A Beginner's Guide to Silkscreen Printing | 60

QST

DIGITAL EDITION

ARRL The National Association for Amateur Radio®

January 2022 www.arrl.org

DEVOTED ENTIRELY TO AMATEUR RADIO

A New Year On the Air

QST Reviews

Baofeng GT-5R Dual-Band Handheld Transceiver

West Mountain Radio CBA V Battery Analyzer

Wire Strippers for the Amateur Workshop

SOTABEAMS ContestConsole for Icom Transceivers

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- Memory Auto Grouping (MAG) / VFO Band Skip Function

Primary Memory Group Touch & Go operation

Touch & Go Operation

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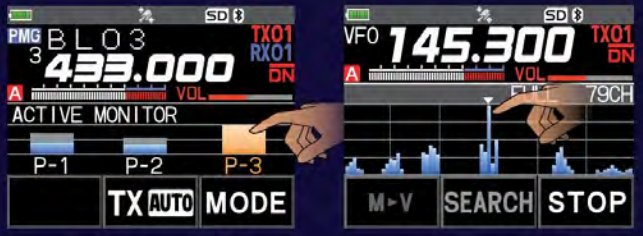

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- **New Memory Auto Grouping (MAG) Function**
- **New Multi-Channel Standby (MCS) Function**
- **High-Speed 61 Channel Band Scope**
- **Easy Hands-Free Operation with Built-in Bluetooth® Unit**

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50 W DIGITAL MOBILE TRANSCEIVER

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WIRES-X

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MA-6B 6-Band Beam

Small Footprint -- Big Signal

2-Elements on 20/17/15/12/10/6 Meters!!!

Cushcraft's latest MA-6B gives you *2-elements on six bands!* You get solid *signal-boosting directivity* in a bantam-size and weight.

It mounts on your roof or mast using standard TV hardware. It's perfect for exploring exciting DX without the high cost and heavy lifting of installing a large tower and a full-sized array. Its 7 foot 3-inch boom has less than 9 feet of turning radius. Contest tough -- handles 1500 Watts.

The unique MA-6B is a *two-element Yagi* on 20/17/15/12/10/6 Meters. It delivers solid power-multiplying gain over a dipole on *all* bands. You get automatic band switching and a super easy installation in a compact 26-pound package.

When working DX, what really matters are the interfering signals and noise you *don't hear*. That's where the MA-6B's impressive side rejection and front-to-back ratio really shines.

MA-5B, $599.95. Like MA-6B but five bands: 20/17/15/12/10 Meters. 12 and 17 Meters is a single element trapped dipole. ***See cushcraftamateur.com*** *for gain figures.*

Cushcraft 10, 15 & 20 Meter Tribander Beams

Only the best tri-band antennas become DX classics, which is why the Cushcraft World-Ranger A4S, A3S, and A3WS go to the head of the class. For more than 30 years, these pace-setting performers have taken on the world's most demanding operating conditions and proven themselves every time. The key to success comes from attention to basics. For example, element length and spacing has been carefully refined over time, and high-power traps are still hand-made and individually tuned using laboratory-grade instruments. All this attention to detail means low SWR, wide bandwidth, optimum directivity, and high efficiency -- important performance characteristics you rely on to maintain regular schedules, rack up impressive contest scores, and grow your collection of rare QSLs!

It goes without saying that the World-Ranger lineup is also famous for its rugged construction. In fact, the majority of these antennas sold years ago are still in service today! Conservative mechanical design, rugged over-sized components, stainless-steel hardware, and aircraft-grade 6063 make all the difference.

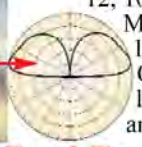
The 3-element A3S/A3WS and 4-element A4S are world-famous for powerhouse gain and super performance. **A-3WS, $569.95,** 12/17 M. **30/40 Meter** *add-on kits* available.

Cushcraft R9 . . . *80-6 Meters* *80 Meters . . . No Radials . . . 1500W*

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/poor band conditions.

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.

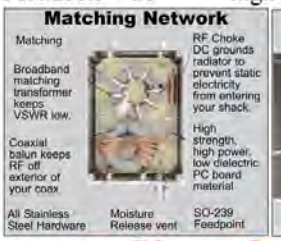
Rugged Construction: Thick fiberglass insulators, all-stainless steel hardware and 6063 aircraft-aluminum tubing is double or triple walled at key stress points to handle anything Mother Nature can dish out.

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

R8, $619.95. Like R9, less 75/80 M.

R-8TB, $109.95. Lets you tilt your antenna up/down easily by yourself to work.

R-8GK, $89.95. Three-point guy kit for high winds.



Cushcraft Dual Band Yagis

One Yagi for Dual-Band FM Radios

Dual-bander VHF rigs are the norm these days, so why not compliment your FM base station with a dual-band Yagi? Not only will you eliminate a costly feed line, you'll realize extra gain for digital modes like high-speed packet and D-Star! Cushcraft's A270-6S provides three elements per band and the A270-10S provides five for solid point-to-point performance. They're both pre-tuned and assembly is a snap using the fully illustrated manual.

Cushcraft Famous *Ringos* Compact FM Verticals

W1BX's famous *Ringo* antenna has been around for a long time and remains unbeaten for solid reliability. The Ringo is broad-banded, lighting protected, extremely rugged, economical, electrically bullet-proof, low-angle, and more -- but mainly, it just plain works! To discover why hams and commercial two-way installers around the world still love this antenna, order yours now!

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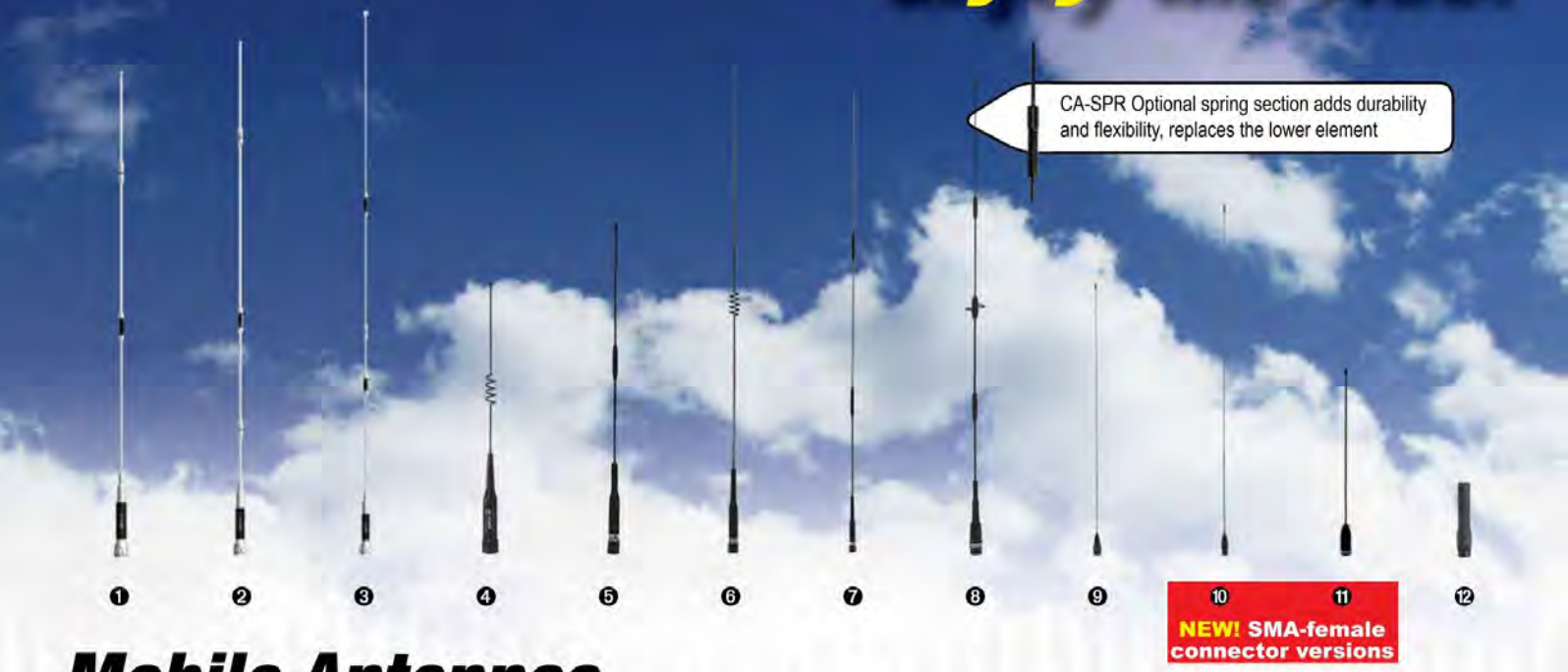

Mobile Antennas

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

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

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

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

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

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

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

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

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

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

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

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

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Jodi Morin, KA1JPA
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Steve Ewald, WV1X
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Write for *QST*

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

Our Cover
Winter conditions at the homestead of Bill Alsup, N6XMW. Shown among his antenna farm is a Cushcraft A4S with the boom extended 3 feet on each end to accommodate a two-element, 40-meter Yagi made from two Cushcraft D40 dipoles. With a new year and wintry weather upon us, it's a good time to think about where you'd like to go with ham radio in 2022. If you're interested in improving your station, you might find Meredith W. Hillier's, KG7EUM, article, "Effects of Common Building Materials on Radio Wave Propagation," an insightful look into how your shack's construction might play a role. Homebrewers looking to give their projects a professional touch should check out the tutorial, "A Beginner's Guide for Silkscreen Printing Projects," by Douglas Smith, NZ8V. There's a lot more to this issue, so dive in and start planning your new year on the air! [Bill Alsup, N6XMW, photo]

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As seen in QST Magazine January 2021
Page 48 Product Review Section

«The Dr.Duino Explorer Edition is a well-designed development, prototyping and troubleshooting platform»
Revied by Glen Popiel, KW5GP

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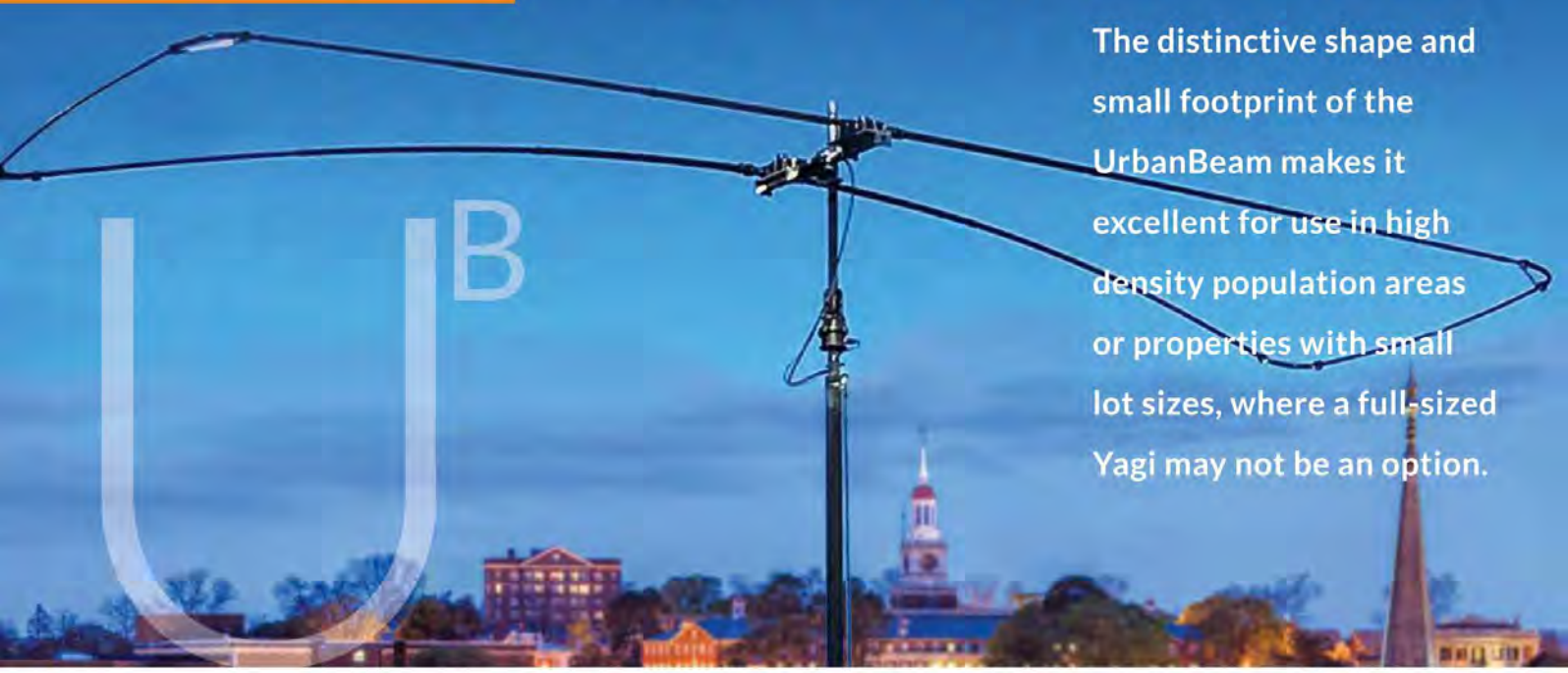
BIG DELIVERY

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

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X700HNA Special Features:

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- Wideband performance
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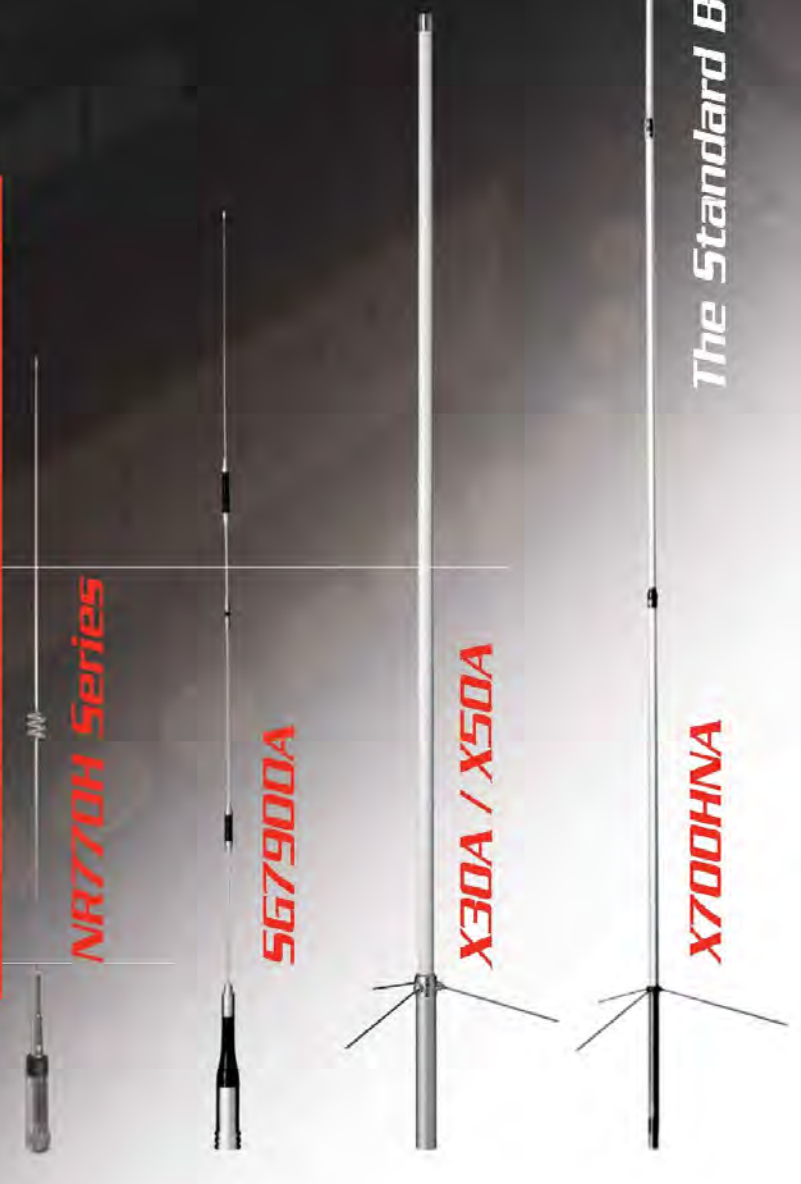
Here is a small sample of our wide variety of antennas

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



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

Second Century

A Passion for Learning

When I was first getting into amateur radio, my dad took a special interest in providing me with the basic tools necessary to be successful. One of the first things he gave me as a Christmas present was the 1977 ARRL Handbook. *I dove into the book with gusto! Much of it was over my head, but I began putting small bookmarks through the book as reminders of things to go back to, to try for myself! This also led to a love of reading older editions of the* Handbook *that featured tube transmitter projects.*

In November, we brought a similar passion for the *Handbook* to new and beginner-level hams with a YouTube series about this valuable resource. We partnered with a group of YouTube content creators who each gave their view of a section of the 2022 *Handbook*. Their dives into the book made it less intimidating, each covering subjects relevant to projects and activities the viewers may have in mind. The video series was a resounding success, and something we will do again in the future with other topics. We will also be featuring a forum track at the ARRL National Convention in February, called "Hands-On *Handbook*," which will expand upon the learning from this video series.

Our books, magazines, and digital content make ARRL the leading destination for ham radio learning and information. ARRL has published *QST* for more than 100 years. But did you know that we publish four magazines — *QST*, *On the Air*, *QEX*, and *NCJ* — and that all of them are accessible to members digitally at **www.arrl.org/arrl-magazines**? I have always subscribed to *NCJ*, ARRL's *National Contest Journal* — which is celebrating 50 years of publication this year — to support the publication, and also to keep myself aware of and constantly learning from the great work contesters are doing, from station design, to receiving antennas, to operating techniques. It is this passion for learning that drives us at ARRL, and where we're going as a part of our digital transformation.

We recently launched the ARRL Learning Center, which you can visit at **learn.arrl.org**. This has been an effort with the creative agency Mintz & Hoke to establish a portal for presenting education and learning content. Some of the learning tracks available at the Learning Center will lead to certificates associated with ARRL programs, such as ARES. We will continue to develop content for the Learning Center and are open to your ideas. Feel free to submit them at **arrl.org/ideas**.

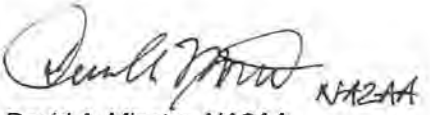
We are also constantly finding opportunities to create short, focused videos, and are posting them on our YouTube channel at **youtube.com/ARRLHQ**. We recently licensed the Technician class training videos from Dave Casler, KEØOG, adding these to our YouTube channel, with the General- and Extra-class videos being featured in the Learning Center. As the Learning Center and YouTube channel become destinations for members and potential new hams alike, they will offer plenty of support for getting or upgrading your amateur radio license.

Recently, we had the good fortune to hire Steve Goodgame, K5ATA, to take the helm of our Education & Learning Department. Steve was a schoolteacher who had tremendous success working amateur radio into his curriculum and getting his students licensed and active. Working with ARRL gives Steve the opportunity to do this at a national level. We are now in the beginnings of working with various state Boards of Education on aligning new technology curriculum standards with activities related to amateur radio. We recently had the opportunity to meet with a representative of the Illinois State BOE, and have established a working relationship as we find meaningful ways to incorporate amateur radio into more schools.

Over the past year, I have been very focused on the quality of content in our books. As members purchase these books — sometimes spanning multiple editions as the content changes — it is critical that what we are offering is up to date and free from errors. To that end, I am committed to taking on our next satellite book as my own project. I want to integrate QR codes that link to supplemental content as the reader navigates the book, looking at videos and the most up-to-date information on current satellites. It has always amazed me how quickly out of date satellite information and presentations become. By pursuing this digital immersion that involves print, text, and video, the content can become evergreen and make learning easier and more relevant for the reader!

Passion for radio. Passion for learning. It's what we're all about. We're open minded to approaches and to new content creators, so let us know what has been successful for you! Be radio active, connect those potential or new hams to our content, and let us know what you think.

Very 73,



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Chief Executive Officer

hy-gain Antennas and Rotators

HF Verticals

Work amazing DX with these extremely low radiation angle omnidirectional antennas. All self supporting, 1500 Watts PEP SSB, low SWR. Heavy duty, slotted, tapered, swaged, aircraft quality aluminum tubing. Stainless steel hardware. Two year limited warranty.

AV-680, $619.95. 9 Bands: (6, 10, 12, 15, 17, 20, 30, 40, 80 Meters). 26 ft., 18.5 lbs. *Our most popular vertical now has 75/80 Meters! Lets you work exciting DX with a low 17 degree radiation angle!* Easily mount on decks, roofs, patios. *No ground or radials needed.* Extra wide 2:1 SWR bandwidths. *Each* band tunable. Auto band-switching, handle 1.5kW, 80 MPH wind survival, low 2.5 sq. ft. wind surface. Aircraft aluminum tubing, stainless steel hardware.

AV-640, $519.95. Like AV-680 less 80M. 25'/2', 17'/2 lbs.

AV-620, $419.95. Like AV-640 less 40M. 22'/2'/10'/2 lbs.

AV-14AVQ, $249.95. (10, 15, 20, 40 Meters). 18 ft., 9 lbs. *Classic* AV-14AVQ uses same trap design as famous Hy-Gain Thunderbird beams. 3 air dielectric Hi-Q traps with oversize coils give superb stability and 1/4 wave resonance on all bands. Automatic bandswitching.

AV-12AVQ, $189.95. (10, 15, 20 Meters). 13 ft., 9 lbs. Lowest priced *automatic bandswitching* tri-band vertical! Uses Thunderbird beam design air dielectric traps for extremely hi-Q performance in limited space.

AV-18VS, $169.95. (10,12,15,17,20,30,40,80M). 18 ft., 4 lbs. hy-gain's lowest priced vertical gives you 8 bands. Easily tuned to any band by adjusting base loading coil.

See our website for even more hy-gain vertical antennas!

HF Beams

Hy-gain beams are *stronger, light-er, have less wind surface and last years longer.* Why? *Hy-gain* uses durable *tooled* components -- massive boom-to-mast bracket, heavy gauge element-to-boom clamps, thick-wall swaged tubing -- no failures!

TH-11DX, $1399.95.
11-element, 4.0 kW PEP, 10,12,15,17,20 Meters. *The choice of top DXers.* With 11-elements, excellent gain and 5-bands, the super rugged TH-11DX is the *"Big Daddy"* of all HF beams! Features low loss log-periodic driven array on all bands with mono- band reflectors, BN-4000 high power balun, corrosion resistant wire boom support, hot dipped galvanized and stainless steel parts.

TH-7DX, $1199.95. 7-Element, 1.5 kW PEP, 10, 15, 20 Meters. 7-Elements gives you *the highest average gain of any Hy-gain* tri-bander! Dual driven for broadband operation without compromising gain. SWR less than 2:1 on all bands. Combined monoband and trapped parasitic elements give you an excellent F/B ratio.

TH-3MK4, $569.95. 3-Element, 1.5 kW PEP, 10, 15, 20 Meters. Gives most gain for your money in full-power, full-size *hy-gain* tri-bander! Impressive gain and a *whopping* average front-to-back ratio and still fits on an average size lot. 95 MPH wind survival.

TH-3JRS, $439.95. Compact 3-Element, 600 W PEP, 10, 15, 20 Meters. *Hy-gain's most popular and lowest-priced tri-bander fits smallest lot,* 14.75 ft turning radius, 21 lbs. Excellent gain and front-to-back let you compete with the "big guns"! 80 MPH wind survival.

hy-gain Rotators . . . the first choice of hams around the world!

HAM-IV . . . $729.95

The most popular rotator in the world! For medium communications arrays up to 15 sq. feet wind load area. 5-second brake delay! Test/Calibrate function. Low temperature grease permits normal operation down to -30° F. Alloy ring gear gives extra strength up to 100,000 PSI for maximum reliability. 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 antenna movement. North or South center of rotation scale on meter, low voltage control, max mast size of 2'/$_{16}$".

HAM-VI, $909.95. For medium arrays up to 15 sq. ft. wind load. Like HAM-IV but has *new* ***DCU-2*** *Digital Rotator Controller.* Just dial in your beam heading or let your computer control your antenna.

HAM-VII, $999.95. Like HAM VI but with ***DCU-3*** digital controller with *six programmable memories.*

Tailtwister T-2X . . . $969.95

For large medium antenna arrays up to 20 sq. ft. wind load. Choose ***DCU-2*** *digital* controller (T-2XD2) or *analog* control box (T-2X) with *new* 5-second brake delay and *new* Test/Calibrate function. Low temperature grease, alloy ring gear, indicator potentiometer, ferrite beads on potentiometer wires, *new* weather-proof AMP connectors plus 8-pin plug at control box, triple bearing race with 138 ball bearings for large load bearing strength, electric locking *steel* wedge brake, N or S center of rotation scale on meter, low voltage control, 2'/16" max. mast.

T-2XD2, $1079.95. Tailtwister with ***DCU-2*** *digital* controller.

T-2XD3, $1139.95. Tailtwister with ***DCU-3*** digital controller with *six programmable memories.*

AR-40, $419.95. For compact antenna arrays and FM/TV up to 3.0 sq. ft. wind load. Dual 12 ball-bearing race. Fully automatic.

CD-45II, $519.95. For antenna arrays up to 8.5 sq. ft. Bell rotator design gives total weather protection. Dual 58 ball bearing race.

Digital Rotator Controller with 6 Programmable Beam Headings

DCU-3
$519.95

***New* DCU-3** Digital Controller lets you program 6 beam headings! Gives you fully automatic or manual control of your hy-gain HAM or Tailtwister Rotators.

Push a memory button or dial in your beam heading or let *Ham Radio Deluxe* (or other program) control your DCU-3. Your antenna automatically rotates precisely and safely to your desired direction.

Replace Your Yaesu Rotator Controller

YRC-1
$399.95

Replace your Yaesu rotator controller. More features and a much more robust controller that is far less prone to lighning damage. YRC-1 costs less than repairing your original controller!

hy-gain VHF/UHF Antennas

VB-214FM, $149.95. 14-element 2-Meter FM beam antenna provides exceptional front-to-back ratio and maximum obtainable gains.

VB-23FM, $69.95. 3-element.
VB-25FM, $79.95. 5-element.
VB-28FM, $129.95. 8-element. Threaded stub for feedpoints. Accepts up to 2 inch mast.
DB-2345, $139.95.
Dual band 144 (3-elements) 440 (5-elements) MHz.

hy-gain **Antennas, Rotators & Towers** 308 Industrial Park Rd, Starkville, MS 39759 USA
Sales/Tech: (662) 323-9538 • **FAX:** (662) 323-5803 Open 8-4:30 CST, Mon.-Fri.
Add Shipping. Prices and specifiecations subject to change. (C) 2021 hy-gain

It's a Great Gift...

No matter the QTH, this Mag Loop Antenna is for you.

- Quick Setup
- No Tower (6' is plenty high)
- No Radials Required
- Deploy in Backyard, Balcony, Loft
- No HOA Hassles
- Very Low Noise
- Auto Tuned for Best SWR
- 80m to 10m Models

No Compromises

Retaining all the great features of our HG3 PRO model, the new HG3 QRO high power (1.5 KW) model (shown here), raises the bar again in magnetic loop antenna (MLA) performance. It covers 80*-10 meters. Adding the optional second radiator loop (two turns), allows full power operation on 80 meters.

Unrivaled Tuning Capability

Shown below is the high Q vacuum capacitor with a 45,000-step resolution stepper motor. This delivers an unprecedented 511 Hz tuning resolution and allows the operator to set his/her band preferences.This is very helpful when making QSOs under non-ideal and crowded band conditions.

New HG3 *plus* Controller

It is completely redesigned. It controls both the HG3 PRO and HG3 QRO MLA models and the AR1 Rotator. It remotely tunes 3.5-30 MHz with stepper motor precision and resolution. *RapidTune* automatically scans each band for the lowest SWR and works with most HF radios.

HG3 QRO

- 1.5 KW PEP
- High Q Vacuum Cap
- 45K Step Resolution
- Auto assist tuning
- 40m-10m standard
- 80m-30m add-on loop

Stepper Motor
Positioned High Q
Vacuum Cap

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Array Solutions Lightning Arrestors

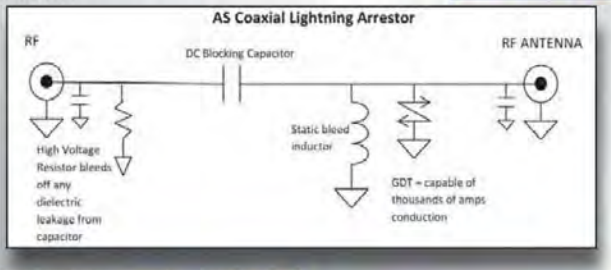
Coaxial , Ladder Line, Single wire, Control Line protection for Rotators, Switches, and Antenna Motors

AS-300 Series arrestors are known for their reliability and performance. They feature easy mounting to plates, ground rods with our stacking bracket and also a convenient screw lug. The stacking bracket can be used on plates as well to save precious room in arrestor enclosures.

- Available in SO-239, Type-N, and 7/16 DIN
- connectors
- DC blocked, DC pass is available as a custom option
- Unique static bleed system with a UL approved Gas Discharge Tube, also ITU K 12 tested. This system usually prevents the GDT from ever firing unless a direct hit is taken. Saves your radio from static build up on large antennas.
- Models available for 3 kW, 5 kW, 10 kW and higher, details on website. Lower power available.
- FM low power broadcast model AS-303D FM
- Model AS-309H high-power single wire or ladder line arrestor, also DC block with static bleed
- Control line Arrestors for 8, 12, and 16 wires – 65V sparkover.
- Models for HF, VHF to UHF – Extremely low loss and Low VSWR

AS-303U

AS-309H



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5kW - DC to 6m

RATPAK – 1x6

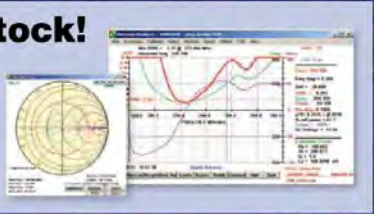
Choice of Multiple Controllers

SIXPAK – 2x6

VNAuhf Back in Stock!

Vector Network Analyzer

5 kHz -1.3 GHz **$1295**



Hamation Station Automation

Hamation remote and Local Station Control products allow you to automatically or manually select antennas, bandpass filters, and control accessories. Accessories can be StackMatches, Antenna switches, antenna phasing systems, SteppIR controller, turning radios on and off, etc. All of this can be done directly from the Ethernet as well!

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.

A more complex system could be a SO2R contest station as shown.

The Shared Apex Loop Array™!

Capture the whole band or the whole HF spectrum at once with the Shared Apex Loop Array 2nd Generation. Can be remote controlled over the internet or in your station. 8 directions of directivity.

The Shared Apex Loop Array™ is a revolutionary receiving antenna that will change the way that you listen to the radio! The patented design provides performance in a size and over a wide range of frequencies that will please both the rag-chewer and DXer alike.

Three models to choose from:

- AS-SAL-30 - optimized for VLF, BCB, 1.8-10 MHz
- AS-SAL-20 - optimized for BCB, and 1.8-30 MHz
- AS-SAL-12 - optimized for 3-30 MHz

StackMatch

The original, not the imitations. For phasing 2, 3, 4 and even 6 antennas. Also it can be used to combine vertical and horizontal polarized antennas to diminish fading.

PowerMaster II

RF Power and SWR meter. Couplers for 3 kW, 10 kW or higher available for HF/6 m. VHF and UHF couplers for 1.5 kW. You can connect up to 5 couplers to the display to monitor RF power on different TX lines.

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Array Solutions' products are in use at top DX and Contest stations worldwide as well as commercial and governmental installations. We provide RF solutions to the DoD, FEMA, Emcomm, UN, WFO, FAA and the State Dept. for products and installation of antennas systems, antenna selection, filtering, switching and grounding. We also offer RF engineering and PE consulting services.

Member Spotlight

Bob Willman, WB8NQW

"For as long as I can remember, I have been curious about how things work," says Bob Willman, WB8NQW, of Bowling Green, Ohio. "In the mid-1940s, many new technologies came to market. Our next-door neighbor was the first to have a television. Static-free FM radio stations started coming online, too. It was a great time to be a precocious child."

In 1959 Bob entered the 2-year electronics program at DeVry Technical Institute in Chicago. There, he developed an appetite for kit building. Bob recalls building a 300 V dc power supply, a 20-W-per-channel stereo amplifier, an FM tuner, and a transistorized preamplifier, among other things.

Planting the Amateur Radio Seed

"My lab partner at DeVry was the late Rich Mencel, who was K9TSY at the time, and later K9UA," Bob recalls. "I fondly remember the time we went to the Chicago FCC office one afternoon and passed our Second- and First-Class radiotelephone and radar exams. Rich shared my love of technology. He was an avid county hunter and DX hound. He planted the seed for amateur radio in my life, although it took 10 years for it to take root."

Bob finally became a Novice in 1971, and he kept an on-air schedule with Rich on Saturday mornings on 75 or 40 meters. They chatted by CW initially, but two years later Bob earned his Advanced license and they switched to SSB. "Our families made annual visits to each other's homes, and the Dayton Hamvention was an annual family expedition," Bob said.

In 1971, Bob joined the Wood County Amateur Radio Club in Bowling Green, Ohio and has remained a member ever since. He has also been a member of SKYWARN since its inception and has been a volunteer in the Community Collaborative Rain, Hail, and Snow network since 2011.

For Bob, mastering Morse has always been a struggle, so when the code exam requirement was dropped, he finally clinched his Amateur Extra license in 2014. "For the last year I have been trying to improve my CW skills," Bob said. "But after not using it since 1973, it has been a slow process."

A Passion for Heathkits

Bob developed a passion for Heathkit® projects while still in high school, and throughout his life he built much of the Heathkit product line, everything from test equipment to televisions. "As a Novice I assembled a DX-60B transmitter," Bob said. "That was followed by the Heathkit HD-10B external VFO. With the acquisition of my Advanced ticket, I decided it was time to build the Heathkit SB-401 transmitter to match my SB-301 receiver, followed by the SB-200 linear amplifier. Many more Heathkits came later. I can't even remember all the Heathkits I've built!"

Beyond Amateur Radio

Bob also manages to find time to pursue other interests. For more than 50 years he has been an active hunter, target shooter, bullet caster, and cartridge reloader. Bob had a student pilot's license for about 10 years and still has the desire to fly. His activities also include photography and high-end audio.

As if all those pursuits weren't enough, Bob has been a hobby blacksmith for more than 40 years. He was one of the founding members of Northwest Ohio Blacksmiths and still does demonstrations at the Wood County Museum "Boom Town" exhibit.

More Than Three Decades with IBM

Bob was hired by IBM in 1961 to do field service, starting with keypunches, card sorters, and mechanical tabulating machines. That eventually progressed to working with solid state computers, including mainframes. Bob was also involved with troubleshooting high-speed data communication networks. "When many corporations downsized in the early 1990s, my 33 years with IBM ended," Bob said.

Nurturing New Hams

Bob believes that attracting new hams, especially young hams, is essential to the future of ham radio and that innovative technology can be the hook. "Since our club installed an internet-linked Yaesu System Fusion repeater, new amateurs in our area are talking to the world without a major investment in time and money," Bob said. "It is a great way to get started and the smiles on their faces tell the story."

Guide to Member Benefits

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Create an online ARRL Member account, and get access to members-only benefits. Register at **www.arrl.org/myARRL**. Already registered? Log in at the top of the ARRL website.

- **Magazines | www.arrl.org/qst and www.arrl.org/ota**
  Members in the US receive a choice of print magazine: *QST*, ARRL's membership journal (12 monthly issues), or *On the Air*, our new magazine for new and beginner-to-intermediate-level radio amateurs (6 bimonthly issues). All members can access the digital editions of *QST*, *On the Air*, *QEX*, and *NCJ* from a web browser and apps available for iOS, Android, and Kindle Fire devices. Members need a valid ARRL account to access ARRL's digital magazines, the Archives and Periodicals Search, and the Product Review Archive.
- **E-Newsletters | www.arrl.org/myARRL**
  Subscribe to the weekly **ARRL Letter** and a variety of other ARRL e-newsletters and announcements.
- **New! The ARRL Current Email Newsletter**
  Members can elect to receive this monthly email within their online profile. Each issue provides a reminder of the available digital magazine issues and highlights articles from all four digital publications, along with podcast overviews, benefit updates, product and publication specials, and more.
- **New! ARRL Learning Network**
  www.arrl.org/arrl-learning-network
  This 30-minute webinar series features member-volunteers covering a variety of topics: technology, operating, and public service. Live presentations are recorded for viewing later.
- **Email Forwarding Service**
  Email sent to your **arrl.net** address will be forwarded to any email account you specify.

Technical Information Service | www.arrl.org/tis

Call or email our expert ARRL Technical Information Service specialists for answers to all your technical and operating questions.

Advocacy | www.arrl.org/regulatory-advocacy

ARRL supports legislation and regulatory measures that preserve and protect meaningful access to the radio spectrum. Our **ARRL Regulatory Information Branch** answers member questions concerning FCC rules and operating practices. **ARRL's Volunteer Counsel** and **Volunteer Consulting Engineer** programs open the door to assistance with antenna regulation and zoning issues.

Group Benefits* | www.arrl.org/benefits

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- **Liberty Mutual Auto and Home Insurance**
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The American Radio Relay League, Inc.

ARRL The National Association for Amateur Radio® in the United States: supports the awareness and growth of Amateur Radio worldwide; advocates for meaningful access to radio spectrum; strives for every member to get involved, get active, and get on the air; encourages radio experimentation and, through its members, advances radio technology and education; and organizes and trains volunteers to serve their communities by providing public service and emergency communications *(ARRL's Vision Statement, adopted in January 2016)*.

ARRL is an incorporated, noncommercial association without capital stock chartered under the laws of the State of Connecticut, and is an exempt organization under Section 501(c)(3) of the Internal Revenue Code of 1986. Its affairs are governed by a Board of Directors, whose voting members are elected every 3 years by the general membership. The officers are elected or appointed by the Directors.

ARRL is noncommercial, and no one with a pervasive and continuing conflict of interest is eligible for membership on its Board.

"Of, by, and for the radio amateur," ARRL numbers within its ranks the vast majority of active amateurs in the nation and has a proud history of achievement as the standard-bearer in amateur affairs.

A *bona fide* interest in Amateur Radio is the only essential qualification of membership; an amateur radio license is not a prerequisite, although full voting membership is granted only to licensed amateurs in the US.

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

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As an ARRL member, you elect the Director and Vice Director who represent your Division on ARRL policy matters. If you have a question or comment about ARRL policies, contact your representatives listed below.

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President
Rick Roderick, K5UR*
P.O. Box 1463, Little Rock, AR 72203
501-988-2527; **k5ur@arrl.org**

First Vice President
Michael N. Raisbeck, K1TWF*
85 High St.
Chelmsford, MA 01824
978-250-1235; **k1twf@arrl.org**

Second Vice President
Bob Vallio, W6RGG
18655 Sheffield Rd.
Castro Valley, CA 94546
510-537-6704; **w6rgg@arrl.org**

International Affairs Vice President
Rodney J. Stafford, W6ROD
5155 Shadow Est.
San Jose, CA 95135
408-238-4671; **w6rod@arrl.org**

Chief Executive Officer and Secretary
David A. Minster, NA2AA*
225 Main St.
Newington, CT 06111
860-594-0404; **dminster@arrl.org**

Treasurer
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Atlantic Division

www.atldiv.org
Tom Abernethy, W3TOM*
P.O. Box 73, Accokeek, MD 20607
301-257-6225; **w3tom@arrl.org**

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

Central Division

www.central.arrl.org
Carl Luetzelschwab, K9LA
1227 Pion Rd., Fort Wayne, IN 46845
260-637-6988; **k9la@arrl.org**

Vice Director: **Brent Walls, N9BA**
2151 E. Bomar Ln.,Greenfield, IN 46140
317-557-7224; **n9ba@arrl.org**

Dakota Division

www.arrldakota.org
Bill Lippert, ACØW
2013 6th Ave. SE, Austin, MN 55912
507-433-5835; **ac0w@arrl.org**

Vice Director: **Lynn Nelson, WØND**
3204 Willow Ln. SE, Minot, ND 58701
701-833-1000; **w0nd@arrl.org**

Delta Division

arrldelta.org
David A. Norris, K5UZ
907 Evening Sunset Cir., Redfield, AR 72132
870-613-1606; **k5uz@arrl.org**

Vice Director: **Ed B. Hudgens, WB4RHQ**
1441 Wexford Downs Ln., Nashville, TN 37211
615-630-2753; **wb4rhq@arrl.org**

Great Lakes Division

arrl-greatlakes.org
Dale Williams, WA8EFK*
291 Outer Dr., Dundee, MI 48131
734-529-3232; **wa8efk@arrl.org**

Vice Director: **Scott Yonally, N8SY**
258 Valley Hi Dr., Lexington, OH 44904
419-512-4445; **n8sy@arrl.org**

Hudson Division

www.hudson.arrl.org
Ria Jairam, N2RJ
P.O. Box 73, Sussex, NJ 07461
973-594-6275; **n2rj@arrl.org**

Vice Director: **William Hudzik, W2UDT**
111 Preston Dr., Gillette, NJ 07933
908-580-0493; **w2udt@arrl.org**

Midwest Division

www.arrlmidwest.org
Art Zygielbaum, KØAIZ
6601 Pinecrest Dr., Lincoln, NE 68516
402-421-0840; **k0aiz@arrl.org**

Vice Director: **Dave Propper, K2DP**
747 Old Bonhomme Rd., University City, MO 63132, 314-225-5167; **k2dp@arrl.org**

How to Contact ARRL Staff

To send an email to any ARRL Headquarters staff member, put his or her call sign (or first initial and last name) in front of **@arrl.org**. For example, to send to Hiram Maxim, First President of the ARRL, use **w1aw@arrl.org**, or **hmaxim@arrl.org**.

