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QST
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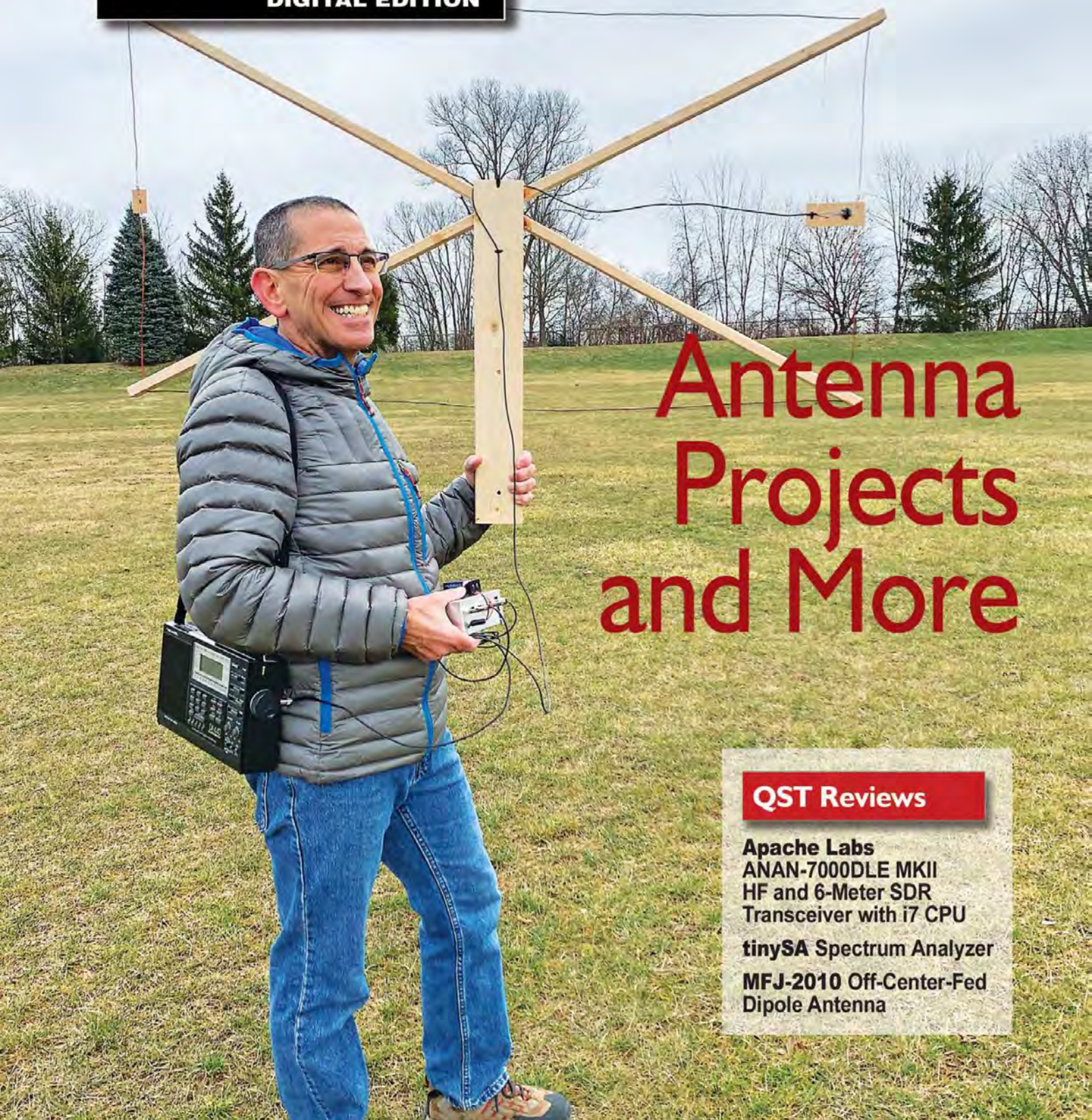

