Dr. *TI:* 146.76 (100 Hz). *Adm:* $6. **www.ocarcny.org**

Ohio (Berea) — Sep. 27 D F H Q R S T V
8 AM – 1 PM. *Spr:* Hamfest Assn. of Cleveland. Cuyahoga County Fairgrounds, 164 Eastland Rd. *TI:* 145.41 (110.9 Hz). *Adm:* $6. **www.hac.org**

Ohio (Findlay) — Sep. 13 D F H R T
8 AM – 1 PM. *Spr:* Findlay RC. Hancock County Fairgrounds, 1017 E. Sandusky St. *TI:* 147.15 (88.5 Hz). *Adm:* $10. **www.findlayradioclub.org**

Ohio (Westminster) — Oct. 10 F H R T
8 AM – 1 PM. *Spr:* NW Ohio ARC. Westminster UMC, 6650 Faulkner Rd. *TI:* 146.67. *Adm:* $10, children under 12, with an adult, are free. **www.nwoarc.com**

Pennsylvania (Butler) — Sep. 13 F H R T V
8 AM – 3 PM. *Spr:* BCARA. Unionville Fire Dept., 102 Mahood Rd. *TI:* 147.36 (131.8 Hz). *Adm:* $5. **www.w3udx.org**

Pennsylvania (East Stroudsburg) — Sep. 20 D F H R T V
8 AM. *Spr:* Eastern PA ARA. American Legion Post 346, 126 E 5th St. *TI:* 147.045 (131.8 Hz). *Adm:* $7. **www.qsl.net/n3is**

Pennsylvania (Revloc) — Sep. 19 D F H Q R S T V
9 AM – 4 PM. *Spr:* Cambria RC, Revloc VFD. Revloc Volunteer Fire Co., 547 Cambria Ave. *TI:* 145.21 (123 Hz). *Adm:* Free. **www.cambriaradio.com**

SOUTHERN NEW JERSEY SECTION CONVENTION

September 13, Mantua, NJ

D F H Q R S T V

8 AM – 2 PM. *Sprs:* Gloucester County ARC. Gloucester County 4-H Fairgrounds, 462 Harrison Ave. *Tl:* 147.18 (131.8 Hz). *Adm:* $10.

South Carolina (Spartanburg) — Sep. 12 D F H R T V

8 AM – 3 PM. *Spr:* Blue Ridge Amateur Radio Society. Piedmont Interstate Fairground, 575 Fairgrounds Rd. *Tl:* 146.61. *Adm:* Advance $9 (see website), door $10. **www.brars.cc**

Tennessee (Sevierville) — Sep. 19 D F H R S T V

8 AM – 4 PM. *Spr:* Sevier County ARS, 470 ARG. Sevier County Fairgrounds, 754 Old Knoxville Hwy. *Tl:* 146.94. *Adm:* $5. **www.seviercountyars.com**

WASHINGTON STATE CONVENTION

September 26, Spokane Valley, WA

D H Q R S V

9 AM – 4 PM. *Sprs:* Inland Empire VHF Radio Amateurs, Kamiak Butte Amateur Repeater Assn., University High School ARC, Spokane DX Assn., Palouse Hills ARC. University High School, 12420 E. 32nd Ave. *Tl:* 147.38. *Adm:* $5.

Wisconsin (Milwaukee) — Sep. 25 – 26 D H R S V

Friday noon – 5:30 PM, Saturday 9 AM – 4 PM. *Spr:* Milwaukee Radio Amateurs' Club. Ham Radio Outlet Milwaukee, 5710 W. Good Hope Rd. Ham Radio Outlet Superfest. *Tl:* 145.13 (127.3 Hz). *Adm:* Free. **www.w9rh.org/club-events/superfest/superfest-2020**. Call ARRL's toll-free number at 1-800-243-7768, or email **ads@arrl.org**.

To All Event Sponsors

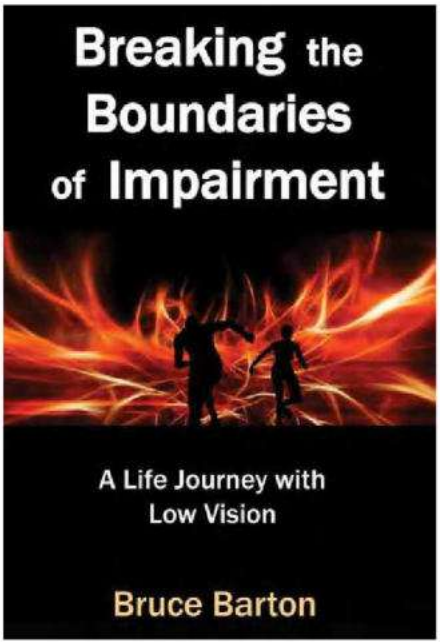
Before making a final decision on a date for your event, you are encouraged to check the Hamfest and Convention Database (**www.arrl.org/hamfests-and-conventions-calendar**) for events that may already be scheduled in your area on that date. You are also encouraged to register your event with HQ as far 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 **September 1** to be listed in the **November** 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



QST Congratulates...

Bruce Barton, KE6OEM, on the publication of his book, *Breaking the Boundaries of Impairment*. The book details his lifelong struggle with visual impairment and offers encouragement to others engaged in similar struggles. It is available on **Amazon.com**.

ARRL VEC Volunteer Examiner Honor Roll

The ARRL VEC Honor Roll recognizes the top five Volunteer Examiners in each ARRL Division according to the total number of ARRL exam sessions in which they have participated since their accreditations. Considering each session requires an average time commitment of 2 to 4 hours or more, the thousands of hours these VEs have invested represent extraordinary dedication! Whether you are one of our VE Teams that tests once a week, once a month, or once a year, we want to express our warmest appreciation to all volunteers for your generous contribution to the ARRL VEC program.

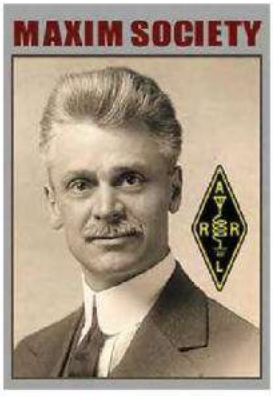
If you are an ARRL VE, you can view your session stats online at **www.arrl.org/ve-session-counts**.
If you are not a VE, become one today! See **www.arrl.org/become-an-arrl-ve**.

Examiner	*Sessions*	*Accreditation Date*
Atlantic		
Jobst Vandrey, AC0LP	324	23-Jun-08
James McCloskey, NS3K	320	14-Nov-94
Edward Genoino, WA2NDA	298	10-Jul-85
George Brechmann, N3HBT	280	01-Apr-91
William Klepser, Jr., WB2AIV	215	09-Jun-99
Central		
Ed Wagner, AB9FN	345	01-Jul-02
Allan Bukowski, N9ZD	316	01-Jun-92
Eldon Boehm, NK9U	316	21-Nov-86
Donald Hlinsky, N9IZU	302	01-Mar-91
Timothy Pechtold, AA9BV	277	01-Nov-92
Brian Eder, WB9UGX	273	01-Jan-92
Dakota		
John Schwarz, Jr., AE0AL	309	26-Oct-94
Jeffrey Goodnuff, W0KF	305	17-Jun-03
Shep Shepardson, N0NMZ	251	12-Mar-01
Daniel Royer, KE0OR	239	01-Jul-91
Dennis Ackerman, KB0OQQ	221	15-Jul-96
Delta		
Arthur Parry, Jr., WB4BGX	269	01-May-91
Joe Lowenthal, WA4OVO	248	25-May-06
Roger Gray, N5QS	230	01-Mar-93
Bobbie Williams, W1BEW	218	01-Jun-92
Dawn Gray, N5QT	213	01-Mar-93
Great Lakes		
Charles Hall, W8HF	286	01-Jun-92
Archie Mack, Sr., AF4EB	225	19-Aug-97
Dale Pritchett, KC8HJL	223	26-Mar-98
Christian Anderson, K8VJ	220	09-Feb-90
Stanley Arnett, II, AC8W	212	06-Sep-84

Examiner	*Sessions*	*Accreditation Date*
Hudson		
Paul Maytan, AC2T	665	06-Sep-84
Stanley Rothman, WA2NRV	458	01-Mar-85
E. Drew Moore, W2OU	445	01-Aug-90
Fritz Boigris, KB2O	422	26-Oct-84
Gerald Miller, Jr., AA2ZJ	400	05-Dec-95
Midwest		
David Bartholomew, AB0TO	720	22-Mar-02
Kevin Naumann, N0WDG	633	17-Nov-02
Harry Steger, Jr., W0HMS	557	26-Aug-08
Roland Kramer, W0RL	526	21-Jun-01
Jeanette Nordman, AB0YX	460	21-Aug-03
New England		
Bob Phinney, K5TEC	462	20-Jan-14
Robert Beaudet, W1YRC	386	01-Aug-90
Paul Lux, K1PL	351	25-Jan-85
Bruce Anderson, W1LUS	338	11-Feb-88
Lawrence Polowy, KU1L	338	02-Jan-85
Stefan Rodowicz, N1SR	335	20-Nov-84
James Mullen, KK1W	335	01-Mar-91
Northwestern		
Richard Morgan, KD7GIE	450	11-Aug-00
Loren Hole, KK7M	381	06-Sep-84
George Ftikas, N7TQZ	301	01-Dec-92
David Brooks, N7HT	297	10-Jun-87
S. Riley McLean, W7RIL	296	02-Sep-99
Pacific		
Morris Jones, AD6ZH	481	27-Nov-01
Dieter Stussy, KD6LVW	417	27-Jan-94
Gordon Fuller, WB6OVH	351	06-Sep-84
Bill Nichols, NN7K	333	01-Sep-93
Jim Brunk, N6BHX	284	13-Jul-95

Examiner	*Sessions*	*Accreditation Date*
Roanoke		
Judy Friel, AC4RG	286	01-Feb-91
Alan Ronald Moeck, WA2RPX	264	27-Sep-94
David Snyder, W4SAR	249	01-May-93
Sheila Frank, KT4YW	221	30-Oct-96
Terry Sanner, WV8V	216	06-Sep-84
Rocky Mountain		
Robert Hamilton, N0RN	384	19-May-87
David Avery, N0HEQ	301	13-Jan-88
Jeffrey Weinberg, W0QO	294	01-Apr-93
Donald Baune, AC0EX	259	19-Sep-06
David Sharpe, KI0HG	257	02-Feb-98
Southeastern		
Gary Lee Pike, KA4KBX	527	03-Sep-09
Victor Madera, KP4PQ	465	01-Mar-92
Val Jacyno, AK4MM	388	08-Nov-11
Pablo Soto, KP4SJ	374	01-May-92
Ryan Krenzischek, W4NTR	362	04-Jan-13
Southwestern		
Bill Martin, AI0D	1,056	01-Nov-84
Fred Bollinger, AB7JF	536	17-Apr-95
David Morrill, N7TWT	431	20-Jul-00
Bruce Ziemienski, WA6BZ	321	25-Mar-02
Richard Buck, KC7OCT	312	21-May-97
West Gulf		
Franz Laugermann, K3FL	1,044	01-Dec-91
Gerald Grant, WB5R	475	04-Jan-85
Adolph Chris Koehler, K5VCR	470	29-Sep-95
Wilbert Cannonier, KK5JJ	469	03-Nov-95
David Fanelli, KB5PGY	438	01-Oct-91

Feedback



In the July 2020 issue of *QST*, the list of Leadership Donors should have included Frank Kaleyias, KV5FD; Art Samuelson, W6VV; Thomas Williams, WA1MBA, and Dr. Michael Therrien, N1MD, as well as James A. Tiemstra, K6JAT, and Eliza T. Greene, KE6EHD. The list of Maxim Society Donors, President Class should have included Bernie Krasowski, KD5QHV, and Linda Krasowski, KE5BQK. *QST* regrets the omissions.

