Read the Wrap-Up on the 2018 ARRL International Grid Chase Page 89

QST

DIGITAL EDITION

ARRL The national association for AMATEUR RADIO®

April 2019 www.arrl.org

DEVOTED ENTIRELY TO AMATEUR RADIO

Annual Antenna Issue

Featuring Winners of the 2018 *QST* Antenna Design Competition

QST Reviews

Xiegu Communication X5105 HF/6 Meter QRP Transceiver

Antenna Disconnectors from **Paradan** and **INRAD**

Heil Parametric Receive Audio System and Powered Speaker

Mortty Morse Code and RTTY Keying Interface Kit

DIGITAL FEATURE

53| See our Video Review of the **Xiegu** Communication X5105 HF/6 Meter QRP Transceiver.

The Conclusive Choice

2- Intuitively grasp changes in the strength of the signals

3DSS (3-Dimensional Spectrum Stream)

Having an informative Waterfall display is one of the advantages of SDR technology. The FTDX101 utilizes our sensational newly developed 3DSS (3-Dimensional Spectrum Stream) system in addition to a conventional Waterfall display that flows from the top to the bottom.

The 3DSS display is a remarkable completely new system that displays the constantly changing band conditions in three dimensions (3-D) with the frequency as the horizontal axis (X axis), the signal strength as the vertical axis (Y axis), and the time axis as the Z axis. The operator can effectively view the constant changes in a signal's strength as the signal flows to the back of the screen giving you a sensation of traveling in Time Space.

The 3DSS exhibits a colorful easily viewed presentation that contains the outputs from both the Narrow band SDR and the Direct sampling SDR within one common screen. The display color of each SDR output can be selected to please the eye of each individual FTDX101 user. The operator can effectively see the close-in QRM situation from the Narrow band SDR output while at the same time easily observe activity across the whole band from the Direct sampling SDR output – On the same screen at the same time.

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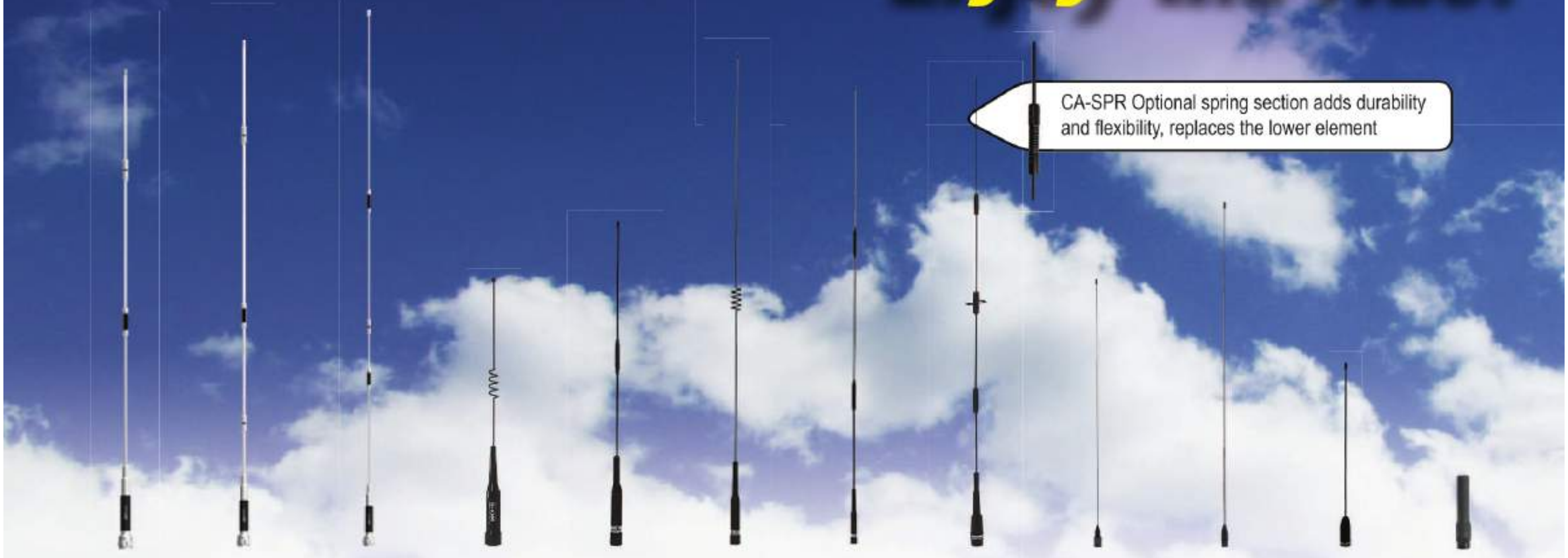

❶ ❷ ❸ ❹ ❺ ❻ ❼ ❽ ❾ ❿ ⓫ ⓬

NEW! SMA-female connector versions

Mobile Antennas

❶ C★MET 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 C★MET 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 C★MET CSB-790A DUAL-BAND 2M/440MHz w/FOLD-OVER
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❹ C★MET 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 C★MET SBB-2/SBB-2NMO DUAL-BAND 2M/440MHz
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❻ C★MET 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

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Contents

April 2019 ♦ Volume 103 ♦ Number 4

Includes video
Includes audio
Additional content

Columns

Departments

Our Cover

John Small, W2VP, wanted to retire with the Amateur Radio antennas of his dreams, so he installed this 150-foot rotating tower at his home in Byron, Georgia, which graces the cover of *QST*'s annual Antenna issue. His labor of love took nearly a year to design and build. The tower supports a four-element 40-meter Yagi antenna, three triband Yagis for 20, 15, and 10 meters, two Yagis for 17/12 meters, and a 6-meter Yagi. All antennas were designed and built by JK Antennas. [John Small, W2VP, photo]

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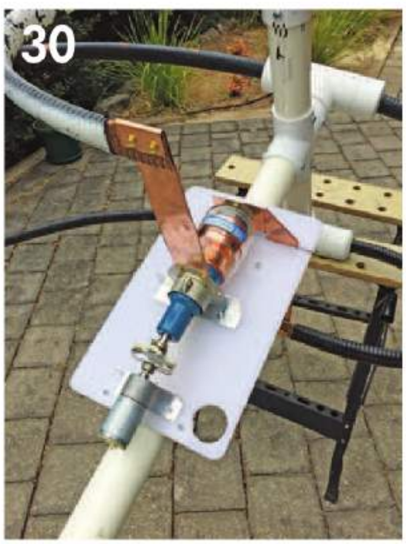

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X510HD (3 Section)	2m/70cm	17.2	330/250	UHF or N
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X200A (2 Section)	2m/70cm	8.3	200	UHF
X50A (1 Section)	2m/70cm	5.6	200	UHF or N
X30A (1 Section)	2m/70cm	4.5	150	UHF
Monoband Base Station/Repeater 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
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NR22L	2m	96.8 in.	100	UHF
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Howard E. Michel, WB2ITX, ARRL Chief Executive Officer, hmichel@arrl.org

Second Century

The IARU and You

April 18 is World Amateur Radio Day. The International Amateur Radio Union (IARU) has selected the observance's theme for 2019: "Celebrating Amateur Radio's Contribution to Society." Some of you may ask, "What is the IARU, and why should I care?"

The International Amateur Radio Union is a federation of national Amateur Radio associations, founded on April 18, 1925 in Paris with representatives from an initial 25 countries. ARRL is the International Secretariat for the IARU, and also represents the United States in the IARU. The International Telecommunication Union (ITU), which is the United Nations specialized agency for information and communication technologies (ICTs), has recognized the IARU as representing the worldwide interests of Amateur Radio.

The ITU has three main areas of activity called sectors: radiocommunications, standardization, and development. Working through these sectors, ITU allocates global radio spectrum and satellite orbits, develops the technical standards that ensure that networks and technologies seamlessly interconnect, and "strives to improve access to ICTs to underserved communities worldwide." Directly relevant to Amateur Radio, ITU-R, the ITU's "Radiocommunications Sector," coordinates the international management of the radio-frequency spectrum.

The IARU works through the ITU. According to its constitution, the IARU's "objectives shall be the protection, promotion, and advancement of the Amateur and Amateur-Satellite Services within the framework of regulations established by the International Telecommunication Union, and to provide support to Member-Societies in the pursuit of these objectives at the national level…"

Protecting and Expanding Access to Spectrum

Since its founding in 1925, the IARU has fought to protect and expand Amateur Radio spectrum privileges worldwide, in frequency bands strategically located throughout the radio spectrum. In the 1927 International Radiotelegraph Conference in Washington, DC, Amateur Radio gained the allocations still recognized today — 160, 80, 40, 20, and 10 meters. That conference was chaired by Herbert Hoover, who was US Secretary of Commerce at the time, and had participants from 80 countries.

ITU's world radiocommunication conferences (WRC) are held every 3 to 4 years to review, and, if necessary, revise the international treaty governing the use of the radio-frequency spectrum. The next world radiocommunication conference, WRC-19, will happen this fall in Egypt. ARRL and IARU have been preparing for this conference, and to protect Amateur Radio spectrum.

Because of this critically important service that IARU provides, it has grown to include 160 member-societies in three regions. These regions are organized to roughly mirror the structure of the ITU and its related regional telecommunications organizations. IARU Region 1 includes Europe, Africa, the Middle East, and Northern Asia. Region 2 covers the Americas, and Region 3 comprises Australia, New Zealand, the Pacific island nations, and most of Asia.

According to the IARU, there are about 3 million hams worldwide. There are about 700,000 hams in the US. ARRL has about 157,000 members.

Tell the World About Amateur Radio

What are you doing to celebrate World Amateur Radio Day? What are you doing to celebrate Amateur Radio's contributions to society? Visit **www.iaru.org/world-amateur-radio-day.html** to see what your fellow hams around the world are doing this year.

I have given a challenge to ARRL staff. April 18, 2020 will be the 95th anniversary of the founding of the IARU. Let's create a worldwide event — a non-competitive "contest" — to publicize Amateur Radio. I can imagine an operation similar to ARRL Field Day. Clubs or *ad hoc* teams operate from schools, shopping centers, parks, or other highly visible locations. Stations get multipliers for social criteria, like having someone under the age of 20 make a contact. Let's have multipliers for press coverage, both in traditional media and on social media, and the number of placements or "likes" received. And another multiplier for demonstrating all aspects of Amateur Radio — contesting, DXing, emergency communications, homebrew equipment, and more — at your event. The goal of the contest is not to make as many contacts as possible, but to make the biggest impact enticing the next generation of hams into Amateur Radio.

These details are only my suggestions. As always, I invite your comments to me at **wb2itx@arrl.org.** Let's take advantage of this event to show the world what Amateur Radio is!

Howard E Michel WB2ITX

Member Spotlight

Richard Factor, WA2IKL

Richard Factor, WA2IKL, has had a ham license for more than 50% of the time that radio has been in existence. He was first licensed in 1959, and has retained his original call sign, despite upgrading to Amateur Extra while a high school student in New York City.


Richard Factor, WA2IKL.

Richard bought gear on New York's famous "Radio Row," built Heathkits, and also designed and built equipment of his own. Not having access to power tools, Richard, with true ham ingenuity, made do with hammers and screwdrivers.

"I built a RTTY modem," Richard recalled. "I told my mom I was sick, stayed home from school, and built a tube demodulator. It's amazing I didn't kill myself."

Beginning a Business

These early experiences led to Richard's career in designing and selling recording equipment that's been used by everybody from Aerosmith to Emerson, Lake & Palmer. It began when Richard and friends Kenny Schaffer (now N2KS) and Steve Katz (ex-WA2RBX) were building a recording studio.

"At another studio, Steve had a very tiny control room, and needed to run a tape machine, but there was no room for an assistant," Richard said. To solve the problem, he built a locator that automatically rewound to a specific spot. They ended up selling the device to Ampex, which made big multitrack recorders. "Suddenly, we had a product and we had a business," Richard said.

They brainstormed other products and brought them to Audio Engineering Society conventions in the 1970s, when music recording and production was undergoing great change. Digital was taking hold, and integrated circuits were brand new. A product that Richard and his partners called the "Instant Phaser" became the foundation of their company, Eventide. Until that point, phasing required an engineer to manipulate reel-to-reel tape by hand. The Instant Phaser changed all of that.

Another product — a digital delay line that slowed down audio and created effects — practically sold itself when Richard lent it to recording studios. When it was time for the studio to give the delay back, they didn't want to. Sales were made, and Eventide continued to develop the product over the years.

An Eventide product called the Harmonizer® — designed by Tony Agnello — could change pitch, which was a revolutionary achievement. Eventide moved from New York City to Little Ferry, New Jersey, in 1984, and the company's success continued. "I don't remember the 1990s at all, I was so busy," Richard remarked.

DXCC and GRAMMY Honors

During Eventide's early years in New York City, Richard built a Heathkit SB-104 and used it with a vertical at the office. When the company moved to New Jersey, he put up towers and resumed what he calls his "DXing career." He'd earned DXCC back in the 1960s, but his New Jersey station enabled him to make it to the top of the DXCC Honor Roll. "With the exception of North Korea," he laughed.

For the past several years, Richard has lived in Sedona, Arizona. He's still involved with Eventide, and he's on the air — mostly chasing DX, but occasionally for a ragchew or to hop into a contest for a few hours.

Eventide, which is coming up on its 50th anniversary, has been so successful that its innovations earned Richard and Tony Agnello a 2018 Technical GRAMMY Award, which, according to the Recording Academy's website, goes to "individuals who have dramatically pushed boundaries and made groundbreaking, important, outstanding, and influential contributions of technical excellence and innovation to the recording field throughout their lifetimes."

When asked what he received the Technical GRAMMY for, Richard said, "We were very early pioneers in digital equipment, and our fingerprints are all over most canonical records after the Beatles — David Bowie, Led Zeppelin. Almost every major recording studio in the US and UK had Eventide equipment."

When one considers that past winners of the Technical GRAMMY include Ray Dolby (1995), Les Paul (2001), Apple Computer (2002), Phil Ramone (2005), Yamaha (2007), and Thomas Alva Edison (2010), it's easy to understand the magnitude of Richard's contribution to the recording industry.

Richard and Tony attended the main GRAMMY ceremony in January 2018, and received their award at a July 2018 ceremony. Richard describes the feeling of winning a GRAMMY as "some part amazement at the unexpected honor, and some part 'let's get back to work, there's a lot to be done.'"

Keep an ear out for this industrious ham on the 40 – 10 meter bands.

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"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.

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

First Vice President
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13457 Sixth St. N., Stillwater, MN 55082
(651-436-8811); **k0gw@arrl.org**

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18655 Sheffield Rd.
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1925 Bidwell St., West St. Paul, MN 55118
(651-238-4444); **k0qb@arrl.org**

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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: Vacant

Central Division
www.central.arrl.org
Kermit Carlson, W9XA
1150 McKee St., Batavia, IL 60510
(630-879-0983); **w9xa@arrl.org**

Vice Director: **Carl Luetzelschwab, K9LA**
1227 Pion Rd., Fort Wayne, IN 46845
(260-637-6988); **k9la@arrl.org**

Dakota Division
www.arrldakota.org
Matt Holden, K0BBC
8161 33rd Ave. S., Unit 706
Bloomington, MN 55425
(952-232-1984); **k0bbc@arrl.org**

Vice Director: **Lynn Nelson, W0ND**
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
(615-333-9859); **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: **Thomas Delaney, W8WTD**
4632 Glenway Ave., Cincinnati, OH 45238
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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
Rod Blocksome, K0DAS
690 Eastview Dr., Robins, IA 52328-9768
(319-393-8022); **k0das@arrl.org**

Vice Director: **Art Zygielbaum, K0AIZ**
6601 Pinecrest Dr., Lincoln, NE 68516
(402-421-0839); **k0aiz@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
Fred Hopengarten, K1VR*
6 Willarch Rd., Lincoln, MA 01773
(781-259-0088); **k1vr@arrl.org**

Vice Director: **Mike Raisbeck, K1TWF**
85 High St., Chelmsford, MA 01824
(978-250-1235); **k1twf@arrl.org**

Northwestern Division
www.arrl.nwdiv.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
www.pdarrl.org
Jim Tiemstra, K6JAT*
13450 Skyline Blvd., Oakland, CA 94619
(510-569-6963); **k6jat@arrl.org**

Vice Director: **Kristen McIntyre, K6WX**
40711 Witherspoon Ter., Fremont, CA 94538
(510-703-4942); **k6wx@arrl.org**

Roanoke Division
arrl-roanoke.com
George W. "Bud" Hippisley, W2RU*
981 Circle Creek Rd., Penhook, VA 24137
(540-576-2527); **w2ru@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, K0RM
9975 Wadsworth Pkwy. K2-275
Westminster, CO 80021
(303-432-2886); **k0rm@arrl.org**

Vice Director: **Robert Wareham, N0ESQ**
300 Plaza Dr., Suite 200
Highlands Ranch, CO 80129
(720-592-0394); **n0esq@arrl.org**

Southeastern Division
www.facebook.com/ ARRLSoutheasternDivision
Greg Sarratt, W4OZK
321 Dupree Dr., Huntsville, AL 35806
(256-337-3636); **gsarratt@arrl.org**

Vice Director: **Joseph Tiritilli, N4ZUW**
4116 NW 1st St., Deerfield Beach, FL 33442-8033 (954-296-4234); **n4zuw@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: **Ned Stearns, AA7A**
7038 East Aster Dr., Scottsdale, AZ 85254
(480-948-5080); **aa7a@arrl.org**

West Gulf Division
arrlwgd.org
John Robert Stratton, N5AUS*
P.O. Box 2232, Austin, TX 78768-2232
(512-445-6262); **n5aus@n5aus.com**

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Delaware: Bill Duveneck, KB3KYH, 18682 Sunny Sky Blvd., Milton, DE 19968-2486 (302-537-4755); **kb3kyh@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: Ron Morgan, AD9I, 114 Herman St., East Peoria, IL 61611-4420 (309-397-9549); **ad9i@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: Richard H. "Skip" Jackson, KS0J, 1835-63rd St. E, Inver Grove Heights, MN 55077 (651-260-4330); **ks0j@arrl.org**

North Dakota: Nancy Yoshida, KG0YL, 1079 Harvest Ln. NE, Thompson, ND 58278-9408 (218-779-6596); **kg0yl@arrl.org**

South Dakota: Chris Stallkamp, KI0D, P.O. Box 271, Selby, SD 57472-0271 (605-870-1784); **ki0d@arrl.org**

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Arkansas: James D. Ferguson, Jr., N5LKE, 1500 Lauren Dr., Searcy, AR 72143-8477 (501-593-5695); **n5lke@arrl.org**

Louisiana: John Mark Robertson, K5JMR, 201 Madewood Ct., Bossier City, LA 71111-6325 (318-572-7917); **k5jmr@arrl.org**

Mississippi: Malcolm Keown, W5XX, 64 Lake Cir. Dr., Vicksburg, MS 39180 (601-636-0827); **w5xx@arrl.org**

Tennessee: Keith E. Miller Sr., N9DGK, 1635 Jarratt Dr., Rockvale, TN 37135 (615-631-9952); **n9dgk@arrl.org**

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Michigan: Jim Kvochick, K8JK, 10366 Greystone Ct., Brighton, MI 48114-7650 (810-229-5085); **k8jk@arrl.org**

Ohio: Scott D. Yonally, N8SY, 258 Valley Hi Dr., Mansfield, OH 44904-9792 (419-512-4445); **n8sy@arrl.org**

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NYC-Long Island: Jim Mezey, W2KFV, 38 Appletree Ln., Carle Place, NY 11514-1336 (516-315-8608); **w2kfv@arrl.org**

Northern New Jersey: Rob Roschewsk, KA2PBT, 104 Buckhorn Dr., Washington, NJ 07882 (908-916-2570); **ka2pbt@arrl.org**

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Iowa: Robert McCaffrey, K0CY, 1210 Noble Hills Pl., Boone, IA 50036 (515-432-2512); **k0cy@arrl.org**

Kansas: Ronald D. Cowan, KB0DTI, P.O. Box 36, LaCygne, KS 66040 (913-757-3758); **kb0dti@arrl.org**

Missouri: Cecil Higgins, AC0HA, 27995 County Rd. 220, Hermitage, MO 65668-8493 (417-399-5027); **ac0ha@arrl.org**

Nebraska: Matthew N. Anderson, KA0BOJ, 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: Bill Crowley, K1NIT, 150 Maple St., Farmingdale, ME 04344-4809 (207-623-9075); **k1nit@arrl.org**

New Hampshire: Peter Stohrer, K1PJS, 9 Gladstone St., Concord, NH 03301 (603-715-9539); **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: Ray Hollenbeck, KL1IL, 1457 Pioneer Peak Dr., Wasilla, AK 99654 (907-373-6771); **kl1il@arrl.org**

Eastern Washington: Jack Tiley, AD7FO, 1806 S. Fawn Dr., Spokane Valley, WA 99206-3318 (509-951-7214); **ad7fo@arrl.org**

Idaho: Dan Marler, K7REX, 6525 W. Fairfield Ave., Boise, ID 83709 (208-914-8939); **k7rex@arrl.org**

Montana: George Forsyth, AA7GS, 212 Skyline Dr. NE, Great Falls, MT 59404 (406-868-2212); **aa7gs@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, AF7PQ, P.O. Box 3008, Silverdale, WA 98383 (360-633-7665); **af7pq@arrl.org**

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

East Bay: Jim Siemons, W6LK, 2308 Lomond Ln., Walnut Creek, CA 94598-3705 (925-330-0049); **w6lk@arrl.org**

Nevada: John Bigley, N7UR, 2420 Palora Ave., Las Vegas, NV 89121-2157 (702-673-0904); **n7ur@arrl.org**

Pacific: Joe Speroni, AH0A, 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 (916-879-7449); **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: Dan Pruitt, AE6SX, 4834 N. Diana St., Fresno, CA 93726 (559-779-2974); **ae6sx@arrl.org**

Santa Clara Valley: Brandon Bianchi, NI6C, P.O. Box 60128, Palo Alto, CA 94306 (559-313-3373); **ni6c@arrl.org**

Roanoke Division (NC, SC, VA, WV)

North Carolina: Karl Bowman, W4CHX, 5509 Shimer Farm Ln., Raleigh, NC 27614-6301 (919-669-6068); **w4chx@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: Jack Ciaccia, WM0G, P.O. Box 21362, Boulder, CO 80308-4362 (303-587-0993); **wm0g@arrl.org**

New Mexico: Bill Mader, K8TE, 4701 Sombrerete Rd. SE, Rio Rancho, NM 87124 (505-250-8570); **k8te@arrl.org**

Utah: Mel Parkes, NM7P, 2166 E. 2100 North, Layton, UT 84040 (801-547-1753) **nm7p@arrl.org**

Wyoming: Rick Breininger, N1TEK, 11 E. 2nd North St., Green River, WY 82935 (307-707-4010); **n1tek@arrl.org**

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

Alabama: JVann Martin, W4JVM, 16 Baron Dr., Chelsea, AL 35043-6607 (205-281-4728); **w4jvm@arrl.org**

Georgia: David Benoist, AG4ZR, 190 Fox Hall Crossing East, Senoia, GA 30276 (404-290-0470); **ag4zr@arrl.org**

Northern Florida: Kevin J. Bess, KK4BFN, 908 Flagler Ave., Edgewater, FL 32132-2124 (386-547-2838); **kk4bfn@arrl.org**

Puerto Rico: Oscar Resto, KP4RF, HC 77 Box 8743, Vega Alta, PR 00692-9660 (787-883-6878); **kp4rf@arrl.org**

Southern Florida: Barry M. Porter, KB1PA, 13908 Via Nidia, Delray Beach, FL 33446 (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: Darrell Davis, KT4WX, 6350 Mills Rd., Fort Meade, FL 33841 (863-245-9923); **kt4wx@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: Carl Gardenias, WU6D, 20902 Gardenias St., Perris, CA 92570 (951-490-2270); **wu6d@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: Jay T. Urish, W5GM, 1065 Overland Dr., Lowry Crossing, TX 75069-4727 (972-965-6229); **w5gm@arrl.org**

Oklahoma: Kevin O'Dell, N0IRW, 1718 South Fairgrounds, Stillwater, OK 74074 (580-220-9062); **n0irw@arrl.org**

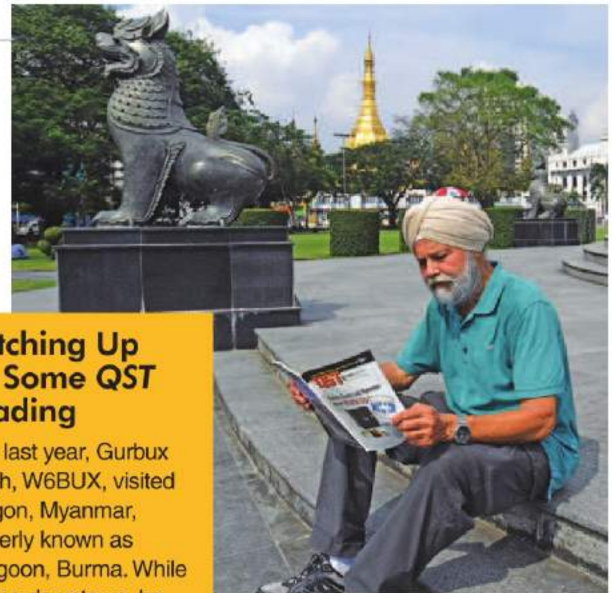
South Texas: Paul Gilbert, KE5ZW, 1209 Doris Ln., Cedar Park, TX 78613-7067 (512-468-0792); **ke5zw@arrl.org**

West Texas: H. Dale Durham, W5WI, P.O. Box 375, Buffalo Gap, TX 79508 (830-719-9000); **w5wi@arrl.org**

Up Front

Elevated Radio

Tim Carter, W3ATB, and Jim Cluett, W1PID, did a Parks on the Air activation at Ellacoya State Park beach in central New Hampshire along the shore of Lake Winnipesaukee. Jim took his rig to "new heights" as he reeled in the contacts. [Tim, W3ATB, photo]



Catching Up on Some *QST* Reading

Late last year, Gurbux Singh, W6BUX, visited Yangon, Myanmar, formerly known as Rangoon, Burma. While touring downtown, he decided to relax with a copy of the November 2018 issue of *QST*. The photo was taken in the Independence Square with the famous Sule Pagoda in the background.

If the Shoe Fits…

Dave Newman, W2JFY, spotted these shoes during a visit to Venice, Italy. As Dave said, "I've never worked W6YZ, but I like his shoes!"

While there is indeed a W6YZ (Bob Treseder in North Salt Lake City, Utah), the call sign and the shoes are not related. W6YZ is a shoe brand marketed by the Italian company Wizz, LLC. The letter "W" stands for the first name of the designer, Walter Van Beirendonck, and the numeral 6 represents "the Antwerp Six," a group of designers he attended college with in Antwerp, Belgium. According to Beirendonck, "…Y stands for young and Z is for zany, crazy. It's the final letter of the alphabet, but the start of something new."

Breakfast Ham(s)

This group of amateurs in Orland Park, Illinois, claims to have one of the longest-running breakfast meetings in the country. They've been meeting for breakfast since 1988! Late last year they had the good fortune of hosting Luca Della Giovampaola, IW0DJB, who is the trustee of the Vatican City station HV5PUL. Shown from left to right: Chuck Krezwick, WV9C; Mike Freitag, W9GYC; Luca Della Giovampaola, IW0DJB; Al Szoldatits, K9MDW; Tom Palmisano, W9AEB; Gerry Klotz, KB9PKI; Bill Will, WW9WW; Barry Cohen, N2BJ, and Bill "Jake" Jacobowski, KC9FJN.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Letters from Our Members

Complete ESD Protection

I wanted to say that the article, "Protecting Shack Equipment from Electrostatic Discharge," by Dino Papas, KL0S, in the January 2019 issue of *QST* was a great start for most amateurs.

As an electromagnetic interference and compatibility engineer, I deal with this a lot, and I often perform audits of our production facilities to ensure that there are no potential electrostatic discharge (ESD) issues that might cause latent product failures.

While Dino's personal protection and touch-off concept is good, the overall workbench could be approved on even more. In the photo, I saw a large amount of plastic and wood items directly on the work surface — all of these non-conductive items can still build up a charge, even on an ESD mat. The nested plastic containers will build up a charge as they are separated. While I cannot begin to guess if that charge is enough to damage a component, it is a risk. The same is true of the bins on the side of the bench.

Just to illustrate why these items caught my attention, simply opening a poly three-ring binder with papers in it can generate 10,000 V. Of course, this depends on humidity and a host of other environmental concerns, but I would hate for someone to mistakenly believe they are fully ESD-protected and still damage equipment. As a rule of thumb in the defense industry, we keep a 1-meter standoff distance between an active ESD workstation (where exposed circuit cards are in work) and any non-conductive and non-ESD-safe materials. Additionally, chairs must have arms removed, and the operator must wear an ESD protective smock. This might be a bit excessive for the normal radio amateur, but it depends on what they're digging into. I certainly wouldn't open up an Icom 7300 without some level of protection!

Ken Cechura, KC9UMR
Fenton, Missouri

Radio on the Rails

As soon as I saw the "Radio on the Rails" article by Steve Ford, WB8IMY, in the February 2019 issue of *QST*, I knew I had to share the story of how I got into ham radio.

I have been a rail fan since I was a child. In 1994, I had some extra money and decided to buy a scanner so I could listen to trains, but I was also aware of how many various states, counties, and municipalities had laws outlawing portable scanners.

Fortunately, I had a friend at work who was a ham. He told me that if I got a ham radio license, I could legally use a handheld transceiver as a scanner as long as it had ham radio frequencies on it. I researched and found out that it was true; FCC rules preempt state and local laws. I signed up for a Technician licensing class at the Skyview Radio Society, and in 1994, I got my license and bought a used Icom IC-2GAT (which I still have). But along the way, I also found out how much fun Amateur Radio is and how helpful and friendly hams are.

Joseph J. Birsa, N3TTE
Pittsburgh, Pennsylvania

Offline Operation

Steve Ford's "Eclectic Technology" column in the December 2018 issue of *QST* gives a good understanding of "The Importance of Time" while operating WSJT modes, but it makes the basic assumption that you have internet service. I can give several scenarios where this is not the case, like camping in the Ozarks, where you lack internet service and most likely lack cell service, too.

With the release of *WSJT 2.0*, which allows the use of FT8 on field days, it becomes imperative that a source for a time standard be available. The global position system (GPS) is a great solution to this problem. For under $50, you can use a GPS receiver to sync your computer clock to well within 1 second of accuracy. I currently have two different setups: one using an Icom IC706 and computer running Windows 7, and another with an IC7300 and a computer running Windows 10. Each needs a slightly different software package because of the different GPS receiver.

First, you need a generic USB GPS receiver, which are available on Amazon for about $20. Most common generic GPS receivers are based in the U-BLOX chipset. I use a software package developed by Monte Varakojis, KE6GQO, whose website has all the information needed to set up your computer for GPS sync at **www.visualgps.net**. There are other packages, but I have found this to be an easy setup, and if you run into any problems, you can email Monte and receive an immediate reply.

Al Nessel, K1GTK
Eureka, Missouri

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

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A High-Power 160- and 80-Meter Transmitting Loop Antenna

Steve Adler, VK5SFA

My journey building a transmitting magnetic loop antenna began in late 2015 after I decided to have a 160-meter, DX-capable antenna that I could install within my suburban block. There were many challenges to overcome, including space and radio frequency interference from the neighbors. Considering these issues, the idea to revisit the concept of a transmitting magnetic loop antenna was born.

I chose a magnetic loop primarily because it was physically small (able to fit into a 13-foot square footprint area of the backyard) and relatively immune to local E-field interference from within the near field. It can also radiate a reasonable amount of RF power between 20° and 45° elevation for DX operation, all while supporting near vertical incidence sky-wave radiation for short- to medium-distance communications.

Designing a practical loop that could achieve all these important requirements, including my desire to operate at full legal power (in Australia, that's 400 W PEP output) had its challenges. [At high power levels, RF exposure compliance distance should be carefully evaluated on all three axes. For examples see, "RF Exposure Compliance Distances for Transmitting Loops, and Transmitting Loop Current (Technical Correspondence)," *QST*, May 2017, pp. 64 – 65. Compliance distances can be calculated using *4NEC2*, but be sure to evaluate both the *total* H- and *total* E-fields. — K. Siwiak, KE4PT, for the ARRL RF Safety Committee.] Undaunted, I set about systematically approaching and overcoming each of the design challenges, with the satisfying result of a successful low-band antenna.

This compact loop was the first-place winner in the 2018 *QST* Antenna Design Competition.

The Design Phase

A small magnetic loop antenna is defined as having a circumference of approximately 1⁄10 of a wavelength. This equates to approximately 54 feet on the 160-meter band. Using this circumference, the diameter of the loop would be approximately 17 feet. On the surface, this poses considerable mechanical challenges. After hearing about this project, Gus, KB0YH, wrote suggesting that there can be some flexibility in dimensions for a transmitting loop.

Ultimately, it was decided that this size was too large to be easily realizable, particularly given the need to have a nonmetallic supporting structure.

The Two-Turn Loop

I decided to make a two-turn loop, approximately 10 feet in diameter. This had several benefits; the structure would be far more manageable in size and the self-inductance of the loop quadruples the capacitance required to bring it into resonance, resulting in a less expensive and more easily obtainable vacuum variable capacitor.

The efficiency would also increase slightly because the overall circumference is now approximately 15% of a wavelength. The additional turn in the loop would help offset the loss in radiation resistance brought about by the smaller diameter.

The radiation resistance quadruples while the RF loss resistance merely doubles. On this point, it's worth noting that the efficiency-reducing loss resistance is directly proportional to the loop circumference. Meanwhile, the radiation resistance is proportional to the square of the loop area or the fourth power of the circumference. What this means is, although the smaller resulting diameter substantially reduces the radiation resistance, the additional turn then increases it by a useful factor of four, clawing back about half of what was lost due to the loop area reduction.

Ultimately, a successful practical loop antenna design is all about attaining the oftentimes elusive sweet spot of maximizing the radiation resistance and simultaneously minimizing loss resistance to maximize antenna efficiency. In this design, this important objective is achieved on 160 meters as it is on 80 meters, where the antenna efficiency becomes impressively high due to the rapid rise in radiation resistance.

In addition, on the lower-frequency 160-meter band, one must be careful to not attain such a high Q factor that the resultant SWR bandwidth becomes too narrow to pass an SSB signal. The two-turn design, once realized, achieves a useable bandwidth of 4 kHz on 160 meters, more than enough for SSB transmission, demonstrating that the antenna is indeed practical for most activity on the 160-meter band (except perhaps double-sideband AM).

Modeling

Before setting out to construct the antenna, the first step was to model its performance. Special thanks must be given to Paul Lawson, VK5SL, for his skills with *4NEC2*. Paul produced the model used to assess the antenna's capabilities.

From the modeling, it became clear that the antenna would meet most of the objectives set for the project. The antenna pattern showed very usable radiation at angles as low as 30° above the horizon with respect to an isotropic radiator, only 3 dB down. To obtain equivalent performance from a half-wave dipole it must be mounted at least a quarter of a wavelength off the ground — that's 133 feet!

The modeling also revealed some of the other challenges the design would face. At 400 W, the circulating currents would reach 87 A. Careful attention would need to be paid to how the antenna was constructed, both mechanically as well as electrically, if the high-performance vision were to be realized.

The other physical aspect determined from modeling was the directionality the loop would provide, making it clear that it needed to be rotatable to be effective. This was an added advantage, as it assisted further with noise reduction. Physically, it would lead to some challenges with mechanical stability once installed that needed to be addressed, as will be discussed later in the article.

Materials and Assembly

Now that the theory had been reviewed, it was time to gather the required hardware and commence assembly. One of the design objectives was to source as many of the parts from the local hardware store as possible. The design also had to be assembled using only common hand tools that the average amateur would have at hand. This drove a number of the material selections throughout the design.

Loop Material

One of the first things considered was what to make the primary loop element out of. Here is where I had a stroke of genius. I identified that the material needed to be lightweight, preferably insulated (to prevent corrosion), and semi-rigid. After giving it some thought, I identified that 7 GHz Heliax™ waveguide fulfilled all of these requirements perfectly. It has a solid-copper, corrugated outer

Table 1
Bill of Materials

Item	Quantity
12 V dc motor and 10:1 reduction gearbox	1
7 GHz waveguide or LDF550 coaxial cable	76 feet
Antenna rotator	1
Copper strap, 2 inches wide by 1⁄10 inch thick	40 inches
Connector for rigid coax, L44N for LDF450	1
Coaxial cable, rigid ½-inch diameter, LDF450, Heliax or equivalent	10 feet
Hardwood pole, 1.6 inches square	13.1 feet
Nylon mounting board, 10 × 16 inches	1
Pop rivets	As needed
Power cable, dc	As needed
Pulse width modulation dc motor controller	1
PVC cross fittings, 2-inch diameter	4
PVC end caps, 2-inch diameter	19
PVC pressure pipe, 2-inch diameter, 12 inches long	8
PVC pressure pipe, 2-inch diameter, 20 inches long	1
PVC pressure pipe, 2-inch diameter, 60 inches long	4
PVC pressure pipe, 2-inch diameter, 7 inches long	1
PVC saddles, 2-inch diameter	2
PVC T fittings, 2-inch diameter	8
Quick-set cement	90 – 120 pounds
RF suppression toroids or beads	5
RG-58 N connector, male	2
RG-58CU coaxial cable	7 feet
Rotator cable	as needed
Self-tapping screws	100
Steel pole, 2-inch diameter	10 feet
Toroid core, 3.5-inch diameter, type 43 75 mix	1
Vacuum variable capacitor ceramic coupling	1
Vacuum variable capacitor mounting hardware	1 set
Vacuum variable capacitor, 25 to 500 pF, 15 kV	1
Plastic water container, 5 gallons	1

conductor that is protected by a polyethylene sheath and is relatively flexible. However, unlike coaxial cable, it has nothing inside it but air. This makes it very lightweight, while still providing the required conductor cross-sectional surface area for good skin effect to support the high RF current flow. The waveguide used in this project weighed in at less than ½ pound per foot.

If you can't obtain Heliax waveguide, a somewhat heavier alternative is to use ⅞-inch or even ½-inch coaxial cable similar to Andrew type LDF5-50, LDF4-50, or equivalents. While you are not interested in the inner conductor in this design, either type of feed line will provide enough surface area with their outer solid-copper jackets to work effectively in this type of antenna.

Tuning Capacitor

The next key element is the tuning capacitor. A transmitting magnetic loop antenna needs to be brought into resonance to work. This is done by connecting a capacitor in parallel with the loop inductor. I selected a Jennings 25 – 500 pF variable vacuum capacitor rated at 15 kV (see Figure 1). This is a high enough voltage rating to handle at least 400 W PEP of input power. (A single turn loop would have required a 750 – 1,000 pF unit, costing more than twice the price).

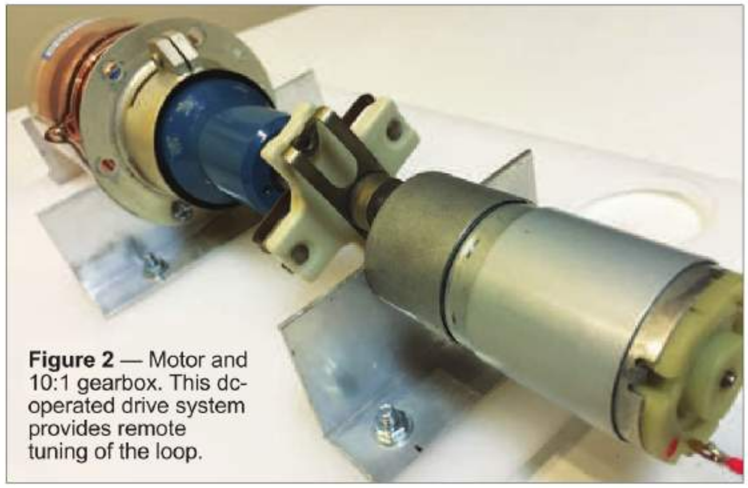


Figure 2 — Motor and 10:1 gearbox. This dc-operated drive system provides remote tuning of the loop.

Remote Tuning Mechanism

The introduction of the tuning capacitor presents the next challenge of how to tune it from the operating position. When using high power, there are very high voltages and currents resulting in high energy circulating in the antenna, so it is not feasible to tune it by hand. Some form of remote-control drive system is required to make the antenna practical to use.

This was achieved by using an inexpensive dc motor coupled to a 10:1 reduction gearbox and a reversible pulse-width modulation (PWM) dc motor controller (see Figure 2). Both items were purchased from an online auction seller for a very modest cost. Many people use stepper motors for the purpose, but this simple system is also very effective, bringing the tuning rate down to 1 pF per second — the perfect speed to tune such a narrow-bandwidth antenna.

A ceramic insulator drive coupler should be used to isolate the RF from the dc motor. The capacitor, motor, and drive coupler can then be mounted to a nylon board (a kitchen cutting board makes a good source) using some suitably sized angle aluminum. Exact dimensions for how to do this will vary depending on the mechanical size of the vacuum capacitor you obtain.

Figure 1 — Jennings 25 – 500 pF variable vacuum capacitor used to tune the loop to resonance.

Test-fitting the waveguide to the support frame will expose any issues.

Supporting Frame

Next, it is time to consider the construction of the supporting frame. As the coax loops must be supported by nonmetallic materials, it is important to carefully consider what to make the frame from. Ideally, the frame will be strong, reasonably lightweight, and easy to procure.

My solution was to use 2-inch, high-pressure PVC water pipe and the associated fittings. The four-way cross pieces, the T pieces, and end-cap fittings were purchased from a specialist irrigation parts supplier, while the PVC pressure pipe was purchased from a local hardware store.

To assemble the main frame, start by building the hub and four 5-foot supports. Then thread an 11.2-foot hardwood timber pole through the main vertical support to add stiffness to the structure without adding too much weight. My pole was 1.6 inches square, but your timber may be of a somewhat different size (see Figure 3).

Once the spokes are attached, add a T-piece to the end of each spoke, and then two 11.8-inch lengths of PVC pipe, one on each side of the T-piece. Add two more T-pieces to the ends of the 11.8-inch pipes, which will then become the guides for the Heliax cable.

Next, make sure every joint is bolted or riveted together as shown in Figure 4. Don't just rely on PVC pipe glue because the weight of the finished antenna is enough to lead to long-term failures if glue alone is used. Once that is complete, you are ready to assemble, and test fit it to your rotator. Figure 5 shows the mechanical details of the support frame construction.

The next step is to test-fit the waveguide. You will need approximately 76 feet to construct the loop and to leave enough material for the connections to the tuning capacitor.

Figure 3 — Timber insert into the main vertical support. This hardwood pole adds stiffness to the structure.

Figure 4 — A close-up look at how the joints are assembled. Riveting or screwing the joints avoids structural failure due to loss of glue integrity.

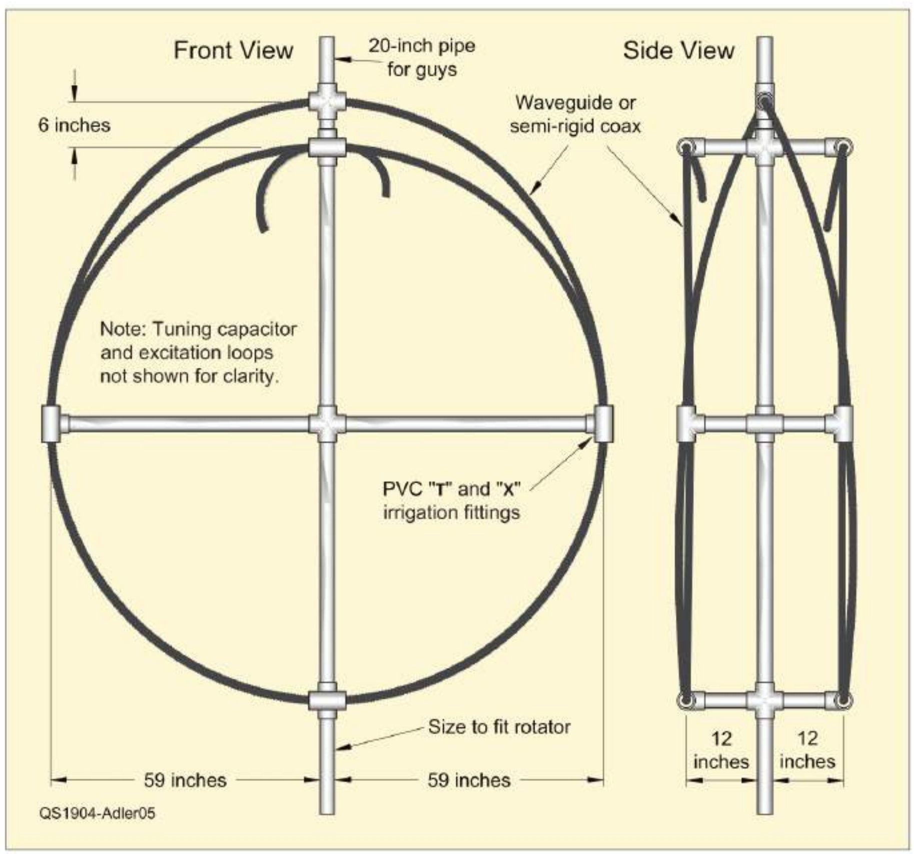
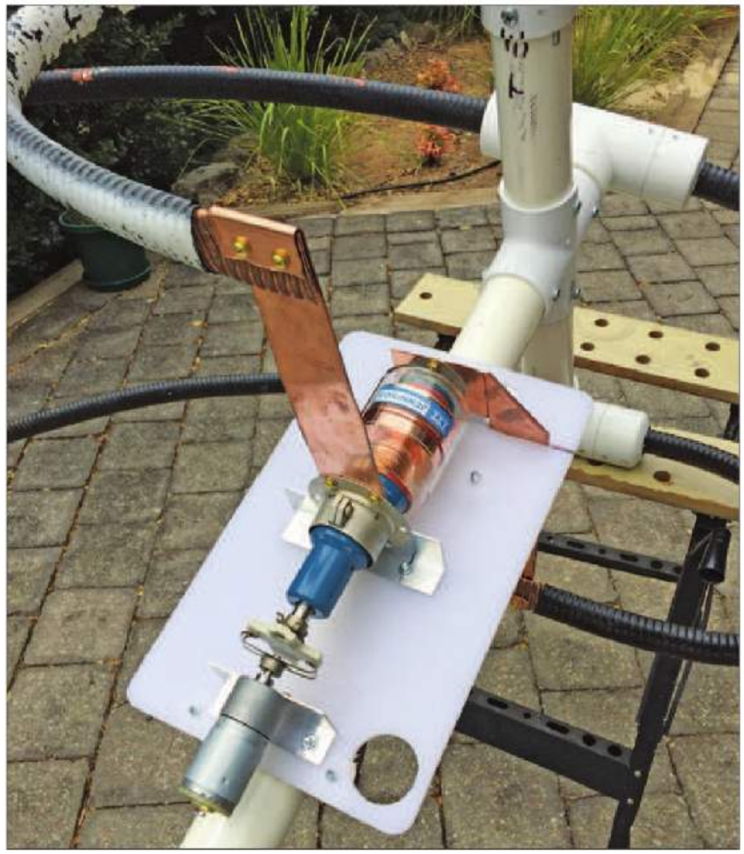


Figure 5 — Mechanical layout details for the support loop frame.

End cap and cable final assembly showing attachment method for waveguide.



The tuning assembly mounted to the frame. All joints must be welded, or otherwise low-resistance connected, to minimize resistive losses.

To secure the end caps, 2-inch lengths of the 2-inch PVC pipe are cut, and an end cap is then fitted on one end. A 1.5-inch hole is then drilled in the end of the cap through which the waveguide will be threaded. You will need 18 of these assemblies. Next, you slide these onto the waveguide at the right moments while threading the cable through the main support frame.

The end-cap system is important as it allows you, with the use of large cable ties, to secure the waveguide within the frame structure once you have completed adjustments to set the shape of the primary loop. Only secure the cable ties once everything is in place. At this point, you are ready to stand the loop up and confirm you have correctly achieved the basic layout.

Next, the vacuum variable capacitor tuning assembly is mounted to the frame and connected to the waveguide. This was achieved with 2-inch saddle clamps and a 2-inch-wide flat copper strap. Note that brass nuts and bolts must be used to connect the copper strap to the waveguide to avoid dissimilar-metal corrosion problems. However, they are not sufficient to ensure a very low resistance connection within the primary loop. Remember, dc resistance loss is the natural enemy of a transmitting magnetic loop antenna. You must also braze, weld, or silver-solder every joint to maximize the end-to-end conductivity of your construction.

Further, do not be tempted to substitute thick copper wire or braided copper strap. The large RF current circulating around the loop is conducted on the outer surface by skin effect. Large conductor surface area and low resistance of all interfacing joints associated with the high-Q resonant loop are the keys to making this antenna work properly. You may need to perform some copper "origami" to route the connections cleanly from the primary loop to the tuning capacitor.

Next, install the rain hood over the tuning mechanism. The hood was made from a plastic water container with the top cut off, and then installed upside down. Slots are cut into the side to feed the connections through to the capacitor.

Waterproof the connections from the waveguide to the capacitor using many layers of UV-resistant PVC tape. This will help protect the copper from tarnishing, which can introduce losses into the antenna.

The Secondary Loop

The next step was to construct the secondary feed loop necessary to excite the primary loop. LDF4-50

Secondary loop construction. The loop diameter should be 35.43 inches.

Heliax coaxial cable was chosen because it has a solid-copper outer conductor that has better skin effect performance than a braided outer-conductor coaxial cable, such as RG-213. Any equivalent ½-inch semi-rigid cable would also be suitable.

The sizing of the secondary loop was found to be critical. After some experimentation, a 35.4-inch diameter loop yielded the best results. This delivered a return loss of approximately 17.5 dB, or an SWR of 1.3:1.

Secondary Loop Construction

To make the secondary loop, cut a 118-inch length of the ½-inch cable and terminate one end with a suitable connector. At the other end, strip back the outer insulation, jacket, and foam inner core, exposing approximately 2 inches of the center conductor. From the end of the remaining outer jacket, measure back along the cable 111.4 inches and expose approximately 2 inches of the outer shield conductor. Next, solder the center conductor from the far end to the outer conductor where you removed the insulation. This will form the secondary loop driven element of the antenna. Next, use the UV-resistant PVC tape to waterproof the joint.

Secondary loop soldering arrangement.

Finally, use cable ties to install the secondary loop on the main antenna frame. Be aware that this is where some empirical experimentation will be required to achieve the correct coupling. A good starting point is to mount it approximately 4 inches above the plane of the primary loops by strapping it to the main vertical support frame. You can expect to have to move it up and down or change its shape to more of an oval to achieve a good SWR.

Balun Construction

A common-mode choke is required to decouple the antenna structure by stopping extraneous RF currents from flowing down the outer conductor of the transmission line and to balance the Faraday-shielded secondary feed loop. You will need a 75-mix, 3.5-inch-diameter ferrite toroid and approximately 7 feet of suitable ¼-inch flexible coaxial cable (RG-58 is suitable — do not use foam dielectric cable).

First, wind seven turns on one side of the core, then cross over and wind a further seven turns on the other side. Next, connect your dc motor drive cable to the drive controller. You must also use ferrite beads or toroids around all the other conductors as well (dc motor control cable and rotator control cable) to break them up from RF induction, otherwise they will behave like ground radials. You should do this about every 15 feet.