New England Division

https://nediv.arrl.org
Fred Kemmerer, AB1OC
39 Baldwin Ln., Hollis, NH 03049
603-413-5400; **ab1oc@arrl.org**

Vice Director: **Phillip E. Temples, K9HI**
125 Coolidge Ave. #803
Watertown, MA 02472-2875
617-331-0183; **k9hi@arrl.org**

Northwestern Division

www.arrlnwdiv.org
Mike Ritz, W7VO
33643 Burma Rd., Scappoose, OR 97056
503-987-1269; **w7vo@arrl.org**

Vice Director: **Mark J. Tharp, KB7HDX**
P.O. Box 2222, Yakima, WA 98907
509-952-5764; **kb7hdx@arrl.org**

Pacific Division

pacific.arrl.org
Kristen McIntyre, K6WX
900 Golden Wheel Park Dr., #85, San Jose, CA 95112, 510-703-4942; **k6wx@arrl.org**

Vice Director: **Anthony Marcin, W7XM**
6836 Boulder Canyon St.,
North Las Vegas, NV 89084,
702-984-9589; **w7xm@arrl.org**

Roanoke Division

arrl-roanoke.com
Dr. James Boehner, N2ZZ
525 Barnwell Ave. NW, Aiken, SC 29801-3939
803-641-9140; **n2zz@arrl.org**

Vice Director: **Bill Morine, N2COP**
101 Windlass Dr., Wilmington, NC 28409
910-452-1770; **n2cop@arrl.org**

Rocky Mountain Division

www.rockymountaindivision.org
Jeff Ryan, KØRM
9975 Wadsworth Pkwy. K2-275
Westminster, CO 80021
303-432-2886; **k0rm@arrl.org**

Vice Director: **Dan Grady, N2SRK**
8706 S. Buchanan Way, Aurora, CO 80016
720-236-7397; **n2srk@arrl.org**

Southeastern Division

www.facebook.com/ARRLSoutheasternDivision
Mickey Baker, N4MB
14764 Black Bear Rd., West Palm Beach, FL 33418, 561-320-2775; **n4mb@arrl.org**

Vice Director: **James Schilling, KG4JSZ**
44 Joel Massey Rd., Haines City, FL 33844
407-504-2629; **kg4jsz@arrl.org**

Southwestern Division

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

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

West Gulf Division

westgulfdivision.org
John Robert Stratton, N5AUS*
P.O. Box 2232, Austin, TX 78768-2232
512-445-6262; **n5aus@n5aus.com**

Vice Director: **Lee H. Cooper, W5LHC**
2507 Autrey Dr., Leander, TX 78641
512-658-3910; **w5lhc@arrl.org**

ARRL Section Managers

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Atlantic Division DE, EPA, MDC, NNY, SNJ, WNY, WPA

Delaware: Mark Stillman, KA3JUJ, 48 Upland Ct., Newark, DE 19713-2817 302-384-0916; **ka3juj@arrl.org**
Eastern Pennsylvania: George Miller, W3GWM, 293 Woods Rd., Wyalusing, PA 18853 570-250-1007; **w3gwm@arrl.org**
Maryland-DC: Marty Pittinger, KB3MXM, 4 Pegram Rd., Owings Mills, MD 21117 410-356-7899; **kb3mxm@arrl.org**
Northern New York: Thomas Dick, KF2GC, 11 Jenkins St., Saranac Lake, NY 12983 518-891-0508; **kf2gc@arrl.org**
Southern New Jersey: Tom Preiser, N2XW, 177 Bowsprit Rd., Manahawkin, NJ, 08050-5001 609-618-0224; **n2xw@arrl.org**
Western New York: Laura Mueller, N2LJM, 2011 E. Main St., Falconer, NY 14733 716-338-3122; **n2ljm@arrl.org**
Western Pennsylvania: Joe Shupienis, W3BC, P.O. Box 73, Falls Creek, PA 15840-0322 814-771-3804; **w3bc@arrl.org**

Central Division IL, IN, WI

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

Dakota Division MN, ND, SD

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

Delta Division AR, LA, MS, TN

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

Great Lakes Division KY, MI, OH

Kentucky: Steve Morgan, W4NHO, 1124 W. 12th St., Owensboro, KY 42301-2975 270-926-4451; **w4nho@arrl.org**
Michigan: Les Butler, W8MSP, P.O. Box 237, Gregory, MI 48137-0237 517-861-6325; **w8msp@arrl.org**
Ohio: Tom Sly, WB8LCD, 1480 Lake Martin Dr., Kent, OH 44240-6260 330-554-4650; **wb8lcd@arrl.org**

Hudson Division ENY, NLI, NNJ

Eastern New York: John K. Fritze, Jr., K2QY, 4 Normanskill Blvd., Delmar, NY 12054-1335 401-261-4996; **k2qy@arrl.org**
NYC-Long Island: Jim Mezey, W2KFV, 38 Appletree Ln., Carle Place, NY 11514-1336 516-315-8608; **w2kfv@arrl.org**
Northern New Jersey: Bob Buus, W2OD, 8 Donner St., Holmdel, NJ 07733-2004 732-946-8615; **w2od@arrl.org**

Midwest Division IA, KS, MO, NE

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

New England Division CT, EMA, ME, NH, RI, VT, WMA

Connecticut: Charles I. Motes, Jr., K1DFS, 22 Woodside Ln., Plainville, CT 06062 860-747-6377; **k1dfs@arrl.org**
Eastern Massachusetts: Tom Walsh, K1TW, 9 Wildwood Dr., Bedford, MA 01730 781-275-5882; **k1tw@arrl.org**
Maine: Robert Gould, N1WJO, 572 Poland Springs Rd., Casco, ME 04015-4016 207-415-5419; **n1wjo@arrl.org**
New Hampshire: Peter Stohrer, K1PJS, 9 Gladstone St., Concord, NH 03301-3130 603-345-1470; **k1pjs@arrl.org**
Rhode Island: Bob Beaudet, W1YRC, 30 Rocky Crest Rd., Cumberland, RI 02864 401-333-2129; **w1yrc@arrl.org**
Vermont: Paul N. Gayet, AA1SU, 11 Cherry St., Essex Junction, VT 05452 802-878-2215; **aa1su@arrl.org**
Western Massachusetts: Raymond Lajoie, KB1LRL, 245 Leominster Rd., Lunenburg, MA 01462-2031 978-549-5507; **kb1lrl@arrl.org**

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

Alaska: David Stevens, KL7EB, 8521 Golden St., Apt. 4, Anchorage, AK 99502 907-242-6483; **kl7eb@arrl.org**
Eastern Washington: Jo Whitney, KA7LJQ, P.O. Box 2222, Yakima, WA 98907 509-952-5765; **ka7ljq@arrl.org**
Idaho: Dan Marler, K7REX, 6525 W. Fairfield Ave., Boise, ID 83709 208-914-8939; **k7rex@arrl.org**
Montana: Paul Stiles, KF7SOJ, 5427 Deadwood Dr., Billings, MT 59105 406-671-7092; **kf7soj@arrl.org**
Oregon: David Kidd, KA7OZO, 21760 S. Larkspur Ave., Oregon City, OR 97045-9164 503-320-3484; **ka7ozo@arrl.org**
Western Washington: Monte L. Simpson, W7FF, P.O. Box 3008, Silverdale, WA 98383 360-633-7665; **w7ff@arrl.org**

Pacific Division EB, NV, PAC, SV, SF, SJV, SCV

East Bay: Mike Patterson, N6JGA, P.O. Box 30627, Walnut Creek, CA 94598; 925-200-8300; **n6jga@arrl.org**
Nevada: John Bigley, N7UR, 2420 Palora Ave., Las Vegas, NV 89121-2157 702-498-5829; **n7ur@arrl.org**
Pacific: Joe Speroni, AHØA, 278 Kapiolani Blvd. #502, Honolulu, HI 96826 808-955-2496; **ah0a@arrl.org**
Sacramento Valley: Dr. Carol Milazzo, KP4MD, P.O. Box 665, Citrus Heights, CA 95611-0665 916-259-3221; **kp4md@arrl.org**
San Francisco: Bill Hillendahl, KH6GJV, P.O. Box 4151, Santa Rosa, CA 95402-4151 707-544-4944; **kh6gjv@arrl.org**
San Joaquin Valley: John Litz, NZ6Q, 1434 Douglas Rd., Stockton, CA 95207-3536 209-331-3078; **nz6q@arrl.org**
Santa Clara Valley: James Armstrong, NV6W, 2048 Paseo Del Sol, San Jose, CA 95124-2048 408-679-1680; **nv6w@arrl.org**

Roanoke Division NC, SC, VA, WV

North Carolina: Marvin K. Hoffman, WA4NC, P.O. Box 2208, Boone, NC 28607 828-964-6626; **wa4nc@arrl.org**
South Carolina: Marc Tarplee, N4UFP, 4406 Deer Run, Rock Hill, SC 29732-9258 803-327-4978; **n4ufp@arrl.org**
Virginia: Joseph Palsa, K3WRY, 9101 Arch Hill Ct., Richmond, VA 23236-2725 804-350-2665; **k3wry@arrl.org**
West Virginia: Dan Ringer, K8WV, 18 W. Front St., Morgantown, WV 26501-4507 304-292-1999; **k8wv@arrl.org**

Rocky Mountain Division CO, NM, UT, WY

Colorado: Robert Wareham, NØESQ, 300 Plaza Dr., Ste. 200, Highlands Ranch, CO 80129 720-592-0394; **n0esq@arrl.org**
New Mexico: Bill Mader, K8TE, 4701 Sombrerete Rd. SE, Rio Rancho, NM 87124 505-250-8570; **k8te@arrl.org**
Utah: Pat Malan, N7PAT, 10102 S. Redwood Rd. #95401, South Jordan, UT 84095 801-413-7438; **n7pat@arrl.org**
Wyoming: Rick Breininger, N1TEK, 240 W. Railroad Ave., Green River, WY 82935 307-707-4010; **n1tek@arrl.org**

Southeastern Division AL, GA, NFL, PR, SFL, VI, WCF

Alabama: Roger Parsons, KK4UDU, 5791 Birmingport Rd., Mulga, AL 35118-9670 206-641-9063; **kk4udu@arrl.org**
Georgia: Jim Millsap, K9APD, 5127 Bramblewood Dr., Acworth, GA 30102-2405 770-355-0480; **k9apd@arrl.org**
Northern Florida: Kevin J. Bess, KK4BFN, 908 Flagler Ave., Edgewater, FL 32132-2124 386-547-2838; **kk4bfn@arrl.org**
Puerto Rico: Rene Fonseca, NP3O, Urb Santa Isidra 4 G8 Calle 6, Fajardo, PR 00738-4145 939-579-4134; **np3o@arrl.org**
Southern Florida: Barry M. Porter, KB1PA, 14555 Sims Rd., Apt. 251, Delray Beach, FL 33484 561-499-8424; **kb1pa@arrl.org**
Virgin Islands: Fred Kleber, K9VV, P.O. Box 24275, Christiansted, VI 00824-0275 **k9vv@arrl.org**
West Central Florida: Michael Douglas, W4MDD, 2527 Apple Blossom Ln., Wauchula, FL 33873 863-585-1648; **w4mdd@arrl.org**

Southwestern Division AZ, LAX, ORG, SDG, SB

Arizona: Rick Paquette, W7RAP, 1600 W. Sunkist Rd., Tucson, AZ 85755-9561 520-425-6877; **w7rap@arrl.org**
Los Angeles: Diana Feinberg, AI6DF, P.O. Box 4678, Palos Verdes Peninsula, CA 90274-9618 310-544-2917; **ai6df@arrl.org**
Orange: Bob Turner, W6RHK, P.O. Box 973, Perris, CA 92572 951-236-8975; **w6rhk@arrl.org**
San Diego: Dave Kaltenborn, N8KBC, 630 Alber St., Chula Vista, CA 91911 619-616-8758; **n8kbc@arrl.org**
Santa Barbara: John Kitchens, NS6X, P.O. Box 178, Somis, CA 93066 805-216-2569; **ns6x@arrl.org**

West Gulf Division NTX, OK, STX, WTX

North Texas: Steven Lott Smith, KG5VK, 125 Contest Ln., Ben Franklin, TX 75415-3830 318-470-9806; **kg5vk@arrl.org**
Oklahoma: Mark Kleine, N5HZR, 2651 84th Ave. SE, Norman, OK 73026 405-410-6756; **n5hzr@arrl.org**
South Texas: Stuart Wolfe, KF5NIX, 5607 Sunshine Dr., Apt. 219, Austin, TX 78756 512-660-9954; **kf5nix@arrl.org**
West Texas: H. Dale Durham, W5WI, P.O. Box 375, Buffalo Gap, TX 79508 830-719-9000; **w5wi@arrl.org**

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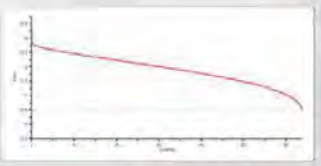

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Up Front

Museum Ships Weekend Aboard the USS *Alabama* and USS *Drum*

Members of the Deep South Amateur Radio Club (DSARC), K4DSR, renovated the Radio Room aboard the Battleship USS *Alabama*, restoring original antennas, replacing old coax lines, and repairing other equipment. They were able to finish the restoration and operate the Radio Rooms and Code Rooms aboard the USS *Alabama* and USS *Drum* during Museum Ships Weekend on June 4 – 6, 2021.

Led by DSARC president Mike Hartman, K4MR, club members Patty Webb, KO4DMR; Tim Morgan, WE5TM; Bruce Miller, KF4FFQ; Mike Taylor, W4MWT; Bryan Swearingen, N4FBO; Ryan Bridges, KD4AMK; Michael Varner, WY5Y, and Ken Bell, K4EES, operated from the USS *Alabama*, while club members Larry Anderson, K5LDA; Roy Davis, K5RMD; Jeff Chunn, NØJMC, and Todd Mitchell, KG4VVO, activated the USS *Drum*. During the 48-hour weekend and operation, DSARC members participated in tours of the ships' museums, and were able to interact with visitors, including Eric Kuhlenberg, KO4OHL, whose father served aboard the ship during the 1940s.

The USS *Alabama* at Battleship Memorial Park in Mobile, Alabama. [Photo courtesy of the USS *Alabama* Battleship Foundation, Inc.]

DSARC members operating from the wartime Radio Room of the USS *Alabama* during the 2021 Museum Ships Weekend. [Ken Bell, K4EES, photo]

The USS *Drum* at Battleship Memorial Park in Mobile, Alabama. [Photo courtesy of the USS *Alabama* Battleship Foundation, Inc.]

Morse at Port

In September 2021, ARRL Life Member Ray Day, N6HE, and his wife, Donna, W6DLD, were out boating in Alamitos Bay in Long Beach, California, and saw a boat named *Morse Code*. They were unable to identify the (presumably ham) owner of the vessel, but they were happy to see the boat at port.

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Correspondence

Letters from Our Members

Celebrating a Decade of Digital *QST*

January 2022 marks the 10-year anniversary of the digital edition of *QST*. It's so nice to read the magazine online before the print edition arrives in my mailbox, as I'm able to stay up to date on everything that's happening across ARRL.

Being older, I sometimes struggle with reading small text. The digital editions allow me to zoom in by double-clicking on the page I'm reading or adjusting the zoom toggle at the top left of the screen. If I'm looking for something specific, it's easy to search within the current edition or throughout all of the issues in the online archive, and the search results appear chronologically. Also, I can click on any active link to view additional information on a topic. The digital edition is fantastic!

With this digital platform, ARRL members have instant access to over 120 issues of *QST*, 12 issues of *QEX*, 12 issues of *On the Air*, and 12 issues of *National Contest Journal* (*NCJ*). This is a great benefit, especially to new members — they don't miss out on reading issues published prior to joining ARRL.

Al Rabassa, NW2M
Rockville, Maryland

Gotham V-80 Memories

Reading "The All-Band Gotham V-80 Vertical" by John Ellis, NP2B, in the June issue's "Classic Radio" column brought back memories. I earned my license when I was a sophomore in high school in 1962, and I knew nothing about antennas. I made a homebrew crystal-controlled 807-type radio from a design I saw in *The ARRL Handbook for Radio Communications*, and connected it to the shortwave listening (SWL) long-wire antenna that went from my second-floor bedroom to a tree in the backyard. I heard nothing on the Hallicrafters SX-140 receiver that I shared with my dad and brother.

I decided to purchase a Gotham V-80 antenna for $17 (which was a lot of money for someone my age in 1962), based on an ad I read in *QST*. It was simple to erect on the side of the house outside of my bedroom by using a bracket, 23 feet of tubing, a coil, and an alligator clip. Other than an across-town contact that I made with my friend Dick Kinney, K1QCP (now W1RKK), the only "successful" contact I ever made was an Official Observers (OO) Report for out-of-band operation on 40 meters. I didn't realize at the time that without radials, the V-80 antenna was resonating on 40 meters.

I eventually got my Technician-class license and built a 2E26 6-meter AM radio, and fell in love with the 6-meter band. I became determined to learn more about the physics of antennas and they've been of great interest to me ever since. I've also created a resource (**www.qsl.net/w1dyj/Antenna%20Modeling%20Talk.pdf**) to help other hams who may be struggling with understanding antennas.

Larry Banks, W1DYJ
Woburn, Massachusetts

A Call to Standardize State QSO Parties

It's nice to see hams from out of state participating in the Nevada QSO Party. I like to return the gesture by sometimes sending in my log (even though it might be small) to help hams in other states with their QSO parties. However, sometimes there can be four or more of these events on a given weekend. I think it would be beneficial if all states adhered to one exchange protocol, such as a signal report and state (or state and county abbreviation). This would simplify logging requirements and the ensuing confusion that comes with having different protocols for each state's QSO party. It might even encourage participation from stations who are wandering a particular band for contacts, because they wouldn't have to look up the exchange requirement prior to engaging. It would be great to see more participation in state QSO parties.

Howie Holden, WB2AWQ/7
Reno, Nevada

A Film Review of *NIGHT*

I recently read about the premiere of *NIGHT* (**www.youtube.com/watch?v=Kf1Q4tS32Ww**) in an issue of *The ARRL Letter*. In this 34-minute film, the sun doesn't rise one morning. One of the characters wants to use his grandfather's radio to try and help, as there's currently no access to internet, power, or telephones. I found the film interesting and liked that it showcased amateur radio in a positive light, but I think it was lacking some important details about the hobby.

The film could've benefited from an explanation of how hams maintain their own backup power sources during ac power disruptions, by using batteries for short-term outages and generators for longer ones.

Additionally, it would've been nice to see a mention of the Amateur Radio Emergency Service® (ARES®) and/or the Radio Amateur Civil Emergency Service (RACES). The main character could've been shown checking into a local ARES/RACES or Community Emergency Response Teams (CERT) net to volunteer.

If there's a sequel, I hope they can work more ham radio details like these into the story.

Rich Stiebel, W6APZ
Palo Alto, California

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DMRoIP RFinder Radio over IP

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Android Platform	X	X	X	X	
Google Play	X	X	X		
MotoTrbo/DMR	X	X	X	X	X
Home Hotspot Compatible	X	X		X	X
PTT + POC	X				
Front Camera	X		X	X	
Number of Contacts	Virtually Unlimited	2,000	Not Documented	Not Documented	500,000
Frequencies	VHF/UHF	UHF	VHF or UHF	UHF	VHF/UHF
ROIP	X		X	X	
Field Programmable	X				X
Bridged with Echolink	X				
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NanoWSPR
A Low-Cost Multiband Transmitter

Build this microcontrolled transmitter from available modules without performing any Arduino programming.

George R. Steber, WB9LVI

Weak-signal propagation reporter (WSPR) is one of today's highly sophisticated radio modes that permits communication to the far corners of the world using very little power. What makes this possible is a combination of special coding techniques and software that can reliably decode signals near the noise threshold. It was described in detail in the article, "WSPRing Around the World," by Joe Taylor, K1JT, and Bruce Walker, W1BW, from the November 2010 issue of *QST*. It has proved to be useful, providing practical information on radio propagation paths for all to see on **WSPRnet.org**.

I built an ultra-low-cost WSPR transmitter, which I dubbed "NanoWSPR" because of its Arduino Nano heritage. No Arduino programming is required for this project. For less than $20, it should make an attractive weekend project. You need a laptop or a PC with a USB port to make it work.

WSPR Operation

Ordinarily, you'd need a computer running WSPR software, a sound card, and an SSB transceiver to participate in WSPR communications and view real-time results on the WSPRnet world map. The transceiver is connected to the sound card, which is used by the software to both transmit and receive WSPR signals. In actuality, you don't need a transceiver — usually a receiver or a transmitter will do, depending on your goal.

Teachers, students, and shortwave listeners (SWLs) routinely report receptions using just a receiver. Receivers allow monitoring the entire WSPR band at one time without tuning for individual stations. Students can learn a lot about radio theory by participating in this effort. There are even lesson plans for teachers, thanks to Professor Lynne Reynolds, PhD, available at **stellarworldwide.bravesites.com**.

Many of us enjoy building transmitters. For this project, I used readily available modules to build a low-cost, WSPR transmitter with multiband capability (10 to 160 meters). This transmitter produces signals in the 12.5 to 125 mW range. Even with such miniscule power, the results are astonishing. Figure 1 shows a WSPR map from VK7JJ (**wsprd.vk7jj.com/**) of all the stations that reported receiving my 30-meter signal over a period of just a few hours. In one startling case, not shown, my signal was received by OE9GHV 7,050 kilometers away. The amazing part is that my transmitter was running only 125 mW into a quarter-wavelength wire antenna raised about 8 feet above the floor.

"This NanoWSPR transmitter employs only two modules — an Arduino Nano and a Si5351 clock generator."

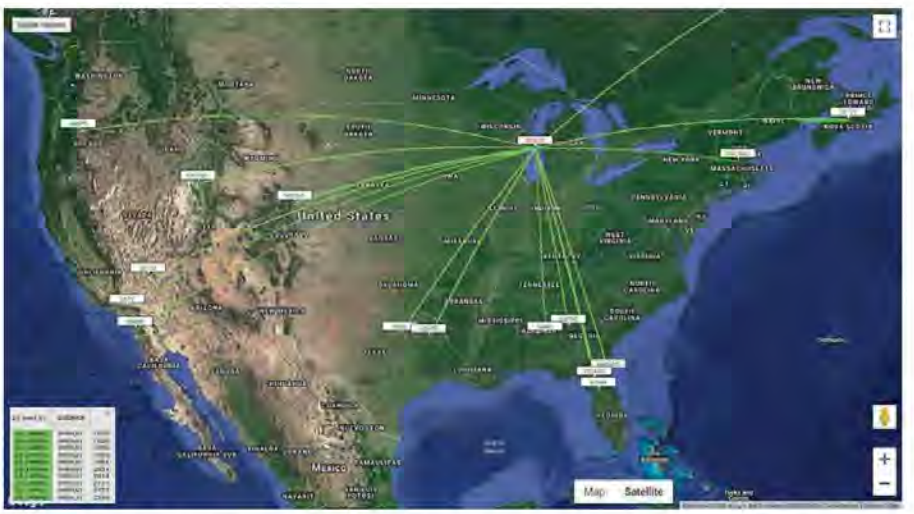

Figure 1 — This WSPR map shows WB9LVI receptions on the 30-meter band using the NanoWSPR transmitter.

This NanoWSPR transmitter employs only two modules — an Arduino Nano and a Si5351 clock generator. Power is supplied by the USB port. An optional chip can be added if you want to increase the transmitted power. Although not absolutely needed, an oscilloscope and frequency counter would be handy to monitor the signal and measure the frequency. Finally, you must assemble an RF filter and an antenna for the band of interest.

So, if you want to get started with the worldwide WSPR network of low-power stations probing radio propagation paths, build this NanoWSPR transmitter.

Design Philosophy

There are WSPR transmitter designs that can be built using Arduino or other microcontrollers. They often involve attaching real-time clocks, GPS modules, or OLED displays to make them portable. In order to use these designs, you must learn how to modify the firmware using a development system. This is great if you want to learn more about how software is created and used in a device. But the downside is that you must download a lot of integrated development software (IDE) onto your computer. In addition, many of these software environments require having Microsoft Framework installed on your computer. Windows 10 usually comes with Framework installed, but laptops running older versions often do not.

Many of us just want to build a project, not learn how to be an expert programmer. With that in mind, I decided to create a project that does not involve programming. However, you'll need to know how to install a driver and run a program on your computer to load a hex file into the Arduino Nano. In some cases, you may need to register a file on your PC. You should be able to run it on an old PC with a USB port, running any version of Windows.

You can now concentrate on designing and constructing your antenna and RF filters. You can tailor other aspects of the project to what you want, such as arranging the modules and designing your own enclosure.

Arduino Nano and Si5351 Clock Generator Modules

Figure 2 shows the Arduino Nano and the Si5351 modules used here. The Si5351A Clock Generator Breakout Board (8 kHz to 160 MHz) works well with the Arduino Nano and is available from multiple online sources for $8 to $10. It uses the onboard precision clock to drive multiple PLLs and clock dividers using I2C instructions. By setting up the PLL and dividers, you can create precise arbitrary frequencies. There are three independent outputs, and each one can have a different frequency. Outputs are 3 V_{p-p} square waves, either through a breadboard-friendly header or, an optional SMA connector. For this project, the module should have an onboard 25 MHz crystal.

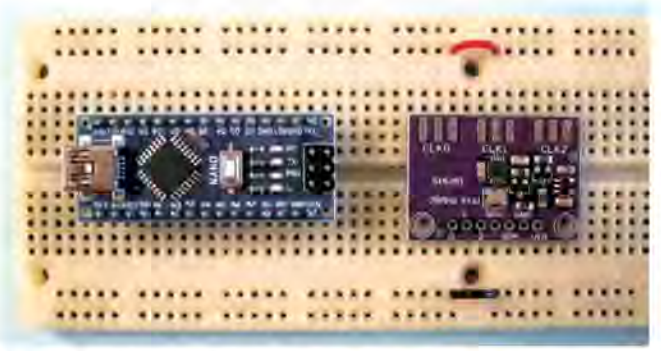

Figure 2 — The Arduino Nano and Si5351 modules used in this project.

Characteristics of WSPR Signals

A WSPR signal is basically a frequency-shift keyed (FSK) tone and does not require amplitude linearity. We can utilize the Si5351 clock with square wave output. A filter is then added to remove higher order harmonics inherent in the square wave.

WSPR signals have a bandwidth of only 6 Hz and fit into a tiny 200 Hz segment on a given band. This permits several tens of stations to coexist with minimal interference. For example, the 30-meter band is centered at 10.140200 MHz. Such a narrow band requires a very accurate and stable oscillator reference for the transmitter. Because the Si5351 clock depends on the onboard 25 MHz crystal, we will likely have some frequency error in our transmitted signal due to crystal tolerance. This error must be corrected to avoid transmitting outside the WSPR band.

NanoWSPR Transmitter Design

My minimalistic transmitter achieved several key features. It was very low cost, had no Arduino programming, had multiband capability, and had the ability to enter call signs, maidenhead grid coordinates, and power levels. It produces an output of 12.5 mW and can be upgradable to 125 mW or higher.

"By setting up the PLL and dividers, you can create precise arbitrary frequencies."

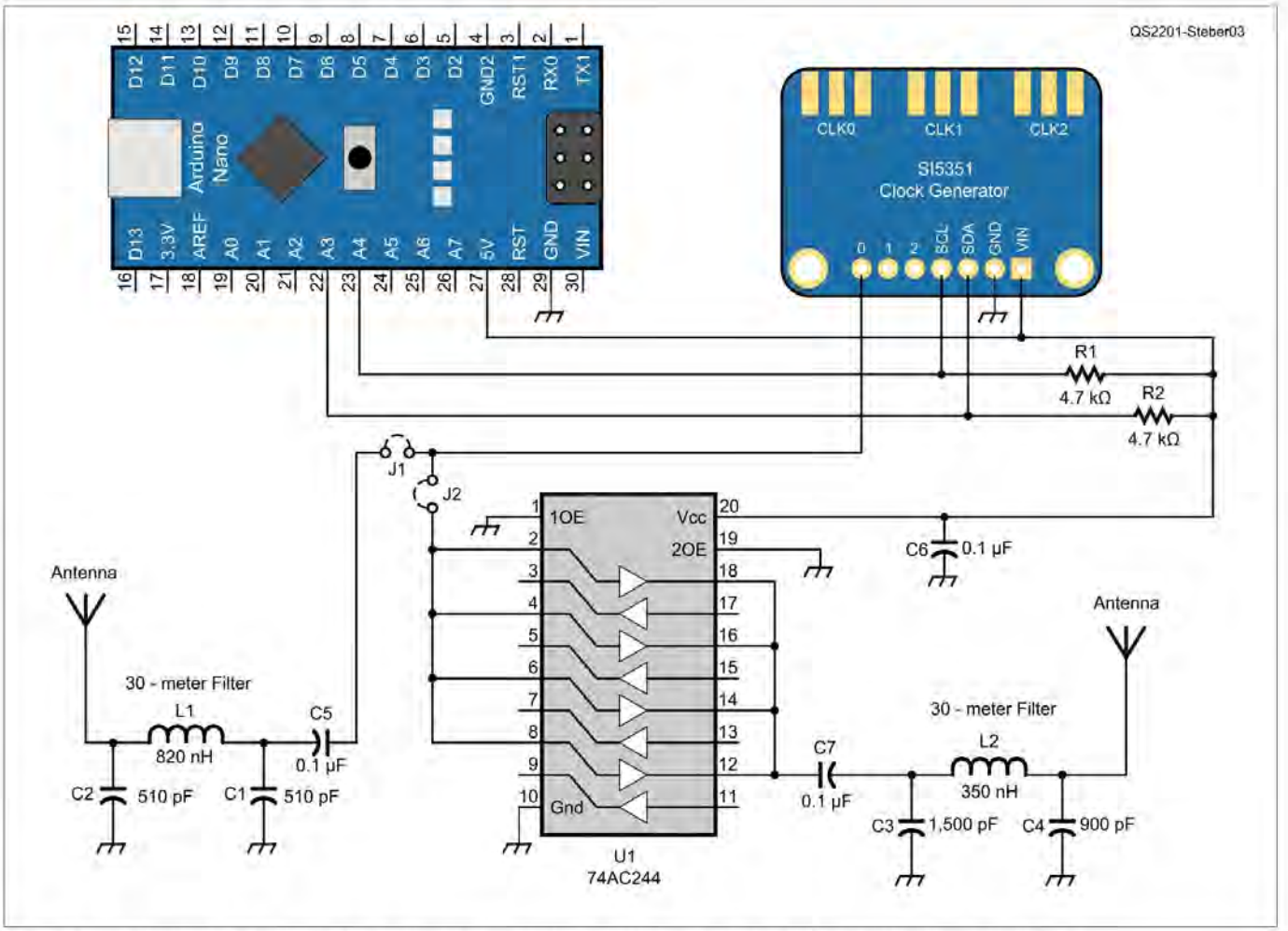

Figure 3 — A schematic diagram of the NanoWSPR multiband transmitter. All parts from Mouser Electronics or eBay.

A schematic for the transmitter is shown in Figure 3. There is very little wiring between the modules, and power is derived from the USB port. You need two 4.7 kΩ pullup resistors (R1, R2) on the SCL and SDA lines.

Various techniques may be employed to build this transmitter. As a first pass, I suggest that the two modules be mounted on a solder-less breadboard strip. This is good for loading the firmware and testing the software. Be very careful when installing the module pins in the strip, as the modules can be damaged by excessive force. Later on, you can decide on a more permanent arrangement of the modules, perhaps on a PCB and in an enclosure with connectors.

There are only a few steps to perform to get your NanoWSPR running, including using the NanoWSPR project software. There are three folders in the project folder on **arrl.org/qst-in-depth** web page.

Loading Firmware into Arduino Nano

Firmware must be loaded into the Arduino Nano for it to operate. This is done just once. First connect the Arduino Nano to your PC with a USB cable. If it is recognized, a COM port will be generated and will appear in Device Manager under Ports (COM & LPT), such as COM1, COM2, etc.

If a new COM port is not found, then the serial driver for the Arduino Nano is probably not installed. In this case, go to the project software and install the CH340 serial port driver.

When this is done successfully, a new COM port will appear in Device Manager. Make a note of this COM port, as it will be needed to install the firmware. Let's assume that COM12 was assigned by your PC for the Arduino Nano. (Of course, it will be different for every PC.)

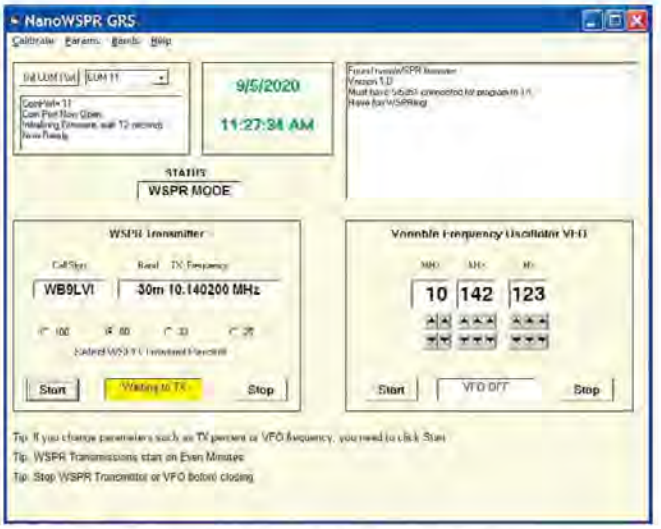

Figure 4 — The main window of the NanoWSPR program.

Now go to the **HEX FILE LOADER** folder in the project folder. Edit the "*bat*" file in the folder with a simple editor like *Notepad*. Do not open it or use it with a sophisticated word processor like Word, as that will add extra characters to the file. Find the following line: "avrdude -C avrdude.conf -v -p atmega328p -c arduino -P COM11 -b57600 -D -U flash:w:WSPR.hex:i"

Change the COM11 to the number of your COM port, say COM12. Save the file. Now, run the *bat* file by clicking on it, and it will load the firmware into your Arduino Nano.

NanoWSPR Software

Software was written in Visual Basic to control the Arduino Nano for WSPR operation. Find the program *NanoWSPR.exe* in the project software and run it. Figure 4 shows the NanoWSPR screen. Here again you must know the COM port assigned to the Arduino Nano. Follow the on-screen instructions by selecting the COM port and initializing it.

If everything is going well, you should see a message saying that the firmware has been found and that it is being initialized — taking up to 12 seconds.

If things did not go well, there are some things to try. Sometimes a necessary file like *mscomm32.ocx* is not registered. Place it in Windows **SYSTEM32** directory or **SYSWOW64** folder, and register it. This file and others are discussed in the project software *readme* file.

We cannot rely on the onboard 25 MHz Si5351 crystal to be correct, so we must calibrate our unit. The easiest way is to set the output frequency to 10 MHz using the NanoWSPR VFO. Now measure it with a frequency counter at Clock 0. Be sure to insert a 470 Ω resistor in the counter test lead to avoid overloading the Si5351.

In my case, the measured frequency was 69 Hz high. The error at 25 MHz would be 69 × 2.5 = 172.5 Hz. Therefore, the corrected crystal frequency is 25,000,000 + 172.5, or 25,000,172 Hz. Enter the correct crystal frequency into the NanoWSPR program. Don't expect absolute accuracy, as the frequency will change with temperature, but it is good enough to hit the WSPR bands without problems.

Filters and Antennas

Each WSPR band transmitter square wave must be filtered and matched to the antenna. Because of the low-output power, you can use small inexpensive components for the filters. Mouser and eBay are good sources.

In Figure 3, there are two RF filters and a 74AC244 integrated circuit (IC). With J1 connected (and J2 open), a 30-meter filter is connected to the Clock 0 output of the Si5351 via capacitor C5. This is the low-power output, with transmitting power in the range of 10 to 20 mW. I designed the filter using RF Tools LC filters design at **https://rf-tools.com/lc-filter**. It is a 50 Ω terminated, third-order, 0.5 dB ripple Chebyshev filter for the 30-meter band.

For higher output power, connect J2 (and open J1) to use the 74AC244 IC. Four drivers are connected in parallel to provide 125 to 150 mW of power. If you want even more power, you can add the four other drivers in the chip in parallel to get up to 300 mW output. In designing a filter for the 74AC244, we want to match the four paralleled outputs of the 74AC244 — roughly 12 Ω — to the 50 Ω antenna. We need a 1:4 impedance matching filter. The 30-meter filter comprises C3, L2, and C4 in Figure 3. Use online filter design tools to design filters for other WSPR bands.

Ordinary resonant half-wave dipoles can be used with good success. You can also use a quarter-wavelength of wire with a long wire counterpoise.

NanoWSPR Setup

WSPR transmits on even-numbered minutes, and the start of transmission must be accurate to within 1 second. Correct UTC can be set on your PC by using internet time. Otherwise, you can use low-cost atomic time clocks tuned to WWV.

Your call sign, Maidenhead grid, power level, and transmit percent also must be set up in the

"Teachers, students, and shortwave listeners (SWLs) routinely report receptions using just a receiver."

NanoWSPR software. To share spectrum, please reduce your transmissions to less than to 50%. This will allow others to share the frequency. Select your output filter, connect your antenna, and you are ready to go.

NanoWSPR Final Words

The NanoWSPR transmitter should make a nice project for those wishing to experiment with the WSPR mode. Results will depend on the band chosen and antenna construction. Even with such low power, don't be surprised if you get a spot from across the ocean.

Note that not all laptop USB ports are the same. If you are having difficulty using the 74AC244, consider running it on its own power supply. Adding an extra bypass capacitor might help too.

I enjoyed designing and using this NanoWSPR transmitter. WSPRing is fun and also educational. In addition to observing which propagation paths are open, it can be used to demonstrate low-power radio technology.

Please let me know when you get your NanoWSPR transmitter working. Propagation permitting, your signal will be copied in the far distant regions of the world.

George R. Steber, PhD, WB9LVI, is Emeritus Professor of Electrical Engineering and Computer Science at the University of Wisconsin-Milwaukee. He is retired, having served over 35 years, and he still lectures occasionally on science and engineering topics. George has an Advanced-class license, is a Life Member of ARRL and IEEE and is a professional engineer. He is involved in cosmic ray research and is developing methods to study them on a global basis. He has also worked for NASA and the USAF. George has written articles for several technical magazines, including *QEX* and *Nuts and Volts*. When not dodging protons, pions, and muons, he enjoys WSPR and JT9 amateur radio, racquet sports, astronomy, and jazz. You may reach him at **steber@execpc.com** with "Nano" in subject line and email mode set to text.

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October 2021
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Harold Smith
KE6TI

In his article, "The DC2020 Receiver," Harold Smith, KE6TI, shows us how to build a direct-conversion receiver that tunes the bottom part of the 40-meter band. The design consists of a variable oscillator, a product detector, a low-pass filter, and an audio amplifier.

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The DC2020 Receiver

This basic direct-conversion receiver uses just a few parts and can be modified for other bands.

Harold Smith, KE6TI

This is an ordinary direct-conversion receiver of fairly simple design, comprising only seven transistors. I built it for quick and easy assembly and mounted it in an enclosure. I used only leaded through-hole components, (no integrated circuits — ICs), with all easily available parts. It tunes the bottom 100 kHz of the 7 MHz band for CW reception. Increasing the cutoff frequency of the audio low-pass filter could also allow reception of SSB. A 1 μV signal from a signal generator is clearly audible in my headphones.

Circuitry

The receiver consists of four stages (see Figure 1):

1. A variable oscillator that is voltage tuned via a pair of common rectifier diodes.
2. A product detector with audio output.
3. A low-pass filter that rolls off above roughly 1 kHz.
4. An audio amplifier with more than enough gain to drive headphones.

I chose to tune the variable oscillator with a pair of rectifier diodes serving as varactors. This avoids the expense of an air variable capacitor. You might try diodes from your junk box in place of the 1N4002s that I used.