A Look Back


QST
November 1970
75 Cents
devoted entirely to
amateur
radio
OFFICIAL JOURNAL OF THE ARRL
ARRL

A 3-500Z Grounded-Grid Amplifier for 50 MHz

Simple High Power for Owners of Medium-Powered Exciters

BY THOMAS F. McMULLEN, JR.,* W1QVF, AND EDWARD P. TILTON,** W1HDQ

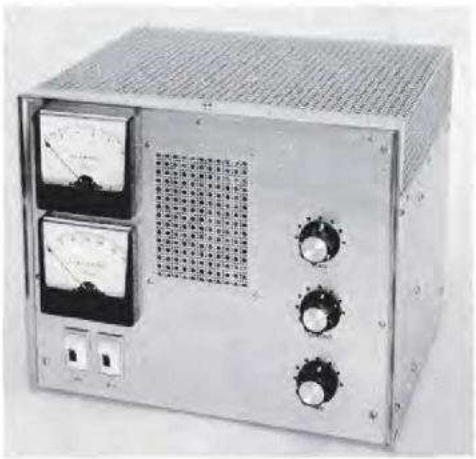
MOST KILOWATT amplifiers for vhf service described to date have been grounded-cathode types, requiring no more than a few watts exciter power.[1] Such amplifiers are still probably the best way of going to high power for the owner of a small exciter or transverter; but on 50 MHz, at least, the 100-watt ssb transceiver is becoming almost standard. Throwing away most of the output of such a rig, in order to avoid over-driving a kilowatt amplifier, is hardly the ideal approach. Conversion to the grounded-grid amplifier, which has already happened en masse on the hf bands, is now logical for many 50-MHz enthusiasts as well.

If your vhf experience goes back to the days of neutralized-triode amplifiers, you've probably had your moments of sighing for the simplicity and moderate cost of triode vhf rigs of those long-gone times. The triode amplifier described here may satisfy some of that nostalgia. It is hardly low-cost, but it *is* simple. Though it uses a fairly expensive tube and socket, it will probably get you into the high-power class about as inexpensively as any method available, except perhaps for the total junk-box-and-surplus route.

The Eimac 3-500Z triode was specifically designed for grounded-grid service. One of the more recent arrivals on the grounded-grid scene, it is a zero-bias tube with slightly higher dissipation capability than the older 3-400Z. Having a maximum frequency of 110 MHz for full ratings, it seems like a good choice for 50-MHz amplifiers. This design requires only a single simple power supply, no more than two meters, no plate-tuning capacitor at all, and no neutralization, so it is attractive from the standpoints of cost and complexity, compared with any good alternative. The amplifier is capable of 600 watts cw output, at about 30 watts driving power. As a Class-B linear, single-tone conditions, its rated maximum PEP output is 750 watts.

*RFD Collinsville, CT 06022.
**VHF Editor, *QST*.

[1] "Kilowatt Amplifiers for 50 and 144 Mc.," February, 1964, *QST*; *Radio Amateur's Handbook*, 1966 — 1970; *Radio Amateur's VHF Manual*, all editions.



The 50-MHz grounded-grid amplifier is a tabletop design only 10 by 12 inches in size. Grid and plate current are monitored continuously. Knobs at the right control input tuning, bottom, amplifier loading, center, and plate tuning, top. Illuminated switches, lower left, are in the filament and high-voltage primary circuits. Stainless steel molding, intended for counter-top use, covers the joints between the panel and other case surfaces.

Circuitry

This amplifier uses a single-ended adaptation of what K2AYM termed "breadslicerless tuning," when he used it in a push-pull amplifier for 50 MHz a few years back.[2] Mechanical, electrical and parts-procurement problems encountered frequently with conventional tuning methods in high-powered vhf amplifiers are eliminated with this shorted-turn inductive-tuning system. There are no multiple ground paths, such as may be unavoidable in capacitor frames, and no troubles with arcing lead screws, which often develop after periods of use with rotating-disk capacitors. Only the output capacitance of the 3-500Z, and the small stray circuit capacitance, appear across the plate tank. The result is a nice large and efficient inductor; larger than the plate circuits of conventional hf amplifiers that may have a hard time reaching the 10-meter band, let alone 6.

Plate voltage is shunt fed to the tube, to remove the possibility of high voltage appearing on the coupling loop or the antenna line. The output circuit is series-tuned, its variable capacitor serving as a loading adjustment, once the loop position is set approximately to the optimum position.

Driving power is applied to the filament circuit in a grounded-grid amplifier, so the tube filament

[2] Jones, "Six-Meter Kilowatt with 4-400As," *QST*, March, 1967.

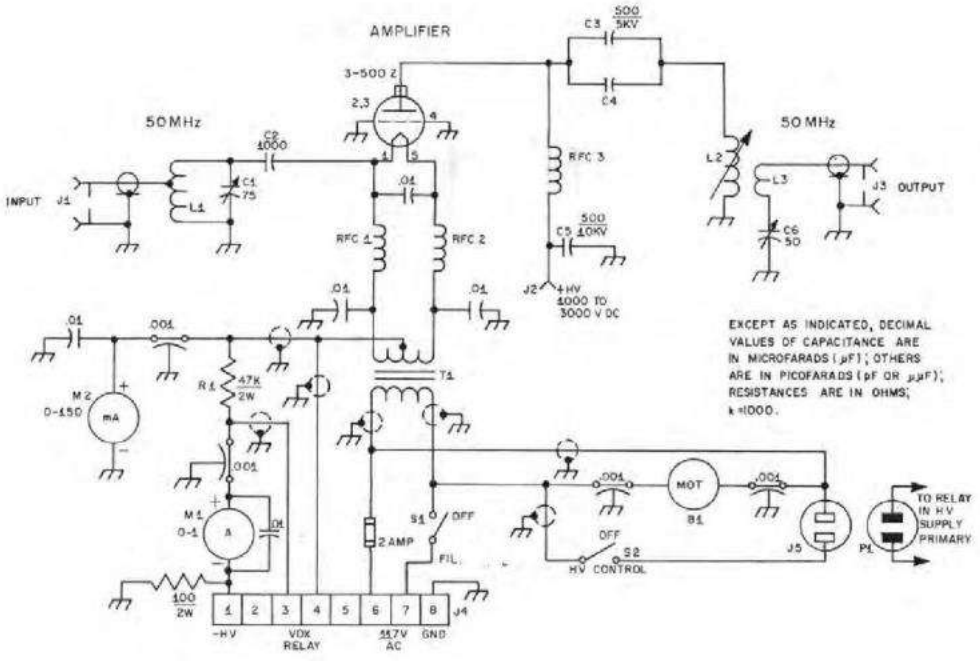


Fig. 1 — Schematic diagram and parts information for the 50-MHz grounded-grid amplifier.
B1 — Blower, 15 ft 3/min. or more.
C1 — 75-pF variable (Johnson 167-4).
C2 — 1000-pF dipped mica.
C3, C4 — 500-pF 5-kV transmitting ceramic (Centralab 858S-500).
C5 — 500-pF 10-kV or more TV "Doorknob."
C6 — 50-pF variable (Johnson 167-3).
1 — BNC coaxial socket.
J2 — High-voltage connector (Millen 37501).
J3 — Type N coaxial receptacle.
J4 — 8-pin male power connector, chassis-mounting.
J5 — AC receptacle, chassis-mounting.
L1 — 4 turns No. 12 enam., 1 inch long, 1-inch diam. Tap 2 1/2 turns from ground end.
L2 — 3 1/2 turns 1/4-inch copper tubing, 3 1/2-inch diam., 5 1/4 inches long. Diameter is finished dimension, not that of form used for winding. See text and photo for turn spacing. Tuning ring is closed loop of 1/2-inch copper strip, 2 5/8-inch diam.
L3 — 1 turn, 3-inch diam., and leads, made from one piece of 1/8-inch copper tubing or No. 8 wire.
M1 — DC meter, 0 - 1 ampere (Simpson Wide-Vue, Model 1327).
M2 — 0 - 300 mA, like M1.
P1 — Ac plug, on cable to power supply.
R1 — 47,000-ohm 2-watt resistor.
RFC1, RFC2 — 21 turns each, No. 12 enam., 1/2-inch diam., bifilar.
RFC3 — 30 turns No. 20 enam., spaced wire diam., on 3/4-inch Teflon rod, 3 3/4 inches long. Drill end holes 1/2 and 2 3/4 inches from top.
S1, S2 — SPST, rocker type, neon-lighted (Carling LT1L, with snap-in bracket).
T1 — Filament transformer, 5 V, 15 A, (Stancor P6433; check any electrical equivalent for fit under 3-inch chassis).

must be kept above ground with rf chokes capable of carrying 14 amperes. These are bifilar-wound, as may be seen in the bottom-view photograph. The input impedance of such a stage is low (in the vicinity of 120 ohms) so a good match to a 50-ohm line from the exciter is made with the tap toward the top end of the tuned input circuit, L1 C1.

Most of the lower portion of the schematic diagram, Fig. 1, has to do with control, and is largely self-explanatory. The voice-control relay (if the exciter has one) shorts our R1, allowing grid current to flow, and making the amplifier operative, if the filament switch, S1, and the high-voltage-primary control switch, S2, have been closed. Feeding ac voltage to the high-voltage plate-supply relay through J4 and P1 as shown makes it impossible to apply plate voltage unless the filament and blower are also on.

Construction

The amplifier has a chassis of aluminum, 10 by 12 by 3 inches in size, with the tube socket centered 3 1/8 inches from the front edge. The sheet aluminum panel is 10 inches high. A decorative edging is made from stainless steel "cove molding," a material used by cabinet makers on counter tops, where a horizontal surface meets a vertical or corner. Sides and back are also sheet aluminum. Where they are not to be removable, for any reason, they are fastened together with pop-rivets. Tools and rivets for this work can be found in most hardware stores. If you do much building with metal, you'll find a pop-rivetting kit a good investment. Perforated aluminum "cane metal" is used for the top, and for covering the viewing hole in the front panel.