Final Installation

Now the moment has been reached when all the elements come together, and the antenna can be tested. To mount the loop, first dig a hole about 3 feet deep and 1 foot in diameter.

Side view of the secondary loop placement relative to the primary loop element. Start with the secondary loop 4 inches above the main loop.

Place the rotator mounting pipe in the hole and pour in 90 – 130 pounds of quick-set concrete. Allow the necessary time for the concrete to cure and then mount the loop on the pole.

Normally, the ideal height is two loop diameters above ground to minimize ground losses. However, the practicalities of that height should not be underestimated. In the example shown here, the antenna is instead approximately 7 feet above ground. At that height, no serious compromises to performance have been observed.

It may also be necessary to add a few nonmetallic guy ropes to the top of the loop to stabilize it in high winds. This was achieved here with a modification of the top PVC adaptor. It was changed from a T to a cross piece to allow an additional 12-inch length of 2-inch pipe to be added. This provided an anchor point from which to attach the guys. Doing it this way did not impede the ability to rotate the antenna.

Testing and Tuning

Now we've reached the fun part of the project — tuning the antenna for the first time. The first step is to connect a receiver to the antenna and switch off the receive automatic gain control (AGC). This will make it easier to determine the antenna's resonant frequency.

Next, set the antenna tuning capacitor to maximum capacitance and then tune your receiver from 1 to 2 MHz. Monitor the receiver noise level by ear and on your radio's S-meter. As the loop's resonant frequency is approached, you should hear a pronounced rise in receiver noise, indicating that the antenna is at least working. Note down the frequency at which the noise peaks for future reference.

The next step is to move your receiver to your favorite 160-meter operating frequency. Repeat this receiver listening process, but this time, instead of tuning the receiver, adjust the antenna's tuning capacitor. Once the noise peaks on 160 meters, you are ready to move to the next stage — transmitting.

Be aware of your transmitter's settings. When first applying RF to the system, make sure you have an SWR meter capable of accurate 1.8 MHz operation in line. Set your transmit power level to no more than 1 or 2 W. The antenna will look like an almost infinite SWR until it is brought into resonance and its resonant point will be very narrow. If you are not careful, damage can be done to your transceiver power amplifier if you do not keep the power to a minimum at this early phase.

Next, key your transmitter and adjust the loop tuning using the motor drive. If you have peaked the loop first on receive, you should not have to change the tuning by much before finding a pronounced dip in the SWR. You should be able to achieve an SWR of around 1.3:1 when the loop is correctly adjusted. It is a good idea to set the motor speed to minimum using the PWM dc controller to easily see the transition through the resonant point.

You can then start to increase your transmit power, checking the SWR as you go. Fine adjustments may be required as more power is applied and the SWR measurement accuracy improves.

Finally, you should be able to transmit at full power — at which point you are ready for your first on-air contact.

Once you have confirmed it is working as expected on 160 meters, change your radio to 80 meters and start tuning the antenna capacitor again with the servo-motor (remember that you need to decrease capacitance to retune the antenna up to the 80-meter band). Repeat the peaking procedure and confirm you can also operate across all of 80 and 75 meters. On my antenna, I again achieved an SWR of 1.3:1.

Troubleshooting

If you can't find a resonant point, then it is back to some experimentation and fault finding. First, check that all the joints are properly soldered and brazed. Any increase in the resistive losses around the loop will destroy the Q and render the antenna useless.

You may need to experiment with your secondary loop's position. Try moving it vertically within the plane of the primary loops. You may also need to adjust the size or shape of the secondary loop. Try a larger, then smaller loop size to see if you can improve the coupling. It is sensitive to the materials used, so take some time at this point to experiment. Soon enough you should be able to find your own sweet spot for the loop to fall into resonance and start behaving like an antenna!

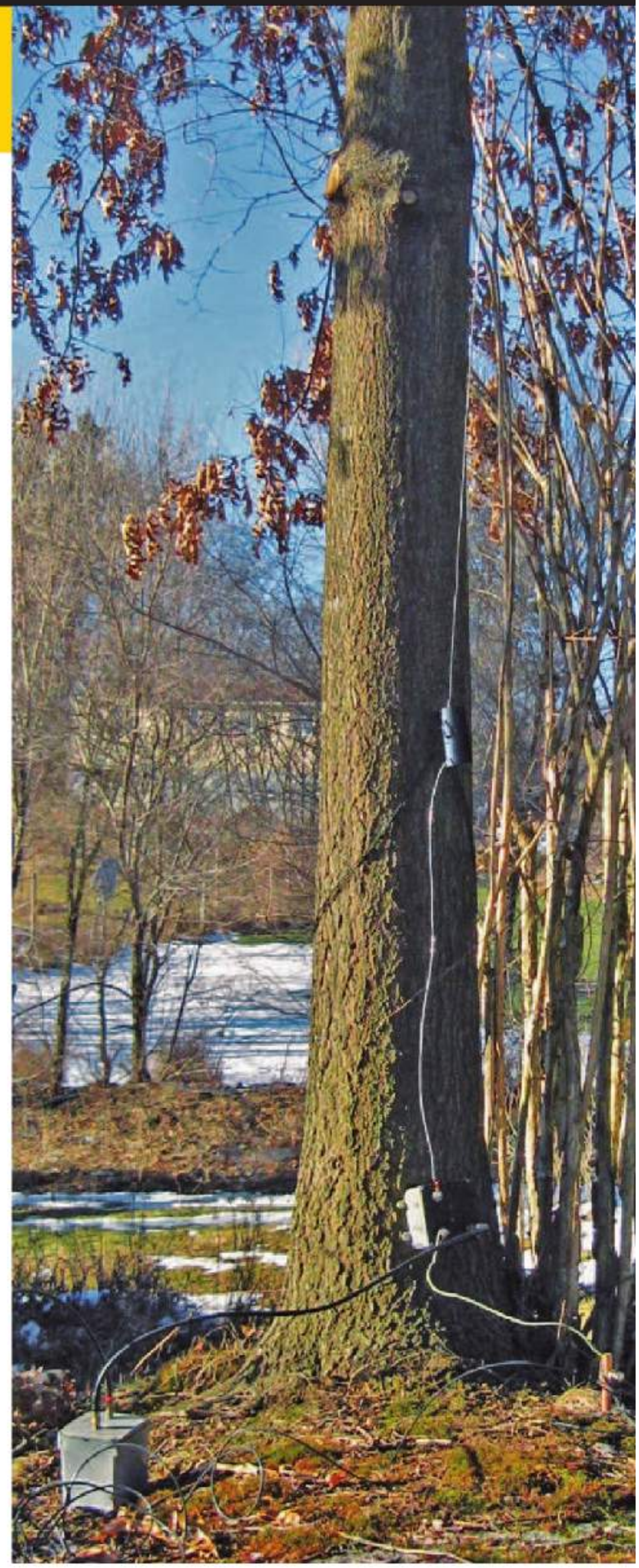
Steve Adler, VK5SFA, has been a licensed amateur since 1976. He worked in commercial radio broadcast engineering, heading up large AM, FM, and DAB networks.

He lives with his family in Adelaide, South Australia, and is a keen DXer with a sharp focus on the low-frequency bands and 6 meters. You can contact Steve at **steve_adler@netspace.net.au**.

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

A Reversible LF and MF EWE Receive Antenna for Small Lots

This antenna was the second-place winner of the 2018 *QST* Antenna Design Competition.



Michael K. Sapp, WA3TTS

The EWE antenna, originally developed by Floyd Koontz, WA2WVL, is one of several variants of low-noise, non-resonant receiving antennas with a resistive termination.[1] The EWE provides a cardioid directional pattern with a deep rearward null and a broad forward beamwidth. The rear null zone can be used to reduce noise or attenuate strong interfering signals. The three-dimensional pattern shape of the null zone can be controlled to a certain extent by varying the termination resistance.

This version of the EWE was optimized for weak signal reception on the 2200- and 630-meter bands, but it is also useful on the 160- and 80-meter bands. It also maintains a useful measure of directivity into the 10,000-meter band (30 kHz range), and a reasonably low standing-wave ratio (1.3:1 typical) throughout the lower LF/MF range. Key features of this reversible LF/MF EWE include:

- Antenna transformers based on four BN73-02 binocular ferrite cores superglued together in a series-connected arrangement providing an 11:1 transformation ratio.
- Perimeter ground wire around the four antenna ground rods, as well as center x-wire ground wires and rods to improve consistency.
- A high-impedance binocular common-mode choke near each antenna transformer connection.
- Midpoint grounding of the 75 Ω coaxial feed-line pair.
- An opposing-phase, common-mode choke in the station location for the dual-receive feed lines.
- A 75 – 50 Ω isolation transformer to isolate the antenna system from the receive converter and ac service ground while antennas are in use (single-point common grounding provided when antennas are not used).

As with other EWE antennas, the dimensions are not critical and can be reduced to fit a small lot with some corresponding reduction in signal capture.

Basic EWE Antenna

A simple EWE antenna is comprised of a length of wire configured into an inverted-**U**. For 160- and 80-meter applications, the antenna is typically 12 to 15 feet tall and 35 to 50 feet long. One vertical seg-

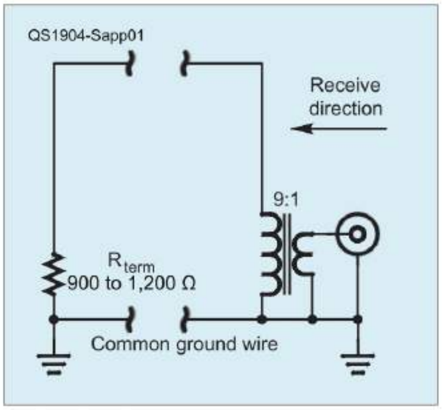


Figure 1 — Sketch of typical EWE receive antenna. Unidirectional low angle response is from the right side of the figure.

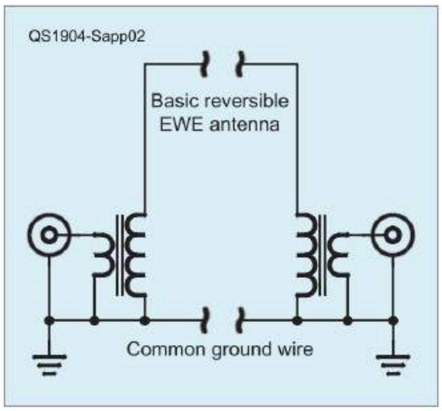


Figure 2 — LF/MF reversible EWE antenna at WA3TTS.

ment is connected to ground via a 9:1 transformer and the transformer end of the antenna becomes the forward receiving direction. The other vertical segment is terminated with a 900 to 1,200 Ω resistor to ground. The resistor end serves as the reflector end of the antenna. The horizontal wire section provides a phasing delay, and radio energy reflected from the termination resistor becomes additive at the matching transformer to provide the directional reception pattern across a relatively broad frequency range (see Figure 1).

A problem that can arise with the basic EWE antenna is that it can be very ground-dependent. Changes in ground conductivity cause the antenna pattern to be unstable over time with varying ground resistance.

Table 1
Parts List for MF/LF EWE Antenna

1. EWE Antennas (two) and Ground System

Quantity	Description
200 feet	#14 AWG insulated stranded copper THHN wire per antenna. 100 feet per antenna
240 feet	#14 AWG insulated stranded copper THHN wire for ground wires
4	Ceramic antenna insulators (or equivalent made from PVC, Teflon, or similar material)
250 feet	Nylon Paracord, ⅛- or 3/16-inch diameter for antenna tie-off supports
4	Ground rods, 8 feet long, ⅝-inch diameter, copper-clad, cut in half
8	Ground rod lugs, brass or bronze, with stainless bolts
500 feet	RG6QS coaxial cable
25	Type F, male coaxial connectors, Belden SnapNSeal or equivalent
1	SnapNSeal connector tool, if needed
2	Dual type F grounding block for mid-point RG6QS cable ground
1	SPST copper-blade knife switch (antenna system ground to ac mains ground)
2	A/B coax switches, antenna type F, Pico Macom AB or equivalent, with internal 75 Ω termination resistors
2	Refridgerator-type plastic boxes, or equivalent, for A/B switch weather protection
	Scotch Brite pad and silicone oil for conductor preparation

2. Antenna Transformers (four)

Quantity	Description
4	NEMA boxes for antenna transformers
16	Ferrite cores, BN73-02, four per transformer
1 roll	Kynar insulated #30 AWG, wire-wrapping wire
4	Single-sided PCB FR4 2 × 4 inch, for antenna transformer mounting
1	Superglue or quick-set epoxy for securing antenna transformers to board
8	Sets of 6-2 or 4-0 stainless hardware for mounting transformer board to inside of NEMA box lids
8	Through-hole mount double-female F-connectors
8	Stainless-steel bolts, ¼ × 1 inch, for antenna and ground connections on antenna transformers, two each
16	Stainless-steel nuts and washers, for above
8	Large wire lugs (auto supply store) for wire connections to stainless hardware terminators

3. Antenna Transformer Common-Mode Chokes (four)

Quantity	Description
48	Ferrite cores, type FT-87A-W
32	Ferrite cores, type FT-82-75
8	Ferrite solid beads, type 43, ½-inch inner diameter
60 feet	Mini coax cable, Belden 9221
8	Through-hole mount double-female F-connectors
4	Electrical junction boxes, NEMA

4. Opposing Phase Common-Mode Choke

Quantity	Description
1	Electrical junction boxes and lids, commercial size, galvanized
4	BNC jacks, ground isolated
1	Ferrite core, Magnetics F-44932-TC, AsubL 7080 or equivalent
1	Ferrite core, 2.9-inch FT-90-W or equivalent

5. 75 – 50 Ω Isolation Transformer

Quantity	Description
8	FT50-75 ferrite cores cemented as a single 4 × 4 toroid transformer core. 15 turns primary (75 Ω), 12 turns secondary (50 Ω), #24 enamel wire (for use in 10 – 500 kHz range).

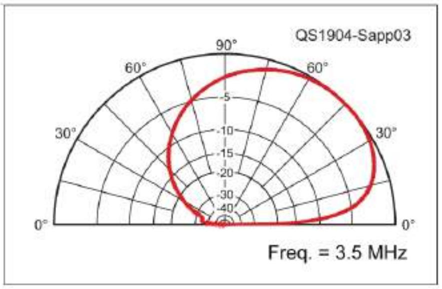


Figure 3 — Elevation radiation pattern of EWE antenna at 3.5 MHz.

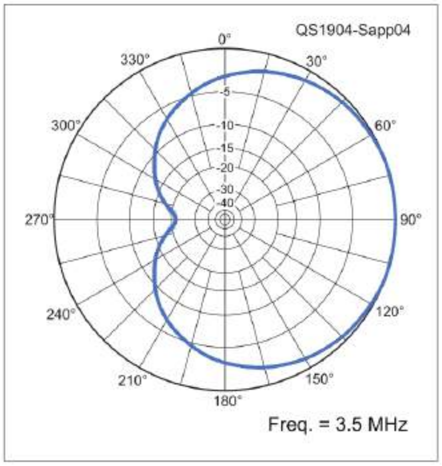


Figure 4 — Azimuth radiation pattern of EWE antenna at 3.5 MHz.

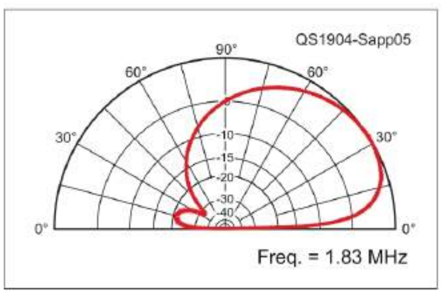


Figure 5 — Elevation radiation pattern of EWE antenna at 1.83 MHz.

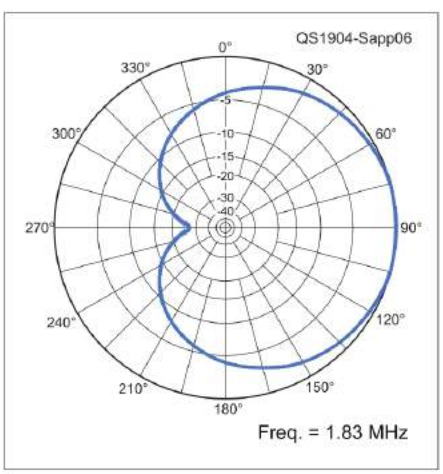


Figure 6 — Azimuth radiation pattern of EWE antenna at 1.83 MHz.

A simple remedy is to tie both ground rods together with a common ground wire.

The Two-Direction EWE Antenna

The original *QST* article describing the EWE suggests that it is possible to place an antenna transformer at both ends and send two receiving antenna feed lines to the radio station. This allows the termination resistor to be accessible at the radio location. Because the second antenna transformer steps down the ac impedance by a factor of the transformer impedance ratio, a low-value resistor can be used. Typically, it would be in the same resistance range as the characteristic impedance of the feed line used to connect the termination resistor to the antenna transformer (usually 50 or 75 Ω).

One can then swap the termination and receive feed-line positions at the radio receiver location to change receiving directions. One catch to this configuration is that the antenna transformers must have a common ground connection (primary and secondary) with the common ground wire at the antenna. I had the good fortune a few years back of exchanging emails with Floyd, who confirmed the need for a common ground wire on the EWE to make the antennas reversible, as well as to improve antenna pattern stability (see Figure 2). Typical *EZNEC*-modeled antenna patterns are shown in Figures 3 through 10.[2]

LF/MF Antenna Transformers

The antenna transformers (see Figure 11) were made by gluing four BN73-02 cores end to end. I first tried using Teflon™ tape with a copper tube as the primary turn. This approach did not seem to make a measurable difference in insertion loss on back-to-back transformer tests versus three-turn wire transformer primary windings. The four-core BN73-02

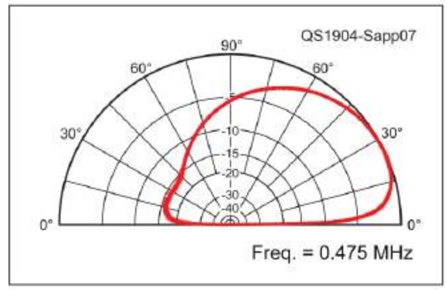


Figure 7 — Elevation radiation pattern of EWE antenna at 475 kHz.

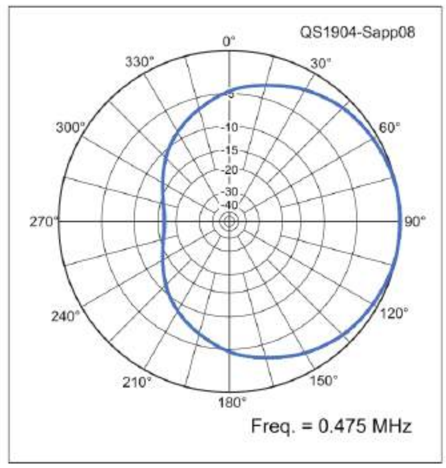


Figure 8 — Azimuth radiation pattern of EWE antenna at 475 kHz.

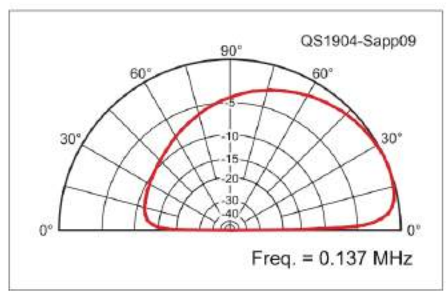


Figure 9 — Elevation radiation pattern of EWE antenna at 137 kHz.

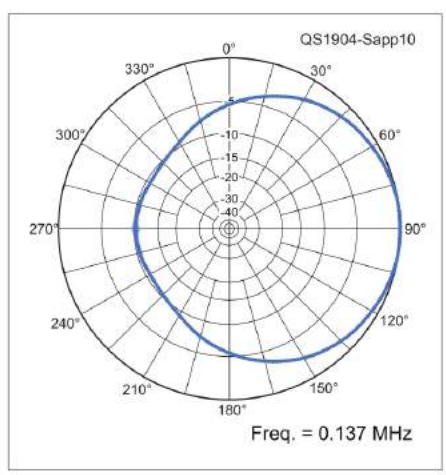


Figure 10 — Azimuth radiation pattern of EWE antenna at 137 kHz.

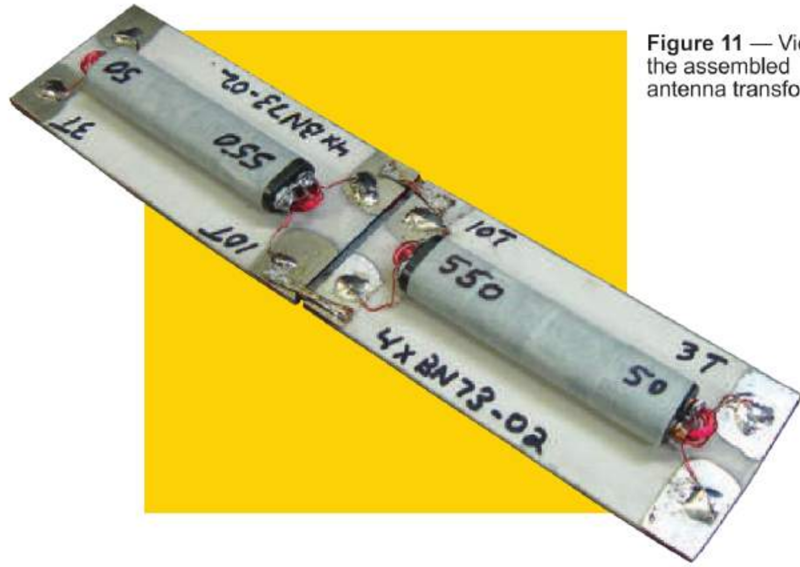


Figure 11 — View of the assembled antenna transformers.

transformers have 0.1 dB insertion loss each at 500 kHz and 137 kHz. The insertion loss increases to 1 dB at 22 kHz. If you want the low-end transformer frequency response to roll off at around 100 kHz, then use three superglued BN73-02 cores instead. If you only want 630- and 160-meter operation, use a pair of superglued BN73-02 cores for the 3-to-10 turn ratio transformer. Kynar insulated #30 AWG wire-wrap wire is a good match for the BN73-02 core size. The 3-to-10 turn ratio provides approximately an 11:1 impedance transformation (50 to 550 Ω, or 75 to 825 Ω, in 50 or 75 Ω systems). BN73-02 cores were selected on the basis of their superior IMD performance.[3]

Expanding to Four Directions

With two reversible EWE antennas positioned in a more or less orthogonal orientation, it is possible to have a four-way receiving setup. This arrangement can also be easily tested for SWR with an antenna analyzer and the dc loop resistance can be easily checked to ensure proper antenna operation.

I also find it useful to apply a momentary dc sealing current at a 12 or 24 V potential every few weeks via 100 Ω or so of current limiting resistance.[4] This application of momentary sealing current keeps the coaxial and antenna connections at a low dc resistance value. With 100-foot range feed lines, a dc loop resistance in the 8 to 10 Ω range (including choke resistances) has been shown to be a good indicator of proper antenna system operation.

Grounding Arrangements

For the EWE antenna ground system, a perimeter wire around the four outer ground rods made a worthwhile improvement in receive system performance. The idea is to equalize differences in ground potential at all four antenna-transformer locations, as well as to provide a measure of ground potential equalization across the antenna ground area.[5] This limits ground potential differences that would otherwise contribute to common mode energy ingress into the antenna system.

Each ground rod is 4 feet long and each is made from an 8-foot-long, ⅝-inch-diameter copper-plated ground rod. (Remember to call 811 before you dig or drive ground rods to ensure you won't hit underground utility lines.) For ground wire, I used #14 AWG vinyl-coated THHN house wire. I used brass/bronze ground rod connectors, which have a single large stainless-steel fastener. I use scouring pads and silicone oil two or three times a year on the ground rod and wire connections to keep them clean and low resistance. It has been my experience that while attempting to receive *WSPR 2.0* signals at 2,000 times below the average noise floor (–33 dB SNR), even small antenna and feed-line connection improvements make a noticeable difference.

Depending on the local noise environment at any given point in time, sometimes a lower noise solution is available by grounding the 75 Ω termination resistor to the station ac service ground (see Figure 12). At my particular location, the effect appears to be most noticeable on the 2200-meter band and in the lower to middle non-directional beacon band (190 to 300 kHz) to attenuate local noise sources.

Note that the horizontal and vertical gain values are in the –7 dBi range for 137 kHz, versus the –8 dBi range for 475 kHz. However, also keep in mind the 20 × Log(F) component of the free space path loss (FSPL) is 10.8 dB lower for far field signals arriving at the antenna at 137 kHz (–17.3 dB) versus 475 kHz (–6.5 dB).

Common-Mode Chokes

The opposing-phase common-mode choke uses ground-isolated BNC connectors and a commercial galvanized electrical junction box to also function as a magnetic shield. The electrical junction box is grounded to the ac mains, but the choke itself is floating relative to the ac-mains ground. Only the cable shields are shorted across the antenna side of the choke. This cable shield short stops the pair of coax feed cables from acting like an open-wire transmission line for common-mode suppression. Local 50 kW AM signal levels present as common-mode energy and were noticeably attenuated with the cable pair shields tied together. Keep the two EWE feed lines as far away as possible from other RF cables and ac-power branch-circuit lines to minimize stray capacitive coupling. The schematic of the opposing-phase common-mode choke is shown in Figure 13, with a photo in Figure 14.

Reversible EWE Antenna Switching

I use 75 Ω A/B switches located outdoors near the antennas in plastic

Fitting the EWE Into Your Space

My real estate limitation is a 50 × 200 foot lot. My house is toward the front of the property and garage in the middle. This leaves about a 50 × 100 foot backyard to share antenna space with the two reversible EWEs at the back of the property and my HF vertical setup as a ground plane secured at the back of my garage. The EWE antennas are supported by available trees in a 30 × 40 foot space. This makes the diagonals 50 feet long, the length of the horizontal sections of the two EWE antennas.

The height of the EWE antennas is approximately 25 feet. I allow one horizontal EWE section to droop about 2 feet below the other to minimize capacitive and inductive coupling between the antenna wires. For LF weak signal receiving, it is essential to understand that in a high-impedance circuit (including nearby EWE antenna wires), it only takes a few picofarads of capacitance for conductors such as antenna wires or coaxial cables to share RF energy at LF/MF frequencies. Figure 12 details the essential design of this four-way LF/MF EWE antenna system.

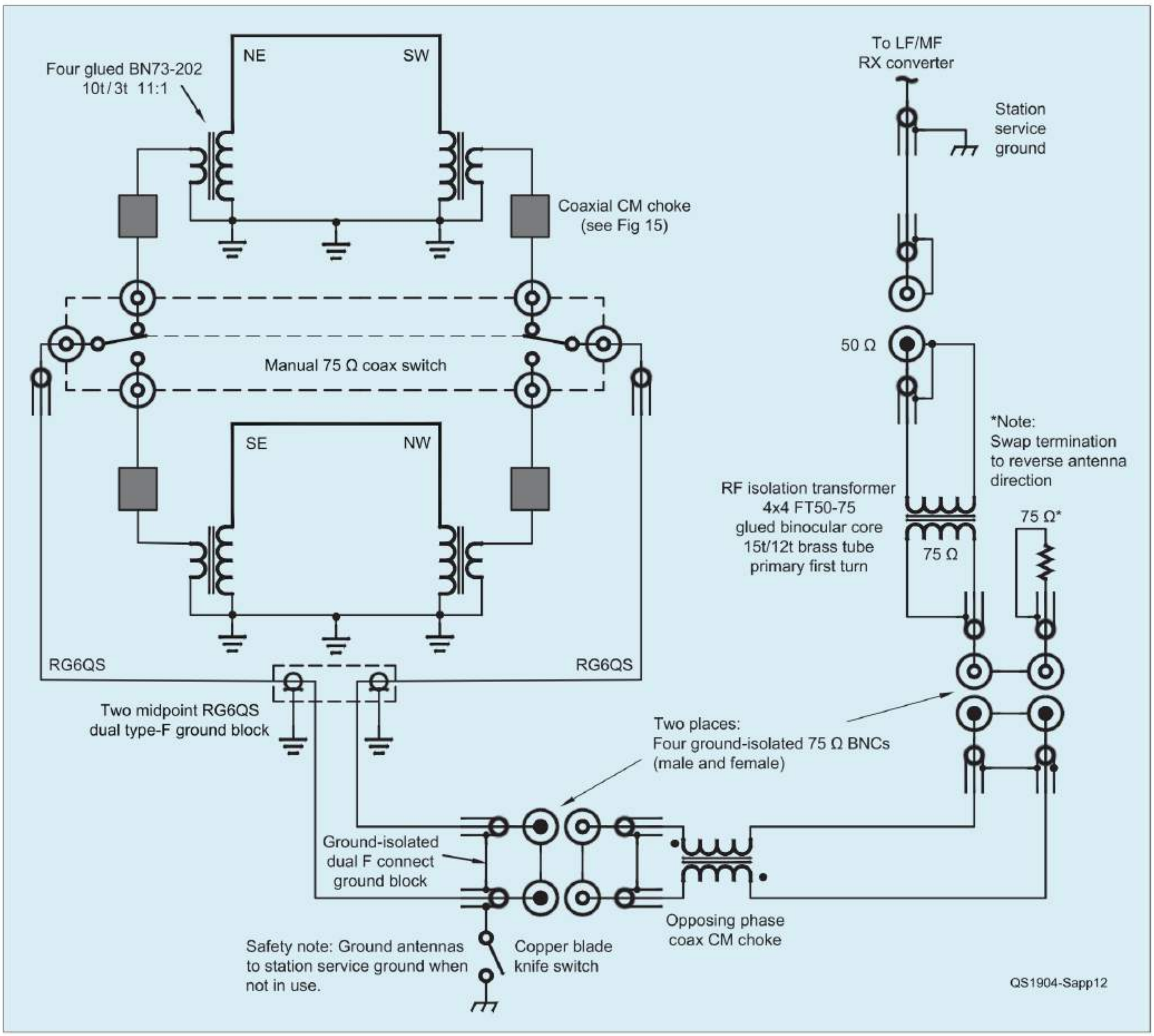


Figure 12 — The essential design details of the four-way LF/MF EWE antenna system.

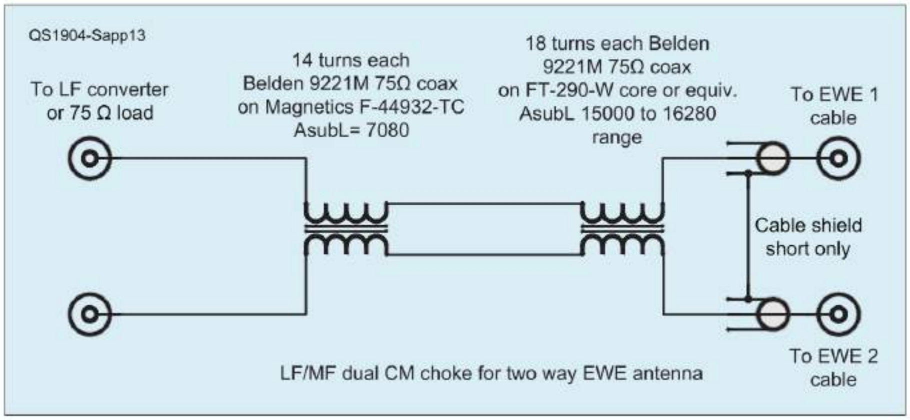


Figure 13 — Schematic diagram of the opposing-phase common-mode choke.

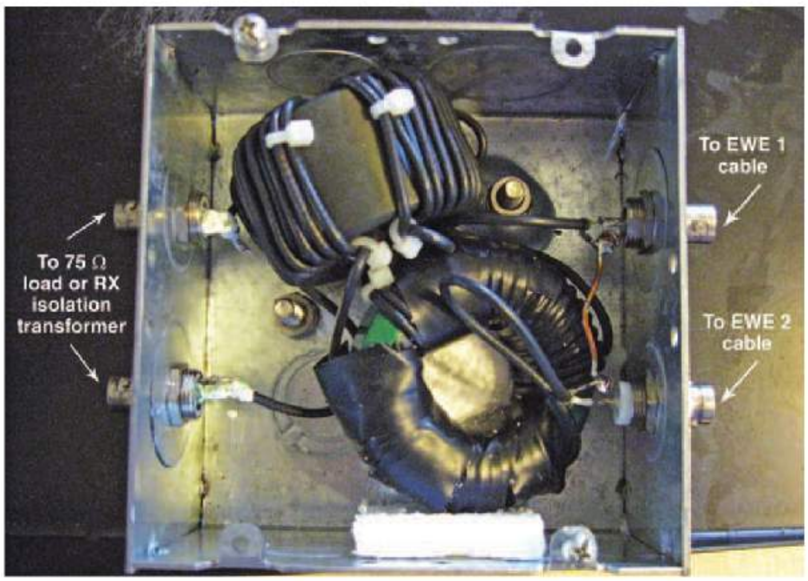


Figure 14 — Photograph of the opposing-phase common-mode choke.

Figure 15 — Photo of the coaxial common-mode choke, used on each antenna termination.

kitchen boxes for antenna switching. This arrangement works for me because I tend to use WSPR mode extensively and often leave the antenna directions the same for several hours or overnight. When I do make antenna switch changes, I do not mind walking out to the switches to reset antenna directions.

It is important to note that 75 Ω TV A/B switches are typically designed to automatically terminate the unused port in 75 Ω. The internal switch termination is rather convenient in this two-EWE configuration. For example, if both antenna switches are set in the **A** position, then both ends of one EWE come back to the radio station location via the two cables. If **A** is the northeast/southwest antenna, then I have those two options for termination and receiver connections.

But, if I set one A/B switch to **A** and the other A/B switch to **B**, then there are two antenna transformers selected on two EWEs and the other two antenna ends automatically terminate in 75 Ω inside the A/B switches. Thus, you can run two separate receivers on the two EWE antennas. In my A/B switching setup, I can choose northwest and northeast or southwest and southeast for feeding individual receivers. With the aid of a two-port 180° LF/MF combiner, it is possible to combine northwest and northeast to obtain an east-west bidirectional pattern.

Trees and LF/MF EWEs

I support my LF/MF EWE antennas from available trees in my yard, with little choice but to live with the situation. A fishing reel and sling shot get the nylon support cord over the trees to the desired 25-foot level. A decision was made to close-couple the vertical sections of the EWEs to the trees, based in part on W5JGV's work with a tree-coupled antenna for LF/MF.[6] For LF, if you view the live tree as a high-impedance RC circuit, the EWE wire is capacitively coupled in near proximity. We also know that LF/MF energy can transfer via relatively small capacitance values at LF/MF in high-impedance circuits. My assumption is that the live tree both absorbs RF energy and re-radiates a portion of the RF energy. Basically, I am attempting to minimize the tree RF absorption loss with close coupling of the EWE wire to the tree trunk.

Notable Reception Results

The EWE antennas have been used over several years with *WSPR 2.0* reception reports on the 630-meter band as far away as Alaska, Hawaii, and Australia to the west, Europe to the east, and Cayman Islands to the south (ZF1EJ). Although my e-probe antenna is set up and works reasonably well, it has only made transcontinental receptions in the lower 48 states on the 630- and 2200-meter bands and at lower *WSPR 2.0* capture rates versus what the EWE antennas are capable. ZF1EJ is regularly captured to the south with the e-probe on the 630-meter band. The southeast EWE seems to hear ZF1EJ much better than the southwest EWE, possibly from pattern skewing due to local objects in the nearby environment.

In one particularly good opening to the west, over 50 K9FD captures were made on my northwest EWE antenna in one overnight fall session on the 630-meter band. The northwest EWE always seems to capture K9FD signals better than the southwest EWE for some reason. I have had a transcontinental 630- to 80-meter CW cross-band contact with VE7SL, with reception on the northwest EWE. The farthest station received to the east has been DH5RAE in *WSPR 2.0* mode in the 630-meter band on the northeast EWE. VE7BDQ was received at his estimated 200 mW ERP on the 137 kHz band on *WSPR 2.0* mode on the northwest EWE in midwinter. Additional performance and reception reports are found in the *QST*-in-Depth version of the article (**www.arrl.org/qst-in-depth**).

Conclusions

After several LF/MF-listening seasons, the EWE antennas have provided excellent weak-signal reception at my station location. Front-to-back (F/B) ratios have been observed to generally match the *EZNEC* model pattern predictions in the LF/MF range. At higher angle, short-hop D-layer paths, the F/B ratio is only 5 or 6 dB, which is consistent with the modeled antenna patterns. F/B ratios of 10 to 13 dB or more (137 and 475 kHz, respectively) occur on signals arriving at low angles.

For the 160- and 80-meter bands, the height of the antenna raises the peak front antenna pattern incoming signal angle more than what one would desire for long-distance weak-signal and low-angle reception. From casual reception observations made on the 160- and 80-meter bands, there is still a measure of useful directivity with the 25-foot-tall by 50-foot-long antenna size. For future testing, I may try some type of switch arrangement midway up each vertical section of the EWE wire and add a second horizontal wire. That arrangement would allow switching in a lower horizontal wire to improve the low-angle reception on 160- and 80-meter bands.

Notes

[1]F. Koontz, WA2WVL, "Is this EWE for You," *QST*, Feb. 1995, pp. 31 – 33.

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

[3]"Intermodulation in BroadBand Transformers," **www.cliftonlaboratories.com/imd_in_broadBand_transformers.htm**.

[4]"Sealing Current Generator for a Telephone Circuit," US Patent 5,131,033.

[5]"Grounding for the Control of EMI," **https://m.eet.com/media/1114898/duff_ch_5.pdf**.

[6]See *QST*-in-Depth for additional performance results at **www.arrl.org/qst-in-depth**.

Mike Sapp, WA3TTS, studied electrical engineering at Pennsylvania State University for 3 years before switching to a business administration major in accounting at Robert Morris College, where he earned his Bachelor's degree. He then continued with 30 credits of graduate work in business administration at Robert Morris.

He is a Senior Researcher and Technical Writer for a Pittsburgh-based patent services enterprise.

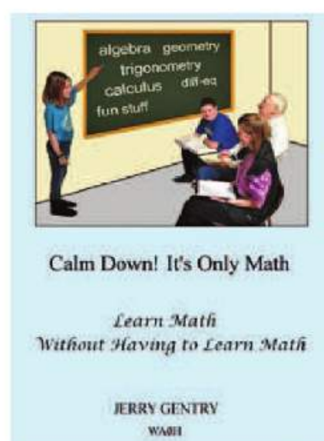
Mike passed his Novice-class exam in 1972 and passed the Amateur Extra-class exam in 1974. He is a past president and past vice president of the Steel City Amateur Radio Club, a current member of the W3SO multioperator VHF/UHF contest team, and a current member of the Pittsburgh Antique Radio Society. You can reach Mike at **wa3tts@verizon.net**.

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

Strays

QST Congratulates…

ARRL Life Member Jerry Gentry, WA0H, on the publication of two new books: *Calm Down! It's Only Math* and *Calm Down! Learn to Program*. Both books are available on **Amazon.com**.



The 3/8-Wavelength Vertical — A Hidden Gem

This vertical antenna design is the third-place winner in the 2018 *QST* Antenna Design Competition.

Joe Reisert, W1JR

As the solar cycle rapidly winds down, the upper HF bands will be less available, but 20 meters will still be plenty active during the day. Many 20-meter operators are always looking for a small or stealthy antenna with good performance, and the 3/8-wavelength vertical antenna is a good candidate to fill that role.

When my son, Jim, AD1C, was first licensed, he built a homebrew receiver and 5 W transmitter for 40 meters. Later, he wanted a simple but efficient antenna. As I looked for a solution, the 3/8-wavelength vertical stood out. It is only about 50 feet in height on 40 meters. Because this vertical has a series impedance of about 200 Ω resistive, plus an inductive reactance of about 300 – 700 Ω, it is easily matched with a 4:1 step-up toroid transformer followed by a series matching capacitor. We strung up an approximately 50-foot wire in a nearby tree and four quarter-wavelength, ground-mounted radials to complete the installation and quickly matched the antenna. It worked quite well in contacting about 50 DXCC entities using Jim's 5 W.

Vertical Antenna Considerations

Ground planes are quite popular (see Figure 1). They are simple to construct and usually don't require matching networks, but do require some tie-down points. Elevated radials, however, can have several problems, including visibility and safety. The ends of the insulated radials are a high voltage point. A quarter-wavelength vertical with many radials on or near ground is also popular. For maximum efficiency, they require a minimum of 16 quarter-wavelength radials.[1] Performance often suffers from ground clutter near the base. The typical *EZNEC* modeled radiation pattern with a takeoff angle of 26° is shown in Figure 2.[2] The current distribution over the monopole is shown in Figure 3. Note that the region of highest current — the place where maximum radiation takes place — is at the bottom of the antenna.

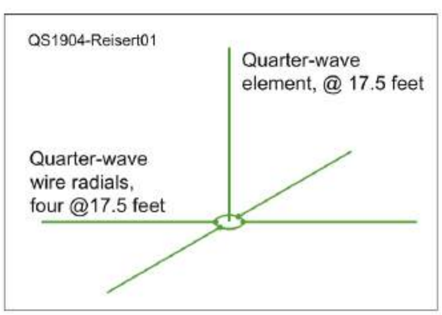


Figure 1 — Dimensions of a quarter-wave, ground-plane vertical antenna for 20 meters. The dimensions are similar for a ground-mounted version, but more radials are required.

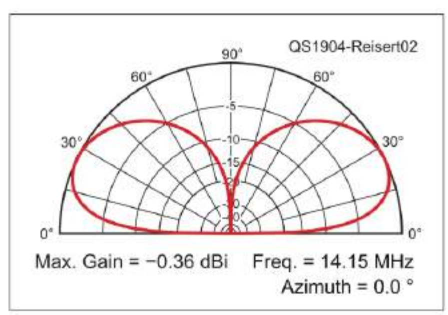


Figure 2 — Elevation pattern of a ground-mounted, quarter-wave antenna for 20 meters.

Table 1
Parts List for 20-Meter, ⅜-Wave Vertical Monopole

60 – 70 feet	#14 AWG PVC insulated wire for radials
1	Plastic electrical box for the matching network (see Figure 10)
2	Capacitors, ceramic disc NPO 20 pFd 1 – 2 kV, as required
1	Ferrite toroid core, T-240-61 2.4-inch OD
4 – 6 feet	#16 AWG PVC insulated twisted-pair wire for the toroid transformer
1	RF coaxial socket to match coax cable
Quantity	**Material (for tubing version only)**
5 – 6	Aluminum tubing 1 – 1.5 inches diameter, 5 – 6 feet long I used a surplus MFJ-1792 vertical antenna
1	Suitable base mount supported by around a 1-inch diameter stake
1	Base insulator
Quantity	**Material (for wire version only)**
2	Antenna insulators
26 feet	#12 AWG copper antenna wire

Meet the ⅜-Wave Vertical

The ⅜-wavelength vertical antenna (see Figure 4) is often an overlooked design. It has several advantages over the common quarter-wave vertical and just adds 50% to the height. Here are some advantages:

- It has a low takeoff angle of radiation at 23°, versus 26° for a ground-mounted, quarter-wave vertical (see Figure 5 and compare to Figure 2). This is a big advantage for working DX.
- It will work well even ground mounted because its maximum radiation point is ⅛ wavelength (about 8.7 feet at 20 meters) above the ground (see Figure 6). This is above the typical clutter present at ground level.
- It is easy to impedance match and, once matched, has a wide bandwidth with low SWR.
- Finally, it has a much higher radiation impedance. Therefore, four quarter-wavelength radials are all that is required for good performance.

Construction

This antenna can be easily constructed using either aluminum tubing or wire. I chose to modify a spare commercial vertical that I already had from a prior project. It had all the aluminum and hardware I needed, plus a good base and base insulator with tilt-over capability. It went together quickly (see Figure 7). Later, a wire equivalent was built at

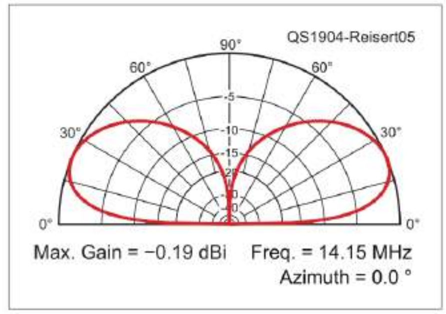


Figure 5 — Elevation pattern of a ground-mounted ⅜-wave antenna for 20 meters.

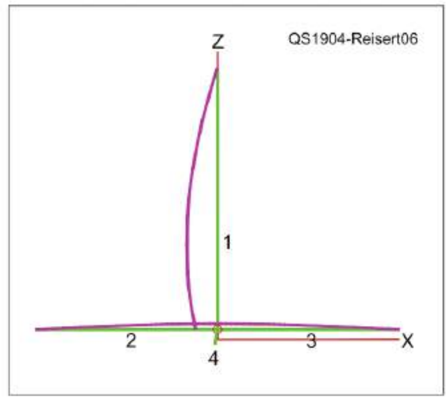


Figure 6 — Current distribution along the ⅜-wave monopole. Note the maximum current, so maximum radiation is ⅛ wavelength up from the base. This is about 8 feet for 20 meters.

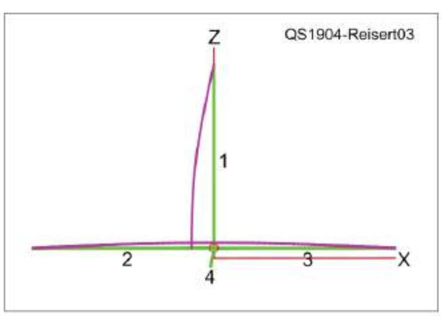


Figure 3 — Current distribution of a quarter-wavelength vertical monopole. Note that for the ground-mounted version, the maximum current and location of the maximum radiation are near the base, where nearby objects can diminish radiation.

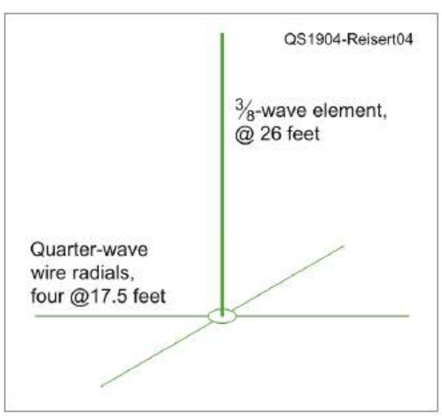


Figure 4 — The ⅜-wave vertical, a practical alternative to the quarter-wave, with some advantages.

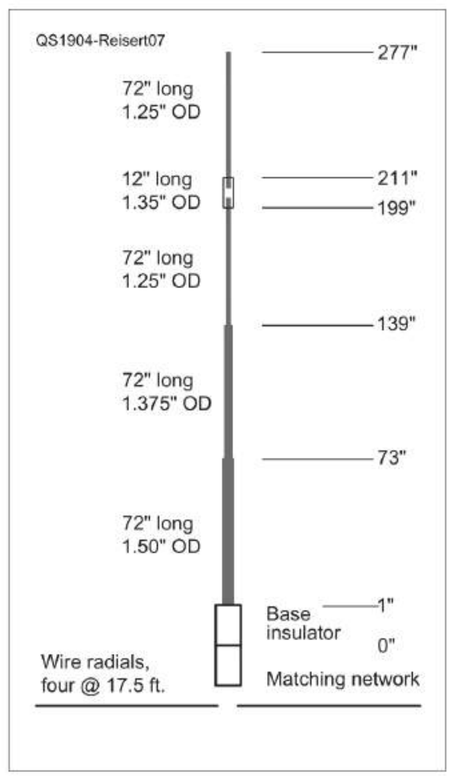


Figure 7 — Tubing construction for a ⅜-wavelength vertical antenna.

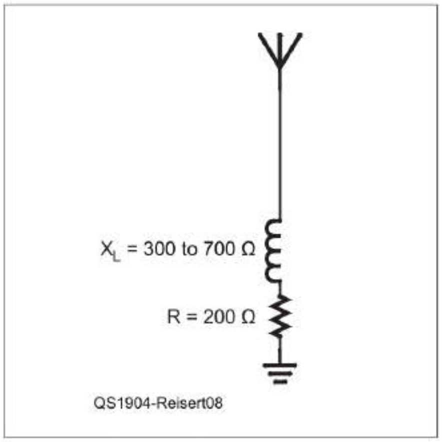


Figure 8 — Typical ⅜-wavelength antenna base feed impedance.

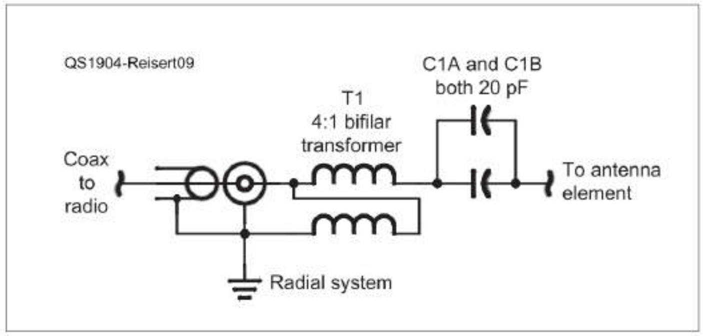


Figure 9 — Impedance-matching network for the ⅜-wavelength vertical. T1 is bifilar twisted pair #16 AWG PVC-covered wire, seven turns on T-240-61 2.4-inch outside diameter toroid. C1A and B are typically 20 pF, 2 kV ceramic disk capacitors. Lower voltage capacitors are useable for low-power operation.

the same location using ordinary seven-conductor #12 AWG copper antenna wire. It requires a top and bottom insulator and some higher structure such as a tree to hold it in place. It had a similar overall length.

Matching Network and Tuning

The ⅜-wavelength vertical antenna has a series impedance of approximately 200 Ω resistive with a series inductive reactance of 300 to 700 Ω (see Figure 8). Therefore, a 4:1 step-up transformer will match the resistive component, and a series capacitor tunes out the inductive reactance (see Figure 9). Typically, the required series capacitance is approximately 40 to 50 pF at 14 MHz and is not critical. A photo of a typical matching network in a 4 × 4 × 2 inch plastic box from an electrical supplier is shown in Figure 10.

The matching network is easy to use. Figure 11 shows a typical setup using an antenna analyzer to adjust for minimum SWR on the wire version of the antenna. Connect the ground side of the antenna connector to the on-ground radials. Connect the upper terminal to the bottom of the vertical tubing or wire. Next put in the specified capacitors or a ceramic (or equivalent) variable capacitor set to approximately 40 pF. Connect an SWR meter to the base.

Ground Radials

For optimum performance, ground radials are required on most vertical monopoles. They can be made of wire of any gauge or material. I recommend #14 AWG copper wire with a PVC covering because the makeup of the ground material will have little effect on long-term performance. The ⅜-wavelength vertical only requires four quarter-wave radials, which can be installed on the ground. The best length is a quarter-wavelength, or approximately 15 – 17 feet at 20 meters, but length is not critical.[3]

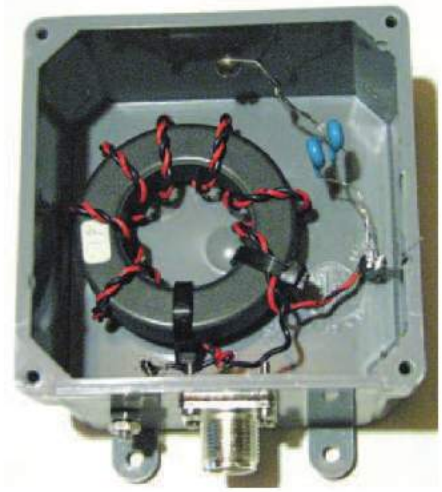


Figure 10 — Construction of impedance-matching network of Figure 9. The enclosure is a plastic electrical box.