I chose a Hartley oscillator configuration, because it gave good tuning range with not too extreme tuning voltages. The Hartley uses a tapped inductor that I wound myself on a T50-7 toroid. I also used only NP0 and C0G ceramic capacitors in the oscillator to provide stability that was more than adequate for CW. I did have to tweak the coil a little to put the oscillator range where I wanted it, which allowed me to avoid using a trimmer capacitor. The tweaking consisted of compressing and stretching the turns on the toroid until it tuned the range I wanted. You can also add or subtract turns if needed.

The mixer and product detector is a differential stage, which gives good gain and light loading of the tuned circuit. The tuning range in this version is small enough that I didn't need to provide for peaking the front end to follow the oscillator tuning. You can change the bandwidth of the front end by paralleling a resistor across C1 to lower its Q, or by changing the number of turns on the primary of T1. This will lower the front-end gain.

An active low-pass filter with a cutoff of about 1 kHz follows the detector stage. It should be scalable to other frequencies by changing the values of the low-pass filter resistors. For a 3 kHz cutoff, make R11 and R12 each 510 Ω and change C17 to 100 pF. This will increase the audio bandwidth without affecting the gain.

The two-transistor audio amplifier is based on a Sziklai Pair. It produces plenty of audio to drive headphones. Mount the audio volume control, R15, close to Q5 and Q6. I used a volume control with a built-in switch to turn the power to the radio ON and OFF. The very large decoupling capacitor, C19, is used for hum suppression.

The low-frequency response is determined almost entirely by the value of C20 and the impedance of the headphones. It is common homebrew practice to use 32 Ω stereo phones with little radios like this, usually with the phone

"Increasing the cutoff frequency of the audio low-pass filter could also allow reception of SSB."

Effects of Common Building Materials on Radio Wave Propagation

Various obstructions were placed and tested between elevated Yagi antennas at VHF and UHF.

Meredith W. Hillier, KG7EUM

VHF and UHF communication transmissions must often, out of necessity, originate within buildings or pass through them in the line-of-sight path. I investigated the effects of such structural obstructions in a project for the Washington State Science and Engineering Fair. There, I was also selected to present my work at the May 2020 International Science and Engineering Fair.

The Testing Range

I built a test range with elevated Yagi transmit and receive antennas, as well as a raised platform on which to construct various obstructions (see Figure 1). While such tests would ideally take place in an anechoic chamber, an outdoor range like this, with measures taken to minimize unintended reflections worked reasonably well. The various obstructions constructed were 5.4 meters from the transmit antenna and 8 meters from the receive antenna, both in the far field of all three bands tested.

I used a simplex frequency in each of the 2-meter, 70-centimeter, and 23-centimeter bands, as well as separate single-band Yagi antennas for each band — six in total. I used FM voice mode, with no modulation

Figure 1 — The radio test range, depicted here with the elevated Yagi antennas placed on either side of the obstruction test platform. The spectrum analyzer can be seen on the ground near the base of the receive antenna. There's a 4 × 8-foot shield at the back of the test platform's base, to block diffraction and ground reflections.

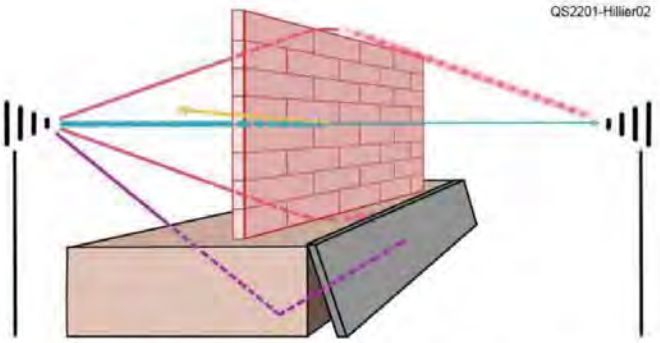

Figure 2 — Radio waves interact with the obstructions by a direct path with some absorption, by ground refection, and by diffraction around the obstruction edges.

and minimum transmit power, using an Icom IC-9100 transceiver (2.4 W on 2 meters, 2.1 W on 70 centimeters, and 0.7 W on 23 centimeters). It was checked with a Bird 4314C wattmeter. The SWR, measured with a RigExpert AA-1400 antenna analyzer, ranged from 1.12 to 1.22 for all six antennas. Note that the 23-centimeter band, approximately 1240 MHz, lies between two commonly used cell phone bands, 900 MHz and 1800 MHz, and therefore could yield good insight into cell phone propagation.

Testing with Obstructions

Structural obstructions can affect radio waves in various ways (see Figure 2). We were most interested in measuring the absorption or reflection of the direct radio signals passing through the obstruction, but we should note also that radio waves can diffract around an obstruction, especially if the wavelength is greater than the width of the obstruction. I constructed obstructions of various sizes: a concrete brick wall of 6 × 6 feet; plywood, drywall, and aluminum reflector structures that were all 8 × 8 feet; and rebar structures that were 10 × 10 feet.

For 2-meter signals, the cement brick wall's width and height were only 0.9 wavelength (λ) and the rebar was 1.7 λ, so I expected substantial diffraction around some of the obstructions. This was less problematic with the two other bands where the obstruction dimensions ranged from 2.7 to 4.5 λ (for the 70-centimeter band) and 7.9 to 13.1 λ (for 23 centimeters). After determining that diffraction and ground reflection could interfere with the results, I made a reflector out of polystyrene covered in aluminum foil and set it on the ground at the far (receiving) side of the platform.

With each set of experiments, I took a baseline measurement using a Rigol 1030A spectrum analyzer, then I took measurements with the obstruction in place. The results given are the difference between the two readings, in dB.

Results

An 8 × 8-foot aluminum obstruction (see Figure 3A) attenuated a 23-centimeter signal substantially (21 dB), but did surprisingly little to a 2-meter signal

Table 1
Baseline Change with Direct Ray and Reflector

Band	No shield (dB)	With shield (dB)
2 meters	–0.7	–2.5
70 centimeters	–5.1	–8.1
23 centimeters	–19.9	–21.0

(A)

(B)

Figure 3 — Tests were done with (A) an 8 × 8-foot aluminum reflector, and (B) an 8 × 8-foot aluminum reflector with a shield behind the platform.

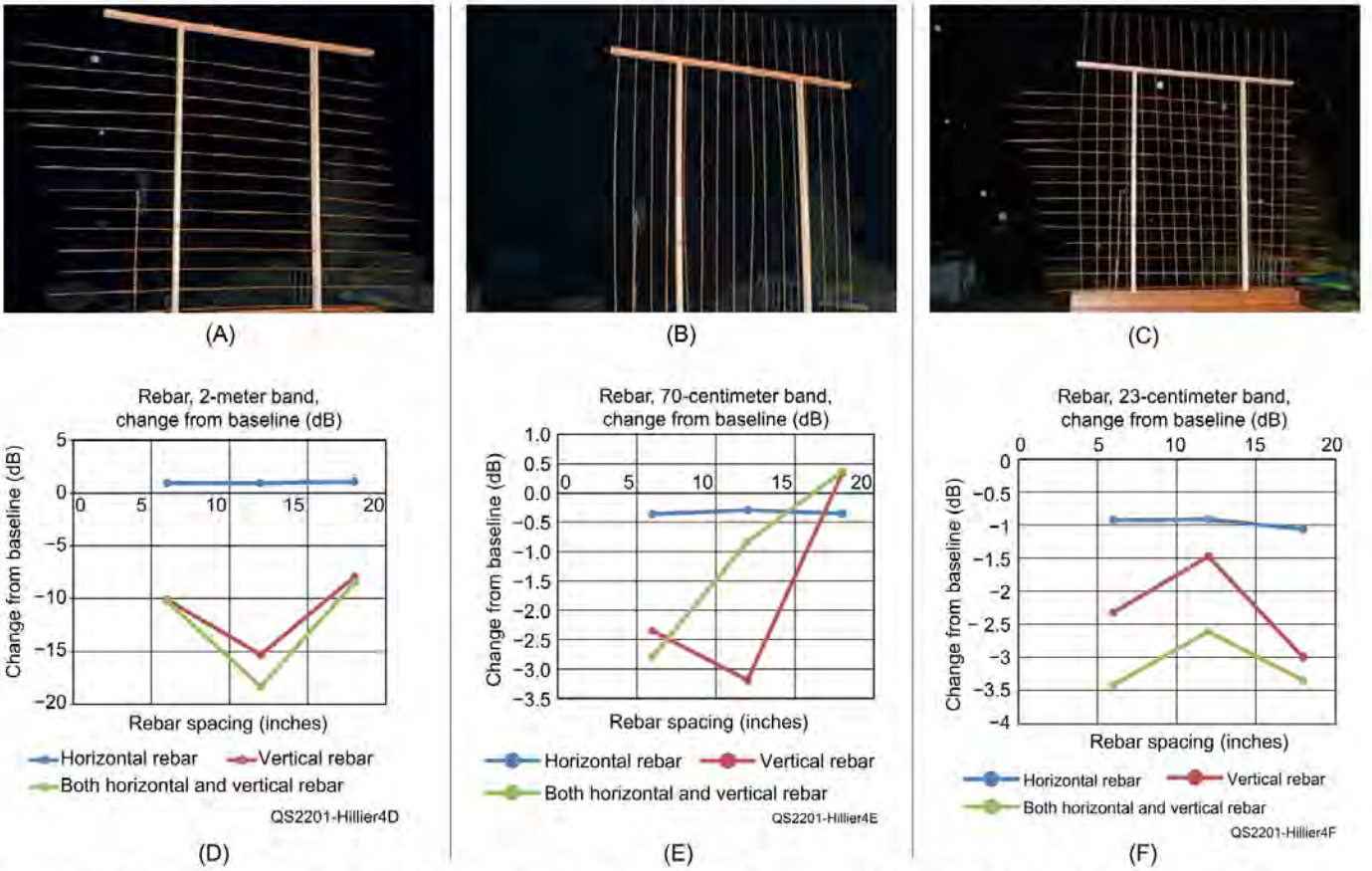

Figure 4 — Obstructions were made from 10-foot, ⅜-inch rebar arranged (A) horizontally, (B) vertically, and (C) both horizontally an vertically. Graphs show the attenuation relative to the baseline. In the various orientations, the rebar was separated by 6, 12, and 18 inches in the (D) 2-meter band, (E) 70-centimeter band, and (F) 23-centimeter band.

(2.5 dB), presumably due to strong diffraction around the aluminum piece. This led me to lean the reflective shield against the far side of the platform (see Figure 3B). It appeared to block both diffraction under the obstruction and reflection from the ground, reducing the received signal in each band by 1.1 to 3 dB. Therefore, I left the shield in place for all remaining measurements.

Regardless of spacing, steel reinforcing bar (rebar) oriented horizontally (see Figure 4A) had no measurable effect on 2 meters (see Figure 4D), and only slight attenuation at 70 and 23 centimeters (see Figures 4E and 4F, respectively) as it was easily penetrated by vertically polarized radio waves. Vertical orientation, though, had a profound effect on all three bands, as did rebar with both vertical and horizontal orientation. Note that there was much greater attenuation at 2 meters than at 23 centimeters; presumably, the signals with much shorter wavelengths passed between the bars more easily. It is unclear why vertical rebar attenuated 2-meter signals greatly but the 8 × 8-foot aluminum obstruction didn't. Repeating the experiment yielded the same results.

The received signals were complex combinations of direct, diffracted, and ground-reflected signals, which could add constructively or destructively, depending on their relative phase relationships. Complicating this situation is that the rebar could also reradiate signals like an antenna, which may explain the anomalous improvement at 70 centimeters with rebar spaced at 18 inches and the nonmonotonic results for different rebar spacings in all three bands.

A 4-inch-thick cement brick wall with no rebar had no significant effect on 2-meter signals (see Table 2), but a slight increase at 70 centimeters and significant attenuation on 23 centimeters. Dielectrics (insulators) generally attenuate higher frequencies more than lower frequencies. Adding vertical and horizontal rebar to the wall attenuated 2-meter signals substantially, similar to how the rebar alone affected the signals. The 23-centimeter signals that had passed easily between the rebar alone were now attenuated by the rebar plus cement brick wall, with the difference attributable to the cement.

Table 2
Change Due to Cement Plus Rebar

Band	no rebar (dB)	6-inch rebar (dB)	12-inch rebar (dB)	18-inch rebar (dB)
2 meters	+0.3	–15.8	–9.4	–5.6
70 centimeters	+1.7	–6.2	–0.5	0
23 centimeters	–4.9	–4.2	–5.6	–5.6

Steel studs (see Figure 5), commonly used in interior walls of buildings, had similar test results as the rebar: the 2-meter signals were most affected. Losses were 7.2 dB at 2 meters, 2.1 dB at 70 centimeters, and 2.5 dB at 23 centimeters.

A single 8-foot vertical #14 AWG copper wire had no measurable effect on any band. But eight similar vertical wires spaced 12 inches apart had effect similar to the vertical rebar. The attenuation was greatest at 2 meters, with 9 dB. Changing the wire to #32 AWG copper caused significantly less attenuation (only 5.7 dB) at 2 meters, presumably because of the wire's higher resistance.

I built a structure similar to an interior wall using two sheets of ½-inch drywall, 16-inch-spaced 2 × 4 wood studs, and no insulation. There was no measurable attenuation on 2 meters, 0.9 dB loss on 70 centimeters, and 3.6 dB loss on 23 centimeters.

Discussion

Vertical metal objects and flat metallic sheets attenuated the vertically polarized VHF and UHF signals the most, while the signals penetrated horizontally oriented thin metal structures most easily. Shorter wavelengths passed more easily through the spaces between linear metal objects, which explains why UHF signals often pass through windows in buildings more easily than VHF. But longer wavelengths diffracted more easily around objects. Dielectrics had only modest attenuation and were worse at higher frequencies.

Figure 5 — An obstruction of steel studs of 2 inches × 4 inches × 8 feet with 16-inch spacing.

Interestingly, even the strongest attenuation observed, 21 dB on 23 centimeters with the 8 × 8-foot aluminum reflector, was not as great as one might have anticipated.

Consider a 10 W 23-centimeter signal transmitted from an antenna with 6 dBi gain. Assuming no cable losses, a receive antenna with 0 dBi gain 1 kilometer away would produce a signal of –49 dBm, as calculated using the Friis transmission equation. If the receiver has a sensitivity of 0.16 µV (–123 dBm), the signal link could still tolerate more than 70 dB signal loss. Even the effects of ground reflections and multipath scattering should not prevent a usable signal, even with an 8 × 8-foot aluminum reflector in the line-of-sight path only 5 meters from one of the antennas.

Operators can use intuition about building material attenuation to plan antenna placement. Indeed, understanding the modest signal attenuation caused by many common building materials could lead to interesting and useful applications. For example, rescuers searching for survivors after a building collapse could potentially locate them by their cell phones, despite the overlying debris, by using a cell site simulator with small or directional antennas that would interrogate and locate the devices.

All photos by David Hillier, AA7XX.

General-class licensee Meredith Hillier, KG7EUM, was first licensed at age 9. She is a senior at Newport High School in Bellevue, Washington. She is an active member of the West Seattle Amateur Radio Club, and she was selected in both 2019 and 2020 for the International Science and Engineering Fair. Her father, David Hillier, AA7XX, who is an Amateur Extra-class licensee with a PhD in electrical engineering, oversaw her projects and provided guidance when necessary. In February 2020, Meredith was inducted as a Lifetime Fellow into the American Junior Academy of Sciences. You can reach Meredith at **meredithwh13@gmail.com**.

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

Product Review

Baofeng GT-5R Dual-Band Handheld Transceiver

Reviewed by Steve Ford, WB8IMY
wb8imy@arrl.net

Bottom Line

Baofeng's GT-5R complies with FCC requirements. It lacks some features of more expensive handheld radios and can be challenging to program without software, but its low price may make it attractive.

According to Baofeng's online advertising, their GT-5R transceiver departs from its predecessors in one particularly important way: "100% legal version with the compliant transmit range and spurious emission, complies with FCC Equipment Rule Part 15B and Part 90."

Baofeng's introduction of a transceiver that can only transmit on amateur frequencies is a positive development. Still, there is the matter of spectral purity. Over the years, the ARRL Laboratory has repeatedly found a high percentage of Baofeng transceivers tested by the Lab to be noncompliant with FCC emission requirements.

According to Baofeng, this issue has been remedied in the GT-5R. Did they succeed? More about that later.

Dual Bands, and More

The tiny Baofeng GT-5R can almost disappear in a shirt pocket, or within the palm of your hand. Despite its size, the GT-5R offers dual-band functionality at output power levels specified at 1 W or 4 W (see Table 1 for ARRL Lab measurements).

The frequency ranges include 144 to 148 MHz, and 420 to 450 MHz, and as Baofeng has stated, the GT-5R will not transmit outside of these ranges. It will receive between 136 and 174 MHz and 400 and 480 MHz, but if you enter a frequency outside the amateur bands and press the push-to-talk button, nothing happens other than the sound of the error beep.

The GT-5R package includes an 1,800 mAh lithium-ion battery and a desktop charger (see Figure 1). An optional 3,800 mAh battery is available. On a full charge, the battery seemed capable of powering the radio for many hours, depending on how much transmitting is taking place, and at what power level. There is also a battery-saving function that can place the GT-5R in one of four sleep/wake cycles. The trans-

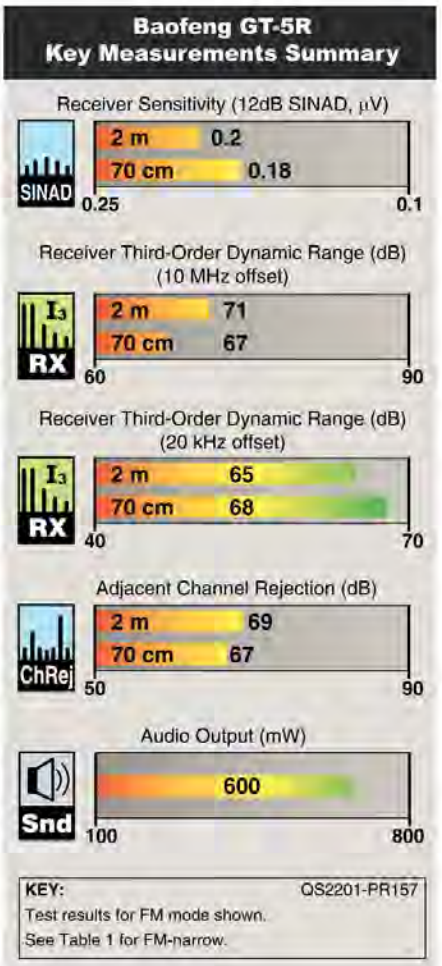

Table 1
Baofeng GT-5R, S/N 21GT5-R- 0000087 FCC ID: 2AJGM-UV5R

Manufacturer's Specifications	Measured in ARRL Lab
Frequency coverage: 144 MHz – 148 MHz 420 MHz – 450 MHz.	Receive:136 MHz – 174 MHz and 400 MHz - 520 MHz. Transmit: 144 MHz – 148 MHz and 420 MHz – 450 MHz.
Modes of operation: FM, FM-N (FM-Narrow) (25 kHz/12.5 kHz bandwidth).	As specified.
Power requirements: 7.4 V dc, ± 20% (1800 mAh battery supplied).	Receive: 45 mA (min. volume, lights off); 350 mA (max. volume, lights on). Power off, < 1 mA. Transmit (high/low): 146 MHz, 1.50/0.77 A 440 MHz, 1.51/0.83 A
Receiver	**Receiver Dynamic Testing**
FM sensitivity: For 12 dB SINAD, 0.20 µV.	For 12 dB SINAD: 146 MHz, 0.20 µV (FM), 0.16 µV (FM-N). 440 MHz, 0.18 µV (FM), 0.16 µV (FM-N).
FM two-tone, third-order IMD dynamic range: Not specified.	20 kHz offset: 146 MHz, 65 dB, 440 MHz, 68 dB. 10 MHz offset: 146 MHz, 71 dB, 440 MHz, 67 dB.
FM two-tone, second-order IMD dynamic range: Not specified.	146 MHz, 47 dB; 440 MHz, 75 dB.
Adjacent-channel rejection: 65/60 dB.	20 kHz offset (FM/FM-N): 146 MHz, 69/75 dB; 440 MHz, 67/70 dB.
Squelch sensitivity: Not specified.	Squelch range, 146 MHz, 0.1 – 0.25 µV; 440 MHz, 0.13 – 0.35 µV.
S-meter sensitivity: Not specified.	For four bars, 146 MHz, 0.39 µV; 440 MHz, 0.35 µV.
Audio output: 1000 mW.	600 mW into 8 Ω at 10% THD THD at 1 V_{RMS}, 1.5 %.
Transmitter	**Transmitter Dynamic Testing**
Power output: 4 W / 1 W (5 W max.).	At 8.15 V (full charge), High/Low: 146 MHz, 4.1/1.2 W 440 MHz, 3.3/0.8 W.
Spurious signal and harmonic:	146 MHz: >65 dB (low), >70 dB (high). 440 MHz: >78 dB (high and low). Complies with FCC spectral purity requirements.
Transmit-receive turnaround time (PTT release to 50% of full audio output): Not specified.	Squelch on, S-9 signal: 146 and 440 MHz, 150 ms.
Receive-transmit turnaround time (TX delay): Not specified.	146 MHz, 83 ms; 440 MHz, 69 ms.

Size (height, width, depth): 4.3 × 2.3 × 1.25 inches (including protrusions). Antenna length: 5.75 inches. Belt clip, add 0.2 inches to depth. Weight: 7.5 ounces.

ceiver "wakes up" whenever a signal is present, though you may occasionally miss the first second or two.

The LCD shows the frequencies for the A and B VFOs as well as battery status. You switch between VFOs using the A/B button. The display is small and may present a challenge those with visual impairments. Fortunately, the GT-5R has a well-designed voice enunciator that warns when the battery is low, in addition to imparting other bits of helpful information. It "speaks" in clear, unaccented English and is quite easy to understand.

Audio volume is controlled by the sizeable knob on the top of the case, which also serves as the power on/off switch. The GT-5R has plenty of audio punch, but it is easy to drive the tiny speaker into distortion. The squelch level is adjusted via the menu system. The factory setting is 3, which I found to be somewhat high; a setting of 2 or even 1 was better for casual listening

You can also open the squelch by pressing and holding the **MONI** button on the side of the radio. If you give this button just a brief press, the GT-5R lights a white LED at the top of the case that is intended to serve as a flashlight. Press the **MONI** button again and the LED will begin pulsing, presumably as a kind of visual beacon. When you consider that many amateurs carry their handheld radios while hiking, this could be a useful feature.

Figure 1 — The GT-5R package includes a desktop charger, earphone/transmit-receive switch, and belt clip.

If you grow tired of listening to amateur radio communications, the GT-5R offers FM broadcast enjoyment. On the same side of the radio as the **PTT** and **MONI** buttons, you'll find an orange button with the curious label **CALL**. I suspect this button has a different function in non-amateur versions of the GT-5R, but in this version, it activates FM broadcast reception (monaural audio only).

According to the user guide, if you press and hold the **MONI** button while in the FM broadcast mode, it will activate an "alarm" function. With this function active, you can tune to your favorite FM broadcast station with the up/down arrows and listen, but if a signal appears on whichever ham frequency you've designated within the active band, the GT-5R will switch automatically. This worked as described, but it added an annoying ticking sound as the radio frequently checked for amateur signals. I preferred my FM listening without this feature; another press of the **MONI** key turned it off.

An orange **VFO/MR** button on the front of the radio switches between what the voice enunciator calls the "channel" and "frequency" modes, or what the guide refers to as "memory" or "VFO" modes respectively. In the frequency mode, the frequencies of both selected bands appear in the display, but only the active band — the band selected with the **A/B** button — can be heard.

The GT-5R offers a dual-watch function that will scan continuously between the two displayed frequencies. When a signal appears at either frequency, the scan will halt for as long as the signal is present. Keep in mind, however, that this is not the same as continuous, simultaneous reception at two different frequencies. That option isn't available in the GT-5R.

The GT-5R's scanning feature is typical of what you'll find in other radios. It can scan across a selected frequency range or through the programmed memory channels. You can also select whether the scan stops for a period of time when it detects a signal or remains on the frequency until the signal disappears.

Memories and Programming

The GT-5R offers 128 memory channels. The user guide states that it is possible to save frequency information manually to a given memory slot, but it refers the reader to a nonexistent "Manual programming" section for details about how to accomplish this. Those instructions are actually in the "Advanced features" section under the headings "Simplex Channels" and "Duplex Channels."

The duplex channel programming discussion is potentially confusing. The guide seems to assume that you'll be setting up a nonstandard or possibly cross-band duplex frequency arrangement. And it is important to note that Baofeng's definition of "duplex" is really half duplex; the GT-5R can't transmit at one frequency while simultaneously receiving at another.

When the guide addresses manual setup for repeater operating, you discover that you must first enter the menu system and select the transmit offset, such as +600 kHz or –600 kHz, before punching in the receive frequency. Unlike many transceivers, the GT-5R does not determine this offset automatically according to the receive frequency. If you set up the radio for, say, 147.36 MHz with an offset of +600 kHz and then tune down to 146.64 MHz, you'll notice that the offset is still set to +600 kHz. You'll need to go back into the menus and change the offset to –600 kHz.

Without question it is much easier to program the GT-5R using a computer. The manual devotes a few pages to describing how to program the transceiver using the free *CHIRP* software (**chirp.danplanet.com**), complete with examples. Baofeng sells an inexpensive USB programming cable that you simply connect between your computer and the earphone/mic jacks on the radio. (Be sure to push the plug firmly into the GT-5R until you feel and hear a solid *click*.)

Using *CHIRP,* I was able to set up several memory channels within minutes. This included designating seven-character alphanumeric tags for each channel, a programming feature that is *only* accessible with software.

RT Systems (**www.rtsystemsinc.com**) sells a version of their excellent programming software that is compatible with the GT-5R, but you must purchase the

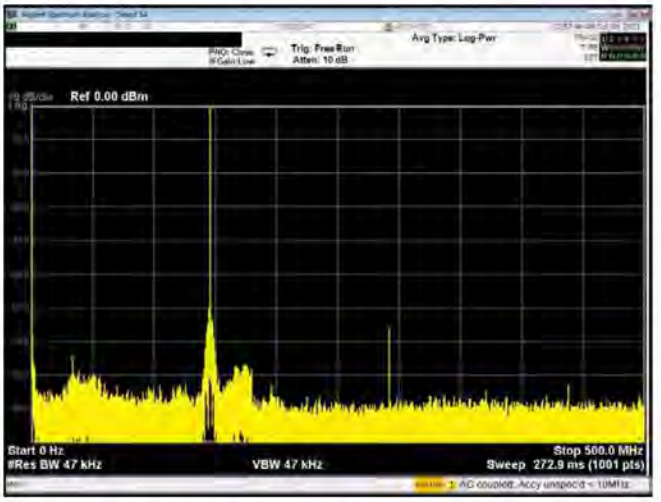

Figure 2 — Worst-case spectral display of the Baofeng GT-5R transmitter output. Power output is 1.1 W on the 146 MHz band. This plot shows the output spectrum from 0 to 500 MHz. The second harmonic is down 66 dB from the carrier, and the third harmonic is down 72 dB. The vertical scale is 10 dB per division.

package that includes the RT Systems programming cable. Their software will *not* work with the Baofeng cable.

Testing and Operating

ARRL Laboratory test results are shown in Table 1 and Figure 2. As you can see, the GT-5R met FCC requirements for spectral purity. In terms of sensitivity, the GT-5R underperformed compared to more advanced transceivers, but considering the selling price, this wasn't a surprise.

Using the Baofeng with its flexible antenna, I was able to access several local repeaters. The GT-5R did seem to be less sensitive than other handheld transceivers I've tried. On occasion I had to hold the radio in specific positions to get a full-quieting signal, even from machines not far from my area. When connected to a better antenna, such as my dual-band ground plane, reception improved considerably. Adding a superior antenna, however, also increased overload interference and this was apparent on some frequencies.

Signal reports were good, including evaluations of my transmit audio. It is worthwhile to mention that the GT-5R includes a voice-operated switch (VOX) function. While it can be a bit sensitive, it was handy for hands-free operating.

Despite its shortcomings, the GT-5R is a competent transceiver for casual use. It lacks the features and performance of more expensive handheld radios, but for some amateurs the GT-5R's low price may tip the balance in its favor. It ultimately comes down to the functionality and performance you require versus how much you're willing to pay.

Manufacturer: Baofeng, Fujian Province, China, **www.baofengradio.com**. Review radio purchased from Radioddity, 6945 Speedway Boulevard, Suite H102, Las Vegas, NV 89115; **www.radioddity.com**. Price: $25.

West Mountain Radio CBA V Battery Analyzer

Reviewed by Phil Salas, AD5X
ad5x@arrl.net

In the November 2013 issue of *QST*, I reviewed the West Mountain Radio CBA IV Battery Analyzer. The CBA V is the next generation of this device.

CBA V Overview

The CBA V measures 2.8 × 3 × 3.5 inches — identical in size to the CBA IV. It is a software-controlled, constant-current load box with an integral heatsink and fan, and it's powered and controlled from your computer via the included USB cable. The software permits testing and analyzing all current battery chemistries up to 57 V. Anderson Powerpole connectors provide the battery interface.

Bottom Line

The West Mountain Radio CBA V lets you know the health of any of your battery packs, regardless of chemistry.

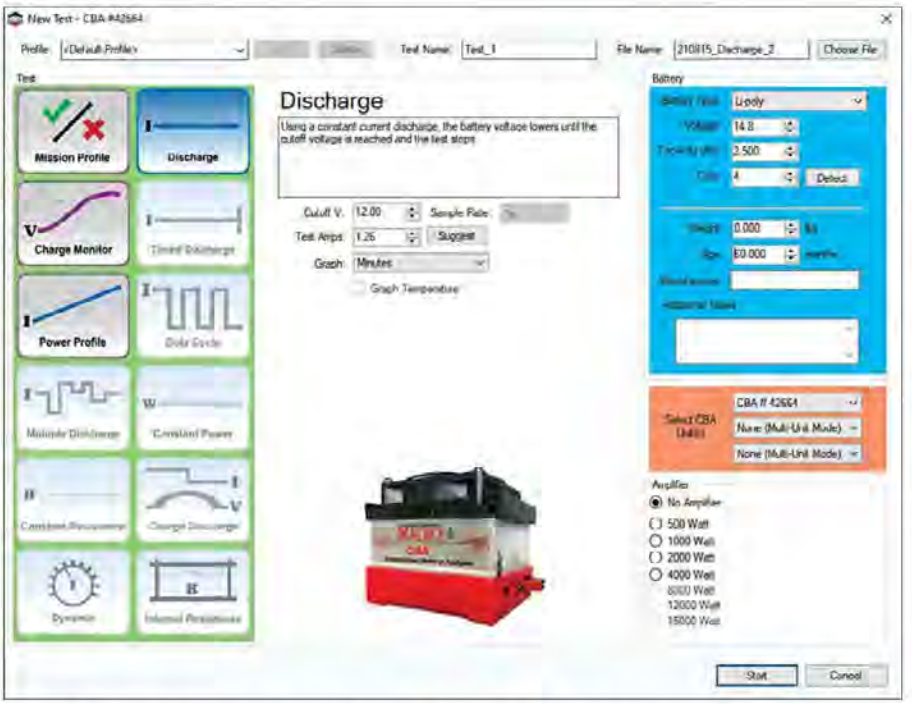

Figure 3 — This is the LiPo battery start-up screen in the CBA V software. Test parameters and information about the battery under test are shown in the center and right-hand sectors. The panel on the left shows available tests.

The analyzer measures battery voltage versus time for a continuous load up to 150 W or an intermittent one up to 200 W. The software automatically senses the battery cell count, provides a safety check of the proposed test rate, and recommends a minimum safe discharge voltage. The data is displayed graphically in amp-hours (Ah), watt-hours (Wh), or minutes. You can overlay multiple battery graphs for comparison, and the graphs can be saved and printed. You can print test labels for your batteries that show the last time they were tested and how they performed, although only Dymo brand printers are currently supported. Finally, there is a "calibrate current" adjustment for improved accuracy at very low discharge rates or for critical applications.

There are four versions of the CBA V, as shown in Table 2. In addition to increased accuracy, the CBA V Pro versions include a remote sensing cable for measuring voltage reading offsets — useful for high-current tests or long battery cables. The CBA HR is designed to evaluate small cells and batteries of 0.7 to 10 V at load currents from 1 mA to 1,000 mA, in increments of 1 mA. There are also a few other options available that extend the CBA V for industrial applications. These include optional amplifiers to permit testing in 500 W load increments up to 2,000 W, and an optional CBA Charger that interfaces the CBA V with a user-provided battery charger to automatically switch between charge and discharge cycles for battery lifetime testing.

CBA Software

The current software package can be downloaded from **www.westmountainradio.com**. It has been enhanced to permit testing and analyzing batteries using all current battery chemistries, including lead-acid, NiMH, NiCad, several lithium varieties, and others. The same software is used for the CBA II through the CBA V (the original CBA requires different software). The CBA V also has some hardware enhancements over previous versions. These include increased maximum load (up to 200 W), a tri-color LED for improved operational and fault reporting, an easy-access automotive-type fuse, and the external voltage sensing and thermal probe for the Pro version.

An optional Extended Software license adds duty cycle, constant power, multiple discharge, and constant resistance test capability. The Extended Software license also adds the ability to graph the battery temperature when the optional temperature probe is connected.

The software is supplied on a CD-ROM, but check the West Mountain Radio website for a later version. Soft-

Table 2
CBA V Versions

Version	Discharge Range	Accuracy	Max. Voltage	Price
CBA V	1 – 200 W	~2%	57 V	$190
CBA V Pro	1 – 200 W	<1%	57 V	$230
CBA V Pro 100 V	1 – 200 W	<1%	100 V	$250
CBA HR	1 – 10 W	1%	10 V	$160

Table 3
Transceiver Current Requirements

	QCX-mini (5 W)	Xiegu G90 (20 W)
Receive	70 mA	500 mA
Transmit, key-down	400 mA	5.0 A
Transmit, key-up	70 mA	2.0 A

ware installation is trivial, involving just a few prompted mouse clicks. However, at the time of this review, loading the driver was a problem because it didn't have the required Microsoft Driver Signature Verification on 64-bit machines with Windows 8.1 or later. When I loaded the driver I got a message saying that the file was corrupt or tampered with. I contacted West Mountain Radio technical support, and almost immediately received a link to a work-around that allowed me to load the driver. As this issue of *QST* was going to press, West Mountain Radio has indicated that the driver issue has been resolved.

Finally, you should select **UPDATE FIRMWARE** under the CBA **DEVICES** tab. If the host computer is connected to the internet, the software will automatically find the latest version of firmware and install it in the CBA V. Also note that once the software is loaded, it will automatically check for software updates whenever the CBA program is re-started.

Using the CBA V

How you use the CBA V will depend on your selection of batteries and requirements. I wanted to evaluate batteries I use for portable low-power operation with two transceivers — a QCX-mini for 20-meter CW, and a Xiegu G90 20 W multiband, multimode HF radio. The current requirements for these two radios are shown in Table 3.

The QCX-mini operates full break-in (QSK) — that's why the key-up current is the same as the receive current. For the G90, I set break-in time to 500 milliseconds, as I don't like to hear a lot of transmit-receive relay clicking.

In portable operation, I turn my radio on with the specific purpose of making contacts. My portable operation is approximately 50% listening and 50% operating (QSO time). During a contact, I assume 50% receiving and 50% transmitting times. Finally, the CW duty cycle using the standard PARIS format is key-down 44% of the time, and key-up 56% during the transmission. Adjust the receive-only versus QSO time fraction of time based on your particular operation. In my case, going with the 50% listening and 50% QSO time, I determined the average battery current (Avg I) as follows:

Avg I = RX Time + QSO Time

RX time = 0.5 × RX Current

QSO Time = 0.5 [0.5 × RX Current + 0.5 (0.44 × TX Current + 0.66 × Key-Up Current)]

This is probably conservative, as you are likely to transmit a little less than that because of pauses between words and sentences. So using the above equation, the average current for the QCX-mini would be 164 mA, with a peak current of 400 mA. The G90 has an average current draw of 1,255 mA with a peak of 5 A. I rounded up the average currents to 170 mA and 1260 mA, respectively, as the CBA V software has a 10 mA minimum step setting.

The batteries I tested are shown in Table 4. The alkaline and NiMH AA-size batteries are new, with 10 of each installed in battery holders to reach the desired voltage. I have two of the Power Sonic lead-acid batteries, both removed from a failed garage door opener backup system. The LiPo battery is about five years old and has been used extensively for portable operation with my Elecraft KX3 transceiver.

The lead-acid and LiPo batteries were tested at 1,260 mA because these batteries would be used with the G90 transceiver at 20 W and should easily source the required 5 A peak transmit current required. The AA-size alkaline and NiMH batteries were tested at 170 mA, because these should be able to handle the 400 mA peak transmit power of the QCX-mini transceiver. I have a Thunder AC680 intelligent multifunction charger that permits selecting the battery type, number of cells, and charging current. It also has a balance input for lithium batteries.

I first evaluated the lead-acid and LiPo batteries. Figure 3 shows the setup menu for the LiPo battery. While most of the test information is automatically sensed and suggested, I set the actual battery amp-

Table 4
Batteries Analyzed

	Number of cells/ Amp-hours	Nominal Voltage	Discharged Voltage	Charged Voltage
Alkaline/ AC Delco Ultramax	10 AA cells / ?Ah	15 V	10 V	16 V (new)
NiMH/ PowerOwl	10 AA cells / 2.8 Ah	12 V	10 V	13.5 V
Lead Acid/ Power Sonic	6 cell / 5 Ah	12 V	9 V	14.8 V
LiPo/ Floureon	4S2P / 6.2 Ah*	14.8 V	12 V	16.8 V

*4S2P = two 4-cell packs in parallel

hour and test current discharge rates for my specific batteries and application. Once you press **START**, the CBA V software will check the battery and begin the test.

When the LiPo test was complete, I evaluated the two lead-acid batteries. I overlaid the three graphs because these batteries would all be used in my G90 20 W application. As I suspected, the amp-hour capacities of all three batteries had dropped off due to their age and use. The LiPo battery had about 3.8 Ah of capacity, and the lead acid batteries had about 3 Ah. This is not too bad, as it means I can get about 3 hours of use with each battery when using my G90. Figure 4 shows the results plotted versus minutes at the 1,260 mA average current.

Next, I tested the 10-cell NiMH battery pack with the CBA V at the 170 mA average current expected for my QCX-mini transceiver. These batteries were purchased new, and claimed to have 2.8 Ah of capacity. I charged the 10-cell AA NiMH pack with my Thunder AC680 smart charger. The results were horrible! I ran three separate tests after recharging the 10-cell battery pack. The first test showed the battery pack to only have about 0.8 Ah of capacity. But this got significantly worse with each charge/discharge cycle as you can see in Figure 5.

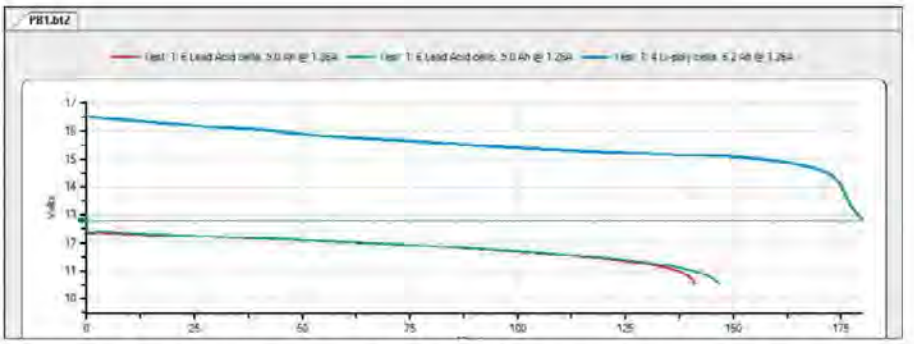

Figure 4 — This plot shows minutes of use at 1,260 mA average current draw; test results are for the LiPo (blue trace) and lead-acid (red and green traces) batteries.