In winding the bifilar rf chokes, RFC1 and RFC2, pull the two wires tightly while winding them side-by-side on a suitable form of wood or metal. Leave this form in until the wire leads have been soldered in place, so that the windings are self-supporting. Then slide out the form and coat the windings with coil dope, to help keep them together and in alignment.

The grid terminals are on opposite sides of the socket, as seen in the bottom view. They are grounded to the chassis with very short copper straps, adjacent to each pin. These are 1/4 inch wide, and run through slots by the pins. They are soldered to the pins, and bolted to the chassis with No. 6 screws. Be sure that the chassis is clean and that a lock washer is used, so that a good rf ground is made. This could be important in getting the amplifier to operate stably in the vhf range.

Looking into the top of the amplifier, it will be seen that the hot end of the plate inductor, L2, is supported on the top of the two blocking capacitors, C3 and C4, which in turn are mounted on the Teflon rod that serves as the form for the shunt-feed choke, RFC3. The ground end of L2 is supported on a 1 3/8-inch piece of 3/8-inch copper tubing. The end of the coil is fitted with a heavy copper lug, such as is commonly used in high-current electrical circuits, but a suitable terminal can be made by pounding the end of the copper tubing flat, and drilling a hole in the flat portion. The end or terminal is held tightly on the support with a 2-inch brass bolt that goes through the terminal, the tubing support, and the chassis. Be sure to make this a clean, solid connection to ground; this is a high-current point.

Since it is effectively across the tank circuit, the shunt-feed rf choke, RFC3, must be a good one. It is strongly recommended that you make it yourself; we know of no ready-made rf choke that is as good as this hand-made one.

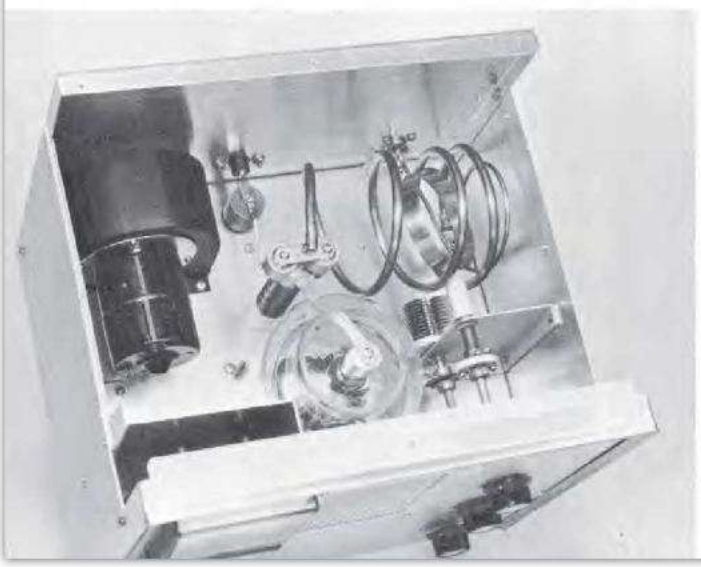
Teflon rod is slippery stuff. It will help if you can get a shallow thread cut in the form, to hold the winding in place. If you don't have a lathe, perhaps a machinist friend can do it for you. If not, a satisfactory winding job can be done as follows: Cut two lengths of No. 20 enameled wire, a bit more than 7-feet long. Clamp one end of the pair in a vise. Hold the other end in heavy pliers, and stretch the wires a bit, which will help to stiffen them. Now, feed the wire ends through one hole in the Teflon form, and wind the coil with the two wires bifilar, keeping them under considerable tension. Pull the ends through the other hole in the form, and bend one back tightly at the edge of the hole. Now remove one winding, and you will have an evenly-spaced coil that makes an excellent rf choke. This may take a little practice, but the results are worth the effort.

The blocking capacitors, C3 and C4, are sandwiched between brass plates. One is fastened to the top of the rf choke form with a sheet metal screw, and the other connects to the hot end of L2. The latter has a wrap-around clip of flashing copper for this purpose. Connection to the tube plate is made with braid removed from a scrap of coax. A strip of flashing copper 1/4-inch wide is also good for this. Use a good heat-dissipating connector, such as the Eimac HR6.

The shorted-turn tuning ring is centered between the first two turns of L2. The first part of the shaft for the ring is a ceramic stand-off. The main shaft is 1/4-inch diameter rod or thick-wall tubing, the end of which is tapped for 8-32 thread. The shaft runs through a bearing mounted in a bracket 4 inches high and 2 3/4 inches wide, that fastens to the chassis and the side of the enclosure. The output loading capacitor, C6, is also mounted on this bracket. It is one inch above the chassis, and the tuning-ring shaft bearing is 3 1/4 inches above the chassis. The input tuning capacitor, C1, is mounted under the chassis, with equal spacing between the three, for symmetrical appearance.

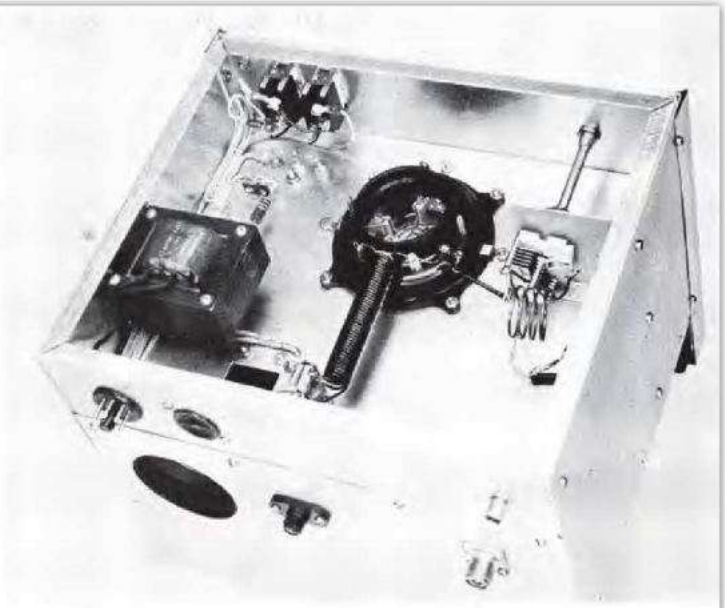
The output coupling loop, L3, is mounted just inside the cold end of L2. It can be adjusted for optimum coupling by "leaning" it slightly into or out of L2. Be sure that it clears the shorted turn throughout movement of the latter.

The coaxial output jack, J3, is mounted on the rear wall of the enclosure. A small bracket of aluminum connects it to the chassis, to form a good ground that is independent of the bonding between the chassis and the enclosure. Plate



Interior view of the 50-MHz amplifier shows the shorted-turn tuning system, plate coil and output coupling, upper right. The tuning and loading controls are mounted on a bracket to the right of the 3-500Z tube and chimney. Meter shielding is partially visible in the left front corner.

QST for



With the bottom cover removed, a look into the chassis from the rear shows the input circuit, L1C1, left, the bifilar filament chokes foreground, filament transformer and control switches. Opening in the rear wall is for air intake.

voltage enters through a Millen 37001 high-voltage connector, J2, on the rear wall, and is bypassed immediately inside the compartment with a TV "doorknob" high-voltage capacitor, C5.

The blower assembly is mounted on the chassis in the left rear corner. It draws air in through a hole in the back of the compartment, and forces it down into the enclosed chassis. The only air path is then back up through the socket and chimney (Eimac parts SK-410 and SK-406 recommended) and out through the cane-metal top of the enclosure. The blower has a 2-inch wheel turning at 3000 rpm. A larger wheel turning slower might do as well, and be quieter. The data sheet for the 3-500Z specifies an air flow of 13 cubic feet per minute, when the tube is operated at 500 watts plate dissipation. The ac leads for the blower motor come into the enclosure on feedthrough bypass capacitors.

The two meters are enclosed in an aluminum shield fastened to the front and side panels. Their terminals are bypassed for rf inside this shield, and the leads come through the chassis on feedthrough capacitors. Like all power wiring, these leads are shielded wire. The filament and high-voltage-control switches just below the meters are the rocker type with built-in lamps (Carling Electric). The high-voltage switch is not meant to control the plate supply directly, but rather through a relay, as shown in the 3000-volt power supply in Chapter 12 of the *Handbook*. (Fig. 12-37 in the 1970 Edition.) The plate meter is in the negative lead, so be sure that your power supply is compatible with this arrangement. Do not use this system where a potential difference exists between the amplifier and power supply chassis.

Use of shielded wire (Belden 8862) throughout, bypassing of all exposed points, and feedthrough capacitors wherever power leads pass through the chassis had the desired effect. With the amplifier running at full input, only the faintest trace of rf can be found on wiring outside the cabinet.

Adjustment and Use

The tube manufacturer cautions against applying drive to the 3-500Z without the plate voltage being on, so it is well to make initial tuneup adjustments with only a few watts of drive, and with reduced plate voltage. The input circuit tunes quite broadly, and will show very low reflected power on an SWR bridge connected between J1 and the exciter, if the tap on L1 is at the proper point.

With a 50-ohm load connected to J3, and with C6 near minimum capacitance, apply 1000 to 1500 volts through J2, and turn on the driver. Adjust the shorted turn inside L2 for a dip in plate current. Adjust C6 and the position of L3 with respect to L2 for maximum output, and retune the plate circuit with each adjustment.

The tuning range was adjusted to cover 49.8 to 52.7 MHz by changing the relative spacing of the turns of L2. The closer they are spaced at the shorted-turn end, the greater will be the tuning effect of the ring. The highest frequency is reached with the ring in a vertical plane (greatest coupling to L2) where it reduces the plate coil inductance by the greatest amount.

Since there is no tuning adjustment other than the ring, the total inductance of L2 is critical, and some experimentation with coil diameter and turn spacing may be necessary. The wrap-around lug at the hot end of the coil should not be soldered in place until you are sure that the coil is the right size. The various mounting dimensions that affect the tuning range are as follows: Grounded support for L2 – 1 1/8 inches from the right side of the chassis and 3 1/4 inches from the rear. RFC3 mounting position – 4 inches from the rear and 5 1/2 inches from the left side. Shorted turn – approximately centered between turns 1 and 2 of L2. The start of L3 bends from the stator of C6 to near the start of L2. The end toward J2 passes

(Continued on page 58)

160-Meter Contest

Operating Tips by W1BB

The ARRL 160-Meter Contest, authorized by the Board of Directors just this past May, premieres Dec. 12-13, 1970. October *QST* carried the full rules for this initial event. What you don't usually find in rules, however, is a *modus operandi.* If you're unfamiliar with the band, you too will welcome a few tips from Mr. 160 Meters – W1BB, of course!

Conditions: 160 is not a good daytime band, except for very local QSOs. There are lots of broadcast harmonics on the band plus all sorts of noise. The band is enjoyable only after dark (somewhat like 80 meters, only less so). Conditions peak at dusk and sunrise. This is the time to work DX. East coast to west contacts are best at west coast sunset time, say a half hour before and an hour after their sunset time. European DX will peak twice, once at our sunset time and once at their sunrise time. QSB is prevalent. Slow sending and sending "double" are helpful in circumventing this condition.