Figure 11 — An antenna analyzer is used in this typical test setup to adjust the matching of the antenna. The wire version is shown.

Figure 12 — A ferrite in-line choke is installed on the coax feed line to minimize common-mode current effects.

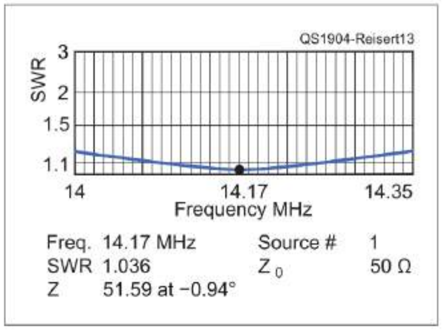


Figure 13 — Typical SWR curve for a 20-meter 3/8-wavelength vertical antenna, tubing or wire, after the matching network is adjusted. Note the bandwidth is comfortably wide.

To prevent radiation from the feed line, it is recommended that a ferrite inline choke (see Figure 12) be installed on the feed line. A 2.4-inch outside diameter ferrite toroid with type 61 ferrite and 10 – 12 turns of RG-303 PTFE coax, W1JR style, makes a good choke.[4] You should now be ready to test.

First, measure the SWR. The upper tubing or wire height can be lengthened or shortened a few inches if required to minimize SWR in the 20-meter band. Next, if a variable capacitor is used, adjust it for best SWR. Continue back and forth until the desired SWR is obtained. Typical SWR results are shown in Figure 13. Then replace the variable capacitor (if used) with fixed capacitors as shown in Figure 9. Because current and voltage are high at this point, two parallel high-voltage ceramic-disk capacitors are recommended.

Performance Results

With this antenna, I quickly qualified for Worked All Continents on 20 meters, running only 100 W. I was able to break through the TX5T Austral Islands pileup in short order to complete the objective.

This antenna can easily be scaled to other amateur bands using the 3/8-wavelength principles. In less than 1 hour, I added two more tubing sections on the top of the 20-meter antenna to a total of approximately 33 feet of tubing. I lengthened the radials to a quarter wavelength, retuned the series capacitor (approximately 52 pF) for minimum SWR and was operational on 30 meters. Immediately, I contacted an African station while running 100 W. However, this modification is tall enough that I recommend a few insulated guy wires.

Notes

[1]R. Severns, N6LF, "Radial System Design and Efficiency in HF Verticals," **www.antennasbyn6lf.com.**

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

[3]See Note 1.

[4]J. Reisert, W1JR, "Simple and Efficient Broadband Balun," *Ham Radio Magazine*, Sep. 1978, pp. 12 – 15.

Joe Reisert, W1JR, is an ARRL Life Member and Amateur Extra-class licensee. Joe was first licensed in 1951 as WN2HQL, one of the first holders of the new Novice-class license.

He received his AAS degree in electronic technology from the State University of New York at Farmingdale, Long Island, in 1956. Over the years, he has been employed by Sperry, IBM, Lockheed Missiles and Space, Fairchild Microwave, The MITRE Corp., Wang Labs, and Cushcraft. In 1992, he formed Antennaco, Inc. and designed and manufactured commercial antennas for VHF, UHF, and microwave communications.

His Amateur Radio interests are primarily DX from HF through microwave. He was a pioneer on Earth-Moon-Earth communications, especially on 70 centimeters. He holds DXCC 392/340, DX Challenge 3160, 13BWAS, 11BDXCC, and IOTA 1100. In 2014, he was inducted into the CQ DX Hall of Fame.

Joe was at one time on the ARRL DX Advisory Committee and was also the Chairman of the VHF/UHF Advisory Committee that developed the present VHF/UHF Band Plans. He has published over 150 technical papers and given over 125 invited talks on various Amateur Radio subjects. You can reach Joe at **w1jr@arrl.net**.

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

Feedback

- In the article "A Force-Sensing CW Paddle" by Art Heft, K8CIT, in the February 2019 issue of *QST*, Pins 2 and 3 of U1A and Pins 5 and 6 of U1B should be swapped.

- In the article "An Arduino-Powered RF Detector" by Teri Bloom, AC5YL, in the March 2019 issue of *QST*, there are two errors in the schematic diagram shown in Figure 3. The Arduino Nano pin labeled "RAW" should have been labeled "VIN." The cathode of diode D1 should be connected to the Vin pin, not the 5.5 V pin.

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

Product Review

Xiegu Communication X5105 HF/6-Meter QRP Transceiver

Reviewed by Phil Salas, AD5X
ad5x@arrl.net

For many years, I've enjoyed operating QRP (low power) portable with a number of popular commercial and homebuilt transceivers. I was looking forward to trying a new entry into the compact QRP transceiver field — the Xiegu X5105 — which is made in China and distributed and supported by MFJ Enterprises in the US.

Overview

The Xiegu X5105 is an attractive and very solid-feeling, compact transceiver that covers the 160- to 6-meter ham bands, along with a general-coverage receiver that tunes continuously from 500 kHz to 54 MHz. Transmit power is adjustable from 0.5 to 5 W in half-watt increments, and operating modes include SSB, CW, FM, AM (1.5 W carrier), as well as digital modes using an external computer.

The X5105 offers many features, including split-frequency operation, receiver incremental tuning (RIT), a built-in SWR bridge, an automatic antenna tuner (ATU), a receiver preamp and attenuator, a noise blanker, digital noise reduction, a notch filter, and variable band-pass audio filters. Additionally, there is a built-in automatic keyer with three memories, along with a CW trainer. And finally, there is a speech processor for the SSB operator.

A 3.6-inch, backlit LCD shows everything necessary during operation. In addition to the clearly marked X5105 operating controls, the included microphone's multifunction keypad permits access to most of the radio's features. There is a built-in speaker, plus enough audio power to drive an external speaker if desired. There's even a built-in, front-panel microphone and manual transmit (PTT) switch, should you wish to operate the radio as a handheld.

Interfaces and Controls

The X5105 is loaded with controls and interface connectors, yet everything is easily accessible. Figure 1 shows the radio's top and side panels. On the left side are the BNC antenna jack, plus connectors for the first IF output, an external speaker or headphones (3.5-millimeter stereo), and dc power (2.1 × 5.5 millimeters). On the right side, you'll find a mini-DIN eight-pin **ACC** connector for digital mode interfacing and a 3.5-millimeter stereo jack for your CW key (manual, paddle, or external keyer). There is also an **ATU** interface for automatic band changing with external devices, and a **COM** serial port interface for computer control and firmware updates. Finally, there is an RJ45 microphone jack.

Bottom Line

The Xiegu X5105 is a compact, feature-loaded, 5 W portable transceiver that should satisfy any QRP operator.

On the top of the radio are up/down (**UP/DN**) buttons for frequency band selection and volume control (labeled with large and small speaker icons), along with the aforementioned **PTT** switch. A small, front-mounted speaker is located just to the left of the LCD.

The four buttons under the display are soft keys with functions that change based on the menu item selected. The soft key functions are displayed on the LCD screen. The functions of all other buttons are clearly marked. The tuning knob is dual purpose in that it is also used to change parameters when the menu is selected. The other buttons are not multipurpose — what is labeled is what you get, which makes operating the radio very straightforward. There are also three status LEDs: **T/R** (transmit/receive

Figure 1 — The Xiegu X5105 side panels and top panel.

indicator), **DATA** (a signal is present), and **LINK** (external equipment is connected).

Power Requirements

The internal 3,800 mAh lithium battery permits 6 to 8 hours of operation between charges. Of course, the X5105 can operate from an external 13.8 V dc, 2.5 A power supply. With an external power supply connected, the X5105 automatically powers itself from that power supply.

Charging requires an external power supply of at least 13.5 V dc. When the X5105 is off and an external power supply of 13.5 V dc or greater is connected, the radio automatically begins charging the internal battery. **CHARGING...** is displayed, along with the external input voltage and the internal battery voltage. A fully discharged battery takes about 10 hours to charge. When the battery is charged, the display shows **CHARGE... FINISH**. When the X5105 is turned on, you must select **CHG ON** in the menu to charge the internal battery while receiving. However, you cannot transmit during the charging process.

Firmware Updates

MFJ maintains links to the latest X5105 firmware and documentation on their website. A USB serial cable with a 3.5-millimeter phone plug on one end is provided with the radio for firmware upgrades. Updating the firmware requires numerous steps, including downloading a freeware terminal emulator program. All of the programming steps are detailed in the X5105 user manual. While this is a somewhat tedious process, it is not at all difficult.

Testing

Table 1 and Figures 2, 3, and 4 show the results of testing in the ARRL Lab, with additional comments in the "Lab Notes" sidebar. In addition to the ARRL Lab tests, I did detail testing on transmit power versus transmit power setting and found that the power setting is reasonably accurate.

Next, I did some automatic antenna tuner (ATU) loss testing. There is no information given on the ATU's capability, so I ran tests to determine its resistive matching range using a precision setup. The results were interesting. From 160 to 40 meters, the loss characteristics follow what I normally expect to see — tuner loss increases with SWR. On 20 to 6 meters, however, in some cases, the loss at a higher SWR measured less than at a lower SWR. I did check the X5105 RF output spectrum and verified that the unit was not oscillating.

I can't precisely measure the power into the auto tuner because the ATU is internal to the X5105, and so my reference power is the bypassed power. I suspect that on the higher bands, the actual impedance of the tuned ATU may impact the RF output of the X5105. In some cases, the transmitter output power may be higher when the SWR is not precisely tuned at 1:1.

I also performed open/short circuit testing. Ideally a tuner should not be able to match an open or short. If it does, this means that it is tuning into its own internal losses. No antenna tuner is lossless, because it is built with real-world components, and so most wide-range antenna tuners can find a match on one or more frequencies when connected to an open or a short. However, I found no instances where the X5105 ATU would match an open or short. This implies that the X5105 ATU has low internal losses — obviously a desirable characteristic. See the *QST* in Depth web page (**www.arrl.org/qst-in-depth**) for detailed tables with my power level and ATU loss rest results.

General Operation

Operating the X5105 is a pleasure. As mentioned earlier, the controls and buttons are self-explanatory. The menu system is well thought out. Tap the **MENU** button, and you enter the **FUNCTION** menu for setting frequently used parameters, such as split-frequency operation, noise reduction, filter bandwidth, break-in, and so on. Press and hold the **MENU** button, and you enter the **SYSTEM** menu where you will find parameters that are changed infrequently, such as beep level, sidetone frequency, compression level, and others.

The X5105 internal antenna tuner is very easy to use. Tap the **ATU** button once to engage the ATU, and a **TUNE** icon appears at the top of the screen. Then press and hold the **ATU** button to start the tuning process. When tuning is complete, the radio automatically switches back to receive mode. To disengage the tuner, press **ATU** once and the **TUNE** icon will disappear.

CW Operation

The X5105 includes a number of features tailored to the CW operator, which was of major interest to me as CW is my favorite mode. The internal keyer speed range is rated for 5 to 100 WPM. Because I adjust keying speed frequently, I leave **FUNCTION MENU 4** displayed on the soft keys. Then, to change speed, I simply tap the **KSP** (keying speed) soft key, adjust the speed, and tap the soft key again.

CW pitch is adjustable from 50 to 1,200 Hz (800 Hz default), and the sidetone sounds during adjustment. You can select either CW or CWR (reverse) depending on interference conditions. The default CW filter bandwidth is 500 Hz, but this can be set to 2.4 kHz or 6 kHz by tapping the **FIL** soft key in the **FUNCTION** menu. You can also customize the filter bandwidths by adjusting the characteristics in the **SYSTEM** menu. There is also an audio notch filter for eliminating a close-in interfering tone, and the three CW message memories are each capable of up to 100 characters.

There are, however, a few anomalies with CW operation. First, the X5105 is supposed to be capable of full-break-in operation. This is not the case. If you set break-in delay to zero, the keying becomes very erratic at higher speeds. Adding just 5 milliseconds of break-in delay cures this problem, but the receiver does not recover between Morse code characters as it should with just 5 milliseconds of delay. This is due to the 116-millisecond receive processing delay, as measured in the ARRL Lab.

Table 1
Xiegu Communication X5105, serial no. X0300623, v1.0.06

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Receive, 1.0 – 54 MHz, transmit, 160 – 6 meter, amateur bands.	Transmit, as specified. Receive, 0.5 – 54 MHz.
Power requirement: 13.8 V nominal at 500 mA max. (receive) and 2.5 A max. (transmit). Operating voltage: 9 – 15 V dc. Internal battery: 12 V dc, 3,800 mAh.	At 13.8 V dc: Transmit, 2.1 A (max). Receive: 533 mA (no signal, max. volume, max lights); 433 mA backlight off). Off, charging internal battery, 407 mA.
Modes of operation: SSB, CW, AM, FM, data.	As specified.
Receiver	**Receiver Dynamic Testing†**
SSB/CW sensitivity: 1.0 – 1.8 MHz, 0.35 µV; 1.8 – 30 MHz, 0.25 µV; 50 – 54 MHz, 0.25 µV.	Noise floor (MDS), 500 Hz BW: *Preamp* *Off* *On* 1.0 MHz −124 dBm −127 dBm 3.5 MHz −122 dBm −129 dBm 14 MHz −124 dBm −135 dBm 50 MHz −123 dBm −130 dBm
AM sensitivity: 1 – 1.8 MHz, 10 µV; 1.8 – 30 and 50 – 54 MHz, 2 µV.	10 dB (S+N)/N, 1 kHz tone, 30% modulation: 6 kHz BW: *Preamp* *Off* *On* 1.02 MHz 3.89 µV 2.14 µV 3.8 MHz 3.42 µV 1.70 µV 29 MHz 3.31 µV 1.19 µV 50.4 MHz 11.1 µV 3.84 µV
FM sensitivity: For 12 SINAD, 28 – 30 MHz and 50 – 54 MHz, 0.35 µV.	For 12 dB SINAD, 3 kHz deviation, 15 kHz BW: *Preamp* *Off* *On* 29 MHz 4.51 µV 0.56 µV 52 MHz 1.84 µV 0.66 µV
Blocking gain compression dynamic range: Not specified.	Blocking gain compression dynamic range, 500 Hz BW; *20 kHz offset Preamp off/on* — *5/2 kHz offset Preamp off* 3.5 MHz 95/98 dB 75/58 dB 14 MHz 94/99 dB 75/58 dB 50 MHz 94/96 dB 77/69 dB
Reciprocal mixing dynamic range: Not specified.	14 MHz, 20/5/2 kHz offset: 91/91/70 dB.

ARRL Lab Two-Tone IMD Testing (500 Hz bandwidth)

Band/Preamp	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR*
3.5 MHz/off	20 kHz	−122 dBm	−33 dBm	89 dB
		−97 dBm	−24 dBm	
		−34 dBm	0 dBm	
14 MHz/off	20 kHz	−124 dBm	−32 dBm	92 dB
		−97 dBm	−17 dBm	
		−42 dBm	0 dBm	
14 MHz/on	20 kHz	−135 dBm	−43 dBm	92 dB
		−97 dBm	−28 dBm	
14 MHz/off	5 kHz	−124 dBm	−53 dBm	71 dB
		−97 dBm	−43 dBm	
		−13 dBm	0 dBm	
14 MHz/off	2 kHz	−124 dBm	−55 dBm	69 dB
		−97 dBm	−44 dBm	
		−10 dBm	0 dBm	
50 MHz/on	20 kHz	−130 dBm	−38 dBm	92 dB
		−97 dBm	−26 dBm	

Second-order intercept point: Not specified.	Preamp off/on: 14 MHz, +37/+37 dBm; 21 MHz, +39/+39 dBm; 50 MHz, +47/+47 dBm.
FM adjacent channel rejection: Not specified.	Preamp on: 29 MHz, 59 dB; 50 MHz, 66 dB.

Manufacturer's Specifications	Measured in the ARRL Lab
FM two-tone, third-order IMD dynamic range: Not specified.	Preamp on: 20 kHz offset, 29 MHz, 59 dB;* 52 MHz, 66 dB.* 10 MHz offset, 114 dB; 52 MHz, 116 dB.
S-meter sensitivity: Not specified.	For S-9 signal, preamp off/on: 14 MHz, 65.2/10.0 µV; 50 MHz, 70.7/12.3 µV.
Squelch sensitivity: Not specified.	At threshold: Preamp on, FM, 29 MHz, 1.32 µV; 52 MHz, 1.35 µV. SSB, preamp off/on, 14 MHz, 0.66/0.11 µV.
Receiver processing delay time: Not specified.	116 ms.
Spurious and image rejection: IF rejection, 60 dB. Image rejection, 70 dB.	IF rejection: 14 MHz, 96 dB; 50 MHz, 86 dB. Image rejection: 14 MHz, 76 dB; 50 MHz, 69 dB.
IF/audio response: Not specified.	Range at –6 dB points:** CW (500 Hz BW): 492 – 822 Hz; SSB (2.4 kHz BW): 310 – 2,720 Hz; AM (6 kHz BW): 2 – 3,830 Hz.
Transmitter	**Transmitter Dynamic Testing**
Power output: 5 W (CW, SSB, FM); 1.5 W (AM).	At 13.8 V dc: HF, 0.5 to 5 W (typical CW, SSB, FM); 50 MHz, 0.4 to 3.7 W. At minimum operating voltage: HF, 4.75 W (typ.); 50 MHz, 3.7 W.
Spurious and harmonic suppression: 45 dB.	HF, 68 dB typical; 51 dB worst case (15 m); 50 MHz, 67 dB. Meets FCC requirements.
Third-order intermodulation distortion (IMD) products: Not specified.	3rd/5th/7th/9th order, 5 W PEP: –37/–43/–48/–51 dB (HF, typical) –26/–35/–44/–49 dB (worst case, 160 m) –36/–40/–45/–48 dB (50 MHz)
CW keyer range: 5 to 100 WPM.	Tested at 3.4 to 40 WPM, iambic modes A and B. See text.
CW keying characteristics: Not specified.	See Figures 2 and 3.
Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.	SSB and CW, AGC fast, 214 ms.
Receive-transmit turnaround time (TX delay): Not specified.	SSB, 184 ms; FM, 29 MHz, 100 ms; 52 MHz, 122 ms.
Transmit phase noise: Not specified.	See Figure 4.
Size (height, width, depth): 2.0 × 7.1 × 3.8 inches (including protrusions); weight, 2.0 lbs.	

†Receiver tests with 500 Hz IF filter and 300 – 800 Hz audio filter.
*Measurements are noise limited at the value indicated.
**DSP is adjustable

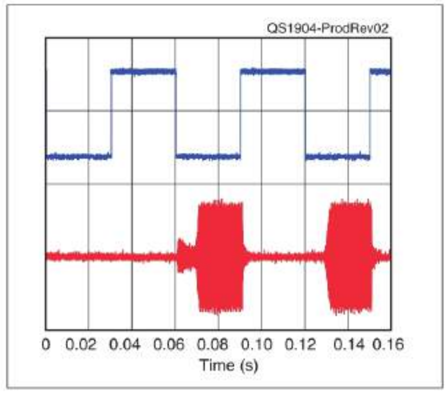


Figure 2 — CW keying waveform for the Xiegu X5105, showing the first two dits in full-break-in (QSK) mode using external keying and the default rise time setting. Equivalent keying speed is 40 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 ms. The transceiver was being operated at 5 W output on the 14 MHz band.

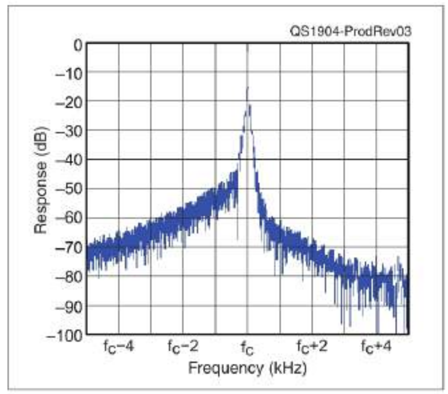


Figure 3 — Spectral display of the Xiegu X5105 transmitter during keying sideband testing. Equivalent keying speed is 40 WPM using external keying and the default rise time setting. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 5 W PEP output on the 14 MHz band, and this plot shows the transmitter output ±5 kHz from the carrier. The reference level is 0 dBc, and the vertical scale is in decibels.

The X5105 is an excellent semi-break-in performer if you leave the break-in delay set at the default 200 milliseconds.

Another CW issue is that glitch at the beginning of the first dit on any new transmission, as can be seen in Figure 2. This glitch does not reoccur until you pause long enough for the receiver to recover and then transmit again. However, I could not hear anything funny with that first dit when listening on an adjacent receiver. So this is more of an "observable on an oscilloscope" problem and not so much of a real-world problem.

The last issue has to do with the CW rise and fall times. Although the CW keying waveform has improved significantly since initial testing (see the "Lab Notes" sidebar), the rise time is only about 1.5 milliseconds, and the fall-time is even less. Typically, rise/fall times shorter than about 4 milliseconds lead to key clicks. As you can see in Figure 3, the keying sidebands are stronger below the intended frequency.

I cabled a sampled S-7 signal from the X5105 into a separate monitor receiver (an IC-706MKIIG with 500 Hz CW filter). Key clicks were noticeable up to

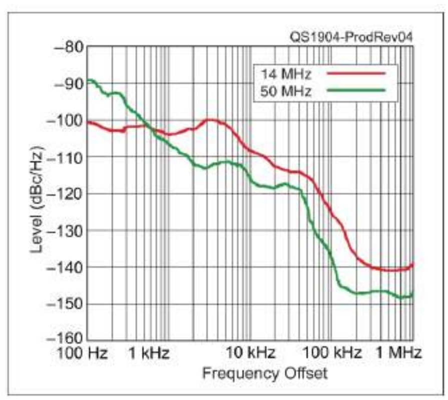


Figure 4 — Spectral display of the Xiegu X5105 transmitter output during phase-noise testing. Power output is 5 W on the 14 MHz band (red trace), and 3.7 W on the 50 MHz band (green trace). The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 100 Hz to 1 MHz from the carrier. The reference level is –80 dBc/Hz, and the vertical scale is 10 dB per division.

5 kHz below the X5105's transmit frequency, and 2 kHz above the transmit frequency with this quiet setup. As a comparison, when my Elecraft KX3 was connected into the same setup, I heard no key clicks.

Of course, with the typically low signal levels of QRP transmitters, the key clicks will fall below the normal band noise floor. During numerous contacts, I asked the receiving stations to tune off to the side, and they were unable to hear the clicks. Regardless of whether they can be heard or not, the key clicks contribute to the noise floor, and the problem will undoubtedly show up if an external amplifier is used. I hope that Xiegu will continue to improve the rise/fall times in a future firmware update.

Voice Operation

Speech compression is turned on and off via a soft key in the **FUNCTION** menu. Compression level and microphone gain are set in the **SYSTEM** menu. While there is no transmitter audio equalizer, the transmit audio is excellent, as monitored on a separate transceiver as well as on-the-air reports.

The default SSB filter bandwidth is 2.4 kHz, but you can select a 6 kHz bandwidth for receiving extended SSB (ESSB). You can also adjust the low- and high-pass receive. I found that the default receive audio passband response was very pleasant.

Lab Notes: Xiegu X5105 HF/6-Meter Transceiver

Bob Allison, WB1GCM, ARRL Lab Assistant Manager

The Xiegu X5105 is the first HF and 6-meter transceiver from China that we have tested with acceptable results at the ARRL Laboratory. These results didn't come easily, with much testing in the ARRL Lab and with great cooperation from US distributor MFJ and the manufacturer.

Initial testing in early 2018 showed that the X5105 had several issues. The CW keying had no shaping whatsoever, with resulting key clicks and a broad keying spectrum. It also transmitted high harmonic levels, with a total harmonic power greater than the fundamental power. It transmitted on all frequencies that it could receive on. MFJ worked with the manufacturer to clear up these issues and make the radio legal for use by US amateurs. The current X5105 reviewed here complies with FCC spurious emission suppression requirements and transmits only within the amateur bands, and these changes have been made in current production radios.

The X5105's receiver has adequate SSB and CW sensitivity; it can hear signals at or below a typical rural listening environment (about –120 dBm). FM sensitivity is also adequate, but AM sensitivity could be a bit better on 6 meters.

The lowest dynamic range at 2 kHz spacing is blocking at 58 dB, which is not great compared to current desktop radios. With the AGC off (our standard test condition), a single signal at –66 dBm (S-9 plus 7 dB), 2 kHz away, will start to lower the intended (tuned) signal's audio level. A stronger adjacent signal will significantly lower the audio level of the tuned signal. This may not be a problem during portable operation, but more of a problem when using a substantial antenna during good band conditions or if you live near other stations that are using the same band. Third-order IMD dynamic range and reciprocal mixing dynamic range are on par with other economy transceivers. Image and IF rejection are adequate.

The X5105's transmitter has reasonably low transmit audio IMD. The transmit phase noise is a bit high up to 11 kHz away from the transmitted signal, but not the highest we've seen in the Lab. As discussed in the text, the keying waveform lacks the fall time needed for narrow keying sidebands, but transmissions are free from audible key clicks. Because of the higher-than-normal keying sidebands and transmitted phase noise, I would not recommend using a power amplifier with the X5105.

Despite some shortfalls, radio amateurs should be able to enjoy using the Xiegu X5105 for portable operation at a park, beach, or picnic table in the backyard on a sunny day.

Digital Modes

The X5105 can be operated with a computer and sound card for FT8, RTTY, PSK, or any of the other popular digital modes. You will need to build or buy an interface cable with a mini-DIN eight-pin connector for the radio and appropriate connectors for your computer sound card. The interface connections are well documented in the X5105 user manual.

The X5105 does have a built-in receive modem, enabled via the **SYSTEM** menu, for copying PSK31 signals without using a computer. When a PSK31 signal is centered on the display, the modem locks to it and begins displaying up to three lines of streaming text below the LCD screen. As PSK31 tuning is critical, the automatic frequency control (AFC) correction option can be turned on to ensure the decoder stays locked to the incoming signal.

Other Features

The X5105 can drive the internal speaker, an external speaker, or external headphones. When using headphones, press the **SPK** soft key in the **FUNCTION** menu to attenuate the audio output because the 600 mW normal speaker output is too high for headphones and your ears. A speaker or headphone icon appears on the screen, so you know which audio level mode is selected.

The X5105 receiver includes a preamp and attenuator. It also has an adjustable noise blanker and DSP noise reduction. Split-frequency operation is available, and the split operation can be set for the same band — or even different bands. There is even a scan receive mode that will sweep the selected band and graphically display band activity.

There are 100 memory channels available, each of which may be custom labeled. I used 10 of these for the five CW and five SSB center frequencies for 60 meters.

The X5105 accessory port (labeled **ATU**) provides dc voltage levels that may be used to drive remote band-switching devices, such as amplifiers and antenna switches. However, the well-documented voltages do not conform to any current band voltage standard, so you must create your own interface circuitry if you use external, non-Xiegu products.

Finally, the X5105 can plot SWR within any given ham band. This is a neat feature that makes tweaking a portable antenna easy in the field — no antenna analyzer needed. The default scan width is 100 kHz in 1 kHz steps (±50 kHz of center). Both the step spacing and center frequency are displayed. One complete scan requires about 15 seconds. Five scan width settings are available, each with 100 sampling points (100/200/300/400/500 kHz). The X5105 continuously scans until **QUIT** is pressed.

Conclusion

The Xiegu X5105 is a well-thought-out package that will interest the QRP operator. Everything needed is built in, including a lithium battery, so it is particularly easy to carry along on vacation or in the field. There are no options necessary, and no external devices to cable up for normal CW and SSB operation. Just connect your antenna and mic or key, and operate.

Manufacturer: Xiegu Technology Co. Ltd., **www.cqxiegu.com.** Distributed and supported in the US by MFJ Enterprises, 300 Industrial Park Rd., Starkville, MS 39759, **www.mfjenterprises.com**. Price: $600.

Visit https://youtu.be/QxVI2VPpaC4 to see our review of the Xiegu Communication X5105 HF/6-Meter QRP Transceiver on YouTube.

Antenna Disconnectors from Paradan and INRAD

Reviewed by Ward Silver, N0AX
QST *Contributing Editor*
n0ax@arrl.org

Bottom Line

These Paradan and INRAD antenna disconnect devices offer an easy way to automatically ensure that your antenna is disconnected from your radio when not in use, offering some protection against transients from nearby lightning strikes. For best results, careful attention to station grounding and bonding practices is required.

In the August 2014 issue of *QST*, Phil Salas, AD5X, described a feed line control box that included lightning and static discharge protection for his Elecraft KAT500 amplifier's three outputs.[1] Relays grounded the antenna lines when power was removed, and a gas discharge tube (GDT) acted as a voltage clamp for transients on the feed line when power was on. At the time, I thought it was a great idea to automatically protect the equipment outputs.

After I got serious about building my station in rural Missouri, where lightning is common, the idea of protecting the transceivers resurfaced. Operating the station by remote control is also something I want to do, and I am not at the station all the time to connect and disconnect cables. Lightning protectors are installed on all of the feed lines, but leaving the radios and amplifiers connected seemed too risky. Then I discovered the single-line INRAD Antenna Disconnect Actuator (DCA) and the

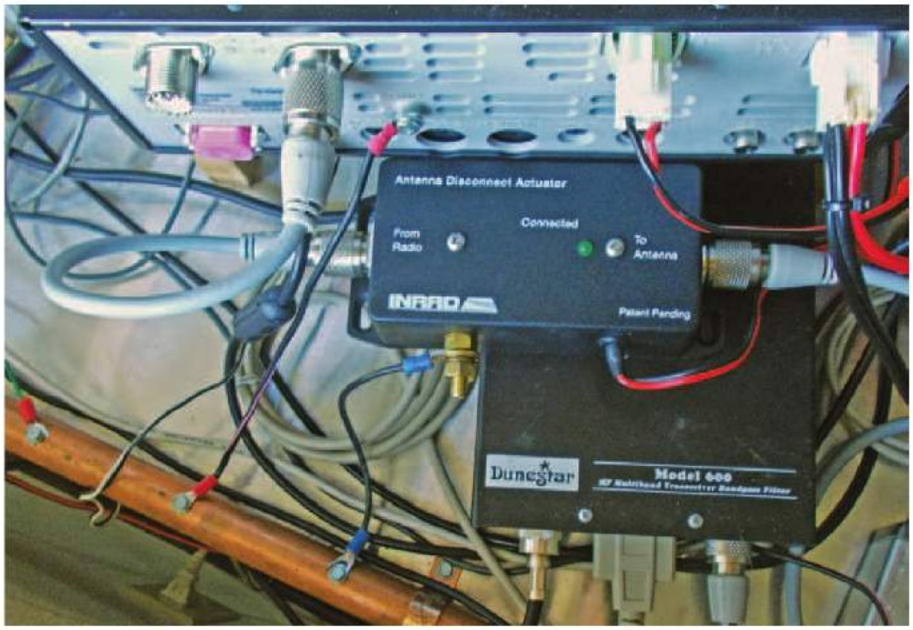


Figure 5 — The single-line INRAD DCA protection unit installed at the back of the reviewer's Kenwood TS-590S transceiver. Power is supplied from the TS-590S antenna tuner connector. Both the radio and disconnect unit are connected to the station ground bus (see text). A more effective location would be at a station's grounded entry point for feed lines with a short connection to the ground system.

Paradan Radio Dual Antenna Disconnector. (Paradan also offers a single-line model, and as this review went to press, INRAD announced that they would be adding a dual-line unit to their product line.) These units simulate unplugging the feed line from the radio and grounding the antenna when the radio is not in use.

How It Works

Both the INRAD and Paradan manuals include schematic diagrams, and the INRAD DCA manual is available online. Operation of all models is similar. When power is off, a relay shorts the **TO ANTENNA** connector to the unit's case. The relay also disconnects the **FROM RADIO** connector shell from the case. As a result, the output connector is completely disconnected from the radio and the feed line to the antenna is shorted. When power is on, the input and output are directly connected, with the shell connected through the relay and the case.

A GDT is connected across the input connector to protect the radio if a transient occurs while power is applied. (The GDT is shorted by the relay when power is off.) The GDT breakover voltage is not specified, but it must be high enough to not trigger on normal RF output. If the unit is rated to handle 1.5 kW, that's 385 V_{PK} at 50 Ω and higher as SWR increases (33% increase for an SWR of 2:1). I asked Paradan and learned that the GDT is rated at 600 V. Lower-voltage transients will not trigger the GDT and will be passed through (if power is on). That won't faze an RF power amp, but it might cause problems for a 100 W transceiver. Once the GDT fires, it will clamp the transient to about 15 V until the arc quenches from lack of energy. A low-power version of the protector might be a good addition to this product line. Remember that this product only protects the RF port and not accessory inputs and outputs, such as USB computer interfaces or control signals.

The single-line unit draws 60 mA at 12 V dc when power is on (120 mA for the dual-line version), driving the relay(s) continuously. In most cases, 12 V power is available from an accessory jack on the radio. This allows the unit to be switched automatically by turning on the radio. The Paradan and INRAD units both come with a phono plug installed on the power leads. Anderson Powerpole connectors and barrel crimp terminals are also supplied if you need to change connectors or add length — a nice touch.

The antenna disconnector can be wired directly to a radio power supply rather than powered from the transceiver. In this case, turning on the power supply will also power the dis-

Table 2
INRAD Antenna Disconnect Actuator

Manufacturer's Specifications

Frequency range: 1.8 to 54 MHz.
Power requirements: 10 – 18 V dc at 60 mA when turned on to connect antenna.
Insertion loss: <0.05 dB at 29 MHz, <0.1 dB at 54 MHz.
Power rating: 1.5 kW.
Relay contact rating: 15 A.
Size: 4.8 × 2.6 × 1.6 inches, not including mounting tabs. Weight, 13 oz.
INRAD division of Vibroplex, 1001 North Broadway St., Knoxville, TN 37917; **www.vibroplex.com**. Price: $109.95.

connector and connect the radio to the antenna. If you want to leave the power supply on all the time but turn the radio on and off, you'll need Paradan's optional Radio ON Sensor. The sensor can turn the disconnector on and off by sensing the radio's current draw. I did not test the sensor, as it was unneeded in my station.

The Ground Connection

The ground terminal is certainly heavy enough — a ¼-inch brass stud. A crimp terminal to fit the stud is also included with the unit. The instructions direct you to *not* connect the ground stud directly to the transceiver ground. Rather, the connection is supposed to be made directly to an external ground, such as a ground rod. A connection to the radio's ground terminal or local RF bonding bus creates a path around the unit, so the feed line shield remains connected to the transceiver, although the center conductor is shorted to the case.

I understand the reasons for this instruction, but it's probably impractical if the unit is installed inside the station. My initial connection of the INRAD Antenna Disconnect Actuator is shown in Figure 5. This is a likely behind-the-radio installation with the ground stud connected to a grounding RF bonding bus. This configuration does protect the radio, but the amount of protection depends on the quality of the overall ground system.

A long connection to an external ground will have a lot of inductance, even if heavy wire or a strap is used. That means a sharp transient on the feed line will result in a transient on the case, as well. For this reason, it is best to install the unit on or near a feed line point of entry or on a single-point ground panel (SPGP) with a very short, direct connection to an external ground system.[2]

The Dual-Line Version

Paradan's Dual Antenna Disconnector is intended for radios with two antenna jacks that are used with two separate antennas. Think of it as two separate single-line disconnectors in one box. I decided to try using it to protect both radios in my two-radio station, replacing the single-line unit I had been using previously on one of the transceivers.

I have two transceivers and two amplifiers connected to a 2 × 6 antenna selector (two radios, six antennas). Each output of the selector is connected to a four-position remote coax switch. The Dual Antenna Disconnector was installed between the amplifiers and the 2 × 6 switch. Both transceivers are connected to the antenna system through the amplifiers and the disconnector all the time. Two single-line units could be installed here, as well.

All of these devices are mounted in and bonded to a 19-inch rack cabinet that serves as the central connection for the station's ground system. There is also an SPGP where all of the outside feed lines enter the station that is connected to the perimeter ground. Figure 6 shows the dual-line unit mounted on the rack panel that also serves as the station's main inside ground point. The ground panel is connected to the external perimeter ground system with about 5 feet of #6 AWG wire.

Figure 6 — The Paradan Radio Dual Antenna Disconnector protection unit installed on a grounded rack panel. Cables at the top connect to the amplifier outputs. Cables at the bottom routed to the nearby 2 × 6 antenna switch are also bonded to the rack. The panel is grounded to the station perimeter ground with a short length of #6 AWG wire.

Table 3
Paradan Dual Antenna Disconnector

Manufacturer's Specifications

Frequency range: 1.8 to 54 MHz.

Power requirements: 10 – 18 V dc at 120 mA when turned on to connect antennas.

Insertion loss: <0.05 dB at 29 MHz, <0.3 dB at 54 MHz.

Power rating: 1.5 kW (each line).

Relay contact rating: 15 A.

Size: 5.5 × 3.5 × 2.5, not including mounting tabs. Weight, 2 lb.

Paradan Radio, 1221 Seminole Dr., Satellite Beach, FL 32937; **paradanradio.com**. Price: Dual Antenna Disconnector, $190; Radio On Sensor, $90; Antenna Disconnect (single line), $110.

Disconnector Performance

Specifications for the INRAD and Paradan units are shown in Tables 2 and 3. For both units, the extra length of the connection from the output connector shell through the relay to the case does not raise the SWR on any of the HF bands or on 6 meters, the highest frequency specified for the disconnect devices. Insertion loss was unnoticeable from 1.8 through 54 MHz for either the single- or dual-line units.

Isolation from input to output with the disconnector off is not specified, but I could estimate it by unplugging the unit's power while monitoring a strong signal. On 14 MHz, an S-9 signal dropped well below S-1 when the disconnector power was removed. That's at least 40 dB of attenuation at 5 dB per S-unit, and 48 dB at 6 dB per S-unit. On 80 and 160 meters, signals dropped completely into the residual noise floor. On 6 meters, the signal was still slightly audible but not strong enough to move the S-meter, even with the preamp on.

The final proof for this product is what happens during a lightning storm. The Paradan manual clearly states there have been no "direct strike" tests. That would be beyond the resources available to most small manufacturers of gear for amateurs. I can say, though, that since installing the disconnectors, there have been several severe weather events around my station with lots of lightning, but the equipment is unscathed. I've had some damage previously, so I know it's possible. This isn't a conclusive test, of course, but I do feel better with this extra level of protection for the transceiver and amplifiers.

Notes

[1]P. Salas, AD5X, "Antenna Feed Line Control Box," *QST*, Aug. 2014, pp. 40 – 44.

[2]My recent book *Grounding and Bonding for Radio Amateurs* (**www.arrl.org/shop/Grounding-and-Bonding-for-the-Radio-Amateur**) covers this and related subjects in detail and will explain unfamiliar jargon and abbreviations such as SPGP.

Heil Parametric Receive Audio System (PRAS) and Powered Speaker

Reviewed by Joel R. Hallas, W1ZR
QST *Contributing Editor*
w1zr@arrl.org

The Heil PRAS package includes a compact parametric control preamplifier and a 24 W amplified, two-way speaker with a 5-inch, low-frequency driver and 2-inch tweeter in a medium-sized bookshelf enclosure, as shown in Figure 7. The preamplifier allows significant control of frequency response. It is intended to improve articulation of received audio, especially for those with hearing impairments, but provides better receive audio for all listeners.

A Close Look

The PRAS is quite different from the usual parametric equalizer, which typically allows control of audio response in multiple narrow ranges. Instead, this system is focused specifically on maximizing the articulation of received voice signals. The frequency range is divided into just three ranges: **HIGH**, centered on 6 kHz; **LOW**, centered on 160 Hz; and **MID**, with adjustable focus from 800 Hz to 4 kHz. It is the middle range that is most important to articulation, and by being able to adjust the frequency of the peak of the response, and its level there, the system is said to be able to improve the readability of the received voice signal. While designed for voice, the CW response works very well also.

Even for those of us with reasonably unimpaired hearing, the adjustments can definitely improve the audio quality, particularly of voice signals. I suspect there could be a more significant improvement to those with some kinds of hearing impairments that could use a boost or cut in some portions of the audio spectrum. If you have a particular hearing issue, I suggest you try to find someone with a PRAS and see if it helps. Alternately, your audiologist or hearing specialist may be able to compare your needs to the benefits provided by the PRAS.

Documentation

The PRAS comes with a six-page instruction booklet that provides inter-

Bottom Line

The Heil Parametric Receive Audio System and companion HPS-5 two-way speaker can provide enhanced articulation to your transceiver's receive audio system. This can help compensate for some hearing limitations or significantly improve the sound of your received audio.

Figure 7 — The Heil HPS-5 amplified speaker.

connection diagrams and suggestions on how to adjust the preamp to solve different kinds of issues. In addition, a single sheet indicates the suggested starting positions of all the controls.

The manual does not include specifications, such as the range of cut and boost levels, which might be helpful with those wishing to overcome specific hearing limitations. That information is provided on the Heil website, however.

Setup

I set up the PRAS to use with my Elecraft K3 transceiver. The connections, shown in Figure 8, are straightforward, with cables provided in the package. The preamplifier has **INPUT** connections sized for ¼-inch or ⅛-inch stereo plugs, as well as for a three-pin balanced XLR plug. While one might expect the three input choices to have equal response, at least on our unit, the ¼-inch input had significantly less gain than the ⅛-inch jack. I didn't have a cable or adapter to allow checking the XLR input. The instructions recommend using the ⅛-inch jack, but they don't say why.

An input cable with ⅛-inch stereo plugs is provided, along with an adapter for ¼-inch plugs, but as noted above, that is best used on the transceiver end if needed. The preamplifier output is provided via an XLR or ¼-inch jack, and an XLR-to-XLR cable is provided to interconnect to the speaker. The speaker also has a ⅛-inch input jack that makes it easy to use the supplied cable to bypass the preamp, if desired. While the speaker sounds nice by itself, inserting the preamplifier can make a major improvement by being able to shape the response.

I should mention that the PRAS is a monoaural system, as are many HF transceivers. The K3 transceiver has two audio channels, which can be used in multiple ways, but with the PRAS, the two channels are combined at the input, resulting in a single audio channel going toward the speaker. For many, this won't be an issue at all, but it is important to understand what you will be getting. If you find the PRAS helpful to your hearing and want to receive two channels separately, for example to listen on two frequencies from separate receivers, a second PRAS system with its speaker on the other side of the radio would be an option.

Using the PRAS

The audio out of the PRAS definitely sounded easier to listen to and comprehend than audio either from the K3's internal speaker, or from the pair of relatively inexpensive stereo bookshelf speakers that I generally use with the K3. Operating the PRAS is quite straightforward. Once the tonal balance is set the way you want it, all speaker reception operations can be carried out from the front panel controls of the transceiver, as with any other speaker.

While not even close to the bandwidth limiting that a DSP filter can provide, during reception of weak signals, the PRAS system offers some signal-to-noise improvement by reducing the high-frequency level response, as well as by shifting the peak of the mid-range to a somewhat lower frequency.

You can also use the PRAS with headphones. Instead of plugging your headphones into the transceiver, they plug into headphone jack **1** or **2** on the front panel of the preamp. Use of these jacks doesn't disable the speaker. Instead, there are separate **HEADPHONE LEVEL** controls for each jack on the preamplifier front panel. The **OUTPUT LEVEL** control just adjusts the speaker level, so all three outputs can be adjusted separately, which is nice for use by multiple listeners with different hearing sensitivity.

There is also a front-panel jack for use with a media recorder. This ⅛-inch stereo jack also has its own **REC LEVEL** control.

A potential operational concern I observed is that, if using the supplied power adapter, both the speaker and preamplifier must be turned on and off using switches on the rear panels of each unit. This might be inconvenient in some installations. Both specify that the power required is 12 V dc, so an alternative might be to supply power from your station's 12 V dc power supply and make use of its **POWER** switch instead. Bob Heil confirmed that the usual station 13.8 V dc supply is suitable to the task. Another option would be the use of a switch-controlled power strip that you probably have anyway.

I also found that, while running key-down CW at 1,500 W PEP output, I had RFI pickup on most bands,

Figure 8 — PRAS rear panel, showing the connections described in the text.

resulting in a hum showing up in the speaker and overwhelming the CW sidetone note. There was also a bit of chatter during SSB voice peaks. The effect wasn't there at 100 W, and it was reduced considerably after I put a heavy, unidentified snap-on RFI bead found on my workbench around the speaker input and power cables. Based on this success, I would expect normal RFI remediation techniques could eliminate or reduce the problem. My amplified computer speakers act the same way, if turned on. Of course this doesn't impact the quality of the receive audio, but it is annoying.

Final Thoughts

There is no question that the PRAS preamplifier and speaker can make some very nice sound. Improvement in articulation compared to what you would get by using a good quality speaker directly connected to your transceiver will depend on the capabilities built into your transceiver. For example, my transceiver has an eight-band parametric equalizer that can be adjusted to change the level within each of the bands by ±16 dB. While it would take a bit longer, and would be less convenient, I'm sure I could come up with the same response I would want from the PRAS using my built-in system. On the other hand, this functionality is not provided in many other amateur transceivers, which could be beneficial.

Then there's the speaker. While there are many high-quality, low-distortion speakers around, Heil has made the selection simple by providing the whole matched package.

Manufacturer: Heil Sound; 5800 North Illinois, Fairview Heights, IL 62208; **www.heilsound.com**. Price $490.

Mortty Morse Code and RTTY Keying Interface Kit

Reviewed by Rich Cady, N1IXF
n1ixf@arrl.net

Interfacing your computer to your radio for keying CW, RTTY, or both just got a little easier and more convenient. Even better, the device reviewed here produces keying that may be superior to typical serial COM port solutions, because it doesn't rely on that port, your logging program, Windows, or your computer's processing capabilities to generate the proper timing. Utilizing open-source software that runs on the popular Arduino Nano microcontroller, Larry Gauthier, K8UT, and Steve Smith, N8AR, are offering a hardware computer-to-radio interface kit — called Mortty — for sending CW or RTTY (frequency shift keying, FSK)

from your computer logging program. In keeping with the open-source concept, they have even made their schematic and hardware design available as copyrighted freeware, and provide a complete parts list with Mouser part numbers.

Bottom Line

Once assembled, the Mortty kit results in a very compact and professional-looking CW and/or FSK RTTY interface at a cost that would be hard to match if you tried to acquire all the discrete parts yourself.

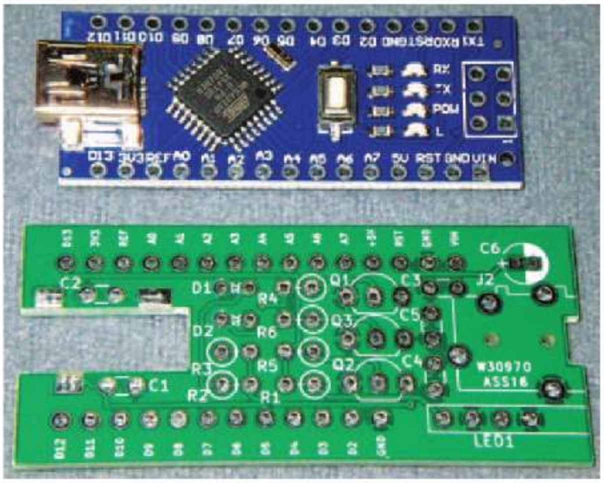
Mortty Advantages

While there are many ways to generate CW and FSK keying, the Mortty interface provides three distinct advantages. First, it doesn't rely on the increasingly rare serial COM port, instead using a USB interface to your computer. Second, the Mortty kit allows your logging program and computer to offload the production of perfect CW/FSK timing to its built-in Arduino Nano microcontroller, thereby minimizing the impacts of other competing tasks your operating system might deal with. Third, it is compact, offering a small "cable-like" connection with only a 2 × 1 × 1 inch box between your radio and computer.

The Mortty kit provides the hardware platform for any of three different Arduino software programs (called "sketches"):

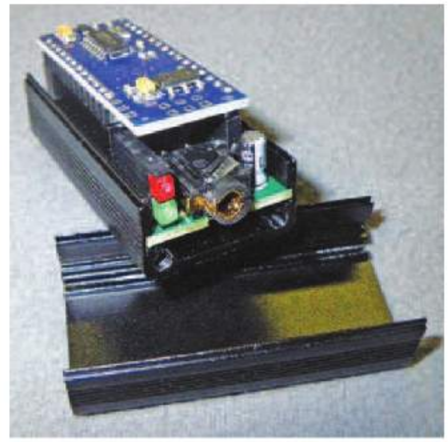
- K3NG's *Arduino CW Keyer* (**blog.radioartisan.com/arduino-cw-keyer/**) for Winkeyer CW interface protocol emulation;
- K0SM's *TinyFSK — An FSK Keyer for the Arduino Platform* (**www.frontiernet.net/~aflowers/tinyfsk/**) for a RTTY transmit solution; or
- W1HKJ's *NanoIO* (**www.w1hkj.com/files/nanoIO/**) for dual-mode configuration — CW and FSK — with *fldigi*. Note that solder bridge jumpers on the PC board are required to support software switching between CW and RTTY modes with the NanoIO sketch.

When you purchase the Mortty kit, you specify which of these programs you would like pre-loaded on your kit's Arduino Nano microcontroller,



◀ **Figure 9** — The Arduino Nano (top) will connect to the main PC board (bottom) with headers, so no point-to-point wiring is required.

▶ **Figure 10** — The completed Mortty interface with its enclosure. The miniature phone jack is for the cable to the transceiver's CW or FSK RTTY keying input.



although at any time, you can easily reprogram your Mortty's Arduino Nano to use any one of the other sketches. Instructions and a comprehensive video describing how to do this can be found on the Mortty website (**hamprojects.info/mortty/**).

Building the Kit

The kit (version 3) arrives with all the parts neatly packaged in a 6 × 9¾ inch plastic bag. That bag includes the Arduino Nano, pre-programmed as ordered and in an anti-static package; a two-piece aluminum enclosure; 3D printed plastic end caps along with two aluminum end caps if you wish to construct your own; a small parts bag with components (all through-hole parts except for a surface-mounted phone jack); and a high-quality, double-sided, through-plated PC board designed by N8AR (see Figure 9). That PC board is silk-screened, clearly showing the part locations.

As you begin assembly, you will immediately notice the attention that has been taken to develop a high-quality kit. It is evident in the well-documented assembly instructions with photographs of each construction step and the fit of the PC board/Arduino Nano assembly to the enclosure. The result is a finished package that is compact and professional in appearance. The labeling adds polish and the appearance of a commercially produced product to your assembly.

Nothing in the construction of the Mortty kit requires special skill beyond the ability to follow instructions and basic soldering experience. The kit is designed using headers to connect the Arduino Nano to the PC board. This means that there is no point-to-point wiring required and makes for secure connections. Additionally, the headers help ensure that the PC board/Nano assembly fits squarely into the enclosure. One caution: be sure to carefully follow the header assembly instructions or the assembly won't fit in the enclosure.

There's no need to fear the surface-mounted miniature phone jack. I first placed a little solder on one PC board pad, then simply reheated the solder once I had the jack positioned correctly on its pads. That held the phone jack in alignment while I soldered the other pads. I then touched up the first pad with a bit of fresh solder to ensure a good connection. Figure 10 shows the completed kit.