Antenna Projects and More

QST Reviews

Apache Labs
ANAN-7000DLE MKII
HF and 6-Meter SDR
Transceiver with i7 CPU

tinySA Spectrum Analyzer

MFJ-2010 Off-Center-Fed
Dipole Antenna

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- Superior Operating Performance by means of the MPVD*3

The World Leading HF Transceiver with Hybrid SDR

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FTDX101D 100W

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- 7-inch TFT Color Touch Panel with 3DSS*1 Visual Display
- Superior Operating Performance by means of ABI*2 & MPVD*3

* Microphone M-1: Optional

* Photo shows the FTDX101MP

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

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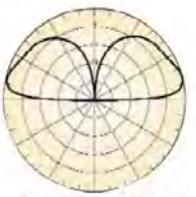
R8, $599.95. Like R9 antenna but less 75/80 Meters.

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

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



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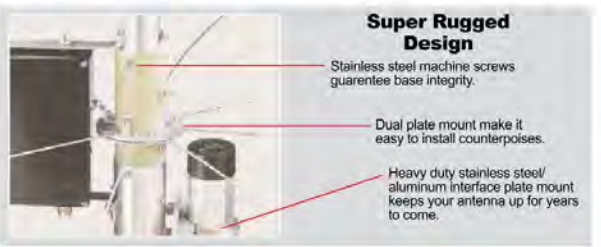
Low angle radiation gives incredible worldwide DX.



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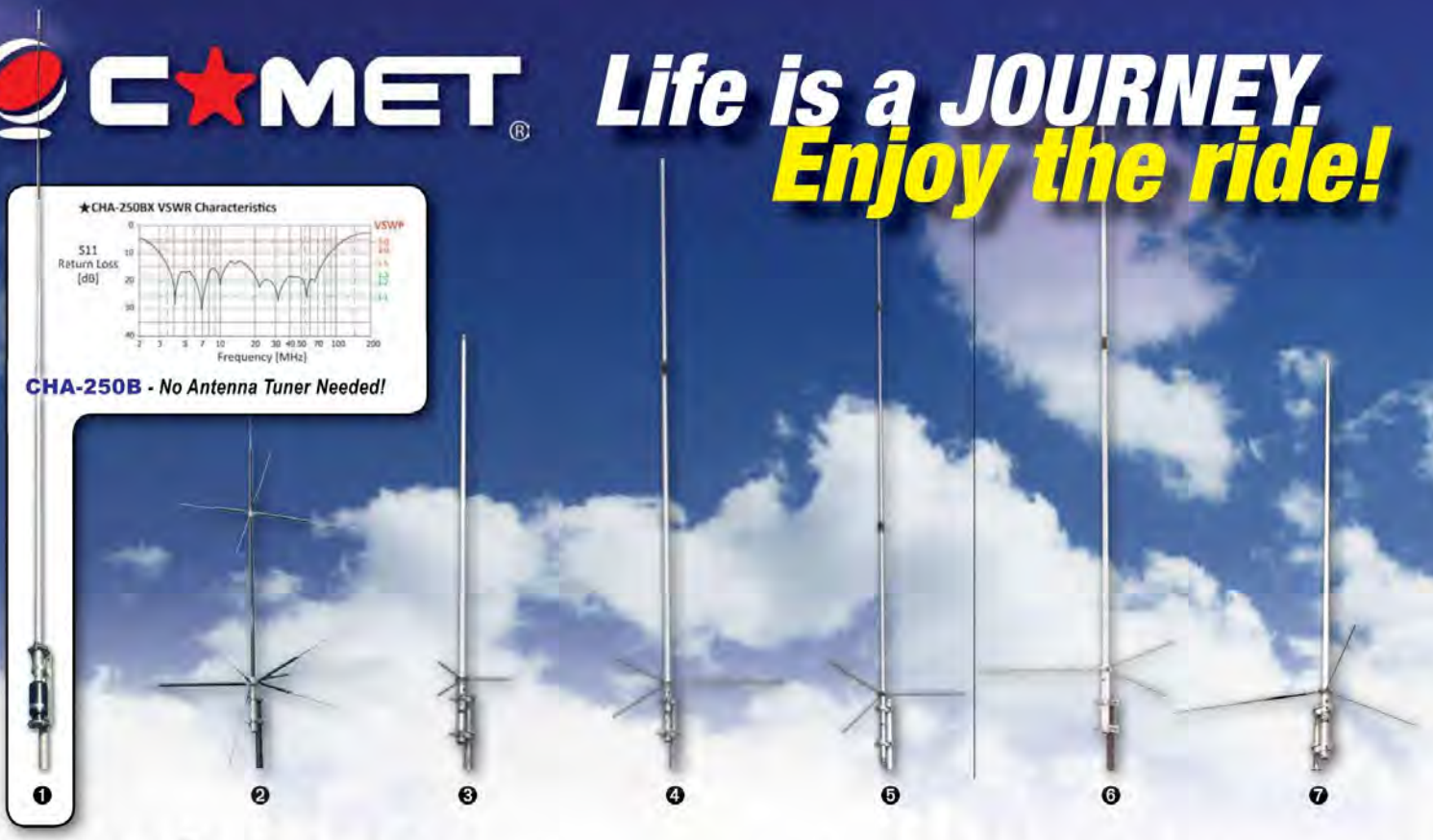