Where to look: One must scan the band carefully where DX is expected. For example, you'll find that east coast stations tend to work near 1800 kHz while west coast operation takes place near 2000 kHz. EU DX works a little in our band near 1800 khz, but mostly between 1825-1830 kHz. This used to be a clear section just outside of 1800-1825 permitting DX to get through. When the new regulations went into effect it spread the W/VE QRM into this area. Top banders are voluntarily cooperating to keep the 1825-1830 kHz. DX "window" open. VK signals will be found around 1800-1804 kHz., early mornings just after sunrise. ZLs will be found around 1885 and JAs from 1905.5-1907.5 kHz.

Antennas: The biggest and highest antenna possible is a big help. An inverted V is an excellent choice. A good number two choice would be a top-loaded vertical with ground radials. The inverted V is particularly good being quieter on receive than the vertical. For a rule of thumb, each leg of the V should be 129 feet long and trimmed with the aid of an SWR meter to bring the SWR down to 1/1.

Current Operation: Currently activity is about 50/50 phone and cw. There are quite a few ssb stations on although still quite a lot of am operation. However, 95% of real DXing is done by cw only, simply because it gets through the poor conditions in better fashion.

Operating efficiently on 160 is about like any other band as to procedures, except that it is harder to work DX. QST

3-500Z Grounded-Grid Amplifier

(Continued from page 27)

between the first two turns of L2, clearing the tuning ring in any position of the latter.

Once you have determined that everything tunes properly, and you are familiar with the "feel" of the amplifier, apply higher voltages, up to the maximum of 3000. The plate current with no drive should be about 160 mA. If you feel better with a bit less static plate current, it can be lowered by inserting a small (0.1 to 0.4 ohm) resistor in series with R1 and the filament center-tap. A Zener diode, 2 to 9 volts, 10 watts, could do this job, as well.

Keep the amplifier tuned for maximum output at all times. Do not decouple to reduce output; cut down drive and/or plate voltage instead. Initial adjustment for linear operation, either ssb or a-m, requires a scope. With a little experience you will have no trouble recognizing conditions that provide good linearity, and those that result in flat-topping and splatter.

Maximum output, minimum plate current and maximum grid current should all occur at the same setting of the plate tuning. If they do not, the output loading is over-coupled, or there is regeneration in the amplifier. Do not expect a tremendous plate-current dip at resonance. With proper loading the dip is plainly visible and smooth, but not of great magnitude.

Operating conditions for the 3-500Z, as given in the manufacturer's literature or in the tube data section of the *Handbook* provide a good guide to proper operation. The amplifier can be run effectively with as little as 1000 volts on the tube plate, so varying the ac voltage to the plate-supply high-voltage transformer is a convenient way to control the power level. In most vhf communication there is no reason whatever to run near the legal power limit, and any 50-MHz station should include provision for running less. With just one power supply, and no critical operating conditions, this amplifier makes operating courtesy and consideration for others on the band easy. When you need the power, you'll have it at your disposal, quickly, without fussy readjustment of operating conditions. QST

Phone Patching

(Continued from page 31)

that would do this would be ideal for maintaining transmitter modulation at the proper level and might be useful in controlling the level of signals applied to voice couplers.

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Ron Pollack, K2RP, ron.k2rp@gmail.com

Classic Radio

Transceivers Before Plug and Play

Today's HF transceivers, used by the vast majority of active HF operators, are truly self-contained units. Most of them include a VFO (often dual VFOs), a keyer, transmit/receive switching, antenna tuners, power supplies, frequency memories, and a host of other conveniences that today's amateurs take for granted. They are true plug-and-play stations. Plug in an antenna, and perhaps a power supply, push the button on the included microphone, and you're on the air. Things weren't always this convenient.

A younger ham looking at a typical station from the 1950s and '60s would likely be struck by the comparatively large size and weight of the equipment, and would notice that the transmit and receive functions were performed by separate, free-standing units. While a few transceivers were introduced in the '50s, their use did not become common until the mid-60s, and not nearly universal until the '80s.

Switching Complexity

From an operational standpoint, operating a station with a separate receiver and transmitter was more complex and labor intensive than using a modern transceiver.

Consider what needs to be accomplished when switching between transmit and receive during a contact. The antenna needs to be connected to the proper unit, the receiver needs to be muted, and the transmitter activated when going from receive to transmit, and the opposite when transitioning from transmit to receive. A transceiver performs these functions automatically with the microphone push-to-talk button or by pressing the CW key. The traditional setup required external means to accomplish these changes. Most common was a transmit/receive (T/R) relay, usually activated by switching the transmitter

Figure 1 — Johnson Co. transmit/receive switch. [Ron Pollack, K2RP, photo]

Figure 2 — Various VFOs and keyers. [Ron Pollack, K2RP, photo]

that activated the relay and performed the antenna-switching function. It often had auxiliary contacts that muted or unmuted the receiver as required.

Another option was to use an electronic T/R switch that performed the functions instantaneously, enabling the operator to hear the receiver between CW characters, known as break-in keying (see Figure 1). Some basic stations even used a double-pole, double-throw knife switch mounted on the operating desk.

The majority of transmitters — especially entry-level types — did not include a built-in VFO. They relied on quartz crystals to control the transmit frequency. When Novices upgraded, their first purchase was often an external VFO. Manufacturers such as Heathkit, EICO, Globe, Knight, and others marketed inexpensive VFOs, adding another box on the desk (see Figure 2).

Other Considerations

Another consideration was independent frequency control to ensure that the transmitted signal coordinated with the received signal. With a transmitter VFO, a procedure called *zero beating* set the transmitter to the received frequency. This is a lost art with transceivers.

Electronic keyers — using keyer paddles for automatically generating dits and dahs — also grew in popularity in this era. Again, many of today's rigs incorporate keyers as standard equipment. In the vacuum-tube era, these were external accessories, with most of the aforementioned manufacturers offering one or more models. In the late 1950s, Hallicrafters offered the TO keyer, the first commercially successful model (see Figure 3). It used six vacuum tubes, compared to today's solid-state models, built with one chip the size of a postage stamp.

Antenna couplers and tuners have also changed with the times, partially due to the transition from tube-type final stages to solid-state designs. Tube finals are far less sensitive to SWR mismatches. Many of those rigs offered pi-network outputs, capable of matching a significant range of antenna impedances, so antenna-matching devices were not as common as they are today. Wire antennas and beams could be built easily, and they could be used directly with transmitters of that era. For some antenna systems that used balanced lines, external couplers, such as the Johnson Matchboxes and homebrew transmatches, were often used. Today's solid-state final stages must be presented with a near 1:1 SWR match, resulting in antenna couplers, either internal or external, needed for most installations.

Figure 3 — Hallicrafters HA-1 Keyer. [Ron Pollack, K2RP, photo]

Operating

The FCC licensing structure was much different in those years. The entry-level Novice-class license only granted limited privileges on 80, 40, 15, and 2 meters. All operations, except 2 meters, were restricted to CW, and Novices were restricted to 75 W maximum input and crystal control. Most limiting was the 1-year license term, which could not be renewed. The Novice license was a "once in a lifetime" event; it was upgrade or get off the air.

Another regulation required a detailed log of each and every station operation, including stations called or worked, time and date of operation, frequency band, and power, among others. While many hams voluntarily continue to maintain a log for their own records, the legal requirement to keep a station log ended in the early '80s.

Hams who operated mobile or portable, except for brief periods, were required to notify the FCC districts of their primary operating location and the districts for proposed operations. This requirement was also rescinded along with the logging requirements.

This was the era of the Cold War. Early in the '50s, the FCC enacted CONELRAD (Control of Electromagnetic Radiation). In case of imminent enemy air raids, all radio transmission would cease, to prevent aircraft from using radio signals for direction finding. Fresh in the mind of regulators was the 1941 attack on Pearl Harbor, when Japanese bombers were reported to have homed in on Honolulu broadcast stations. Broadcast stations would be required to go off the air, and emergency broadcasts would be made on 640 and 1240 kHz from rapidly changing locations that would be difficult for an enemy to track. In the mid-50s, amateurs became subject to the rules.

Various means of compliance were used. A TV or broadcast radio within earshot of the station would qualify. There were numerous clever automatic designs published. Some monitored the AGC circuit of a broadcast receiver, and activated a light or buzzer if the AGC voltage dropped. There were other systems proposed, and Heathkit and others offered CONELRAD monitors. The requirement for hams ended in 1962. (I suspect that most hams ignored the whole thing altogether.)

Times have changed, of course. Operating an amateur station is much easier and more compact. But, the thrill and magic of radio communication remains the same.

Celebrating Our Legacy

A Chance Encounter with Amateur Radio

I discovered amateur radio accidentally when I was a teenager in the early '70s, by listening to an all-band radio. I listened to shortwave broadcasts, air traffic to and from the New York airports, and discussions of radio and other technical topics.

The people I heard were ham radio operators using a 2-meter repeater, and some were members of the Wantagh Amateur Radio Club in Long Island, New York. I attended the club's amateur radio Novice licensing class at a local park, while studying the ham radio books I found at my local public library. I earned my Novice-class license, WN2TVB, in 1974.

My first station was a Heathkit HR-10B receiver and a one-tube transmitter that I built based on the article, "A 10-Watt, One-Tube Transmitter," by Lewis McCoy, W1ICP, and Gus Wilson, W1NPG, from the March 1971 issue of *QST*. I had a single crystal and managed one contact with it. New crystals were expensive, and all the used ones I found were for the older Novice allocation, so I decided to get a Heathkit HG-10B variable frequency oscillator (VFO) and hook it up to my one-tube transmitter. Unfortunately, that didn't work, so I purchased a Heathkit DX-60B kit.

Two years ago, I found my old one-tube transmitter in the basement of my family's home. I want to see if I can get it to work with the VFO, so I've been tinkering with it in my spare time. I've learned a lot about vacuum tube circuits and made many circuit modifications, but I can't seem to get much power out.

Over the last 46 years, I've enjoyed amateur radio, and I owe it all to my luck at hearing a nice group of hams on my all-band radio. You never know who might be listening on the air and be inspired to learn about amateur radio.

Joseph E. Pingree, WB2TVB
Los Angeles, California
Life Member

My Lifelong Radio Journey

When I was 12 years old, I spent a month at sleepaway camp. On the last day of camp, I saw a fellow camper drawing on a piece of paper. When I asked what he was drawing, he told me it was a schematic.

My new friend taught me all about electronics. He also had a shortwave receiver, and I found a whole new world of excitement with shortwave listening. Soon I had my own receiver, a Realistic DX-150A, and began sending reception reports to all the international radio stations I listened to.

In 1970, I earned my Novice-class license and was given the call WN2GXM. I bought a Heathkit DX-60B and spent weeks in the basement building it. I paired it with the DX-150A and made my own manual transmit/receive (T/R) switch and various other accessories. My father helped me set up a multiband vertical mounted on the roof of our garage, with four elevated radials extending to the four corners of our yard. When I made my first contact, I was so nervous that my hands were shaking, and I could hardly send code.