Using the Mortty

You'll need to supply a radio-specific cable connecting your rig's push-to-talk (PTT) and CW or FSK RTTY keying lines to the Mortty jack. Again, the manual provides suggestions to guide you in constructing this cable. In addition to sending messages from your logging software, you can connect a CW paddle to the Mortty for manual sending.

To use the Mortty after you've connected it between your radio and computer, you'll need to configure your logging/radio control program to utilize it. It is best to follow the instructions of your specific logging program and/or search the web for configuration details.

If you are configuring your logging program for the CW version of Mortty, you should follow that program's instructions for setting up a Winkeyer. For the RTTY version, you'll need to follow instructions for a TinyFSK setup in both your logging program and RTTY software (such as *MMTTY*, *2Tone*, or *GRITTY*).

Don't expect all the bells and whistles of a dedicated CW keyer or RTTY interface. For example, the Mortty uses the features of your logging program to set the CW speed rather than adding a speed potentiometer, and for RTTY, you will still need to separately interface the receive audio from your radio to your computer soundcard so that you can decode RTTY signals. What the Mortty does provide is a simple and effective keying solution for CW and FSK.

Manufacturer: Mortty — K8UT and N8AR Morse Code and RTTY Keyer; **hamprojects.info/mortty/**. Additional information and support is also available through the Mortty email reflector: **groups.io/g/mortty**. Price: $18 plus shipping.

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

The Doctor is In

Two Ways to Provide a Ground for a Monopole

Q Rich, W3OFD, asks: I have a commercial four-band trap vertical antenna currently mounted just above a buried radial field (with 17 radials) in place from a previous installation. I would like to mount it on top of a 12-foot mast that will be in the clear and above my roofline.

Can I just attach a ground wire from the antenna base to the existing radial field? How well will the antenna system work? Will the azimuth pattern still be omnidirectional? Will I need to use a remote tuner at the antenna base?

A There are two ways to set up the ground system for an antenna such as yours. The first is to ground-mount the antenna and use a large number of non-resonant buried or on-ground radials, as you have now. In that configuration, the electric field from the monopole will terminate at ground, the antenna will act like a quarter-wave monopole on each band, and off you go.

The alternate approach is to elevate the antenna base and use insulated, resonant (quarter-wave) radials, in place of the actual ground. In addition to getting the antenna "in the clear," raising it up (a reasonable amount) will also provide a lower peak radiation angle, which is better for long-range operation. Even two insulated radials (opposite each other) per band will provide higher efficiency than a fairly large number of buried radials. So, raising it up would be a good thing, but only if you can add the insulated radials built just like antennas — insulated from ground, except at the center.

Your idea of providing a ground by connecting the base to your existing ground field might work, but it won't be what you expect. The wire from the base to the ground field will act like part of the antenna itself, making it a kind of off-center-fed something.

I recommend you use at least two radial wires per band. Note that they don't have to be horizontal, but can droop downward if more convenient. It is best if the pair for each band be opposite each other to preserve the omnidirectionality. While three or four per band might be even better, any difference will not likely be noticeable. If you make some strong enough and keep them insulated, they could also do double duty as guy wires to hold up your mast. Note that the outward ends of the radials are a high-RF voltage point, so protect them from accidental contact, especially if they get below 8 feet above the ground.

The *EZNEC*-modeled performance is shown in Figures 1 and 2 for a representative band.[1] Figure 1 is the elevation pattern of a 20-meter quarter-wave fed against a ground radial system of 16 quarter-wave buried radials (*EZNEC* medium ground, conductivity 0.005 S/m, dielectric constant 13). The azimuth pattern is omnidirectional. Note that while that is a close match to what you had, the performance of a monopole with buried radials could be improved with more radials. It becomes diminishing returns after perhaps 30 to 60 radials, depending on ground conductivity. An important rule of thumb is that for any limited length of radial wire, more short radials work better than a few longer ones, but 30 to 60 long ones are even better.

Figure 2 is a similar plot of the same monopole with a base of 12 feet above the same ground, but without the buried radials, instead using two

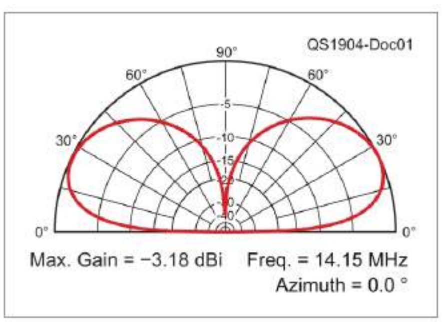


Figure 1 — *EZNEC* elevation plot of a ground-mounted quarter-wave monopole on 20 meters. The antenna version is fed against 16 buried quarter-wave radials.

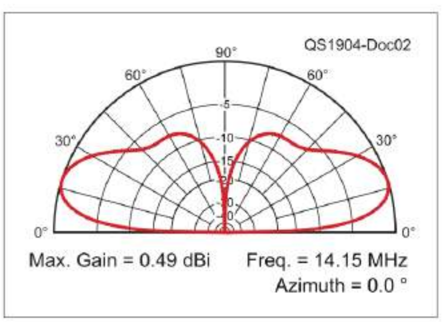


Figure 2 — Elevation plot of a quarter-wave monopole on 20 meters with its base elevated 12 feet above ground. This version of the monopole in Figure 1 is fed against two elevated quarter-wave radials above bare ground.

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

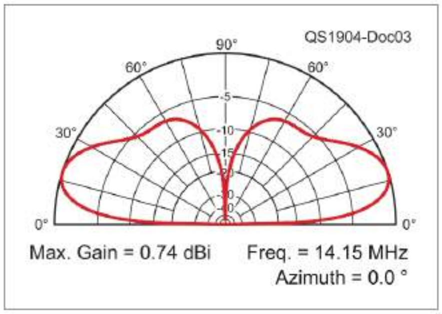


Figure 3 — The same as Figure 2, except that the buried radials of Figure 1 are still in place and tied to the antenna base. In addition to providing a lightning ground, this actually adds a bit of additional gain. So, if you have the ground field in place, there's no need to remove it.

quarter-wave, insulated, resonant (quarter-wave-long) and elevated wire radials. Note the improvements in performance:

- The peak gain has increased from –3.2 dBi to +0.49 dBi, an increase in intensity of almost 3.7 dB. That's about ⅔ of an S-unit — not too shabby for a piece of pipe!
- Of possibly more significance for the DXer, the peak elevation angle has been reduced from 26° to 18°. This will provide additional long-distance coverage.

In another piece of good news, you don't have to remove the old radial field. As long as you have provided the elevated radials as a termination for the transmitted electric field, you can leave the buried radials in place beneath the antenna and drop a vertical wire from the base to the center of the radial field. It will provide some lightning protection and even give you a few tenths more of a dB gain! See Figure 3.

The lower the frequency band, the more likely it is that the ground-mounted approach will be the one selected, because both the required height and width of the elevated radials can be a problem for the elevated system, especially on 80 and 160 meters.

Q Ken, K0KS, asks: How does an autotuner cause such poor propagation? I got a call from a friend who was having trouble making contacts with his regular antenna, being fed by his autotuner. While he was transmitting with 600 W, the tuner tuned fine, but nobody would answer him. When I got a call from him and listened, the 40-meter band seemed alive, so why was his propagation so bad? A short trip to his house and a look at the meters indicated that the antenna SWR was 10:1 and the tuner was doing its job.

I'm wondering how many of us take that autotuner for granted and don't realize when the antenna has changed, blaming lack of activity on the band, instead. Many autotuners, including mine, don't provide any feedback about the match.

A You raise a good point! Automatic antenna tuners are very convenient, but they can mislead us. Let's face it — an antenna that the tuner can tune when it's in the air, can often also be tuned while it's on the ground. This is usually not a problem with manual tuners, especially if we log the settings for each antenna at a number of frequencies within each band. Not only does this allow us to change settings for new frequencies quickly, but it gives us early warning that something is awry.

Another technique to use to make sure all is well is to record the antenna SWR on each band segment with the tuner bypassed, if that can be done with your tuner. I also try to have more than one antenna that can at least hear on every band. If I can't hear anything on one, but can on another, the band probably isn't dead. A simple field-strength meter can also be used to check that you are transmitting. While most do not offer calibrated readings, they should read the same anytime you check — as long as your antenna is still working.

Q Ken, N2DF, asks: It seems that repeater offsets typically increase as the frequency of the repeater increases. For example, a 10-meter repeater would have an offset of 100 kHz, while a 440 MHz repeater typically has an offset of 5 MHz. It seems that the 6-meter repeater band may have two offsets; 0.5 MHz for repeaters on 51 MHz and 1.0 MHz for repeaters with an output of 53 MHz. Is there any technical reason for this difference?

A The tough part of making a repeater is to keep the repeater's transmitted signal out of the repeater's receiver, because they both have to operate at the same time. All things being equal, the further apart the frequencies, the easier it is to make filtering with enough stop-band attenuation to be successful at keeping the repeater's transmitted signal from overwhelming the repeater's receiver.

One limitation is that both frequencies have to be in the same band (actually they don't, but most repeaters are set up that way). Thus, the 5 MHz spacing at 440 won't work on any lower frequency band, because they are all narrower than that. If you think about filters, the key is the fraction of bandwidth difference between the two frequencies. So, filters for frequencies separated by 600 kHz at 2 meters are similar in complexity to filters with about 210 kHz spacing on 6 meters, and about 119 kHz on 10 meters.

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

Also listen to the "ARRL The Doctor is In" podcast, sponsored by DX Engineering, on iTunes, Blubrry, Stitcher, or on the ARRL website at **www.arrl.org/doctor**.

Paul Wade, W1GHZ, w1ghz@arrl.org

VSWR, Return Loss, and Antennas

The last "Microwavelengths" column, in the January 2019 issue of *QST*, mentioned a return loss or VSWR (voltage standing wave ratio) shorted-aperture test for the 3D-printed horn antennas. There seems to be some confusion about return loss, so I thought it merited revisiting.

What we are really talking about is reflected power on a transmission line that is carrying RF power to a load, an antenna, or some electronic device. If the load is perfectly matched to the transmission line's characteristic impedance, then no power is reflected, and all the power gets to the load or antenna. More often, the load is not perfect, and some power is reflected and travels back from the load toward the transmitter. While this could easily be expressed as *n*% reflected, it is more common to measure the ratio of power reflected to power transmitted, so that absolute power measurement is not needed. The usual ways to express this ratio are VSWR or return loss.

Voltage Standing Wave Ratio

Voltage standing wave ratio refers to the standing waves created on the transmission line, shown in Figure 1. The power reflected from the load travels back along the line, adding in phase and subtracting out of phase with the transmitted or forward power traveling toward the load. Each load creates a unique pattern of standing waves that repeats every half-wavelength (an animated GIF illustrating standing waves may be found at **www.wa1mba.org/StandingWaves.htm**). The VSWR is the ratio of the maximum voltage (V_{max}) to the minimum voltage (V_{min}).

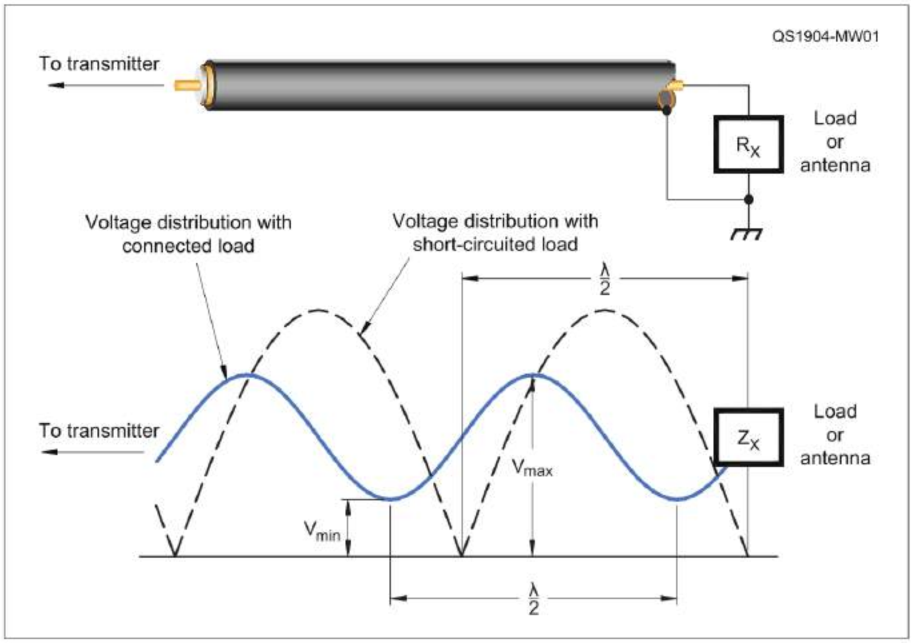


Figure 1 — The standing wave voltage along a transmission line for a typical mismatched load and for a short circuit.

In the worst case, a short circuit reduces V_{min} to zero, so the VSWR is V_{max} divided by zero, or infinite. A perfectly matched line with a VSWR of 1.0 would have no voltage variation along the line.

These standing waves are measured using a slotted line (see Figure 2) which samples the voltage at points along the line with a small probe inserted through a narrow slot in the coax outer conductor or the broad wall of a waveguide. Some typical coax and waveguide slotted lines are shown in Figure 3. By sliding the probe along the slot, the voltage on the line may be sampled to detect the standing wave. The ratio of the maximum to the minimum voltage is the VSWR. Slotted lines have been supplanted by the vector network analyzer (VNA), but are still a much less expensive way to make measurements in waveguide, if you can find or make a slotted line.[1]

Return Loss

Rather than VSWR, microwave engineers usually use return loss (RL), which compares the power flowing toward the load with the power reflected from the load in decibels. Since only the difference matters, absolute power accuracy is not required. A matched load will reflect no power at all (high return loss) and the worst possible load, a short or an open, will reflect all the power (low return loss).

In order to measure return loss, we need to measure the power flowing from the source to the load, while at the same time, we measure power reflected from the load back to the source. All this power is travelling on the same transmission line. A directional coupler (see Figure 4) sorts out the forward energy from the

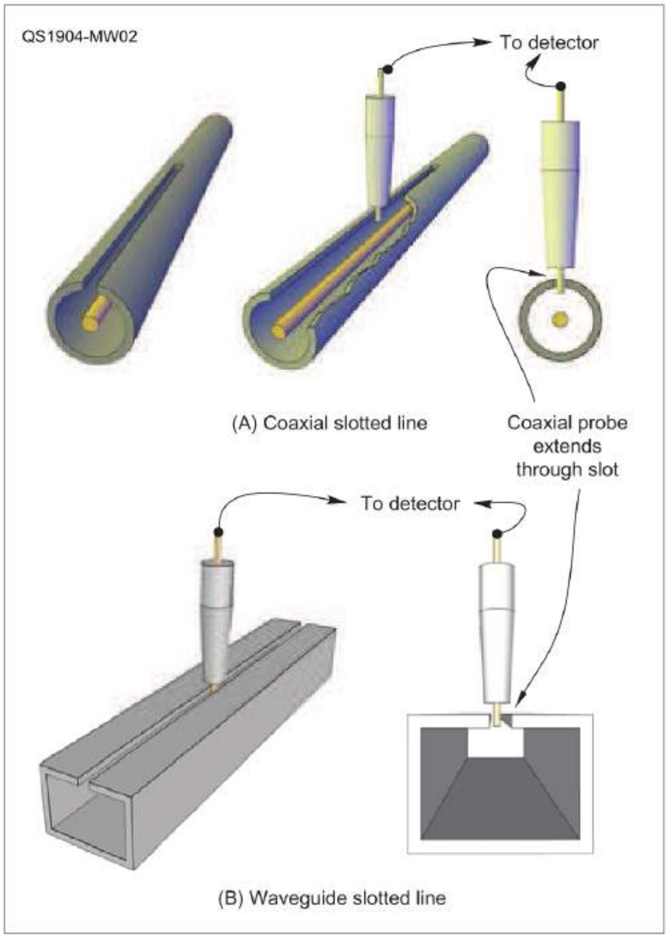


Figure 2 — A slotted line samples the voltage at points along the line with a small probe inserted through a narrow slot in the coax or the broad wall of a waveguide.

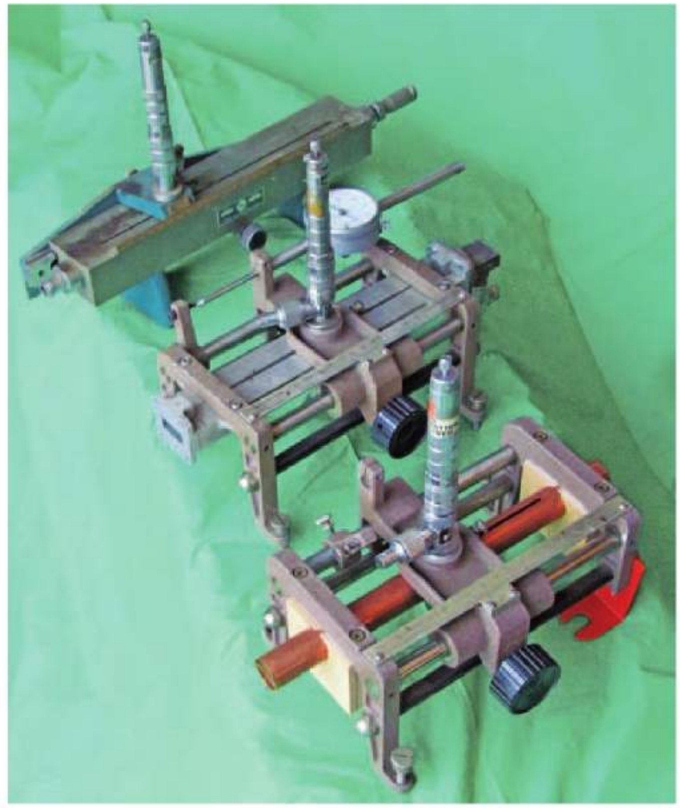


Figure 3 — Typical slotted lines. The top shows coaxial slotted line, the middle is a waveguide slotted line, and the bottom is a homebrew circular waveguide (water pipe) slotted line on surplus carriage.

reflected energy and extracts a small fraction of the power travelling in one direction on the transmission line. The coupler may be reversed for the other direction; a dual coupler can sample both directions simultaneously. A typical directional coupler extracts the sampled energy 20 dB or 30 dB below the power level in the transmission line — if the sampled power from one watt is 1 mW, the coupling is –30 dB. Directional couplers are available with coupling from 6 dB to 50 dB. The common Bird Model 43 Thruline® directional wattmeter indicates forward and reverse power by reversing the directional coupler in the slug, using slugs with different coupling for different power levels.

The important thing about a directional coupler is not the coupling ratio, but the directivity. No directional coupler is perfect — some power from the opposite direction always leaks through. Directivity compares the power sampled in the desired direction to the power leakage in the opposite direction. For instance, if the sampled forward power from one watt is 1 mW with a –30 dB coupling, and the sampled reverse leakage power is .01 mW and 50 dB down, then the directivity is 20 dB. But the leakage also makes the apparent return loss 20 dB, the difference between forward and reverse sampled power. The directivity limits the maximum return loss that can be accurately measured with a directional coupler — the leakage can add in phase with actual reflected power, making the measured return loss higher than actual, or it can add out of phase with actual reflected power, making the measured return loss lower than actual. Tuning for perfection could be making things worse rather than better.

Commercial directional couplers are often designed for flat coupling over a broad frequency range rather than high directivity. As a result, they typically have 15 dB to 25 dB of directivity over the broad bandwidth, but it can be better at some frequencies. With careful design and construction, it is possible to make homebrew directional couplers with higher directivity.[2] A VNA uses a calibration procedure and software correction to compensate for the directivity of internal directional couplers. The antenna analyzers used by hams also have limitations, but they are rarely documented.

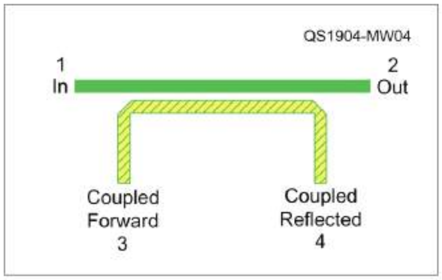


Figure 4 — Sketch of a directional coupler. Many commercial versions have one coupled port terminated internally.

Conversion

Because VSWR and return loss are expressions of the same quantity, we can convert from VSWR to return loss:

$$RL = -20\log\left[\frac{VSWR-1}{VSWR+1}\right]$$

And from return loss to VSWR:

$$VSWR = \frac{1+10^{\frac{-RL}{20}}}{1-10^{\frac{-RL}{20}}}$$

Figure 5 gives a better idea of the relationship between RL and VSWR. Most antenna analyzers will display either quantity, so you can compare as you measure.

Shorted Aperture Test

When a transmission line is terminated in a short circuit, whether planned or not, all the power is reflected, and the return loss is close to 0 dB (or infinite VSWR). If the transmission line has loss and we are measuring from the other end, then the return loss is twice the loss of the line — for instance, if the line loss is 2 dB, then the power is reduced by 2 dB on the way to the short and 2 dB more on the way back, so the return power is 4 dB down for 4 dB return loss. This is an easy way to measure loss of a length of transmission line.

Shorting the aperture of a horn or feedhorn with aluminum foil, as Glenn Robb, KS4VA, suggested in the January 2019 "Microwavelengths" column, is a clever way of ensuring that the horn is an antenna and not a resistor. The shorted aperture is the same as a shorted transmission line because there is nowhere else for the power to go except back down the line. A good metal antenna should have almost no loss, so the return loss will be close to 0 dB. But if the printed horn is lossy from a poor metal coating or other problem, then the return loss will be higher and power would be wasted in heating up the horn. Glenn suggested that a swept-frequency test is best — an enclosed cavity, like the shorted horn, may have resonances which can produce unexpected results near the resonant frequency.

Potential Error

Amateurs can be obsessive about VSWR, but there is the matter of when it actually causes an effect. A return loss of 20 dB, or VSWR of 1.22:1, is 1% of the transmitted power coming back — such a small amount that it may not have a great impact. On the other hand, a 2:1 VSWR, or return loss of 9.5 dB, implies that the impedance the transmitter sees can be anywhere between 25 Ω and 100 Ω, or have a large reactive component. This could easily upset some solid-state power amplifiers by causing larger-than-normal voltages or currents in expensive transistors. Because antenna tuners are rarely used at VHF and above, we try to tune our antennas for reasonably good return loss. But, due to the fact that directional couplers typically limit accurate RL measurement to about 20 dB, it doesn't make sense to try and make it much better.

Another device that is sensitive to the antenna impedance is the low-noise amplifier (LNA) or preamp. Gallium arsenide field-effect transistor (GaAsFET) devices are often tuned for the best noise figure in a 50 Ω test system, but the noise figure can change dramatically when connected to a mismatched antenna. Good return loss is also important on receive.

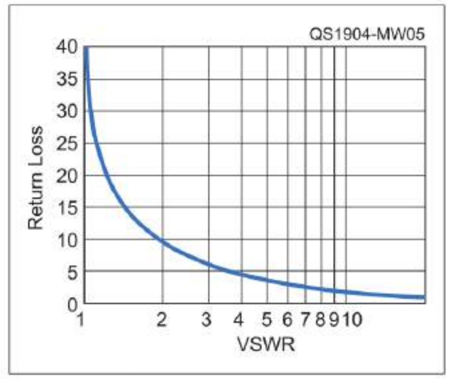


Figure 5 — Curve showing inverse relation between VSWR and return loss.

Another frequent source of error is harmonics generated by the transmitter or signal generator. The power at harmonic frequencies may be reflected by the antenna and appear as extra reflected power. Instruments using diodes as detectors, such as the Bird wattmeter and many amateur VSWR meters, are particularly susceptible to harmonics, as diodes detect peak voltage, and the voltage waveform is distorted by harmonics, leading to false indications.

Summary

VSWR and return loss are different ways of expressing the same thing — unwanted reflected power. We usually measure return loss, but hams prefer VSWR. We can use either to be sure that our antennas are well matched. Using a shorted aperture test to see that they have low loss adds confidence that our power is being radiated. Where it goes then is a matter of antenna design.

Notes

[1]Paul Wade, W1GHZ, "Understanding Circular Waveguide — Experimentally," *QEX*, Jan./Feb. 2001, pp. 37 – 48. Available at **www.w1ghz.org/QEX/circular_wg.pdf**.

[2]Paul Wade, W1GHZ, "High-Power Directional Couplers with Excellent Performance," *DUBUS*, II/2010, p. 9. Available at **http://w1ghz.org/coupler/High-Power_Directional_Couplers_with_Excellent_Performance.pdf**.

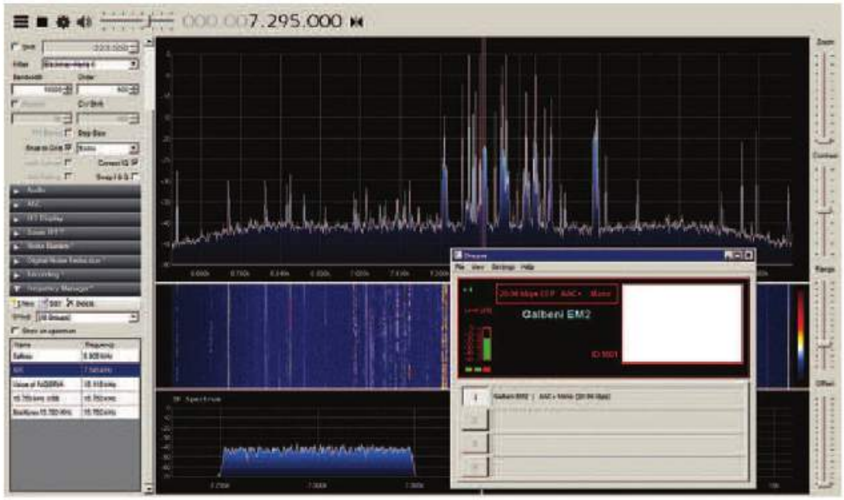
Steve Ford, WB8IMY, wb8imy@arrl.org

Eclectic Technology

Whither Digital Radio Mondiale?

Even before the turn of the century, it had become obvious that the internet was having a severe impact on traditional shortwave broadcasting. Audiences were quickly shrinking as listeners abandoned analog shortwave for the high-fidelity digital audio that the internet could provide. Many broadcasters responded by closing their transmitting facilities, or at least re-directing their signals to areas of the world the web had yet to reach.

In response to the looming threat, broadcasters, equipment manufacturers, regulators, and others came together in 1998 to form a consortium known as *Digital Radio Mondiale* (DRM). Their first task was to create a specification for digital shortwave broadcasting that, they hoped, could compete with the internet and revive listener interest. DRM promised a high-fidelity, FM-quality signal that also carried text information such as program titles and news headlines.



An All India Radio shortwave DRM broadcast being decoded with a software-defined receiver and *DREAM* software.

DRM Transmissions

You've probably heard a few DRM signals as you've tuned through the shortwave broadcast bands, but you may not have realized it. A DRM transmission sounds like wide-bandwidth noise.

The DRM signal carries three separate data channels. The primary channel, the one that transports the audio information, is the Main Service Channel. Then there are two subsidiary channels: the Fast Access Channel (FAC) that provides the essential data required to fully decode the signal, and the Service Description Channel (SDC).

DRM transmissions rely on a form of modulation known as coded orthogonal frequency division multiplex (COFDM). While it is highly resilient to interference and fading, the complex COFDM signal requires a significant amount of processing at the receiving end to extract the data from the carriers and reassemble everything in the correct fashion. I dabbled with DRM reception using *DREAM* software (**https://sourceforge.net/projects/drm/**) about 10 years ago and I needed to use a powerful PC (well, powerful by 10-year-old standards) to reliably decode signals. With today's hardware, processing horsepower is no longer an issue.

DRM Today

Unfortunately, Digital Radio Mondiale failed to halt the decline of shortwave broadcasting; it was too little, too late. It didn't help that consumer electronics manufacturers lacked enthusiasm for the new shortwave format. Without an abundance of affordable off-the-shelf receivers, the audience for DRM never coalesced. Those who remember attempts to popularize AM stereo in the United States in the 1980s, and quadraphonic FM in the 1970s, will recognize the pattern.

However, there are still shortwave broadcasters using DRM on a regular basis today. The list includes the BBC, Radio France International, and All India Radio, to name just a few.

The rise of software-defined radio (SDR) has provided new avenues for DRM shortwave listening. For example, it is possible to decode DRM signals with inexpensive SDR "dongle" receivers. Various tutorials are available online, like the RTL-SDR tutorial available at **www.rtl-sdr.com/tutorial-drm-radio-using-rtl-sdr/**.

DRM's future may lie in domestic digital broadcasting rather than international shortwave. India has invested heavily in DRM for its local and regional broadcast services; Brazil is doing the same.

And I cannot fail to mention that amateurs were on the DRM bandwagon quite early, experimenting with a derivative of DRM using a software application known as *WinDRM*. Much has changed over the intervening years and today, the HF digital voice application of choice is *FreeDV* (**https://freedv.org**). If you hear buzzing signals at 14.236 MHz, chances are you're hearing a FreeDV conversation.

Hints & Hacks

Tool-Free Mobile Radio Installation, Folding Antenna Support, and More

Install or Remove Mobile Radios Without Tools

Every so often, I need to remove my mobile radio to use it in the shack, or for security reasons. I didn't like needing a screwdriver nearby and keeping track of the small screws every time I did this. I wanted to find a way to remove the screws by hand.

For my Yaesu FT-1900, the screws are metric, but I was able to find the screws needed at a home improvement store. I used Phillips pan-head machine screws, size M4-.7 × 10, and purchased the wing nuts with threads to match. I simply inserted the screws backwards through the wing nuts. I also put a little glue under the screw head to keep it from backing out during use (see Figure 1), but a lock washer would also work.

This has made the process of removing and reinstalling my mobile radio much more convenient for me. — *73, Joe Hopkins, K4BKI,* **jhopkins1938@gmail.com**

New Life for Weller Soldering Guns

I have two Weller soldering guns, a 100 W and a 300 W. I use them often and started having problems with both, especially the larger one. I decided to repair the issue, and hopefully make the guns better than before.

The problem was the screws holding the tips in place were always getting loose. The smaller gun was easy to fix. I just enlarged the hole for the screw and re-tapped it, using a larger screw. This worked quite well. The larger screw now has better bite into the tip and can apply more force, producing better contact.

The larger gun had aluminum electrodes, and the contact screws stripped out the threads quickly. I first tried the drilling/tapping trick, but the stripped threads returned. I knew there had to be a better way.

I found two steel nuts large enough that I could drill out the threads and fit both of them onto the electrodes, still leaving enough of a gap so there wasn't a possibility of them shorting together. I then drilled and tapped a hole in the side of the bolt, so a 10-32 steel screw could be used as the new tip contact. I drilled the original hole in the electrode large enough that the 10-32 screw would slip through it.

This modification turned out great, and it can be done on both models of gun. The new screws could even be put through the side of the electrodes, but I was in a hurry and went through the top and bottom. Going through the side would have meant grinding off a corner of the nuts to make room for them between each other when installed. On the smaller gun, you could use a large nut so you have more thread to work with, and ground the side of the nut that faces the other electrode so there's enough space between the electrodes when both nuts are installed. I haven't needed to do this on my small gun yet, but I will eventually.

Also, I know that new tips can be hard to find when the shops are closed. In a pinch, I have used #14 and #12 solid wire successfully as tips in the smaller gun. #10 or #8 should work for the larger gun, but I have never had to replace this tip. To do this, form a loop of wire and tightly twist the curved end of the loop to form the tip. Only two or three turns are needed.

Both of these Weller guns have been trusty tools of mine for over 40 years, and I am sure that my grandchildren will appreciate them for many more. — *73, Clint Millett, VE3CMQ,* **cmillett@prairiemobile.com**

Figure 1 — The wing nut installed for tool-free removal and installation. [Joe Hopkins, K4BKI, photo]

A Foldable Wooden Antenna Support

As soon as my son earned his General-class license, I wanted to get him an antenna system outside for HF, VHF, and UHF that he could easily maintain himself. Fortunately, he owns a home in the country, so antenna installation is not an issue. My two antennas of choice to start with were an end-fed wire for HF and a dual-band J-pole antenna for 2 meters and 70 centimeters.

I set out to design a structure from pressure-treated two-by-fours that would be simple to build, inexpensive, and would support both of these antennas (see Figure 2). The chosen location behind the house dictated that the bottom two "tower" two-by-fours would need to be 12 feet in length to clear the edge of the roof. In addition, I wanted a tip-up/down mast added to the top of this tower that would use one additional 12-foot two-

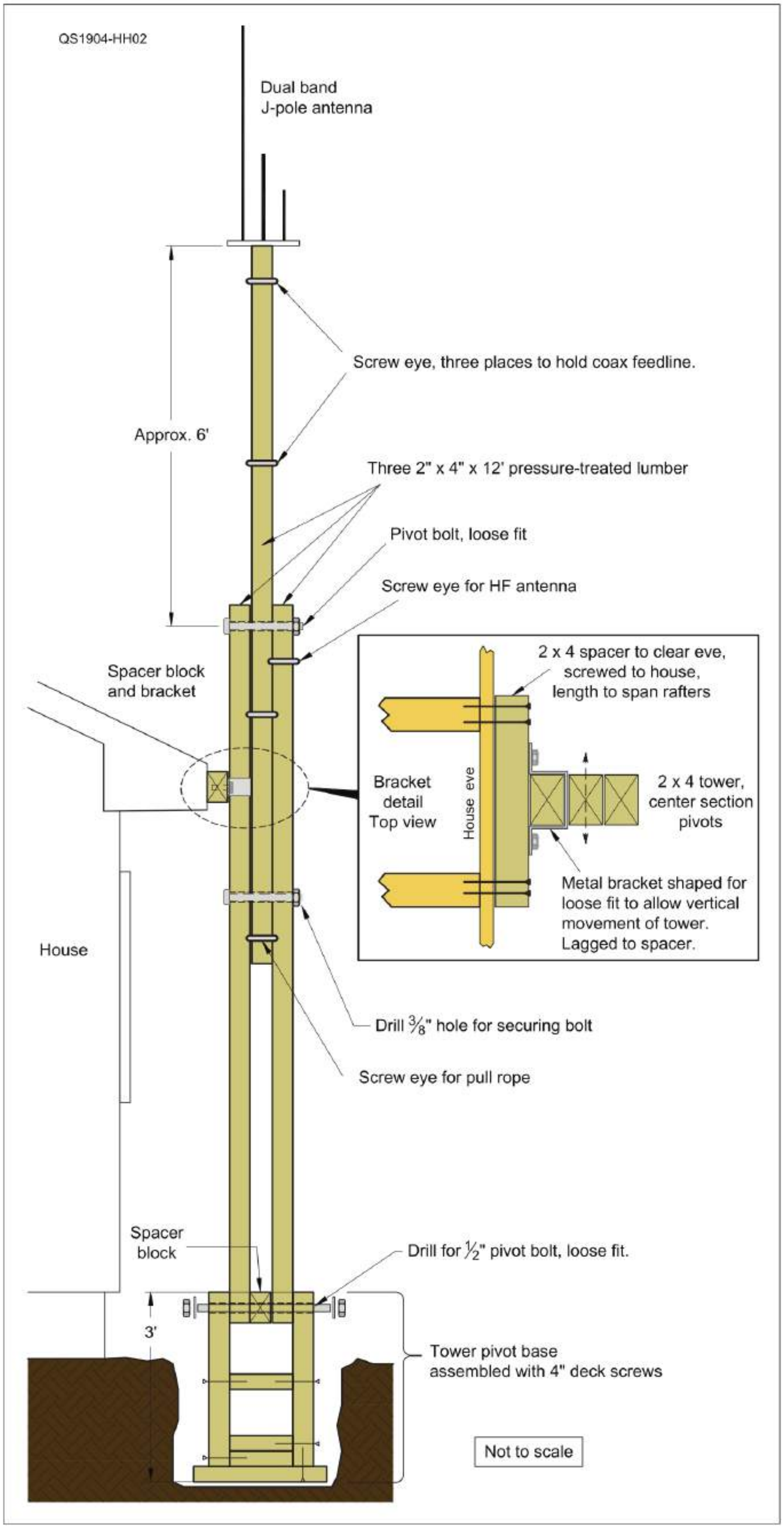


Figure 2 — A schematic of the author's wooden, foldable antenna support.

by-four. This would give me a total height of about 19 feet. If one person was to do any antenna work at this height, the tower and mast would have to be designed to fold down to the ground for safety reasons (see Figure 3).

The materials list for this build was short. It required:

- Four pressure-treated two-by-fours, at 12 feet long
- One ½ × 12 inch threaded steel rod with flat washers and nuts
- Two ⅜ × 5 inch bolts with flat washers and nuts
- Four large eye screws (sized to pass a PL-259 connector through)
- Two ¼ × 1½ inch lag screws and a small box of 4-inch long #10 deck screws

To hold the tower against the house, we needed a metal U-shaped bracket that fit loosely around the three sides of one of the two-by-fours. It was made from a 10-inch length of 3/32-inch-thick steel that was 1½ inches wide. This bracket would allow the completed assembly to settle into the dug hole in the ground while not pulling down on the attachment point at the house.

For tools, I used a powered miter saw to make all the necessary cuts and a battery-powered hand drill to drill the holes. Accurate saw cuts and perpendicularly drilled holes for the bolts were essential for proper fit and alignment. A drill press would have been perfect here, but none was available. One two-by-four was cut into all of the required pieces, and the other three required no cutting at all.

With all materials procured, I started the build early in the morning with my sons — Mark, N8KPV, and Alan, KN4IJR. I measured out the wood pieces and made the cuts while the boys drilled holes for the bolts. We then started the assembly on the ground, screwing and bolting the various pieces together. Three screw eyes were spaced down from the top

Figure 3 — This wooden fold-over antenna support allows for easy antenna work. [Karl Schwab, KO8S, photo]

Figure 4 — The completed wooden antenna support. [Karl Schwab, KO8S, photo]

of the mast to hold the coax and end-fed antenna wire. The last screw eye was attached at the bottom for a pull-down rope. At this point, all the building was complete.

We dug a hole in the ground about 2 feet deep that would except the 3-foot-long fold-over base assembly. Directly above this hole, we attached a 24-inch length of two-by-four at the fascia using 4-inch-long deck screws. This two-by-four would space the tower out from the house in order to clear the edge of the roof shingles.

We placed the fold-over base in the hole and got the tower assembly (minus the mast) raised and held to its vertical position against the house. We made adjustments by moving the base in the hole and tweaking its position against the house to make sure everything was plumb.

Next, we attached the metal bracket to the house with two lag screws securing the towers inside the two-by-four to the house. The hole we dug was then filled with dirt and the mast was bolted in its center position in the tower and pivoted down for attaching the two antennas. We easily raised the mast into its vertical position by pulling down on the rope, and secured it using a single ⅜ × 5 inch long bolt and then removed the rope. At this location, the pivoting mast could be pivoted down in either of two directions if needed. The far end of the end-fed wire antenna was then pulled up high in a nearby tree, thus completing all this antenna work in a single day (see Figure 4).

If this assembled unit ever needs to be brought down to the ground for any reason, only the two lag screws that secure the metal bracket to the house need to be removed and then it will fold down. Careful planning made this a quick, inexpensive ham radio project.

After this antenna work was completed, it was time to try it out. For the first time, good signal reports were given on the local repeater. On 20-meters SSB, our first contact was with Ecuador, and the second with an aircraft flying at 38,000 feet over Ecuador! It was a nice reward for a good day's work. — *73, Karl Schwab, KO8S,* **ko8s@arrl.net**

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

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

Strays

Six New American Amateurs in South Korea

Last summer, Dale Tongue, AC7NP, conducted an 8-week Technician-class license course for a group of Americans living in Seoul, South Korea. The result was six new Technician licensees. At the end of the exam, the Volunteer Examiners and the proud new amateurs posed for a photo. Front row, left to right: Michael Garvey, KE0SQZ; Jessica Robertson-Tucker, KE8KIS, and Dale Tongue, AC7NP (VE). Back row, left to right: Jason Vlasak, W2VLA (VE); Brian Chad O'Rourke, K4UL (VE); Melinda Thayer, KM6VBG; Cyril Rodriguez, KM6VBQ; David Sheets, KI7ZZH, and Stephen Reep, KD2QHM.

The Joy of SOLDERING

A look at a time-honored skill that continues to serve us well.

Joseph L. Lynch, N6CL

Many old-school hams feel that there is nothing sweeter than the smell of boiling rosin — the flux used for making solder connections. Usually, soldering was the first skill acquired after obtaining an Amateur Radio license, and I still remember my mentor, Earl Wiederhold, K6SMT (SK), teaching me the basics.

Building a Dipole

After taking the licensing exam, which was administered by Earl, I got my Novice license in January 1961. But before I could get on the air, I had to construct an antenna. Because I had crystals for 40 meters, I chose a dipole for that band.

Quickly, I learned that constructing the antenna was not simple. For parts, I needed two egg insulators, a longer glass insulator, 67 feet of solid copper wire, and a length of RG-8 coaxial cable.

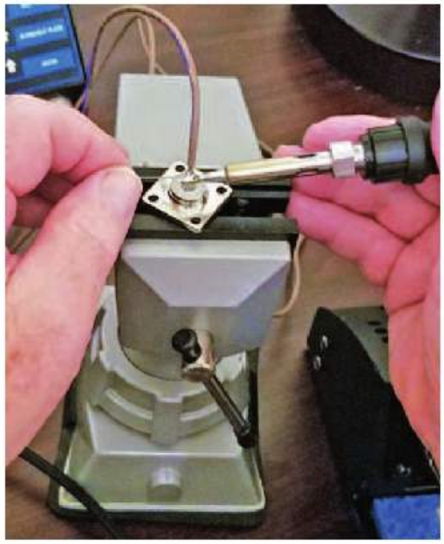
Earl showed me how to run the wire through the egg and glass insulators, both of which had holes in each end. I watched as he connected the coaxial cable to the wire attached to the glass insulator.

After cutting 33½ feet of copper wire, Earl used sandpaper to shine 2 inches of the wire, which he then threaded through the egg insulator, being careful to wrap it along the insulator's grooves. I watched carefully as he went through the process of pulling the wire through the insulator, wrapping it around the wire entering the insulator. After using the sandpaper on the part of the wire to be wrapped, he used needle-nose pliers to tightly wind the other section of wire around the now-shiny part.

> *"I watched carefully as Earl added solder, slowly moving the iron gently across the remaining surface."*

Learning to Solder

Earl took his time, methodically going through the process slowly as he instructed me along the way. Before beginning, he laid out the materials, informing me that the first step of the process was choosing the type of soldering flux, because while acid flux worked better on plumbing, rosin flux worked better on electrical connections because it prevented corrosion.



Joe Lynch, N6CL, soldering one end of a VHF loop antenna to the center conductor of a PL-259 coax connector.

Next, he showed me how to hold the egg insulator and the wire so as not to get burned while soldering. Then he started his work on the antenna, and I was mesmerized, watching and retaining all of the information. He explained, "Heat the rosin so it is boiling by touching the iron onto the wire where you applied the rosin. While it is boiling, it is cleaning the copper of any remaining impurities. Next, while holding the iron in place, apply the solder to the wire, waiting for it to be hot enough to flow across the wire." He stressed the importance of the wire being hot enough, warning that if done improperly, it could cause a dry solder joint.

I watched carefully as Earl added solder, slowly moving the iron gently across the remaining surface. He carried on with his instruction, saying, "After you've applied enough solder, gently remove the solder and the iron, making sure to not move or jiggle the wire until after it has cooled." I noted the importance of this last instruction, as it would ensure a solid connection was made.

After he assembled half of the dipole antenna, under his careful tutelage he had me construct the other half.

Finishing the Job

Next, Earl used his knife to strip the end of the coaxial cable. He made sure I understood how important it was to not nick either the center conductor or the braid with the knife. "Because," he explained, "a nick weakens the wire, thereby subjecting it to the possibility of breaking."

Continuing his careful movements, he explained how to weave the center conductor of the coaxial cable into the twist of the wire at the glass insulator. He did the same with the braid and the other wire on the glass insulator. Finally, my antenna was ready to be raised.

Testing My Skills

One of my most memorable soldering jobs occurred in Cifuentes, Cuba, in February 1995. On my third humanitarian trip to Cuba, I reconnected with some ham radio friends from the previous year, including Humberto Diaz, CM6HH.

To replace his very austere 20 W, 40-meter transceiver that he'd shown me on a prior visit, I brought him a Kenwood TS-520 transceiver.

Hours after I'd given it to him, Humberto told me the radio did not work, and my heart sank, knowing what the new transceiver had meant to him. I began troubleshooting it and found that it had a cracked printed circuit board, which caused a split between circuits. I gathered my necessary supplies, including a soldering iron, hookup wire, and a volt ohm meter (VOM), and went to work.

Turning the VFO knob, I noticed the receiver was cutting out across the band, so I used the VOM and located a loose connection between the variable capacitor and the frame. I soldered a wire between the shaft and the frame and fixed the problem — much to Humberto's pleasure.

> *"I soldered a wire between the shaft and the frame and fixed the problem."*

Feeling Nostalgic

Over the decades, I constructed several wire antennas, often remembering Earl's solder lessons. My most recent recollection occurred 2 years ago. On a trip to San Antonio with my wife, Carol, W6CL, we'd planned to spend the weekend in Tulsa, Oklahoma, visiting family. This also gave me the chance to operate in the ARRL DX Phone Contest, but in order to save some space packing, I only brought my Icom IC-7300 and switching power supply and planned to build a 20- and 40-meter dipole antenna once we arrived in Tulsa.

I bought a tool box, an SO-239 connector, a box of RG-58 coaxial cable, a soldering iron, #14 THHN house wire, jumper cables, a rope and painter poles (from which to hang the antenna), ½-inch PVC T-connectors for the insulators, and a roll of rosin-core solder.

While constructing my last-minute HF dipole, I paused long enough to appreciate how Earl taught me decades earlier the correct way to construct my first dipole antenna. Then, glad that rosin-core solder still existed, I thought to myself, "There is nothing sweeter than the smell of boiling rosin."

[Years ago, solder, as mentioned in the text, contained lead. Inhaling fumes from the boiling rosin could therefore lead to inhaling dangerous levels of lead. Lead/rosin solder has now been outlawed and replaced by lead-free solder, which may be harder to work with, but is much safer. — *Ed.*]

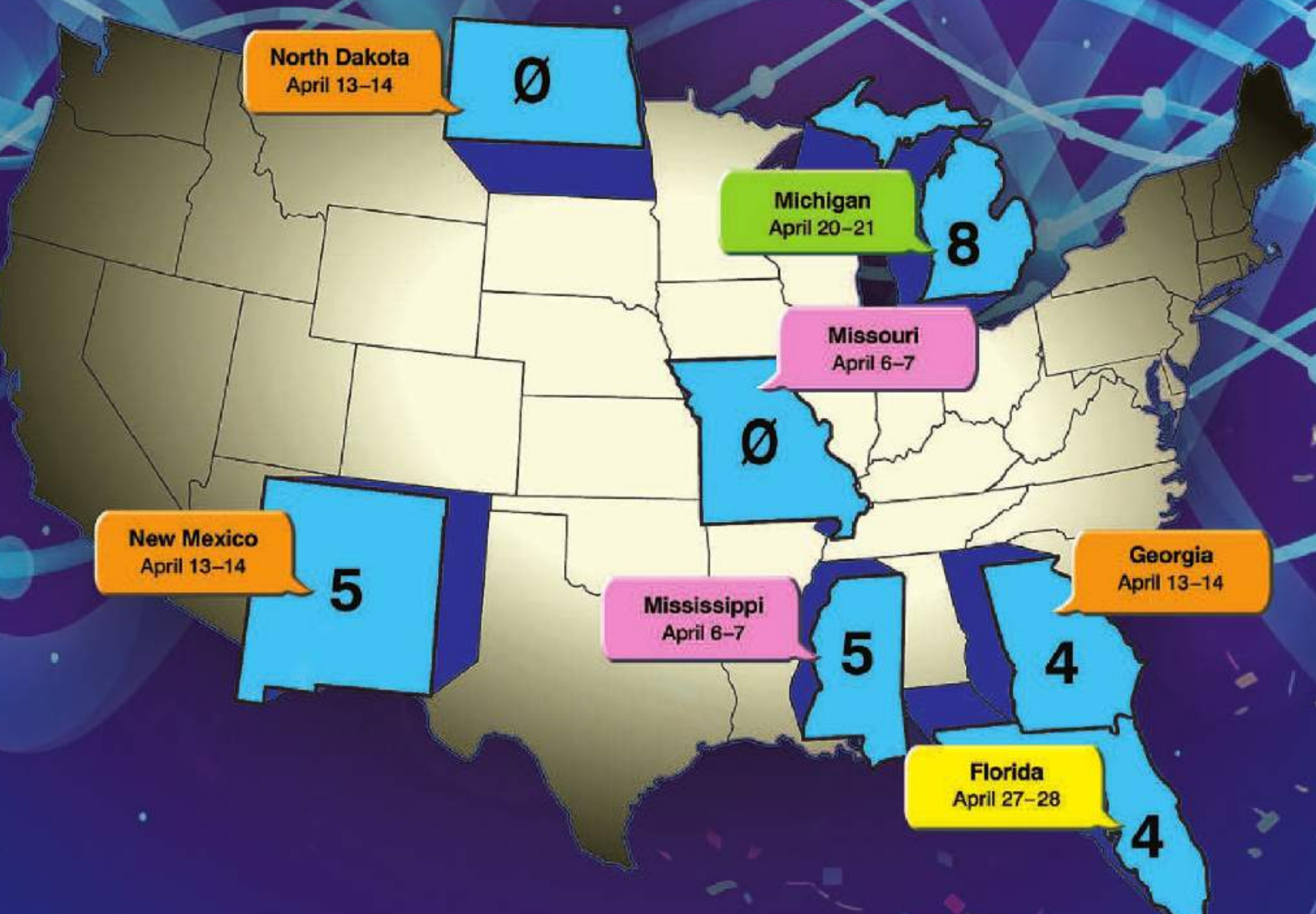
Life Member and ARRL VE Joseph L. Lynch, N6CL, was first licensed in 1960 and upgraded to General class in 1961. He has served as Emergency Coordinator for South San Diego County, a MARS operator in Vietnam (eventually becoming NCOIC of the Cu Chi, Vietnam MARS Station, AB8AJ), and ARRL Oklahoma Section Manager from 1988 to 1996. Joe was responsible for the more than 300 Amateur Radio volunteers who supported emergency communications in the aftermath of the April 19, 1995 Murrah Building bombing in Oklahoma City. He was VHF Editor for *CQ* magazine for 22 years, Editor of *CQ VHF* magazine for 12 years, and Editor of *QCWA Journal* for 2 years, and is presently a columnist for *The Spectrum Monitor*. Joe is a director of religious education for the US Army Garrison at West Point, New York, where he volunteers for the USMA Cadet Amateur Radio Club, W2KGY, and has assisted in the testing and licensing of more than 60 US Military Academy Cadets. He is married to Carol, W6CL. Joe can be reached at **n6cl@arrl.net**.

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

State and Regional QSO Parties

Something for Everybody

Whether you approach them as a contest or just some on-air fun, it's easy to get involved with these events that enliven the bands year 'round.



Hal Kennedy, N4GG

Highly appreciated by those that know about them, state and regional QSO parties are an on-air activity that many operators have yet to discover. All 50 states have one, and operators can choose how they want to participate in these events, treating them as if they are low-key parties, contests, or both. There will be a few stations going all-out, but even if you dislike contesting, QSO parties are still an activity for you.