Base Antennas

❶ COMET CHA-250B BROADBAND 80M THROUGH 6M VERTICAL ANTENNA
A newly designed broadband vertical with NO GROUND RADIALS. EXTREMELY easy to assemble, requires no tuning or adjustments and VSWR is under 1.5:1 from 3.5-57MHz! • TX: 3.5MHz – 57MHz • RX: 2.0– 90MHz • VSWR is 1.5:1 or less, continuous • Max Power: 250W SSB/125W FM• Impedance: 50 Ohm • Length: 23' 5" • Weight: 7 lbs. 1 oz. • Conn: SO-239 • Mast Req'd: 1" – 2" dia. • Max wind speed: 67MPH

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

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

❹ COMET GP-6 DUAL-BAND 146/446MHZ BASE REPEATER ANTENNA
Wavelength: 146MHz 5/8 wave x 2 • 446MHz 5/8 wave x 5 • Max Pwr: 200W • Length: 10'2"• Weight: 3lbs. 8ozs. • Conn: Gold-plated SO-239 • Construction: Fiberglass, 2 Sections

❺ COMET GP-9 / GP-9N DUAL-BAND 146/446MHZ BASE REPEATER ANTENNA
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❻ COMET CX-333 TRI-BAND 146/220/446MHZ BASE REPEATER ANTENNA
Wavelength: 146MHz 5/8 wave x 2 • 220MHz 5/8 wave x 3• 446MHz 5/8 wave x 5 • Max Pwr: 120W • Length: 10'2" • Weight: 3lbs. 1oz.• Conn: Gold-plated SO-239 • Construction: Fiberglass, 2 Sections

❼ COMET GP-15 TRI-BAND 52/146/446MHZ BASE REPEATER ANTENNA
Wavelength: 52MHz 5/8 wave • 146MHz 5/8 wave x 2 • 446MHz 5/8 wave x 4 • Max Pwr: 150W • Length: 7'11" • Weight: 3lbs. 1oz. • Conn: Gold-plated SO-239• 2MHz band-width after tuning (6M) • Construction: Single-piece fiberglass

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Contributing Editors

Michelle Bloom, WB1ENT
Production Supervisor

Jodi Morin, KA1JPA
Assistant Production Supervisor

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Production Coordinator

David Pingree, N1NAS
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Yvette Vinci, KC1AIM
Marketing and Sales Manager