I learned how to dip the plate of my DX-60B and adjust the grid current, very carefully, even repeatedly for the same contact. I never burned out a tube. However, I hadn't yet learned about antenna tuners or baluns. When I operated my station, I had to be careful what I touched because RF bites were everywhere.

I continued to use the DX-60B/DX-150A combo into my teen years, during which time I quickly upgraded to General- and Advanced-class licenses (which I held for the next 40 years).

I've replaced my original DX-60B after reluctantly selling it, and I still have the Realistic DX-150A that I copied CW with for so many hours. I have more modern equipment too, of course, and am making proper use of antenna tuners and baluns — no more RF in the shack. I'm currently relearning CW, which is still as exciting to me as ever!

Richard A. Spohn, WB2GXM
Floral Park, New York
Life Member

Joseph Pingree's, WB2TVB, old one-tube transmitter.

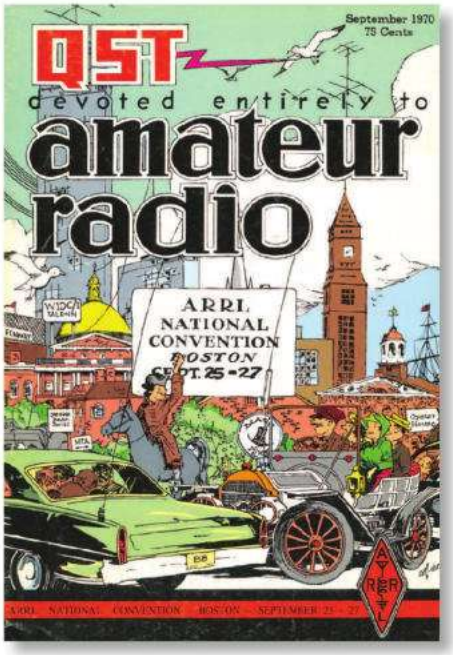
Send reminiscences of your early days in radio to "Celebrating Our Legacy," ARRL, 225 Main St., Newington, CT 06111 or **celebrate@arrl.org**. Submissions selected for publication will be edited for space and clarity. Material published in "Celebrating Our Legacy" may also appear in other ARRL media.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

Al Brogdon, W1AB

100, 50, and 25 Years Ago

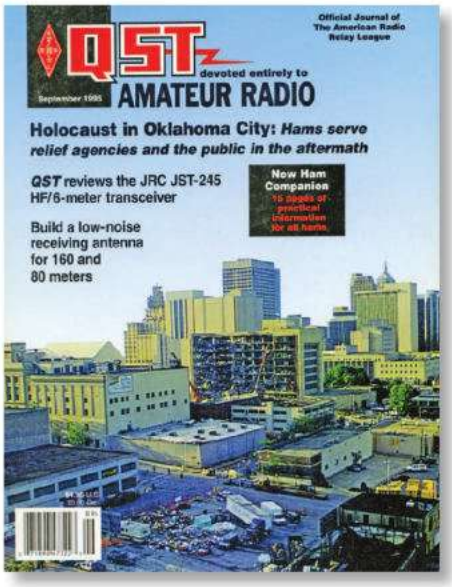
September 1920

- The cover photo shows the excellent station of 8XK, in Pittsburgh, Pennsylvania. [A few months later, 8XK became the early broadcasting station KDKA. — *Ed.*]
- The editorial, "In Introspect," takes a look at ham radio of the time, and finds much to be pleased and hopeful about.
- The lead article, "A Few Ideas for Amateur C.W.," begins with the observation that "The number of C.W. sets is rapidly increasing."
- "Station Performance during the Bureau of Standards – A.R.R.L. QSS Tests of June and July, 1920" presents the data collected by participating stations, as we try to learn about fading and its causes.
- McMurdo Silver presents information on the "Construction of a Two-Step Amplifier" for audio signals.
- "Our Less Experienced Brothers," by former League president Hiram Percy Maxim, W1AW, warns against the exclusion of newcomers to our grand adventure by the more experienced operators.
- A. L. Groves tells us "How to Tune the Honeycombs," to get maximum results from honeycomb coils.



September 1970

- The cover art by Gil, W1CJD, reminds us of the League's National Convention, to be held in Boston later that month.
- The editorial, "A Tough Decision," discusses the FCC's expansion of the phone subbands.
- Douglas Blakeslee, W1KLK, shows how to build "A Solid-State VOX."
- Yardley Beers, WØJF, shares Part II of "Short Antennas for the Lower Frequencies," discussing trap construction and adjustment.
- Jerry Arnold, WN6MBP, reports on building "A Two-Band Vertical for the Novice" that covers 40 and 15 meters.
- Doug DeMaw, W1CER, describes how to build "A QRP Console," a mate for the QRP transceiver described in the August 1970 issue of *QST*.
- Reed Fisher, W2CQH, and Richard Turrin, W2IMU, write about their "UHF Directional Coupler," a handy piece of equipment for UHF hams.
- Frank Walsmith, W8PHR, explains how to build a circuit to provide "Automatic Amplifier Tuning," to maintain tank-circuit resonance when changing frequency.



September 1995

- The cover photo shows the Federal Building in Oklahoma City, and notes that hams served in several roles after it was car-bombed.
- The editorial, "Why Band Plan?", explains why today's bands require observance of the operating segments in our bands.
- "Holocaust in Oklahoma City" recounts the efforts of hams in providing essential communications support following the truck bombing in Oklahoma City.
- "Thrills, Butter Churns, and Honeycombs: A Visit to The Hammond Museum of Radio" describes the wonderful museum operated by Fred Hammond, VE3HC, in Guelph, Ontario.
- Brian Beezley, K6STI, teaches us how to build "A Receiving Antenna that Rejects Local Noise."
- Edwin Andress, W6KUT, joins in with "A K6STI Low-Noise Receiving Antenna for 80 and 160 Meters."
- "Hard-Core QRP," by Richard Arland, K7YHA, shares the tale of his enjoyment of ham radio with transmitter outputs at the milliwatt and microwatt levels.
- The article, "California Mobile Antennas and the Moment of Truth," by Doc Selman, WE6A, includes photos of the antennas used on a day when high-power mobile hams gathered to compare antennas.