Benefits of Participation

There are many reasons to take part in a state or regional QSO party. As a low-key operating event, its biggest draw is to have fun with it, whether you're participating to say hello to old friends, encourage newcomers, or you're looking to fill in some counties or grid squares in your logbook.

Most QSO parties also provide the benefit of having one or more rover (mobile) stations that travel through different counties, and they can be worked each time they enter a new one (see the sidebar, "Increase Your Score County by County"). Following their progress is a lot of fun, can sharpen your state geographic knowledge, and can develop new friendships. Rovers drive many hours to give operators new counties, and supporting their efforts can go a long way toward increasing your score.

No one should fear jumping in, because these events are often seen as a casual way to make contacts. There is a lot of participation by operators that only get into one on-air activity a year — the QSO party for their state. Even as a hardcore contester, I find that these events are the perfect opportunity to sharpen old skills or build new ones, all at a relaxed pace. If you are a newbie or an old-timer getting rusty, the parties provide the perfect learning atmosphere. Leisurely and hardcore participants mix very well in state QSO parties, and the high-speed all-out guys will invariably slow down for beginning operators.

Awards

If you're interested in pursuing awards, the easiest way to win them is by participating in state QSO parties. Many contacts in state QSO parties are casual because many participants aren't trying to win anything, but sometimes, operators will win something without even trying.

Every state and regional QSO party issues dozens of paper certificates for various achievements. In 2014, I won a beautiful plaque from the New England QSO Party (NEQP), which arrived as a complete surprise.

Hal Kennedy, N4GG, received the New England QSO Party plaque for his efforts in the event. [Hal Kennedy, N4GG, photo]

The plaque (on right) awarded to the W8UM operating team after winning the 2014 Michigan QSO Party. As an added bonus, the University of Michigan Amateur Radio Club and rival Michigan State University Amateur Radio Club have developed their own trophy (on left) to be held by the winner each year. [Dan Romanchik, KB6NU, photo]

State and Regional QSO Party Schedule

January	Montana
February	Vermont, Minnesota, North Carolina, South Carolina
March	Idaho, Louisiana, Oklahoma, Virginia, Wisconsin
April	Florida, Georgia, Michigan, Mississippi, Missouri, Nebraska, New Mexico, North Dakota
May	New England QSO Party (ME, NH, VT, MA, CT, RI), 7th Call Area QSO Party (WY, UT, OR, WA, NV, MT, ID, AZ), Arkansas, Delaware, Indiana
June	Kentucky, West Virginia
August	Maryland/DC, Hawaii, Ohio, Kansas
September	Alabama, Washington State Salmon Run, New Hampshire, Maine, Texas, Colorado, Iowa, New Jersey, Tennessee
October	California, Arizona, Pennsylvania, Illinois, New York, South Dakota

For dates, times, and rules, check **www.contestcalendar.com/stateparties.html**.

Hal, N4GG, enjoying a coffee break during leisurely participation in the Georgia QSO Party. [Hal Kennedy, N4GG, photo]

Increase Your Score County by County

Working counties is important! Every state QSO party is scored using a formula that includes number of QSOs × number of counties contacted. The details vary however, so check the rules. Some QSO parties let you count a county twice on each band — once for an SSB contact and once for CW. Working as many counties as possible on as many bands and modes as possible is a time-tested way to earn a plaque for your wall. Contacting the roving mobile stations is your key to maximizing county totals.

Other awards are more extravagant and specific to the state. For instance, the California QSO Party (CQP) awards a bottle of California wine to each of the top 20 scorers from outside the state, and the NEQP flies a lobster dinner for two overnight to the out-of-state winner. Other states send handmade plaques shaped like their state, and Hawaii awards plaques shaped like surfboards. These awards are often won without much effort, but they can be very special and meaningful, offering an added incentive to join in the fun.

When you do win a plaque or award in any contest or QSO party, it would be nice to send a thank-you note to the award sponsor. Email is fine these days, but I still mail handwritten thank-you notes via the USPS. I've gotten comments about how appreciated those are, and when I sponsor plaques, the thank-you notes mean a great deal to me.

Choosing a QSO Party

There are state and regional QSO parties many weekends of the year (see the sidebar, "State and Regional QSO Party Schedule"), so you can schedule which ones you want to participate in, and your options are abundant.

Times and days may vary, with some events running for a few hours throughout the weekend, and some taking place all day. Based on when you want to operate and the time you're willing to commit to the event, there will always be options for you. It is important to check the event's website for rules and times before operating in the QSO party.

See you in the next state or regional QSO party!

Tips on Deciphering Exchanges

For operators new to state QSO parties, it is important to understand the concept of *directed CQs*. A directed CQ is one where the CQing station is looking for a reply from a specific place. For example, in the Georgia QSO party (GQP), stations outside Georgia want to make contacts with Georgia, so they call "CQ GA" on CW, or "CQ Georgia" on SSB.

Stations inside Georgia would call "CQ GQP" on CW, or "CQ Georgia QSO Party" on SSB. In the GQP, I will sometimes call "CQ GQP de N4GG/CHER" on CW, indicating I am in Georgia, specifically in Cherokee County for those looking for my county.

When I am out of state and the QSO party is in a "4" calling area, known as the "4-land" (including Kentucky, Virginia, Tennessee, North Carolina, South Carolina, Alabama, Georgia, and Florida), I usually sign N4GG/GA to help other operators know that, while I have a "4-land" callsign, I'm not in the state they are looking for.

Nearly every logging program supports the state QSO parties and every county in the US has a four-letter abbreviation. Logging programs have the county lists built in. Keep the counties list close by to use as a cheat sheet during exchanges.

Amateur Extra Hal Kennedy, N4GG, has been licensed and on the air for 57 years. He received his BSEE from Lafayette College and an MS in management from the Sloan School at MIT. Now retired, Hal worked in the aerospace and defense industry for 30 years. Hal has won numerous awards as an active contester and DX chaser on all HF and VHF bands, and he particularly likes building and experimenting with wire antennas. Hal has written articles for *NCJ* and *QST*, and he is a contributor to both *The ARRL Handbook* and *The ARRL Antenna Book*. In 2010, Hal built "Blue Lightning," a replica 1910 rotary spark-gap transmitter that has been displayed at several hamfests. Hal can be reached at **n4gg@arrl.net**.

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

ARRL Board of Directors Addresses Ambitious Agenda

Rick Lindquist, WW1ME

A demanding agenda faced the ARRL Board of Directors when it convened for its annual meeting on January 18 – 19 in Windsor, Connecticut. President Rick Roderick, K5UR, chaired the session. Several new faces were around the table, with four newly elected ARRL Directors, one newly elected Vice Director, and one recently appointed Vice Director.

The ARRL Board of Directors met for its annual meeting on January 19 – 21 in Windsor, Connecticut. [Michelle Patnode, W3MVP, photo]

Attending for their first meeting as Board members were Hudson Division Director Ria Jairam, N2RJ; New England Division Director Fred Hopengarten, K1VR; Northwestern Division Director Mike Ritz, W7VO, and Roanoke Division Director George "Bud" Hippisley, W2RU. Also present were Northwestern Division Vice Director Mark Tharp, KB7HDX, and Rocky Mountain Division Vice Director Robert Wareham, N0ESQ, who was appointed last fall to fill a vacancy.

Amateur Radio Parity Act Petition

The Board adopted a resolution to withdraw, without prejudice to refiling, ARRL's December 18 *Petition for Rule Making* to the FCC, which sought to amend the Part 97 Amateur Service rules to incorporate the provisions of the Amateur Radio Parity Act (ARPA). The Directors determined that ARRL needs to "review, re-examine, and reappraise ARRL's regulatory and legislative policy with regard to private land-use restrictions." The resolution also asked members of Congress who had refiled Parity Act legislation to refrain from seeking to advance that legislation, pending further input from ARRL.

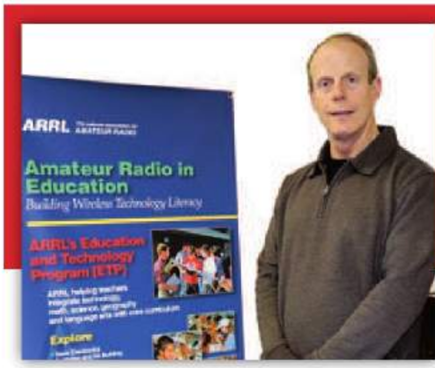
ARRL has been pursuing congressional approval of the Amateur Radio Parity Act for several years, and measures were twice passed by the US House. "While everyone understands that getting Congressional approval on any matter can be a lengthy process, the difficulty getting the ARPA approved has been a source of frustration to the organization and its members," the Board said in a post-meeting statement. "A majority of the Board now believes that there is a need to reassess the organization's approach to this issue."

The Board said the hiatus should not be interpreted as an abandonment of ARRL's efforts to obtain relief from private land-use restrictions. The intent is "to renew, continue, and strengthen ARRL's effort to achieve relief from such restrictions" and that the action "represents a chance to get the best product possible for all US Amateur Radio operators."

The Board expressed appreciation to the thousands of ARRL members who contacted their representatives in Congress to urge them to support the Amateur Radio Parity Act. The Board also thanked members of Congress who consistently supported the rights of US Amateur Radio operators.

Lifelong Learning Initiative

On a voice vote, the Board set the Lifelong Learning Initiative in motion, endorsing and funding the program and retaining Connecticut consultants Mintz + Hoke to work with ARRL Lifelong Learning Manager Kris Bickell, K1BIC, and other ARRL staffers to build this learning environment. The Board authorized $485,000 to fund the Lifelong Learning Initiative, which will seek to provide a series of learning tracks that will serve the needs of the various interest groups within the Amateur Radio community. While designed for everyone with an interest in learning more about Amateur Radio, the initial focus will be on creating online learning opportunities for newer hams.



"We are building a new learning environment."
— Lifelong Learning Manager Kris Bickell, K1BIC

Mintz + Hoke will conduct the research necessary to identify the different educational needs within the broader Amateur Radio community and develop lifelong learning strategies and programs aimed at attracting and retaining ARRL members, especially newly licensed radio amateurs.

Bickell noted that youth education will be a critical component of this Learning Initiative, but he also believes that overall opportunities in this area are huge, as many individuals are looking to expand their knowledge of Amateur Radio. Where appropriate, he said, learning tracks will build upon the knowledge base that already exists within ARRL, such as the material in *QST* and *QEX* magazines, as well as other ARRL publications and manuals. The Learning Initiative will also offer resources that allow individuals to delve further into a subject, rather than them relying solely on ARRL content.

"We are building a new learning environment," Bickell said. "It will take a lot of work to put this all together, but we believe that this initiative will firmly establish ARRL as an educational leader in Amateur Radio." He expects the online Lifelong Learning platform to launch in the fall of 2019.

Headquarters Reorganization

The Board received the report of ARRL CEO Howard Michel, WB2ITX, who outlined plans to reorganize and refocus the activities at ARRL Headquarters. Michel said providing better value to membership is a top priority, and he sees value creation and value delivery as key components to long-term membership retention and growth.

"I see ARRL as a membership association, a business, and a 501(c)(3) public charity," Michel said after the meeting. "As CEO, I intend to strengthen all three aspects. And all three must remain in balance for ARRL to function effectively."

Michel said that, as a business, ARRL is not just *QST*, *The ARRL Handbook*, DXCC, or the VEC program. "We can't allow ourselves to continue to think within those traditional parameters," he continued. "ARRL's businesses are value creation, value delivery, and advocacy."

The reorganization would involve three key components. A Management Council will be established to discuss ideas, operations, and long-term planning and to foster horizontal lines of communication within the organization. A Product Development Manager will be retained to create new ideas for products and services, develop pilot programs to quickly test those ideas, and then — if the pilot programs are successful — transition them to operations. A Marketing Communications Manager will be hired to promote "a coordinated and consistent message, across all forms of media" that will resonate both with current and potential members. "Our brand works with our traditional members," Michel observed. "It is not working for newly licensed hams."

The Board also endorsed the purchase of a modern association management software system that should dramatically improve ARRL members' experiences, Michel said.

Amateur Radio Emergency Service

The Board adopted an Amateur Radio Emergency Service (ARES) Plan, as recommended by the Programs and Services Committee. Committee Chair Dale Williams, WA8EFK, said the ARES Plan will establish training programs and three levels of ARES membership. It also revises ARES appointment definitions and designates the Emergency Coordinator (EC) as the lead person in local activations. Section and District Emergency Coordinators will serve as resources.

The Board further established an Emergency Preparedness Manager Requirements Committee, charged with setting the requirements for

"ARRL's businesses are value creation, value delivery, and advocacy."
— ARRL CEO Howard Michel, WB2ITX

Other Business

The Board's agenda also addressed the following:

♦ Elevated the ad hoc Logbook of The World (LoTW) Committee to permanent status, reporting to the ARRL Administration and Finance Committee.

♦ Received the report of ARRL's investments for 2018 from ARRL Treasurer Rick Niswander, K7GM, who said ARRL's portfolio recorded a small loss for the year, "consistent with market-derived expectations."

♦ Heard from Chief Financial Officer Diane Middleton, W2DLM, who reported that "a financially strong balance sheet generated a larger-than-expected gain from operations for 2018." Cash flow also continued to be favorable.

♦ Received the report of EMC Committee chair Kermit Carlson, W9XA, who told the Board his panel is working to raise awareness of a variety of issues stemming from major technological advances, such as wireless power transfer systems for charging electric vehicles. Carlson said that while new systems need spectrum, protection of other bands for other services is necessary. He invited the Board's vigilance in alerting the EMC Committee to potential concerns.

♦ Affirmed its support of the National Traffic System and all amateurs involved in traffic handling, and their role as partners to ARES in ARRL's public service tool kit.

♦ Considered recommendations of the Administration and Finance Committee and adopted the ARRL 2019 – 2020 Plan.

♦ Elevated past New England Division Director Tom Frenaye, K1KI, to Director Emeritus, commending him for his more-than-30 years of service to Amateur Radio "as a leader in his community, ARRL Division, and nationwide." Since 1975, Frenaye has served as an ARRL employee, Director, and Vice President, and as President of the ARRL Foundation.

♦ Elevated retiring West Gulf Director Dr. David Woolweaver, K5RAV, to ARRL Honorary Vice President, in recognition of "providing outstanding leadership" throughout his 19 continuous years as a Vice Director and Director.

♦ Directed the ARRL Secretary to cast ballots in support of the re-election of IARU President Timothy Ellam, VE6SH, and IARU Vice President Ole Garpestad, LA2RR, for additional 5-year terms.

♦ Received greetings from IARU Secretary David Sumner, K1ZZ, on behalf of IARU President Tim Ellam, VE6SH, and from Radio Amateurs of Canada President Glenn MacDonell, VE3XRA.

the staff position of ARRL Emergency Preparedness and Response Manager.

ARRL Governance and Legal Matters

Addressing an ARRL governance issue, the Board repealed the *ARRL Policy on Board Governance and Conduct of Members of the Board of Directors and Vice Directors*, commonly known as the "Code of Conduct," on an 11 – 3 vote with one abstention.

The Board voted unanimously to create a Legal Structure Review Committee to study and make recommendations to update ARRL's legal structure "to reflect ARRL's current operational needs."

Amateur Radio on the International Space Station

A permanent Amateur Radio on the International Space Station (ARISS) Committee was approved "to develop an interactive relationship" with ARISS, which sponsors voice contacts between ISS crew members and school groups and gatherings on Earth, "bringing together STEM program objectives and local Amateur Radio groups." The Board motion said ARISS "has demonstrated very positive public relations benefits to ARRL, and that it's in ARRL's best interests to support ARISS."

ARRL Bill Leonard, W2SKE, Media Awards

The Directors named the recipients of two ARRL Bill Leonard, W2SKE, Professional Media Awards, as recommended by the ARRL Public Relations Committee, with the concurrence of the Programs and Services Committee.

Tom Knapp of **www.lancasteronline.com** and the LNP Media Group Inc. of Lancaster, Pennsylvania, was named as the 2018 Bill Leonard, W2SKE, Professional Media Award for Print Reporting recipient. The Board said Knapp "went above and beyond to capture the workings of Field Day at W3RRR, the Red Rose Repeater Association."

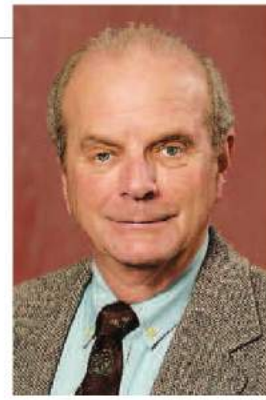
The Board named Andrew Schmertz and New Jersey Television (NJTV) as recipients of the 2018 Bill Leonard, W2SKE, Professional Media Award for Video Reporting. The Board cited Schmertz and NJTV for "outstanding coverage" of the February 23 – 24, 2018, HamSCI (**www.hamsci.org**) conference at New Jersey Institute of Technology (NJIT). NJTV, which is New Jersey's public television network, covered the conference. Schmertz interviewed Frissell, numerous faculty members, attendees, and members of NJIT's Amateur Radio station, K2MFF, "all with an eye to explain clearly to the public the significance of measuring the effects of solar activity on communications," the Board said.

The ARRL Bill Leonard, W2SKE, Award honors professional journalists or journalistic teams whose outstanding coverage highlights the enjoyment, importance, and public service value of Amateur Radio.

Minutes of the annual meeting have been posted. — *Thanks to ARRL Communications Manager David Isgur, N1RSN, who provided some material for this report*

Rick Lindquist, WW1ME, ww1me@arrl.org

Happenings



Riley Hollingsworth, K4ZDH.

Riley Hollingsworth, K4ZDH, to Oversee Volunteer Monitors Development and Implementation

Riley Hollingsworth, K4ZDH, will oversee the development and implementation phases of ARRL's new Volunteer Monitors (VM) program, which will replace the Official Observers (OO) program. Hollingsworth, who once handled Amateur Radio enforcement for the FCC, stepped down in February as ARRL Atlantic Division Vice Director to avoid any appearance of a conflict of interest. The development phase of the program is already under way.

"I am grateful for the Atlantic Division ARRL members supporting me, but I think I can better serve the Atlantic Division and all ARRL divisions by working in the Volunteer Monitors program," Hollingsworth said in his resignation letter.

ARRL President Rick Roderick, K5UR, said that Hollingsworth was the ideal person to lead ARRL's efforts in the development and implementation of this joint program with the FCC. "I support Riley's decision to concentrate his efforts on this very valuable project on behalf of the ARRL," he said.

Approved by the ARRL Board of Directors last July, the Volunteer Monitors will work in cooperation with the FCC. Volunteers trained and vetted by ARRL will monitor the amateur bands for possible instances of misconduct or to recognize exemplary on-air operation. Cases of flagrant violations or noncompliance will be directed to the FCC for action, in accordance with FCC guidelines. The program, which aims to re-energize Amateur Radio enforcement efforts, was proposed by the FCC following the closure of several FCC regional offices and reductions in field staff.

Hollingsworth has identified three phases to the program — development, solicitation and training, and implementation.

The development phase will include drafting a mission statement, clearly defining ARRL's and the FCC's requirements and needs as part of the program, drafting a Volunteer Manager job description, and developing a training manual for volunteers.

"I am grateful for the Atlantic Division ARRL members supporting me, but I think I can better serve the Atlantic Division and all ARRL divisions by working in the Volunteer Monitors program."

The solicitation and training phase will involve identifying the geographical locations where volunteer monitors will be most needed, soliciting applications, and screening applicants. Current Official Observers will be invited to apply for appointment as Volunteer Monitors (VMs).

Implementation will involve having the volunteers provide field reports, and ARRL staff offering guidance to volunteers to ensure that the information gathered meets FCC requirements. Continuing education will be provided to the volunteers as part of the program.

Hollingsworth has committed to ensuring training adequacy for new VMs, reviewing the quality and utility of Volunteer Monitor submissions to the FCC for enforcement action, and advocating for rapid disposition of cases appropriately submitted to the FCC.

ARRL officials estimated in February that it would take up to 1 year before the first Volunteer Monitors begin filing reports.

US Navy Explores Amateur Radio as a Training Adjunct

The US Navy's Naval Air Warfare Center Weapons Division (NAWCWD) has adopted Amateur Radio training as a possible new approach to basic RF and electronics instruction. More than 20 NAWCWD employees took part in a week-long class in Point Mugu, California, in December. The class, which culminated in an examination session for the Technician license, offered NAWCWD employees a novel approach to teaching radio propagation, said Brian Hill, KF4CAM, the lead for electromagnetic maneuver warfare experimentation in the Avionics, Sensors, and E*Warfare Department. Hill, who got his license while he was still in high school, is also the department's "innovation ambassador."

"I looked at the breakdown of current new hires and saw that many had degrees in computer science and thought that their classwork might not have covered things like RF propagation," Hill said. Rather than have employees sit through hours of *PowerPoint* briefings, Hill thought that a licensing course might be a more dynamic, hands-on approach to convey the basics — and cover areas such as directional antennas, signal propagation, and modulation that are necessary for their work.

Initially, Hill had 10 class slots funded, but then Target Design Engineering Branch Head Ian Mann, KI6YVO, got wind of the class, saw its potential, and helped get funding to expand participation. Mann, a General-class licensee and a ham for nearly 10 years, said he's been able to apply knowledge learned in the class to his NAWCWD work.

Target Systems Division Head Milton Gabaldon also saw merit in the approach. He sat in on the licensing classes, took the exam, and is now KM6YPA. For him, it's about connecting the dots.

Some of the 23 NAWCWD Amateur Radio class members hold their Certificates of Successful Completion of Examination (CSCEs).

"It's about introducing people to electronics, to start understanding what RF is all about ...so when we talk about it in the test and evaluation world, [students] know what we're talking about," Gabaldon said. "They get a better view than 'I just do software.' Now they see 'My software controls this piece, which sends out RF jamming signals that protect the warfighter.' That's the most important takeaway."

In all, 23 employees who took the Technician exam passed, and several also successfully tested for General and Amateur Extra-class licenses during the initial test session. Hill hopes to offer more hands-on classes in the future, and he's planning a foxhunt for additional hands-on training. *— Thanks to NAWCWD and Public Affairs Officer Kimberly Brown; some information from* C4ISRNET

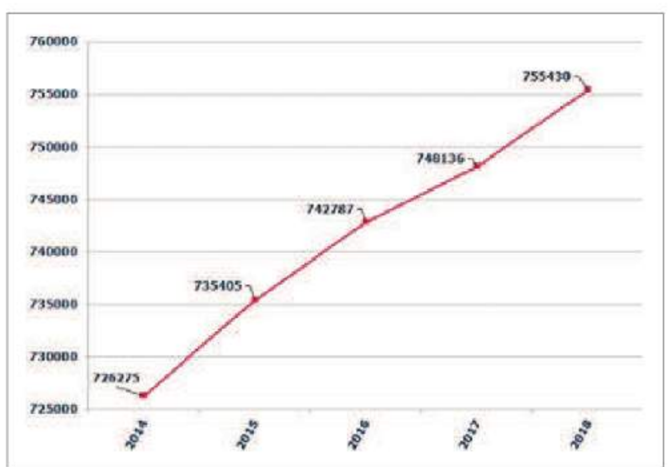
US Radio Amateur Population Grows Slightly in 2018

The US radio amateur population once again grew by about 1%, based upon 2017 and 2018 year-end FCC database statistics provided by Joe Speroni, AH0A. The 755,430 total licensees represent nearly 7,300 more license holders than those that were in the database at the end of 2017. Nearly 51% of the Amateur Radio population in the US — 384,145 — hold a Technician license. Generals are second with 175,949, and Amateur Extra-class holders number 147,369. Advanced and Novice licensee populations continue to decline, with 39,607 Advanced and 8,360 Novices, as the FCC no longer issues Advanced or Novice licenses. A more significant statistic is 31,576 *new* FCC licenses last year, although that's 620 fewer than came aboard in 2017.

"New amateur licenses granted by FCC are down 2% over last year," noted ARRL Volunteer Examiner Coordinator (VEC) Manager Maria Somma, AB1FM, "but this is the fifth year in a row the total has been greater than 31,000. I predict that the number of new licensees will be more than 30,000 at the end of this year as well, and I'm optimistic this trend will continue."

Upgrades are also down slightly, compared to last year — 9,456 in 2018 versus 9,576 in 2017, she added. "For the fifth year in a row, we have conducted more than 7,000 Amateur Radio exam sessions in a year — an important milestone for the ARRL VEC," Somma recounted.

ARRL VEC filed a total 30,393 license application forms last year, compared to 31,014 in 2017. That includes new, upgrade, modification, renewal, and club station filings. At 7,035 in 2018, the number of exam sessions conducted by ARRL VEC marginally trailed the 7,075 held in 2017. ARRL VEC served 34,493 exam applicants in 2018, compared to 35,352 in 2017. Exam elements administered by ARRL decreased from 47,152 last year to 45,817 this year, Somma said.



The growth of the US radio amateur population since 2014.

FCC Reaches $900,000 Settlement in Unauthorized Satellite Launch Case

The FCC has settled an investigation into an alleged unauthorized launch and operation of small satellites by Swarm Technologies. The company agreed to a *Consent Decree* that included a $900,000 penalty, an extended period of FCC oversight, and a requirement of pre-launch notices to the FCC, among other stipulations.

"We will aggressively enforce the FCC's requirements that companies seek FCC authorization prior to deploying and operating communications satellites and earth stations," FCC Enforcement Bureau Chief Rosemary Harold said. "These important obligations protect other operators against radio interference and collisions, making space a safer place to operate."

In April 2017, Swarm Technologies applied for an Experimental license to deploy and operate two Earth stations and four tiny ¼ U CubeSats called SpaceBEEs. The FCC denied the application in December 2017 over concerns about the ability to track the satellites. Swarm nevertheless launched the satellites on January 12, 2018, on a vehicle that also carried an Amateur Radio satellite into space. After reports of the unauthorized SpaceBEEs launch surfaced, the FCC began an investigation in March 2018.

The FCC determined that Swarm had launched the four SpaceBEEs from India and had unlawfully transmitted signals between Earth stations in Georgia and the satellites for more than a week.

The FCC issued an *Enforcement Advisory* last April to remind satellite operators that they must obtain FCC authorization for space station and Earth station operations. — *FCC Media Release*

FCC Seeks Comment on Amateur Radio-Related Petition

The FCC in February invited public comments on a *Petition for Rule Making* (RM-11826) from an Ohio radio amateur seeking to amend the Part 97 station identification rules to better accommodate and simplify station identification during an emergency net, drill, or activation. ARRL member Robert A. Dukish, KK8DX, filed the petition in December.

Dukish seeks a change to Section 97.119(a) of the rules, which requires an amateur station to transmit its "assigned call sign on its transmitting channel at the end of each communication, and at least every 10 minutes during a communication." He noted that during emergency networks, requiring participating stations — often portable — to use their assigned call signs during each transmission could prove "burdensome and can hinder the flow of emergency traffic on the channel."

Specifically, he suggested a simple approach would be to permit the net control station or other designated participant to announce from a single point the call signs of every station taking part in the net or exercise — when tactical call signs are often in use — at 10-minute intervals, using automatic CW identification. Dukish suggested amending Section 97.119(a) to add, "except during a local emergency network activation or drill," and providing that in such situations, a net control or designations station would be "authorized to announce all participating stations' assigned call signs at no more than 10-minute intervals while the net is in progress."

In Brief...

- **The Amateur Radio on the International Space Station (ARISS) packet system is back on the air with new equipment.** The replacement gear arrived last November and was installed on February 2. ARISS hardware team members on the ground were able to locate a functional duplicate of the old ISS packet terminal node controller (TNC) module that had been in operation for 17 years and had become intermittent; the RF gear remains the same. The ISS packet system, located in the ISS *Columbus* module, went down in July 2017, but it unexpectedly came back to life the following summer. The packet system operates on 145.825 MHz. ARISS is an official back-up system for astronauts to talk with Mission Control in the unlikely failure of the station's primary communication systems. In 2017, hams relayed nearly 89,000 packet messages via the ISS; response to its recent return has been enthusiastic, ARISS said. — *Thanks to ARISS*

- **Following the partial government shutdown early this year, the FCC speedily tackled a backlog of applications already in the queue.** Although it at first sought to hold back the flood of applications, asking that Volunteer Examiner Coordinators (VECs) give the agency a little breathing room before submitting additional new files, the FCC was ultimately able to work through its backlog very quickly, reported Assistant ARRL VEC Manager Amanda Grimaldi, N1NHL. The ARRL VEC had piled up some 2,700 pending Amateur Radio applications, many of them from 425 ARRL VEC examination sessions that took place during the shutdown or immediately prior to it. These do not include files that the other 13 VECs may have ready to upload. The large volume of filings submitted during the partial government shutdown were entered into the Universal Licensing System (ULS) in batches and assigned a January 29 receipt date, the FCC said. That included Amateur Radio vanity call sign applications filed between January 3 and January 29.

■**A WWV 100th anniversary special event is in the planning stages.** The WWV Centennial Committee has a tentative agreement with the National Institute of Standards and Technology (NIST) to mount a special event station this fall adjacent to the site of WWV in Colorado to mark the 100th anniversary of the time and frequency standard station. WWV is the world's oldest continuously operating radio station. Dave Swartz, W0DAS, of the Northern Colorado Amateur Radio Club (NCARC) heads the committee, which is developing plans for an NCARC special event from September 28 through October 2, with a NIST centennial observance tentatively set for October 1. After fears were raised that funding for the NIST radio stations might be cut, the Fiscal Year (FY) 2019 NIST budget for WWV, WWVH, and WWVB will remain level for the next year, which ends on September 30. Swartz said NIST management is "on board" with the celebration, and Deutch plans to attend Hamvention May 17 – 19 to promote the centennial event.

The WWV building near Fort Collins, Colorado. [Photo courtesy of NIST]

■**Several new ARRL Foundation Board members joined the Foundation's annual meeting on January 29.** ARRL Foundation Board members elected by the ARRL Board of Directors at its January 18 – 19 annual meeting include Atlantic Division Director Tom Abernethy, W3TOM, for a 3-year term; Northwestern Division Director Mike Ritz, W7VO, for a 2-year term; Pacific Division Director Jim Tiemstra, K6JAT, for a 1-year term, and Southwestern Division Director Dick Norton, N6AA, for a 3-year term. Past West Gulf Division Director Dr. David Woolweaver, K5RAV, who stepped down from the ARRL Board in January was elected to remain on the ARRL Foundation Board for another 3-year term and will serve as president. Others on the ARRL Foundation Board are Tim Duffy, K3LR; Jim Fenstermaker, K9JF; Brian Mileshosky, N5ZGT, and David Norris, K5UZ. Mileshosky was elected Vice President; Rick Niswander, K7GM, was re-elected as Treasurer, and Lauren Clarke, KB1YDD, was re-elected as Secretary. Woolweaver appointed Fenstermaker to chair the Scholarship Committee with Abernethy, Duffy, Norris, Ritz, and Tiemstra as members. Mileshosky was tapped to again head the Proposals Committee, with Norton and Woolweaver as members. Woolweaver will chair the Audit and Financial Committee, with Mileshosky and Niswander as members.

Section Manager Nomination Notice

To all ARRL members in the Colorado, Eastern Washington, Georgia, Los Angeles, Sacramento Valley, San Francisco, South Texas, West Virginia, and Western Washington Sections: 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.

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 June 7, 2019. If more than one member is nominated in a single Section, ballots will be mailed from Headquarters no later than July 1, 2019, to full members of record as of June 7, 2019, which is the closing date for nominations. Returns will be counted August 20, 2019. Section Managers elected as a result of the above procedure will take office October 1, 2019.

If only one valid petition is received from a Section, that nominee shall be declared elected without opposition for a 2-year term beginning October 1, 2019. If no petitions are received from a Section by the specified closing date, such Section will be resolicited in the October 2019 issue of *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. — *Norm Fusaro, W3IZ, Radiosport Department Manager*

SM Nomination Petition Resolicitation

Because no nomination petitions were received for the Montana Section Manager election by the nomination deadline of December 7, 2018, nominations are hereby resolicited. See above for details.

Rick Lindquist, WW1ME, ww1me@arrl.org

Bulgaria to Host the 2019 Youngsters On The Air Summer Camp

The ninth Youngsters On The Air (YOTA) summer camp will be held in Bulgaria, with the Bulgarian Federation of Radio Amateurs (BFRA) hosting the event.

"In this YOTA Camp, we will be continuing with our train-the-trainer program, which will be the main theme of the week," IARU Region 1 Youth Working Group Chair Lisa Leenders, PA2LS, said in announcing the annual event. "Participants will be working on the future of Amateur Radio and will be involved in workshops where they gain skills to start similar Amateur Radio youth events back home. With this, we are aiming to create a snowball effect [to inspire] more and more YOTA events all over the world."

Leenders said time will be set aside for the up-to-80 campers to enjoy Amateur Radio and become acquainted with Bulgaria. "Previous events have shown that all participants [have] an unforgettable week, where many new friendships are started," she said.

While primarily an IARU Region 1 event, young radio amateurs from Region 2 and Region 3 have also attended. "We are open for teams outside Region 1," Leenders told ARRL. "Depending on the number of applications we receive, we will decide how many participants outside the Region we can support."

Individual IARU member-societies select candidates aged 15 to 25 for the summer camp, which will take place August 11 – 17 near the Bulgarian capital city of Sofia. — *Thanks to IARU Region 1 Youth Working Group Chair Lisa Leenders, PA2LS, via IARU Region 1 News*

Wireless Institute of Australia No Longer Providing Exam and Call Sign Services

The Wireless Institute of Australia (WIA) is handing over Amateur Radio exam provision and call sign management to a new provider. The Australian Communications and Media Authority (ACMA) has selected the University of Tasmania and Australian Maritime College (AMC) to handle these functions. The WIA said it would assist in the transition to the new provider.

"It is the view of the WIA Board and the WIA Education Group that anything other than a smooth transition to the AMC will damage the already fragile Amateur Radio community," the WIA said in a statement.

The WIA National Office was in the process of transferring all call sign applications, assessments, and other activities that were in progress as of February 1, 2019, to the ACMA. WIA had provided these services for some 20 years.

WRTC 2022 Organizing Committee Unveils New Website, Initial Qualification Rules

The World Radiosport Team Championship 2022 (WRTC 2022) Organizing Committee has debuted its official website, **www.wrtc2022.it**, as well as final qualification rules to be selected as a WRTC 2022 team leader. While 2022 may seem a long way off, the qualifying events — 24 in all — take place between February 2019 and November 2020. Each qualifying event has a point value that's used in calculating qualifying scores, and each entry category has been assigned a weighting factor.

"Please don't think that WRTC is only for 'top guns,'" the announcement said. "You might have a chance." According to the announcement, WRTC 2022 selection areas are much smaller, so operators on all continents will have more chances to qualify. Team leaders, once established, will select a team member from among the top applicants who did not qualify as team leaders. "WRTC 2022 is now for everybody. The only things that you will need are commitment, motivation, and skill," the announcement said.

The first qualifying event was the ARRL International DX Contest (CW) in February. WRTC 2022 will be held in Bologna, Italy.

Rick Palm, K1CE, k1ce@arrl.org

Partners of Excellence in Service: A Roundup of Current Events

Much of the work of ARRL volunteers, especially ARES® members, is performed under the umbrella of mutually beneficial, formal written agreements (memoranda of understanding) with national organizations and federal agencies that provide service, safety, and response in the public interest.

Perhaps the grandfather of the ARRL's twelve partners of excellence is the American Red Cross — ARRL signed the initial agreement in 1940. Their field work is conducted by state and local chapter levels, where ARRL Section and local Emergency Coordinators engage with their counterparts. The best known Red Cross/ARES interface occurs at shelters, with amateurs providing communications for shelter managers and residents.

For the second year in a row, the Red Cross with support of its partners, including ARRL, served millions affected by record-breaking major-scale disasters — wildfires, hurricanes, tornadoes, etc. These outreach services are well known, but I did not know that home fires are the nation's most frequent disaster, accounting for the vast majority of disasters that the Red Cross responds to.

A perfect service opportunity for ARRL members is to participate in the Red Cross's Home Fire Campaign. With support from local partners, volunteers go door-to-door to install free smoke alarms and help families create home fire escape plans. In 2018, nearly 400,000 smoke alarms were installed, and more than 165,000 homes were made safer through home fire safety visits. Participating ARRL/ARES members garner the collateral benefit of presenting themselves as radio communications resources within their neighborhoods.

FEMA and Citizen Corps

ARRL is an affiliate (as of June 2003) under FEMA's four charter Citizen Corps programs — Neighborhood Watch, Volunteers in Police Service, Community Emergency Response Teams (CERT), and Medical Reserve Corps. The functions and training (provided by professional responders and qualified volunteers) for CERTs — teams of neighbors and other community members organized to provide immediate disaster response — have been expanded to include Disaster Preparedness, Fire Suppression, Medical Operations, Light Search and Rescue, Psychology, and Team Organization.

A critical role on CERTs exists for ARES members, because radio communications is a cornerstone of disaster response, and not just for the Amateur Service. It's important for us to be familiar with, to own, and know how to operate radios in the personal radio services that are commonly found in the hands of neighbors. Lloyd Colston, KC5FM, a professional emergency manager in Oklahoma, wrote, "For a ham radio response to a 911 outage, I would propose an operator investing in a pair of family radio service (FRS) handheld transceivers tuned to FRS channel one with no PL tone. Monitoring the channel for calls from the neighborhood, the ham could either relay the call for help or advise the caller of the direct line to call for help."

Review the CERT training module for emergency communications online.[1]

ARRL/FEMA Tests Interoperability

FEMA Region 10 (Pacific Northwest states) recently conducted a monthly communications exercise (COMMEX), with amateurs taking part. The intent of these exercises is to test and exercise interoperable communication (among federal, state,

[1]**https://www.fema.gov/media-library/assets/documents/28059**

ARRL Partners of Excellence

American Red Cross: **www.redcross.org**
APCO-International: **www.apcointl.org**
Boy Scouts of America: **www.scouting.org**
Citizen Corps: **www.ready.gov/citizen-corps**
Civil Air Patrol: **www.gocivilairpatrol.com**
Federal Emergency Management Agency: **www.fema.gov**
National Voluntary Organizations Active in Disaster: **www.nvoad.org**
REACT International: **www.reactintl.org**
Salvation Army and SATERN: **www.salvationarmyusa.org**, **www.satern.org**
SKYWARN (National Weather Service): **www.weather.gov/skywarn/**
Society of Broadcast Engineers (SBE): **www.sbe.org**
United States Power Squadron: **www.usps.org**

local, tribal, and Amateur Radio assets) during a major disaster in which the communication infrastructure is significantly damaged or destroyed.

In another example, an item from Public Safety and Emergency Communications News Clippings, (Vol. 7, issue 19, October 1 – 15, 2018) reported the FEMA Region IV (southeastern states) Regional Emergency Communications Coordination Working Group (RECCWG) discussed lessons learned from Hurricane Florence. North Carolina mobilized ESF-2 (Communications) for 16 days. Every state in Region IV contributed resources, including personnel and equipment, to support response efforts, which North Carolina heralded as a benefit partially derived from the RECCWG. Information-sharing and relationship-building fostered by the Region IV RECCWG resulted in a more coordinated response from COMLs and COMTs, partners from the PSAP community, Amateur Radio personnel, and federal partners.

SATERN

ARRL and The Salvation Army's Team Emergency Radio Network (SATERN) have a rigorous, long-standing, and close working relationship at the national level as well as with their field organizations and on major-scale disaster responses.

SATERN is a major player in disaster response. The Alaskan earthquake (7.0 M) of November 13, 2018, struck as the Alaska-Pacific Emergency Preparedness (A-P) Net was beginning its daily net on 14.292 MHz. The A-P Net immediately began monitoring the situation, receiving reports from locally affected amateurs. Net member Ken Gilliland, AG6SV, who is also International SATERN SSB Net Manager, provided situation reports to National SATERN Liaison Bill Feist, WB8BZH. Feist then passed the reports to Western Territory Disaster Coordinator John Berglund; Western Territory SATERN Coordinator Ian Anderson, KO2IAN, and National Disaster Specialist Tameka Sharp. Feist also began monitoring the A-P Net frequency from the WB5ALM SATERN station at the ALM (Alabama, Louisiana, and Mississippi) Division's Emergency Disaster Services center in Jackson, Mississippi. More SATERN members relayed additional information to SATERN leadership. Berglund and Sharp thanked SATERN for communication services rendered.

National Weather Service and SKYWARN

Since the '70s, trained SKYWARN® spotters coupled with Doppler radar, satellite, and other technology have helped the NWS issue more timely and accurate warnings for tornadoes, severe thunderstorms, and flash floods. Under the formal ARRL/NWS agreement, first inked in 1986 and since updated, the National Weather Service works with ARES volunteers at the local level to establish SKYWARN nets and specialized weather emergency alert and relief systems. In this context, radio amateurs serve as communicators and spotters. NWS Warning Coordination Meteorologists are responsible for maintaining this working partnership, which has served the public so well.

SKYWARN Recognition Day (SRD) was developed in 1999 by the NWS and ARRL to celebrate the contributions that volunteer SKYWARN-prepared radio operators make to the country's severe weather warning system. The 2018 event took place in December, with many special event stations on the air from NWS offices, contacting radio amateurs around the world. Stations exchanged their call sign, a signal report, and their location, plus a quick description of the weather. "Amateur Radio operators comprise a large percentage of the SKYWARN volunteers across the country," an NWS announcement said, adding that they can "provide vital communication between the NWS and emergency management."

Gordon Gibby, KX4Z, demonstrates sending and receiving email messages via HF Winlink at the 2019 Florida statewide Amateur Radio Emergency Communications Conference held in Gainesville on February 2 – 3. [Rick Palm, K1CE, photo]

VoIP Hurricane Net

Another partner in excellence under the weather service umbrella is the Voice over Internet Protocol (VoIP) Hurricane Net that handled a number of critical reports for supporting WX4NHC, and emergency traffic for a high-water rescue in the affected area of storm Florence in eastern North Carolina in 2018. It was a case where a life was directly saved by the net's efforts.

For the net's Hurricane Michael activation, manager Rob Macedo, KD1CY, noted the net was often very quiet. Because the winds were so powerful, amateur operators had to take cover as the worst hit their region. Reports of winds sustained at 100 MPH with gusts over 115 MPH were received by monitoring weather stations before they were no longer visible online or were damaged by the winds.

VoIP Hurricane Net reps met with partners at the 2018 National Hurricane Conference in Orlando, Florida, and supported the WX4NHC Communications Test at the start of the 2018 Atlantic Hurricane Season. The National Hurricane Center station WX4NHC is the net's principal client.

George Misic, KE8RN, ke8rn@comcast.net

Six-Meter AM Radios of the 1960s

In the 1960s, there were many different low-cost, low-power 6-meter transmitter/receiver units available for AM operation. Lafayette Radio Electronics, World Radio Laboratories (WRL), and Olson Electronics marketed 6-meter AM rigs for fixed station or mobile use, while Allied Radio Knight Kits and Heathkit offered similar radios in kit form. Here's a breakdown of some of these popular rigs by manufacturer.

Gonset

Gonset sparked the 6- and 2-meter AM marketplace with their popular family of Communicator products, starting around 1950. The Communicator I, II, and III all featured an ac and dc mobile power supply that used a vibrator to make mobile operation possible. A crystal-controlled transmitter with a 2E26 tube in the final served as the transmitter. A lever switch on the front panel selected transmit or receive.

Gonset made a larger, higher-power radio for 6 or 10 meters: the 6-meter G-50 or the 10-meter G-28. These radios ran nearly 50 W input, but still used class-A Heising modulation. Of course, no mobile power supply was included, and transmit/receive switching was still accomplished with a lever switch.

The Gonset Communicator II, part of the company's popular Communicator line.

The Knight Kit TR-106 included internal speakers and PTT transmit/receive switching.

Gonset went on to develop the Communicator IV, which included PTT transmit/receive switching and a transistorized power supply for mobile operation. The Communicator IV had the size and shape of the model G-76, the only low-band AM transmitter/receiver that also included 6-meter operation.

Gonset finished their many years as a ham radio equipment manufacturer by producing 6- and 2-meter SSB, AM, and CW radios that were largely solid state and were initially called the Sidewinders. The radios quickly developed a bad reputation and Gonset came out with updated versions.

Lafayette Radio Electronics

Lafayette Radio Electronics offered the HE-35, a very minimalistic 6-meter radio without PTT transmit/receive switching and no internal dc power supply. Lafayette also sold the popular HE-45, which did include PTT transmit/receive operation, a built-in ac and dc vibrator that operated power supplies, and a final amplifier stage using a 2E26 tube. The HE-45 was a single-conversion design with a 1,650 kHz IF. Later models had a rear-panel power socket for a VFO also sold by Lafayette. The company marketed a 10-meter version of the HE-45, known as the HE-50.

Later, Lafayette offered the Japanese-built HA-460 for 6-meter AM and the HA-410 for 10-meter AM. These included a solid-state dc power supply and a built-in VFO plus crystal control. They were dual conversion, offering better selectivity and stability than the other models. Lafayette also made a few different imported 6-meter AM radios that were all solid state.

Allied Radio Knight Kits

Allied Radio produced 6- and 2-meter AM transmitter/receiver kits in their popular Knight Kit line: the 6-meter TR-106 and the 2-meter TR-108. Both kits included a double-conversion receiver and a crystal-controlled transmitter with a 2E26 final amplifier tube. Both had a built-in ac and dc power supply for mobile or fixed station use. Internal speakers and PTT transmit/receive switching were included. Allied also made the V-107 matching VFO, which could be built for either 6 or 2 meters, but not both.

Utica and Olson Electronics

Olson Electronics sold a 6-meter AM radio built by Utica Communications. The Olson model RA-570 had a built-in ac and vibrator-type dc power supplies. It was a reduced-cost version of the Utica 650. Both these radios had dual-conversion receivers with crystal-controlled first conversions using a 40 MHz crystal and only covered 50.0 – 52.0 MHz.

Clegg

Clegg started in VHF equipment with the compact 99er 6-meter AM transceiver. The 99er had only a power supply for home station use, but the vacuum tubes used could be lit directly from a 12 V automotive electrical system, and the ac power supply could be used for mobile with a 50 W dc-to-ac inverter. Clegg went on to produce the higher-power Thor 6 with a separate ac or dc power supply and modulator unit for fixed or mobile use. The Thor 6 was unique in that it automatically transmitted on the receive frequency, making it technically a transceiver, rather than a transmitter/receiver.

Clegg also marketed a high-power 6- and 2-meter transmitter, the Clegg Zeus, and the companion receiver, the Clegg Interceptor. The Clegg Venus, a transceiver for SSB, AM, and CW, soon followed. Clegg later produced essentially the last 6-meter AM-only transmitter/receiver — the Clegg 66er, which had an internal ac and solid-state transistorized dc power supply built in.

Heathkit

Following the initial design of their first CB radio, the CB-1, Heathkit developed and refined the 10- and 6-meter versions, the Tener and Sixer. They went on to develop the 2-meter version, the Twoer, as well. The original HW-29 Sixer used 50 MHz fifth overtone crystals, which were expensive and hard to find. The improved HW-29A replaced the earlier model and used the more readily available 8.367 – 9.0 MHz crystals. The Sixer and Twoer had a super-regenerative receiver and an internal ac supply and speaker. Transmit/receive switching was done by a lever switch and no internal dc power supply was provided. They sold well and introduced many hams to VHF operation well before 2-meter FM became popular.

The Shawnee and Pawnee 6- and 2-meter transmitter/receivers were a significant step up from the Sixer and Twoer. Both units had a double-conversion superheterodyne receiver, a built-in speaker, internal ac and dc power supplies, internal VFOs for the transmitter, internal BFOs for CW and SSB reception, and PTT transmit/receive switching.

Hallicrafters

Major radio companies of the 1960s did not develop AM 6-meter transmitter/receivers, aside from Hallicrafters. Hallicrafters first marketed the SR-34 6- and 2-meter transmitter/receiver, then the SR-42 2-meter transmitter/receiver and the SR-46 6-meter transmitter/receiver, plus a transmit VFO to use with them. Hallicrafters sold a mobile kit for use with the SR-42 and SR-46 that included a mechanical vibrator for the dc power supply, a dc power cord for connecting the radios to a mobile 12 V dc power source, and a mobile mounting bracket.

Poly-Comm

The Poly-Comm Company built only three products for AM radio: a 6-meter transmitter/receiver, a 2-meter version of the same radio, and a radio covering both 6 and 2 meters. All the Poly-Comm radios had a built-in ac and 12 V dc nominal power supply, so they could be used for base station or mobile use. The Poly-Comm products had a built-in transmit VFO but could also be crystal controlled with common crystals in the 8 – 9 MHz range. The unit had PTT operation and included a handheld microphone. The 6-meter version was a double-conversion receiver with a first IF of 5.405 MHz and a second IF of 455 KHz. The 2-meter version was triple conversion and used 6 meters as the first IF. The 6- and 2-meter version used the same stages as the separate 6- and 2-meter versions.

WRL

WRL's low-cost Tech-Ceiver was a low-power transmitter/receiver for 6 meters. It had no internal power supply, but WRL sold one for ac use. The receiver was a single-conversion design with no squelch or noise limiter. The transmitter ran about 5 W input power with crystal control. Transmit/receive switching was done by a rotary switch. It was a low-end radio, but not a bad value for only $39.95 in kit form, without the ac power supply.

All photos by the author.

The Poly-Comm 6 could be used for base station or mobile use.