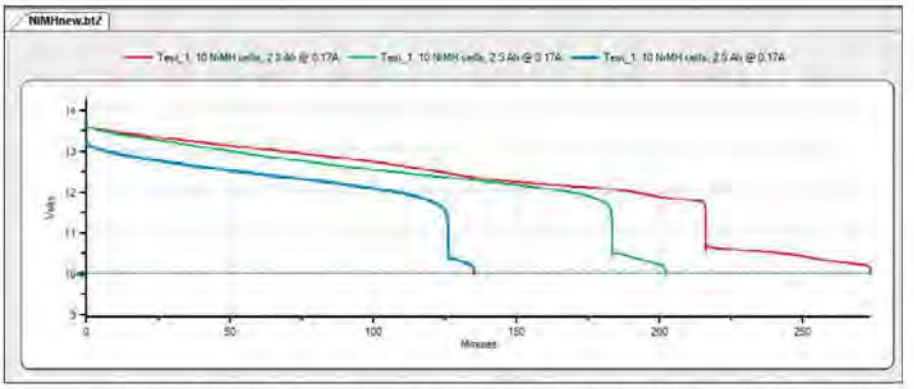

Figure 5 — As described in the text, the initial results for the pack of 10 NiMH AA cells at 170 ma average current grew worse over three charge/discharge test cycles. By the third cycle (blue trace), the battery pack would provide just over 2 hours of operation for the QCX-mini.

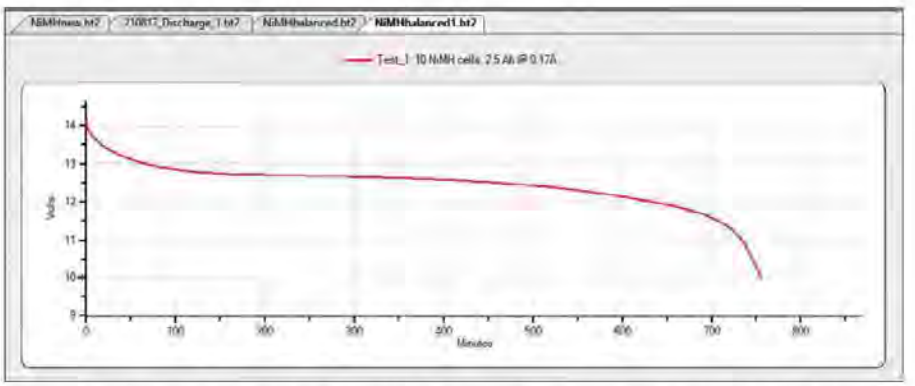

Figure 6 — After individually charging and balancing the 10 NiMH AA cells on a different charger, re-running the test at 170 mA revealed that the battery pack had enough capacity to power the QCX-mini for more than 12 hours.

I couldn't believe these batteries were that bad, and so I looked at the individual battery voltages when charged and discharged. I found a noticeable difference in the voltages among the batteries at both levels, so I wondered if these batteries need to be balanced.

I purchased the recommended PowerOwl AA/AAA NiMH charger (about $15 from Amazon), which charges up to eight batteries individually. There is an LCD screen that shows the status of the individual batteries. This charger uses an external USB power supply source, and the charging current is then divided by the number of batteries that are being charged, so it does take a while to charge the batteries.

Once I had all 10 AA batteries charged in this new charger, I put the batteries back into the 10-cell AA pack and re-ran the CBA V analysis. As you can see in Figure 6, performance was significantly improved to about 2.1 Ah. That is less than the 2.8 Ah capacity advertised for these batteries, but it is much better

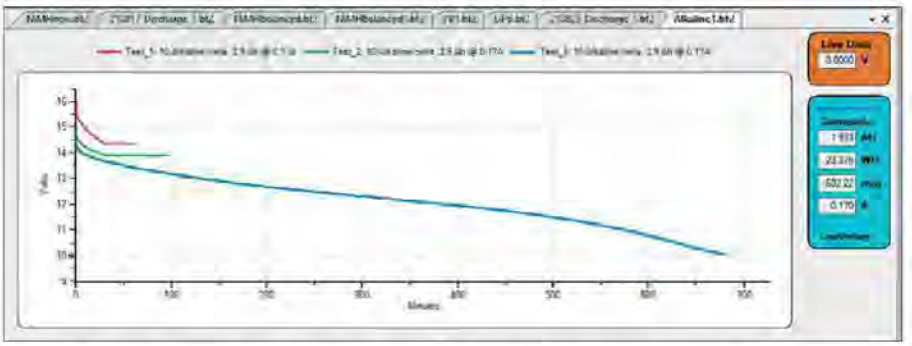

Figure 7 — This screen shows testing of the 10-cell AA alkaline battery pack at 170 mA using the Append feature of the CBA V. The first part of the test lasted about 1 hour (red trace), followed by about 90 minutes (green trace), and finally running the battery pack to depletion (blue trace).

the individual tests. As you can see in Figure 7, I first ran the load test for about 1 hour. Then I stopped the test and appended a new test that ran for about 1.5 hours. Then I appended these tests with my final test, which ran until the battery pack was depleted. As you can see, subsequent tests all started at the stopped voltage of the previous tests as expected. The total capacity of this alkaline pack was more than 2.2 Ah. That will give me a lot of QCX-mini operating time!

than before and should still give me more than 12 hours of operation with my QCX-mini.

Without the CBA V, I would have just charged the 10-cell pack with my Thunder AC680 charger and been disappointed with the results. The lesson is that when used in a multi-battery pack, AA NiMH batteries need to be balanced for best performance. Incidentally, I found an error in the amp-hour calculation for NiMH batteries. I've informed West Mountain Radio and hope it that will be corrected before this review is published.

The last test was with the Delco Ultramax 10-cell AA-size alkaline batteries. These batteries are advertised to be used for high-current operation, though they don't specify an amp-hour capacity. For this test, I wanted to show the Append feature of the software. This permits you to start and stop tests, but then show the results of

Conclusion

The West Mountain Radio CBA V is a sophisticated, yet relatively inexpensive battery analyzer for amateur and commercial battery evaluation. My only gripe is that it currently supports only Dymo label printers (I have a Brother unit — West Mountain Radio has indicated that they would try to support other printers upon request). If you want to know what your batteries are capable of, and where they are in their lifetime, the CBA V is worth considering.

Additional images for this review are available from **www.arrl.org/qst-in-depth**.

Manufacturer: West Mountain Radio, 1020 Spring City Dr., Waukesha, WI 53186; **www.westmountainradio.com**. Price: $190.

Wire Strippers for the Amateur Workshop

Reviewed by Paul Danzer, N1II
n1ii@arrl.net

One of the most popular tools in a ham's workshop is a wire stripper. After reviewing the many choices available online, we selected five that looked useful, ranging in price from about $10 to $30. Some include additional features such as crimping capability for wire terminals.

I tried each of the wire strippers with a variety of typical workbench wire sizes and types as shown in Table 5. In some cases, a stripper didn't work well with a particular type of wire. On large wire sizes, for example, sometimes it cut the insulation as expected, but was difficult to slide the cut segment off the wire. Typically, this happened when trying to strip more than ½ inch of insulation. For example, the insulation on #12 solid THHN electrical wire is particularly rugged and can be tough to remove.

Klein Tools 1003 Compact Wire Stripper and Cutter

The Klein Tools 1003 shown in Figure 8 is the simplest and least expensive tool reviewed here. This type of wire stripper/cutter has been around for ages and is similar to other tools that are widely available. The Klein version weighs just over 2 ounces and is rated to handle #12 to #26 AWG solid wire and #14 to #28 AWG stranded.

Figure 8 — The Klein Tools 1003 offers minimal cost, minimal weight, and minimal features — but works well enough to just toss into your tool box.

The adjusting screw with retaining nut on the handle limits how far the jaws can close. Slide the screw toward the bottom of the handle, and the jaws close tighter to strip #26 or #28 AWG wire. Move the screw toward the tip for larger wire. Properly adjusted, the screw allows stripping of most common wire sizes without nicking the conductor. With practice, though, you can often apply the right pressure to safely cut insulation without adjusting the screw. More expensive versions of this basic tool incorporate a circular disk with an offset to adjust the jaws for various wire sizes.

I found that for larger wire sizes, I sometimes had to twist the stripper blade around the wire to cut the thick insulation all around the metal conductor. This tool wasn't as easy to use as some of the other units while stripping the insulation on the #12 AWG wire from BX cable or the #12 AWG solid THHN wire. It also had difficulty with #26 AWG Teflon insulated wire.

This inexpensive utility tool will suffice if you don't have to strip a lot of wire.

Manufacturer: Klein Tools, **www.kleintools.com**. Price: $10.

Klein-Kurve 1019 Wire Stripper/ Crimper/Cutter Multi Tool

The Klein-Kurve 1019 shown in Figure 9 is rated to strip #10 to #26 AWG solid and #12 to #28 AWG stranded wire. The stripping jaws have two scales, one for stranded wire and the other for solid wire. The tool weighs about 6 ounces, and the curved, padded handles are comfortable to use. The jaws pivot smoothly. It successfully stripped all of the wire types listed in Table 5, although it required some effort to slide the insulation off the #12 AWG solid THHN wire.

The jaws include a section at the base for cutting wire, and the tips are serrated to use as gripping pliers. The tool can also be used as a crimper for insulated and non-insulated terminals, with one slot for each type regardless of wire size. You might get better results by using a single-purpose crimping tool with slots sized for different size wire terminals. The Klein-Kurve also crimps type B low-voltage connectors typically used to butt-splice telephone wires, as well as Scotchlok IDC connecters. I didn't test either of these connectors.

Figure 9 — The Klein-Kurve 1019 is very comfortable to use. The two sides of the cutting jaws are calibrated differently for solid and stranded wire.

Table 5
Wire Types Tested

Type	Size (AWG)
THHN — solid*	12
Single conductor from BX cable — solid**	12
THHN — stranded*	14
Single conductor from NM cable — solid***	14
Window line feed line conductor — solid	18
Plastic insulated hookup — solid	18
Plastic insulated hookup — solid	20
Plastic insulated hookup — solid	22
Mil-spec Teflon insulated — stranded	22
Teflon insulated — stranded	26

Notes
*THHN (thermoplastic high heat nylon coated wire) is a soft-drawn copper wire used in electrical wiring. The stranded version is also popular for amateur antennas.
**BX is a multiconductor armored cable used in electrical wiring. The insulation on each conductor is a very thick composite material.
***NM is a multiconductor cable with non-metallic sheathing used in electrical wiring (also known by the trade name Romex).

One additional feature is a built-in screw cutter for shortening #6-32 and #8-32 machine screws. The threaded holes for the cutter are located just below and to the side of the center jaw pivot. It worked well on a #6-32 brass screw, cutting the screw to length and repairing the thread at the cut as I backed the screw out of the tool. Cutting #8-32 screws required a lot more hand strength.

Manufacturer: Klein Tools, **www.kleintools.com**. Price: $20.

Gardner Bender GST-70M Multi Tool with Circuit Alert

The Gardner Bender GST-70M shown in Figure 10 is similar to the Klein-Kurve and weighs about 7 ounces. The packaging says that the tool can strip #8 to #20 AWG solid or stranded wire. However, separate markings on the jaw indicate #8 to #20 AWG solid and

Figure 10 — The Gardner Bender GST-70M is similar to the Klein-Kurve 1019 but includes a Circuit Alert non-contact sensor for checking for live ac circuits. The Circuit Alert module is locked into the upper handle in this photo.

#10 to #22 stranded. The handles are about ⅝ inch farther apart than the Klein-Kurve, and so it was not as comfortable to use for someone with smaller hands. Also, the jaws did not pivot smoothly.

The stripping function worked well on #14 AWG to #20 AWG wire. On several tries, I had to twist the stripper around in a circle to strip #12 AWG solid wire. It did not strip #22 AWG solid but worked fine with #22 AWG stranded (consistent with the markings on the jaws). As with the Klein-Kurve, it required some effort to slide the insulation off the #12 AWG solid THHN wire.

The area just below the stripping section is a wire cutter. There is also a screw cutter for six different screw types, ranging from #4-40 to #10-32. I found it difficult to use for even the smallest screw size, probably because it was difficult to get a solid grip with the widely spaced handles.

The crimpling function has three slots — #22 to #18 AWG terminals, #16 to #10 AWG terminals, and one labeled **COAX** that looks about right for type F connectors for RG-6 coaxial cable. As with the screw cutter, crimping terminals required a great deal of finger strength.

The Circuit Alert feature is a voltage sensor that is handy for working around house wiring. It looks like a flash drive and snaps into one of the handles. The sensor is convenient to use without removing it from the handle, or you can detach and use it separately. Place the Circuit Alert near a wire carrying 50 to 600 V ac, press the button, and it sounds a tone and lights up if voltage is present.

Manufacturer: Gardner Bender, **www.gardnerbender.com**. Price: $30.

Capri Tools 20010 Precision Wire Stripper

The Capri Tools wire stripper shown in Figure 11 is very similar to a tool that I have had for more than 20 years. The Capri 20010 weighs about 12 ounces, and

Figure 11 — Capri Tools 20010 is a conventional wire stripper design with jaws calibrated for a variety of wire sizes. Replacement blades and blades for other wire sizes are available. The included stopper for setting repeatable strip lengths is not shown.

it is rated for #8 to #20 AWG solid wire and #10 to #22 AWG stranded wire. It could not strip the #22 AWG solid test wire successfully, but did strip #22 AWG stranded wire. It also easily stripped the #12 AWG solid THHN wire. The handles have a soft plastic cover, and the tool is comfortable to use. Replacement blades and blades for other wire sizes are available.

As seen from the front, there are two sets of jaws. As you squeeze the handles, the left-hand jaws grip the insulated wire. The right-hand jaws cut the insulation. As you squeeze further, the jaws separate horizontally and the cut section of the insulation slides off to the right. This last step was especially nice for separating the insulation from the #12 solid THHN wire.

An envelope included in the package held several small parts whose purpose was not apparent (nor were there any instructions). A call to the manufacturer revealed that the parts are used to make an adjustable stopper that allows you to set the length of the stripped wire end. This add-on works very well if you need to strip a large number of wires uniformly. With the stopper in place, the wire sizes marked on the jaw are obscured, so you have to estimate which jaw opening is applicable for your wire size.

Manufacturer: Capri Tools, **capritools.com**. Price: $30.

Irwin Vise-Grip Self-Adjusting Wire Stripper (2078300)

The Irwin Vise-Grip wire stripper shown in Figure 12 has two sets of jaws, similar to the Capri Tools unit. Unlike the other wire strippers in this review, the jaws of the Irwin Vise-Grip have no calibrated markings corresponding to various wire sizes. This unit uses the left-hand jaws to grip the wire, and the right-hand set of jaws are self-adjusting. Simply put the wire in the jaws, and the tool adjusts automatically to cut the insulation and slide it off the wire.

Figure 12 — The Irwin Vise-Grip 2078300 is a self-adjusting stripper that does not require you to know the wire size ahead of time. The yellow stopper in the figure is set to the maximum length of ¾ inch, and it swivels out of the way for longer strip lengths.

At 11 ounces, this tool is heavy, but the padded handles feel comfortable in hand. It's rated to strip #10 to #24 AWG wire, and there is an adjusting mechanism for wire sizes smaller than #20 AWG. I was able to strip all of the wire types shown in Table 5 successfully, without any adjustment. It worked fine with the #26 AWG Teflon-insulated stranded wire and the #12 AWG THHN wire that were problematic for some of the other tools in this review. The only wire that I had difficulty with was a piece of #14 AWG wire taken from a length of Romex cable.

The yellow assembly shown in Figure 12 is a plastic stopper that you can use to set the length of insulation to strip off. It's adjustable from about ¼ to ¾ inches, and it swivels out of the way if you don't want to use it. This feature worked well for me, but several reviews on Irwin's website indicate that the stopper is prone to damage.

Below the pivot point is a wire cutter and slots for crimping insulated and uninsulated terminals for #10 AWG to #22 AWG terminals. Similar to other units tested, it required some hand strength to crimp the terminals securely.

Manufacturer: Irwin Tools, **www.irwin.com**. Price: $22.

SOTABEAMS ContestConsole for Icom Transceivers

Reviewed by Steve Ford, WB8IMY
wb8imy@arrl.net

As much as I enjoy my Icom IC-7300 transceiver, there are times when I wish I could extend some of its features to make them a bit more convenient to use. This is particularly true for the voice, CW, and RTTY memory-keying functions.

These memories are intended to alleviate some of the work involved in sending the same information — such as your call sign — over and over. You simply record the desired information into one of the transceiver's memories and send it with a tap on the touchscreen.

It's the touchscreen tapping that tends to become problematic, though. The virtual buttons on the screen are not large, so it is easy to tap the wrong one. Of course, using the touchscreen also means you must have the radio within your arm's reach. Also, the buttons take up space on the screen that I'd rather use for the spectrum display or other features.

The SOTABEAMS ContestConsole solves this issue by using the IC-7300's external keypad feature to move all the touchscreen tapping to an external box

Bottom Line

The SOTABEAMS ContestConsole moves the Icom transceiver memory controls off the touchscreen and onto an external keypad that can be placed in a convenient spot at the operating position.

Figure 13 — The ContestConsole connections.

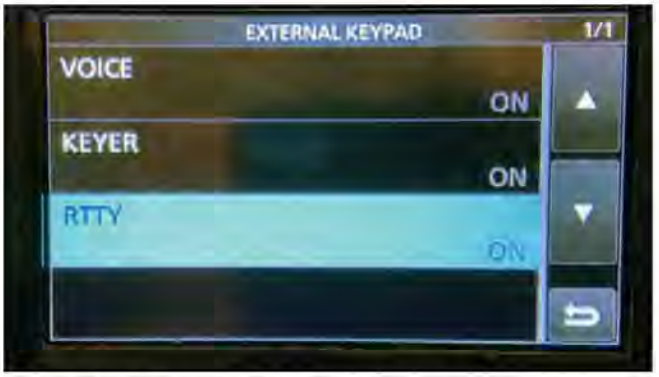

Figure 14 — This screen is used to set the IC-7300 to use an external keypad for CW, SSB, and RTTY.

that measures only 4.25 × 2.75 × 1.5 inches. The ContestConsole offers eight sizeable pushbuttons: four for memories 1 through 4, **PTT** (push to talk), **TUNE**, and two for **FREQUENCY DWN/UP**.

Your microphone or headset plugs into a rear-panel eight-pin **MIC** jack (see Figure 13). On the same panel you'll also find a 3.5-millimeter jack for an auxiliary microphone and another for a foot switch or other manual PTT switch. The socket labeled **TUNE** is for the antenna tuner command function. With the optional cable connected between the **TUNE** socket and the transceiver, you can operate an external antenna tuner with a push of the top-panel **TUNE** button. I didn't evaluate that function during this review.

Although the ContestConsole was intended originally for use with the popular Icom IC-7300, it will work with many other Icom radios. The complete list may be found on the SOTABEAMS website.

Simple Setup

The first step in setting up the ContestConsole is to let the transceiver know that you're using an external keypad. In the IC-7300, you simply go to the **CONNECTORS** screen, tap **EXTERNAL KEYPAD**, and then toggle CW, Voice, and RTTY to "on," assuming you intend to use all three memory groups with the ContestConsole. (See Figure 14.)

A 20-inch cable at the back of the ContestConsole plugs into the transceiver's microphone jack, and your microphone plugs into the ContestConsole. That's all there is to it.

Using the ContestConsole

With the ContestConsole attached and your transceiver properly configured, press one of the blue memory buttons (**M1** – **M4**) to transmit the contents. I used the ContestConsole during an SSB contest to send my call sign and exchange. With a press of a button, my transceiver switched to transmit, and my prerecorded voice issued forth. This saved considerable wear and tear on my vocal cords.

I also used the ContestConsole to send my call sign and exchange during a recent CW competition. Again, it made memory keying much easier.

Should you need to transmit without sending the contents of the memories — such as when you're operating voice and want to say something other than your canned messages — just press the **PTT** button. I found the **FREQUENCY** buttons handy for a quick change of frequency when the need arose. One button press increments the frequency by whatever step you've selected in your transceiver menu (such as 10 kHz). If you press and hold the **UP** or **DWN** buttons, the frequency will keep incrementing up or down until you release the button.

Although the ContestConsole is designed for contest operating, I found it useful anytime I wanted to use memory keying. It would be a godsend when you're making repeated calls in the hope of breaking through a DX pileup. It would also be a significant help during operations such as Parks On The Air, Summits On The Air, or even special-event stations — any application where you need quick, convenient access to your transceiver voice, CW, or digital memories.

Manufacturer: SOTABEAMS, **www.sotabeams.co.uk**. Distributed in the United States by DX Engineering; **www.dxengineering.com**. Price: $85.99. Optional Tune Lead CC-LEAD-KT; $12.99.

Steve Ford, WB8IMY, wb8imy@arrl.net

Eclectic Technology

Experiments at 40 MHz

If you happened to listen to Episode 41 of the *Eclectic Tech* podcast a few months ago, you heard my conversation with Greg "Lin" Holcomb, NI4Y. If you missed it, you can still catch the episode in the podcast archive at **www.arrl.org/eclectic**.

Lin, of Atlanta, Georgia, is the operator of WL2XUP, an experimental station on 8 meters authorized by the Federal Communications Commission. With commercial users shifting to UHF and microwave frequencies, the 8-meter band is largely empty. Lin's goal is to explore the propagation characteristics of the band, with an eye toward potential use by amateurs.

He uses WSPR for most of his transmissions, which are at about 40.662 MHz. He occasionally tries FT8 as well. He runs about 20 W PEP into a simple omnidirectional wire dipole antenna. The 8-meter station had been on the air for just a few days when, on July 22, Lin received his first WSPR report from Guy Charron, VE3QC, in Gloucester, Ontario, Canada (see Figure 1). Soon after came a transatlantic hop and subsequent report from Paul, G7PUV, in the United Kingdom (see Figure 2). More reports have followed, but Lin says he can use even more.

Figure 1 — A WSPRnet report showing VE3QC's report of Lin's 8-meter signal in July 2021, via sporadic-E propagation.

Figure 2 — The first transatlantic report came in from Paul, G7PUV. [Image courtesy of EI7GL]

You Can Help

Lin asks more amateurs to listen for his WSPR or FT8 signals. Many HF-through-6-meter transceivers have the ability to receive on 8 meters, as do even most inexpensive software-defined receivers. By using *WSJT-X* software, monitoring for FT8 or WSPR, and auto-uploading reports to PSKReporter (**pskreporter.info/pskmap.html**) or WSPRnet (**www.wsprnet.org**), you can contribute to the data he is accumulating. Since I last spoke with Lin, other experimental stations have popped up on the band, including WM2XCW, WM2XAN, WL2XZQ, WM2XCC, and WM2XCS.

According to Lin, "I hope these experiments will assist in E-skip forecasting. Other areas of inquiry would include the so-called 'spotlight' openings. And can we develop a better understanding of the mechanisms behind brief 'micro-openings.' These odd band openings last too long to be meteor scatter, so are they a type of sporadic E, or are they something else?"

In addition to his work on 8 meters, Lin's authorization includes the 4-meter band. Amateurs in many other countries, especially Europe, have privileges on this band, but US hams don't. They can, of course, monitor that band without restriction. Much of the 4-meter activity is FT8 at around 70.155 MHz.

Dave Casler, KEØOG, askdave@arrl.org

Ask Dave

Get more information from the "*QST*: Ask Dave" YouTube playlist at **https://bit.ly/3z2MBMI**.

Chirp, Autotransformers, and More

Transformers vs Autotransformers

Q Ioan Rusan, YO2URS, of Romania asks: "What is the difference between a transformer and an autotransformer? What are their respective advantages and disadvantages?"

A The basic difference is that transformers have separate windings around a common core, while autotransformers share a common winding around the core. Figure 1 shows a transformer with five turns on the primary and 25 turns on the secondary, wound around a common core, usually a toroid. The voltage across the secondary will be five times that of the primary. The impedance ratio of a transformer is the square of the turns ratio. With a turns ratio of 5:1, the impedance ratio is 25 to 1. If 50-ohm coax is feeding the primary, the impedance at the secondary will be 1250 ohms.

Now let's look at whether the circuit is balanced or unbalanced (see Figure 2). One side of the primary is connected to ground, usually via the shield on the coax, with the center conductor connecting the other side. The secondary winding of the transformer is balanced but floating, i.e., with no ground reference. We can easily make it balanced with respect to ground by connecting a tap at its center to ground (see Figure 3), usually by just connecting it to the primary ground. This is a common balun configuration.

An autotransformer has one set of windings on a core, and the primary and secondary share some of them. In Figure 4, the primary uses the upper segment of windings from A to B. The tap at A connects to ground, usually the coax shield, while the coax center conductor goes to B. The secondary is the entire set of windings from B to C. Note that there are more secondary windings than primary windings; this makes it a step-up autotransformer for both voltage and impedance, a very common design for voltage baluns. The windings A to B carry *both* the primary and secondary currents, while the windings A to C carry only the secondary current. The designer must ensure that the wire used can handle the combined currents in windings A to B. If the A to B and A to C windings number the same, the voltage step-up ratio will be 2:1 and the impedance step-up will be 4:1, while the output across the secondary will be balanced with respect to ground.

You can, of course, turn the autotransformer around to use for stepping down the voltage and impedance if you need to, but that is a less common usage.

The advantages of an autotransformer are that it is simpler and uses less wire than a traditional transformer does. The increased current in the shared windings could pos-

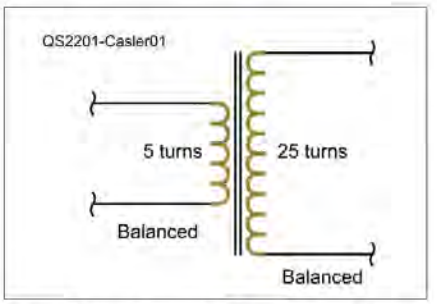

Figure 1 — A basic RF transformer. The vertical lines represent a core, usually in toroid form.

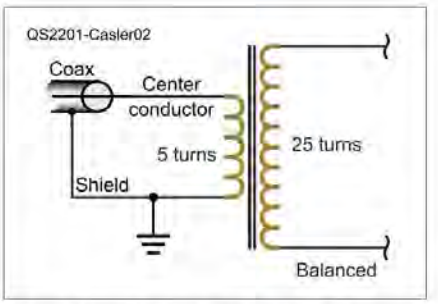

Figure 2 — Connecting one side of the primary to the coax shield makes it unbalanced.

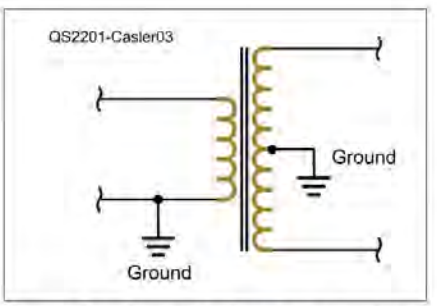

Figure 3 — A grounded center tap makes the secondary balanced with respect to ground.

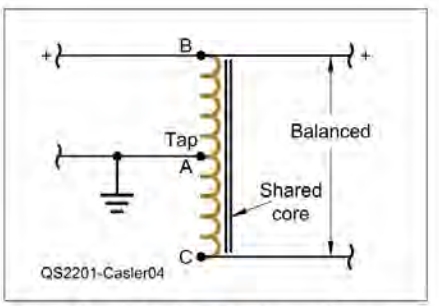

Figure 4 — A basic RF autotransformer.

sibly be a disadvantage, or at least a parameter that you should be careful about.

In addition to their uses at RF, autotransformers are also often used in ham shacks at ac line frequency. A classic use of variable autotransformers, such as those made by Variac® and Powerstat®, is to adjust 120 V ac from the wall outlet to a voltage anywhere from zero to about 150 V. They are often used to lower the ac voltage for old radios built back when the line voltage was only about 110 V, which may be necessary to reduce the strain on tube filaments.

Do Modern Rigs Create Chirp on CW?

Q Jeff Blackmon, W8YI, of Ohio asks: I've been listening to 40-meter CW lately. Some of the signals have a sort of chirp to them, very much like a whooshing sound. It's very short at the beginning of a transmission at the first key closure. Then the signal seems to maintain frequency well. What's going on?

A Zak Lau, W1VT, ARRL Senior Lab Engineer, points out that it could be an automatic level control (ALC) issue on transmit or an automatic gain control (AGC) issue on receive. He notes that the ARRL Lab sometimes finds "first dit" anomalies even on modern radios. Zak then sent the question to me.

If you're having "first dit" problems, look at the transmit station power supply first. I've long advocated using power supplies specifically made for ham radio. There are many supplies available on Amazon and eBay that seem to be great bargains, but aren't robust enough for ham use. Consider that the power supply must typically transition from delivering two or three amps (receive current) to maybe 20 A (transmit current, key down) instantaneously, while maintaining a rock-steady 13.8 V. Supply voltage sag during the initial high current draw can cause the operation of the radio to become "unpredictable."

In the receiving radio, the AGC maintains signals at a constant audio amplitude, regardless of their strength. If the received signals are weak and a strong dit comes in suddenly, the AGC must quickly reduce the gain (usually in the IF stage) so the signal does not blast your eardrums. This is not instantaneous; there's a finite interval (called the AGC "attack" time) to reduce the signal to an appropriate level. A slow attack time in CW operation can allow anomalous audio artifacts through on that first dit, although that setting may be optimal for voice. (Many radios also have adjustable AGC "release" times.) Adjust the AGC settings for your mode of operation (I usually leave mine on medium).

By the way, to let another operator know their station has a consistent chirp (on every dit and dah), add the letter "C" to the Readability-Signal Strength-Tone (R-S-T) system (e.g., "559C").

EZNEC Will Soon Be Free

Q Robert Black, N7GNH, of Arizona, asks: "I'm considering purchasing *EZNEC* for designing antennas. Is it still for sale? If not, is there an alternate source for similar software?"

A It's a common misconception that *EZNEC* is a design program, but it is really an analysis program. *EZNEC* and several other programs use Numerical Electromagnetics Code (NEC), antenna modeling software that was developed for the US government under contract by Lawrence Livermore National Laboratory. NEC is an old program, written originally in FORTRAN. Several developers have put a "code wrap" around the software to create a much friendlier user interface. *EZNEC* was one of the first of these.

The *EZNEC* family of software products was put together by Roy Lewallen, W7EL, and for many years they have been a mainstay tool for US amateurs. However, Roy is retiring at the end of 2021 and will no longer support the products, but he will make *EZNEC (Pro/2)* available for free starting in 2022. That may have already happened by the time you read this. The *EZNEC* website is at **www.EZNEC.com**.

A few other pieces of software also provide a wrap for NEC. A popular free one is *4NEC2*. Its interface is like that of the *EZNEC* family, but it still usually involves a learning curve.

These programs typically come with free sample files, each representing a particular type of antenna. These sample files are good starting points for developing the antenna you have in mind.

Other resources include *The ARRL Antenna Book*, which features downloadable supplemental material such as design software for HF Yagis, as well as modeling files for *EZNEC*. There are also numerous antenna design programs as well as complete antenna designs on the

Send your questions to **askdave@arrl.org**, or fill out the form at **www.ke0og.net/ask-dave**. I answer some questions here, and some via videos on my YouTube channel (**www.youtube.com/davecasler**), or during my weekly livestream on Thursdays at 6:45 to 8:15 PM Mountain Time on my channel.

Hints & Hacks

Crafting Your Own Bus Bar; An Elegant Approach to Improving Electrical Bonding

Building a Bus

I needed a copper bus bar for my station RF ground, so I fabricated my own, as shown in Figure 1. Looking around my shop, I found a section of 2-inch-diameter heavy-wall copper pipe that I salvaged from the remodeling of our swimming pool. I cut a 14-inch section of pipe in half and drilled a line of evenly spaced 17/64-inch holes. The fastening hardware comprises ¼ inch by 1-inch bolts, nuts, and washers. The bolts are fed through the bottom and secured with a nut. A second nut and a washer are used to secure the ground strap. Using two nuts makes it easy to get ground straps on and off. The rubber feet are made from a 1½-inch section of ¼-inch fuel line hose, and I used a small drop of automotive trim glue to hold them in place. The ground wire lug can be placed anywhere along the bus bar. — *73, John Quinzio, W7JMQ,* **radio.w7jmq@gmail.com**

Removing Paint or Other Surface Finishes to Improve Electrical Bonding

Improving the electrical bonding connections on your radio or test equipment usually necessitates removing the existing paint or other surface coatings around the screw hole to ensure a quality, metal-on-metal electrical connection. The usual method, after removing the existing screw, is to use a file, rasp, sandpaper, steel wool, or other tools or materials to abrade the paint or coatings off the chassis, and then reinstall the screw. However, that typically results in unsightly blemishes and an inconsistent surface finish that could oxidize or corrode over time.

There is an easy solution, and you probably even have it in your hardware drawer. The center hole of a metal washer actually makes a fine template for confining the area from which paint or coating is removed from a chassis. The result is a clean, contained, bare metal finish that provides a reliable bonding surface for a screw or ring terminal and maintains a professional appearance.

Note that this process will produce airborne dust particles from the paint or surface coating. Therefore, it is recommended that you wear an appropriate face mask, safety glasses or goggles, and other protective clothing as necessary.

Check that the location of the hole has adequate clearance around it. Find a washer that has an inner diameter that just fits over the head of the existing screw. Ideally, the inside diameter of the washer should be at least 1/32 of an inch, but not more than 1/16 of an inch, larger than the outer diameter of the screw head so that not too much bare metal surface shows. Table 1 suggests washers to use for various screw sizes. Figure 2 shows a fender

Figure 1 — A custom copper bus bar made from a 2-inch-diameter pipe.

Figure 2 — The top side of a flat washer has slightly beveled or rounded edges, while the bottom has sharper edges. Place the bottom side against the chassis.

Table 1
Suggested Washer Sizes

Screw Size	Washer Interior Diameter (inches)
#4	7/32
#6	1/4
#8 (sheet metal screws with 1/4-inch hex heads)	11/32
#8	5/16
#10	3/8

Figure 4 — The paint is totally removed, revealing shiny metal that will ensure a solid electrical connection.

Figure 5 — The screw is reinstalled.

Figure 3 — A Dremel 443 steel wire brush.

washer that just fits over the screw head. Fender washers typically have significantly larger outer diameters, making them well suited for use as templates, though they might not be readily available in all sizes. If the equipment chassis surface is textured, as shown in the photo, or is easily scratched or damaged, you can protect it with a layer of painter's tape or masking tape applied to the bottom side of the washer.

To start, remove the screw from the chassis.

Insert a Dremel® #443, 1/8-inch steel wire brush (see Figure 3) into a Dremel tool. You may also use a Dremel #225 flexible shaft accessory if necessary.

The brush should be new or in very good condition. If it has many missing, twisted, or damaged bristles, it may tend to wander out of the washer and might be ineffective at removing the paint or coating.

Center the washer over the screw hole and hold it in place with your fingertips.

With the Dremel tool set at its lowest speed, hold it (or the flexible shaft) like a pencil as you insert the tip of the brush straight into the center hole of the washer.

Keep these points in mind:

- Let the tool do the work; excessive speed or pressure could make the tool hard to control.
- Tilting or angling the brush too much could prematurely deform the bristles.

Using a soft plunging motion, carefully and slowly move the brush around within the center hole of the washer to ensure complete removal of all paint or other coating.

Keeping the washer in place, take the Dremel and brush away and check to see if all the paint or coating is removed yet. If it is all shiny, clean metal (Figure 4), you may proceed to the next step; if not, keep working at it with the brush.

Remove the washer and clean the dust away from the area of the screw hole. Install the screw (see Figure 5) and repeat the process for any other screw holes used for electrical bonding.

For chassis locations where there is simply not the space to place a large flat washer over a screw hole, one solution may be to fabricate your own templates from soft steel. Cut a length of steel plate and carefully drill a hole of the appropriate size on one end. You can bend the steel plate if needed to make the grip more comfortable. Be sure to remove any burrs and rough edges. — *73, Mark Kupferschmid, AC9PR,* **mkkupferschmid@gmail.com**

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

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

Paul Wade, W1GHZ, w1ghz@arrl.org

Microwavelengths

10 GHz Activity up in 2021

I've observed an increase in 10 GHz activity in 2021, and there even seems to be more activity between contests. It could be that hams, being at home more because of the pandemic, were available when conditions warranted. And this past summer saw a lot of thunderstorms in the Midwest, creating opportunities for rainscatter propagation (see "Microwavelengths," *QST*, October 2020).

For example, on July 13 I joined in the weekly 222 MHz activity night and made a call, but then my SDR screens showed FT8 E-skip activity on 2 meters, and even openings to Europe on 6 meters. Before I could even choose one of them, I got a text message from Hugh Duff, VA3TO, that there was a good possibility of rainscatter on 10 GHz. We had been trying such a contact unsuccessfully for over a year, so I immediately moved to that band and started calling. We soon completed a 608 km contact on CW. I also worked four VE3 stations using CW. Signal levels then improved, so VA3TO called me on FM to chat on 10 GHz (FM works well on strong rainscatter, while SSB suffers serious distortion).

I've even had other contacts "tail-ending" at the end of a 10 GHz rainscatter contact, since the antennas don't have to be pointed at each other, just pointed at a common storm cell that will scatter signals. Credit for the proliferation of rainscatter contacts goes to Andy, KØSM. His website, **rainscatter.com**, shows current storm conditions and active stations, and calculates antenna headings to a chosen storm cell for both stations. Some stations just send CQ toward a large storm and post a notice online, like "CQ 10368.100 toward storm at FN23vg" on email groups like **10GHzUp@groups.io** or **MidwestMicrowave@groups.io** so that others can point at the same storm cell.

Activity is not limited to those with 10 GHz home stations; many operators' locations are unsuitable for microwave activity or are only good in some directions. Some find a better location nearby, where they can quickly set up a portable operation on short notice; VA3TO, for example, often operates from FN03cn on a railroad overpass within a few miles of his home. Others rove to different grid squares when conditions or storm activity seems promising. Peter Prabucki, VA3ELE, operated from 25 grids this year to promote activity — he provided me with three new grids — in addition to being very active from home, where he has worked 48 grids on 10 GHz.

There are also enthusiastic newer operators like Gedas Vysniauskas, W8BYA, whose location in Indiana

Figure 1 — A map from **rainscatter.com** in March 2021 showing a storm front approaching location of Gedas Vysniauskas, W8BYA, with many active 10 GHz stations within rainscatter range. [Gedas Vysniauskas, W8BYA, image]

Figure 2 — Jay Rinkel, KB4GRD, John Reynolds, N5AYD, Russ Kendrick, K5RUS, and Tom Smith, W4RXR operating the 2021 ARRL 10 GHz and Up Contest from the top deck of the parking garage at the Huntsville Hamfest. [Ben Lowe, K4QF, photo]

seems ideally located between several microwave hotspots, like the Rochester, NY and southern Ontario area, the Lake Michigan area, and the St. Louis area. 10 GHz stations surround him (see Figure 1). These areas are all within rainscatter range for him, but some are too far apart to reach other hotspots except under exceptional conditions. He has encouraged many operators to be more active and has himself accumulated a total of 42 grids in only 17 months since getting on 10 GHz.

Airplane scatter can also be used for 10 GHz DX, and it is more predictable than rainscatter. A large aircraft can enhance CW signals by a few dB that would otherwise be too weak to copy. I've made a number of these contacts myself. Roger Rehr, W3SZ, has created a program, *AircraftScatterSharp*, which tracks in-flight data to predict possible enhancements. The program is available at **https://w3sz.com/AircraftScatter.htm**.

My informal internet survey of 10 GHz activity received 36 responses, with roughly half of them reporting higher activity in 2021. A quarter of the stations reported more than 40 contacts outside of contest periods, and half worked at least five new grid squares. More than half reported their best DX ranges were greater than 400 km, and many of them were even more than 600 km, which would have been rare a few years ago. Five of the responders were new to 10 GHz in 2021, and some reported contacting new stations, which is an encouraging trend.

Can you join in this activity without being on a hilltop? Certainly — a high thunderstorm or an airplane can provide the altitude for signal reflection. Find a convenient location where you can set up on short notice – anywhere that provides a clear takeoff in the desired direction will suffice. An overpass or parking deck can be enough to clear local obstructions (see Figure 2). In flat terrain, looking along a road or across a field in the desired direction is good – some of the operators in the Midwest have found convenient local spots for at least some directions.

You don't need a superstation or a perfect location to have fun on 10 GHz, so get out your microwave gear and get an early start on 2022 activity!

New Products

5 W DSP Noise-Cancelling In-Line Module

The new bhi DSP noise-cancelling In-Line Module cleans up noisy signals at eight levels, 8 to 40 dB, and works on most radios and receivers. The 5 W audio amplifier connects in between your radio and loudspeaker. The loudspeaker audio is muted when headphones are connected, and when the unit is switched off, the audio bypass feature routes the signal directly through to the loudspeaker. The In-Line Module is powered from a suitable 10 to16 V dc power supply and has a three-position switch that turns the unit on and switches the noise cancellation on and off. The unit has an audio input overload LED and an audio output level adjust control. It is supplied with a 3.5-millimeter mono plug lead, a fused dc power lead, a *User Manual*, and four rubber feet. The new bhi In-Line Module is available from DX Engineering and GigaParts in the US and at **www.bhi-ltd.com**.