Silent Keys

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

N1AED **Roux**, Richard M. "Dick," Bedford, NH
K1AMS **Schindler**, Andrew M. "Mike," Niantic, CT
W1BEP **Paiva**, Bradford E., East Freetown, MA
•WA1DVU **Gray**, Rodney W., Belchertown, MA
N1DZM **Allard**, Almon R., Billerica, MA
K1EST **Osborne**, Paul H., Milford, ME
♦W1GV **Gibilisco**, Stanley P., Lead, SD
NB1HF **Blaiklock**, Neal E., Merrimack, NH
K1HFR **Kratovil**, Jonathan D., Feeding Hills, MA
N1HRM **Contois**, Stanley L., Essex Junction, VT
K1JG **Gawronsky**, John A., Athol, MA
•KA1KXQ **Blaskey**, Bernice E., Palm Coast, FL
W1MAP **Dupont**, Donald S., Farmingdale, ME
♦WA1MXN **Burnham**, David W., Concord, NH
W1QDV **Doucette**, Conrad R., Cincinnati, OH
W1TAB **Peloquin**, Robert H., Jr., Worcester, MA
KB1VAD **Russ**, Raymond, South Chatham, MA
KB1XI **MacCord**, Donald A., Derry, NH
KA2AJH **Cicirello**, James A., Wellsville, NY
K2ANJ **Frasier**, James H., Amherst, MA
•WB2BSN **Hall**, Tom, Lyons, NY
W2CRS **Super**, John P., McNeal, AZ
WT2D **Damen**, Theodoor C., Colts Neck, NJ
KC2GZY **Paul**, Allan T. "Dusty," East Aurora, NY
K2IEC **Pickering**, Bernard F. "Bernie," Susquehanna, PA
K2LP **Hall**, Marvin D. "Bud," Eastham, MA
WA2NHA **Messing**, Howard, Sparta, NJ
N2PEN **Robideau**, Paul J., Clifton Park, NY
WA2SJO **Ofshinsky**, Sam J., Dumont, NJ
KX2W **Shontz**, Freeman S. "Sam," Southampton, NJ
•KA2WYZ **Malhenzie**, Bernard, Athens, AL
KH2Z **Hildebrand**, Brent W., Loma Linda, CA
W2ZM **Raide**, Robert J., Penn Yan, NY
K3IP **Shaubach**, Henry "Kip," Jr., Quarryville, PA
♦K3IUY **Sanders**, Irvin M., Middletown, PA
K3JE **Morrison**, Edward S., Clearfield, PA
♦W3JTV **Vaccaro**, Joseph, Hermitage, PA
K3KFD **Flink**, Stephen, Penn Valley, PA
♦WN3LIF **Jones**, Walter, Duryea, PA
N3MZJ **Piper**, Robert W., Chambersburg, PA
W3NQN **Wetherhold**, Edward E., Annapolis, MD
W3NTT **Groover**, James A., Slatington, PA
KA3RNW **Murphy**, Mark G., Annapolis, MD
KB3SGX **Peach**, Robert A., Hookstown, PA
AA3VK **Minschwaner**, Walter E., Wellsboro, PA
KI4AMO **Allen**, Glenn P., Benton, TN
N4ANV **Tyree**, Gene, Fayetteville, NC
WA4AON **Hardigree**, George A. "Allan," Bishop, GA
W4AV **Vitolo**, Anthony A., Grayson, GA
AK4BE **Shipes**, Joe F., Yorktown, VA
WE4C **Stadtlander**, David, Cocoa, FL
KI4CGN **Bateman**, Bert D., Topton, NC
AI4DU **Bossert**, Raymond A., Calabash, NC
KI4DXB **Turner**, Delbert S., Floral City, FL
KE4EC **Frazier**, Donald E., Punta Gorda, FL
♦AD4F **Curle**, Charles E. "Charlie," Jr., Coltewah, TN
KV4FK **Campbell**, Donn V., Annapolis, MD
•WD4HDV **Coleman**, James C., Jr., Mechanicsville, VA
♦WB4HHN **Stevens**, Russell J., Manassas, VA
NC4HK **Martin**, Haynes K., Fuquay-Varina, NC
K4HSK **McCrary**, Clifford R., Jr., Elkin, NC
•N4JNL **Lindeman**, Linda, Coconut Creek, FL
KM4KLT **Aspinwall**, Thurman R. "T. Ray," Mobile, AL
KK4MQP **Barry**, Rebecca F., Decatur, AL
KD4ODQ **Schmauss**, Jo Anne, Lakeland, FL
KA4PCN **Murphy**, Dewey E. "Edward," Odum, GA
W4PJZ **Anderson**, Bluford J. "Andy," Louisville, KY
N4PWP **Head**, Kenneth L., Elizabethton, TN
KI4SBT **Hoppe**, Robert W., Dacula, GA
AE4SH **Hamm**, Scott B., Cherryville, NC
WA4SYZ **Smith**, Brady O., St. Petersburg, FL
W4TZQ **McCaslin**, Nick G., Arden, NC
K4UQR **Foley**, James A., Jr., Birmingham, AL
KN4Y **Palagyi**, Edward F. "Ed," Crawfordville, FL
KK5AR **Shook**, Roland S., Silver City, NM
KB5BRZ **Grisham**, Farrar, Meridian, MS
•WT5C **Edlin**, James I. "Jim," Lubbock, TX
KD5CQX **Crawford**, John R., Eads, TN
K5CRJ **Warburton**, Alan W., Long Beach, MS
•AA5EA **Foster**, Wallace C., El Paso, TX
AC5F **Hughes**, Robert L. "Leon," Willis, TX
♦N5GAR **Blackwell**, Thomas M., Dallas, TX
AB5HA **Smith**, Paul B., Bossier City, LA
KI5HBX **Bural**, Benjamin T. "Tyler," Edmond, OK
KD5HEO **Murphy**, Clifford L., Fort Worth, TX
KU5K **Phelps**, Cecil C., Ignacio, CO
KA5KBM **Strachan**, Steve S., Lavaca, AR
KF5OEB **Sly**, Benjamin C., Sherman, TX
W5SFN **Emmons**, Albert D., San Antonio, TX
•W5TDH **Gilbert**, Kenneth L., Plainview, TX
W5TYD **Allen**, Henry L., Caddo Mills, TX
•K6DPZ **Guretzky**, Harold "Hal," Richmond Hills, NY
W6GCL **Hammons**, Jerry D., Clovis, CA
•W6IWM **Popenoe**, Paul, Jr., Portland, ME
KK6JJ **Pritchard**, Grant S., Novato, CA
N6JTA **Richards**, Russell D., III, Turlock, CA
W6RUF **Tsompanas**, Emmanuel C., Modesto, CA
W6VNQ **Towle**, Harry D. "Dave," Arbuckle, CA
KK6ZTN **McLaren**, Dorothy J., Santa Barbara, CA
KE7BZD **Brassard**, Raymond A., Puyallup, WA
W7GXX **Powell**, Robert B., Taylorsville, UT
K7HEN **Gilbert**, Mack, Ephraim, UT
W7HTJ **Andresen**, David C., Lakewood, WA
♦WA7JCK **Hutton**, Merle K., Tucson, AZ
K7JGU **Korn**, Theresa M., Tucson, AZ
WA7PFR **Parker**, David H., Portland, OR
N7UKN **Metzler**, Donald E., Glendale, AZ
W7VTW **Hawley**, James N. "Jim," Newport, OR
W7YRU **Bohman**, Ronald G. "Gene," Rexburg, ID
•K8BP **Cooper**, Wyatt C. "Clarke," Muskegon, MI
♦K8DHW **Eblin**, James B. "Jim," Corvallis, OR
W8END **Geerlings**, David N., Manistee, MI
N8GCH **Warren**, Vincent A., Lima, OH
WA8HDG **Gietzen**, William D., Norton Shores, MI
N8IEA **Childers**, Calvin, Dayton, OH
N8JMK **Homer**, Bruce A., Cambridge, OH
WD8JOF **Ludwig**, David L., Swartz Creek, MI
•WB8JRW **McCloy**, Eugene, Vermontville, MI
♦•W8LTX **Knott**, Thomas E., Spring Hill, FL
•W8PJS **Thatcher**, George R., Asheville, NC
•K8RDO **Armstrong**, Donald P., Lehigh Acres, FL
W8REW **Weston**, Ross E. "Ed," II, Reynoldsburg, OH
W8WPC **Brown**, Ralph E., Greenville, OH
•W8WSR **Cowley**, Robert C., Toledo, OH
♦KD8YR **Olson**, Harold C. "Charlie," Troy, OH
W9ANT **Rudis**, Anthony J., Jr., Manhattan, IL
K9BBU **Burbey**, Lawrence A. "Larry," De Pere, WI
W9BCO **Booher**, David C., Aurora, IL
KB9CJG **Michas**, Nick W., Princeton, IN
K9CTH **Hubbard**, William H., Kokomo, IN
KA9FRM **Wilson**, Charles, Robbins, IL
W9HC **Brown**, Stephen E., Mahomet, IL
N9JSM **Wessels**, Heye C., Norfork, AR
KB9KMH **Cedzo**, George S., Sheboygan, WI
KC9NEB **Beckner**, Nancy, Rensselaer, IN
WB9ORO **Daniels**, Ruthann, McGregor, IA
WA9ZYO **McCarty**, Robert R., Racine, WI
WØBDO **Huber**, Frank J., Montgomery, MN
WAØBOB **Bartholic**, Robert W., Ogden, KS
KØDXX **Moody**, Michael D., Winfield, MO
AFØF **Hisserich**, James F. "Jim," Ironton, MO
WBØHNB **Horn**, Bernard H., Nashua, IA
NØICF **Kesselring**, Pamela J., Ottumwa, IA
WAØOFO **Smith**, Thomas C., Sun City West, AZ
ACØPJ **Gardner**, James W., Ogden, IA
•WØQAP **Arbogast**, Burl T., El Dorado, KS
KØRTF **Goetsch**, J. Bruce, Decorah, IA
WAØTNA **Long**, James R., Wentzville, MO
•KØUL **Schreiner**, Thomas D., Southbury, CT
WØVLY **Haumann**, David W., Thedford, NE
WQØX **Biggs**, Rodger D., Ellendale, ND
KBØXK **Steiner**, Harold B., Holstein, NE
KCØYNS **Mesenbrink**, Corey, Hallsville, MO
VE1OP **Nichols**, Scott B., North Sydney, NS, Canada
VE3ENC **Mullen**, Bernard A., Maberly, ON, Canada
♦VE3ISJ **Murphy**, Thomas K., Dunnville, ON, Canada
VE7CRU **Leach**, Graham Rodney, Oliver, BC, Canada
VE7ETU **Walker**, Hugh, Kaslo, BC, Canada
ZL1BKE **Beets**, Robert F., Queensland, Australia

♦ Life Member, ARRL
• 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.

Many hams remember a Silent Key with a memorial contribution to the ARRL Foundation or to ARRL. If you wish to make a contribution in a friend or relative's memory, you can designate it for an existing youth scholarship, the Jesse A. Bieberman Meritorious Membership Fund, the Victor C. Clark Youth Incentive Program Fund, or the General Fund. Contributions to the Foundation are tax deductible to the extent permitted under current tax law. Our address is: The ARRL Foundation Inc., 225 Main St., Newington, CT 06111.

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IC-9700 | *All Mode Tri-Band Transceiver*

• 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

IC-7851 | *HF/50MHz Transceiver*

• 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-7700 | *HF/50MHz Transceiver*

The Contester's Rig • HF + 6m operation • +40dBm ultra high intercept point • IF DSP, user defined filters • 200W output power full duty cycle • Digital voice recorder

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-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-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

IC-2300H | *VHF FM Transceiver*

• 65W RF Output Power • 4.5W Audio Output • MIL-STD 810 G Specifications • 207 alphanumeric Memory Channels • Built-in CTCSS/DTCS Encode/Decode • DMS

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

IC-R30 | *Digital/Analog Wideband Xcvr*

• 100 kHz to 3.3 GHz Super Wideband Coverage • P25 (Phase 1), NXDNTM, dPMRTM, D-STAR Mode • 2.3" Large LCD Display & Intuitive User Interface • MicroSD Card Slot for Voice & Data Storage • USB Charging & PC Connection

IC-PW1 | *HF/50 MHz Amplifier*

• Wide freq. coverage - 1 kW from 1.8 MHz to 50 MHz (amateur bands only) • Wide ALC adjustable range • Full duty cycle • Auto antenna tuner built-in • Auto AC input voltage selector is employed

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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

FTDX3000 | *100W HF + 6M Transceiver*

• 100 Watt HF/6 Meters • Large and wide color LCD display • High Speed Spectrum Scope built-in • 32 bit high speed DSP /Down Conversion 1st IF

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

FTM-7250DR | *C4FM/FM 144/430MHz Dual Band*

• 50 Watt Mobile • System Fusion-II Compatible • Operates Advanced C4FM Digital & Conventional FM Modes • 3 Watt Powerful & Clear Audio with Front Speaker

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

5 Ways to Shop!

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HF/50/144/430 MHz <SSB/CW/RTTY/AM/FM/DV> 10 W TRANSCEIVER

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  * The down-conversion IF sampling method is used for 25 MHz and above.
- **Real-Time Spectrum Scope and Waterfall Display**
- **Large Touch Screen Color Display**
- **Compact and Lightweight Design** * Approximately 1.1 kg, including the battery pack.
- **BP-272 Battery Pack or 13.8 V DC External Power Source**
- **Maximum Output Power 5 W (BP-272), 10 W (13.8 V DC)**

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BP-272 Li-ion Battery Pack,
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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.

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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"

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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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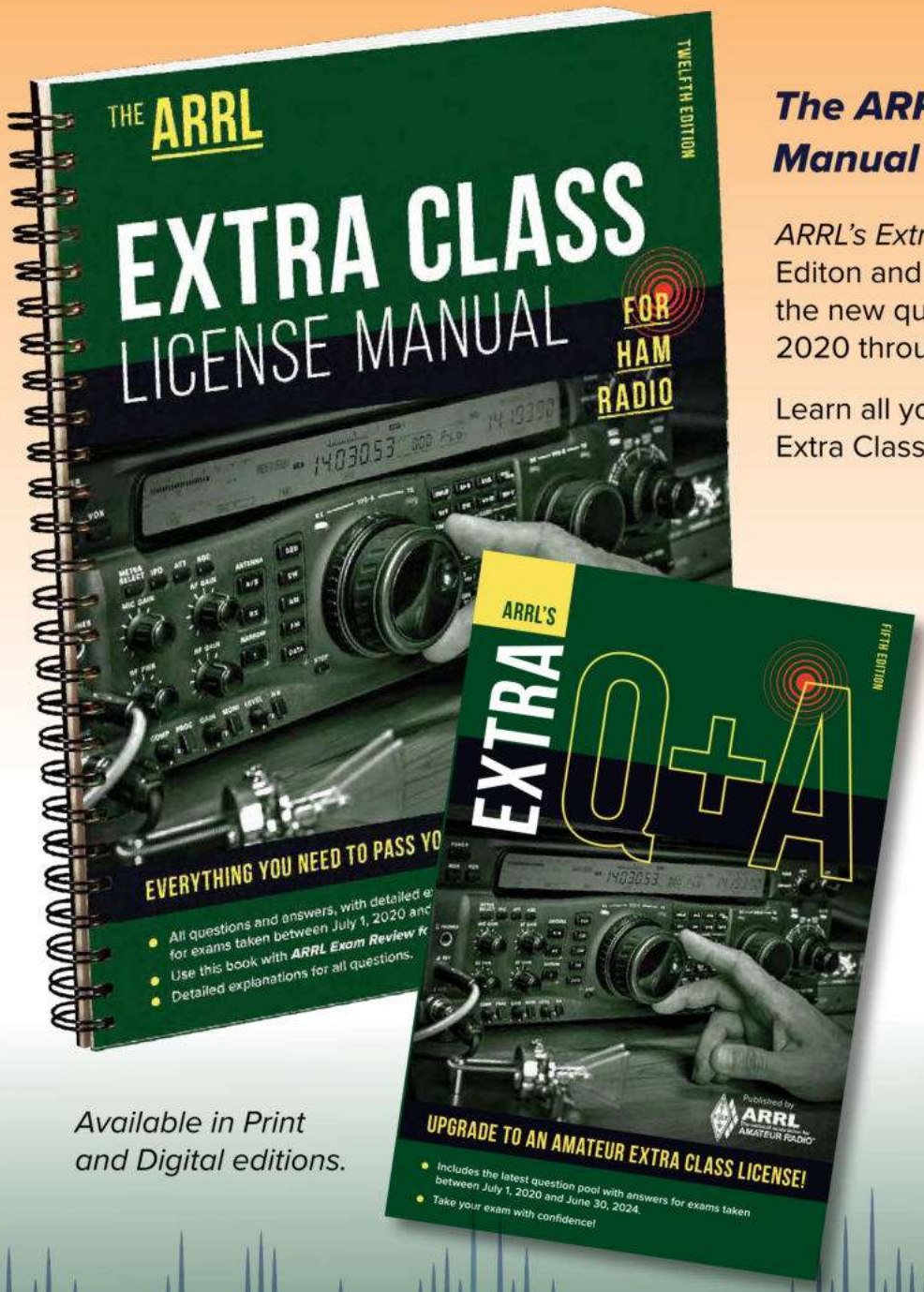