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

Contest Corral

April 2019

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

Start - Finish Date-Time		Date-Time		Bands	Contest Name	Mode	Exchange	Sponsor's Website
1	0800	7	2000	All	IQRP Quarterly Marathon	CW Ph Dig	RS(T)	www.arimontebelluna.it
1	1900	1	2030	3.5	RSGB 80-Meter Club Championship, CW	CW	RST, serial	www.rsgbcc.org/hf
2	0100	2	0300	3.5-28	ARS Spartan Sprint	CW	RST, SPC, power	arsqrp.blogspot.com
3	2000	3	2100	3.5	UKEICC 80-Meter Contest	Ph	4-char grid square	www.ukeicc.com
4	1700	4	2000	3.5	SARL 80-Meter QSO Party	Ph	RS, serial, grid locator	www.sarl.org.za
4	1700	4	2100	28	NRAU 10-Meter Activity Contest	CW Ph Dig	RS(T), 6-char grid square	www.nrau.net
4	1900	4	2100	1.8-28	SKCC Sprint Europe	CW	RST, SPC, name, mbr or power	www.skccgroup.com
6	0400	6	0800	7	LZ Open 40-Meter Sprint Contest	CW	Serial, serial received from previous QSO	www.lzopen.com
6	1000	7	0400	14	PODXS 070 Club PSK 31 Flavors Contest	Dig	SPC, mbr or name	www.podxs070.com
6	1000	7	1000	50-1296	SARL VHF/UHF Digital Contest	Dig	RST, 6-char grid locator	www.sarl.org.za
6	1400	7	0200	3.5-UHF	Mississippi QSO Party	CW Ph Dig	RS(T), county or SPC	www.arrlmiss.org
6	1400	7	2000	1.8-UHF	Missouri QSO Party	CW Ph Dig	RS(T), county or SPC	www.w0ma.org
6	1400	7	2200	3.5-28	Florida State Parks on the Air	CW Ph Dig	Park ID SPC	flspota.org/rules
6	1500	7	1500	1.8-28	SP DX Contest	CW Ph	RS(T), SP province or serial	pzk.org.pl
6	1600	7	1600	3.5-28	EA RTTY Contest	Dig	RSQ, province or serial	concursos.ure.es/en
7	1900	7	2030	3.5	RSGB RoLo SSB	Ph	RS, previous 6-char grid square received	www.rsgbcc.org/hf
8	1900	8	2300	144	144 MHz Spring Sprint	CW Ph Dig	4-char grid square	sites.google.com/site/springvhfupsprints
10	0030	10	0230	3.5-14	NAQCC CW Sprint	CW	RST, SPC, mbr or power	naqcc.info
10	1900	10	2030	3.5	RSGB 80-Meter Club Championship, SSB	Ph	RS, serial	www.rsgbcc.org/hf
13	0000	13	2359	1.8-28	QRP ARCI Spring QSO Party	CW	RS, SPC, mbr or power	qrparci.org
13	0700	14	1300	1.8-28	JIDX CW Contest	CW	RST, Prefecture number or CQ Zone	www.jidx.org
13	1200	14	1200	1.8-28	OK/OM DX Contest, SSB	Ph	RS, 3-letter county code or serial	okomdx.crk.cz
13	1200	14	1200	3.5-28, 144	F9AA Cup, PSK	Dig	RST, serial	www.site.urc.asso.fr
13	1200	14	2359	1.8-50	SKCC Weekend Sprintathon	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
13	1400	14	0200	1.8-50	New Mexico QSO Party	CW Ph Dig	Name, county or SPC	www.newmexicoqsoparty.org
13	1400	14	2000	All	Texas State Parks on the Air	CW Ph Dig	RS(T), park abbreviation or SPC	www.tspota.org
13	1800	14	1800	1.8-144	North Dakota QSO Party	CW Ph Dig	RS(T), county or SPC	www.kg0yl.net/QSO.html
13	1800	14	2359	1.8-50	Georgia QSO Party	CW Ph Dig	RST, county or SPC	www.georgiaqsoparty.org
13	2100	14	2100	1.8-28, Sats	Yuri Gagarin International DX Contest	CW	RST, ITU Zone	gc.qst.ru/en/section/32
14	1000	14	2200	3.5-14	WAB 3.5/7/14 MHz Data Modes	Dig	RS, serial, WAB square or country	wab.intermip.net/Contests.php
14	1200	14	1800	3.5-14	International Vintage Contest HF	CW Ph	RS(T), 4-char grid square	contestvintage.beepworld.it
14	1500	14	1700	3.5	Hungarian Straight Key Contest	CW	RST, serial, power code	hskc.ha8kux.com
14	1800	14	2359	3.5-50	ARRL Rookie Roundup, SSB	Ph	Name, 2-digit year licensed, state/province/XE area/"DX"	www.arrl.org/rookie-roundup
15	0000	15	0200	1.8-28	4 States QRP Group Second Sunday Sprint	CW Ph	RS(T), SPC, mbr or power	www.4sqrp.com
16	1900	16	2300	222	222 MHz Spring Sprint	CW Ph Dig	4-char grid square	sites.google.com/site/springvhfupsprints
19	2100	20	2100	1.8-28	Holyland DX Contest	CW Ph Dig	RS(T), 4X area or serial	www.iarc.org
20	0500	20	0859	3.5-7	ES Open HF Championship	CW Ph	RS(T), serial	www.erau.ee/en
20	0600	21	0559	3.5-28	Worked All Provinces of China DX Contest	CW Ph	RS(T), BY province or serial	www.mulandxc.org
20	0800	20	1800	3.5-28	QRP to the Field	CW Ph	RST, SPC, name	www.zianet.com/qrp/qrpttf
20	1200	21	1159	3.5-28	YU DX Contest	CW Ph	RS(T), YU/YT county or serial	yudx.yu1srs.org.rs
20	1200	21	2359	3.5-28	CQMM DX Contest	CW	RST, continent, category	www.cqmmdx.com
20	1300	21	2200	1.8-UHF	Nebraska QSO Party	CW Ph Dig	RS(T), county or SPC [FT8: S/N, grid]	www.qcwa.org/chapter025.htm
20	1600	21	0400	3.5-28	Michigan QSO Party	CW Ph	Serial, county or SPC	www.miqp.org/Rules.htm
20	1700	21	1300	3.5-28	EA-QRP CW Contest	CW	RST, category, "M" if member	www.eaqrp.com
20	1800	20	2159	1.8-50	Feld Hell Sprint	Dig	RST, mbr, SPC, grid	sites.google.com/site/feldhellclub
20	1800	21	1800	1.8-144	Ontario QSO Party	CW Ph	RS(T), county or SPC	www.va3cco.com/oqp
22	0100	22	0300	1.8-28	Run for the Bacon QRP Contest	CW	RST, SPC, mbr or power	qrpcontest.com/pigrun
24	0000	24	0200	1.8-28	SKCC Sprint	CW	RST, SPC, name, mbr or power	www.skccgroup.com
24	1900	24	2300	432	432 MHz Spring Sprint	CW Ph Dig	4-char grid square	sites.google.com/site/springvhfupsprints
24	2000	24	2100	3.5	UKEICC 80-Meter Contest	CW	4-char grid square	www.ukeicc.com
25	1900	25	2030	3.5	RSGB 80m Club Championship, Data	Dig	RST, serial	www.rsgbcc.org/hf
27	0001	28	2359	28	10-10 International Spring Contest, Digital	Dig	Name, mbr or "0," SPC	www.ten-ten.org
27	1200	28	1200	3.5-28	SP DX RTTY Contest	Dig	RST, province or serial	pkrvg.org/strona,spdxrttyen.html
27	1300	28	1259	1.8-28	Helvetia Contest	CW Ph Dig	RS(T), Canton or serial	www.uska.ch
27	1600	28	2159	7-28	Florida QSO Party	CW Ph	RS(T), county or SPC	floridaqsoparty.org
28	1700	28	2059	3.5-28	BARTG Sprint 75	Dig	Serial	bartg.org.uk/wp/contests

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.*

US Amateur Radio Bands

ARRL The national association for AMATEUR RADIO®

US AMATEUR POWER LIMITS — FCC 97.313 An amateur station must use the minimum transmitter power necessary to carry out the desired communications. (b) No station may transmit with a transmitter power exceeding 1.5 kW PEP.

Amateurs wishing to operate on either 2,200 or 630 meters must first register with the Utilities Technology Council online at **https://utc.org/plc-database-amateur-notification-process/.** You need only register once for each band.

2,200 Meters (135 kHz)

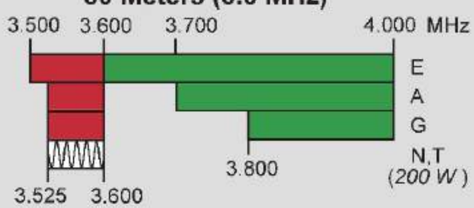
630 Meters (472 kHz)

5 W EIRP maximum, except in Alaska within 496 miles of Russia where the power limit is 1 W EIRP.

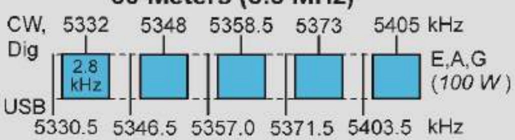
160 Meters (1.8 MHz)

Avoid interference to radiolocation operations from 1.900 to 2.000 MHz

80 Meters (3.5 MHz)

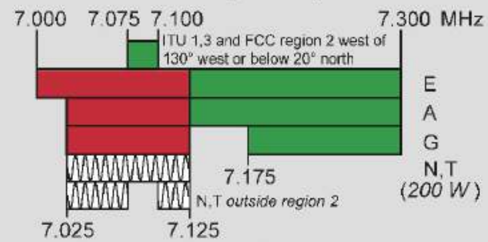


60 Meters (5.3 MHz)



General, Advanced, and Amateur Extra licensees may operate on these five channels on a secondary basis with a maximum effective radiated power (ERP) of 100 W PEP relative to a half-wave dipole. Permitted operating modes include upper sideband voice (USB), CW, RTTY, PSK31 and other digital modes such as PACTOR III. Only one signal at a time is permitted on any channel.

40 Meters (7 MHz)

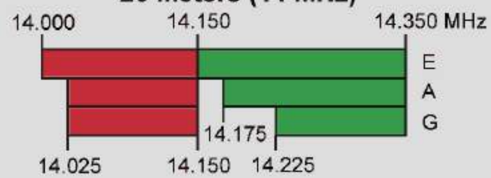


See Sections 97.305(c), 97.307(f)(11) and 97.301(e). These exemptions do not apply to stations in the continental US.

30 Meters (10.1 MHz)

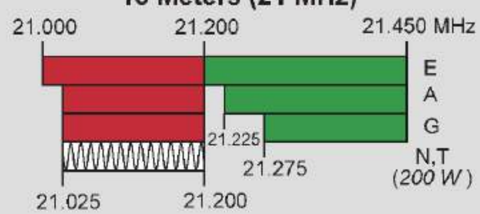
Avoid interference to fixed services outside the US.

20 Meters (14 MHz)

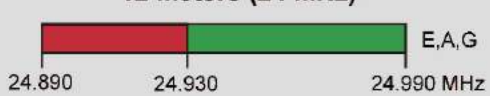


17 Meters (18 MHz)

15 Meters (21 MHz)



12 Meters (24 MHz)

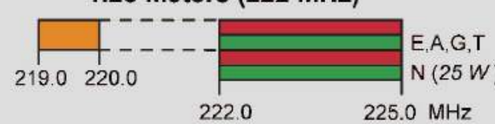


10 Meters (28 MHz)

6 Meters (50 MHz)

2 Meters (144 MHz)

1.25 Meters (222 MHz)



*Geographical and power restrictions may apply to all bands above 420 MHz. See *The ARRL Operating Manual* for information about your area.

70 cm (420 MHz)*

33 cm (902 MHz)*

23 cm (1240 MHz)*

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

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

‡ No pulse emissions

KEY

Note:

CW operation is permitted throughout all amateur bands.

MCW is authorized above 50.1 MHz, except for 144.0-144.1 and 219-220 MHz.

Test transmissions are authorized above 51 MHz, except for 219-220 MHz

- = RTTY and data
- = phone and image
- = CW *only*
- = SSB phone
- = USB phone, CW, RTTY, and data
- = Fixed digital message forwarding systems *only*

E = Amateur Extra
A = Advanced
G = General
T = Technician
N = Novice

See *ARRLWeb at www.arrl.org* for detailed band plans.

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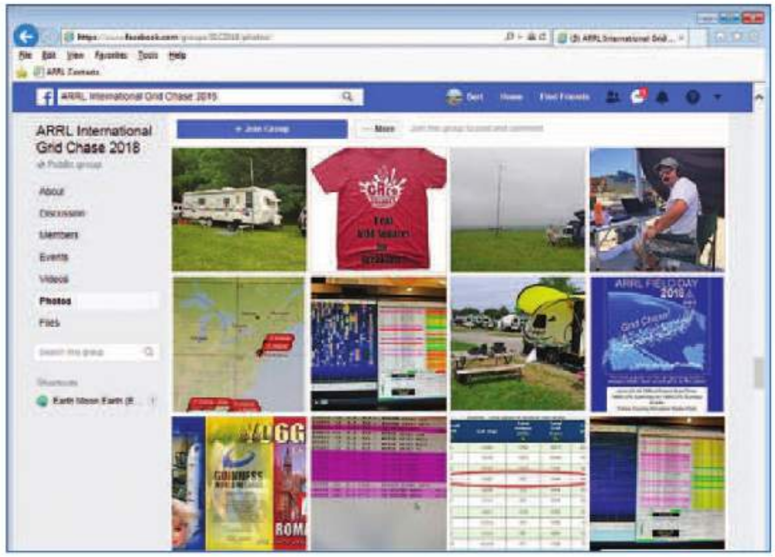
Bart Jahnke, W9JJ, Contest Branch Manager, w9jj@arrl.org

The 2018 ARRL International Grid Chase Wrap-Up

Join the discussion on Facebook at https://www.facebook.com/groups/IGC2018 and check out the #IGC hashtag on Twitter.



The IGC Facebook page was a fun place for participants to stay in touch and cheer each other on.

The 2018 International Grid Chase (IGC) has come to a close. What started during the fireworks over Greenwich, England, at 0000 UTC January 1, 2018, ended with an exciting flurry of last-minute contacts — and even some last-minute unique grids — at 2359 UTC on December 31, 2018.

Detailed summaries will follow on the ARRL website. Go to the IGC page at **https://igc.arrl.org/index.php** to see our detailed full results.

IGC Facebook Activity

In conjunction with the 2018 International Grid Chase, ARRL established a Facebook group for participants in the IGC to stay in touch all year long. This turned into a popular place to share tips and photos, and served as another avenue for connecting with radio operators around the world. Perhaps the most valuable aspect of the Facebook group was the ability to alert fellow chasers to upcoming grid square activations. Go to **www.facebook.com/groups/IGC2018** to revisit the year's activity.

Based on comments in the Facebook group, the IGC also encouraged a number of individuals to get their Amateur Radio licenses and get on the air. The event also brought some inactive hams back to the hobby, like Pat Freeman, N3GWZ, who posted this message on January 1, 2019:

> Thank you, fellow grid chasers. For the first time since the '89 peak of sunspot numbers, I got addicted to ham radio for an entire year. Put up a second stealth long-wire antenna and got on 160 meters (I'm antenna restricted). Bought an amp so I could be heard by DX. Got Worked All States (WAS) on many bands. Currently, ranked 311 on the leaderboard… I never thought any of this was possible. IGC participating hams helped make all of this happen. Thank you!

On January 2, 2019, Joe Donnelly, KA0KVW, wrote:

> First off, I would like to say thanks! Thanks to the ARRL for putting on the Grid Chase, and thanks to everyone that participated. I had a blast… it got me on the radio (a lot). I looked forward to firing up the rig and trying to make a lot of contacts.

Looking Forward

In recent years, ARRL has had a pattern of year-long events every other year — the 2014 Centennial, 2016 National Parks on the Air, and the 2018 International Grid Chase. There are no current plans for an upcoming year-long event, but who's to say what could develop in the future? At present, we are immersed in bringing the 2018 IGC to its close, developing in-depth year-end reporting, including summaries with recognition of activity levels and categories. Watch the IGC page (**https://igc.arrl.org/index.php**) and its leaderboard for more information about all the activity in 2018.

For now, stay tuned and feel free to share your future event ideas by sending them to **contests@arrl.org**. We hope participants continue to get on the air and enjoy all the bands and modes have to offer, and share our hobby with newcomers. Keep up that grid chase spirit!

2018 September VHF Contest Results

Check out the results of the event, held September 8 – 10, 2018.

Ralph Bowen, N5RZ (wb5aar@gmail.com)

Jarred, KF2MR/R, activated grids FN12, FN13, FN02, and FN03 — driving his score to 1st place in the Classic Rover category — during the 2018 September VHF Contest. This photo was taken in FN13 as he lined up his antennas to work the Toronto area. [Jarred Jackson, KF2MR, photo]

Top Ten

Classic Rover

KF2MR/R	63,602
VE3OIL/R	46,835
NF2RS/R	44,166
N7GP/R	24,067
N6MTS/R	21,586
K0DI/R	21,576
W5VY/R	21,505
AG4V/R	20,349
W3ICC/R	16,695
KT5TE/R	13,020

Limited Rover

AC0RA/R	121,264
K2EZ/R	42,536
WW7D/R	33,440
KJ2G/R	20,928
WB5IDY/R	12,960
AE5P/R	12,570
N6RH/R	12,450
K0BBC/R	12,215
W1RGA/R	9,947
K7BDB/R	8,811

Unlimited Rover

N0LD/R	117,824
K5SRT/R	109,610
VE3SMA/R	49,880
N2SLN/R	31,047
K6MI/R	24,300
KC0SKM/R	16,665
KD5IKG/R	11,340
N6JET/R	8,736
KJ1K/R	1,840
K7ATN/R	1,148

Single Operator, High Power

K1RZ	157,435
K1TEO	108,500
W0UC	79,051
VA3ELE	56,448
K3TUF	41,216
K1KG	30,705
K1TR	30,685
N4QWZ	28,971
WZ1V	28,530
W3IP	27,390

Single Operator, Low Power

AF1T	72,390
WB1GQR (W1SJ, op)	58,707
K9MU	33,152
VE3DS	32,528
N8RA	21,052
WA3EOQ	17,775
WB2JAY	15,576
W3EKT	14,224
N0LL	10,080
WZ8T	10,080

Single Operator, Portable

W4DVE	8,525
VE7FYC	1,040
VE2NCG	1,037
WB2AMU	987
AA6XA	784
AG7NC	488
N2YTF/P	468
K7ZOO	208
W7MTL	192
AC2GJ	150

Single Operator, Three-Band

KO9A	14,773
KG6IYN	9,792
K3SFX	5,250
KA2BPP	4,158
N7IR	3,612
K2RMX	3,570
WA4GPM	2,376
N7RK	1,892
N3ALN	1,738
AF6SA	1,617

Single Operator, FM Only

KM4KMU	14,154
W6IA	920
WB9WOZ	847
K1FJM/6 (N6ZE, op)	432
W7AIT	266
N9HRT	162
K7IMA	150
VA2DG	132
KX1W	98
NC6Q	90
KM6PHB	90

Limited Multioperator

N2NT	93,900
K2LIM	89,780
AA4ZZ	80,618
W3SO	69,432
K5QE	43,420
W2LV	38,000
K0DAS	12,530
W9RVG	10,640
NE5BO	7,068
K2BAR	4,884

Unlimited Multioperator

W2SZ	275,315
W2EA	143,736
WQ0P	61,204
W4NH	50,794
N8ZM	38,735
WE1P	25,650
W1XM	14,352
WS9V	4,698
W3RFC	4,522
W3ARO	4,452

Division Winners

Classic Rover

Atlantic	KF2MR/R	63,602
Dakota	KC0P/R	9,842
Delta	W5VY/R	21,505
Hudson	WB2SIH/R	7,854
Midwest	KS0TRC/R	480
Northwestern	KE7MSU/R	11,790
Pacific	N6MTS/R	21,586
Rocky Mountain	KK6MC/R	3,402
Southwestern	N7GP/R	24,067
West Gulf	KT5TE/R	13,020
Canada	VE3OIL/R	46,835

Limited Rover

Atlantic	K2EZ/R	42,536
Central	WD9HBF/R	88
Dakota	AC0RA/R	121,264
Delta	WA4JA/R	20
Great Lakes	K8JH/R	2,478
Hudson	KD2BKD/R	456
Midwest	K9JK/R	2,912
New England	KJ2G/R	20,928
Northwestern	WW7D/R	33,440
Pacific	NI6G/R	8,130
Roanoke	W7IY/R	495
Rocky Mountain	W0AMT/R	1,340
Southeastern	W4POT/R	28
Southwestern	N6GP/R	4,848
West Gulf	WB5IDY/R	12,960
Canada	VE7AFZ/R	748

Unlimited Rover

Atlantic	N2SLN/R	31,047
Dakota	KC0SKM/R	16,665
Midwest	N0LD/R	117,824
New England	KJ1K/R	1,840
Northwestern	K7ATN/R	1,148
Pacific	K6MI/R	24,300
West Gulf	KD5IKG/R	11,340
Canada	VE3SMA/R	49,880

Single Operator, High Power

Atlantic	K1RZ	157,435
Central	W0UC	79,051
Dakota	W0ZQ	23,463
Delta	N4QWZ	28,971
Great Lakes	KB8U	4,930
Hudson	W2BVH	11,505
Midwest	KF0M	12,474
New England	K1TEO	108,500
Northwestern	KE7SW	16,324
Pacific	AE6GE	17,697
Roanoke	W3IP	27,390
Rocky Mountain	W7QQ	5,248
Southeastern	KE8FD	24,130
Southwestern	N1RWY	16,320
West Gulf	K5LLL	22,194
Canada	VA3ELE	56,448

Single Operator, Low Power

Atlantic	WA3EOQ	17,775
Central	K9MU	33,152
Dakota	WB0LJC	429
Delta	K5OMC	770
Great Lakes	K8MR	819
Hudson	WB2JAY	15,576
Midwest	N0LL	10,080
New England	AF1T	72,390
Northwestern	WZ8T	10,080
Pacific	KC6ZWT	9,184
Roanoke	WA7TOF/4	3,000
Rocky Mountain	N7DBW	126
Southeastern	W4RAA	2,898
Southwestern	W6IT	3,190
West Gulf	K5TRA	4,250
Canada	VE3DS	32,528

Single Operator, Portable

Atlantic	AC2GJ	150
Great Lakes	AA8CH	20
Hudson	WB2AMU	987
Midwest	N0JK	12
New England	N1PRW	88
Northwestern	W4DVE	8,525
Pacific	AA6XA	784
Southwestern	K7ZOO	208
West Gulf	W5RST	8
Canada	VE7FYC	1,040

Single Operator, Three-Band

Atlantic	K3SFX	5,250
Central	KO9A	14,773
Dakota	AA0AW	221
Delta	KS4X	1
Great Lakes	K8AB	160
Hudson	KA2BPP	4,158
Midwest	K0CQ	154
New England	N1ZN	476
Northwestern	WB7FJG	1,404
Pacific	AF6SA	1,617
Roanoke	WA4LDU	1,242
Rocky Mountain	N5EPA	646
Southeastern	WA4GPM	2,376
Southwestern	KG6IYN	9,792
West Gulf	KV5W	924
Canada	VA2BN	646

Single Operator, FM Only

Central	WB9WOZ	847
Dakota	N0SUW	48
Delta	K4NRT	15
Great Lakes	WN8P	2
Hudson	KX1W	98
Northwestern	K7IMA	150
Pacific	W6IA	920
Roanoke	KM4KMU	14,154
Southeastern	K3TW	5
Southwestern	K1FJM/6 (N6ZE, op)	432
West Gulf	N5LUL	54
Canada	VA2DG	132

Limited Multioperator

Atlantic	K2LIM	89,780
Central	W9RVG	10,640
Dakota	W0STV	598
Delta	NE5BO	7,068
Hudson	N2NT	93,900
Midwest	K0DAS	12,530
New England	NE1C	4,284
Northwestern	WW7LW	288
Roanoke	AA4ZZ	80,618
Rocky Mountain	K5LRW	81
Southeastern	WB4WXE	4,815
West Gulf	K5QE	43,420

Unlimited Multioperator

Atlantic	W2EA	143,736
Central	WS9V	4,698
Great Lakes	N8ZM	38,735
Hudson	WE1P	25,650
Midwest	WQ0P	61,204
New England	W2SZ	275,315
Pacific	W6YNO	390
Roanoke	W4NH	50,794
Southwestern	KJ6KK	250
West Gulf	KC5MVZ	539

Full Results Online

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

Regional Leaders

Boxes list call sign, score, and class: LM = Limited Multioperator; R = Classic Rover; RL = Limited Rover; RU = Unlimited Rover; SO3B = Single Operator, Three-Band; SOFM = Single Operator, FM Only; SOHP = Single Operator, High Power; SOLP = Single Operator, Low Power; SOP = Single Operator, Portable, and UM = Unlimited Multioperator.

West Coast Region
(Pacific, Northwestern, and Southwestern Divisions; Alberta, British Columbia, and NT Sections)

N7GP/R	24,067	R
N6MTS/R	21,586	R
K0DI/R	21,576	R
KE7MSU/R	11,790	R
WW7D/R	33,440	RL
K7BDB/R	8,811	RL
NI6G/R	8,130	RL
N6GP/R	4,848	RL
K7JSG/R	4,082	RL
K6MI/R	24,300	RU
N6JET/R	8,736	RU
K7ATN/R	1,148	RU
AE6GE	17,697	SOHP
KE7SW	16,324	SOHP
N1RWY	16,320	SOHP
N7EPD	13,677	SOHP
K7YDL	8,388	SOHP
WZ8T	10,080	SOLP
KC6ZWT	9,184	SOLP
K2GMY	6,475	SOLP
N7QOZ	5,162	SOLP
WR6Z	4,500	SOLP
W4DVE	8,525	SOP
VE7FYC	1,040	SOP
AA6XA	784	SOP
AG7NC	488	SOP
K7ZOO	208	SOP
KG6IYN	9,792	SO3B
N7IR	3,612	SO3B
N7RK	1,892	SO3B
AF6SA	1,617	SO3B
W6KKO	1,420	SO3B
W6IA	920	SOFM
K1FJM/6 (N6ZE, op)	432	SOFM
W7AIT	266	SOFM
K7IMA	150	SOFM
NC6Q	90	SOFM
KM6PHB	90	SOFM
WW7LW	288	LM
W7DK	253	LM
W6YNO	390	UM
KJ6KK	250	UM

Midwest Region
(Dakota, Midwest, Rocky Mountain, and West Gulf Divisions; Manitoba and Saskatchewan Sections)

KT5TE/R	13,020	R
KC0P/R	9,842	R
KG5UCA/R	7,680	R
KK6MC/R	3,402	R
N0HZO/R	2,548	R
AC0RA/R	121,264	RL
WB5IDY/R	12,960	RL
AE5P/R	12,570	RL
N6RH/R	12,450	RL
K0BBC/R	12,215	RL
N0LD/R	117,824	RU
K5SRT/R	109,610	RU
KC0SKM/R	16,665	RU
KD5IKG/R	11,340	RU
W0ZQ	23,463	SOHP
K5LLL	22,194	SOHP
K0SIX	15,120	SOHP
KF0M	12,474	SOHP
K0TPP	11,375	SOHP
N0LL	10,080	SOLP
K5TRA	4,250	SOLP
KV5TX	2,058	SOLP
WB0LJC	429	SOLP
KB0HNN	312	SOLP
N0JK	12	SOP
W5RST	8	SOP
KV5W	924	SO3B
N5EPA	646	SO3B
AE5B	513	SO3B
AA0AW	221	SO3B
K0CQ	154	SO3B
N5LUL	54	SOFM
N0SUW	48	SOFM
NR0T	8	SOFM
AE0EE	1	SOFM
K5QE	43,420	LM
K0DAS	12,530	LM
W0STV	598	LM
K5LRW	81	LM
WQ0P	61,204	UM
KC5MVZ	539	UM

Central Region
(Central and Great Lakes Divisions; Ontario East, Ontario North, Ontario South, and Greater Toronto Area Sections)

VE3OIL/R	46,835	R
K8JH/R	2,478	RL
AC8W/R	210	RL
VA3TO/R	108	RL
WD9HBF/R	88	RL
VE3SMA/R	49,880	RU
W0UC	79,051	SOHP
VA3ELE	56,448	SOHP
W9EWZ	8,845	SOHP
K9EA	6,804	SOHP
KB8U	4,930	SOHP
K9MU	33,152	SOLP
VE3DS	32,528	SOLP
W9GA	7,000	SOLP
WA9DU	1,410	SOLP
KO0Z	1,176	SOLP
VE3EG	44	SOP
AA8CH	20	SOP
KO9A	14,773	SO3B
W9ZB	522	SO3B
VE3SST	510	SO3B
N9OBB	352	SO3B
VE3IQZ	210	SO3B
WB9WOZ	847	SOFM
N9HRT	162	SOFM
WN8P	2	SOFM
W9RVG	10,640	LM
N8ZM	38,735	UM
WS9V	4,698	UM
N2BJ	3,706	UM

Southeast Region
(Delta, Roanoke, and Southeastern Divisions)

W5VY/R	21,505	R
AG4V/R	20,349	R
W7IY/R	495	RL
KJ4ZYB/R	228	RL
W4PH/R	220	RL
KM4OZH/R	50	RL
W4POT/R	28	RL
N4QWZ	28,971	SOHP
W3IP	27,390	SOHP
KE8FD	24,130	SOHP
N4JQQ	8,004	SOHP
N3MK	1,638	SOHP
WA7TOF/4 (WA7TOF, op)	3,000	SOLP
W4RAA	2,898	SOLP
K4FJW	1,400	SOLP
K5OMC	770	SOLP
WG4I	473	SOLP
WA4GPM	2,376	SO3B
WA4LDU	1,242	SO3B
KK4BZ	243	SO3B
N5SMQ	108	SO3B
K3YDX	48	SO3B
KM4KMU	14,154	SOFM
K4NRT	15	SOFM
AD4TJ	12	SOFM
W4LAN	12	SOFM
K3TW	5	SOFM
AA4ZZ	80,618	LM
NE5BO	7,068	LM
WB4WXE	4,815	LM
WX4PC	736	LM
W4AQL	680	LM
W4NH	50,794	UM

Northeast Region
(New England, Hudson, and Atlantic Divisions; Maritime and Quebec Sections)

KF2MR/R	63,602	R
NF2RS/R	44,166	R
W3ICC/R	16,695	R
K2TER/R	12,496	R
WA3PTV/R	10,373	R
K2EZ/R	42,536	RL
KJ2G/R	20,928	RL
W1RGA/R	9,947	RL
K1SIG/R	7,326	RL
KD2BKD/R	456	RL
N2SLN/R	31,047	RU
KJ1K/R	1,840	RU
K1RZ	157,435	SOHP
K1TEO	108,500	SOHP
K3TUF	41,216	SOHP
K1KG	30,705	SOHP
K1TR	30,685	SOHP
AF1T	72,390	SOLP
WB1GQR (W1SJ, op)	58,707	SOLP
N8RA	21,052	SOLP
WA3EOQ	17,775	SOLP
WB2JAY	15,576	SOLP
VE2NCG	1,037	SOP
WB2AMU	987	SOP
N2YTF/P	468	SOP
AC2GJ	150	SOP
KQ2RP	105	SOP
K3SFX	5,250	SO3B
KA2BPP	4,158	SO3B
K2RMX	3,570	SO3B
N3ALN	1,738	SO3B
KC2THQ	1,296	SO3B
VA2DG	132	SOFM
KX1W	98	SOFM
VE2HEW	12	SOFM
N2NT	93,900	LM
K2LIM	89,780	LM
W3SO	69,432	LM
W2LV	38,000	LM
K2BAR	4,884	LM
W2SZ	275,315	UM
W2EA	143,736	UM
WE1P	25,650	UM
W1XM	14,352	UM
W3RFC	4,522	UM

Buff, WB2SIH/R, drove his Rover to a 1st-place finish in the Hudson Division by activating five grids in the Classic Rover category. [William "Buff" Fisher, WB2SIH, photo]

2019 Straight Key Night Results

More than 185 hams around the world joined in ARRL's classic New Year's Day event.

Bart Jahnke, W9JJ,
bjahnke@arrl.org
ARRL Contest Branch Manager

During the 2019 Straight Key Night (SKN), more than 185 participants made over 1,200 contacts around the world, all enjoying sending Morse code manually (using code keys or bugs).

Soapbox Comments

Here are just a few of the highlights shared by SKN participants on the ARRL Soapbox page (**www.arrl.org/soapbox**):

- Ralph Bane II, KC9PKF, enjoyed his first CW contact. He said, "Jim, W1IK, came in after a while of calling… I told him right away that he was my first CW QSO and he was very patient with me."
- Paul Huff, N8XMS, had a goal of making one contact per straight key he could find. His keys consisted of a Codemaster toy key from the 1960s; a homebrew hacksaw key; a 1941 J5A Signal Corps flameproof key; a RadioShack plastic practice key; a Straight Key Century Club Marconi key; a Speed-X key; an antique strap key, and a Whiterook MK-11 micro key.
- Scott McDonald, KA9P, said that he "really enjoyed five great ragchews with all homebrew stuff and a Type 51 RAF key as used on the venerable Vulcan bomber aircraft."
- Roger Rauvola, NA6DX, said he only had time for one contact during SKN 2019, "but it was a good one." He connected with Greg Triplett, WA6HNA. Roger said, "As it turns out, we are the same age and were Novices in the same year (1973)."
- Carl Young, K5HK, said he used six different straight keys this year, including a J-38; a Wesclox No. 9; a Winslow 66150 KY-116/U, and a Spanish Llaves Telegraficas Artesanas mini key.
- Karl Zuk, N2KZ, reminisced that the event marks a special occasion for him. He said, "It is the anniversary of my very first QSO on January 1, 2000, and my becoming a ham — now 19 years ago… How could I not love Straight Key Night?"

Best Fist and Most Interesting QSO

Each year, SKN participants are asked to vote on who had the Best Fist and who gave them their Most Interesting QSO. This year, Best Fist was a four-way tie between Richard Geordan, W6SGJ; Clifford Marks, KB3VQU; Camilo Castillo, HP1AC, and last year's winner, Thomas Warren, K3TW. Most interesting QSO went to Henry Wyatt, W2QF.

Joe, KA4WJB, made four contacts using this T-784A. This unit (later designated GRC-109) first appeared during the Cold War and was intended for use by CIA agents. Joe said, "The rig even has a built-in key." [Joseph Scoglio, KA4WJB, photo]

Remember, you don't have to wait a year to enjoy hand-sent CW. Get on the air, have fun, and enjoy what your straight key has to offer! ARRL will hold the next Straight Key Night on January 1, 2020.

Participating Stations

AA2MX, AA4AI, AA4Q, AA4TB, AA5KV, AA7FV, AA8UU, AA0QZ, AB6QK, AB7MP, AB8FJ, AC6AC, AC7AF, AD0BI, AD0KH, AE1T, AE3A, AE7AX, AE7CG, AE8EA, AI9IN, HP1AC, HP1IBF, HP1RIS, K1APJ, K1EEE, K2GBH, K2HT, K2NPN, K2PQ, K2TV, K3AFS, K3BVQ, K3MD, K3SWZ, K3TW, K4DS, K4EOR, K4HGX, K4RT, K4TRH, K5HK, K5LDA, K5MBA, K5SOH, K6GPB, K6KQV, K6LQ, K6PBQ, K6SQL, K7NTW, K7SU, K7ZYV, K8JV, K8NB, K9VKY, K9YA, K9ZTV, KA4WJB, KA7T, KA8NNY, KB5NJD, KB8TL, KB0LMB, KC2LM, KC4HW, KC7YE, KC9PKF, KC0GXX, KD2BD, KD6WKY, KE7LOY, KG4KGY, KI0G, KJ4M, KN5L, KN7NN, KO8S, K0CVN, KQ7TJ, KQ9J, KT3A, KW6G, KZ3W, N2BE, N2BZD, N2KZ, N2RC, N3HCN, N4HA, N4HAI, N4NYK, N5XE, N6FVY, N6JJA, N6TCZ, N8DNA, N9BOR, NC6Q, NF8M, NI0R, NJ3K, NN7A, NO0V, N0UMP, NR4M, NV6W, NW3V, NW0M, NY0O, VA3AMX, VE3AIH/W5, VE3CBK, VE7AHT, VE7NI, VK6GX, VO1MRC, W1DUW, W1GF, W1PID, W1TPB, W1TS, W1UJ, W1WEF, W2EB, W2GIW, W2IY, W2LID, W2NTN, W2VTV, W2WSC (WS2C & N2HM, ops), W4RK, W4SGP, W4YE, W5AKU, W5CYF, W5LRP, W5NZ, W5PDW, W5QLF, W5ROS (+ club ops), W5XW, W6JHQ, W6KN, W6KOW, W7AIT, W7EEE, W7FOX, W7OS, W8DPK, W8FDV, W8WTS, W8WZ, W9ABD (W4RK, op), W9KMP, WA1CFX, WA1PMA, WA2ALY, WA2CHV, WA2ELW, WA3VXJ, WA4KFZ, WA5FRF, WA6ARA, WA6HNA, WA7OET, WA9PWP, WA9ZBW, WA0VQY, WB3CEG, WB3JKQ, WB6AAJ, WB8CFO, WB9AYW, WB9DLC, WB9HFK, WB0B, WB0CJB, WD4ERM, WD8RIF, W0AAA, W0FUN, W0KIZ, W0YBS, and WU4B.

DX stations included HP1AC, HP1IBF, and HP1RIS.

April 2019 Frequency Measuring Test

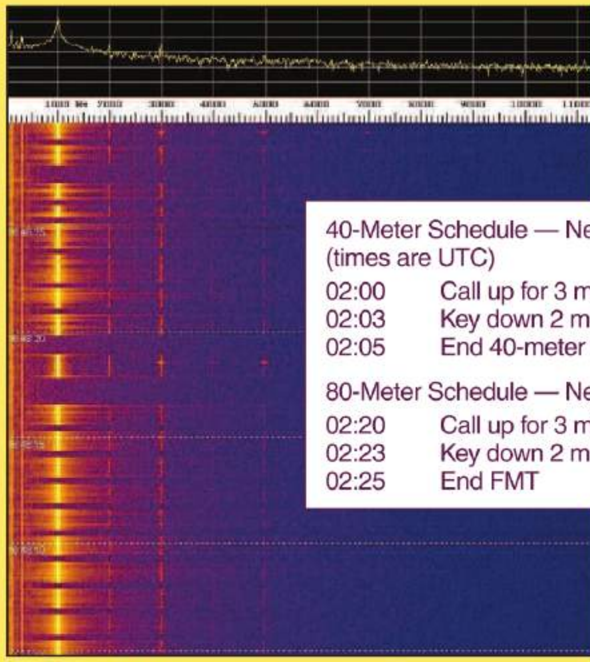
0200 – 0225 UTC, April 12

The format of the April Frequency Measuring Test (FMT) will be to measure a single-frequency signal transmitted first on 40 meters then on 80 meters from one station in eastern Oklahoma: K5CM.

The FMT will begin at 0200 UTC, April 12 (Thursday evening in North America). Measure the transmitted frequency and report your results at the new ARRL FMT page, **fmt.arrl.org**. Results must be submitted by 0200 UTC on April 15, at which time the results will be published on the website.

To be listed in the "Green Box" of the results, submit a measurement with an accuracy of better than 1 Hz.

Although the "call up" is scheduled to start at a very specific time, K5CM will try to start earlier. Every effort will be made to start the key-down measurement period at the published time.



40-Meter Schedule — Near 7065 kHz (times are UTC)

02:00	Call up for 3 minutes
02:03	Key down 2 minutes
02:05	End 40-meter run

80-Meter Schedule — Near 3599 kHz

02:20	Call up for 3 minutes
02:23	Key down 2 minutes
02:25	End FMT

Measuring audio frequencies with *Spectrum Lab*.

W1AW Schedule

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.

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

♦ 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.

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

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

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

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

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

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

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

During 2019, Headquarters and W1AW are closed on New Year's Day, Presidents Day (February 18), Good Friday (April 19), Memorial Day (May 27), Independence Day (July 4), Labor Day (September 2), Thanksgiving and the following day (November 28 and 29), and Christmas (December 25). For more information, visit us at **www.arrl.org/w1aw**.

Gene Spinelli, K5GS, k5gs@arrl.net

VP6D Ducie Island DXpedition Recap

On the weekend of October 13, 2018, 14 team members from six countries met in Papeete, Tahiti, to prepare for their journey to Ducie Island. On October 16, we flew from Papeete to Mangareva, the easternmost major island of French Polynesia, where the expedition ship *Braveheart* (a DXpedition veteran) waited. The vessel provided the camp logistics, tents, generators, gas, and power grid, which reduced our shipping costs.

On to Ducie

Sailing eastward, we entered the Pitcairn Islands Marine Reserve, the world's largest marine reserve. Established by the British government in September 2016, the 324,000-square-mile (834,000-square-kilometer) reserve offers protection to some of the most pristine waters and coral reefs on Earth.

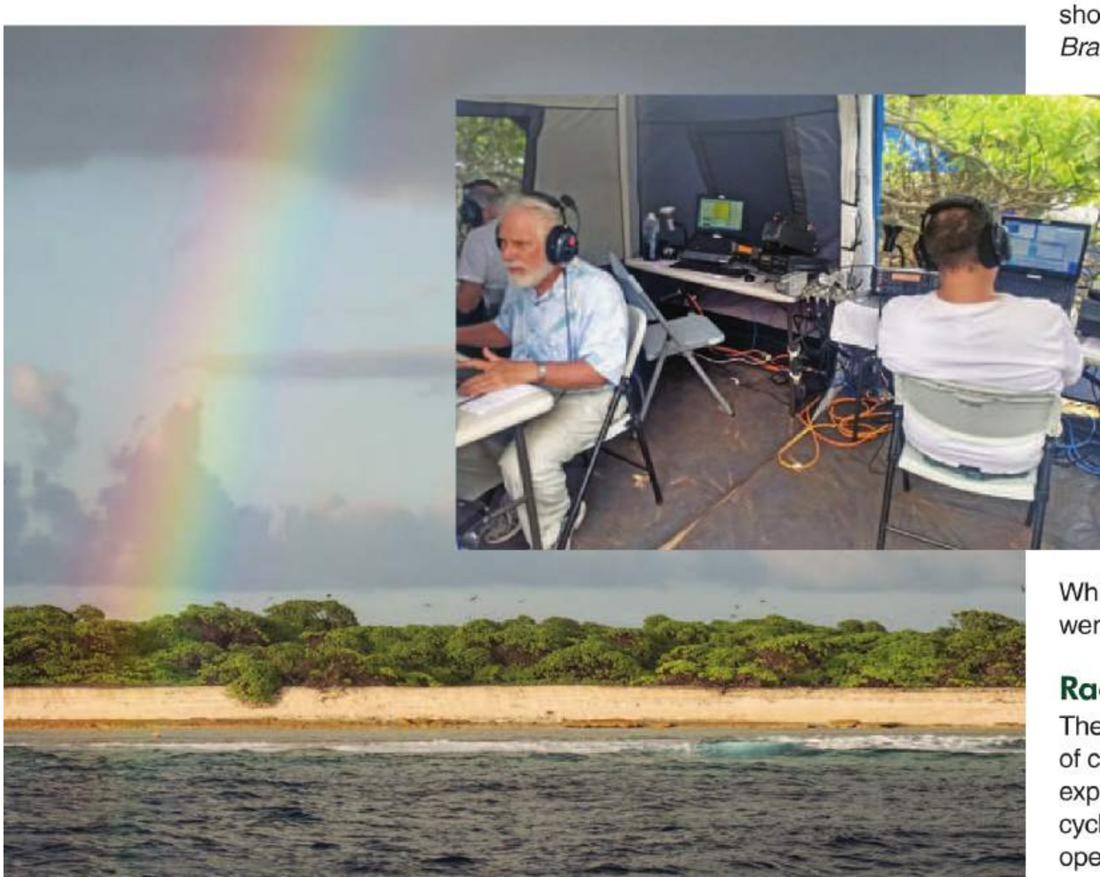
During our passage, the seas were calm and the weather cooperated. We arrived at Ducie Island 12 hours ahead of schedule. On the morning of October 19, we began offloading people and equipment.

Of the four inlets that make up Ducie, we selected Acadia for our DXpedition. Unlike other Pacific atolls we've visited, much of Ducie is heavily treed, its beaches narrow and covered mostly with broken coral and shells.

Fortunately, our skipper, Matt Jolly, and his brother and crew member, Daniel, had been to Ducie before and knew the island very well. The characteristics of the reef that surrounds Ducie made it very difficult for the ship's inflatable boat to make safe beach landings. Instead, the boat went as close to the beach as possible, and the team hopped into the water to get to and from the beach.

Going Ashore

Because we planned two separate camps about 1 kilometer apart from each other, we needed two landing zones. Once people and equipment were shuttled to the island, the first order of business was to erect the operating and sleeping tents. We constructed a camp kitchen, toilet, shower, and covered eating area. *Braveheart* provided plenty of drinking water for the team to stay hydrated.



Ducie Island (VP6/D) as seen from the *Braveheart*. [David Lloyd, K3EL, photo]
Inset: VP6D Ducie Island team members (left to right) Gene, K5GS; Dr. Arnie, N6HC, and Ricardo, PY2PT. [Steve Dyer, W1SRD, photo]

Once we became familiar with the route between the camps, the walk was about 15 minutes, over terrain ranging from flat ground, to beach, to exposed coral during low tide, and then back into the bush to traverse the island. Throughout the DXpedition, the weather varied from hot and humid to varying levels of rain, but we did have some pleasant days. While there was some wind, there were no significant antenna problems.

Radio Operations

The potential to make a large number of contacts drove the design of our expedition. At the bottom of the solar cycle, only a few bands would be open at any one time, so we set up one camp with a CW focus and the other primarily using SSB, although we operated digital modes from both.

The VP6D camp kitchen and meeting area. [Gene Spinelli, K5GS, photo]

The distance between camps allowed two stations to operate simultaneously on a band when it was open.

Elecraft provided eight K3S stations with KPA 500 amplifiers that we evenly divided between the camps. HF antennas were homemade vertical dipole arrays. Each camp had a 40-meter four-square. For CW, we had a 30-meter four-square and verticals for 80 and 160 meters. SteppIR provided two Yagi antennas and, later in the DXpedition, we added a 30-meter vertical to the SSB camp for FT8. The first contact was logged on October 20 at 0417, followed by all eight stations getting on the air the next day, as propagation allowed.

Even at the bottom of the sunspot cycle, most bands were busy during their expected open hours. We had 10 laptops connected by Ethernet cable and a Wi-Fi link between camps. Two computers in the headquarters tent were connected to separate Broadband Global Area Network (BGAN) satellite terminals.

We used the DXA logging site (**www.cordell.org/DXA**) to provide near real-time acknowledgement of contacts made, and contacts were also uploaded to the VP6D online log. These operations were not as smooth as we had hoped due to the challenges of building a robust network across the island (which was achieved after a couple of days of experimentation) and some incompatibilities between *N1MM+* and *WSJT-X*, resulting in some contacts not making it to the *N1MM+* log while on the island.

Project Attainment

Among the project's goals were to provide callers with an all-time new one (ATNO), provide band/mode fills, and make JT65 contacts on 6-meter Earth-Moon-Earth (EME) and FT8 contacts on HF — both a first from Ducie. At a solar cycle low, we estimated we would have between 60,000 – 80,000 contacts.

At the DXpedition's close, we logged over 112,000 total contacts with 189 DXCC entities. Of those contacts, 24,411 were with FT8, and 28 were through JT65 on 6-meter EME. The FT8 mode proved to be very popular, and it exceeded the 23,286 SSB contacts we made. This is because when SSB propagation faded away, we could still work FT8 on the seemingly dead bands. The final tally included 52.9% of total contacts with North America, 26.6% with Europe, and 15.8% with Asia. Considering our location in the southern Pacific, Europe was well represented in the numbers. Also of note were our 5,685 RTTY contacts, which made up 5.1% of our total.

Thanks to Our Sponsors and Friends

DXpeditions to uninhabited remote islands are expensive. We appreciate the support from DX clubs, foundations, and individual donors. Our major financial sponsors were the Northern California DX Foundation (NCDXF), the German DX Foundation (GDXF), and ARRL's Colvin Award. Equipment was donated, loaned, and/or deeply discounted by Elecraft, DX Engineering, SteppIR, Arlan Communications (RadioSport), Expert Linears America, RigExpert, and Spiderbeam.

We can't say enough about Matt Jolly and the *Braveheart* crew. Aside from getting us safely across the sea, they created and maintained a tent city and power grid for us in just a couple of days, prepared three meals a day, and even delivered clean laundry.

We also appreciate the cooperation we received from the Pitcairn Island Council. They guided us through the landing permit, radio licensing, and entry visa processes, and were welcoming with their remote paradise. Please visit **www.vp6d.com** for additional information.

Jon Jones, N0JK, n0jk@arrl.org

More Winter Surprises: North America-to-Australia 6-Meter Opening

Lightning struck again in January. After the unexpected and astonishing January 2 event, another widespread opening between North America and Australia took place on January 11 – 12. Jay, W9RM, noted that a powerful opening from western Colorado to California set the stage. The XE2K/B was 40 dB over S9 for 4 hours. This set up potential links to trans-equatorial propagation to the Southern Hemisphere. From Australia, VK4CZ and others heard the FK8SIX/b via sporadic E. This established that sporadic E was present on both ends of the North America-to-Austrailia/New Zealand path.

Rod, ZL3NW, in New Zealand, had his radio parked on 50.313 MHz. He noted a few Australian decodes, and left *WSJT-X* running to grab some lunch. On returning, Rod's computer showed he'd decoded 11 US stations on 6 meters, one being Larry, N0LL (EM09).

Starting at 0020Z on January 12, VK4MA worked WB5HJV (EM20) then AC4TO (EM70) on FT8. N0LL (EM09) decoded many US stations working Australia, including W4TAA, VK3ZBQ, K9VSW, K0JY, WT0DX, W9RM, and several VKs calling CQ. VK4WTN logged AI5I (DM65) on JT65 at 0037Z and W9RM (DM58) worked VK4CZ (QG62) on FT8.

Jay, W9RM, said:

> I worked eight VK station in call areas 4 and 5, the farthest being VK5PJ in PF95 at 8,800 miles. Everyone else was a VK4. I was called by two other VK5s, but that final hop seemed to be unstable, with rapid and deep fading. Some of the VKs were loud enough that I asked them to change transmission to CW, and then I worked VK4WTN and VK4CZ on that mode with 559 signals. All the rest of the contacts were either FT8 or JT65. At times, some of the stations were certainly loud enough to work on SSB. The band was open to VK from DM58 for at least 90 minutes.
>
> Stations worked were (in time order): VK4WTN, VK4MA, VK4CZ, VK4YH, VK5PJ, VK4CAG, VK4DDC, and VK4HJ. The last several stations answered my FT8 CQs.
>
> Strangely enough, even though I've been active through several sunspot peaks, VK4WTN (and the rest) was a new DXCC contact, marking #141. I had worked many New Zealand stations in the past on F2, but I never did hear an Australian station until last night. That's why I was pleased to be able to work a few of them on old-school CW.

I (N0JK) decoded W4TAA (EL87), working VK4MA at 0008Z on January 12. W4TAA uses a six-element SteppIR and 1,200 W.

At 0050Z, Tom, NH6Y, popped up for Robert, AA5AM (EM13). Robert said, "I saw one CQ from Tom, answered him and the contact was done a few seconds later. I never saw anyone else calling him, and he said I was the only station he'd decoded during the entire opening. That one wrapped up my 6-meter digital Worked All States achievement."

From Hawaii, Tom, NH6Y, noted signals were weak for his contact with AA5AM at –21/–24 on FT8. Tom observed that 10 meters had been open nearly every day in January from Hawaii to Australia across the geomagnetic equator, but not on 6 meters.

The amazing opening continued for over 2 hours. From Texas, Al, W5LUA (EM13), worked VK4MA at 0138Z, VK4CZ at 0145Z, and VK4HJ at 0159Z. Al runs a five-element Yagi at 85 feet with 1 kW. His best report from Australia was –3. Al had the last spot for an Australian station on 6 meters in North America at 0205Z.

This same 6-meter opening was also outstanding for stations in the midwest states. They worked strong stations in south Texas and northern Mexico. N0LL worked XE1H (DL80) at 0150Z. These same E_s clouds allowed stations, like W4UDH (EM52), to work VK4MA across them at the same time.