New Audio Bypass Switch

The new bhi Audio Bypass Switch is meant for use with the bhi Dual In-Line and Compact In-Line DSP Noise-Cancelling units, which don't have an internal audio bypass facility. If you switch the power off on your bhi unit, the audio will not pass directly through to your external speaker. The bhi Bypass Switch routes the audio from your radio directly through to your extension speaker without powering on your bhi unit. This can be particularly useful if you just want to listen to your radio without your bhi noise-cancelling unit switched on. A single pushbutton on the Bypass Switch provides this facility. Press the button, and the audio routes through your bhi DSP noise-cancelling unit (power on). Press the button again to return the switch to the out position, and the audio is routed directly between your radio and loudspeaker. The new Bypass Switch is available from DX Engineering and GigaParts in the US, with more information at **www.bhi-ltd.com**.

Technical Correspondence

Loop Misnomers and the Benefits of Vertical Elevation

Why the Small HF Loop is not a Magnetic Loop

Small HF loop antennas, typically about 1 meter in diameter such as the one shown in Figure 1, have been often mistakenly called "magnetic loops." They are not, and here's why.

Maxwell's equations tell us that the current in the small HF loop is not constant around the loop circumference but can be described by a Fourier series. Using just two Fourier series terms will suffice for accurately describing the current around a loop with a circumference of up to 0.3 to 0.4 wavelength. The amplitude of the *second* Fourier term — the current variation term — is responsible for the near-field electric-to-magnetic-field ratio (wave impedance) at the loop center. Furthermore, this current variation term also produces a far-field component that fills in the loop null.

Figure 1 — An OMØET portable HF loop antenna.

The exact solution to the loop current, using Maxwell's equations and considering just the first two Fourier terms, is,[1]

$$I(\phi) = I_0 \left\{1 - 2C_\lambda^{\,2} \cos(\phi)\right\}$$

where C_λ is the loop circumference in wavelengths and ϕ is the angle around the circumference. The magnitude of the current variation is $2(C_\lambda)^2$.

Figure 2 illustrates the loop current showing the variation around the loop circumference at 7, 14, and 30 MHz. The corresponding equation for the loop near-field wave impedance (or near-fields ratio) at the center of the loop is,

$$Z_W = \frac{E_{center}}{H_{center}} = -j376.7C_\lambda$$

in terms of the free space intrinsic impedance. Figure 3 shows the null depth given in dB…

$$N_{dB} = -20\log(2C_\lambda)\,.$$

These equations are *exact* solutions for two Fourier current terms and are accurate for a loop circumference of up to about 0.3 or 0.4 wavelength before additional Fourier loop current terms are needed. As the loop circumference increases, the higher order current terms gradually begin to dominate, and at $C_\lambda = 1$ we have the well-known one-wavelength diameter loop that radiates broadside to the loop plane, the direction that is the null direction for the electrically small loop, $C_\lambda << 1$. These results can be easily verified and validated using NEC software such as *4nec2* or *EZNEC*. Note that the field in the loop broadside direction is cross-polarized relative to the field in the loop plane.

Now we have three exact expressions that depend solely on the circumference in wavelengths: one for the current variation, one for the near-field wave impedance, and one for the null depth. Thus, we have three interdependent ways of choosing *objective criteria* for when a loop can qualify as a "magnetic-field loop" (not magnetic loop) based on its circumference. We can either define an acceptable far-field null depth, or equivalently, we could define the maximum acceptable

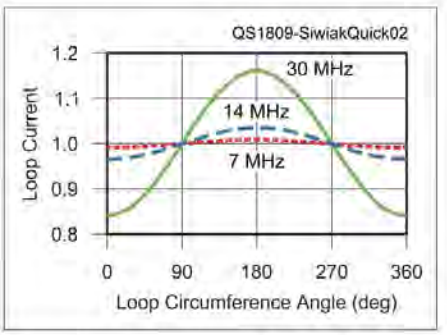

Figure 2 — Loop currents at 7, 14, and 30 MHz along the loop circumference vary in amplitude due to the inclusion of a Fourier series expansion term.

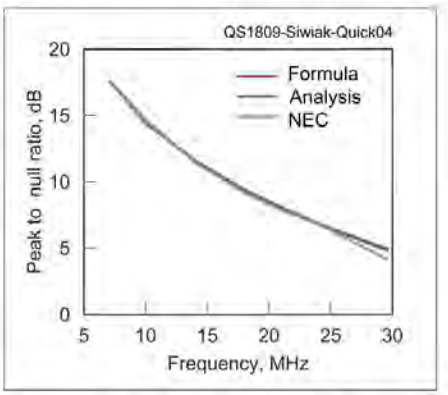

Figure 3 — The null depth steadily decreases across the 7 to 30 MHz operating range. Omitting the current variation term would result in an erroneous infinite null depth.

near-field electric-to-magnetic-field ratio (the wave impedance at the loop center), or we can define the maximum acceptable loop current variation. A true ideal "magnetic-field loop" or a "magnetic-field probe" would have an infinitely deep null, a wave impedance or near electric-to-magnetic-field ratio of zero ohms, and no loop current variation, implying a vanishingly small loop circumference.

Some references arbitrarily define a small loop as having a circumference of under 0.2 wavelength. However, that results in a null depth of just 8 dB — hardly infinite! — and a wave impedance of 75 Ω at the loop center — hardly close to zero! — and a loop current variation of ±8% — hardly a constant.

I propose to define a "magnetic-field loop" antenna as having a modest far-field null that is at least 20 dB deep, which via the null depth equation requires a loop circumference of 0.05 wavelengths or less, somewhat looser than the 0.031 wavelengths for a loop probe suggested by F. M. Greene.[2] The corresponding wave impedance would be 5% of the free-space intrinsic impedance, or about 19 Ω, and the loop current would vary less than ±0.5%. Typical 1-meter diameter loop antennas would meet these "magnetic-field loop" criteria at frequencies below 4.8 MHz. Since the operating range of 1-meter diameter loops is between 7 MHz and 29.7 MHz, they are *never* magnetic-field loops. — *Kai Siwiak, KE4PT,* **k.siwiak@ieee.org**

Raising the ⅜-Wavelength Vertical

"The ⅜-Wavelength Vertical — A Hidden Gem" article in April 2019 *QST*, by Joe Reisert, W1JR, does not allow this gem's full luster to come through by forcing it into the Earth, so to speak, with a ground radial system.

The ⅜-wavelength vertical, when unfettered from the earth, is a ½-wavelength vertical dipole missing ⅛-wavelength. It is the capacitance of this missing ⅛-wavelength bit that is causing the ⅜-wavelength vertical to have an inductive reactance at its feed point, requiring physical capacitors to tune the antenna.

This "missing" ⅛ wavelength, as with any open ⅛-wavelength transmission line, would have provided the capacitive reactance that brings the antenna to zero reactance at resonance, leaving only the radiation resistance.

If a ½-wavelength vertical wire dipole is modeled in free space while being fed ⅛-wavelength (45°) from the bottom end, software will confirm that the feed point radiation resistance will be close to $R_r = R_o/(\sin 45^\circ)^2$.

R_o is the radiation resistance at the current maximum, which for a dipole is the center, and in free space $R_o = 73\ \Omega$. Being off-center fed, the resonant ½-wavelength dipole feed point radiation resistance will be $2 \times 73\ \Omega = 146\ \Omega$. The software calculated $R_r = 141\ \Omega$.

When we bring this off-center-fed vertical dipole down with the bottom end near earth's surface, the feed point radiation resistance becomes closer to $2 \times 98\ \Omega = 196\ \Omega$. Why? Because the image of the vertical dipole in the earth is in phase with the vertical dipole and the radiation resistance at the center, the current maximum, is not 73 Ω, but closer to 98 Ω. The software calculated 188 Ω at 1 foot above ground.

Of course, this now is not the ⅜-wavelength vertical, quite yet. But it can be made so by bending that added ⅛-wavelength bit at the bottom end 90 degrees, parallel with ground, keeping the entire bent vertical dipole above ground, say, by 1 foot.

The length of that bent ⅛-wavelength bit will need some adjustment because now not only does it have a self-capacitance with the ⅜-wavelength part above it, it also now has capacitance with its ground image below as well.

If we use two of these wires, arranged co-linearly, the current flow in each, for equal lengths, will have equal but opposite currents, and fields that will cancel, reducing their horizontal radiation to a theoretical zero.

Thanks to the capacitance of these two wires above ground with their images below, the required length to form a capacitance to cancel the 3/8-wavelength monopole's inductive reactance will be around ± 4 feet when placed 1 foot above ground.

The software confirms that with two co-linear wires, 1 foot above ground, ±4.1 feet long, the feed point impedance of the ⅜-wavelength wire vertical to be 198-*j*3.8 Ω, which, with a 4:1 current balun would give an SWR of 1.01:1.

It is important to note that with this bent arrangement the radiation resistance at the feed point is in close agreement with the software calculated radiation resistance of the entire ½-wavelength vertical dipole, with its bottom end near ground, of 188 Ω.
— *John Lenahan, KØRW,*
kørw@arrl.net

Notes

[1]K. Siwiak, KE4PT, and R. Quick, W4RQ, "Small Gap-resonated HF Loop Antenna", *QST*, Sep. 2018, pp. 30-33: available at **www.arrl.org/files/file/QST%20Binaries/September2018/QSTinDepth-Sept-2018-Siwiak-Quick.zip.**

[2]F. M. Greene, "Development of Electric and Magnetic Near-Field Probes," National Bureau of Standards Report No. NBS TN-658, Jan. 1975, see p. 46.

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A Beginner's Guide to
Silkscreen Printing

Follow this seven-step guide to help take your custom projects to the next level.

Douglas R. Smith, N8HI

If you're looking to give your kits and custom projects a sharper appearance, I recommend trying silkscreen printing. It can produce professional-grade results, even on smaller projects. It offers versatile design possibilities, and is fairly affordable to do.

EZScreenPrint®, an online store for do-it-yourself screen-printing products, offers a few different kits, as well as a full list of supplies. I purchased their basic starter kit (**www.ezscreenprint.com/products/diy-basic-screen-printing-starter-kit**) for $46.99. This article will walk you through using this kit to enhance your projects with silkscreen printing.

Step 1: Create Your Design

For my project, I wanted to print a design onto a chassis for a transceiver kit that I was building. The chassis had bare aluminum metal on the front and back, which was perfect for my silkscreen application.

First, I outlined the front and back of the chassis to get its dimensions. I kept the drawing in a 1:1 ratio on my computer screen for better visualization. Next, I created my design. For this step, you can use text, drawings, graphics, clipart, etc. However, if you use text, I recommend choosing a font size of at least 12 points, as the clarity of the lettering suffers if it's smaller than that. Software programs like *Microsoft Word* or *PowerPoint* work well for creating the design. I used a free-trial version of *CorelDRAW*, and I found it to be very intuitive. I don't recommend using *Microsoft Paint*, as it doesn't print well.

After creating your design, set your printer quality to "Best" or "Heavy Ink," and print it on plain white paper to test how your design will print. It's imperative that it prints clearly and opaquely with crisp edges, even in the smallest details. I used an at-home HP inkjet

Materials and Tools

- EZScreenPrint Basic Starter kit
- Inkjet or laser printer
- Jacquard Screen Printing Ink (**www.jacquardproducts.com**)
- Small art palette knife (or something similar)
- Four 2-inch C-clamps
- ¾-inch square wooden dowel
- ¾ × 1½-inch wooden dowel
- Power drill
- Screwdriver
- Drywall screws
- Wood glue
- Gloves
- 320-grit sandpaper sponge (optional)
- Spray paint (optional)
- Water-based polyurethane spray (optional)

The EZScreenPrint Basic Starter Kit includes an exposure board unit, two EZScreen Stencils, two small EZScreen Stencil test pieces, two transparency sheets, a plastic canvas, a squeegee, a washout brush, and instructions. [Photo courtesy of **www.ezscreenprint.com**]

I chose Jacquard Screen Printing Ink because it can easily be cleaned up with soap and water. [Photo courtesy of **www.jacquardproducts.com**]

printer (you can also use a laser printer), and I didn't have any issues with the opaqueness or sharpness of my image.

If your printer test was successful, you can now print your design on one of the transparency sheets that came with the kit. If you choose to use a transparency material other than what the kit provides, be aware that the silkscreen in the kit is UV-sensitized, and some plastics and glass may block UV radiation.

Step 2: Prepare Your Silkscreen for Exposure

All work during this step must be done in a dimly lit room so that the photosensitive silkscreen isn't exposed. I worked in a darkened room with a flashlight, and I covered the bulb to control the light level. The kit manufacturer says that a yellow bug light bulb (60 W or less) could be used. Don't use fluorescent bulbs, as they emit more UV light than incandescent bulbs do.

I didn't need the entire 8½ × 11-inch sheet of silkscreen for my project, so I cut it in half (while inside my low-light environment). I made sure to leave at least a ¾-inch space around my design for mounting the silkscreen to a wooden frame.

Figure 1 — When preparing your silkscreen for exposure, place the shiny side of your screen face down against your artwork. Your artwork should be facing up, on top of your clear acrylic exposure board unit.

Place your artwork, facing up, on top of the clear acrylic exposure board unit provided by the kit. Next, take the silkscreen out of the light-shielding bag and remove and dispose of the clear protective backing. Place the shiny side face down against your artwork, making sure it's centered (see Figure 1). Then put the felt side of the black exposure board unit on top of the silkscreen, and secure it around the perimeter with the clips supplied in the kit (make sure the clips don't cover any part of your design during the UV exposure).

It's strongly recommended that you test your UV exposure time by using one of the small stencil test pieces from the kit. The UV source itself can be the sun on a clear day (not cloudy or overcast), or a powerful UV lamp or UV LED light.

I used the sun on an autumn day and left the test piece exposed on a chair for 6 minutes (see Figure 2) due to low UV levels at that time of year in Michigan. If I were making this project in the summer, it would require only about 1 minute of exposure time.

Figure 2 — I exposed my silkscreen design in the sun on a clear day for 6 minutes. Exposure time will vary based on the technique you choose (UV lamp or the sun).

Step 3: Wash and Dry Your Stencil

After your project has been exposed, bring it to a dimly lit room that has a sink or shallow container (I used an old photography development tray, as shown in Figure 3) filled with warm water. Remove the silkscreen from the exposure board unit and submerge it in the water, letting it soak for 15 minutes.

After 15 minutes, you should see a ghost image of your design (soaking your silkscreen for a longer amount of time won't damage your image). Next, place your silkscreen stencil on the plastic canvas from the kit and rinse both sides under warm, gently running water to remove any excess residue. If you hold your stencil up to a dim light and still see some residue, use the soft-bristle brush from the kit to gently scrub it away (be careful on the soft-emulsion side of the material).

Place your completed stencil (with the green emulsion side facing up) on paper towels and blot it dry. Then move it to fresh, dry paper towels to fully dry under a light source for more than 10 minutes, so that the stencil emulsion can harden. Once it's completely dry, your silkscreen stencil will be ready to mount on a wooden frame for printing.

Step 4: Mount Your Stencil to Your Frame

Using a ¾-inch square wooden dowel, I built a frame to hold my stencil. I cut the sides long enough to maintain a ¾-inch minimum spacing between the stencil and the inside edge of the wooden frame. I connected the pieces using wood glue and then clamped them together to dry.

Once your frame is dry, you can mount your stencil. While holding the stencil tight and flat, I used construction staples to secure it to my frame (see Figure 4).

Figure 3 — After your project has been exposed, bring it back to your dimly lit room. Remove the silkscreen from the exposure board unit and submerge it in warm water for 15 minutes. A ghost image of your design should appear.

Figure 4 — Hold your stencil tight and flat to mount it to your frame, and secure it using construction staples.

Figure 5 — I needed to build a printing fixture to hold my stencil above my chassis because it was taller than 1 inch. I did this using wooden dowels, wood glue, and inexpensive drywall screws.

Step 5: Build Your Printing Fixture

If the item you wish to print on is taller than 1 inch, you'll need to build a fixture to hold your stencil. The fixture needs to hold the stencil frame (without covering any of your design), as well as be tall enough to fit over the item you're printing onto.

Cut four pieces from the remainder of your ¾-inch square wooden dowel to serve as the legs of the fixture. Their length will be dependent on the size of the item you're printing onto. Add 1 inch to the overall measurement. For example, if your surface is 4 inches high, then you'll need to cut each leg to be 5 inches long. You'll also need to cut two additional pieces to support your stencil assembly, which will be used in Step 7, to go along the sides of the printing fixture and be adjustable in height by using C-clamps.

Next, you'll need to create the side base pieces of your fixture using a 1½ × ¾-inch wooden dowel. Cut these pieces to a length that allows them to hold the four legs upright, as well as hold the stencil frame tightly between the four fixture legs. I used wood glue and inexpensive drywall screws to hold everything together (see Figure 5).

Step 6: Prepare for Printing

You'll want to make sure that the surface you're printing onto is clean. Because my surface was a bare aluminum chassis, I lightly sanded it using a 320-grit sanding sponge to help the paint stick to the surface, before wiping it clean. Be sure to wear gloves when cleaning your surface, to avoid contaminating it after it's been cleaned.

Because my chassis was bare, I painted it black prior to printing my design on it. I used a flat enamel spray paint that only required a couple of thin coats of paint.

Step 7: Print Your Design

First, place your printing fixture over the item. Next, place a 0.040-inch spacer (0.040 to 0.050 inches is acceptable), such as a piece of thin glass, over your item (see Figure 6). The spacer will help to keep the printing nice and sharp by preventing the ink from smearing. Then place your silkscreen stencil over the spacer.

Next, you'll need to set the stencil to the correct height above your printed surface by using the two additional wooden dowel pieces that were cut for the sides of your printing fixture in Step 5. Using C-clamps, clamp them to the inside of the fixture support legs to hold the stencil frame to the correct height (when the stencil is level and just barely

Figure 6 — Using a thin glass spacer between the item you're printing onto and your silkscreen design, will help prevent the ink from smudging.

touching the spacer). With the spacing properly set, carefully lift the entire printing fixture (with the stencil) to remove the spacer.

Once the spacer is removed, place your fixture and stencil back over the item you're printing onto, and carefully align your item to the stencil so that it prints onto the desired location. If you didn't need to build a printing fixture because the item you're printing onto was shorter than 1 inch (such as a panel), place your stencil above your printing surface and make sure it doesn't move while printing.

Next, use a small palette knife or something similar to spread the silkscreen ink (I purchased Jacquard Screen Printing Ink from **www.dickblick.com**) on one end of your stencil, but not directly on your artwork. Add enough ink to spread over the entire length of your design.

While holding the squeegee from your EZScreenPrint kit at a 45° angle, use light pressure to spread the ink over your stencil design. Spread the ink over the design once more from the opposite direction. Next, carefully lift the entire printing fixture straight up, so you don't smear your freshly printed work (see Figure 7).

If you encounter any problems, wash the ink off of your stencil with water and try again. Once you're

Figure 7 — I used light pressure to spread the ink over my stencil design from both directions. When I was done, I carefully lifted the fixture to remove my freshly printed project.

satisfied with your printing, clean up with water and place your item in a warm location until it's completely dry. Once mine was dry, I lightly sprayed it with a water-based polyurethane to give it a semi-gloss appearance and further protect my printing.

All photos by the author.

Doug Smith, N8HI, was first licensed in 1972 as a Novice, earned his Advanced-class license in 1975, and earned his Amateur Extra-class license in 1988. He is retired after working 42 years in electronics aviation at Lear Siegler Incorporated and GE Aviation Systems (formerly Smiths Aerospace) working on gyroscopes and microelectronics, and was a test technician on military and civilian aircraft. He has been an ARRL Member for over 40 years, and his amateur radio interests are digital modes and amateur satellites. Doug also enjoys woodworking and riding his recumbent bicycle on the many trails where he lives in Grand Rapids, Michigan. He can be reached at **drsmith784@comcast.net**.

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Feedback

The article, "The Beverage Antenna, 100 Years Later," by Ward Silver, NØAX, and Frank Donovan, W3LPL, from the November 2021 issue of *QST* contained an error in Figure 4. The max gain of the antenna was written as 8.52 dBi, but it should be –8.52 dBi. *QST* regrets the error.

Using an Ionosonde to Understand the Ionosphere

This specialized HF radar system can show you how radio propagation is affected by the ionosphere and help you make the most out of your DX operations during Solar Cycle 25.

Eric Nichols, KL7AJ

The upper regions of the atmosphere, namely the ionosphere, are primarily responsible for long-distance HF communications, and solar indices explain how the ionosphere is supposed to behave. Because the sun's EUV light is the main source of the ionosphere, propagation forecasters look at solar numbers as the be all and end all, taking a "top down" approach to try to understand the ionosphere's behavior. Solar numbers are important, but they don't explain what's happening in your neighborhood at an exact moment, which can greatly affect your ham radio operations.

One of the most important and useful tools for figuring out what the ionosphere is doing and how it affects your radio propagation, is the *ionosonde*, which is a specialized form of radar used for probing the ionosphere. Because the ionosphere is invisible (except during an active aurora), we have to look at it somewhat indirectly. For many years, ionosondes were only available to universities and other scientific institutions. Now, real-time ionosonde data in the form of an *ionogram* is continually available on the internet.

Essentially, an ionogram is a map of the local ionosphere that primarily shows the height of the reflection of radio waves as a function of frequency. A large network of Lowell Digisonde International (LDI) DIGISONDE® (Digital Ionospheric Goniometric IonoSONDE) ionosondes produce new ionograms about every 15 minutes, and there are about 90 of these ionosondes in the world. Most of the highly standardized DIGISONDE ionograms can be accessed at **www.digisonde.com/stationlist.php**.

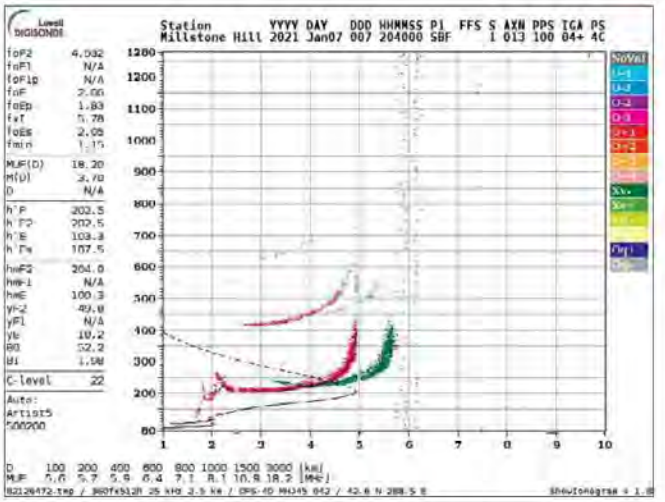


Figure 1 — This ionogram from the Millstone Hill, Massachusetts, DIGISONDE shows that the 17-meter band had good operating conditions on January 7, 2021.

Interpreting an Ionogram

The ionosphere is sparse, which is why ionograms can change so rapidly, and why real-time ionospheric sounding is so important. The part of the atmosphere most responsible for long-distance HF propagation is the F layer (the highest layer) of the ionosphere, which is between about 200 – 600 kilometers in altitude.

An ionosonde sends a short radio pulse straight up from Earth, looks for a reflection, increases the frequency by a few kHz, sends another pulse upward, looks for a reflection, and then repeats the process from the beginning. An ionogram from the Millstone Hill, Massachusetts, DIGISONDE can be seen in Figure 1.

You'll see that the frequency is swept between about 1 and 10 MHz. However, each DIGISONDE can be set up slightly differently. The time it takes for the pulse to be reflected is directly related to the height of the radio pulse, assuming it travels at exactly the speed of light (see the sidebar, "Understanding the Speed of Radio Propagation").

In an ionogram, the x-axis of the graph is typically the frequency in MHz, and the y-axis usually reads the vertical reflection height in kilometers. The column to the left of the graph shows the various critical frequencies. In Figure 1, the "main" critical frequency is 4.932 MHz. Any vertical incident signal below this frequency is reflected (or more accurately, refracted) back to Earth. Any signal transmitted above this frequency goes right through the ionosphere and into outer space.

It's important to view the Maximum Usable Frequency (MUF), which is shown in the left column, as well as below the graph. The D measurement above MUF at the bottom of the graph is the ground distance to where the hop comes down (the signal's journey from Earth to the ionosphere and back to Earth). The MUF increases above the critical frequency as the launch angle (the angle of transmission above the horizon) is decreased. In Figure 1, a horizontally radiated signal has an MUF of 18.2 MHz, telling us that the 17-meter band is pretty good to operate on. This is not an estimation — it's an actual, real-time measurement. Typically, solar indices are not this accurate.

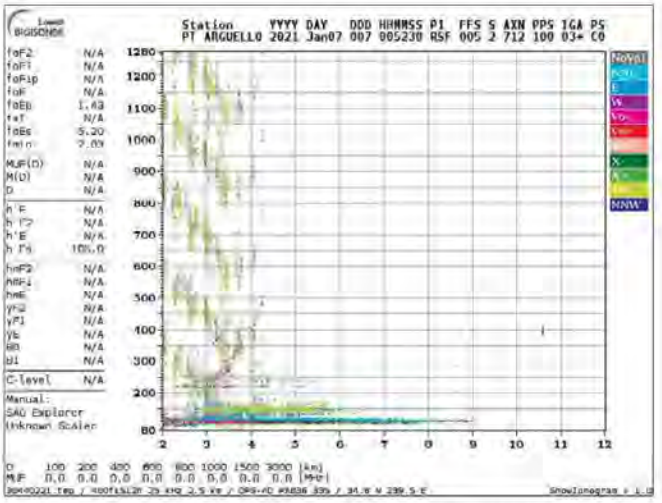


Figure 2 — There was some great sporadic-E propagation at the Vandenberg Space Force Base in Lompoc, California, on January 7, 2021, shown by the horizontal trace at about 90 kilometers from 0 to 9 MHz.

The Importance of Free Electrons

To interpret an ionogram, it's important to understand that the main components responsible for long-distance radio propagation are free electrons (and lots of them). When there are a lot of free electrons in the atmosphere, you will have good radio propagation. However, a lot of other things have to happen first.

The various critical frequencies and MUFs shown in the figures in this article are obtained from ionosonde reflection data, which is represented by the red and green curves on the graph. The curves tell us that there are multiple Earth-ionosphere-Earth reflections, which is not too surprising. Whenever you see duplicate reflections at exact multiples of the lowest reflection, as in Figure 1, and especially Figure 2, this is a pulse going up, coming back down, going back up again, and coming back down again (and so forth). The multiple reflections are at the same height — in reality, the ionosonde measures time of flight, and twice the time of flight looks like twice the height. When multiple reflections occur, this tells us that the absorption of the signal is fairly low. I've seen as many as six reflections, telling me that absorption was nearly non-existent at that time (which is almost always a harbinger of great propagation, especially on the low bands). However, in Figure 1, the most important reflection is the point where the red curve turns abruptly upward, which is the critical frequency (foF2) of the F layer at 4.932 MHz. This frequency also coincides with the maximum free electron density in the F layer, which is shown by the black curve that's solid on the bottom and dashed on top. The peak of this curve (200 kilometers) shows where the highest concentration of free electrons is.

Circular Polarization

When an HF signal is launched into the ionosphere, the Earth's magnetic field causes it to split into two different rays or waves: ordinary (O mode), which is displayed in red on the ionogram, and extraordinary (X mode), which is displayed in green. The O mode wave is right-hand circularly polarized, and the X mode wave is left-hand circularly polarized. On average, the critical frequency for the X mode is about 1 MHz higher than the O mode. Generally, the O mode signal is a bit stronger than the X mode (especially as you go lower in frequency). Both modes naturally skew off the great circle path a bit due to the Earth's magnetic field. The great circle path is the shortest distance between two points on the surface of a sphere, such as Earth, which is your normal guide for steering a directional antenna toward a particular DX station. Even HF operators with multi-element Yagi-Uda antennas would find it difficult to determine how far off the O mode and X mode are from the great circle path.

All ionospherically propagated HF signals are circularly polarized. You'd normally never notice this unless you use a circularly polarized antenna on HF. For more information on X and O modes, read my December 2010 *QST* article, "Gimme an X, Gimme an O, What's that Spell? — Radio."

Understanding Electron Density Profiles

Typically, the sun creates a nice, smooth, even bath of EUV radiation. EUV radiation is what removes electrons from air molecules, creating free electrons. When the sun has lots of sunspots, the EUV radiation is more intense. However, contrary to popular opinion, sunspots themselves do not cause EUV radiation, they're only an indicator of it. This is why sunspots are helpful, even if they are on the "wrong" side of the sun.

When it comes to electron density profiles, there are two conflicting factors. At very high altitudes (low pressures), it's easy to ionize an air molecule. But, as I suggested before, there aren't many located at these altitudes to ionize in the first place. At lower altitudes (high pressures), there are a lot more ions, but the air molecules are much harder to ionize. Therefore, the peak electron density is the height at which these two conflicting factors balance out, and it usually happens between about 200 and 250 kilometers.

More Ionogram Examples

Figure 2, an ionogram from the Vandenberg Space Force Base in Lompoc, California, is a great example of seeing sporadic-E propagation. When reading this ionogram, you can ignore the pale green/yellowish marks near the left side, that's just noise. Take a look at the horizontal trace at about 90 kilometers from 0 to 9 MHz. The reddish and greenish traces are essentially right on top of each other, meaning that there's basically no X and O dispersion. Magnetic effects don't occur until much higher altitudes. The colors also tell you about Doppler shift. A shift toward the red means the ionosphere is receding, and a shift toward the blue tells us the ionosphere is moving downward. Sporadic-E propagation is not dependent on frequency like F-layer propagation, which is why there's no MUF information on this ionogram. Also, the E layer is much lower than the F layer, so skip distances (the distance the radio wave travels) will be much shorter.

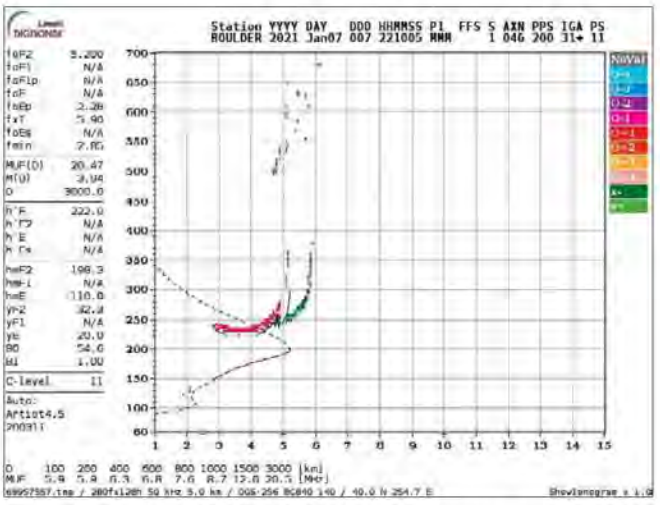


Figure 3 — This ionogram from Boulder, Colorado, shows that on January 7, 2021, the O mode critical frequency (foF2) was 5.200 MHz, which is ideal for working 75- and 80-meter near vertical incidence skywave (NVIS) propagation.

In Figure 3, an ionogram from Boulder, Colorado, we see that the O mode critical frequency (foF2) is 5.200 MHz. This is ideal for operating 75- and 80-meter near vertical incidence skywave (NVIS) propagation. You might even be able to get by with some 60-meter NVIS propagation. For this type of propagation, you want to be about 10% below the critical frequency.

Understanding the Speed of Radio Propagation

When working with ionosondes (or studying the ionosphere in general), one will encounter two related terms: virtual height and true height. The speed of radio propagation through the ionosphere can be considerably less than the speed of light in free space. Like a transmission line, the ionosphere has a velocity factor (VF), but unlike a transmission line, the VF of the ionosphere is continually changing with respect to height. This can make things a little complicated.

The height of reflection is important to hams, because on the most fundamental level, it tells us how far we can get on a single skip. Usually, the "higher" the ionosphere is, the more distance we can get per hop, which is generally good for DX operations.

Because the VF through the ionosphere is so difficult to determine, the virtual height can tell us the distance to the reflection point (assuming the VF is 1.0), or the speed of light in free space. This can be significantly different than the true height, which is very difficult to calculate. The DIGISONDE ionogram provides both heights to the left of the graph, and the difference between them is the "thickness" of the ionosphere.

If you're interested in exploring this aspect more deeply, visit **https://ulcar.uml.edu/digisonde_dps.html** for more information.

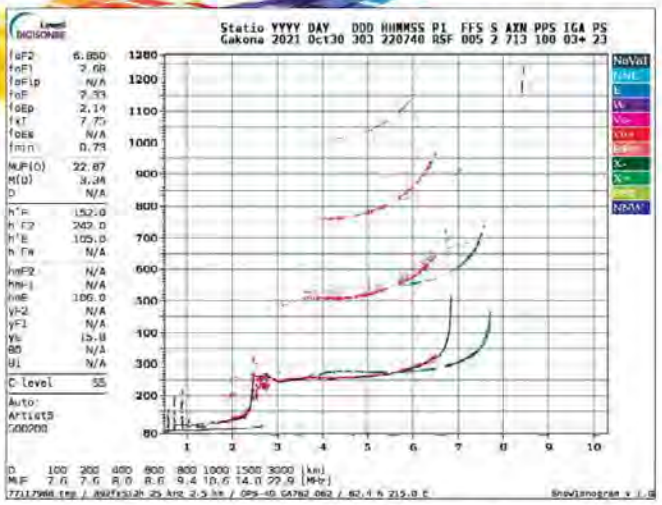


Figure 4 — A more recent ionogram, from the High-frequency Active Auroral Research Program (HAARP) facility in Gakona, Alaska, on October 30, 2021, shows truly vertical incident reflections.

But what's even more encouraging is the 3,000-kilometer first hop MUF at 20.5 MHz. This means you'll probably have some decent 15-meter possibilities and definite 17-meter activity.

More recent propagation has also allowed me to capture some great ionograms from nearby DIGISONDES, particularly the one located at the High-frequency Active Auroral Research Program (HAARP) facility in Gakona, Alaska (see Figure 4).

First, notice how thin the O (red) and X (green) traces are, as well as how pure they are in color. This means that the reflections are truly vertical incident reflections, coming straight down from above. If they were arriving from off-vertical directions, the colors would be altered from their pure hues, which can be seen in the legend in the upper right corner. Cooler hues indicate arrival from the general north, while warmer hues indicate arrival from the general south. (Newer versions of the DIGISONDE indicate the direction of arrival in greater detail.) The thinness of the traces also indicates great stability. If the ionosphere was moving around or returning from multiple wrinkles (or gravitational waves), the traces would be thicker. We also see that there are four visible O-mode traces, and a small hint of a third X-mode trace. These multiple reflections tell us that the ionosphere is essentially non-absorptive — there isn't a D layer to disrupt things. Perfect conditions all around! The O-mode MUF shown at this time is 22.9 MHz, which is one of the highest MUFs we've seen in Alaska in years (typically, there's no ionosphere here).

Visit **www.digisonde.com/digisonde.html** to find additional resources that are available for download, such as the *Digisonde 4D Manual* and *Antenna Array Configuration*.

Conclusion

I hope that this introduction to understanding the ionosphere through the use of ionosondes can help you with your next DX radio adventure. Despite how informative ionograms can be, there's really no substitute for getting on the air and experiencing radio propagation for yourself.

All figures by the author.

Eric Nichols, KL7AJ, has been an active radio amateur since 1972. He is a two-time recipient of the ARRL Bill Orr, W6SAI, Technical Writing Award. Eric has written numerous articles for *QST* and *QEX*, as well as four ARRL books, the latest being *Receiving Antennas for the Radio Amateur*. Eric's latest focus is on encouraging experimentation on our two new bands on 2,200 and 630 meters, while attempting to make LF contacts in England and other European countries with LF privileges. He can be reached at **kl7aj@arrl.net**.

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

Write for *QST*

The membership journal of ARRL is always open to manuscript submissions from ham radio operators.

QST looks for material that appeals to a broad cross-section of readers within the diverse amateur radio community. Feature articles published in *QST* fall into one of two broad categories: *technical* and *general interest*.

Technical articles outline a construction project or a technical concept. General interest articles are "everything else" that's not technical: recaps of DXpeditions, grid expeditions, or public service activities; personal accounts of trying a new mode or style of operating — anything relating to operating or the ham radio avocation.

Whether your manuscript has a technical or general focus, a strong "how-to" component will make it stand out. Readers should come away from the article with specific ideas for recreating your experience.

Please note that *QST* only considers complete manuscripts — we do not evaluate concepts or ideas for manuscripts. The best way to find out whether the editors of *QST* are interested in your idea is to write the article and send it in for consideration via postal mail or email (no phone calls, please).

For more information on what *QST* is looking for, and how to submit manuscripts, see our Author Guide at **www.arrl.org/qst-author-guide**.

Rick Lindquist, WW1ME, ww1me@arrl.org

Happenings

President Names Rosenworcel FCC Chair, Announces Planned Nominations to FCC, NTIA

In late October, President Biden designated FCC acting Chairwoman Jessica Rosenworcel as Chair and announced that he intended to nominate her for another term on the FCC, as well as name another nominee to fill an open seat on the Commission. Rosenworcel, a Democrat, is the first woman to head the Commission. She has served on the FCC since 2012.

FCC Chairwoman-designee Jessica Rosenworcel.

Rosenworcel said she was "deeply humbled" to be designated as FCC Chair. "It is an honor to work with my colleagues on the Commission and the agency's talented staff to ensure that no matter who you are or where you live, everyone has the connections they need to live, work, and learn in the digital age," she said.

Prior to joining the FCC, Chairwoman Rosenworcel served as Senior Communications Counsel for the US Senate Committee on Commerce, Science, and Transportation. Before entering public service, she practiced communications law.

The President also announced that he planned to appoint Gigi Sohn to fill the other Democratic slot on the Commission. Sohn is a Distinguished Fellow at the Georgetown Law Institute for Technology Law and Policy and a Benton Senior Fellow and Public Advocate. She served from 2013 until 2016 as counsel to former FCC Chairman Tom Wheeler.

Biden also announced his intention to nominate Alan Davidson as Assistant Secretary for Communications and Information at the National Telecommunications and Information Administration (NTIA) within the US Department of Commerce.

ARISS Receives Generous ARDC Grant for ARISS STEREO Education Project

Best known for arranging amateur radio contacts between students and astronauts, Amateur Radio on the International Space Station (ARISS) has announced that it's received a generous grant to fund its "Student and Teacher Education via Radio Experimentation and Operations" (STEREO) project. The 5-year Amateur Radio Digital Communications (ARDC) grant, totaling nearly $1.3 million, will fund three distinct initiatives that will enable ARISS to sustain and improve science, technology, electronics, arts, and mathematics (STEAM) educational outcomes.

For Part 1 of the project, ARISS is developing a wireless electronics technology kit called "SPARKI," or Space-Pioneers Amateur Radio Kit Initiative, for use with middle and high school students. This ARDC grant will take SPARKI from prototype to operational phase. ARISS would then deploy these kits among a selected set of formal and informal education organizations that are planning future ARISS radio contacts.

In Part 2 — "Educate the Educator" — ARISS will conduct workshops for a selected set of educators to help them seamlessly employ SPARKI in their education environment and allow ARISS to receive their feedback and ideas. To be successful, ARISS must create awareness of amateur radio, ARISS, and SPARKI among prospective educators.

For Part 3, the grant will also support some of the many costs involved with ARISS contact operations between students and astronauts aboard the ISS.

ARISS-USA Executive Director Frank Bauer, KA3HDO, said ARISS is extremely excited about the new 5-year initiative. "It will be a STEAM education game changer and represents a key element of our ARISS 2.0 vision," Bauer said. "Most importantly, it brings wireless technologies and amateur radio into our ARISS formal and informal classrooms. We thank ARDC for their interest and support and look forward to working with them on this incredible initiative."

ARDC Grants to Fund Amateur Radio Project Expansions

Two recent Amateur Radio Digital Communications (ARDC) grants will benefit the Santa Barbara Amateur Radio Club (SBARC), K6TZ, and Oregon HamWAN.

A $35,550 grant will enable SBARC to construct an amateur radio station at the new Chrisman California Islands Center (CCIC) in downtown Carpinteria, California, at the invitation of the Santa Cruz Island Foundation (SCIF). According to Levi Maaia, K6LCM, who is the K6TZ club call sign trustee, the station is scheduled to open in 2022. SBARC promotes education and training programs for anyone interested in ham radio. It also encourages and sponsors experiments in electronics and promotes the highest standards of practice and ethics in the conduct of communications.

The station will be prominently located near the CCIC main entrance. An interactive display will provide an overview of amateur radio communications and the role that it's played in the history of the islands.

When the station is not staffed, visitors can interact with it using a custom touchscreen that controls an interactive presentation on amateur radio and wireless technologies and their importance to mariners, aviators, scientists, and explorers who visit the rugged islands off the California coast. Webcams connected to the station via SBARC's microwave data network will offer visitors a view of the island's terrain in real time.

An ARRL-Affiliated club, SBARC already maintains open repeaters, data systems, and a club station in Santa Barbara County.

Oregon HamWAN has received an ARDC grant of $88,000 to expand its digital communications network. The project aims to enhance amateur radio digital and emergency communications capabilities between Portland and Salem, Oregon.