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MFJ G5RV Antennas

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.

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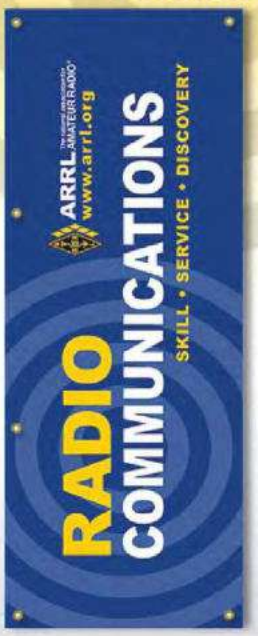

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QST 8/2019

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.

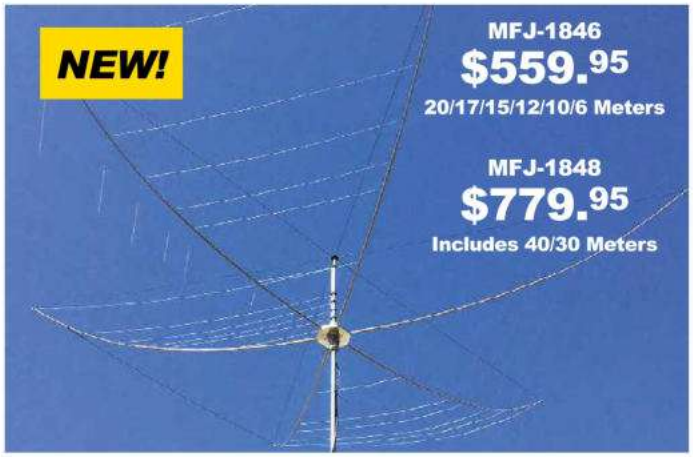
MFJ-1836HK34, $139.95. Add-on kit adds 40/30 Meters to MFJ-1835/1835H and MFJ-1836/MFJ-1836H cobweb antennas.

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!*

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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, or mobile homes.

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 with fast/slow tune manual remote control.

MFJ-1780, $369.95. 20-10 Meters, 150 Watt *Portable 24x24x24" box fan loop with carrying handle.* Highly efficient all-welded contstruction, no-rotating contact butterfly capacitor. Fast/slow tune remote control. No control cable needed. *See QST July 2019 review.*

MFJ-1780XX, $449.95. Like MFJ-1780 with auto band tune remote control, SWR/Wattmeter.

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.

See MFJ Youtube reviews at: *https://m.youtube.com/results?search_query=mfj*

MFJ Magnetic Loop Tuners, 150 Watts

Turns any wire loop into a small, high efficiency multi-band transmitting magnetic loop antenna! Work the world on 3.5 to 30 MHz with a full 150 Watts SSB/CW/Digital. No ground, radials or counterpoises needed. 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).

MFJ low loss *Butterfly* loop tuning capacitor has no rotating contacts. *Easy-Carry* handle. Mount for PVC Cross loop support on cabinet top.

MFJ-936B, $299.95. Antenna current meter, Cross-Needle SWR/Wattmeter. 9¼Wx5½Hx9½D inches.

MFJ-935B, $249.95. Antenna current meter. 6¼Wx5½Hx9½D inches.

MFJ-933, $209.95. 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.

AR-500
$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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MFJ...the World Leader in Ham Radio Accessories!

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
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4 Balanced Line, 2 Coax

4 pairs of high-voltage ceramic feed-thru insulators for balanced lines and 2 coax connectors.

MFJ-4600
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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.

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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 $1^1/_4$x$1^5/_8$ 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

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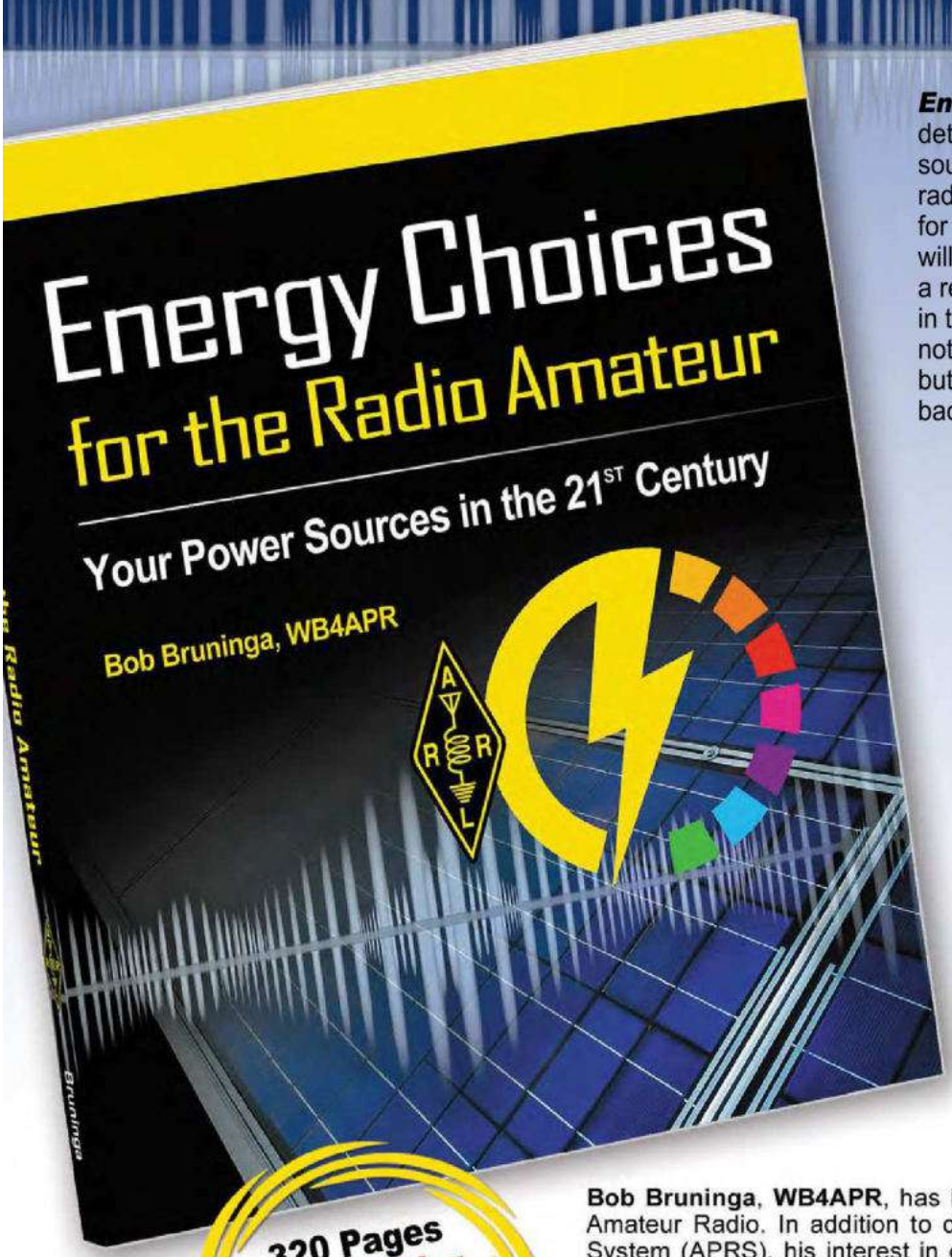

Energy Choices for the Radio Amateur details the author's experiences with new sources of energy. It is intended to help other radio amateurs and DIY hobbyists prepare for the inevitable major energy decisions they will face—choices that can contribute to a reduction in fossil fuel use and save money in the long run. The concepts presented not only satisfy everyday power requirements, but also can help prepare for emergency and backup power at home and in the field.

Chapters include:

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320 Pages of Full Color Photos and Illustrations!

Bob Bruninga, WB4APR, has had a lifelong interest in energy as well as Amateur Radio. In addition to developing the Automatic Packet Reporting System (APRS), his interest in energy technology has led him to embrace home solar, electric vehicles, heat pumps, and other advances that have greatly reduced his family's energy costs while providing a new appreciation for how they all work together at high voltage DC for a whole new approach to emergency power.

Energy Choices for the Radio Amateur

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MFJ-259D...World's Most Popular Antenna Analyzer!

MFJ-259D
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Super easy-to-use!

Dual analog meters, LCD – New and improved, now covers 280 KHz-230 MHz plus 2200 Meter band!

NEW!

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!

You can 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.

You can read SWR, return loss and reflection coefficient at any frequency simultaneously.

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Every MFJ Analyzer is protected by MFJ's famous one year **No Matter What**™ limited warranty. We will repair or replace your MFJ analyzer (at our option) for a full year.

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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.

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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 only 4 x 2 x 6 3/4 inches.

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If digital display is all you need MFJ-249D does everything MFJ-259D does without analog meters.

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280 KHz - 230 MHz *plus* 415-470 MHz, 280-230 MHz plus 2200Meters!

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NEW!

MFJ-269D is a *super* MFJ-259D that adds 415-470 MHz and 12-bit A/D converter that gives you much better accuracy. *Complex Impedance Analyzer* reads series/*parallel* equivalents and magnitude/phase *CoaxCalculator*™ gives line length from electrical degrees and vice-versa for any frequency, Velocity Factor, coax loss in dB. Use any characteristic impedance 10-600 Ohms. Has LCD log SWR bargraph, N-connector.