Legacy Radio on 6-Meter FT8 Update

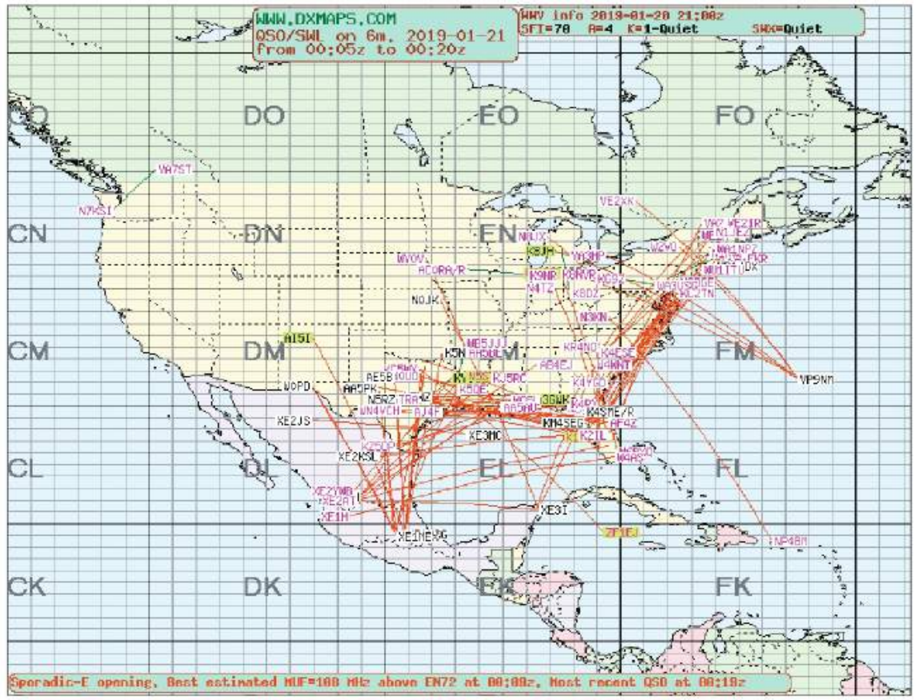
Using the 10 W MFJ-9406 with a *WSJT-X* setup on FT8, described in the last column, and a three-element Yagi, I logged KZ5DP (EL06), XE2X (EL06), XE2AT (DL81), and XE2YWB (DL82) on FT8 during this opening.

Many wonder how two North America-to-Australia 6-meter openings happened with a solar flux of only 70. To investigate, I reviewed the proposed mechanism for the North America-to-New Zealand/Australia 6-meter openings previously, based on Carl Luetzelschwab's, K9LA, analysis in his *WorldRadio* articles. A problem Carl noted was with the trans-equatorial chordal F2 portion of the path. Carl studied this path with a solar flux of 77 in December 2009. The two 2019 openings had a flux of only 70. Even with a solar flux of 77, Carl noted the maximum useable frequency (MUF) of the TEP path would only be 33 MHz for 15 days out of the month and 44 MHz only one day.

Now, the question becomes how the 6-meter signals made it across the geomagnetic equator. Some clues may be found in the reports above. The majority of stations making contacts between North America and Australia on 6 meters were large Yagi, high-power stations. In addition, almost all of the contacts were made via FT8 and JT65, which can extend the weak-signal recovery of a path 10 – 20 more dB below the noise. Tom, NH6Y, noted many days of 10-meter signals on the TEP path between Hawaii and Australia, so the chordal F-layer MUF was rising to 28 MHz routinely.

With a solar flux of 70, the MUF probability of the chordal hop over the equator at 2300Z in January is 44 MHz one day a month, still below 50 MHz. A possibility is forward scatter (also known as over-the-MUF mode). At a MUF of 44 MHz, using established formulas,[1] the additional scatter loss at 50 MHz would be 14 dB. The scatter path loss would be higher for lower MUF frequencies. My best guess, supported by K9LA's findings, suggests a multi-hop sporadic-E opening on both the Australian and North American ends of the path, with a chordal trans-equatorial F-layer hop with forward scatter hopping across the geomagnetic equator.

[1]ITU (International Telecommunications Union) publication Report ITU-R P.2011.1.



Contacts made during the Sunday night of the January VHF Contest. [**dxmaps.com**]

On the Bands

50 MHz. Overall, January was better than December, with numerous sporadic-E openings reported. Most of these were along the Gulf Coast, desert southwest, and northern Mexico. Sporadic-E openings appeared on both days of the January VHF Contest. Larry, N0LL, made 22 contacts in Arizona and California on Saturday evening of the contest. On Sunday afternoon, I (N0JK) decoded K1TO (EL87), several XE2s, and XE3I. KF0M (EM17) worked XE2YWB (I saw his contact) at 0109Z. Quite a few DX stations were active in this contest. I reviewed spots for HH2AA, VP9NM, KP4, TG9, TI, ZF1EJ, and NH6Y. On January 23, WA2GFN heard VO1SIX/b (GN27). On January 25, Julian, XE2JS, operated portable from rare grid DL78. He was into EM28 for 2 hours, calling CQ a lot but there were few takers. I (N0JK) received a –21 signal report from W4TAA on the same evening.

144 MHz. KF0M (EM17) worked the remote-operated AA0F (EN04) station and WE7I (DM79) in the contest. He also logged KG9DUK/r (EM26) using FT8. He had no tones in his speaker, but he did have solid FT8 decodes. K7ULS had an interesting PSK report from W0LGQ (EN21), who copied him on 2-meter FT8 at 2158Z on January 19 in the contest.

Here and There

A21EME will be active on EME from Botswana, Africa, on October 20 – 29, 2019, on EME on 6 and 2 meters, and 70, 23, 13, 9, 6, and 3 centimeters. They will be using CW and JT65. For more information, visit **www.pa3cmc.nl**.

Jim, NW7O, is now a Silent Key. He set a North American record for 2-meter sporadic E in the June 1987 VHF Contest by working KD4WF in Savannah, Georgia, at 3,182 kilometers. He went on many grid expeditions in Nevada, activating rare grids.

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 – Aug. 15, 0000Z – 2359Z, H31A, Panama City, Panama. HP1AVS. **500 Years of the Founding of Panama City, Panama**. 21.074 14.074 10.136 7.074; 80 – 10 meters, SSB, RTTY, PSK31, and FT8. QSL. Victor Sierra, P.O. Box 0830-00338, Panama City 0830, Panama. QSL manager is HP1AVS. *See website for more information.* **www.qrz.com/db/h31a**

Mar. 23, 1400Z – 2100Z, N4H, Daviston, AL. Lake Martin Amateur Radio Club. **205th Anniversary of the Battle of Horseshoe Bend**. 14.325 7.280 3.850. Certificate & QSL. John Philips, P.O. Box 938, Alexander City, AL 35011. **wi4p@arrl.net** *or* **www.facebook.com/K4YWE**

Apr. 1 – Apr. 30, 1600Z – 240000Z daily, W6RO, Long Beach, CA. Associated Radio Amateurs of Long Beach. **40th Anniversary of W6RO Aboard the *Queen Mary***. 14.340 14.040 7.240 7.040. QSL. W6RO/QSL, P.O. Box 7493, Long Beach, CA 90807. *Other bands possible as conditions permit.* **www.qrz.com/db/w6ro** *or* **www.aralb.org**

Apr. 8 – Apr. 14, 0000Z – 2300Z, W0W, Petal, MS. Hattiesburg Amateur Radio Club. **Petal-Southern Miss Pow-Wow**. 14.260 14.033 10.115 7.200 7.033 3.533-3.900. QSL. N5CW, P.O. Box 52, Petal, MS 39465. **www.qrz.com/db/w0w** *or* **www.hattiesburgamateurradioclub.org**

Apr. 13, 1500Z – 2000Z, W8PRC, Cleveland, OH. Parma Radio Club. **7th Annual Earth Day Celebration**. 14.245 7.195. QSL. Parma Radio Club, 8111 Laumer Ave., Cleveland, OH 44105. *Operating with solar power.* **parmaradioclub.com**

Apr. 13, 1600Z – 2100Z, W5BMC, Franklin, LA. Bayouland Emergency Amateur Radio Service. **16th Annual Bayou Teche Black Bear Festival**. 14.280 14.260 7.280 7.260. Certificate. Jackie Price, 708 Front St., Morgan City, LA 70380.

Apr. 13, 1600Z – 2300Z, NI6IW, San Diego, CA. USS *Midway* (CV-41) Museum Ship. **Doolittle Raid**. 14.320 7.250; PSK31 on 14.070. QSL. USS *Midway* (CV-41) COMEDTRA, 910 N. Harbor Dr., San Diego, CA 92101.

Apr. 13 – Apr. 14, 1500Z – 0300Z and **Apr. 14, 1500Z – 2100Z**, K5LRK, The Colony, TX. Lake Area Amateur Radio Klub. **Activation of State Parks in the State of Texas**. CW bottom of band +40 kHz; SSB general segment +25 kHz; VHF (SSB) 50.210 144.210; VHF (FM) 146.535 446.100. Certificate & QSL. Ken Rainy, AC5EZ, 529 Kenilworth Ave., Little Elm, TX 75068. **www.k5lrk.com**

Apr. 20 – Apr. 21, 1500Z – 2300Z, K5T, Nacogdoches, TX. Nacogdoches Amateur Radio Club. **San Jacinto Day Special Event**. 14.265 14.074 14.035 7.215. QSL. Nacogdoches Amateur Radio Club, 167 CR 2093, Nacogdoches, TX 75965. *All contacts will be confirmed via LoTW.* **www.w5nac.com**

Apr. 20 – May 4, 0100Z – 0100Z, W8S/WK8H, Vermontville, MI. Rev. Dr. Rodney L. Harmon. **78th Maple Syrup Festival**. 446.200 MHz PL 74.4 HZ; 145.560 MHz; 147.080 MHz PL 100 HZ; IRLP Node 4868; 446.200 MHZ. Certificate. Rev. Dr. Rodney L. Harmon, WK8H, 172 E. Second St., Vermontville, MI 49096. **srharmon1974@sbcglobal.net**

Apr. 27, 1100Z – 2200Z, W4F, Powder Springs, GA. 5th District of Georgia, American Legion. **Fishing for Freedom**. 7.275. Certificate. W4F/Fishing for Freedom, American Legion Post 294, 3282 Florence Rd., Powder Springs, GA 30127. **georgiafishingforfreedom@gmail.com**

Apr. 27, 1400Z – 2000Z, W1BSA, Fall River, MA. USTNR NE1PL. **W1BSA.** 14.259 7.259. QSL. USTNR, c/o Rick Emord, 135 Wareham St., Middleboro, MA 02346. **ne1pl.org**

Apr. 27, 1400Z – 2200Z, K5M, Paris, AR. Razorback Contest Club. **Operation from the Highest Point in Arkansas**. 14.250 14.040 7.200 7.040. QSL. Don Banta, 3407 Diana St., Springdale, AR 72764. **k5db@cox.net**

Apr. 27, 1700Z – 2300Z, W7VW, Klamath Falls, OR. Klamath Basin Amateur Radio Association. **OC&E Woods Line Last Train Anniversary**. 14.265; FT8 7.074. Certificate & QSL. KBARA, P.O. Box 8106, Klamath Falls, OR 97602. **wo7v@arrl.net** *or* **www.facebook.com/pg/kfalls.radio**

Apr. 27 – May 5, 0000Z – 2359Z, W5L, West Monroe, LA. NorthEast Louisiana Amateur Radio Club. **Commemorating the Louisiana Purchase**. 18.150 14.275 7.225 3.850. QSL. Jim Ragsdale, W5LA, 111 Eagle Lake Dr., West Monroe, LA 71291. **www.nelarc.org/2019-W5L**

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 to the address listed in the announcement. To receive a special event QSL card (when offered), be sure to include a self-addressed, stamped business envelope along with your QSL card and QSO information. *Note: Some clubs may ask for a nominal fee to cover the cost of the certificate or QSL. Request will be made on air during the event or on the club's website.

Special Events Announcements: For items to be listed in this column, use the ARRL Special Events Listing Form at **www.arrl.org/special-events-application**. A plain text version of the form is available at that site. You may also request a copy by mail or email. Offline completed forms can be mailed, faxed (Attn: Special Events), or emailed.

Submissions must be received by ARRL HQ no later than the 1st of the second month preceding the publication date; a special event listing for **June** *QST* would have to be received by **April 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 acknowledgment within a few days, please contact us. ARRL reserves the right to exclude events of a commercial or political nature.

Special Events listed in this issue include current events received through February 10. You can view all received Special Events at **www.arrl.org/special-event-stations**.

April 2019 W1AW Qualifying Runs

Earn your Code Proficiency certificate or endorsements by listening to W1AW Qualifying Runs. 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.

April Qualifying Runs will be transmitted by W1AW in Newington, Connecticut at 9 AM EDT on Thursday, April 4 (1300 UTC) and at 4 PM EDT on Thursday, April 18 (2000 UTC) 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, April 24 at 9 PM PDT (0400 UTC on April 25) on 3590 kHz. Unless indicated otherwise, sending speeds are from 10 to 40 WPM.

Convention and Hamfest Calendar

Abbreviations

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

2019 ARRL NATIONAL CONVENTION AT DAYTON HAMVENTION®

May 17 – 19, Xenia, OH
D F H Q R S V
Fri. 9 AM – 5 PM, Sat. 9 AM – 5 PM, Sun. 9 AM – 1 PM. *Spr:* Dayton ARA. Greene County Fairgrounds and Expo Center, 120 Fairgrounds Rd. *TI:* 146.940 (123 Hz). *Adm:* Advanced $22, door $27. **www.hamvention.org** and **www.arrl.org/expo**.

Alabama (Headland) — Apr. 27
F H R T V
8 AM – noon. *Spr:* Wiregrass ARC. Headland Town Square, 8 Park St. Lunch BBQ for donation, door prizes, and ham radio tickets at gazebo. *TI:* 145.430 (186.2 Hz). *Adm:* Free. **www.w4dhn.org**.

Alabama (Mobile) — Apr. 13
D F H R S V
8 AM – 2 PM. *Spr:* Mobile ARC. Abba Shrine Center, 7701 Hitt Rd. *TI:* 147.3 (203.5 Hz). *Adm:* $5. **w4iax.net**.

Alabama (Northport) — May 4
D F H Q R S T V
8:30 AM – 4:30 PM. *Spr:* Black Warrior Hamfest Assn. Echols Middle School, 2701 Echols Ave. *TI:* 147.06 (179.9 Hz). *Adm:* Advanced $6, door $8. **www.blackwarriorhamfest.org**.

Arizona (Phoenix) — Apr. 20
D F H Q R T V
6 – 11 AM. *Spr:* Arizona ARC. DeVry University, 2149 West Dunlap Ave. *TI:* 147.06 (162.02 Hz). *Adm:* $2. **http://www.w7io.org**.

Arizona (Sierra Vista) — May 4 F H R T
7 AM – noon. *Spr:* Cochise ARA. Green Acres, 2756 Moson Rd. *TI:* 146.76 (162.2 Hz). *Adm:* Free. **http://k7rdg.org/**.

California (Sonoma) — Apr. 27
D F H R S T V
8 AM – noon. *Spr:* Valley of the Moon ARC. Sonoma Veterans' Memorial Building, 126 First St. W. Full breakfast, operating club station W6AJF. *TI:* 145.35 (88.5 Hz). *Adm:* Free. **vomarc.org**.

70TH INTERNATIONAL DX CONVENTION

April 12 – 14, Visalia, CA
D H Q R S
Friday and Saturday 6:30 AM – 11 PM, Sunday 7:30 AM – 11 AM. *Spr:* Northern California DX Club. The Visalia Convention Center, 303 E. Acequia Ave. *TI:* none. *Adm:* Full convention with meals $130; convention only with no meals $60. **www.dxconvention.com**.

Connecticut (Gales Ferry) — Apr. 27
F H R
10 AM – 2 PM (or until last item is sold). *Spr:* Radio Amateur Society of Norwich. Gales Ferry Firehouse, 1772 Rte. 12. Tailgating allowed only for items impractical to be brought into firehouse hall. *TI:* 146.73 (156.7 Hz). *Adm:* $5. **www.rason.org**.

Connecticut (Thompson) — Apr. 28
D F H V
8 AM – noon. *Spr:* Eastern Connecticut ARA. Raceway Restaurant at Thompson Speedway, 205 E. Thompson Rd. *TI:* 147.225 (156.7 Hz). *Adm:* $3. **www.ecara.net**.

DELAWARE STATE CONVENTION

April 27, Georgetown, DE
D H Q R S T V
8 AM – 3 PM. *Spr:* Sussex ARA. Cheer Community Center, 20520 Sand Hill Rd. Delmarva Radio and Electronics Expo. *TI:* 147.09 (156.7 Hz). *Adm:* $6. **www.radioelectronicsexpo.com**.

Florida (Daytona Beach) — Apr. 13 T
8 AM. *Sprs:* Daytona Beach ARA. First Presbyterian Church, 820 Grandview Ave. *TI:* 147.15/75 (127.3 Hz). *Adm:* Free. **www.dbara.org**.

Florida (Waldo) — Apr. 20 D F H R T V
8 AM – 2 PM. *Spr:* Gainesville ARS. First Baptist Church of Waldo, 14370 Kennard St. (SR 24). *TI:* 146.82. *Adm:* Advance $5, door $7. **www.gars.club/hamfest/hamfest.pdf**.

Georgia (Savannah) — Apr. 27 F H R T
8 AM – 1 PM. *Spr:* Coastal ARS. Savannah Hilton Head Regional Airport Recreation Building, 250 Crossroads Parkway. *TI:* 442.70. *Adm:* Free. **coastalamateurradiosociety.net/wpW4LHSblog/?page_id=812**.

Illinois (Sandwich) — May 5 D F H R T
8 AM – 1 PM. *Spr:* Kishwaukee ARC. Sandwich Fairgrounds, 1401 Suydam Rd. DeKalb Hamfest. *TI:* 146.73 (100 Hz). *Adm:* Advance $8, door $10. **www.karc-club.org**.

Indiana (Peru) — Apr. 27 D H R S V
8 AM – 1 PM. *Sprs:* Cass County, Grant County, Miami County, and Kokomo ARCs. Miami County 4-H Fairgrounds, 1029 W. 200 N. *TI:* 147.345 (131.8 Hz). *Adm:* $5. **nci-hamfest.net**.

Iowa (Des Moines) — Apr. 27
D F H R S V
8 AM – 1 PM. *Spr:* Des Moines RA Association. Iowa State Fairgrounds, Elwell Family Center, 3000 E. Grand Ave. *TI:* 146.94 (114.8 Hz). *Adm:* $10, ages 12 and under are free. **www.dmraa.com/hamfest**.

Kentucky (Ashland) — Apr. 27 H R T V
8 AM – 1 PM. *Spr:* River Cities ARA. PNC Bank (rear parking lot), 1000 Carter Ave. Raffle and giveaways. *TI:* 146.94 (107.2 Hz). *Adm:* Free. **www.rcara.net**.

Kentucky (Whitesburg) — Apr. 13
F H T V
7 AM – 2 PM. *Spr:* Letcher County ARC. Mountain Shiren Club, 95 Maryland Dr. *TI:* 145.350 (186.2 Hz). *Adm:* $5.

Maryland (Boonsboro) — May 4
D F H Q R S T V
6 AM – 2 PM. *Spr:* Antietam Radio Association. Washington County Agriculture Education Center, 7313 Sharpsburg Pike. The Great Hagerstown Hamfest. *TI:* 147.09, 146.940 (100 Hz). *Adm:* $7. **https://www.w3cwc.org/hamfest.**

Michigan (Cadillac) — May 4
D F H Q R V
8 AM – noon. *Spr:* Wexaukee ARC. Cadillac Junior High School, 500 Chestnut St. *TI:* 146.98. *Adm:* $5. **www.wexaukeearc.org**.

Michigan (Chassell) — Apr. 27 F H R
9 AM – 1 PM. *Sprs:* Copper Country RAA, Keweenaw County Repeater Association, Baraga County Repeater Association. Chassell VFW, 42103 Wilson Memorial Dr. (US Rte. 41). *TI:* 146.88 (100 Hz). *Adm:* $3. **kcra-mi.net**.

Minnesota (East Grand Forks) — May 4
F H Q R S V
8 AM – 1 PM. *Spr:* Forx ARC. Heritage Village, 219 20th Street NE. *TI:* 146.94 (123.0 Hz). *Adm:* $7. **www.wa0jxt.org**.

AURORA '19 CONFERENCE

April 27, White Bear Lake, MN
H Q S T
9 AM – 4:30 PM. *Spr:* Northern Lights Radio Society. Community of Grace Lutheran Church, 4000 Linden St. Antenna Range (weather permitting). *Adm:* $5. **www.nlrs.org**.

New Hampshire (Deerfield) — May 3 – 4
https://near-fest.com/.

New Hampshire (Hampton) — Apr. 13
D F H R T V
8 AM – noon. *Spr:* Port City ARC. St. James Hall, 77 Tide Mill Road. Seacoast Amateur Radio Flea Market. *TI:* 145.15. *Adm:* $5. **w1wqm.org/**.

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

New Jersey (Succasunna) — Apr. 27
D F H Q R T V
8 AM – 12:30 PM. *Spr:* Splitrock ARA. Roxbury Senior Center, 72 Eyland Ave. *Tl:* 146.985 (131.8 Hz). *Adm:* $7. **www.splitrockara.org**.

New Jersey (Toms River) — Apr. 14
D H R T V
Vendors 7 AM, buyers 8 AM – noon. *Spr:* Jersey Shore ARS. Riverwood Park Building #2, 100 Riverwood Dr. *Tl:* 146.91. *Adm:* $5 donation. **jsars.org**.

New Mexico (Roswell) — Apr. 13 T V
8 AM – noon. *Spr:* Pecos Valley ARC. PVARC Clubhouse, 403 N. Richardson Ave. *Tl:* 147.32, 444.425, 444.950, 146.64 (146.2 Hz). *Adm:* $5, $20 for 5. **https://www.pecosvalleyarc.com/**.

New York (Middletown) — Apr. 28
D H Q R T V
9 AM – noon. *Spr:* Orange County ARC. Town of Wallkill Community Center, 7 Wes Warren Dr. *Tl:* 146.76 (100 Hz). *Adm:* $6. **www.ocarcny.org**.

New York (Palmyra) — Apr. 27
D F H R T V
8 AM – 1 PM. *Spr:* Drumlins ARC. VFW Post 6778, 4306 Rte. 31. *Tl:* 146.745 (71.9 Hz). *Adm:* $5. **drumlinsarc.us**.

RV RADIO NETWORK RALLY
April 24 – 27, Linwood, NC
F S
All day. *Spr:* RV Radio Network. Cross Winds Family Campground, 160 Campground Lane. RV camping, daily net, tours, seminars. *Tl:* 146.55. *Adm:* Free with required check-in, $35 for food and prizes (registration on website). **https://rvradionetwork.com**.

North Carolina (Morganton) — Apr. 27
D F H R S T V
8 AM – 1 PM. *Spr:* McDowell ARA. Burke County Fairgrounds, 145 Bost Rd. Catawba Valley Hamfest. *Tl:* 147.15. *Adm:* Advance $4, door $5. **cvhamfest.com**.

ARRL NORTH CAROLINA STATE CONVENTION
April 20, Raleigh, NC
D F H Q R S V
8 AM – 3 PM. *Spr:* Raleigh ARS. NC State Fairgrounds Jim Graham Building, 1025 Blue Ridge Road. Raleigh Hamfest. *Tl:* 146.640. *Adm:* Advance $8, door $10. **https://www.rarsfest.org/**.

Ohio (Athens) — Apr. 28 D F H R T V
8 AM – 1 PM. *Spr:* Athens County ARA. Athens Community Center, 701 E. State St. *Tl:* 145.15. *Adm:* $5. **www.ac-ara.org**.

Ohio (Cuyahoga Falls) — Apr. 13
D F H Q R V
Vendors 6 AM, shoppers 8 AM. *Spr:* Cuyahoga Falls ARC, Inc. Emidio & Sons Party Center, 48 E. Bath Rd. 65th Annual Hamfest. *Tl:* 147.27 (110.9 Hz). *Adm:* Advance $5, door $6. **www.cfarc.org**.

Ohio (Portsmouth) — Apr. 20
D H R S T V
8 AM – 1 PM. *Spr:* Portsmouth RC. Former National Guard Armory, 2313 17th St. *Tl:* 147.36 (136.5 Hz). *Adm:* $2. **www.facebook.com/groups/portsmouthradioclub**.

OKLAHOMA SECTION CONVENTION
April 12 – 13, Claremore, OK
D F H S V
Friday 4 – 9 PM, Saturday 8 AM – 3 PM. *Spr:* Green Country Hamfest, Inc. Claremore Expo Center, 400 Veterans Pkwy. *Tl:* 147.09 (88.5 Hz). *Adm:* Advance $8, door $10. **greencountryhamfest.org**.

EASTERN PENNSYLVANIA SECTION CONVENTION
May 5, Bristol, PA
D F H Q R S T V
7 AM – 1 PM. *Spr:* Warminster ARC. Bucks County Community College, Lower Bucks Campus, 1304 Veterans Hwy. (Rte. 413). *Tl:* 147.09 (131.8 Hz). *Adm:* $7. **www.k3dn.org/hamfest/**.

Pennsylvania (Spring Grove) — Apr. 27
D F H Q R S T V
8 AM – 1 PM. *Spr:* York Hamfest Foundation. Elicker's Grove Park, 511 Roth Church Rd. *Tl:* 147.33 (123 Hz). *Adm:* $5. **www.yorkhamfest.org**.

ARRL TENNESSEE STATE CONVENTION
April 13, Bartlett, TN
D F H R S T V
9 AM – 3 PM. *Spr:* Mid-South ARA. Bartlett Station Municipal Center Auditorium, 5868 Stage Rd. Memphis FreeFest. *Tl:* 147.03,147.63 (107.2 Hz). *Adm:* Free. **maraonline.org**.

Texas (Garland) — Apr. 27 H S V
9 AM – 4 PM. *Spr:* ARRL North Texas Section, Hella Hams. Hella Shrine Temple, 2121 Rowlett Rd. ARRL NTX Mentorfest 2019. Mentoring new operators. *Tl:* 146.66, 147.39 (110.9, 85.4 Hz). *Adm:* Free. **www.arrlntx.org/mentorfest**.

VHF SUPER CONFERENCE
April 26 – 28, Sterling, VA
D F H R S
All day Friday and Saturday. *Sprs:* Southeastern VHF Society, North East Weak Signal Group, Mt. Airy VHF RC. Holiday Inn Washington-Dulles Intl. Airport, 45425 Holiday Drive. *Tl:* none. *Adm:* Advance $99, door $110 depending on availability. **https://vhfsuperconference.com/**.

COMMUNICATIONS ACADEMY 2019
April 13 – 14, Seattle, WA
D H R S
8 AM – 5 PM. *Sprs:* Seattle ACS, WWA Medical Services, King County ARES, Bellevue ACS. South Seattle College, 6000 16th Ave. SW. Communications vehicle display. *Tl:* 147.08 (103.5 Hz). *Adm:* Advance $40 (1 day), $70 (2 days), door $45 (1 day), $75 (2 days); includes lunch. **www.commacademy.org**.

Washington (Yakima) — Apr. 13
D F H R V
9 AM – 3 PM. *Spr:* Yakima ARC. State Fair Park Modern Living Building, 1301 S. Fair Ave. *Tl:* 146.66 (123 Hz). *Adm:* $7. **yakimaamateurradioclub.com/yakima-hamfest/**.

Wisconsin (Cedarburg) — May 3 – 4
D H R
Friday: noon – 4 PM, Saturday: set up 6 AM, doors 8 AM – 1PM. *Spr:* Ozaukee RC. Columbia St. Mary's Center, W67 N866 Washington Ave. 41st Annual Spring Swapfest. *Tl:* 146.97 (127.3 Hz). *Adm:* $5. **www.ozaukeeradioclub.org/**.

Wisconsin (Stoughton) — Apr. 13
D F H R S V
8 AM – noon. *Spr:* Madison Area Repeater Association. Mandt Community Center, 400 Mandt Parkway. *Tl:* 147.15 (123 Hz). *Adm:* $7. **https://w9hsy.org/**.

Wisconsin (Superior) — May 4
F H Q R V
9 AM – 1 PM. *Spr:* Arrowhead RAC. Head of the Lakes Fairgrounds, 4700 S. Tower Ave. *Tl:* 146.94 (103.5 Hz). *Adm:* $7. **thearac.org**.

Wyoming (Dayton) — Apr. 27 F V
9 AM – 3 PM. *Spr:* Cloud Peak Radio & Electronics Group. Dayton Community Center, 1100 US-14. *Tl:* 147.255 (100 Hz). *Adm:* Free. **cloudpeakradio.org/**.

To All Event Sponsors

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

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

Al Brogdon, W1AB

75, 50, and 25 Years Ago

April 1944

- The cover photo shows W1JLK and his light-beam transmitter-receiver, described in this issue.
- The editorial delivers both kudos and cautions "To Our Gang Overseas" (our fellow hams serving in the military), noting many are still able to receive and read *QST*.
- In "The Alaska Communication System," T/4 Gail Fowler describes the radio system that supported the building of the Alaska Highway.
- A. D. Mayo, W4CBD, reports on "A Ham-Built Communications-Type Receiver," despite the increasing trend of using manufactured equipment.
- Harold Mitchell, W4IBZ, tells us about "WKXM-8 – A Novel WERS Transmitter" that fulfills WERS needs for battery-powered equipment made from priority-free, salvaged materials.
- "Hams in Combat" presents tales from the combat experiences of A. C. Jones, W9NE, receiving SOS calls for the US Navy, and Tech. Sgt. Howard Sullivan, W9QGS, who helped organize a search party in the Sahara.

April 1969

- The cover photo shows W1DBM's triband beam covered by a flock of birds across all three elements.
- The editorial addresses the emerging problem of the obscenities we too often hear on the air.
- Lewis McCoy, W1ICP, scales down a popular beam used on the HF bands to build "The Delta-Loop Beam on 144 MHz."
- R. H. Turrin, W2IMU, tutors us on the "Application of Broad-Band Balun Transformers," using newly available low-loss ferrite materials.
- J. Wayne Waller, W4TZB, describes "A Hidden Mobile Antenna" that uses the car body itself as the antenna.
- In "A Requiem for Radio Row," Gerald Samkofsky, W2YSF, reports that Manhattan's neighborhood of electronic retailers is being cleared out for the construction of the World Trade Center.

Note: In last month's column, we incorrectly identified the principal amateur station involved in making the record-breaking 2300 MHz contact reported in the February 1969 issue of *QST*. The organizer of the contact was John Zimmer, W2BVU.

April 1994

- The cover photo declares, "This Issue Is Packed with Projects," featuring photos of three home-brewed devices.
- The editorial, "Wake-Up Call for 13 cm," discusses FCC proposals to transfer 200 MHz of spectrum to nongovernmental use, which could affect our 2400 MHz band.
- "Build Your Own *Lowfer* Transceiver," by David Curry, WD4PLI, tells us how even non-licensed operators could explore the low 1750-meter band with a high-performance CW transceiver.
- Ben Spencer, G4YNM, gives us "A Function Generator with a Frequency-Counter Digital Readout."
- "The RingMaster Ring Detector," by Robin Rumbolt, WA4TEM, provides increased security for repeaters that are controlled via telephone landlines and at risk due to Caller ID.
- Dennis Drudge, W0XD, tells us how to build a decoder to receive "The Elkhart County Tone Alert" that is used for group call-ups of SKYWARN operators.

Field Organization Reports

January 2019

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.**

720
WA7PTM

524
WB7OSC

460
KD8TTE

435
WA2CCN

330
KK4PUX

325
KB2RTZ

318
WM2C

285
KW9EMG

272
KE8BYC

255
AL0Y

250
KI6LNB

248
KV4LY

246
KF4DVF

245
KT2D
WA3EZN

240
N8SY

238
WD8USA

221
KB1TCE

220
W0PZD

188
KD2LPM

186
N3KRX

180
WC9CW

175
K0IBS

170
W4DNA

165
K8LPC
WD8MWD

163
KT5SR

160
WB9QPM

156
WB8RCR

153
KB5PGY
WA2BSS

145
W5DY
KC1CIC

140
W0LAW
AC8RV
WB4FDT
KK3F

139
W3CB

136
WS6P

135
W2PH
WB9WKO
N2LJM
W3YVQ

134
WM3G

133
KC7ZGG

132
KD8UUB

130
K9LGU
N1LL
AC0KQ
N2JBA
KW1U
K4IWW

126
KC8YVF

125
W4CMH
K8RDN

124
K2TV

123
WA4VGZ

122
K2RMF

120
KI0JO
AG9G
KA9QWC
KD2MEN
AA7BM
KY2D
KO4OL
WK4WC

116
KI4UDZ

115
N9VC
NX9K
KC8WH
KB8MAF

112
NI2W

110
WC4FSU
W1KX
WA3QLW
K3JL
WB8YYS
WB8YLO
WB6OTS
N1PZP
KA2ZNZ
N1TF
W1RVY
KD2JKV
N1IQI
K4GK
K1HEJ
K3IN
AF4NC
WB8TQZ
KC5OZT
KA5AZK
KF5IOU

108
KD2IWN
W4TTO
KA5DON

107
N2DW

105
W7PHX
KC4BQK
K8ED

104
AD3J
KE4AHC

103
AD5CQ
W8IM

102
KA8ZGY

101
W8CPG

100
W4NWT
WB4RJW
KZ8Q
NN7H
KN9P
K9DUR
AB9ZA
KD2MDV
N8CJS
K3RC
K0VTT
KB2YAA
AA3SB
KE5YTA
WB6UZX

98
W9BGJ

97
KT4WX
N3JET

96
N2WGF
KA1G
KA2GQQ
KB1NMO

95
KB3YRU
KW4GU
K1XFC

92
K3FAZ

91
N3RB

90
KM4VTK
KM4WHO
N2TSO
K8KRA
WD8Q
WB0B
WD0BFO
KD4EAQ
AA3N
WB8WKQ
W3BC

88
N1LAH

87
K4VWK
KE5HYW

85
WD8DHC

82
N2PQJ
KD8ZCM

81
W9EEU
WA1LPM
KG5NNA

80
W2PAX
AA4XZ
W9NXM
WB8QLT
KF7GC
KB2QO
KB1NAL
N3SW

79
KB3KYH

78
ND0CW
W2CTG
K6JT

76
WB8SIQ
K8AMH

75
KL7RF
W4INK
KA2HZP

74
KA0DBK
KN4AAG

73
WA0UIG
WB3FTQ

72
KC7ASA
K3YAK

71
KC1HHO
W5XX

70
K6RAU
K0CY
K3MIY

The following stations qualified for PSHR in previous months but were not reported in this column: (Dec. 2018) WB9FHP 188, AB9ZA 145, KA9QWC 137, N1LL 130, K4GK 120, W9EEU 99, W9BGJ 98, K9DUR 95, WD0BFO 90. (Nov.) W8IM 141, N1LL 140, KA9QWC 120, N2DW 106, K9DUR, W9EEU 104, W9BGJ 98, AB9ZA 94, KT4WX 80. (Oct.) W8IM 127, N2DW 88, KT4WX 80. (Sept.) W8IM 118, N2DW 86, KT4WX 80. (Aug.) N1LL 175, KA9QWC 120, AB9ZA 110, K9DUR 98, W9BGJ 90, W9EEU 86, N9SE 85. (Jul.) WB9FHP 250, N1LL 175, KA9QWC 120, AB9ZA 110, K9DUR 93, W9BGJ 90, N9SE 86, W9EEU 74. (May) W9BGJ 92.

Section Traffic Manager Reports

The following Section Traffic Managers reported: AL, AR, AZ, CO, CT, EB, EMA, ENY, EPA, GA, IA, IL, IN, KY, LA, MDC, ME, MI, MN, MS, NC, NE, ND, NFL, NLI, NM, NNJ, NTX, OH, SFL, SNJ, SJV, STX, TN, VA, WCF, WI, WMA, WNY, WPA, WV, WY.

Section Emergency Coordinator Reports

The following Section Emergency Coordinators reported: CT, DE, EPA, GA, IA, ID, IN, KY, LA, MDC, MI, MN, MS, NLI, NNJ, NV, OH, OR, PAC, SFL, SJV, SNJ, STX, WPA, WV.

Brass Pounders League

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

KK3F 1734, NX9K 963, WB9WKO 793, KW1U 550.

The following stations qualified for BPL in previous months, but were not reported in this column: (Dec. 2018) WB9FHP 4793. (Oct.) WB9FHP 452. (Aug.) N1LL 528. (Jul) WB9FHP 5630, N1LL 589. (May) WB9FHP 4398, N1LL 589.

Silent Keys

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

NN1A **Cook**, Alfred W., Beverly, MA
KA1AS **Bolduc**, Albert S., Reading, MA
♦W1BH **Hicks**, Robert G., Sanford, FL
•WB1EEE **Gavagan**, Vincent J., Jr., Inverness, FL
W1GRG **Curtis**, Robert H., Ellsworth, ME
KB1KHA **Cooper**, Michel C., Groton, CT
♦K1KU **Daley**, Darrel L., Putney, VT
N1OFC **Bumpus**, Bruce R., Plainville, MA
W1RWC **Carter**, Richard W., Torrington, CT
•W1RXH **Parsons**, Ernest L., Bowdoin, ME
W1TGY **Young**, Dorothy, Hiram, ME
KB1WFM **Morin**, Henry L., Jr., Fremont, NH
WA1WWG **Tyler**, Thomas R., Mystic, CT
KD2GGD **Love**, Gregory M., Ocean City, NJ
W2GQC **Marino**, James A., Helena, MT
•W2IQB **Huey**, George E., West Chester, PA
♦WA2KCO **Stauder**, Victor M., Dayton, OH
W2MOW **Erb**, Ludwig C., Jr., Scotch Plains, NJ
WA2NCF **Wilson**, Howard R., Poughkeepsie, NY
WA2SRW **Zwinge**, Walter, Inverness, FL
N2TOC **Zillioux**, Thomas J., Rochester, NY
N2UWI **Himelfarb**, Jack, Lake Worth, FL
AB2YP **Bevilacqua**, Anthony L., Hamilton, NJ
WZ2Z **Dally**, Bruce J., West Bloomfield, MI
W3AEG **Holdridge**, Milton E., Jr., Highland, MD
W3FIP **Pannebaker**, Frank I. "Skip," Jr., Millsboro, DE
•WB3FWE **Aldridge**, David E., Solomons, MD
•N3GHI **Murray**, Bruce A., Pittsburg, PA
K3LNV **Allen**, Elmer L., Jr., Perkasie, PA
W3MPN **Asaki**, Goro "George," Pasadena, MD
N3NGA **Ashlin**, Roy A., Jr., Beltsville, MD
KY3Q **Leftridge**, Gary L., Shawnee, KS
N3QBV **Fouse**, Stephen E., Altoona, PA
•KA3TIQ **Guy**, William P., Claysville, PA
•W3TMO **Jones**, Joseph, Justus, PA
♦K3VT **Trotnick**, Vincent W., Jr., McMurray, PA
W3WER **Hadley**, Herbert A., Monocacy, PA
N3ZQY **Fornwalt**, Brian W., Altoona, PA
WA4AIW **Caudill**, James "David," Glade Valley, NC
KN4ARY **Emmons**, Michael R., Jamestown, TN
N4BB **Baker**, Thomas G., Montross, VA
AC4CH **Arnett**, Frank W., Greenbrier, TN
WD4CZV **Hayes**, Robert D., Scottsboro, AL
WD4DES **Riner**, Joseph S., Cleveland, TN
KD4DZE **Eldridge**, William F., Grayson, KY
KR4EP **Harrel**, Hicklin A., Jr., Midlothian, VA
KF4EZE **Grissett**, Sewell H., Waynesboro, GA
AE4FB **Adams**, Michael D., Midland City, AL
KI4FKR **Cole**, Floyd N., Gainesville, GA
WD4GCD **Garbee**, Shirley T., Centreville, VA
K4GLO **White**, Aubrey H., Jr., Chipley, FL
AC4GO **Hampton**, James A., Decatur, AL
AG4HR **Grady**, Rajah E., Deep Run, NC
♦WW4I **Henry**, Philip C., Greenwood, SC
W4ITX **Freeman**, Larry D., Taylors, SC
•KA4J **Ledford**, Larry G., Cleveland, TN
K4JEA **Kicklighter**, Ottis C., II, Jacksonville, FL
N4JJM **Mount**, Jerry, Hull, GA
KD4JSB **Wallace**, Thomas L., Wilmington, NC
♦AK4JW **Weigand**, James M., Groveland, FL
KB4JZ **Gregory**, Curtis "Phil," Moultrie, GA
AF4LG **Randall**, Gary D., Vero Beach, FL
W4LWZ **Zimmer**, Lawrence W., Cape Coral, FL
KK4MBP **Ware**, Glenn T., McLean, VA
•N4MZ **Redding**, Howard E., Melbourne, FL
N4NBM **Best**, Alan T., Largo, FL
K4OOE **Glazner**, Frederick E., Huntsville, AL
•AA4OU **Alexander**, James B., Winston-Salem, NC
KF4QVT **Eary**, Martha E., Ashland, KY
WA4RHT **Cooke**, Dewey Wilson, Tigerville, SC
♦WA4WIP **Tesar**, Richard G., Sarasota, FL
KM4WLV **Michael**, Daniel W., Rockwell, NC
W4XS **Hayes**, James H., Thompson's Station, TN
N4ZX **Lambert**, John M., Charlotte, NC
AC5A **Richardson**, Walter S., Port Saint Lucie, FL
K5BIS **Grab**, Donald J., Albuquerque, NM
KG5CCB **Snyder**, Norman D., Granbury, TX
KB5CN **Baker**, Charles V., Dripping Springs, TX
KX5F **Burns**, Patrick C., Oklahoma City, OK
KC5FRS **Reynolds**, Donald, Conway, AR
W5GAK **Hyatt**, Joe, Kingfisher, OK
KF5IBW **Baker**, Albert E., Tickfaw, LA
K5JZT **Bearden**, William C., Bartlesville, OK
♦KF5KHZ **Ramsey**, John W., Bells, TX
W5NX **Tillotson**, Charles C., Fayetteville, AR
AB5PX **Mayberry**, Greg L., Caddo Mills, TX
KF5SJ **Gowens**, Truman G., Graham, TX
•WB5SWW **Phillips**, Charles C., Laurel, MS
N5UNJ **Roper**, Reagan D., Midland, TX
WA5UNO **Moore**, Larry L., Alamogordo, NM
N5UTI **Weeks**, Denise "Shalanna Collins," Richardson, TX
W5VBD **Fenn**, George L., Jr., Tulsa, OK
KB5VEW **Whitworth**, Richard L., Blackwell, TX
AA5VU **Kriss**, Richard M., Austin, TX
KE5WQU **Bennett**, Donna M., Wichita Falls, TX
♦W5ZHI **Lambert**, Richard E., Albuquerque, NM
WA6AD **Epps**, Clyde, McAlester, OK
K6BNS **Smith**, Bruce N., Walnut Creek, CA
AG6C **Bravin**, Betty, Santa Rosa, CA
W6OLC **Christian**, Charles L., Fairfield, CA
W6EO **Nelson**, Thomas L., Jr., Lakewood, CO
W6ETS **Senser**, Ernest T., Laguna Woods, CA
•KD6FGQ **Christenson**, Tosca A., Greenville, CA
•KE6HUU **Stasio**, Terry D., Fresno, CA
♦W6LSW **Ozment**, William L., Pollock Pines, CA
•K6OT **Vickers**, Thomas E., Grand Island, NY
•WB6QMD **Sumida**, Linda H., Sacramento, CA
•N6SEZ **Rosenberg**, Leah, Phoenix, AZ
•K6TAV **Varin**, Tom, Fountain Valley, CA
N6TQR **Hargrove**, Harold E. "Hal," Salem, OR
K6UXP **Wagner**, William R., Los Angeles, CA
W6WAA **Jones**, Bevan J., Payson, UT
W6WCF **Fertig**, William C., Hesperia, CA
N6YR **Canaday**, James H., Lawrence, KS
KL7AG **Weber**, Albert F., Fairbanks, AK
•KL7AZ **Weber**, Florence R., Fairbanks, AK
KF7GNM **Bach**, Alan R., North Plains, OR
N7JBJ **Sabel**, Gerald J., Welches, OR
W7LB **Brown**, Larry, Tucson, AZ
N7OYG **Weed**, Jane M., Kingman, AZ
K7RFT **Nichols**, Lynn L., Ava, MO
KE7TOC **Griffith**, Greg D., San Antonio, TX
W7YWP **Baker**, William, Olympia, WA
K7ZME **Harger**, Armand John, Surprise, AZ
KH6AF **Dufficy**, Daniel C., San Rafael, CA
KC8DSC **Decker**, Ronald C., Dayton, OH
W8IQB **Corbin**, Lowell D., Cadillac, MI
WA8LUK **Cumbow**, James B., Jr., Lynn Township, MI
N8MNI **Crosbie**, Mark "Andy," London, OH
•K8NMG **Klesch**, Charles J., Oregon, OH
♦•WB8OBW **Mark**, Howard N., Willard, OH
K8OCK **Esborn**, John E., Wickliffe, OH
W8OWN **Rouman**, George L., Big Rapids, MI
WD8SAY **McNabb**, William G., Yellow Springs, OH
WA8SCR **Lober**, Robert F., Perrysburg, OH
WB8SIO **Dean**, James F., Vermilion, OH
K8SMC **Osborn**, William "Terry," Jackson, MI
WB8TGP **Cole**, Clifford, Allendale, MI
K8TSJ **Pitchford**, Delma E., Saranac, MI
W8WNA **Sanderson**, James K., Perrysburg, OH
•KE8YA **Bohannan**, William, Columbus, OH
W8YGW **Neal**, Gordon K., Hamersville, OH
KA8ZYZ **Sandbrink**, William, Lugoff, SC
NO9A **Carr**, Lawrence J., Elk Grove Village, IL
KB9BBI **Charles**, Edward B., Goshen, IN
•N9BOY **Norris**, William F., Evansville, IN
♦AA9CN **Lepouce**, Joel E., Pleasant Prairie, WI
N9FXL **McMichael**, Herman L., Jr., Poseyville, IN
WA9GXZ **Shulz**, Warren G., Griffith, IN
W9HLA **Gizzi**, Joseph, Highwood, IL
N9HZD **Wescoat**, James C., Sr., Mascoutah, IL
K9MJR **Rauen**, Matt J., Palatine, IL
KB9MWS **Hawkes**, Roland K., Concord, MA
N9NAM **Everson**, William A., Green Bay, WI
•W9QNR **Scarborough**, William B., Centralia, IL
KD9UQ **Trenshaw**, George C., Goshen, IN
•NT9W **Mayfield**, Elbert "Clyde," Columbus, IN
W9WPV **Butcher**, Bradley A., Pensacola, FL
N9YDL **Gray**, John L., Jr., Chillicothe, IL
W0ACP **Saint**, Gary A., Idaho Springs, CO
K0ADI **Kittleman**, Rod A., Nixa, MO
KE0AY **Tissot**, Frank G., Florissant, MO
WD0FYJ **Chivers**, Walter J., Jr., Urbandale, IA
W0GPF **Vollmar**, Lewis C., Sainte Genevieve, MO
WA0GUD **Krauel**, Arnold L., Audubon, IA
W0JCF **Hyland**, Ronald I., Minneapolis, MN
AA0JT **Seibold**, Duane L., La Plata, MO
N0LGU **Bauer**, David C., Fremont, NE
♦KB0MH **Callen**, Delbert, Tribune, KS
♦KB0MWG **Coby**, William A., Saint Louis, MO
K0NNC **Stitt**, Nancy, Sun City, AZ
•W0NQB **Pehkonen**, Robert R., Cedar Rapids, IA
N0NWW **Cummings**, Betty M., Saint Marys, KS
•K0OU **Lufcy**, Stephen C., Raytown, MO
KC0STQ **DeGuire**, Thomas D., Saint Louis, MO
N0TMN **Komarek**, Lillian P., Boulder, CO
•KB0WWZ **Chamberlain**, Ronald W., Lamar, CO
N0XDW **Gerst**, Jeff M., Akron, CO
VE3HRB **Gillingham**, Herbert A., Moose Creek, ON, Canada
VE6UX **Elsinger**, Robert, Whitecourt, AB, Canada
VU2BL **Bhanumathy**, M., Hyderabad, India

♦ Life Member, ARRL

• Former call sign

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

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

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

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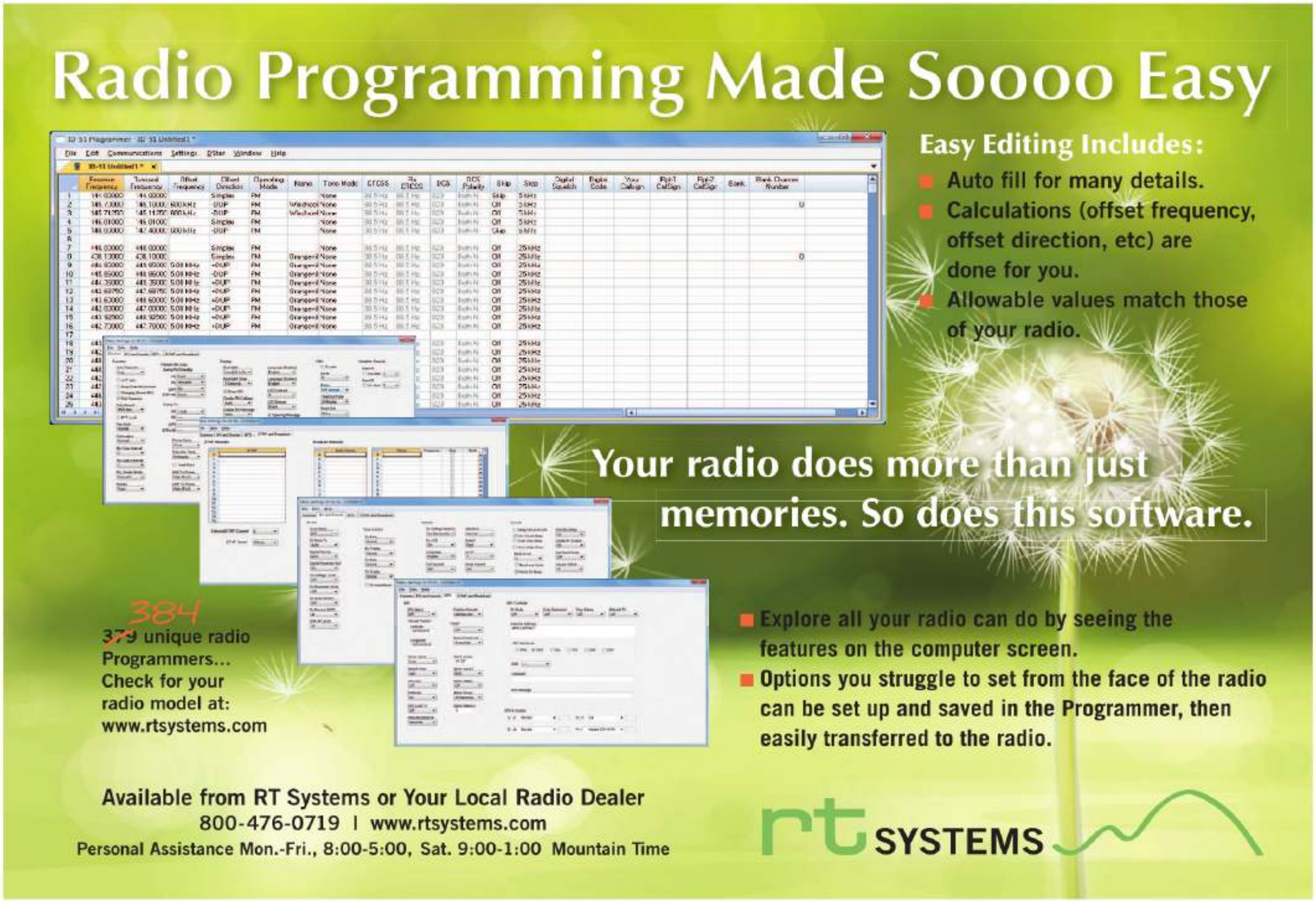

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The First Choice of Hams Around the World!

hy-gain® HF Rotators

HAM-IV – $649.95

The Most Popular Rotator in the World!