The nonprofit plans to expand its digital communications network by deploying 12 network backbone distribution sites between the two cities. Eventually, the sites will connect to the Puget Sound Data Ring, which currently extends from Seattle to Vancouver, Washington. The network would allow emergency management personnel to communicate in the event of a disaster that disrupts telecommunications systems. In such cases, amateur radio operators will be able to quickly set up network nodes where they are needed to provide emergency communication via the Oregon HamWAN digital network. "This will be a game changer for emergency communications in the Portland area," said Oregon HamWAN Project Leader Herb Weiner, AA7HW.

"Deciding to fund [the] Oregon HamWAN project was an easy decision," said ARDC Grants Advisory Committee Chair John Hays, K7VE. "It is a well-organized and well-staffed project that uses multiple amateur radio technologies, such as the 44Net IP address space, 5 GHz radios, and proven software methodologies. It will provide a strong backbone network in Oregon and help preserve our microwave bands."

AMSAT-NA Elects Officers, Discusses Ongoing and Future Satellite Projects

AMSAT-NA President Robert Bankston, KE4AL, told attendees of the 2021 AMSAT Dr. Tom Clark, K3IO, Memorial Space Symposium on October 30, that the organization is looking ahead to future satellite missions, but will "go commercial" in order to keep enough satellites in space. Bankston, who was re-elected at a virtual Board meeting on October 29, said AMSAT is in a solid financial position and donations are "healthy." He said membership numbers are holding strong, with more than 4,000 members in 76 countries, and that recent administrative modernization has reduced overhead costs by more than 30%.

Vice President-Development Frank Karnauskas, N1UW, noted that, despite AMSAT's solid financial standing, additional funds are needed to design, build, and launch satellites. Consequently, AMSAT is ramping up its grant-writing efforts, applying for grants from philanthropic organizations and corporate sponsors.

Bankston said AMSAT's strategic plan prioritizes putting satellites into high-Earth orbits. He also summarized the GOLF (Greater Orbit, Larger Footprint) initiative as part of its plan to reach higher orbits. However, AMSAT will not be giving up on low-Earth satellites (FM CubeSats). "FM satellites are very important and can serve as a stepping-stone to more sophisticated spacecraft," Bankston said. AO-91 and AO-92 are "living on borrowed time," so new initiatives are in order.

Bankston said that going with commercial satellites could shorten development time. AMSAT plans to purchase a v/U 1U FM CubeSat, powered by four lithium-ion cells, but the Board said that 90% of funding would have to be obtained from outside sources. This would not be a permanent approach, however.

The organization will be seeking additional volunteers to put its plans into action. "Any expansion of the strategic plan will need more volunteers," Bankston said, adding that current volunteers "are pretty much at full bandwidth."

Vice President-Engineering Jerry Buxton, NØJY, reviewed satellite proj-

ects in the pipeline. These include providing a linear transponder module to the University of Maine for its MESAT1, set to launch this year.

The GOLF-TEE (Technology Evaluation Environment) CubeSat is under construction and has been added to a launch manifest tentatively for the summer of 2022. Supply chain issues are impacting construction. GOLF-1 is planned for delivery 1 year after the completion of GOLF-TEE.

Space Physics Professor Seeks Radio Amateurs' Help in Making Space Physics Data Audible

Space Physicist Martin Archer of Imperial College London.

Space Physicist Martin Archer of Imperial College London wants to know the best approach to making space physics data audible. Archer is the UKRI (UK Research and Innovation) Stephen Hawking Fellow in Space Physics and Public Engagement and is working in the fields of citizen science and data sonification. He is seeking individuals to complete a 10-minute survey (**https://imperial.eu.qualtrics.com/jfe/form/SV_295iuL4yxfaQ0Qu**), the results of which may help him to determine the best way to give space physics data a voice.

"Our sense of sound can be a powerful tool in exploring and analyzing data collected from satellites. But what is the best way to make this data audible?," Archer asks. Space science researchers at Imperial College London are asking for input from communities with relevant expertise — such as those involved with audio, citizen science, music, public engagement, and science communication. HamSCI Founder Nathaniel Frissell, W2NAF, believes the list could also include radio amateurs.

"Given the connection between radio propagation and geomagnetic disturbances, along with the fact that hams are so used to listening to signals in noise, we think the amateur community would have valuable input," he said.

Specifically, the project seeks the best method of making ultra-low-frequency waves around Earth audible. Archer believes feedback from radio amateurs and others could help space scientists to improve science communication, public engagement, and citizen science.

A participant information sheet (**www.imperial.ac.uk/media/imperial-college/research-centres-and-groups/spat/public/resources/Archer_sonification_SETREC-Participant-Information-Sheet2.pdf**) offers more details on the survey.

Section Manager Nomination

To all ARRL members in Illinois, Indiana, Maine, Northern Florida, Oregon, Santa Clara Valley, Vermont, and Wisconsin. You are hereby solicited for nominating petitions pursuant to an election for Section Manager (SM). Incumbents are listed on page 16 of this issue.

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

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

We suggest the following format:

(Place and Date)

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

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

(Signature _____ Call Sign _____ City _____ ZIP _____)

Any candidate for the office of Section Manager must be a resident of the Section, an amateur radio licensee of Technician class or higher, and a full member of ARRL for a continuous term of at least 2 years immediately preceding receipt of a nominating petition. Petitions must be received at Headquarters by 4 PM Eastern Time on March 4, 2022. If more than one member is nominated in a single Section, ballots will be mailed from Headquarters no later than April 1, 2022, to full members of record as of March 4, 2022, which is the closing date for nominations. Returns will be counted May 24, 2022. Section Managers elected as a result of the above procedure will take office July 1, 2022.

If only one valid petition is received from a Section, that nominee shall be declared elected without opposition for a 2-year term beginning July 1, 2022. If no petitions are received from a Section by the specified closing date, such Section will be resolicited in the July *QST*. A Section Manager elected through the resolicitation will serve a term of 18 months. A Section Manager vacancy occurring between elections is filled through appointment by the Field Services Manager. — *Mike Walters, W8ZY, Field Services Manager*

SM Nomination Petition Resolicitation

Because no nomination petitions were received for the Delaware Section Manager election by the nomination deadline of September 10, 2021, nominations are hereby resolicited. See above for details.

Rick Lindquist, WW1ME, ww1me@arrl.org

Amateur Radio World

ARRL Concurs with Two FCC WRC-23 Advisory Committee Draft Positions

ARRL has said that it agrees with the draft positions of the FCC's World Radiocommunication Conference (WRC) Advisory Committee (WAC) on WRC-23 agenda items 1.13 and 9.1 (Topic A). ARRL is represented on the WAC and participating in its work. The FCC International Bureau issued a call for comments earlier this year.

With respect to agenda item 1.12, ARRL recommends that the US support "studies and possible consideration of a new allocation to the Earth Exploration-Satellite Service (Active) on a secondary basis within the frequency range of 40 – 50 MHz" for spaceborne radar sounders.

"Our support for the draft recommendation is conditioned on explicitly including in the recommendation the need to provide protection and not impose constraints on incumbent services in adjacent frequency bands," ARRL said. "Our expectation is that such studies will identify the capability and adequate means to protect the weak-signal operations of the Amateur Radio Service on the adjacent 50 – 54 MHz band without imposing any restraint on those operations, if the need to use this spectrum for spaceborne radar sounders is confirmed."

In its remarks, ARRL noted Draft Preliminary Views on WRC-23, WAC-23/034 (13.09.2021) appended to the FCC's *Request for Comment* that use of 50 – 54 MHz by radio amateurs was recently studied and documented in ITU-Radiocommunication Report M.2478-0, "Spectrum needs for the amateur service in the frequency band 50 – 54 MHz in Region 1 and sharing with mobile, fixed, radiolocation, and broadcasting services."

ARRL also expressed its support for the WAC's draft recommendation on Agenda Item 9.1, Topic A, Space Weather Sensors. The agenda item calls on the conference to consider and approve the Report of the Director of the ITU Radiocommunication Bureau reviewing the results of studies relating to space weather sensors "with a view to describing appropriate recognition and protection...without placing additional constraints on incumbent services."

The WAC draft recommendation is that the view of the US be "that changes to the Radio Regulations are outside the scope of Agenda Item 9.1" and that the US express its support for "conducting the studies called for in Resolution 657 (Rev. WRC-19)."

"Completion and consideration of these studies are essential to achieving the desired objective of not placing any additional constraints on incumbent services," ARRL said.

ARRL represents the interests of radio amateurs through its participation on World Radiocommunications Conference and FCC advisory committees.

Effort Continues in IARU Region 1 to Address Coexistence of Ham Radio and Navigation Satellites

The issue of coexistence between amateur radio and satellite navigation systems on 23 centimeters continues as a discussion topic in advance of World Radiocommunication Conference 2023 (WRC-23). The issue primarily involves interference potential to one satellite frequency in the European Union's Galileo GPS system.

Agenda item 9.1b at WRC-23 calls for "Review of the Amateur Service and the Amateur-Satellite Service allocations in the frequency band 1.240 – 1.300 MHz to determine if additional measures are required to ensure protection of the radionavigation-satellite (space-to-Earth) service." In late October, the International Amateur Radio Union (IARU) was involved in preparatory work for WRC-23 agenda item 9.1b. These discussions are occurring in ITU-R Working Party 4C (WP4C).

"The working party is considering simulations provided by two administrations [countries] to estimate the interfered area that might exist around a 23-centimeter band amateur service transmitter," IARU said in a news release. "A number of amateur station configurations are under consideration...based on characteristics developed and contributed by the IARU. Both narrowband and wideband emissions are considered."

Various representative station and antenna configurations are being modeled. Interim results show interference distances of up to several kilometers, depending on antenna and power level. This work will continue into the next WP4C meeting.
— *Thanks to the IARU*

Maria Somma, AB1FM, ab1fm@arrl.org

Exam Info

New Technician Question Pool to Take Effect July 1

On July 1, 2022, a new Element 2 Technician-class question pool will take effect for examinations. VECs and VEs will have new test designs available that must be used at exam sessions effective on that date.

The newly revised pool released in December 2021 by the Question Pool Committee (QPC) of the National Conference of Volunteer Examiner Coordinators (NCVEC) must be in use starting on July 1. There are three graphics required for this pool and 412 questions, which is down from 423 in the previous pool. To view all three question pools, visit the NCVEC website at **www.ncvec.org**.

Previous ARRL VEC-supplied Technician-class exam booklet versions (2018 series) and computer-generated Technician-class exams created from the 2018 question pool are only valid until midnight on June 30, 2022. At that time, VE team leaders may destroy the old versions of the Technician-class exams.

ARRL VEC will supply its officially appointed field stocked VE teams with new Technician exam booklet designs by mid-June. VE teams will not receive an updated package if they no longer meet the field stock requirements, they have not conducted a session in the past 2 years, or they have been keeping supplies without qualifying through the VEC. Non-field stocked VE teams should be returning their exam packages and supplies to ARRL VEC after the session is completed. The officially stocked VE teams receive their exam supplies in a large box, which covers 6 months to 1 year, depending on the team's activity levels. To see if your team qualifies to be field stocked with a bulk quantity of our test materials, visit **www.arrl.org/field-stocked-ve-teams**.

2022 ARRL VEC Examination Fee

A $15 fee is charged to every person seeking a new license or upgrade, as listed on the candidate roster. That one fee pays for one attempt at each of the three exam elements. If an applicant retests an exam element, another $15 fee is charged (and another roster entry is created).

VEC activities and fees are governed by FCC rules. VECs are allowed to collect an examination reimbursement fee from each candidate who takes one or more exam elements. Per FCC Rule §97.527, VECs and VEs may be reimbursed by examinees for out-of-pocket expenses incurred in preparing, processing, administering, or coordinating an examination for an amateur operator license.

As long as the expense is warranted and has been prudently incurred, and the expense is specifically related to exam administration, then ARRL VE teams may retain up to $7 of this fee. The team should keep a complete record of the expenses paid (with receipts) in team records for 2 years. Records must be made available to ARRL VEC upon request. Costs should not exceed the allowable reimbursement fees and may not be kept if no expenses were incurred.

Exam fee and reimbursement information for VE teams and examinees are on the ARRL VEC exam fee page at **www.arrl.org/arrl-vec-exam-fees**.

Session Documents Upload Webpage

Teams can upload exam session documents for quicker service. VE teams can upload in-person documents or video-supervised session files via ARRL VEC's secure webpage.

New and upgraded licenses are issued within 1 to 2 business days for weekend sessions, and they are usually issued on the same day for weekday sessions.

Please contact the VEC department (**vec@arrl.org**) for information and instructions on e-filing exam session documents through our upload page. Authorized VEs will be sent the upload page URL, which is hidden from the public.

Resources for ARRL VEs

The ARRL VEC VE Resources page (**www.arrl.org/resources-for-ves**) offers information you will need to help conduct exam session business. Our support page offers easy access to session forms and information, online examinations, and remote video session instructions, VE Manual supplemental information, FCC rules, basic qualification question procedures, and much more. There is also some helpful information for the community, such as preparation resources for candidates, in-person and remote video exam session search, vanity call sign information, and more.

ARRL VEC VE Newsletter

The e-newsletter relays important updates relating to FCC rule or policy changes, exam session document or procedural changes, test booklet updates, the exam session documents upload webpage, online examinations system, and other topics. Subscribe to the ARRL VEC VE Newsletter at **https://reflector.arrl.org/mailman/listinfo/ve-list**.

Rick Palm, K1CE, k1ce@arrl.net

Public Service

Practical Peripherals for Public Service Operators

Peripheral devices can help optimize radio operation in the field, such as at a support and gear (SAG) station during a bike race or at a portable station in a disaster area. These devices connect between radios, batteries, solar panels, ac and dc power supplies, and computers to support input/output functions. They're often overlooked, but can add efficiency to your operation. The units discussed below can all be found in my own ham shack and have been used often over the years, both at home and in the field.

Direct Current Power Management

West Mountain Radio N8XJK Super Booster

If you have problems with low dc power input affecting RF power output, you should consider the West Mountain Radio N8XJK Super Booster (**www.westmountainradio.com/product_info.php?products_id=battery-boost**).

Twelve-volt batteries are a mainstay of dc power management, and modern transceivers require a specific input voltage range to operate optimally. For example, my Yaesu FT-2980R FM transceiver requires 13.8 V, ± 15%, which is a range from 11.7 to 15.8 V. When input supply voltages are lower than this range, the radio might not be able to compensate, which will degrade RF power output. Battery voltage falls for two main reasons: the obvious routine discharging through normal use, but also Ohm's Law. Ohm's Law ($E = I \times R$) says that as the load (the radio) increases its current demand — as when switching from receive to transmit — the supply voltage at the radio will decrease because the current must pass through the combined internal resistance of the battery and resistance of the supply cables. This drop is transient in nature — as soon as the transceiver switches back from transmit to receive, its current demand drops, reducing the $I \times R$ voltage loss. The supply voltage then returns to its previous value, minus the amount lost through battery discharge.

For me, the solution for maintaining my radio's supply voltage was a booster, specifically, the West Mountain Radio N8XJK Super Booster (see Figure 1). When the battery voltage drops, for the reasons described above, the Super Booster automatically raises it back up to a set value (adjustable by a trimmer pot to any value up to 15 V) to maintain optimal transmission. Because my sealed lead-acid (SLA) battery is good for use down to 10.5 V, my Super Booster allows me to make use of that extra ampere-hour capacity below 11.7 V that wouldn't otherwise be available. This boost capability is not without cost, as the device does draw a small amount of current, adding slightly to the demand on the battery.

Figure 1 — My "dc power train" consists of a 12 V 20 Ah Bioenno Power LiFePO4 battery, and a West Mountain Radio N8XJK Super Booster and Epic PWRgate dc power management/charge controller power distribution terminal block.

West Mountain Radio Epic PWRgate

I've used my Epic PWRgate dc power management/charge controller system from West Mountain Radio (**www.westmountainradio.com/product_info.php?products_id=epic-pwrgate**) for several years now (my Product Review appears in in the December 2018 issue of *QST*). I wrote that the device "seamlessly controls the components of an uninterruptible 12 V dc power supply and manages charging for several popular battery types from an ac-sourced dc power supply or solar panel(s)." I use it with my gel-type SLA battery and also with my lithium iron phosphate (LiFePO4 or LFP) battery. The Epic PWRgate has four sets of Anderson Powerpole® connectors, plus a micro-USB port for connection to my laptop, where I run its companion device diagnostics utility software for monitoring the system or programming various charge parameters. The Powerpole connections are for the power supply, solar panel, battery, and output to the radio. The device assures that my radio will continue to run during ac power outages and dc power supply failures. With its small footprint, I run the

unit in conjunction with my Super Booster, along with my LiFePO4 battery, on my wooden mobile "dc power strip" (see Figure 1). For monitoring critical values of voltage and ampere-hours, I use small inexpensive dc inline power meters between components.

Batteries, Solar Panels, and Generators

Bioenno Power® LiFePO4 Battery

My 12 V Bioenno Power LiFePO4 battery, Model BLF-1220A (**www.bioennopower.com/collections/lifepo4-batteries-for-communication-equipment-ham-radio/products/12v-20ah-lfp-battery-pvc-blf-1220a**), has a capacity of 20 Ah. At 5.4 pounds, it is much lighter than my traditional SLA battery (25 lb and 31 Ah), yet it offers more than 1 V higher output at full charge, with no load (14.7 V vs. 13 V). Comparing capacity to weight, my SLA battery offers 1.25 Ah per pound, while my LiFePO4 battery boasts 3.7 Ah per pound.

I derive my power budget for a battery by dividing its capacity by the estimated power consumption. My radio idles at 1.2 A. Therefore, I can expect about 16 hours on idle receive with the LiFePO4 battery.

Renogy 50 W Solar Panel

Using solar for your radio operations is great for two reasons: it's a time-tested battery charger (and it may be the only one you have out in the field), and it is clean, renewable energy. I employ a Renogy 50 W 12 V monocrystalline solar panel (**www.renogy.com/50-watt-12-volt-monocrystalline-solar-panel/?gclid=EAIaIQobChMI7c_vx-n58wIVPwaICR3hGw6-EAAYASAAEgIon_D_BwE**) with my Epic PWRgate charge controller system. I mounted it on a small utility trailer for portability to charge my LiFePO4 battery (see Figure 2). I used zip ties to secure the panel for ease of removal and replacement. This setup has proven quite successful.

Figure 2 — My small utility trailer with a mounted solar panel and secured Honda generator.

Honda 120 V 20 A Gasoline Generator

Also mounted on my small utility trailer, is my Honda EG2800i portable, gasoline-powered generator that puts out 120 V with a load capacity of 20 A (**https://powerequipment.honda.com/generators/models/eg2800i**). I've had good luck with it, and it's quiet and reliable. I put some heavy duty 12-gauge extension cords in the bed of the trailer, preparing it for deployment and use. (Consult an electrical chart for determining the proper gauge and length of a cord for safety reasons. Also, consider using multi-outlet cords with USB connectors for charging peripheral devices.)

Grounding Your Station

A grounding system is also a peripheral, and it provides electrical safety, RF grounding, and lightning protection. More information on grounding can be found at **www.arrl.org/grounding**.

All photos by the author.

Field Organization Reports

October 2021

Public Service Honor Roll

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

809
WA7PTM
570
N9VC
505
WA3EZN
444
AD8CM
362
KE8BYC
360
WM5N
347
W9GRG
345
KT5SR
344
KK6GXG
341
W7PAT
325
W7EES
300
ND8W
292
WA2CCN
288
AC0KQ
W3GWM
285
W8DJG
260
W1RVY
250
KD2NMG
KB3YRU
244
W5LIC
238
KB5PGY
225
KT2D
220
WA0QLW
210
KB2RTZ
205
WO2H
201
KE4DRF
200
N5MKY
199
WB8R

195
K3FAZ
193
N3KRX
190
W0PZD
N8SY
186
KF0BPN
185
KB3YYC
182
KD2GXL
180
W2PH
N3XMB
177
WV5Q
176
K0WAV
175
K9LGU
171
KC8YVF
170
AC8NP
KD2PQP
168
KC8T
KM8V
KE8DON
165
K0RCJ
164
WM2C
162
KV8Z
160
N1LL
KC8WH
155
WB9WKO
N4CNX
150
KC9FXE
KT4WX
KB8PGW
149
KC1QIP
146
K0FBS
AB9ZA
K2EAG
145
W4DNA
KB2YAA

144
KE8ANW
WD8USA
140
KK3F
K4IWW
135
KL7RF
W8GSR
W3YVQ
130
AG9G
N2JBA
KO4OL
KD8ZCM
KF5OMH
KW1U
129
K8AMH
127
KR2HWK
125
KD0HHN
KA9QWC
N2DW
W8IM
KD8KBX
K8KRA
KE5YTA
124
K2BNY
121
KB1TCE
AL0Y
120
WA4VGZ
WC4FSU
AD4DO
K3JL
KD8UUB
N8MRS
KY2D
118
WB8SIQ
117
KD2GRS
116
WB2ZEX
W9EEU
115
KN9P
NX9K
K1XFC
N1TF
114
WB8YYS
113
KG5NNA

110
WA1URS
KA9IKK
K6HTN
N3SW
N2LC
KB3IN
KB2QO
W2AH
WB8TQZ
N3ARB
W2ZXN
KA5AZK
KF5IOU
N1IQI
108
K9ILJ
107
KD2QAR
105
W2PAX
104
K8MDA
102
KB8RCR
100
WB4RJW
KZ8Q
W1KX
W4CMH
KD2LPM
AC8RV
AA3SB
K3YAK
W3CJD
AK2Z
KF5IVJ
99
KD8UOT
N1LAH
98
K1STM
97
NI2W
95
W9BGJ
93
K2KNB
K2VTT
92
KA2GQQ
91
K7OED
90
AA7BM
KJ7BHO
KB9GO
N2TSO

KB8HJJ
KA1G
WB4ZDU
K1HEJ
K3MIY
WX2DX
KA2HZP
K8ED
KC1KVY
KC1HHO
WD0BFO
KA0DBK
87
K8RDN
K6JT
86
W3ZR
85
KB0DTI
AB3WG
83
N4ZM
82
W7PHX
N0UMP
K5OB
KB1NMO
W4KX
80
KM4WHO
KF7GC
KR4ST
KB1NAL
WB3FTQ
AA3N
W4EDN
KC1MSN
79
KU1U
W4TTO
76
W5XX
75
K4FHR
W2ARP
W4INX
N3RB
KA2JFU
74
N6IET
73
K6RAU
71
KB3MXK
K2IE
WA1LPM
70
WB2VUF

The following stations qualified for PSHR in September, 2021, but were not listed in this column last month: W0PZD 277, W9GRG 170, WV5Q 147, WF2Y 110, WS4P 110, KJ7BHO 100, W7PHX 96, K7OED 90, KD2GXL 87, WB2ZEX 84, W5XX 80, KF7GC 75, AA7BM 70.

Section Traffic Manager Reports

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

Section Emergency Coordinator Reports

The following Section Emergency Coordinators reported: ENY, EPA, KY, MDC, ME, MI, MO, MS, NC, ND, NLI, NNJ, NNY, NTX, NV, OH, OK, PAC, SCV, SNJ, STX, TN, UT, VA, VI, WPA, WTX, 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.

NX9K 1,688, KK3F 1,617, KY2D 1,092, K6HTN 851, KW1U 547.

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

Contest Corral

January 2022

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				Bands	Contest Name	Mode	Exchange	Sponsor's Website
Date	Time	Date	Time					
1	0000	1	0100	3.5	AGB New Year Snowball Contest	CW Ph Dig	Category, ARRL section	www.qsl.net/eu1eu/agb_nysb.htm
1	0800	1	1100	3.5, 7	SARTG New Year RTTY Contest	Dig	RST, serial, name, "HNY" greeting	rttyops.com/index.php/contests
1	0900	1	1200	3.5-14	AGCW Happy New Year Contest	CW	RST, serial, mbr (if any)	alt.agcw.de/index.php/en
1	1200	2	1200	1.8-28	WW PMC Contest	CW Ph	RS(T), PMC abbreviation or CQ zone	s59dcd.si/index.php/sl/ww-pmc
1	1400	1	1800	144, 432	AGCW VHF/UHF Contest	CW	RST, serial, power class, 6-char grid	www.agcw.de/contest/vhf-uhf
1	1500	1	1800	3.5-28	QRP ARCI New Years Sprint	CW	RST, SPC, mbr or power	qrparci.org
1	1500	2	1500	3.5-14	Original QRP Contest	CW Ph	RST, serial, power category	qrpcc.de/contestrules/oqrpr.html
1	1800	1	2359	3.5, 7, 14, 18, 21, 24, 28, 2 repeaters	ARRL Kids Day	Ph	Name, age, QTH, favorite color	www.arrl.org/kids-day
3	0000	3	0100	1.8-28	K1USN Slow Speed Test	CW	Max 20 WPM; name, SPC	www.k1usn.com/sst.html
4	0100	4	0159	1.8-50	Worldwide Sideband Contest	Ph	RS, OM, YL, or Youth	wwsac.com/rules.html
4	0200	4	0400	3.5-28	ARS Spartan Sprint	CW	RST, SPC, power	arsqrp.blogspot.com
4	1700	4	1900	3.5-14	RTTYops Weeksprint	Dig	Other's call, your call, serial, name	rttyops.com
5	0200	5	0330	7	QRP Fox Hunt	CW	RST, SPC, name, power	www.qrpfoxhunt.org
5	1300	5	1400	1.8-28	CWops Mini-CWT Test	CW	Name, mbr or SPC	cwops.org/cwops-tests
5	1700	5	2000	144	VHF-UHF FT8 Activity Contest	Dig	4-char grid square	ft8activity.eu/index.php/en
5	1900	5	2000	1.8-28	CWops Mini-CWT Test	CW	Name, mbr or SPC	cwops.org/cwops-tests
5	2000	5	2100	3.5	UKEICC 80-Meter Contest	Ph	6-char grid square	ukeicc.com/80m-rules.php
6	0000	7	0300	7	Walk for the Bacon QRP Contest	CW	<13 WPM; RST, SPC, name, mbr or power	qrpcontest.com/pigwalk40
6	0300	6	0400	1.8-28	CWops Mini-CWT Test	CW	Name, mbr or SPC	cwops.org/cwops-tests
6	0700	6	0800	1.8-28	CWops Mini-CWT Test	CW	Name, mbr or SPC	cwops.org/cwops-tests
6	1700	6	1900	3.5-14	RTTYops Weeksprint	Dig	Other's call, your call, serial, name	rttyops.com
6	1800	6	2200	28	NRAU 10-Meter Activity Contest	CW Ph Dig	RS(T), 6-char grid square	nrrlcontest.no
6	2000	6	2200	1.8-50	SKCC Sprint Europe	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
7	0100	7	0230	3.5	QRP Fox Hunt	CW	RST, SPC, name, power	www.qrpfoxhunt.org
7	2000	7	2100	1.8-28	K1USN Slow Speed Test	CW	Max 20 WPM; name, SPC	www.k1usn.com/sst.html
8	0000	8	2359	3.5-28	PODXS 070 Club PSKFest	Dig	RST, SPC	www.podxs070.com
8	0000	8	2359	3.5-28	YB DX Contest	Ph	RS, serial	ybdxcontest.com
8	0500	8	0900	3.5-28	Old New Year Contest	CW Ph	RST, sum of age and years on the air	www.radio.ru/cq
8	1200	9	2359	1.8-50	SKCC Weekend Sprintathon	CW	RST, SPC, name, mbr or "none""	www.skccgroup.com
8	1300	8	1700	3.5, 7	RSGB AFS Contest, CW	CW	RST, serial	www.rsgbcc.org/hf
8	1800	9	2359	3.5-28	ARRL RTTY Roundup	Dig	W/VE: RST, SP; non-W/VE: RST, serial	www.arrl.org/rtty-roundup
8	2000	9	0700	1.8	EUCW 160-Meter Contest	CW	RST, name, mbr or "NM"	www.eucw.org/eu160.html
9	0630	9	0830	3.5, 7	NRAU-Baltic Contest, SSB	Ph	RS, serial, fylke/län/province/region	nraubaltic.eu
9	0900	9	1059	28	DARC 10-Meter Contest	CW Ph	RS(T), serial, DOK (if any)	darc.de/der-club/referate/conteste
9	0900	9	1100	3.5, 7	NRAU-Baltic Contest, CW	CW	RST, serial, fylke/län/province/region	nraubaltic.eu
10	0100	10	0300	1.8-28	4 States QRP Second Sunday Sprint	CW Ph	RS(T), SPC, mbr or power	4sqrp.com/SSS/sss_rules.pdf
12	1700	12	2000	432	VHF-UHF FT8 Activity Contest	Dig	4-char grid square	ft8activity.eu/index.php/en
15	0000	16	2359	3.5-28	Malaysia DX Contest	Ph	RS, age	9mdxc.com
15	1200	16	1159	1.8-28	Hungarian DX Contest	CW Ph	RS(T), HA county or serial	ha-dx.com/en/contest-rules
15	1200	16	1159	3.5-28	PRO Digi Contest	Dig	RST, serial, "M" if a member	www.procontestclub.ro
15	1200	16	1200	3.5-28	UBA PSK63 Prefix Contest	Dig	RSQ, UBA section or serial	uba.be/en/hf/contest-rules
15	1800	16	0559	1.8-28	North American QSO Party, CW	CW	Name, SPC	www.ncjweb.com
15	1900	15	2300	1.8	WAB 1.8 MHz Phone	CW Ph	RS, serial, WAB square or country	wab.intermip.net
15	1900	17	0359	50 and up	ARRL January VHF Contest	CW Ph Dig	4-char grid square	www.arrl.org/january-vhf
15	2000	16	0559	1.8-7	Feld Hell Sprint	Dig	RST, mbr, SPC, grid	sites.google.com/site/feldhellclub
16	1300	16	1700	3.5, 7	RSGB AFS Contest, Data	Dig	RST, serial	www.rsgbcc.org/hf
16	2300	17	0100	1.8-28	Run for the Bacon QRP Contest	CW	RST, SPC, mbr or power	qrpcontest.com/pigrun
20	0000	21	0300	14	Walk for the Bacon QRP Contest	CW	<13 WPM; RST, SPC, name, mbr or power	qrpcontest.com/pigwalk20
20	0130	20	0330	3.5-14	NAQCC CW Sprint	CW	RST, SPC, mbr or power	naqcc.info
22	1200	23	1200	3.5-28	BARTG RTTY Sprint	Dig	Serial	bartg.org.uk
22	1300	22	1700	3.5, 7	RSGB AFS Contest, SSB	Ph	RS, serial	www.rsgbcc.org/hf
22	1800	23	0559	1.8-28	North American QSO Party, SSB	Ph	Name, SPC	www.ncjweb.com
22	1800	23	0559	1.8-28	NA Collegiate Championship, SSB	Ph	Name, SPC	www.w9smc.com/nacc
23	1400	26	0800	1.8-144	Classic Exchange, Phone	Ph	Name, RS, SPC, rig manuf/model	www.classicexchange.org
26	0000	26	0200	1.8-50	SKCC Sprint	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
26	2000	26	2100	3.5	UKEICC 80-Meter Contest	CW	6-char grid square	ukeicc.com/80m-rules.php
26	2300	30	2300	1.8-7	AWA Linc Cundall CW Memorial	CW	RST, eqpt year, input power	antiquewireless.org
27	0130	27	0330	1.8	NAQCC CW Sprint	CW	RST, SPC, mbr or power	naqcc.info
28	2200	30	2200	1.8	CQ 160-Meter Contest, CW	CW	RST, SP or CQ zone	www.cq160.com
29	0600	30	1800	3.5-28	REF Contest, CW	CW	RST, French department or serial	concours.r-e-f.org/reglements
29	1300	30	1300	3.5-28	UBA DX Contest, SSB	Ph	RST, serial, province (if ON)	uba.be/en/hf/contest-rules
29	1900	30	1900	All	Winter Field Day	CW Ph Dig	Category, ARRL section	winterfieldday.com

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

The ARRL February School Club Roundup

This event begins on Monday, February 14 at 1300 UTC and runs through Friday, February 18 at 2359 UTC.

- Stations may operate for up to 24 hours during the entire contest and may only operate for 6 hours during any single 24-hour period. Any mode — SSB, CW, or digital — is allowed.
- There are five club participation categories: Elementary/Primary, Middle/Intermediate/Junior High School, Senior High School, College/University, and Non-School. There is an additional category for individuals.
- School Club Roundup is co-sponsored by ARRL and the Long Island Mobile Amateur Radio Club (LIMARC). Results will be available in *QST* and online at **contests.arrl.org**. The top three entries in each category will receive an award certificate.
- Don't forget to share your team's photos and stories! One of the best parts of School Club Roundup is showing off your team members and station. You can upload your photos and stories when you submit your score at **contests.arrl.org/arrlscrscoresubmission.php**. Logs are due by 2359 UTC on March 5.

For complete rules, logging sheets, and other resources, visit **www.arrl.org/school-club-roundup**

ARRL The national association for AMATEUR RADIO

SCHOOL CLUB ROUNDUP

Long Island Mobile Amateur Radio Club

ARE PLEASED TO ACKNOWLEDGE THAT

KF5CRF, Tiger Radio Club

has enhanced communication with and among school Amateur Radio groups by making 680 QSOs in the February 2021 School Club Roundup attaining a score of 85,680 points.

1st place Senior High Entry Class

28 States 12 Schools 10 DXCC Countries 7 Clubs 6 Canadian Provinces

In the true spirit of Amateur Radio this has contributed goodwill and friendship among people.

KSUR President, ARRL

K2XNB President, LIMARC

School Club Roundup participants can download certificates to proudly display their achievements. Student members of the Tiger Radio Club, KF5CRF, in Mangum, Oklahoma, achieved first place in the Senior High School category in the February 2021 event. Certificates can be downloaded at **contests.arrl.org/certificates.php**.

NCJ, ARRL's *National Contest Journal*, Celebrates 50 Years of Publication in 2022

NCJ begins its 50th year of publication with the January/February 2022 issue and will celebrate this milestone all year long. The journal started as a small contest-focused newsletter. It was the idea of Tod Olson, KØTO (SK), who recruited collaborators from his own contest club, the Minnesota Wireless Association (MWA), as well as other contesters from around the US, to join him in its publication. Past *NCJ* Editor and MWA member Scott Wright, KØMD, has written a piece for the January/February issue of *NCJ* on the history of the journal and its early publication. Check issues of *NCJ* throughout the year for material that celebrates its 50th year of publication.

NCJ NATIONAL CONTEST JOURNAL

Bernie McClenny, W3UR, w3ur@arrl.org

How's DX?

DXpedition History in the Making

In late 2021, the DX community began hearing of a DXpedition to the Crozet Islands. These French subantarctic islands are located in the southern Indian Ocean and count as a separate DXCC entity, which ranks number three on Club Log's DXCC Most Wanted List. Jean-Michel Duthilleul, F6AJA, editor of Les Nouvelles DX *(***http://lesnouvellesdx.fr***), and Paul Granger, F6EXV, provided the following details of the first-ever DXpedition to this rare DXCC entity.*

A QSL card of Florentin Bard, F4DYW, operating as FT5WO, who was the last person to conduct amateur radio activity from Crozet Island in 2009.

For many months now, Thierry Mazel, F6CUK, has been communicating with the French Southern and Antarctic Lands (Terres australes et antarctiques françaises, or TAAF) and has received permission to put on the first-ever DXpedition to Crozet Island. He has obtained authorization to stay on the island between rotations of the R/V *Marion Dufresne*. This will take place between December 2022 and March 2023 and will be dedicated entirely to amateur radio, which is a first for this rare location. In the past, radio operators were there for a scientific mission, leaving amateur radio activities to be secondary. Mazel plans to be on the island for "more than 2 months." A call sign has been requested, but to keep pirates from abusing it, it won't be announced until after the first contact has been made. The operation will also commemorate the 60th anniversary of the first mission to Crozet, which took place between December 1961 and January 1962.

Paul Granger, F6EXV, will be the treasurer and QSL manager, as well as in charge of communicating any details to the DX community. The budget is still being discussed, but it's anticipated to be between $46,000 and $52,000. A website providing the details is currently under construction.

The last amateur radio activity from Crozet Island was that of FT5WO by Florentin Bard, F4DYW, in 2009.

As more information is released, it'll be mentioned in this column and throughout other DX outlets. You can also follow **@crozet2022** and **@DAILYDX** on Twitter for developing information.

A Game-Changing DXpedition System

At the W8DXCC Convention during the Cincinnati Hamfest on August 28, 2021, I attended the presentation, "Radio-in-a-Box — A Solution to Advance DXpedition Opportunities," by Gregg Marco, W6IZT, and Hal Turley, W8HC. Hal addressed the fact that out of the top 25 DXCC most-wanted entities, 21 are islands, atolls, rocks, or reefs, and many are environmentally protected or considered ecological reserves, which can result in the denial of amateur radio DXpeditions. Additionally, five of them are US possessions. George Wallner, AA7JV, who has been the mastermind behind the radio-in-a-box (RIB) concept, shares some details below of his latest invention and how it can change the way DXpeditions are conducted in the future.

A Special Use Permit (SUP) is required for any DXpedition to operate from an island controlled by the US Fish and Wildlife Service (USFWS). The compatibility criteria are mainly environmental, and over the years, SUPs have become increasingly harder to get. Other countries have similarly difficult environmental restrictions on some of the rarest DX locations. The process first requires a compatible use description to be developed by the operators. Then candidates can apply for a SUP, but the wait time is extensive.

SUPs are necessary because traditional DXpeditions require operators to camp on site. Typically, they need multiple tents (for sleeping, operating, and eating), a shower, and a toilet, and often have many people traveling to and from the location. This is largely why SUPs are becoming unobtainable. The USFWS has many concerns, including the danger of introducing foreign life (plants, small animals, ants, rodents) to an isolated location. However, if camping at the

At the W8DXCC Convention during the Cincinnati Hamfest, the public was able to see what a RIB looks like and take a peek inside.

The antenna connects to one end of the RIB and the power connects to the other.

location wasn't necessary, perhaps it would be easier to obtain a SUP.

For the past 3 years, Gregg Marco, W6IZT; Michael Snow, KN4EEI; Hal Turley, W8HC; Warren Merkel, KD4Z, and I (under the call sign C6AGU), have been testing and refining a system that allows a DXpedition to operate from an environmentally protected location without camping. At the core of the system is what we call a RIB: radio-in-a-box. A RIB is a weather-tight box that houses a complete, fully wired radio station, consisting of a FLEX-6700 transceiver, 1 kW power amplifier, power supplies, and remote-controlled hardware and software. All that is needed at the location is the RIB, antennas, and generators. The RIB is controlled remotely from the boat via a 900 MHz IP link and is completely self-contained. To operate from the boat, simply plug the antenna in on one end of the RIB and the generator at the other end — there's no camping, no mess, or an excessive amount of people on an environmentally delicate island, rock, or reef. Once a day, a small crew travels ashore to check on the generators and to make any required antenna repairs. Otherwise, the location and its wildlife population are left undisturbed.

So far, we've made over 16,000 contacts using RIBs on all bands between 160 and 10 meters, and have participated in six different contests. If you've ever contacted C6AGU during the past 2 years, you've contacted a RIB.

RIBs can not only help with acquiring SUPs, but they can also greatly reduce the setup time during a DXpedition. During our various tests under realistic DXpedition conditions, we were able to set up two 160- to 10-meter RIB stations in less than 4 hours. That included moving equipment to the island and erecting antennas. Anybody who has been on a DXpedition will know that setting up (and moving) all of the gear is the hardest part. With RIBs, the load is greatly reduced, as there are no tents or other infrastructure needed. And, of course, the tear-down time is also considerably less. RIBs will be a great help to any DXpedition, regardless of environmental concerns or camping.

The RIB was developed with assistance from the Northern California DX Foundation (NCDXF). The NCDXF has sponsored the building of a number of RIBs, which will soon be available to any deserving DXpedition. Recently, the RIB's remote-control system was upgraded from a proprietary hardware and software to open Raspberry Pi hardware and *Node-RED* software. These changes make the RIBs easier to program, customize, and operate. For additional information and technical details, visit **http://ncdxf.org/newsletters/2021-SPRING.pdf**.

Between November 22 and December 6, 2021, Don Greenbaum, N1DG; Gregg Marco, W6IZT; Hal Turley, W8HC; Tomi Pekarik, HA7RY; Michael Snow, KN4EEI, and George Wallner, AA7JV/C6AGU, took six RIBs to Wood Cay in the Bahamas (24.900 °N, 76.370 °W) for a 2-week-long, six-station realistic DXpedition exercise. Using the C6AGU call sign, they operated on all HF bands and modes, and participated in the CQ World Wide DX CW and ARRL 160 Meter contests. They welcome and appreciate any signal reports or comments.

All photos courtesy of Bernie McClenny, W3UR.