MFJ-223

1-60 MHz Color Graphic VNA Analyzer

MFJ-223
$339.95

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, MFJ-223 is packed with all the VNA features and performance you need!

- **Single-frequency** and *swept-frequency* operating modes
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- **Seamless DDS** coverage with 280-Hz resolution from 1-60 MHz
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- **Powerful +5-dBm** stimulus generator overrides local interference
- **Field-strength meter** measures local signals, detects potential interference
- **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

MFJ-225
$339.95

Out in the field, 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 detailed 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 fullscreen easy-to-view SWR bargraph, capture vivid swept displays for SWR, impedance, return loss, phase angle, more. DDS generator.

MFJ-269DPRO™ Analyzer

MFJ-269DPro, $459.95

Like MFJ-269D, but UHF range covers ***430 to 520 MHz*** to include commercial and industrial frequencies. Rugged protective shell protects knobs, switches, meters, digital display for commercial, industrial and lab work.

MFJ VNA Antenna Analyzer

MFJ VNA Antenna Analyzer covers 1 to 230 MHz, 1Hz resolution.

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- ***Sign of reactance*** positively identifies inductive or capacitive reactance
- ***Amazing accuracy with OSL (Open-Short-Load) calibration*** – calibrate through feedline/test cable at different frequencies and store in memory. Measure directly or through feedline with exceptional accuracy, correcting for line loss/phase angle. ***Smith Chart*** plots S11 magnitude/phase over any frequency span. ***Capture screens*** in 32 memories to download to PC via USB.

MFJ-226
$359.95

MFJ SWR Analyzer Accessories

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C. **MFJ-66C, $39.95.** Dip coils, set of two covers 1.8-230 MHz.

D. **MFJ-731, $119.95.** Tunable Analyzer Filter, 1.8-30 MHz, for strong RF fields.

E. **MFJ-917, $39.95.** 1:1 Current balun for SWR Analyzers to test balanced line antennas, other loads.

F. **MFJ-5510, $15.95.** 12VDC cigarette lighter adapter.

G. **MFJ-7737, $9.95.** PL-259 to BNC Female.

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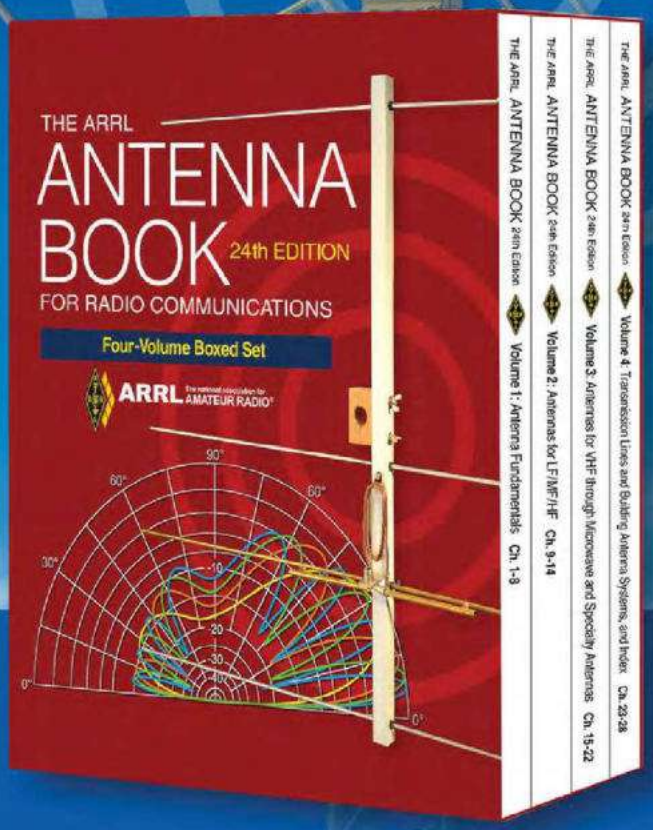

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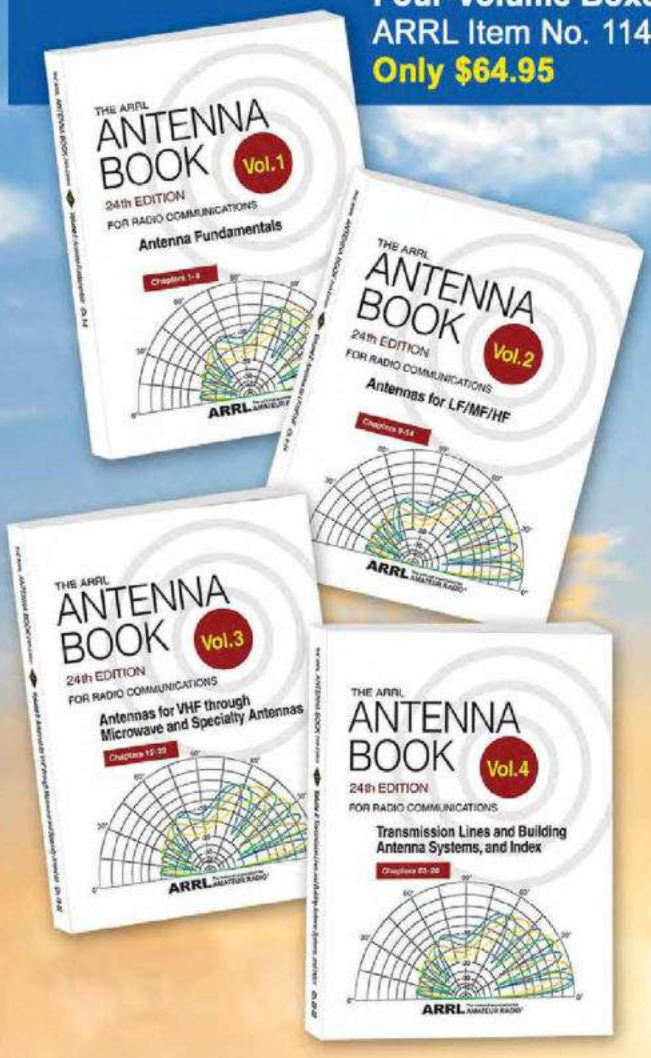

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Why? Because the world's leading tuner has earned a worldwide reputation for being able to match just about anything.

Full 1.8-30 MHz Operation

Tune your antenna for minimum SWR! Works 1.8-30 MHz on dipoles, verticals, inverted vees, random wires, beams, mobile whips, shortwave receiving antennas...Use coax, random wire, balanced lines. Has heavy-duty 4:1 balun for balanced lines.

Custom inductor switch

Custom designed inductor switch, 1000 volt tuning capacitors, Teflon® insulating washers and proper L/C ratio gives you arc-free

no worries operation up to 300 Watts PEP transceiver input power.

The MFJ-949E inductor switch was custom designed to withstand the extremely high RF voltages and currents that are developed in your tuner.

8-Position Antenna switch

Antenna switch lets you select two coax fed antennas, random wire/balanced line or dummy load through your MFJ-949E or direct to your transceiver.

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Full size 3-inch lighted Cross-Needle Meter. Lets you easily read SWR, peak or average forward and reflected power simultaneously. Has 300 Watt or 30 Watt ranges.

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Plus Much More!

Full size built-in non-inductive 50 Ohm dummy load, scratch-proof Lexan multi-colored front panel, $10^5/_8$ x $3^1/_2$ x 7 inches. Superior cabinet construction and more!

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New, improved MFJ- 989D legal limit antenna tuner gives you better efficiency, lower losses and a new true peak reading meter. Easily handles full 1500 Watts SSB/CW, 1.8-30 MHz, including MARS/WARC bands. Six position antenna switch, dummy load. New 500 pF air variable capacitors. New improved AirCore™ Roller Inductor. New high voltage current balun. New crank knob. $12^7/_8$W x 6H x $11^5/_8$D inches.

MFJ-986 Two knob Differential-T™

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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. $10^3/_4$W x $4^1/_2$H x 15 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. $10^3/_4$ x $4^1/_2$ x $10^7/_8$ 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-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, $149.95.** Tuner Kit -- Build your own!

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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 8 x 2 x 6 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.

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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 x $6^1/_2$ x $2^1/_2$ in.

MFJ-971 $149.95

MFJ-901B Smallest Versa Tuner

MFJ's smallest (5 x 2 x 6 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

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Tiny $4^1/_2$ x $2^1/_4$ x 3 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. $7^1/_4$ x $2^1/_4$ x $2^3/_4$ 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 2 x 3 x 4 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, $59.95**

MFJ-9201 $59.95

MFJ-921/924 VHF/UHF Tuners

MFJ-921 covers 2 Meters/220 MHz. **MFJ-924** covers 440 MHz. SWR/Wattmeter. 8 x $2^1/_2$ x 3 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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MFJ-4416C Super Battery Booster

Boost battery voltage as low as 9 Volts back up to 13.8 VDC! Keeps your transceiver at full power output, compensates for run down battery, wiring voltage drop, car off...

MFJ-4416C
$199.95

Keeps your transceiver at full power output, provides full performance, high efficiency, prevents output signal distortion and transceiver shutdown. Compensates for run-down battery, wiring voltage drop or when car is off. Provides up to 25 Amps peak with 90% efficiency. Selectable 9/10/11 Volts minimum input voltage prevents battery damage from over-discharging. RF sense turns MFJ-4416C off during receive to save power, increases efficiency and reduces noise. Adjustable 12 to 13.8 VDC output pass-through improves efficiency and lets transceiver run cooler. Has output over-voltage crowbar protection. *Anderson PowerPoles®* and high-current 5-way binding posts for DC input, regulated output. $7\frac{3}{4}$W x 4H x $2\frac{1}{8}$D inches. **MFJ-4416BRC, $84.95.** Booster Remote Control.

Super Heavy Duty Battery Booster

MFJ-4418
$249.95

Super robust with heavy duty transistors, rectifier, improved switch-mode transformer, larger heatsink. Input and output EMI filters reduce noise to minimum. Rugged construction. *PowerPoles®* and 5-way binding posts. MFJ software adjusts output voltage, measure load current, set minimum voltage level, over-current trip level, ignition control, more. External boost enable, remote input/output voltage sampling, remote controllable with MFJ-4416BRC.

RFI Filter for DC power

MFJ-1142
$74.95

Connects between rig and 12/24/50 VDC power supply/battery. Reduces RFI, hash, transients, motor noises, alternators, fuel pump whine, power windows, more! Binding posts/*PowerPoles®*.

Digital Volt/Amp Meter

MFJ-4442
$49.95

Connect in-line. Displays 4.5-30 VDC and up to 30A simultaneously. .01-.1V resolution. Dual .28" red/blue LED digits. *Anderson PowerPoles™*. Reverse polarity protection. 3 x 2 x 1".

RFI Ferrite Chokes

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$14.95

Suppress RFI. Snap and locks on DC power line, coax, wires. Effectively removes RFI and noise. Install end-to-end or loop multiple turns for more suppression. .275" hole dia. 4 in package.

PowerPole™ DC Outlet Box

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