For medium communications arrays up to 15 square feet wind load area. Has 5-second brake delay, Test/Calibrate function. Low temperature grease permits normal operation down to -30 degrees F. Alloy ring gear gives extra strength up to 100,000 PSI for maximum reliability. *Precision* indicator potentiometer. Ferrite beads reduce RF susceptibility. Cinch plug plus 8-pin plug at control box. Dual 98 ball bearing race for load bearing strength and electric locking steel wedge brake prevents wind induced movement. North/South center of rotation scale on meter, low voltage control, max mast 2$^1/_{16}$".

HAM-VI – $749.95 with DCU-2
HAM-VII – $799.95 with DCU-3

M V Rotator Specificati

Wind Load Capacity (inside tower)	15 square feet
Wind Load (w/mast adapter)	**7.5 square feet**
Turning Power	800 in.-lbs.
Brake Power	**5000 in.-lbs.**
Brake Construction	Electric Wedge
Bearing Assembly	**Dual race/96 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	26 lbs.
Effective Moment (in tower)	**2800 ft.-lbs**

TAILTWISTER SERIES II – $799.95

For Large Medium Antenna Arrays up to 20 sq. ft. wind load.

Has 5-second brake delay, Test/Calibrate functions. Low temp grease, tough alloy ring gear, indicator potentiometer, ferrite beads on potentiometer wires, weatherproof AMP connectors plus 8-pin plug at control box, triple bearing race with 138 ball bearings for large load bearing, electric locking steel wedge brake, North/South center of rotation scale meter, low voltage control, 2$^1/_{16}$" max mast. **MSHD, $109.95**. Above tower heavy duty mast support. T2X, HAM-IV, HAM-V, HAM-VI. Accepts 1$^7/_8$-2$^5/_8$" OD.

T-2XD2 – $899.95 with DCU-2
T-2XD3 – $949.95 with DCU-3

TER Rotator Specifi

Wind Load Capacity (inside tower)	20 square feet
Wind Load (w/mast adapter)	**10 square feet**
Turning Power	1000 in.-lbs.
Brake Power	**9000 in.-lbs.**
Brake Construction	Electric Wedge
Bearing Assembly	**Triple race/138 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	31 lbs.
Effective Moment (in tower)	**3400 ft.-lbs**

CD-45II – $449.95

For antenna arrays up to 8.5 sq. feet mounted inside tower or 5 sq. ft. with mast adapter.

Low temperature grease good to -30 F degrees. New Test/Calibrate function. Bell rotator design gives total weather protection, dual 58 ball bearing race gives proven support. Die-cast ring gear, stamped steel gear drive, heavy duty, trouble free gear train, North center scale, lighted directional indicator, 8-pin plug/socket on control unit, snap-action control switches, low voltage control, safe operation, takes maximum mast size to 2$^1/_{16}$ inches. MSLD light duty lower mast support included.

CD-45D2 – $549.95 with DCU-2
CD-45D3 – $599.95 with DCU-3

II Rotator Sp

Wind Load Capacity (inside tower)	8.5 square feet
Wind Load (w/mast adapter)	**5.0 square feet**
Turning Power	600 in.-lbs.
Brake Power	**800 in.-lbs.**
Brake Construction	Disc Brake
Bearing Assembly	**Dual race/48 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	22 lbs.
Effective Moment (in tower)	**1200 ft.-lbs**

New!

Hy-Gain Programmable DCU-3 Digital Rotator Controller

DCU-3 – $449.95

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

Press a memory button or dial in your beam heading or let *Ham Radio Deluxe* (or other) take control. Your antenna auto rotates precisely and safely to your DX.

DCU-3 automatically jogs your antenna free and safely unlocks it before rotating begins (*great for older rotators with "sticky" brakes*) then turns off your motor before reaching its final heading. Your antenna gently coasts to a stop before the brake re-locks -- greatly reducing damaging overshoots and extending rotator life. Simply press *Left* and *Right* buttons for full manual control and fine tuning.

Bright blue LCD shows current, dialed in and computer controlled beam headings in one degree increments and your call.

Calibrate lets you accurately match your display to your true beam heading. Has USB/RS-232 ports for computer control. Adjustable LCD sleep time. Field upgradeable firmware. 8.5Wx4.3H x9D". 110 VAC. Order DCU-3X for 220 VAC.

DCU-2 Digital Rotator Controller – $399.95
Like DCU-3, but less programmable memories. 110 VAC. Order **DCU-2X**, for 220 VAC.

AR-40 – $349.95

For compact antenna arrays and large FM/TV up to 3.0 square feet wind load area.

Dual 12 ball bearing race. Automatic position sensor never needs resetting. Fully automatic control -- just dial and touch for any desired location. Solid state, low voltage control, safe and silent operation. 2$^1/_{16}$ inch maximum mast size. MSLD light duty lower mast support included.

Wind Load Capacity (inside tower)	3.0 square feet
Wind Load (w/mast adapter)	**1.5 square feet**
Turning Power	350 in.-lbs.
Brake Power	**450 in.-lbs.**
Brake Construction	Disc Brake
Bearing Assembly	**Dual race/12 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**5**
Shipping Weight	14 lbs.
Effective Moment (in tower)	**300 ft.-lbs**

Replace your Yaesu Rotator Controller

YRC-1 – $329.95

Hy-gain YRC-1 -- more features, more robust, far less prone to lightning damage. Costs less than repairing!

Easy-to-use -- dial in your beam heading and tap GOTO button. Exclusive 180 degree *AutoReversal*™ for fast longpath operation. All DCU-2 features. Bright blue LCD shows current, dialed-in, computer controlled beam headings, call. USB port for computer control. Extra heavy-duty AC power supply. Fast variable DC motor minimizes overshoot. Intuitive menu. Field upgradeable. For Yaesu G-800/1000/2800/G450/650. AC or DC motors.

YRC-3, $399.95. Like YRC-1 and adds 6 memories.

AR-500 Rotator/Controller – $149.95

UHF/VHF/6-Meter, MFJ-1886 Rotator/Controller and Remote. For use of small VHF/UHF, 6M, TV, FM, the MFJ-1886 wide band receiving loop and other light-weight ham antennas. Rotator is built in a weather-proof one piece cast aluminum housing with precision all metal gears, steel thrust bearings and automatic braking. Includes rotator, controller, remote, clamps, and all hardware. AR-500 remembers up to 12 directions even after a power outage! Use remote control or direct console. Displays location and relative position.

hy-gain® Antennas, Rotators & Towers 308 Industrial Pk Rd, Starkville, MS 39759 USA
Sales/Tech: (662) 323-9538 ■ **FAX:** (662) 323-5803 Open 8-4:30 CST, Mon.-Fri.

Add shipping. Prices and specifications subject to change.

HAMIV_DCU3_052113_QST_110718DS

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MFJ 4-Band Octopus Antenna

Choose any 4 bands: HF/VHF/UHF

Octopus antenna hub turns your hamsticks into four fully balanced dipoles in minutes!

Mix and match any four HF/VHF/UHF bands.

Example: screw-in 80, 40, 20 Meter hamsticks and a dual band 2M/440 MHz whip (two on each band) on opposite sides. Now you have an automatic bandswitching 5-band dipole! Rotate it for maximum signal and minimum QRM and noise with a small rotator like Hy-Gain AR-500, $149.95.

Works at any height, low for local NVIS and high for DX. At a fixed height, (say 20-30 feet) use 80-Meters for NVIS and 20-Meters for low-angle DX.

Mounts on any mast up to 1-inch diameter. Use a fiberglass pole on a tripod and you're on the air!

Perfect for casual portable operation, limited space, HOAs, field day, camping, ARES during disasters.

Single coax feed, built-in balun.

Interaction between bands is minimized because the ends are spaced apart at a large angle.

You don't need an antenna tuner if you carefully tune each dipole. An easier way is to just set each dipole approximately on frequency and use an antenna tuner to operate and widen the bandwidth.

Hamsticks break down to about four feet for easy storage.

Tough Octopus Hub

Eight 3/8 x 24 threaded connectors for hamsticks. Super strong fiberglass filled ABS base insulator. Your Octopus hub will give you years of trouble-free service!

Based on Geoff Haines, N1GY, award-winning *December 2007 QST* article.

Super Octopus Deals

MFJ-2104, $249.95 Octopus hub with your choice of four (2 each) 250W *HamSticks™. Saves $20!*

MFJ-2104H, $479.95 Octopus hub with your choice of four (2 each) 600W *HamSticks™. Saves $20!*

MFJ 250W & 600W *HamSticks*

MFJ *HamSticks* are ruggedly constructed. They have a sleek, low profile construction with low wind loading. Semi-rigid fiberglass eliminates the need for springs or guys while mobile.

Black anti-static jacket protects loading coil and blends with any vehicle. Nearly indestructible 4 foot, 0.125 inch diameter PH-17-7 stainless steel whips are adjustable for lowest SWR. Chrome plated brass fittings will give you years of reliable service.

Screws into any 3/8 x 24 female mount.

Includes allen wrench, tuning/matching instructions.

MFJ-16XXT *HamSticks* handle 250 Watts PEP. About 7 feet fully extended, 4 feet collapsed.

MFJ-26XXT *Hi-Q HamSticks* handle 600 Watts PEP. Much larger diameter loading coil and wire gauge gives you *higher-Q*. Lower losses let you dramatically talk further and hear better. 101 inches fully extended, 53 inches collapsed.

Band	600W	Price	250W	Price
75-M	MFJ-2675T	$59.95	MFJ-1675T	$24.95
60-M	N/A	N/A	MFJ-1660T	$24.95
40-M	MFJ-2640T	$49.95	MFJ-1640T	$18.95
30-M	N/A	N/A	MFJ-1630T	$18.95
20-M	MFJ-2620T	$49.95	MFJ-1620T	$18.95
17-M	MFJ-2617T	$39.95	MFJ-1617T	$16.95
15-M	MFJ-2615T	$39.95	MFJ-1615T	$16.95
12-M	N/A	N/A	MFJ-1612T	$16.95
10-M	MFJ-2610T	$39.95	MFJ-1610T	$16.95
6-M	N/A	N/A	MFJ-1606T	$16.95
2M/440MHz	N/A	N/A	MFJ-1414	$19.95

Antenna Rotator

AR-500
$149.95

Rotate your Octopus dipoles for maximum gain and minimum QRM/noise!

Weatherproof one piece cast aluminum housing with precision all metal gears, steel thrust bearings and automatic braking. Includes rotator, controller, remote control, clamps, hardware. Remembers up to 12 directions!

Digitally displays position.

110/220VAC switchable.

Portable Tripod with 18-foot mast

MFJ-1919EX
$159.95
w/18' ext. mast

Black *steel* base forms strong braced equilateral triangles on a side. Non-skid feet and strong base and mast locks. Stays in place! Telescopic fiberglass mast with *QuickClamps™* for instant *no-tool* set-up. 18 feet extended. 5 feet collapsed. Strong 1/8" wall fiberglass, $^{3}/_{4}$" diameter top section, $1^{1}/_{2}$" diameter bottom section. 15 lbs. **MFJ-1905, $24.95.** Tripod anchor foot braces. 3-pack stainless hardware set.

MFJ Enterprises, Inc. 300 Industrial Pk Rd, Starkville, MS 39759
Phone: (662) 323-5869 ■ **Tech Help:** (662) 323-0549 ■ **FAX:** (662) 323-6551 8-4:30 CST, Mon.-Fri.

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MFJ-2100_100218_QST_100418DS

MFJ Antennas

MFJ Super High-Q Loop™ Antennas

MFJ-1786 $449.95

MFJ 36-inch diameter loop antenna lets you operate 10 through 30 MHz continuously – including the WARC bands!

Ideal for limited space -- apartments, small lots, motor homes, attics, or mobile homes.

Work exciting DX with low angle radiation and local close-in contacts with high angle radiation when mounted vertically. 150 watts.

Super easy-to-use! MFJ remote control auto tunes to your desired band. Fast/slow tune buttons, Cross-Needle SWR/Wattmeter lets you quickly tune to your exact frequency. No control cable needed.

World's most efficient small loop antenna has all welded construction, welded butterfly capacitor with no rotating contacts, large 1.050 inch diameter aluminum radiator – gives you highest possible efficiency.

Every capacitor plate is welded for extremely low loss and polished to prevent high voltage arcing. Nylon bearing, antibacklash mechanism, limit switches, continuous no-step DC motor gives smooth precision tuning. Heavy-duty ABS plastic housing has ultraviolet inhibitor protection.

Cover 40-15 Meters. MFJ-1788, $499.95. Like MFJ-1786 but covers 40-15 Meters continuous. Includes remote control.

MFJ-1780, $329.95. Portable 24 x 24 x 5 3/4" box fan loop with carrying handle. 20-10 Meters continuous Fast/slow tune remote control. Highly efficient all-welded contstruction.

MFJ *no radial* Multiband Antennas...

...highly efficient end-loading gives full size performance

40/20/15/10/6/2M Vertical

Only 12 feet high with a tiny 24 inch footprint!

MFJ-1796 $299.95

Covers 40/20/15/10/6/2 Meters. Mount anywhere – ground level, tower top, roofs, patios, apartments and small lots.

Small and lightweight – perfect for DXpeditions, field day, camping, vacations.

Efficient end-loading, no lossy traps. Entire length radiates. Full halfwave on 2/6 Meters.

High power air-wound choke balun eliminates feedline radiation. Adjusting one band has minimum effect on others.

Automatic bandswitching, low radiation angle, omni-directional, handles 1500 watts PEP. Goes together in an afternoon.

MFJ-1796W, $299.95. WARC band version for 12, 17, 30, 60 Meters.

40/30/20/17/15/12/10M Vertical

MFJ-1797 $329.95

SkyMaster™ covers 40, 30, 20, 17, 15, 12, 10 Meters. Extra-long 40 Meter radiator gives super 40M performance!

Super low profile makes it perfect for roof mounting, ground mounting, on patio, tower top or to blend into the trees.

23.5 feet tall including extra-long 40 Meter radiator. Weighs just 7.5 lbs.

No ground or radials needed. 1000 Watts PEP. High strength 6063 aircraft aluminum. Use mast up to 1 3/4 inches.

MFJ-1797LP, $299.95. Like MFJ-1797 but without extra-long 40 Meter radiator. Less efficient with narrower bandwidth on 40M. 9 feet tall, weighs just 6 lbs.

80/40/30/20/17/15/12/10/6/2M Vertical

MFJ-1799 $399.95

All Bands HF through VHF!

Highly efficient endloaded 1/2 Wave vertical requires no radials, no lossy traps.

Only 20 feet high with a seven foot footprint so it mounts easily in a small area or patio.

High power air-wound choke balun eliminates feedline radiation. Automatic band-switching, low radiation angle, omnidirectional, 1500W PEP.

Built-to-last. Incredibly strong solid fiberglass rod and aircraft strength aluminum tubing are in the main structure.

MFJ-1799X, $349.95. Like MFJ-1799, but covers 40-2 Meters.

40/30/20/17/15/12/10 Meter ground mounted Vertical

New!

MFJ-1794 $249.95

High performance, low cost, low profile, ground mounted. 7 bands: 40, 30, 20, 17, 15, 12, 10 Meters, full 1500 Watts PEP.

Permanent or temporary in antenna restricted spaces.

Full 11 feet collapses to 7 feet to hide behind fences, etc.

Automatic bandswitching, low radiation angle for DX, omni-directional. Highly efficient end-loading. Entire length radiates. Low SWR.

Ground or roof mount with radials, ground rod.

Portable or permanent operation with **MFJ-1901**, $109.95 (left) 2 x 2 foot *ground-coupled* stainless antenna base. Hard-ware, U-bolts included.

MFJ-1795, $199.95, Like MFJ-1794 but covers 40/20/15/10M.

MFJ-1795W, $199.95, Like MFJ-1795 but for 12, 17, 30, 60 Meters.

MFJ-1901 $109.95

9-Band *Rotatable* Mini-Dipole covers 40-2M

Low profile 14 feet...7 ft. turning radius...40, 30, 20, 17, 15, 12, 10, 6, 2 Meters... 1500 W

New! MFJ-1789 $379.95

Directivity reduces QRM/noise and focus your signal to work real DX. Operate 40, 30, 20, 17, 15, 12, 10 plus 6 and 2 Meters. Run full 1500 Watts SSB/CW on HF!

End-loading inductors and capacitive hats insures highest efficiency. Entire length radiates. 6 and 2 meters are fulllength halfwave dipoles.

Low profile at fourteen feet – size of TV antenna – easily rotated by inexpensive rotators like Hy-Gain's ***AR-500, $129.95.***

Built-to-last – incredibly strong solid rod fiberglass center insulator and 6063 T6 aircraft strength aluminum tubing radiator. Assembles in an afternoon.

MFJ-1775, $319.95. Like MFJ-1789 but covers 40, 20, 15, 10, 6 and 2 Meters.

MFJ-1775W, $319.95. WARC band version for 12, 17, 30, 60 Meters only.

MFJ-1785, $399.95. 80/40/20M. Endloaded *rotatable* dipole 33 feet. 1500W PEP. 6063 T6 al. tubing, solid center fiberglass.

MFJ-4603 Universal Window Feedthrough $89.95. 4 SO-239, 1 N, 1 F, 3 ceramic feedthru for random/balanced lines, binding posts, more!

MFJ G5RV Antenna

MFJ-1778 $49.95

Covers all bands, 160-10 Meters with antenna tuner. 102 feet long. Can use as inverted vee or sloper. Use on 160 Meters as Marconi. 1500 Watts. Super-strong fiberglass center/feedpoint insulators. Glazed ceramic end insulators. All hand-soldered connections. Add coax, some rope and you're on the air!

MFJ-1778M, $44.95. G5RV Junior. Half-size, 52 ft. 40-10M with tuner, 1500 Watts.

Free Dealer/Catalog/Manuals/Instructions – Visit: www.mfjenterprises.com or call toll-free 800-647-1800

MFJ...the World Leader in Ham Radio Accessories!

MFJ G5RV Antennas

Operate all bands 10 through 160 Meters with a single wire antenna!

***The famous** G5RV antenna is the most popular ham radio antenna in the world!*

It's an efficient, *all* band 102 foot long antenna – shorter than an 80 Meter dipole. Has 32.5 foot ladder line matching section ending in SO-239 connector for your coax feedline.

MFJ-1778
$49.95

Use horizontally or as Inverted Vee or Sloper with just one support. 1500 Watts.

Operate all bands 80-10 Meters with an antenna tuner and even 160M with ground.

Fully assembled with *ceramic* end and fiberglass center insulators. *Hang and Play™* – add coax, rope to hang and you're on air!

MFJ-1778M, $44.95. *Half-size,* 52 foot *G5RV JUNIOR for limited space.* 40-10 Meters with tuner. Full 1500 Watts.

MFJ All Band Classic Doublet

MFJ 102 foot *all band* doublet covers 160-6 Meters with balanced line tuner. Super strong custom fiberglass center insulator relieves stress on 100 foot ladder line.

MFJ-1777
$64.95

Glazed ceramic end insulators. 1500 Watts.

RF Isolator

MFJ-915 *RF Isolator* prevents unwanted RF from traveling on the outside of your coax shield into your transceiver. This unwanted RF can cause painful RF "bites" when you touch your microphone or volume control, cause your display or settings to go crazy, lock up your transceiver or turn off your power supply. In mobile installations, stray RF could cause your car to do funny things even blow your car computer. Clear up these problems, plug an MFJ-915 between your antenna and transceiver. 1.8-30 MHz, 1500 Watts. 5 x 2 inches.

MFJ-915
$29.95

MFJ-919, $59.95. 4:1 current balun,1.5 kW.
MFJ-913, $29.95. 4:1 balun, 300 Watts.

True 1:1 Current

Balun & Center Insulator

True 1:1 *Current Balun/Center Insulator* forces equal radiator currents in dipoles for true dipole radiation pattern. Reduces coax radiation and field pattern distortion – your signal goes where *you* want it. Reduces TVI, RFI and RF hot spots. *Don't build a dipole without one!* 50 hi-permeability ferrite beads on high quality RG-303 *Teflon*® coax and *Teflon*® SO-239. 1.5kW 1.8-30 MHz. Stainless steel hardware. 14 gauge stranded copper wire is *directly* connected to your antenna. 5 x 2 inches. Heavy duty weather housing.

MFJ-918
$29.95

2-Position Antenna Switch

MFJ-1702C, $39.95. 2-position antenna switch, lightning surge protection, center ground. SO-239s.

Lightning surge protectors

MFJ-270, $29.95. 400W. **MFJ-272, $39.95.** 1500 W. Gas discharge tube shunts 5000 amps peak.< 0.1 dB loss. 1 GHz. SO-239s.

MFJ-16C06, $4.99. 6-pack *glazed ceramic* end/center ant. insulators.

MFJ-16B01, $19.95. Molded high strength center insulator. SO-239.

MFJ-16D01, $6.95. 450 Ohm fiberglass end/center insulator with ladder line stress relief and SO-239 mount.

MFJ-18H100, $34.95. 100 feet, 450 Ohm ladder line, 18 gauge copper clad.

80-10 Meter End-Fed Half Wave antenna

Cover all bands with one single wire and no tuner!

MFJ-1982HP
$89.95

No tuner needed!
All band 80-10M EFHW antenna

Get-on-the air on all bands 80-10 Meters with just one wire and one support (pole or tree) and no tuner or long counterpoise.

Installs anywhere in minutes! Rugged *insulated*-wire radiator prevents detuning when contacting limbs/branches. "*No-snag*" end insulator slides over branches, leaves.

Toss over a high limb for inverted-V or sloper or go vertical with an inverted-L.

Dark jacketed wire is virtually invisible – *don't let antenna restrictions keep you off the air!* Great for emergencies.

EFHWs naturally resonate on the 1/2-wave fundamental frequency and odd/even harmonics. Covers 80/40/30/20/17/15/12/10 Meters without traps, stubs or resonators.

Broad-band matching transformer at feed point gives SWR so low you may never need a tuner. Compensating inductor optimizes SWR. 800 Watts SSB/CW. 132 feet jacketed antenna wire.

MFJ-1984HP, $79.95. 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, $89.95. Operate 80/40 Meters with a short 85 foot dipole. Full-size on 40 Meters with ultra-efficient end-loading on 80 Meters. 1500 Watts. Super-strong custom molded center insulator with SO-239 connector and hang hole. Ceramic end insulators. 7-strand, 14 gauge hard copper wire. No tuner needed!

MFJ-17758
$89.95
80/40 Meters

MFJ-17754, $59.95. Like MFJ-17758 but is only 42 feet. Operate 40/20 Meters. Full-size on 20 Meters, ultra-efficient endloading on 40 Meters. 1500 Watts.

Single Band Dipoles

Ultra high quality center fed dipoles give years of troublefree service. Custom injection-molded UV resistant center insulator has built-in SO-239 and hanging hole. Glazed ceramic end insulators. 7-strand, 14-gauge hard copper antenna wire. 1500 Watts. Use horizontally or as sloper or inverted vee. Simply cut to length with provided cutting chart.

MFJ-1779A **$69.95** 160M, 265 ft.
MFJ-1779B **$49.95** 80-40M, 135 ft.
MFJ-1779C **$29.95** 20-6M, 35 ft.

OCFD Dipoles

No tuner needed!

MFJ *Off-Center Fed Dipoles* use MFJ's exclusive *ExactRatio™* RF broadband transformer to give low SWR and maximum bandwidth on 40/20/10/6 Meters. A Guanella current balun kills feedline radiation, pattern distortion, SWR shifts, RFI and noise pickup. Install anywhere and get the same predictable performance regardless of feedline length. You get ground reinforced gain over verticals. Use horizontally, inverted vee, sloper. 98% efficient, 14 gauge, 7-strand copper wire, ceramic end insulators.

MFJ-2012 **$79.95** 1500 Watts
MFJ-2010 **$59.95** 300 Watts

MFJ Enterprises, Inc. 300 Industrial Pk Rd, Starkville, MS 39759
Phone: (662) 323-5869 ■ **Tech Help:** (662) 323-0549 ■ **FAX:** (662) 323-6551 8-4:30 CST, Mon.-Fri.

Add shipping. Prices and specifications subject to change. ©2016 MFJ Enterprises, Inc.
• 1 Year No Matter What™ warranty • 30 day money back guarantee (less s/h) on orders direct from MFJ

MFJ_1778_MFJ_1982HP_021417_QST_021617DS

MFJ...the World Leader in Ham Radio Accessories!

MFJ Weather-Proof Window Feedthrough Panels

Weather-proof window feedthrough panels bring coax, balanced lines, HF/VHF/UHF antennas, random wire antennas, ground, rotator/antenna switch cables and DC/AC power into your hamshack without drilling through walls!

MFJ Weather-Proof Window Feedthrough Panels mount in your window sill. Lets you bring all your antenna connections into your hamshack without drilling holes through walls.

Simply place in window sill and close window. One cut customizes it for any window up to 48 inches. Use horizontally or vertically. Connectors are mounted on inside/outside stainless steel plates and attached to a 4 foot long, 3½ inch high, ¾ inch thick pressure-treated wood panel.

Real Western Red Cedar wood is naturally resistant to rot, decay and insects -- lasts longer, maintenance-free. Pitch and resin free for a wide range of beautiful finishes or leave it in its naturally beautiful raw finish. Edges sealed by weather-stripping. Seals and insulates against all weather conditions. Includes window locking rod.

Inside/outside stainless steel plates ground all coax shields. Stainless steel ground post brings ground in.

MFJ-4603 Universal Window Feedthrough Panel

MFJ-4603 $89.95

Four 50 Ohm Teflon® SO-239 coax connectors lets you feed HF/VHF/UHF antennas at full legal power limit.

A 50 Ohm Teflon® coax N-connector lets you use any antenna up to 11 GHz, including 450 MHz, UHF, satellite, moon bounce and 2.4/5.8 GHz Wi-Fi antennas.

A 75 Ohm, 1 GHz F-connector makes it easy to bring in television, Satellite, HD, cable TV and FM radio signals.

A pair of high-voltage ceramic feedthru insulators lets you bring in 450/300 Ohm balanced lines directly to your antenna tuner.

Has random/longwire antenna ceramic feedthru insulator.

5-way binding posts lets you supply 50 Volts/15 Amps DC/AC power to your outside antenna tuners/relays/switches.

Stainless ground post brings in ground connection, bonds inside/outside stainless steel panels together and drains away static charges.

MFJ's exclusive Adaptive Cable Feedthru™ lets you bring in rotator/antenna switch cable, etc. without removing connectors (up to 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® coax connectors for HF/VHF UHF antennas. Separate high voltage ceramic feed-thru insulators for balanced lines and longwire/random wire, Stainless steel ground post.

MFJ-4602 $69.95

6 Coax

6 high quality Teflon® coax connectors for HF/VHF/UHF antennas. Stainless steel ground post. Full 1500 Watt legal limit.

MFJ-4601 $59.95

4 Balanced Line, 2 Coax

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

MFJ-4600 New! $79.95

5 Cables, any-size

5 Adaptive Cable Feedthrus™. Pass any cable with connector: 2 cables with large connectors up to 1¼ x 1⅝ inches and 3 cables with UHF/N size coax connectors. Seals out weather.

MFJ-4604 $99.95

All-Purpose FeedThru/CableThru™

Stacks MFJ-4603 and MFJ-4604! Gives you every possible cable connection you'll ever need through your window without drilling holes in wall – including UHF, N and F coax connectors, balanced lines, random wire, ground, DC/AC power and cables of any size for rotators, antenna switches, etc.

New! MFJ-4605 $159.95

Bring cables through the eave of your house

MFJ-4616 shown with standard full size vent (not included) it replaces. For 6 Cables

$26.95

MFJ-4613 shown with standard half size vent (not included) it replaces. For 3 Cables

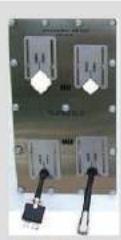
$14.95

Replace your standard air vents on the eave/sofitt of your house with these MFJ AdaptiveCable™ Air Vent Plates and...

Bring in coax, rotator, antenna switch, power cables, etc. with connectors up to 1¼ x 1⅝ inches!

Sliding plates and rubber grommets adjust for virtually any cable size to seal out adverse weather, insects and varmints. Use existing vent hole, mounting screws and screw holes.

AdaptiveCable™ Wall Plates



MFJ-4614 For 4 Cables **$34.95**

Bring nearly any cable -- rotator, antenna switch, coax, DC/ AC power, etc. -- through walls without removing connectors (up to 1¼x1⅝ inches). Sliding plates and rubber grommets adjust hole size to weather-seal virtually any size cable.

Includes stainless steel plates for each side of wall, sliding plates, rubber grommets, weather stripping and screws.

MFJ-4612 For 2Cables **$24.95**

MFJ-4611 For 1 Cable **$14.95**

Free Dealer/Catalog/ Manuals/Instructions – Visit: www.mfjenterprises.com or call toll-free 800-647-1800

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MFJ-4603_092308_QST_031616DS

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MFJ... the World Leader in Ham Radio Analyzers!

MFJ Analyzers

MFJ-269C...530 KHz - 230 MHz plus 415-470 MHz, 12-bit A/D

New and improved. Now covers 530 KHz to 230 MHz and 415 to 470 MHz!

Instantly gives you a complete picture of your antenna.

Read SWR, return loss, reflection coefficient, match efficiency at any frequency simultaneously.

Read Complex Impedance (530 KHz to 230 MHz) as series equivalent resistance and reactance (Rs+jXs) or as magnitude (Z) and phase (degrees). Also reads parallel equivalent resistance and reactance (Rp+jXp).

Determine velocity factor, coax loss in dB, length of coax and *distance to short or open in feet (it's like a built-in TDR).*

Coax Calculator™ calculates coax line length in feet given degrees and vice versa for any frequency and velocity factor.

Measure SWR and loss of coax with *any* characteristic impedance (530 KHz to 230 MHz) from 10 to over 600 Ohms.

Measures inductance in uH and capacitance in pF at RF frequencies, 530 KHz to 230 MHz.

High contrast LCD gives precision readings and two side-by-side analog meters make antenna adjustments smooth and easy.

12-bit A/D converter gives much better accuracy and resolution than common 8-bit A/D converters – *MFJ-269C exclusive!*

Built-in frequency counter, battery saver, low battery warning, Ni-Mh/NiCd charge circuit. 4W x 2D x 6¾ inches, 2 lbs. Use ten double A batteries or 110 VAC with MFJ-1312D, $15.95.

New!

MFJ-269C
$399.95

MFJ-269CPRO™ Analyzer

MFJ-269CPro, $429.95. Like MFJ- 269C, but UHF range covers ***430 to 520 MHz*** to include commercial industrial frequencies. Rugged protective shell protects knobs, switches, meters, LCD for industrial/lab work.

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

More hams use MFJ analyzers than all others in the world!

MFJ-259C

NEW!

530 KHz - 230 MHz,
World's most popular analyzers

New and improved. Now covers 530 KHz to 230 MHz!.

All-in-one ham radio test set...

Includes frequency counter, RF Generator, *SWR Analyzer*™, RF Resistance and Reactance Analyzer, Coax Analyzer, Capacitance and Inductance Meter and more!

Large easy-to-read two line LCD screen and side-by-side meters clearly display your information.

MFJ-259C
$299.95

Here's what you can do...

Super easy-to-use – Read antenna SWR, complex impedance, return loss, reflection coefficient. Determine velocity factor, coax cable loss in dB, length of coax and distance to short or open in feet. Read inductance in uH, capacitance in pF at RF frequencies. Large easy-to-see two line LCD screen and side-by-side meters clearly display your information. Built-in frequency counter, signal generator, Ni-Cad charger circuit, battery saver, low battery warning and smooth reduction drive tuning. *More!*

Maritime and 600 Meter Coverage

MFJ-259CM, $299.95. Like MFJ-259C except the bottom band covers 470-940 KHz for Maritime and 600 Meter bands.

MFJ-223

1-60 MHz Color Graphic VNA Analyzer

MFJ-223
$299.95

This *pocket-sized* wonder breaks the mold for analyzer design with user-friendly convenience, top notch accuracy, and a vivid TFT multi-color display. Don't let the size fool you, MFJ-223 is packed with all the VNA features and performance you need!

- **Single-frequency** and *swept-frequency* operating modes
- **Truly accurate** SWR, R, X, and Z measurements
- **Seamless DDS** coverage with 100-Hz resolution from 1-60 MHz
- **Smooth "skip-free"** encoder tunes fast or slow without missing a step
- **Powerful +5-dBm** stimulus generator overrides local interference
- **Field-strength meter** measures local signals, detects potential interference
- **DDS generator** precision signal source
- **Vivid 1600-pixel/inch** color graphics on a 2x2 inch non-glare TFT screen

MFJ-225

1.5-180 MHz *continuous* Two-Port Graphic Analyzer

Out in the field, MFJ-225 is a compact completely *self-contained hand-held graphing analyzer*. On the bench it becomes a full-fledged two-port (S21) desktop machine when teamed up with your PC. Using powerful IG-miniVNA freeware, you'll run detailed data analysis and print out stunning color-graphic plots to document your work!

MFJ-225
$299.95

Built-in back-lighted *3-inch LCD graphic* display. Make fine adjustments using fullscreen easy-to-view SWR bargraph, capture vivid swept displays for SWR, impedance, return loss, phase angle, more. DDS generator.

MFJ-249C Analyzer

MFJ-249C, $279.95

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

Visit:
www.mfjenterprises.com
or call
toll-free
800-647-1800

MFJ VNA Antenna Analyzer

MFJ VNA Antenna Analyzer covers 1 to 230 MHz, 1Hz resolution.
·Frequency sweep plots:** SWR, Impedance, Resistance, Reactance, Phase Angle, Complex Return Loss, Smith Chart* ***·Sign of reactance positively identifies inductive or capacitive reactance ***·Amazing accuracy with OSL (Open-Short-Load) calibration*** – calibrate through feedline/test cable at different frequencies and store in memory. Measure directly or through feedline with exceptional accuracy, correcting for line loss/phase angle. ***Smith Chart*** plots S11 magnitude/phase over any frequency span. ***Capture screens*** in 32 memories to download to PC via USB.

MFJ-226
$339.95

MFJ SWR Analyzer Accessories

A. **MFJ-29D/MFJ-39D, $24.95.** Carrying Pouch for MFJ-259C/269C.
B. **MFJ-92AA10, $29.95.** 10-Pack 2500 mAh Ni-MH Supercells.
C. **MFJ-66, $24.95.** Dip coils, set of two covers 1.8-230 MHz.
D. **MFJ-731, $99.95.** Tunable Analyzer Filter, 1.8-30 MHz, for strong RF fields.
E. **MFJ-917, $29.95.** 1:1 Current balun for SWR Analyzers to test balanced line antennas, other loads.
F. **MFJ-5510, $9.95.** 12VDC cigarette lighter adapter.
G. **MFJ-7737, $5.95.** PL-259 to BNC Female.
H. **MFJ-7727, $5.95.** PL-259 to SMA Female.
I. **MFJ-633, $29.95.** Ultra-fast intelligent charger.

MFJ

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MFJ *Telescopic* Fiberglass Masts

Portable, telescoping high-strength fiberglass masts extend way up into the sky! Just pull out sections and lock.

Choose Lightweight-Light-Duty or Super-Strong Thick-Wall models -- 10 to 50 feet long. Each collapses to an easy-to-carry size for true portability.

For quick put-up and take-down, light-duty models have Twist & Lock sections and heavy-duty thick wall models use military style *QuickClamps™* or stainless steel hose clamps.

Use them for traveling, camping, at hotels, hamfests, field day, DX-peditions. Put up full size full performance inverted Vee, dipole or vertical antenna in minutes at heights that will snag you real DX.

Use multiple telescoping masts to make loops, quads, rotatable dipoles even beams.

← *Light Duty Lightweight Fiberglass Masts*

So lightweight you can take them anywhere!

MFJ's most popular MFJ-1910 is 33 feet long, 3.3 lbs.

MFJ-1910, $79.95. 33 ft., light duty w/top tie ring.
MFJ-1911, $89.95. 20 ft., light duty w/top tie ring.
MFJ-1913, $89.95. 28 ft., lightweight w/top tie ring.
MFJ-1915, $139.95. 25 ft., for heavier duty use.
MFJ-1916, $159.95. 34 ft., for heavier duty use.
MFJ-1917, $169.95. 43 ft., heavier duty w/top tie ring.

Super-strong .125" Thick-Wall Fiberglass Masts

Use for temporary or permanent wire antennas, small beams or verticals. **Best seller** is 50 ft. long, just 26 lbs.

Heavy Duty Models: All have QuickClamps™ →

MFJ-1908HD, $259.95 is 48 ext., 7.75-ft. collapsed, has $2^1/_2$" OD bottom, 1" OD top, seven 7.75-ft. sections, 24 lbs.
MFJ-1906HD, $219.95 is 38' extended, 6 feet collapsed, has $2^1/_2$" OD bottom, 1" OD top, seven 6-foot sections, 24 lbs.
MFJ-1904HD, $159.95 is 25' extended, 4 feet collapsed, has $2^1/_2$" OD bottom, 1" OD top, seven 4-foot sections, 14 lbs.
MFJ-1904H, $139.95. 22' ext., 5' collapsed, 9 lbs. $2^1/_2$" OD.
MFJ-1902H, $119.95, 10' ext., 38" collapsed, 5 lbs. $2^1/_2$" OD

Standard Models: H models have QuickClamps™

MFJ-1906, $139.95/MFJ-1906H, $189.95, 33 feet, ext., 6 ft. collapsed, six 6-ft. sections, 13 lbs. 2" bottom, $^3/_4$" top OD.
MFJ-1908, $179.95/MFJ-1908H, $229.95, 41' ext., 7.75 ft. collapsed, six 7.75-ft. sect., 16 lbs. 2" bottom, $^3/_4$" top OD.

Mast Accessories

MFJ-1900, $69.95. Mount clamps mast to mounting pipe.
MFJ-14, $59.95. 5 Military *QuickClamps™*. Fit $^3/_4$" to 2" OD.
MFJ-14HD, $69.95. Extra set clamps, 1- $2^1/_2$" masts.

Mast Guy Ring Sets

Fits masts $^3/_4$" to $1^1/_4$" dia OD. **MFJ-2830X, $6.95,** *fiberglass;* **MFJ-2840X, $8.25,** *aluminum.*

Left: *Stainless Steel Hose Clamps recommended for permanent installations. Fiberglass is slotted.*

Right: UV protected Military grade *QuickClamps.*Guy 2 levels when fully extended.

18' Telescopic Mast & Tripod

MFJ-1919EX, $159.95.
Put your antennas up high anywhere with this super-strong 18 foot telescoping fiberglass mast and MFJ-1919 heavy duty steel tripod. QuickClamps™ lower mast to 5 feet. Mast has thick 1/8 in. wall, .75" top, 1.5" bottom dia. 15 lbs. Steel tripod has braced triangle base, non-skid feet, mast lock.

MFJ-1918EX, $89.95.
MFJ-1918 tripod has super strong 9.5 foot telescoping fiberglass mast. 3.8 feet collapsed. *QuickClamps™*. Thick 1/8 inch wall, .75" top, 1" bottom diameters. 6.5 lbs.

Tripods Only

MFJ-1921, $169.95, Giant tripod base spreads to 8 feet! Supports massive antennas. Adjustable length non-skid legs accommodates uneven ground surfaces. Optional foot anchors **MFJ-1905, $24.95**, see **Tripod Anchors** bottom right. 5.75Hx7D feet collapsed. 14 lbs.

MFJ-1919, $89.95, *Large tripod* base spreads to 4.8 feet. Supports 100 pounds. 7.8 feet, 1.4 inch diameter mast. 4.5H x .5D feet collapsed. 9.75 lbs.

MFJ-1918, $49.95, Smaller tripod base spreads to 2.75 ft. Support 66 lbs. 6 foot, 1" dia. mast. 3.2H x .3D ft. collapsed. 6.75 lbs.

80-6 Meter Antenna

MFJ-2980 $99.95 40-6 Meters

MFJ-2982 $149.95 80-6 Meters

3.8 foot fiberglass mast telescopes to a 31 foot self-supporting high performance 80-6 Meter vertical antenna in minutes!

Quarter wave performance on 40 Meters, halfwave on 20M. High-Q air wound loading coil. Use antenna tuner for 30, 20, 15, 12, 10, 6 Meters. 600 Watts SSB/CW.

Use as temporary, portable or permanent antenna for home, RVs, camping, field day, hamfest, DX-pedition.

Includes four 12 foot radials. Current balun reduces feedline radiation and pattern distortion.

MFJ *"HamStick"* Isolated Dipole

Build your own 80-6 Meter *mini*-dipole using two HF mobile whips! Only MFJ-347 mount *isolates* dipole elements and lets you use a balun to give a true *balanced dipole.* Prevents pattern distortion, noise pickup and RFI radiation from RF on coax shield. Solid aluminum. Use mast up to $1^1/_4$" OD.

MFJ-347 $19.95

3/8-24 Hamstick

Mount 3/8-24 HF/VHF hamsticks vertically or horizontally on masts up to 1 inch. Built-in SO239 connector.

MFJ-342T $9.95

MFJ Balcony Mount

MFJ-1907 $39.95

Mount *multiple* HF/VHF hamsticks, verticals, dipoles vertically and/or horizontally on your apartment/condo balcony. High-strength aircraft aluminum extends out 14". Two U-bolts mount up to $1^1/_2$" diameter.

Tripod Anchors

Securely anchor tripod to ground with these 3 stainless steel foot braces and your stakes. For high winds, unlevel ground, tall antennas. Fits legs to $1^1/_2$"OD.

MFJ-1905 $24.95

MFJ Enterprises, Inc. 300 Industrial Pk Rd, Starkville, MS 39759
Phone: (662) 323-5869 ■ **Tech Help:** (662) 323-0549 ■ **FAX:** (662) 323-6551 8-4:30 CST, Mon.-Fri.

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MFJ *Low-Noise Receiving* Loop

Work DX and ragchew through horrendous noise!

Pull weak signals out of static crashes, atmospheric, man-made and power line noise!

Hear 50 KHz to 30 MHz signals clearer than ever and stations you never knew were there. Power line noise and static just disappears.

The MFJ-1886 drastically reduces noise and interference by receiving the magnetic field and rejecting the electric field. Its figure 8 pattern and deep null can be rotated to completely eliminate an interfering signal or greatly peak a desired one.

Excellent antenna and preamplifier balance gives a very deep null. An inexpensive antenna rotator can position this null to eliminate interference.

State-of-the-art Gali MMICs in push-pull give you a preamp with extra wide dynamic range, low IMD and 25 dB of low noise gain. You'll get excellent performance on both strong and weak signals without overload.

Fully protected preamplifier -- magnetically coupled voltages up to 40 Volts and capacitively coupled voltages up to 20 Volts will not damage the preamplifier. The output is protected from transmission line surges induced by distant lightning.

Use it anywhere, inside or outside. Your 50 Ohm coax and included Bias-Tee provides signal and power.

Ruggedly built to withstand extreme weather. 1-inch OD diameter 6061 aluminum tubing. 36-inch loop diameter. $2^1/_2$ pounds. SO-239 connector. Use masts up to $1^3/_4$ inches. **MFJ-1886TR** has built-in T/R switch, Bias-Tee.

Antenna Rotator

AR-500/X
$129.95 ***Perfect for MFJ1886/1786/1788 loop, VHF/UHF, small HF beams, TV, FM antennas.***

Weather-proof one piece cast aluminum housing with precision all metal gears, steel thrust bearings and automatic braking. Includes rotator, controller, remote control, clamps, hardware. Remembers up to 12 directions! Digitally displays position. Order AR-500X for 220VAC.

Wipe out RFI

MFJ-1026
$199.95
Wipe out RFI, noise, interference from any direction at any frequency with a 60 dB notch before it gets into your receiver!

Eliminate power line noise, fluorescent lamps, light dimmers, computers, TVs, lightning, motors, industrial processes.

Null out QRM on rare DX and work him! Null out local ham or AM station to prevent receiver overload. Works on SSB, AM, CW, FM, digital from BCB to lower VHF.

Plugs between antenna and transceiver. 12 VDC, 110 VAC with MFJ-1312D, $15.95.

MFJ *Super High-Q™ Transmitting* Loop Antennas

MFJ-1786
$449.95

MFJ 36-inch diameter transmitting loop antenna lets you operate 10-30 MHz continuously including WARC bands!

Ideal for limited space, HOA.

Work DX with low angle radiation and local close-in contacts with high angle radiation when mounted vertically. 150 watts.

Super easy-to-use! MFJ remote control auto tunes to your desired band. Fast/slow tune buttons, Cross-Needle SWR/Watt meter lets you quickly tune to your exact frequency. No control cable needed.

***World's** most efficient small loop antenna has all welded construction, welded butterfly capacitor with no rotating contacts, large 1.050 inch diameter aluminum radiator – gives you highest possible efficiency.*

Every capacitor plate is welded for extremely low loss and polished to prevent high voltage arcing. Nylon bearing, anti-backlash mechanism, limit switches, continuous no-step DC motor gives smooth precision tuning. Heavy-duty ABS plastic housing has ultra-violet inhibitor.

Cover 40-15 Meters.
MFJ-1788, $499.95.
Like MFJ-1786 but covers 40-15 Meters continuous. Includes remote control.

Portable Loop

MFJ-1780,
$329.95.
Box fan loop with carrying handle, 24 x 24 x $5^3/_4$".
20-10 Meters continuous, 150 Watts. Fast/slow tune remote control. Highly efficient all-welded construction

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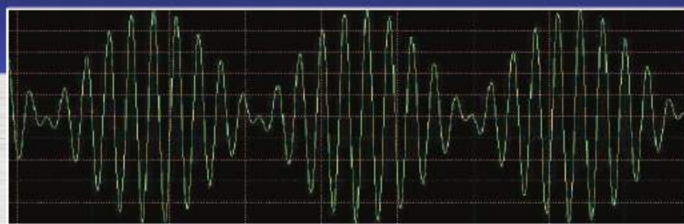
QST QuickStats

Online QuickStats Poll Results for January 1 through February 1, 2019.
Get on the web and vote today at **www.arrl.org/quickstats**!

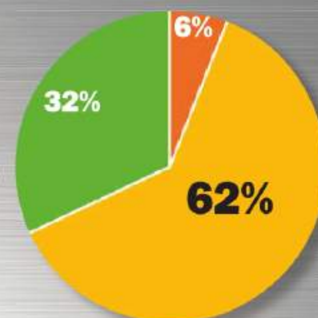
What is your favorite analog voice mode?



SSB 77%
AM 2%
FM 14%
I don't operate analog voice modes. 7%

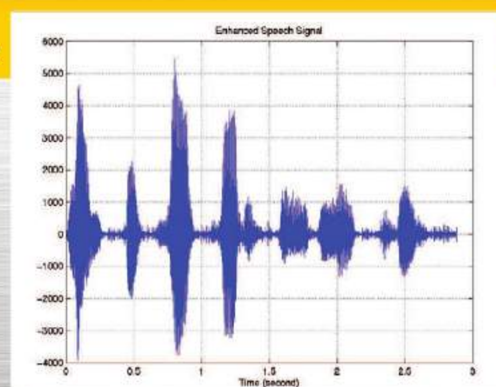
Will you be participating in the phone version of the Rookie Roundup on April 14th?

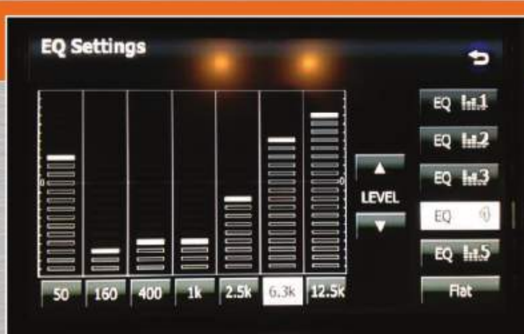
Yes. 6%
No. 62%
Not sure at this time. 32%



When operating SSB, do you use your transceiver's speech compression function?

Yes, all the time. 30%
Yes, but only when I need the extra "punch" to be heard. 33%
No. 26%
My transceiver doesn't have a speech compression function. 4%
I don't operate SSB. 7%





Have you adjusted your transmit audio equalization for operating AM or SSB?

Yes. 46%
No. 30%
My transceiver doesn't have a transmit audio equalization adjustment. 17%
I don't operate AM or SSB. 7%

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3rd IMDR **110** dB*

RMDR **122** dB*

BDR **150** dB*

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- Reciprocal Mixing Dynamic Range (RMDR) 122dB*
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*Values are measured examples. (2kHz spacing:14.1 MHz, CW, BW 500 Hz, Pre Amp OFF)

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- Band scope auto-scroll mode
- Multi-information display including filter scope

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*: 2 kHz spacing measurement standard - Receiver frequency 14.2 MHz, MODE CW, BW 500 Hz, PRE AMP OFF

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Before considering a ham ad please read.

1. Advertising must pertain to products and services which are related to Amateur Radio.

2. The Ham-Ad rate for commercial firms offering products or services for sale is $2.25 per word. Individuals selling or buying personal equipment: ARRL member 1.00 per word. Non-ARRL member $1.50 per word. **Bolding** is available for $2.50 a word. Prices subject to change without notice. You may pay by check payable to the ARRL and sent to: Ham-Ads, ARRL, 225 Main St., Newington, CT 06111. Or, you may pay by credit card sending the information by fax to 860-594-4285 or via e-mail to hamads@arrl.org. The credit card information we need is: the type of credit card, the exact name that appears on the credit card, the credit card number, the expiration date and the credit card billing address.

3. Remittance in full must accompany copy since Ham-Ads are not carried on our books. Each word, abbreviation, model number and group of numbers counts as one word. Entire telephone numbers count as one word. No charge for postal Zip code. No cash or contract discounts or agency commission will be allowed. Tear sheets or proofs of Ham-Ads cannot be supplied. Ads submitted in writing should be typed or printed clearly on an 8 1/2" X 11" sheet of paper.

4. **Closing date for Ham-Ads is the 15th of the second month preceding publication date. No cancellations or changes will be accepted after this closing date.** Example: Ads received December 16th through January 15th will appear in March *QST*. If the 15th falls on a weekend or holiday, the Ham-Ad deadline is the previous working day. Please contact the Advertising Department at 860-594-0255 or hamads@arrl.org for further information or to submit your ad.

5. No Ham-Ad may use more than 200 words. No advertiser may use more than three ads in one issue. Mention of lotteries, prize drawings, games of chance etc is not permitted in *QST* advertising.

6. New firms or individuals offering products or services for sale must check with us to determine if a production sample (which will be returned) should be submitted for examination. Dealers are exempted, unless the product is unknown to us. Check with us if you are in doubt. You must stand by and support all claims and specifications mentioned in your advertising.

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7. AN IMPORTANT NOTICE TO ALL HAM AD POSTERS AND RESPONDERS, FROM THE ARRL ADVERTISING DEPARTMENT Greetings from ARRL HQ! Please note that we have received reports from many ARRL members who have placed classified ads in these listings, and have received responses from individuals proposing "creative" payment schemes. These particular instances involved offers of overpayments for goods by bank check, followed by instructions to deduct the cost of your item from the overpayment, and to transfer the overage back or to another individual. This is a well-known scam. Unfortunately, we have no control over this and other scams of this type. Once your email address is posted, you are vulnerable to those individuals seeking to provide you with questionable information.

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Issue	Reservation Date	Materials Due Date
May 2019 *QST*	Monday, March 11, 2019	Thursday, March 14, 2019
June 2019 *QST*	Monday, April 15, 2019	Thursday, April 18, 2019

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