Wrap-Up

That's it for this month. A special thanks to AA7JV, F6AJA, F6EXV, W6IZT, and W8HC for helping to make this month's column possible. If you have any DX or IOTA news, 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 2022 Quadrantid Meteor Shower

The Quadrantid meteor shower starts off the year 2022 and it has the potential to be the strongest meteor shower of the year. It takes place on January 2 – 3, 2022. The zenith hourly rate (ZHR) of visual observations can peak at over 120, which is higher than the Perseids, but the peak time for the Quadrantid shower is only around 6 hours. Trying to catch the short peak can be daunting.

NASA has issued a peak prediction time of 3:40 PM CST (2140 UTC) on January 3. This is during daylight in North America. The meteors will be invisible to visual observers in North America, but remain useful for radio reflections. The meteors are medium velocity, at 40 kilometers per second. They are great on 6 meters and good for 2 meters. The faster the meteor velocity, the higher the maximum usable frequency (MUF) that the meteor ionization can support.

Based on the Quadrantid radiant location, the best paths and times (local) to see the meteors will be southeast-to-northwest paths (0500 – 0700) and northeast-to-southwest paths (1300 – 1500). If the NASA prediction is accurate, then the northeast-southwest path may be hot for meteor scatter in North America on the afternoon of January 3. Keep in mind NASA's "predicted peak time" is just that — a prediction. You may have the most success if you operate both path/time periods on January 3. If conditions are good, try SSB and CW. Contacts can be made quicker on these modes.

Solar Cycle 25 Update CME Impact

An X-class solar flare occurred on October 28 with an Earth-directed coronal mass ejection (CME). Many were anticipating aurora and other VHF propagation. The CME struck the Earth's magnetic field around 1000 UTC on October 31. The impact was weak, with no geomagnetic storms. Predicating CME impacts is still an imperfect science.

Orionid Shower 6-Meter Grid Expeditions

Two well-equipped grid expeditions were active during the Orionid meteor shower on 50 MHz on October 19 – 21, 2021. Larry Lambert, NØLL, operated fixed portable from grid DN80 (see Figure 1). Tommy Teague, KN4JX, and his wife, Leslie, KC4PDN, did a rover operation from grids EN20, DN80, DN90, DM77, DM87, EM07, and EM08 during the meteor shower (see Figure 2). On October 20, both KN4JX/R and NØLL/P were active from sought-after grid DN80. Both stations took advantage of rare October sporadic-E openings to put DN80 in

Figure 1 — Larry Lambert's, NØLL, portable setup from grid DN80 during the Orionid meteor shower on October 19 – 21, 2021. [Larry Lambert, NØLL, photo]

Figure 2 — The rover setup that Tommy Teague, KN4JX, and his wife, Leslie, KC4PDN, used during their October 2021 grid expedition. [Tommy Teague, KN4JX, photo]

many logs. On October 19, Larry made 13 FT8 sporadic-E contacts, running only 20 W to a shortened, monoband mobile whip before getting his Yagi up. On October 21, AD1C (DM79) and I, NØJK/P (EM28), worked Larry on MSK144. Larry, NØLL/P (DN80), ended up with 99 FT8 and 68 MSK144 contacts on 6 meters. Tommy, KN4JX/R, made 17 FT8 and 36 MSK144 contacts from DN80.

Tommy, KN4JX/R, and Leslie, KC4PDN, reported successful results from the other grids on their expedition as well. Their effective station consisted of a FlexRadio FLEX-6600 SDR with an ACOM 2100 linear amplifier and a four-element Cushcraft LFA Yagi up 10 – 15 feet.

On the Bands

50 MHz. Though occurrence of sporadic E is rare in October, sporadic E did make some appearances this month (see Figure 3). The solar flux was only 76, which is too low for F2 on 6 meters. The K index was 4, due to a coronal hole stream. This may have played a role in the E_s. Lance, W7GJ, was active from FO/W7GJ and TX7MB on EME Q65 mode. Mario, K2ZD, completed contacts with Lance in both countries.

Strong sporadic E openings were also reported on October 18 – 20 across the eastern half of North America. On October 18, the E_s linked to an afternoon TEP zone (trans-equatorial propagation across the geomagnetic equator), allowing NZ3M (FN10) to work Argentina. WW1L (FN54) was also able to copy Brazil and CX6DRA (GF15) in Uruguay. WW1L reported unusual multihop sporadic E to Africa and Europe.

144 MHz. During the last week of October, a strong tropospheric opening took place across the southeast US states. The opening was created by a wave cyclone, which is a weather system with counter-clockwise circulation around low pressure. Tropospheric propagation can occur in the zone between the advancing warm front and approaching cold front south of the low-pressure center. A wave cyclone tropospheric opening typically lasts only a couple of days.

222 MHz. Greg, WQØP (EM19), worked W5EME (EM32) on tropo on October 26 for a new state.

432 MHz. Phil, NØPB (EM39), worked several Florida stations on SSB and CW during the tropo opening. AC4TO (EM70) logged AA9MY (EN50) and K9KLD (EM58) on October 27 on FT8 with 75 W and a single, 29-element Yagi.

Figure 3 — A map of the rare October sporadic-E opening on October 18 – 19, 2021. [**www.dxmaps.com**]

Here and There

New Year and a New Format

Going forward, the column will have more of an emphasis on timely topics of interest. The "On the Bands" section will continue, but as a composite of reports.

New Records

There were a number of record-setting contacts made on the 2-meter double-hop sporadic-E openings on July 13, 2021. Paul Kelley, N1BUG (FN55), logged W7OUU (DN22) at 4,119 kilometers. Jay Rusgrove, W1VD (FN31), worked W7OUU (DN22) at 3,380 kilometers. Robert Striegl, K2DRH (EN41), made a contact with WP4KJJ (FK68) at 3,471 kilometers. Jay Hainline, KA9CFD (EN40), also worked WP4KJJ (FK68) for a 3,425-kilometer contact. All record-setting contacts were on FT8. Ned Stearns, AA7A, maintains the VHF/UHF/SHF Distance Records webpage at **www.arrl.org/distance-records**.

Winter Sporadic-E Season

North America's winter sporadic-E season will be in full swing in January 2022. The first 2 weeks of January openings between North America and Australia/New Zealand can take place on 6 meters. With Solar Cycle 25 picking up, the higher solar flux should increase the possibility of these openings.

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

Special Event Stations

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

Jan. 1 – Jan. 9, 0000Z-2359Z, W2P, Trenton, NJ. Delaware Valley Radio Association. **American Revolution — Battle of Princeton**. 14.250. Certificate* & QSL. DVRA, P.O. Box 7024, Trenton, NJ 08628. **www.w2zq.com** *or* **www.qrz.com/db/w2zq**.

Jan. 2 – Jan. 31, 0000Z – 2359Z, K3Y/0-9, KH6, KL7, KP4, worldwide. Straight Key Century Club. **16th Annual Straight Key Month**. 3.550 7.055 14.050 21.050. Certificate & QSL. SKCC c/o Jeremy Downard, K8JAD, 511 W. Pottawatamie St., Tecumseh, MI 49286. *DX member stations in six WAC areas operating straight key, bug, and cootie keys. QSL card confirms one QSO per area, up to 19 for all-area sweep. See website for operating schedule/map, stats, etc. This is an operating event.* **www.skccgroup.com/k3y**

Jan. 15, 1400Z – 2000Z, W1M, Russell, MA. Western Mass Council, Scouts BSA. **WHOA weekend, Scouts BSA**. 7.190 10.115 14.060 14.290. QSL. Tom Barker, WA1HRH, 329 Faraway Rd., Whitefield, NH 03598. *Paper logging and eQSL.*

Jan. 15, 1800Z – 2300Z, N9WH, Crystal Lake, IL. The 415 Amateur Radio Club. ***The 415.*** 7.250 14.250 146.415. QSL. The 415 Amateur Radio Club, 3208 Bay Rd., Crystal Lake, IL 60012. **www.qrz.com/db/n9wh**

Jan. 19 – Jan 24, 0400Z – 0359Z, WW2FLY, Attica, NY. WWII Flying Fortress Amateur Radio Club. **80th Anniversary of the 8th Air Force**. 1.900 3.850 7.180 14.250. Certificate & QSL. WWII Flying Fortress Amateur Radio Club, 3339 Stroh Rd., Attica, NY 14011. *SSB and FT8; check spotting networks to find us on HF.* **www.qrz.com/db/ww2fly**

Jan. 21 – Jan. 23, 0000Z – 2359Z, K5D/KF5UPC, Alice, TX. Coastal Band Digital Group and South Texas Amateur Radio Club. **Silent Key Memorial Weekend**. 7.265 14.265. Certificate. Pedro Saenz, Jr., 611 Schley, Alice, TX 78332. **pedrojr45@yahoo.com** *or* **https://m.facebook.com/784535814939833**

Jan. 22, 1000Z – 1700Z, W9RH, Milwaukee, WI. Milwaukee Radio Amateurs' Club. **105th Anniversary**. 7.250 14.250 145.390. Certificate. MRAC Special Event, P.O. Box 26938, Milwaukee, WI 53226. *See website for operating frequencies (HF, VHF, WIRES-X) and certificate information; operating from HRO-Milwaukee.* **www.w9rh.org**

Jan. 22 – Jan. 29, 1400Z – 0700Z, W7Q, San Luis, AZ. **Quartzfest**. 7.277 14.285 28.415; 7.074 14.076 28.074 21.740. Certificate. Tom Luther, 7690 W. Derry Rd., Kirkland, AZ 86332. **https://quartzfest.org**

Jan. 29 – Jan. 31, 1600Z – 0001Z, AG6AU, Coloma, CA. El Dorado County Amateur Radio Club. **California Discovery of Gold**. 7.248 14.248 21.348 28.348. QSL. El Dorado County ARC, P.O. Box 451, Placerville, CA 95667. *174th anniversary of the discovery of gold in Coloma, California starting the 49'er gold rush.* **www.edcarc.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 (3 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**, or email information to **events@arrl.org**.

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 **April** *QST* would have to be received by **February 1.** In addition to being listed in *QST*, your event will be listed on the ARRL Web Special Event 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**

Volunteer Monitor Program Report

The Volunteer Monitor (VM) Program is a joint initiative between ARRL and the FCC to enhance compliance in the Amateur Radio Service. This is the October 2021 activity report of the WM Program.

♦Technician operators in Yarmouth Port, Massachusetts, and Richmond, Texas, received advisories after making numerous FT8 contacts on 40 and 20 meters. Technician licensees are not allowed to transmit data on 40 meters and have no operating authority on 20 meters.

♦Operators in Mims, Florida; Moorefield, West Virginia; State Road, North Carolina; and Grottoes, Virginia, received advisories concerning excessive SSB bandwidth on 40 and 75 meters. The operator in Moorefield, West Virginia, previously received an advisory for out-of-band operation on 7.138 MHz. His case will be referred to the FCC for further enforcement action, which could include removal of voice privileges from, or revocation of, his General-class license.

♦An operator in Cave Creek, Arizona, received an advisory for making lengthy transmissions without identifying as required by Commission rules.

♦An operator in Highlandville, Missouri, was reminded that a beacon on 30 meters cannot be automatically controlled, pursuant to 97.203(d) of the Commission's rules, and must have a control operator present at all times of transmission. He was further advised that the FCC may request a schedule of control operators and their duty hours.

♦The final totals for monitoring in September were 1,909 hours on HF frequencies and 2,716 hours on VHF frequencies and above, for a total of 4,625 hours.

♦There was one recommendation to the FCC for case closure and renewal of a license, and one request to review a license application. The FCC referred two cases to the VM Program. *— Volunteer Monitor Program Administrator Riley Hollingsworth, K4ZDH*

Certificate of Code Proficiency

Recipients

Sponsored by
VIBROPLEX
www.vibroplex.com

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

July 2021

Stephen J. Banko, KI5IIL	10
Bert H. Berrong, WZ5L	10
Bill Durham, KG5ZCI	10
Bruce E. Friedline, N9XAU	10
Roy L. Schmiesing, KT6B	10
Richard J. Guerrera, KB1FGC	25
Richard J. Hubbard, Jr., WF4W	30
Dwight Edward Morrow, VE7BV	30
James B. Elkins, KG4IKQ	35
Johnny L. Welch, Sr., KE6K	35
Christopher G. Pearson, G5VZ	40

August 2021

Christopher E. Johnson, WB9FXW	10
Charles E. Ruotolo, KA8VYG	10
George A. Stickney, W7BXW	10
Kenneth G. Koenig, KK6XI	15
Donald W. Brown, WØAF	20
Victor Denisov, N6DVS	20
Ronald L. Edwards, KE8NCJ	20
David W. Hibbard, NKØK	20
Richard B. Dervan, N1RBD	25

September 2021

Mark D. Nill, W5AT	10
Joseph M. Pagurko, KA9IIE	10
Christopher E. Johnson, WB9FXW	15
Mark D. Nill, W5AT	15
Daniel A. Bostick, KG5SSB	20
George W. Fletcher, AD5CQ	20
William Howard, N4MU	20
Mark D. Nill, W5AT	20
John F. Wasciuk, WA8TON	20
Walter Bilous, K3DQB	25
Stan Dicks, W4AG	30

October 2021

Floyd E. Cureton, Jr., WO5S	10
Jay G. Lewis, KA3LNA	10
Harold D. Craft, Jr., AA2JQ	15
David M. Hartley, WQ7F	15
John W. Mellars, WA2MIB	15
Sean Walberg, KN4ZMA	15
Joni Zornes, AA4WA	15
George J. Cosmetis, WA3CCI	20
Dewey L. Edwards, Jr., K4CAB	20
Christopher E. Johnson, WB9FXW	20

November 2021

Joseph DeMattei, Jr., KD4RXB	15
Russell Rzemien, WA1FCC	20

Congratulations to all the recipients.

January 2022 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.

January 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 K9JM on Wednesday, January 26 at 9 PM PST (0500 UTC on January 27) on 3590 and 7047.5 kHz. Unless indicated otherwise, sending speeds are from 40 to 10 WPM.

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

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

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

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

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

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

W1AW Qualifying Runs — January 2022
(All times are in Eastern Standard Time)

Monday	Tuesday	Wednesday	Thursday	Friday
1/3 4 PM – 2100Z 10 – 35 WPM	**1/4** 7 PM – 0000Z **(1/5 – UTC)** 35 – 10 WPM		**1/6** 10 PM – 0300Z **(1/7 – UTC)** 10 – 40 WPM	**1/7** 9 AM – 1400Z 10 – 35 WPM
	1/11 4 PM – 2100Z 10 – 35 WPM	**1/12** 7 PM – 0000Z **(1/13 – UTC)** 10 – 40 WPM	**1/13** 9 AM – 1400Z 35 – 10 WPM	**1/14** 10 PM – 0300Z **(1/15 – UTC)** 10 – 35 WPM
	1/18 9 AM – 1400Z 10 – 35 WPM	**1/19** 10 PM – 0300Z **(1/20 – UTC)** 35 – 10 WPM	**1/20** 7 PM – 0000Z **(1/21 – UTC)** 10 – 35 WPM	**1/21** 4 PM – 2100Z 10 – 40 WPM
1/24 10 PM – 0300Z **(1/25 – UTC)** 10 – 40 WPM		**1/26** 9 AM – 1400Z 35 – 10 WPM	**1/27** 4 PM – 2100Z 35 – 10 WPM	**1/28** 7 PM – 0000Z **(1/29 – UTC)** 10 – 35 WPM

Melissa Stemmer, KA7CLO, mstemmer@arrl.org

At the Foundation

ARRL Foundation Scholarships and Grants

The ARRL Foundation Board of Directors is pleased to announce a new scholarship for the 2022 – 2023 academic year, established to assist amateur radio operators with college or university costs.

The Maryland Military Auxiliary Radio System, Inc. (MMARSI) Scholarship

The Maryland Military Auxiliary Radio System, Inc. (MMARSI) has established two $2,000 scholarships for students pursuing full-time studies at an accredited college, university, junior college, community college, or technical institute. Applicants must be residents of the state of Maryland. If no qualified applicants are identified in Maryland, preference will be given to applicants from the states of Virginia and Delaware and the District of Columbia who are pursuing a career in communications and communications technology. Preference will also be given to applicants showing evidence of demonstrated activity within the several amateur emergency communications programs, such as the Military Auxiliary Radio System® (MARS), the Amateur Radio Emergency Service® (ARES), and the Radio Amateur Civil Emergency Service (RACES).

Full scholarship eligibility requirements for all scholarships can be found at **www.arrl.org/scholarship-descriptions**. The 2022 Scholarship Program will be accepting applications online until December 31, 2021. If you are a high school senior or attending college next year and are an FCC-licensed, active amateur radio operator, you are encouraged to apply. Awards will be announced in May 2022. Awards are sent directly to the recipients' colleges.

ARRL Foundation Grant Submission Period

Submissions to the ARRL Foundation Grant Program will be accepted on February 1 – 28, 2022. Funding is awarded to organizations for eligible amateur radio-related projects and initiatives, particularly those with a focus on educating, licensing, and supporting amateur radio activities. Youth-based projects and initiatives are especially encouraged. Proposals for projects with a high likelihood of sustainability or expansion and with demonstrated support of the local amateur radio community are encouraged and preferred.

ARRL Foundation Grants are awarded to organizations (not individuals) and do not exceed $3,000. Only programs or initiatives conducted within the United States are eligible for consideration. Grant requests for emergency communications equipment, facilities, or projects, or ongoing operations or expenses will not be considered.

To learn more about the ARRL Foundation Grant Program, please visit **www.arrl.org/amateur-radio-grants** or contact Development Manager Melissa Stemmer, KA7CLO, at **mstemmer@arrl.org**.

Life Members

Elected October 25, 2021

Bruce Bittenbender, K3BBB
Judith A. Booker, NB1RD
Jennifer L C. Canillas, WW0MAN
Grantt J. Childress, KN4FRZ
Thomas A. Cook, KW4X
Michael A. Cox, AB9V
Alexander Davidson, W1PE
Kyle L. De Weber, KM6FMY
Logan Dwyer
Richard Dwyer, KA5BUD
Asuna Gilfoyle, K1CKD
Charles H. Gooden, K9LC
Christine F. Grassman, KO4TGZ
Bruce Helgeson, KB4FHA
William H. Johnston, W9HJ
William Mongan, W1CLK
Takashi Nagai, NH7Q
Gaye M. Price, KB2YOA
Noreen M. Puhala, W0NMP
Adam L. Schaible, KB3ZUV
Michael J. Sinnett, N7IPJ
Louis M. Smith, KL7RWS
Austin B. Tindal, KD4AT
Richard Wallace, K4PM
Joseph F. White-Swift, KG5MKQ
Michael D. Withrow, KN4FKK
Sally P. Wood, KI7BET
Barbara J. Yasson, AC7UH
Ronald P. Yearns, KD0HOY
Michael E. Zilavy, WA3C

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
Tl = Talk-in frequency
Adm = Admission

Arizona (Glendale) — Jan. 15 D F H Q R S T V
7 AM – noon. *Spr:* ARCA, Thunderbird ARC. Glendale Nazrene Church, 5902 W. Cactus Rd. *Tl:* 446.15 (100.0 Hz) or 147.040 (162.2 Hz) linked. *Adm:* $5. **www.w7tbc.org**

QUARTZFEST CONVENTION

January 23 – 29 Quartzsite, Arizona
F H S T V
All day, every day. *Spr:* Quartzfest Committee. Roadrunner BLM, US-95 and 53rd St. N. RV and tent dry camping. *Tl:* 146.55 simplex. *Adm:* Free. **quartzfest.org**

Colorado (Loveland) — Jan. 15 D H R S V
9 AM – 1 PM. *Spr:* Northern Colorado ARC. The Ranch, 5280 Arena Circle. *Tl:* 448.025 (100 Hz). *Adm:* $7. **ncarc.net**

Florida (Arcadia) — Jan. 29 D H R T
6 AM – noon. *Spr:* DeSoto ARC. DeSoto County Turner Center Exhibit Hall, 2260 NE Roan St. *Tl:* 147.075 (100 Hz). *Adm:* $5. **desotoarc.org**

Florida (DeFuniak Springs) — Jan. 8 F H R T
8 AM – 1 PM. *Spr:* Walton Co. ARC. Life Enrichment Senior Center, 312 College Ave. *Tl:* 147.285 (100 Hz), Echolink node: 637806. *Adm:* Free. **wf4x.wordpress.com**

Florida (Fort Myers) — Jan. 21 – 22 D H Q R S T V
Fri. noon – 5 PM, Sat. 8 – 3 PM. *Spr:* Fort Myers ARC. Florida SouthWestern State College, 8099 College Parkway. *Tl:* 147.165 (127.3 Hz). *Adm:* $10. **swflhamfest.info**

Florida (New Port Richey) — Jan. 15 T V
8 AM – noon. *Spr:* Gulf Coast ARC. Millennium Academy, 10005 Ridge Rd. *Tl:* 146.67 (146.2 Hz). *Adm:* $5. Email: **keavbv@msn.com**

ARRL NATIONAL CONVENTION

February 10 – 13 Orlando, Florida
D F H Q R S T V
Thurs. 8:30 AM – 5 PM, Fri. 9 AM – 5 PM, Sat. 9 AM – 5 PM, Sun. 9 AM – 2 PM. *Spr:* Orlando ARC. Central Florida Fairgrounds and Expo Park, 4603 West Colonial Dr. *Tl:* 146.760 (103.5 Hz). *Adm:* $20. **hamcation.com**, **www.arrl.org/expo**

Florida (Tampa) — Jan. 8 F H Q R T V
8 AM – 1 PM. *Spr:* Tampa ARC. 7801 N. 22nd St. *Tl:* 147.105 (146.2 Hz). *Adm:* $5. **www.hamclub.org**

ARRL MIDWEST DIVISION CONVENTION

January 22 Collinsville, Illinois
D F H Q R S V
8 AM – 4 PM. *Spr:* St. Louis and Suburban Radio Club. Gateway Convention Center, 1 Gateway Dr. *Tl:* 146.970 (141.3 Hz). *Adm:* $8 Advanced, $10 door. **winterfest.slsrc.org**

Illinois (St. Charles) — Jan. 16 D H R S V
8 AM – 1 PM. *Spr:* Wheaton Community Radio Amateurs. Kane County Fairgrounds Expo Center, 525 S. Randall Rd. *Tl:* 145.31 (107.2 Hz). *Adm:* $8 Advanced, $10 door. **www.w9ccu.org**

Louisiana (Hammond) — Jan. 15 D F H Q R S V
7 AM – 3 PM. *Spr:* Southeast Louisiana ARC. Pennington Student Activity Center, 1350 North General Pershing St. *Tl:* 147.00 (107.2 Hz). *Adm:* $5. **cms.selarc.org/about/hammond-hamfest**

Michigan (Royal Oak) — Jan. 23 D H R
8 AM – noon. *Spr:* Hazel Park ARC. Royal Oak Farmers Market, 316 E. Eleven Mile Rd. *Tl:* 146.640. *Adm:* $5. Email: **n8rel@arrl.net**

ARRL DELTA DIVISION CONVENTION

January 28 – 29 Jackson, Mississippi
D F H Q R S T V
Fri. 5 PM – 8 PM, Sat. 8 AM – 3:30 PM. *Spr:* Jackson ARC. Mississippi Trademart,1200 Mississippi St. *Tl:* 146.76 (77 Hz). *Adm:* $10. **www.msham.org**

New Mexico (Albuquerque) — Jan. 29 F H R T
6 AM – 11 AM. *Spr:* 146.580 Simplex Group. Stoneface Tavern parking lot, 8201 San Pedro Dr. NE. *Tl:* 145.330 (100 Hz) and 444.000 (100 Hz). *Adm:* Free. Email: **kh6jtm@comcast.net**

New York (Marathon) — Jan. 15 F H R V
7 AM – noon. *Spr:* Skyline ARC. Marathon Civic Center, 16 Brink St. *Tl:* 147.180 (71.9 Hz). *Adm:* $5. **skylinehamradioclub.org**

Ohio (Shade) — Jan. 16 D F H R V
8 AM. *Spr:* Sunday Creek Amateur Radio Federation. Shade Community Center, 2380 Old US 33. *Tl:* none. *Adm:* $6. **QRZ: KC8AAV**

ARRL NORTH TEXAS SECTION CONVENTION

January 14 – 15 Forest Hill, Texas
D F H R S T V
Fri. 3 PM – 7 PM, Sat. 7 AM – 3 PM. *Spr:* Cowtown ARC. Forest Hill Civic and Convention Center. *Tl:* 146.940 (110.9 Hz). *Adm:* $8. **cowtownhamfest.com**

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 **February 1** to be listed in the **April** 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**.

W1AW Schedule

PAC	MTN	CENT	EAST	UTC	MON	TUE	WED	THU	FRI
6 AM	7 AM	8 AM	9 AM	1400		FAST CODE	SLOW CODE	FAST CODE	SLOW CODE
7 AM-1 PM	8 AM-2 PM	9 AM-3 PM	10 AM-4 PM	1500-1700 1800-2045	VISITING OPERATOR TIME (12 PM-1 PM CLOSED FOR LUNCH)				
1 PM	2 PM	3 PM	4 PM	2100	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE
2 PM	3 PM	4 PM	5 PM	2200	CODE BULLETIN				
3 PM	4 PM	5 PM	6 PM	2300	DIGITAL BULLETIN				
4 PM	5 PM	6 PM	7 PM	0000	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE
5 PM	6 PM	7 PM	8 PM	0100	CODE BULLETIN				
6 PM	7 PM	8 PM	9 PM	0200	DIGITAL BULLETIN				
6^{45} PM	7^{45} PM	8^{45} PM	9^{45} PM	0245	VOICE BULLETIN				
7 PM	8 PM	9 PM	10 PM	0300	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE
8 PM	9 PM	10 PM	11 PM	0400	CODE BULLETIN				

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

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

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

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

Code bulletins are sent at 18 WPM.

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

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

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

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

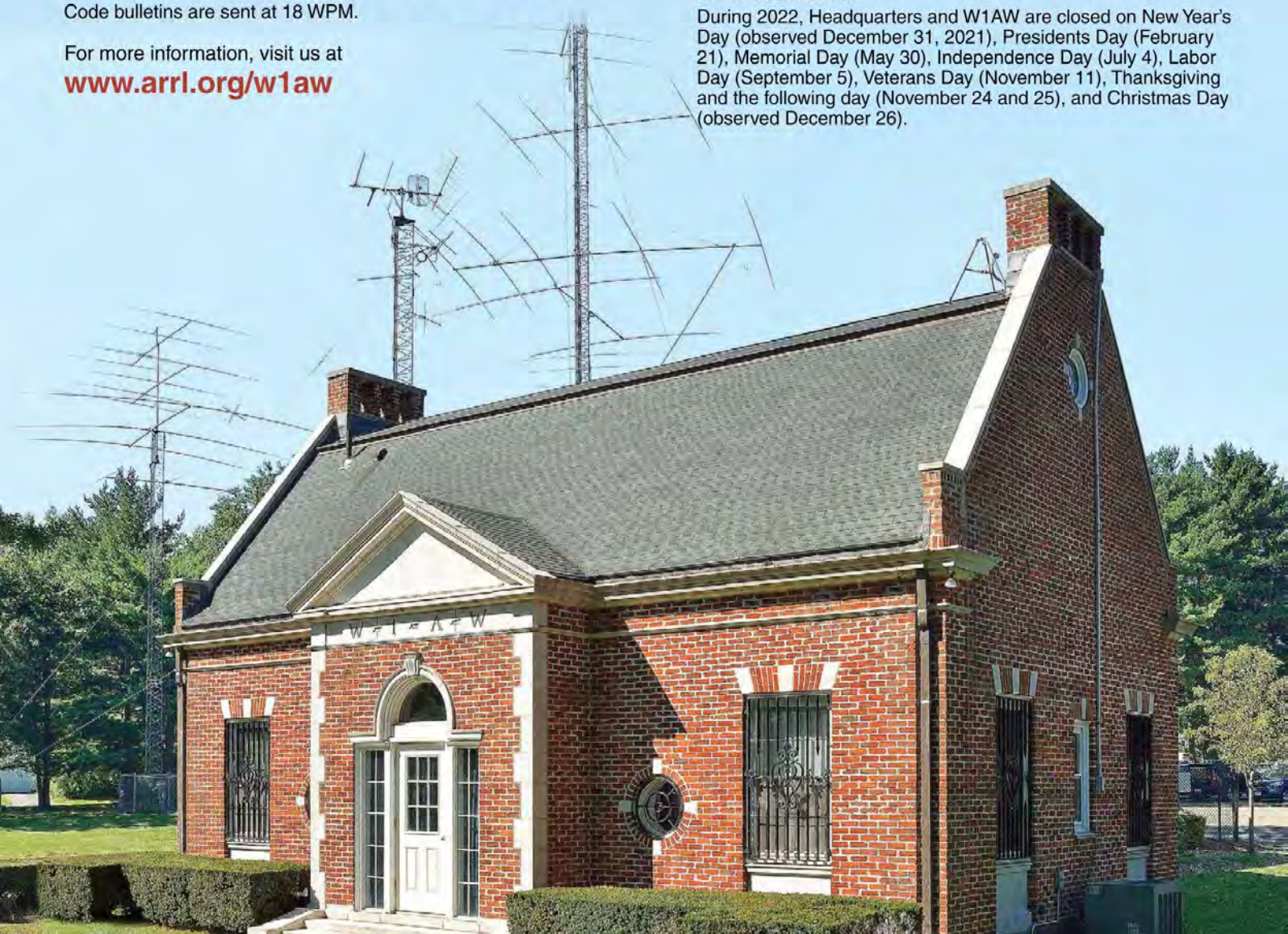
Keplerian elements for many amateur satellites will be sent on the regular digital frequencies on Tuesdays and Fridays at 6:30 PM Eastern time using Baudot and PSK31.

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

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

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

During 2022, Headquarters and W1AW are closed on New Year's Day (observed December 31, 2021), Presidents Day (February 21), Memorial Day (May 30), Independence Day (July 4), Labor Day (September 5), Veterans Day (November 11), Thanksgiving and the following day (November 24 and 25), and Christmas Day (observed December 26).



A Look Back

QST
February 1972
75 Cents
devoted entirely to
amateur radio
OFFICIAL JOURNAL OF THE ARRL

The RCA Carfone fm base station is shown here with its new face. A 10 1/2 × 19-inch aluminum rack panel is used to contain the controls, meter, and speaker. All of the important operating functions are controlled at the front panel. The microphone jack is located at the lower center of the panel. A two-channel frequency selector switch is mounted at the lower right, near the af gain and squelch controls. The meter switch, on-off switch, and pilot lamp are seen at the far left.

A New Face for the Carfone FM Rig

BY DOUG DeMAW,* W1CER

WITH DUE CREDIT to the equipment designers, the RCA Carfone base station is not the prettiest piece of fm gear in amateur service. Additionally, some of the convenience features that base stations should have are not present in the unconverted unit. Therefore, this writer decided to make some modifications which would provide better service from the transceiver, plus spruce up the outward appearance. The resultant product is described herein.

Some Circuit Changes

The Carfone shown here is the 10-watt species which was packaged as a base station. Similar units are available as surplus which provide greater power output, but the circuit modifications discussed here will be pretty much the same for the various models.

In the transmitter setup (Fig. 1), the tuned circuit in the plate of the second doubler (6CL6, designated 2V/X4) does not tune down to 146 MHz without adding some fixed-value capacitance. Proper tuning resulted after adding a 3-pF silver mica in parallel with 2L7, the slug-tuned plate coil. This inductor, in combination with the grid coil of the following stage (2V/X5, a 5763) forms a bandpass coupler. The grid coil, 2L8, required the addition of a 5-pF silver mica from its high-*Z* end to ground.

* Technical Editor, *QST*.

The original three-chassis assembly is attached to the new panel by means of the original chassis brackets. A metal shield plate is used to enclose the bottom of the chassis. The terminal strip on the rear apron of the transmitter was used originally for the mike connections.

Tuned circuit 2L10, the plate inductor for the 5763 third doubler, requires a 5-pF silver mica from its high-impedance side to ground. No other changes are required in this part of the circuit.

The output link from the PA stage, 2L13, needs additional inductance in order to tune the 2-meter band. Since there was insufficient room for a larger link, a new inductor of the same size was made from No. 10 tinned copper wire. However, in one leg of the new link a 2-turn coil was included to increase the inductance. The two turns are a part of the U-shaped link, and are wound near the end of the link nearest chassis ground. The diameter of the turns is 3/16 inch, i.d.

In the model treated here only one crystal channel was wired in. A duplicate of the existing oscillator was wired into the blank space on the chassis, and a double-pole two-position toggle switch was mounted on the panel to allow switching the channels. The cathode circuit of each oscillator is routed to the panel switch so that the desired oscillator can be activated by grounding its cathode.

A microphone connector was wired in parallel with the microphone terminal strip on the back of the chassis. The new microphone jack is mounted on the front panel of the converted unit.

Maximum rf power output from the transmitter was 4 watts prior to modification of the circuit. After the changes were made an output of 13 watts resulted. The operating frequency was 146.34 MHz.

Modifying the Receiver

As was done with the transmitter, an additional oscillator was built into the blank space on the receiver chassis. Channel selection is carried out in

QST for

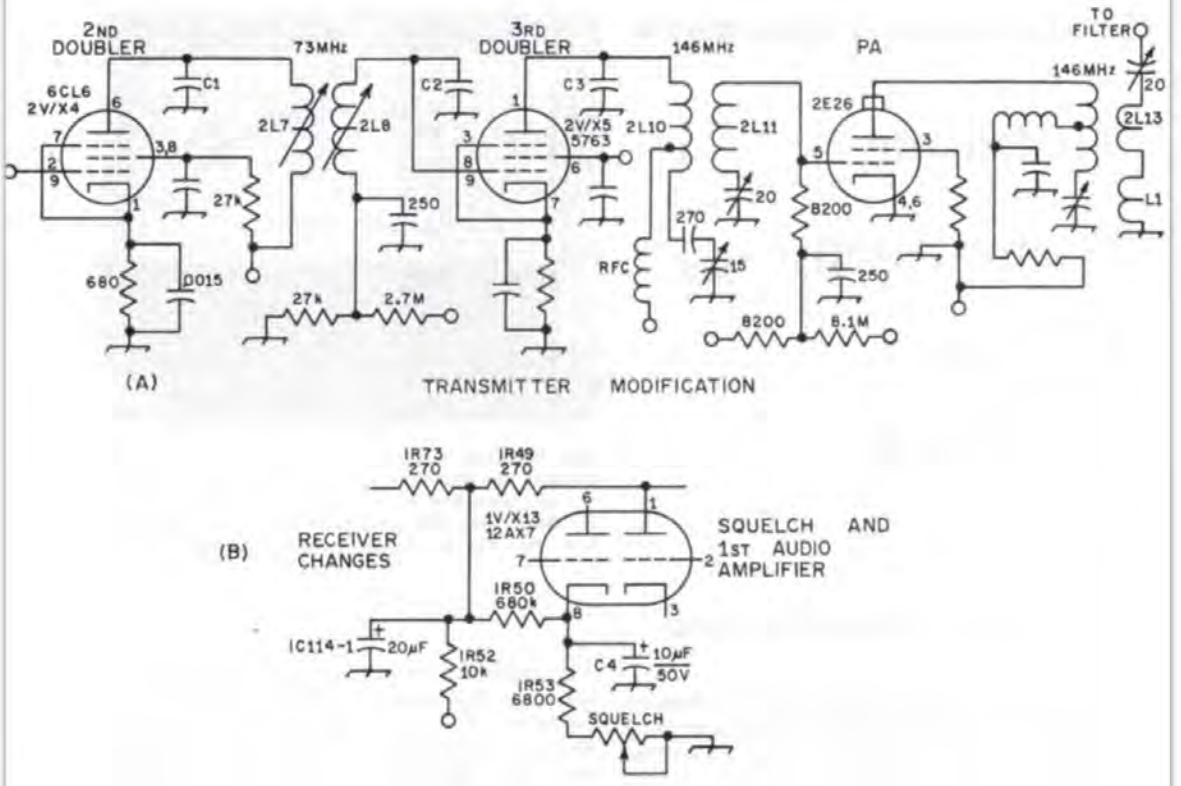


Fig. 1 — Changes to the transmitter circuit are shown at A. C1, C2, and C3 are, respectively, 3 pF, 5 pF, and 5 pF. Coil 2L13 is remade (see text) to include additional inductance L1. In the circuit at B the squelch portion of the receiver is modified to include C4, which is a 10-µF electrolytic. Resistor IR50 is changed from a value of 270,000 ohms to 680,000 ohms as shown.

the same manner as with the transmitter, and by means of the extra set of contacts on the same switch.

A case-history problem in the receiver was solved by adding a 10-µF electrolytic capacitor (50-volt rating) from pin 8 of the squelch tube (12AX7, 1V/X13) to ground. This circuit addition cured an annoying ac hum heard in the audio output of the receiver.

An improvement in the squelch range was effected by changing resistor IR50 (connected to pin 8 of the squelch tube) from a 270,000-ohm unit to one whose value is 680,000 ohms.

The remainder of the changes in the receiver entail moving the squelch and af gain controls to the new front panel. Also, a panel control was added to switch a zero-center 50-µA meter between terminal 2 of jack IJ2 (first-limiter current) and pin 5 of the same jack (discriminator). A surplus Motorola meter was used in this modification, but any zero-center 50-µA meter will work satisfactorily.

The original speaker was mounted on the new front panel, and is protected from damage by an aluminum grille made from perforated sheeting.

Other Changes

The power on-off switch and a new indicator lamp are mounted on the front panel. A single-pole two-position switch is panel mounted to select the metering function desired. The new panel is a gray hammertone aluminum unit which measures 10 1/2 × 19 inches. The trim strip on which the press-on white decal lettering is placed consists of a 19 × 1-inch strip of masking tape which has been painted red. Krylon spray paint was used for the coloring job.

The original RCA emblem and carfone strip was added to the new panel as shown in the photo. The new panel is attached to the same brackets as was the original sloping panel.

Closing Comments

Some dealers sell used Carfones at reasonable prices. Keep a sharp eye out for bargains.[1] The 10-watt units are ideal for use as exciters for high-power amplifiers, but serve nicely as 10-watt base stations when used independently. It is suggested that a thorough check be made of the tubes to assure that they are in good condition. Several "softies" were found in the author's model.

The receiver required very little tweaking to acquire good performance. The final sensitivity was 0.3 µV for 20 dB of quieting .. . . not bad for a piece of well-used surplus! QST

[1] Surplus two-way fm gear can be purchased from such suppliers as Gregory Electronics Corp., 249 Route 46, Saddle Brook, NJ 07662. Also check with Spectronics, Inc., 1009 Garfield St., Oak Park, IL 60304.

• *Beginner and Novice*

Converting the Pip-Squeak to 220 MHz

There is increased interest in 220-MHz operation. Here is a simple way to give the band a try. The Pip-Squeak for 2-meter fm was one of the most popular rigs ever described in QST. *This article shows how to put the Pip-Squeak on 220.*

BY LEWIS G. McCOY,* W1ICP

A VERY POPULAR transmitter was described in a recent issue of *QST* – "The Pip-Squeak."[1] This rig was designed for 2-meter fm operation and was capable of approximately 2 watts output. With more and more stations getting on 2-meter fm, the band has become very crowded in some areas of the country. This has led to increased interest in 220-MHz operation, with the promise of more repeaters showing up on this band. This article treats the conversion of the Pip-Squeak to 220 MHz. Modifying an existing Pip-Squeak requires only a few hours' time. Or, it will make a very interesting project if the complete unit is built from scratch.

Circuit Details

An 18-MHz fundamental-type crystal is used in the oscillator circuit. The collector circuit of the oscillator is tuned to three times the crystal frequency, or 55 MHz. Q2 works as a doubler to 110 MHz and its output is fed to Q3 which also serves as a doubler with its output at 220 MHz. It was found that the original Q3, a 40637, did not provide adequate drive on 220 MHz to the final amplifier. Q3 was changed to a 2N3866 which does provide ample drive. The power output from Q4 is between one and two watts, depending upon the supply voltage.

In this modification, C27 is changed to a 25-pF variable. The coils, L1 through L4, are eliminated and one terminal of each crystal is connected directly to the appropriate switch terminal of S1. The crystal frequency can be changed by adjusting C27.

Modifications

Table I shows the component changes necessary to put the Pip-Squeak on 220 MHz. The changes are, for the most part, coil modifications. Also, to provide more exact impedance matching with the C11-L7 combination, C11 is changed to a variable capacitor, a 15-pF unit. Also, C18 is changed to a 25-pF variable, which can be adjusted for matching the base impedance of Q4 to provide more drive. The same component layout is used in this unit as in the original Pip-Squeak. Full-size templates for the etched circuit board and component placement are still available from ARRL.[2] The only change in the etched circuit board is to jumper the coil holes for L1 through L4, to provide a direct connection, as mentioned earlier.

* Novice Editor

[1] DeMaw, "An FM Pip-Squeak for 2 Meters," *QST*, March, 1971.

[2] Circuit board templates for the transmitter and modulator are available from ARRL for 50 cents and a large self-addressed, stamped envelope. While these templates are the same as used for the original Pip-Squeak, we would appreciate it if the prospective builder specified his order was for the 220-MHz modification. This will provide us some idea of the interest in 220-MHz operation.

A comparison of this photograph of the modified Pip-Squeak with that of the original model will show few differences. However, note that only one crystal has been installed. The blank area near the crystal is for additional channels.

QST for

Construction Notes

If this happens to be your first project using very small components, a few construction tips are in order. Use a pencil-type soldering iron when making connections on printed circuit boards. Do not apply more heat than is necessary. Wherever possible use a heat sink between the solder point and the body of the component. It is very easy to ruin a transistor or diode by letting too much heat reach its body.

Tune-Up Procedures

Connect a No. 47 dial lamp as a dummy load at the transmitter output. The transmitter should *never* be operated without a load on the final amplifier. Otherwise, the PA transistor may burn out. Connect a 300-mA dc meter in series with the B+ and apply voltages. Using a wavemeter or a grid-dip meter as an indicator, adjust C5 for output in the 55-MHz region. Next, adjust the first doubler output to 110 MHz by tuning C9 and C11. The second doubler, Q3, has its output at 220 MHz, so adjust C17 and C18 at this frequency. Next, adjust C23 and C24 for best loading, observing the brilliance in the dial-lamp load. It should be possible to obtain nearly full brilliance of the No. 47 dial lamp.

The modulator is identical with the unit used in the original Pip-Squeak. For receiving on 220 MHz it is suggested that one of the converters described in the *VHF Manual* be used. As mentioned, this is a fairly simple way to try out the 220-MHz band.

TABLE I

C11, C18 – 15-pF variable (E. F. Johnson 189-505-5, or equiv.).
C27 – 25-pF variable (E. F. Johnson 189-509-5, or equiv.).
L5 – 8 turns No. 16 bus wire, 5/16-in. ID X 5/8-in. long. Tap 1 1/2 turns from C5 end.
L6 – 4 turns No. 16 bus wire, 5/16-in. ID X 1/2-in. long.
L7 – 9 turns No. 22 enam., close-wound, 1/4-in. OD.
L8 – 5 turns No. 22 enam., close-wound, 1/4-in. OD.
L10 – 2 turns No. 16 bus wire, 5/16-in. ID X 1/2-in. long.
L11 – 10 turns No. 22 enam., close-wound, 1/4-in. OD.
L12 – 4 1/2 turns No. 16 bus wire, 5/16-in. ID X 1/2-in. long.
RFC3 – 8.2-μH molded rf choke (Millen J302-8.2).
RFC5 – 3.3-μH molded rf choke (Millen J302-3.3).
RFC7, RFC8 – 10-μH molded rf choke (Millen J302-10).

February 1922

. . . This issue contains the complete story of the now famous Transatlantic test. History was really made. The cover depicts the antenna used at 1BCG. In the March issue, there will be a photo of the antenna used at 2BML/2EH, Riverhead, Long Island. It will be interesting to compare them! (I'd better not pursue this one any further.) There is also a complete description of 1BCG, Greenwich, Conn. At Ardrossan, Godley used two receivers. One was a "special" regenerative receiver which looks more like a Paragon RD5 than anything. It had a DA2 detector and amplifier. For the superheterodyne setup, this receiver was used ahead of the resistance coupled i.f. amplifier. These receivers, together with the Beverage antenna, did the job.

. . . Traffic Manager Schnell announces the details of the upcoming Governors'-President's Relay. This is to test the efficacy of our established relay networks.

. . . K. B. Warner editorially explains why this particular issue has allotted so much space to a full official report on the Transatlantics to the exclusion of some regular departments. Of course, the tests were so important and history making that this had to be done. He also comments on the recently announced Hoover Cup. It will be awarded to a ham selected by a special committee.

. . . There is a wild rumor floating around that Armstrong has a new receiver using one tube which is 100,000 times more sensitive than a regenerative detector. Super-regeneration!

February 1947

. . . A World Telecommunications Conference is in the offing, and we will have to await its outcome before pressing the FCC for more phone frequencies in the 7 and 14 Mc bands.

. . . One of the nifty pieces of surplus gear is the BC-645. This is an IFF (identification – friend or foe) rig and the boys have found how to operate it on 420 Mc. John T. Ralph and H. M. Wood, W3JYA, tell how to do this, using wiring diagrams and photos. On-the-air tests showed that good communication could be had for ten or fifteen miles, line of sight.

. . . Here's a tabulation of transmitting ratings of receiving tubes. The popular 6L6 seems to be by far the best of those listed.

. . . Richard M. Smith, W1FTX, describes his stabilized 813 amplifier. Neutralization is accomplished with a single adjustment. Plenty of hams today still using these popular tubes, mostly as ssb amplifiers.

. . . Byron Goodman, W1DX, writes about "S-Meters, So What?" His comments equally apply today. Of course S-meters *are* useful if they are used properly,, but they do not indicate how "loud" a signal is. Quite a number of factors enter into this.

. . . The first 3-Cm amateur work by James A. McGregor, W2RJM, is quite interesting. The photo shows him and Charley Atwater, W2JN, standing by the rig set up in the open air. Antenna is a 2-foot dish. – *W1ANA*

Strays

Another 10-year-old at the key, Doublas Coan, WN4WKF. Doug operates mostly on 40 and 15 meters but is getting ready to plunge onto 80. He got his license with the help of a neighbor ham, K4TXJ. Doug has got his code speed up to 13 so his "N" will be missing someday soon.

Here's the first family 5BDXCC to date! On the left is dad W2FXA, 5BDXCC 88, with son WB2YQH, 6BDXCC 110. Oneupsmanship shows, however; that's dad's 5BWAS no. 36 on the wall.

One of the most popular programs on the air carries no music, no commercials, and only a limited number of announcements. But just about every second it transmits a "tick," which is a short dot. We mean of course WWV and WWVH, well known to U.S. amateurs for their standard frequency and time transmissions from 2.5 to 25 MHz. WWV has a male voice announcer, WWVH a female voice. This past year, WWVH moved into new facilities on the island of Kauai. Present at the opening ceremonies were (l. to r.) Charles L. Trembleth, Engineer-in-Charge; Hawaii ARRL SCM Lee Wical, KH6BZF; retiring Engineer-in-Charge Sadami Katahara, KH6DK; and Mrs. Katahara.

February 1972

Rick Wagner, WA2IKG, now 12, got his first ticket at 10 years of age. Rick is in the eighth grade at Old Field Jr. High (Huntington, N.Y.) where he was founder and past president of the Old Field Amateur Radio Club. The station shown here is shared with dad, W2VRW.

Meet 10-year-old Sam Gonzalez. Newly licensed, Sam is a pretty good cw man according to OM WB2NVU. Together, dad and son constructed his transmitter from the ARRL *Handbook*.

Celebrating Our Legacy

A Lifelong Appreciation for Morse Code

I met my mentor Terry Kennedy, KN6CNN, in 1957, when we were students at a boarding school in Watsonville, California. He was allowed to set up his station in the school's hobby room. I had been interested in learning Morse code for several years, and with Terry as my mentor, I quickly mastered code at 5 WPM.

One Sunday when my mom came to visit me at school, we drove around Watsonville in hopes of finding a house with an amateur radio antenna in the yard. Fortunately, we found one! At the time, any ham with a General-class license or higher could administer the code test, and the ham who lived at the house we found was happy to do so for me. He said that this was the first time he had ever proctored an amateur radio test. In 1958, I received the call sign KN6LIW. In 1960, after being a General-class licensee for 2 years, I passed the Amateur Extra-class exam. I received my N6LW call in 1977.

Amateur radio was the catalyst for my continued interest in science and math. I grew up on a cattle ranch and majored in pre-veterinary science in college. I received a US Air Force commission in 1966, and flew a McDonnell Douglas F-4 Phantom II during combat from 1969 to 1970, before retiring from the military as a lieutenant colonel. I also underwent medical training to be a podiatrist and pursued a law degree.

I still only operate CW on 30 and 40 meters. Look for me on the air if you need a confirmed contact for Billings, Montana, or Straight Key Century Club (SKCC) — I'll always send a QSL.

W. David Herbert, N6LW
Billings, Montana
Life Member

Ham Radio and the Army

My high school electronics teacher, Truman Whorton, WB6QFV (SK), gave me my Novice-class license test in 1969. I received the call sign WN6FZN, and upgraded soon after to General- and Amateur Extra-class licenses. My excitement about electronics and ham radio led me to earning a Bachelor of Science in Electrical Engineering from the University of California, Davis (UC Davis) in 1975. I surprised my dad, George, WN6IFX (SK), when I was commissioned from the Reserve Officers' Training Corps (ROTC) as a second lieutenant of infantry, spending 26 years on active duty in the US Army. Instead of pursuing a career in electronics, I was jumping out of airplanes and running around in the woods with a rucksack. But I kept up with technology by staying active on the air on all modes and continuing to be a dedicated DXer.

Dino Papas, KLØS, with his wife Toby Papas, KLØSS, in their shack in Williamsburg, Virginia.

I now share a ham radio shack with my wife of 44 years, Toby Papas, KLØSS, who is a retired US Army lieutenant colonel. Being hams helped us both throughout our military careers, and it has been a steady hobby of ours for many years.

Dino Papas, KLØS
Williamsburg, Virginia
Life Member

Remembering My First Mentor

In 1956 ham radio was my only interest, and as a Boy Scout my first mentor was my counselor for the Radio merit badge, Bill Tron, W8YNN. I learned basic electricity from my dad, who also introduced me to a crystal radio set and a one-tube broadcast band regenerative receiver.

Mr. Tron supervised my construction of a one-tube 6SN7 shortwave receiver for my merit badge, which was built in a wooden case. I distinctly remember taking it to his house one evening to test it. He said my wiring looked pretty good, but that there were a few areas with "extra baggage" that needed trimming, so he removed the dangling wires. That evening we made some contacts together at his basement shack, which consisted of a Collins 75A-1 receiver and a beautiful homebrew desktop AM transmitter. We talked to a ham in Estes Park, Colorado, on 20 meters, which was an exciting DX contact for a 14-year-old who hadn't earned his Novice-class license yet.

Over the years, I earned my General-class license and built more homebrew gear out of old salvaged parts. I regret not looking up Mr. Tron's contact information to share these moments with him. Some of my other mentors were W8FYO, W8YCP, W8BZX, and W8IX. They were all hams in the Dayton, Ohio, area and were very helpful to a high school kid wanting to learn more about amateur radio.

Carl E. Wolfe, W2IQK
Slate Hill, New York

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

George Misic, KE8RN, ke8rn@comcast.net

Classic Radio

The SideBand Engineers SB-33 and SB-34 SSB Transceivers

The SideBand Engineers (SBE) was formed in 1962 by Faust Gonsett, W6VR, of Gonset VHF equipment fame. The SB-33 was the first successful solid-state SSB transceiver released to the amateur radio marketplace in 1963. The SB-34 followed the SB-33 in 1966, and it had some improvements plus a built-in 12 V dc power supply for mobile operation.

The SBE-33's Clever Design

The SB-33 (see Figure 1) was a compact radio with attractive blue knobs and a speaker grille. It even had a carrying handle on the side. It weighed about 15 pounds. The SB-33 used three tubes — two final amplifiers and a driver tube — with transistors for all other circuit functions. The radio operated SSB only on the phone portion of the 80-, 40-, 20-, and 15-meter bands. The radio included a built-in speaker and an internal ac power supply, selling for $389.50 at a time when the Collins KWM-2 sold for $1,150 without the power supply or speaker.

The circuitry of the SB-33 (see Figure 2) had some clever ideas. The SB-33 had no frequency shift when switching sidebands. This was accomplished by using an intermediate frequency (IF) of 455 kHz, using a 2.1 kHz Collins mechanical filter to provide receiver selectivity and single sideband (SSB) when transmitting. A higher IF was used at five times 455, or 2275 kHz. This was made by multiplying the 455 kHz carrier frequency by either four or six and then adding or subtracting the 455 kHz IF, generating a lower sideband (LSB) or upper sideband signal (USB). Adding the 455 kHz signal to 1820 kHz did not invert the sideband, but subtracting 455 kHz from 2730 kHz did. There was no carrier shift using this method, so no correction from the VFO was needed.

The SB-33's Bilateral Circuit Design

Much of the RF and IF circuitry of the SBE-33 was bilateral in that it used two transistors wired across each other in opposite directions. One was biased **ON** for receive, and the other biased **ON** for transmit. The other transistor was biased **OFF** when not in use. This design directed signal flow in the proper direction for receive or transmit. The RF tuned circuits and IF transformers were used on both receive and transmit, a very clever design that minimized duplication of circuitry.

Geneva Mechanism

The band switch, preselector tuning, and driver tuning were all controlled by a single knob. The knob was connected to a mechanical design called a *Geneva mechanism*, driving both the band switch and the preselector and driver tuning variable capacitor. Starting with the knob all the way clockwise at the word **STOP**, the knob rotated tuning the multi-section variable capacitor for about 80 degrees, and the band switch stayed on 80 meters.

Figure 1 — A restored SideBand Engineers (SBE) model SB-33 with a companion digital VFO. [Dale Parfitt, W4OP, photo]

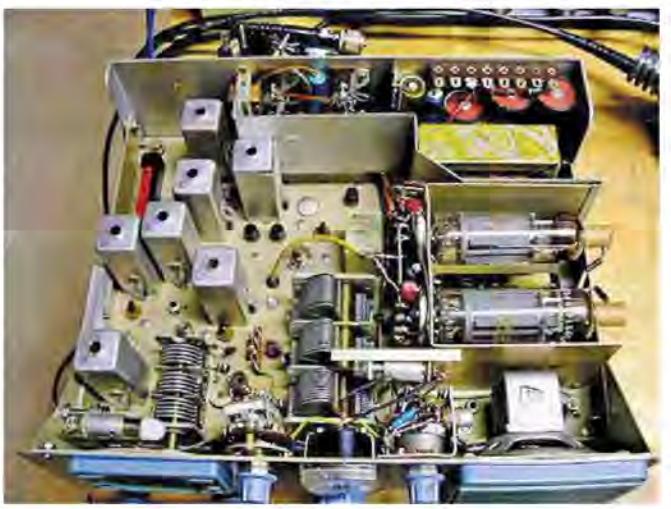


Figure 2 — An inside look of the SB-33 after restoration. [Dale Parfitt, W4OP, photo]

Figure 3 — A restored SideBand Engineers (SBE) model SB-34. [Dale Parfitt, W4OP, photo]

Figure 4 — An inside look of the SB-34 after restoration. [Dale Parfitt, W4OP, photo]

Continued rotation would cause the band switch to move into the next 90-degree segment, switching the radio to the 40-meter band and allowing about 80 degrees of rotation. This again tuned the variable capacitor without moving the band switch. Continued counterclockwise rotation would move the band switch to 20 meters and again enter 80 degrees of tuning. The final step in counterclockwise rotation would access the 15-meter band and the last 80 degrees of tuning rotation. It was a very clever combination of two related controls.

Vacuum Tubes

The radio used three vacuum tubes in the transmitter in the RF driver and final output amplifier stages, where semiconductors were not readily available for high-power RF applications in 1962. The two final output tubes were black and white television horizontal output tubes, or *sweep tubes*, characterized as the 27GB5 pentode or the European number PL500. They were used in parallel to produce up to 135 W peak envelope power (PEP). It provided about 60 W average power on 80, 40, and 20 meters and about 50 W output on 15 meters. A type-12DQ7 pentode tube was used as the driver tube for the 27GB5 finals.

Transistors

The transistors were all germanium and were mostly PNP types. As was often done with transistors for their first decade of use, sockets were provided for all transistors to make replacing them easy. This practice was a carry-over of the accommodation from vacuum-tube circuitry.

The SBE SB-34

By 1966, SBE introduced a new version of the radio, the SB-34 (see Figure 3). Overall, the SB-34 was quite similar to the SB-33, but the blue knobs and speaker grille were replaced with gray features, which had come into style for amateur radio products. The SB-34 ran only SSB on 80, 40, 20, and 15 meters with up to 135 W PEP input power. The SB-34 also had a built-in speaker, an ac power supply, and an added 12 V dc power supply for mobile operation.

The clever system for sideband selection in the SB-33 was retained for the SB-34, as was the unique Geneva mechanism on the combined band switch and driver/preselector tuning. Added as a new feature, the SB-34 the main tuning dial and knob had about 270 degrees of rotation, allowing a six-to-one planetary reduction drive to provide fine tuning of SSB signals. Rotation beyond the 270 degrees bypassed the reduction drive, providing fast tuning to the part of the band desired. This was a very clever addition that made tuning to any part of a band simple and quick and still allowed precise tuning of SSB signals.

The SB-34 used a 12DQ7 driver again but switched the output tubes to 6BG5, which is a European EL-500. These tube filaments can be lit from 12 V dc for mobile operation. Faust Gonsett and his team at SBE built so many clever and patented ideas into the SBE rigs that Raytheon, a big military contractor, bought the company to get SBE's patent portfolio.

SBE Decline

SBE moved on about 1970 to make a model SB-35, but few were made for sale and it likely only reached prototype phase. In 1972, SBE offered the digital-readout SB-36, which was manufacturd by a company called Robyn. SBE offered a few 2-meter FM radios that did very little in the amateur radio marketplace. SBE went into the CB radio business, but then completely vanished by 1975. It was a sad ending to a very innovative company.

Al Brogdon, W1AB

100, 50, and 25 Years Ago

January 1922

- The cover art triumphantly announces the success of the Transatlantic Tests.
- The editorial, "Excelsior!," recounts how an eminent radio engineer thought that hams were foolish for thinking amateur signals could span the Atlantic Ocean.
- "Transatlantic Tests Successful" opens with the sentence, "Oh, Mr. Printer, how many exclamation points have you got? Trot 'em all out, as we're going to need them badly, because WE GOT ACROSS!!!!!!"
- A. L. Groves, 3BID, shares "Some Ideas on Short Wave C.W. Reception."
- Sumner B. Young, 1AE, provides Part 2 of "Improving the Relay Spark Transmitter."
- D. W. Richardson describes "The Antenna System at 3DH."
- H. S. Shaw, Jr., 1JK, offers "Comments on the 'Sure-Fire C.W. Circuit.'"
- While considerable attention was being given to the successful Transatlantic Tests, "A New C.W. Record" was set when 1ES copied the signals on 6ALE for the first transcontinental reception.
- John F. Gray, 6MZ, delivers information on "Boy Scout Radio."

January 1972

- The cover photo shows Jerry Hall, K1PLP, tuning an antenna-matching network using the Macromatcher described in this issue.
- The editorial looks at "1971 in Retrospect."
- Thomas McMullen, W1SL, talks about "An Easy Road to 220 MHz."
- Jerry Hall, K1PLP, and John Kaufmann, WA1CQW, present "The Macromatcher," an impedance bridge for coax lines.
- Gil Kowols, W9BUB, describes "The Simulmonitor — A New Approach to Repeater Inputs."
- Raymond F. Rinaudo, W6ZO, reports on "A 144-MHz Amplifier Using the 8874."
- Gary L. Ellingson, WAØWHE, shares information on "A Helically Wound Vertical Antenna for the 75-Meter Band."
- Lewis G. McCoy, W1ICP, offers basic antenna information for new hams in, "Why a Beam Antenna?"

January 1997

- The cover photo shows Chip Taylor, W1AIM, operating the ARRL 10 GHz Cumulative Contest from the summit of Mount Washington, New Hampshire, in 50 MPH winds and 40 °F temperatures.
- The editorial asks, "What's Our Future in Emergency Communications?"
- Steve Ford, WB8IMY, tells readers to "Get Ready for Phase 3D!," and provides information on how to do so.
- Rod Kreuter, WA3ENK, reports on how he built "Junk-Box Converters for 6 and 2 Meters."
- L. VanProoyen, K8KWD, discusses "Refurbishing 'Boat-Anchors.'"
- Tom Petruzellis, WA2ANG, describes "The Radio Mailbox," a simple voice-mail system for hams.
- Emil Pocock, W3EP, predicts what to expect from the new solar cycle, in "Long Live Cycle 23!"
- Ed Hare, KA1CV, reports on "The FCC's New RF-Exposure Regulations."
- Ken Collier, KO6UX, promotes FM simplex operation, in "Heading in a New Direction."
- Kirk Kleinschmidt, NTØZ, shares that computer memory prices are dropping significantly, suggesting that it's a good time to "Upgrade Your Memory!"
- Ward Silver, NØAX, takes readers back to the basics, in "Test Your Knowledge!"
- In "How's DX?," Bob Allphin, K4UEE, reports on "The Heard Island DXpedition, 1997."

Silent Keys

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

KC1AKH **Lynch**, Michael J., Granby, CT
♦K1ER **Peters**, John D., Aiea, HI
N1NGF **McHugh**, John F., Keene, NH
WA1SDY **Farley**, Donald L., Springfield, MA
•W1UBC **Wright**, Richard E., Acton, MA
WA1YNZ **Scott**, Wilburn A., Washburn, ME
♦K1ZY **Wood**, John W., Jr., Concord, MA
♦W2AC **Campanelli**, Donald A., Elmira, NY
•KD2BU **Ainsworth**, John W., Glenmont, NY
•N2DMV **Merrill**, Theodore B., Jr., Shelburne Falls, MA
W2FED **Smoljan**, Joe, East Patchogue, NY
W2ICQ **Harrison**, Robert J., DeWitt, NY
♦W2IVP **Mosher**, Paul W., Albany, NY
N2NAX **Simmons**, Robert F., New Rochelle, NY
♦N2NN **Simpson**, R. Allen, Bloomingdale, NJ
AA2UK **Lentz**, William, South Hampton, NJ
W3CQC **Riethof**, Thomas R., Harleysville, PA
W3GEG **Heck**, Alfred L., Worthington, WV
N3LM **Miller**, Lyle K., Harmony, PA
W3OIO **Freienmuth**, William L., Waynesboro, PA
♦W3OSM **Kuncas**, John W., Export, PA
N3RSD **Hickam**, Jesse "Frank," Jr., Dade City, FL
♦W3SMV **Volz**, Carl, Jr., Bellefonte, PA
N3VPN **Rosenwald**, Shirley M., Cranberry Township, PA
W4AK **Sims**, William K. "Bill," Louisburg, NC
KM4ASH **Temple**, Craig D., Birmingham, AL
•W4CXQ **Cotten**, Whitworth W., Jr., Orlando, FL
♦K4DES **Schall**, David E., Punta Gorda, FL
K4DRT **Stroupe**, Michael A., Raleigh, NC
K4FIJ **Walter**, James F., Auburndale, FL
K4GCJ **Jacobs**, Gerry C., Raleigh, NC
KI4GPM **Davis**, Dewey B., Cleveland, TN
K4GQX **Vest**, Jack E., Kingsport, TN
AA4H **Smith**, Carl W., Jr., Blountville, TN
KN4HFH **Mathis**, Claude L., Blacksburg, SC
KJ4HHB **Collins**, Stephen L., Chattanooga, TN
WA4LVR **Keith**, Jack R., Jr., Cleveland, TN
W4MDP **Pallans**, Mark D., North Las Vegas, NV
♦AA4NC **Roberts**, William J., Jr., Apex, NC
♦N4NH **Harrill**, Norman G., Asheville, NC
KO4NID **Schultz**, William L., Melbourne, FL
KB4OFB **Thorsen**, Gavin K., Pensacola, FL
WK4P **Lawler**, David "Adam," West Jefferson, NC
•K4ROG **Callihan**, Floyd B., Goochland, VA
KM4TUN **Mardis**, Forrest G., Gadsden, AL
WT5CR **Jackson**, Randell M. "Randy," Shiloh, IL
♦K5EEA **Drake**, Tom, Diamondhead, MS
•N5DML **Roper**, David L., Santaquin, UT
W5FRS **Brady**, Dennis L., Irving, TX
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•K5GFM **Moulton**, Gail F., Jr., Trona, CA
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K7SZ **Arland**, Richard H., Dacula, GA
•N7TL **Clulow**, Edgar A. "Ed," Portland, OR
KD7UBP **Herzog**, Gary S., Wolf Point, MT
♦N8AEH **Griffin**, Ronald J., Findlay, OH
N8APD **Sosinski**, Carl C., Parma, OH
♦KU8B **Noder**, Guenther F., Gardnerville, NV
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G3YQ **Hunt**, Sydney, Hurnberston, Grimsby, UK

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

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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

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• 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

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• 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-5DR *C4FM/FM 144/430 MHz Dual Band*

• 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 • Supports Simultaneous C4FM Digital • 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

FTM-6000R | *50W VHF/UHF Mobile Transceiver*

• All New User Operating Interface-E2O-III (Easy to Operate-III) • Robust Speaker Delivers 3W of Clear, Crisp Receive Audio • Detachable Front Panel Can Be Mounted in Multiple Positions • Supports Optional Bluetooth® Wireless Operation Using the SSM-BT10 or a Commercially Available Bluetooth® Headset

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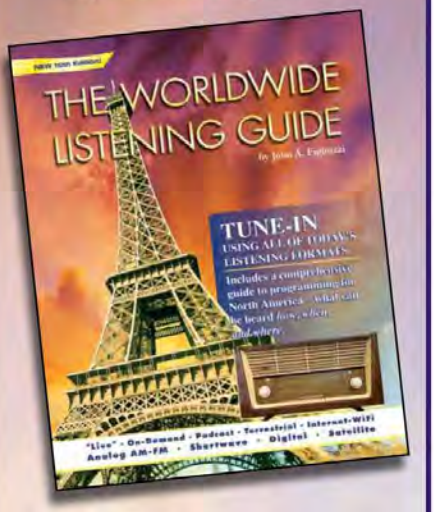

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OIP 3	24 dBm	32 dBm	19 dBm
IIP 3	7 dBm	14 dBm	-6 dBm
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MSHD, $149.95. Above tower heavy duty mast support. Accepts $1^{7}/_{8}$-$2^{5}/_{8}$" OD.

CD-45II

CD-45II **$519.95**

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.

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 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 brngs**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	31 lbs.
Effective Moment (in tower)	**3400 ft.-lbs.**

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 brings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	22 lbs.
Effective Moment (in tower)	**1200 ft.-lbs.**

Hy-Gain Programmable DCU-3
Digital Rotator Controller
DCU-3 -- $519.95

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".

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DCU-2 Digital Rotator Controller --$479.95

$479.95. Like DCU-3, but less programmable memories. 110 VAC. Order DCU-2X, for 220 VAC.

AR-40 -- $419.95

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 desired location. Solid state, low voltage control, safe, silent operation. $2^{1}/_{16}$" max mast. MSLD low mast 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 bolts
Control Cable Conductors	**5**
Shipping Weight	14 lbs.
Effective Moment (in tower)	**300 ft.-lbs.**

Replace your Yaesu Rotator Controller

YRC-1 - $399.95

Hygain 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 minimises overshoot. Intuitive menu. Field upgradeable. For Yaesu G-800/1000/2800/G450/650. AC or DC motors.

YRC-3, $499.95. Like YRC-1 and adds 6 memories.

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25-Amps, $164.95

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., 5¼Wx4½Hx6D".

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Add a pair of *PowerPoles*(R) **MFJ-4230MVP, $144.95** *PowerPoles*(R) on back.

MFJ-4230MPF, $134.95 *PowerPoles*(R) on front of unit.

MFJ-4230DMP, $184.95 Like MFJ-4230MVP but has bright orange digital Volt/Amp display.

35-Amps, $184.95

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25-Amps, $124.95

MFJ-4125 gives 25A surge, 22A continuous. 13.8 VDC switcher has 5-way binding posts on front and quick connects on back. 3.5 lbs.

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MFJ-4035MV 19.2 lb. transformer, 35A max, 30A continuous. 1-14 VDC out, 110 VAC in. Highly regulated, 1% load, 1 mV ripple. 5-way posts, cig lighter. 9½Wx6Hx9¾D".

25-Amps, $134.95

MFJ-4125P. 25A surge, 22A continuous. 13.8 VDC switcher has 2-pair *PowerPoles*(R), 5-way posts, quick connects. 3.5 lbs.

15-Amps, $84.95

MFJ-4115. 17A surge, 15A cont. 13.8 VDC. 110/220 VAC. 3¾Wx2¼Hx7¾D", 1.5 lb. 5-way posts.

MFJ-4215MV, $84.95. Like MFJ-4115 but has backlit volt/amp meters.

28-Amps, $104.95

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MFJ-4218MV, $129.95. 0-24 VDC,18A@13.8/9A@24VDC.

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MFJ-1104, $69.95 *PowerPole*(R) Splitter, 30 Amp fused input, outputs fused at 25, 10, 5A. Open fuse indicator. 2¾Wx3¼Hx1½D".

MFJ-1107, $79.95 40A fused binding posts input, 4 fused *PowerPole*(R) outputs, two 2.1 mm center positive power jacks.

MFJ-1106, $69.95 One in, six out *PowerPoles*(R). 30A total. 7 sets of mating conectors included.

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Power multiple transceivers/accessories from a single DC power supply

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MFJ-1116, $84.95 Like MFJ-1118 but 15A total, 8 pairs 5-ways."On" LED, 0-25 VDC voltmeter.

MFJ-1128, $154.95 12 fused *Power Poles*(R), three 1A, four 5A, four 10A, one 25A, one 40A. Switch, Meter.

MFJ-1112, $69.95 Like MFJ-1116 but 6 pairs 5-way posts, no meter/switch. 12½Wx2¾Hx2½D".

MFJ-1126, $119.95 8 fused *PowerPoles*(R): a 1A, three 5A, two 10A, one 25A, one 40A. Switch, Voltmeter. 9Wx1½Hx2¾D".

MFJ-1117, $94.95 High-current. Powers four HF/VHF radios simultaneously -- 2 at 35A each, 2 at 35A combined. 8Wx2Hx3D".

MFJ-1124, $99.95 4 pairs 35A PowerPoles(R), 2 pairs 35A high current posts.

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Dummy Loads

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MFJ's 2500 Watt *fan cooled* load handles legal limit amps, 2500W average one minute on, ten minutes off, 300W continuous. DC- 6 Meters. SWR <1.25, 30 MHz; <1.4, 30-60 MHz. Detailed power curve. 12 VDC or 110 VAC. 8¼Wx4Hx 9½D in. SO-239s. 5 pounds. MFJ-265 **$279.95**

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Displays forward, refelected power, SWR (1.6-60 MHz) and battery *all in a single glance!* Large 1/2" forward power digits and 5/8" reflected/SWR digits! 0-200W. Power/backlight on/off. SO-239s. MFJ-845 **$139.95**
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MFJ HF *QRP* SWR/Wattmeter

Read forward, reflected power 1.8-50 MHz, 0-5W. Also reads SWR, relative power 100 mW to 50W. SO-239s. 4½Wx 2¼H x3D in. MFJ-813 **$64.95**

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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, $79.95. *Half-size*, 52 foot *G5RV JUNIOR for limited space*. 40-10 Meters with tuner. Full 1500 Watts.

MFJ All Band Classic Doublet

MFJ-1777 **$99.95**

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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. 5x2 inches.

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MFJ-18H100, $49.95. 100 feet, 450 Ohm ladder line, 18 gauge copper clad.

80-10 Meter End-Fed Half Wave antenna

Cover all HF bands with one single wire and no tuner!

MFJ-1982HP, $129.95

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.

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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, $109.95. 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 **$129.95** 80/40 Meters

MFJ-17758, $119.95. 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-17754, $89.95. Like MFJ-17758 but is only 42 feet. Operate 40/20 Meters. *Full-size* on 20 Meters, ultra-efficient end-loading on 40 Meters. 1500 Watts.

Single Band Dipoles

MFJ-1779A **$99.95** 160M, 265 ft.

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MFJ-1779C **$59.95** 20-6M, 35 ft.

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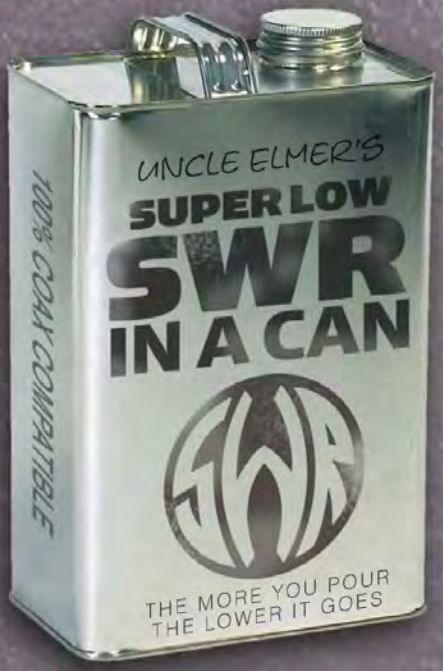

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$129.95

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A 75 Ohm, 1 GHz F-connector makes it easy to bring in telvision, satellite, HFD cable TV and FM radio signals.

A pair of high-voltage ceramic feedthrough insulators lets you bring in 450/300 Ohm balanced lines directly to your antenna tuner.

Has random/longwire antenna ceramic feedthrough insulator.

5-way binding posts let 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 1¼ x 1⅝ in.) Adapts to virtually any cable size. Seals out rain, snow, adverse weather.

3 Coax, Balanced Line, Random Wire

Best Seller! 3 *Teflon*(R) coax connectors for HF/VHF/UHF antennas. Separate high voltage ceramic feed-thru insulators for balanced lines and long wire/random wire. Stainless steel ground post.

MFJ-4601
$89.95

6 Coax

6 high quality *Teflon*(R) coax connectors for HF/VHF/UHF antennas. Stainless steel ground post. Full 1500 Watts.

MFJ-4602
$99.95

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 1¼x1⅝ 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
$199.95

Bring cables thru eave of your house

MFJ-4616 shown with vent (not included) it replaces. *Six Holes*
$49.95

MFJ-4613 shown with vent (not included) it replaces. *Three Holes*
$34.95

Replace standard house eave/sofitt air vents with these *MFJ AdaptiveCable*™ *Plates*.

Bring in coax, rotator, antenna switch, power cables, etc. of nearly any size up to 1¼x1⅝".

Sliding plates, 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.

MFJ *AdaptiveCable*™ Wall Plates

MFJ's exclusive weather-sealed *AdaptiveCable*™ *Wall Plates* let you bring nearly any cable -- rotator, antenna switch, coax, etc. -- through walls without removing connectors. Pass cable connectors up to 1¼x1⅝". Slide plates adjust hole size to weather-seal virtually any cable. Rubber grommet seals out rain, snow, adverse weather. Kit includes 18 gauge *stainless steel* plates for wall side, sliding plates, rubber grommets, weather stripping and hardware. Models for one, two and four cables.

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MFJ-4612 *(Two Holes)*
$49.95

MFJ-4611 *(Single Hole)*
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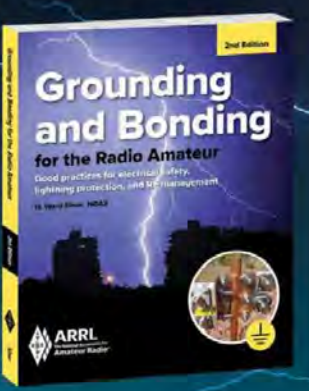

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MFJ-1724B **$39.95** **MFJ-1724B** 2-Meter/440 MHz antenna is perfect for your dual band mobile or HT. Powerful 3½ inch magnet holds firm at highway speeds, rubber guard, 19" black stainless steel whip, low SWR, excellent gain, 300 Watts PEP, 12 feet coax with PL-259. *Free* BNC adapter.

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MFJ 5-inch Magnet

MFJ-335BS SO-239
MFJ-335BM NMO
MFJ-335BT 3/8 - 24 For HF sticks
$29.95 Each

Best Seller!
These jet-black ***5-inch*** *super strong* magnet mounts have 17' coaxial line terminated with PL-259 connectors. SO-239 (BS) or NMO (BM) for your VHF/UHF antennas or 3/8-24 threaded (BT) for your HF hamstick antennas with a 3/8-24 threaded connector.

MFJ 3-inch Magnet

MFJ-333BS pictured
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Release strain on your HT's antenna connector! 3 ft. flexible, mini coax with SO-239 connector.
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Three super-strong 5-Inch Magnets make up this MFJ *Goliath*™ Tri-Magnet Mount. 1/4" thick steel triangle base. 17' coax. Select SO-239, NMO, 3/8-24 antennas. **Caution:** once on, it's difficult to get off!

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1.8-200 MHz SWR/Wattmeter

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Compact 1.8-200 MHz SWR/Wattmeter has HUGE 3" *Cross-Needle* meter. Read forward/reflected power and SWR simultaneously. Perfect for mobile/portable. 30/300 Watt ranges. Built-in meter light. SO-239s. 3¼Wx3¼Hx3¼D". **MFJ-842, $79.95** covers 140-525 MHz, 15/150 Watts.

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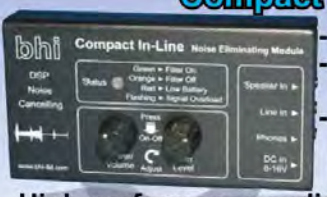

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Determine velocity factor, coax cable loss in dB, length of coax and distance to short/open.

Read SWR, return loss and reflection coefficient at any frequency simultaneously.

Read inductance (uH) and capacitance (pF) at RF frequencies.

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12-bit A/D converter gives much better accuracy and resolution than common 8-bits -- *MFJ-269D exclusive!*

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MFJ's exclusive *IntelliTuner*™, *Adaptive Search*™ and *Instant Recall*™ algorithms give you *ultra fast* automatic tuning with over 20,000 *VirtualAntenna*™ Memories.

You get a highly efficient L-network, 6-1600 ohm matching at 300 Watts SSB/CW and digital or *extra-wide* 6-3200 Ohm matching at 150 Watts SSB/CW and digital, 1.8-30 MHz coverage, Cross-Needle *and* digital meters, audio SWR meter, *backlit* LCD, remote control port, radio interface, heavy-duty 16 amp/1000V relays. MFJ-993B automatically tunes for minimum SWR and remembers your frequency and tuner settings. The next time you operate on that frequency and antenna, these tuner settings are instantly restored and *you're ready to operate in milliseconds!* 10Wx2¾Hx9D inches. Use 12-15 VDC/1 amp or 110 VAC with **MFJ-1316, $31.95**. Radio interface cables, remote control available. See ***www.mfjenterprises.com***

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Extra *wide matching range at less cost.* MFJ's *exclusive* dual power level: 300 Watts for 6-1600 Ohms; 150Watts for 6-3200 Ohms. Cross-Needle SWR/Wattmeter.

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200 Watt ...Compact

Digital Meter, Ant Switch, Wide Range

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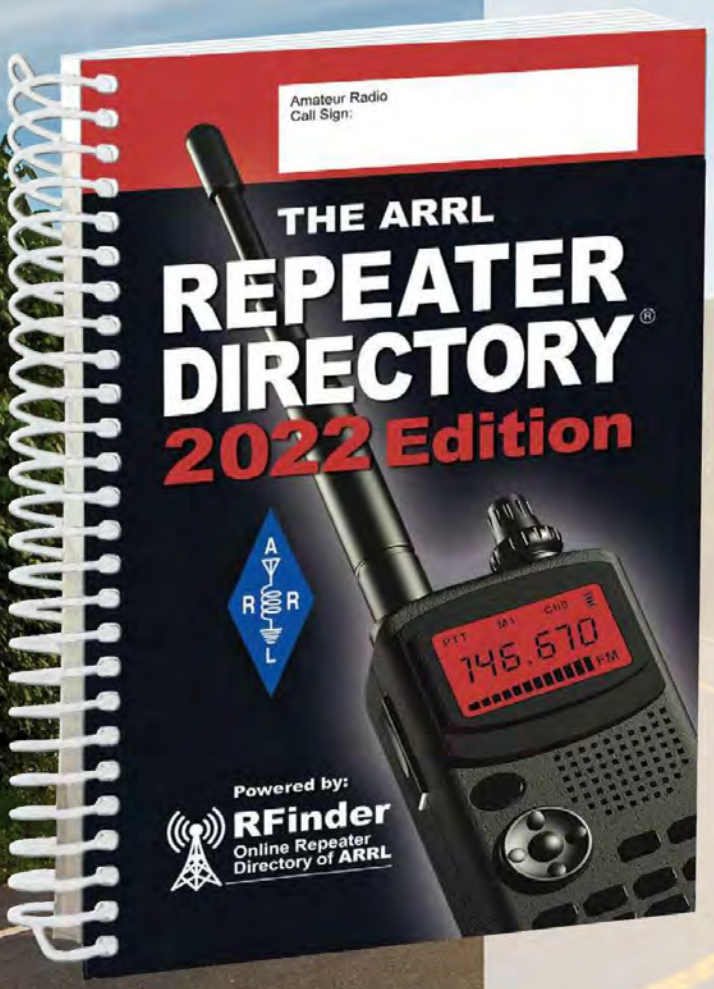

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