Steve Ewald, WV1X
Field Organization Supervisor

Eric Casey, KC2ERC
Convention and Event Coordinator

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Write for *QST*

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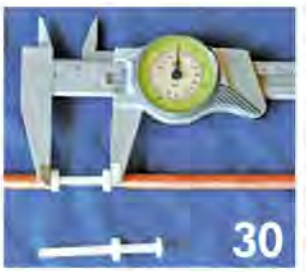
Our Cover
Don Kirk, WD8DSB, hunts down radio frequency interference in the 160-meter and 80-meter bands with his 2-foot-tall by 4-foot-long portable flag antenna. The antenna is the largest size — to maximize gain — that would fit inside his car, but still small enough to maintain a directional pattern from 1.8 to 30 MHz. With an appropriate preamp, the flag is useful for direction finding even in the AM broadcast band. This issue also features build instructions for a Moxon antenna for 222 MHz, as well as a dc power polarity checker. [Chris Kirk, photo]



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

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

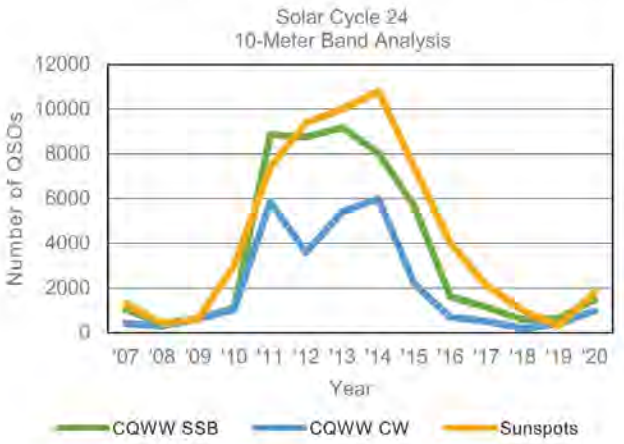
Second Century

Here Comes Cycle 25!

I was licensed in 1977, and what luck from a propagation perspective. With a modest station, running only 40 W and a homebrew vertical on the roof, I was able to break a pileup for Chatham Island in the Pacific — on 10 meters! This experience pales to that of Solar Cycle 19, which peaked from 1957 to 1959. The sunspots were so active that ionization levels never fully diminished during darkness, so propagation on the high bands was occurring 24 hours a day, worldwide! Even 6-meter DX around the world was routine.

Relatively new hams will read this and say "*What?*" because their luck wasn't so good coming into the hobby at the end of Solar Cycle 24. But that 10-meter band you've been thinking was a dud is about to *explode*! Here comes Solar Cycle 25! And some of the latest forecasts from scientists and space weather experts have us hoping for an epic event. A theory related to the actual terminator of each solar cycle, and the measured time between cycles, states that a long period between cycles leads to lower sunspot levels, but a short period leads to much higher sunspot levels for the next cycle. If that theory proves to be true, Solar Cycle 25 could be gangbusters!

Let's look at some correlation between the solar cycle and 10-meter activity. The chart below graphs the total number of 10-meter contacts made by the top US multi-multi contest stations during the CQ World Wide contests going back to the end of Solar Cycle 23. I used CQWW data because CQWW is a "world works the world" contest, and activity on 10 meters during those contests should theoretically represent peak efforts. Other than a drop in the 2012 CW contest that may be attributed to a geomagnetic disturbance, you'll see that the total QSOs track pretty consistently with how the sunspots are affecting ionization at that time in the cycle.



Interestingly, it shows us what the science has also told us: new Solar Cycle 25 sunspots began to show up in November 2019, and we are now starting to see an uptick!

There is still much we do not know or understand about how the solar cycle works. Despite sunspots being tracked by hand for hundreds of years, many theories — not facts — still abound. We've had satellites giving us better imaging and data for the last four solar cycles, which is only a beginning. For ham radio operators, the new solar cycle is more than just an exciting time for operating. It's an opportunity to use *our* tools, many of them new and evolving, to better understand radio propagation. So, how can you get involved?

ARRL will begin showing you how this month with a series of articles in *On the Air* magazine, on the various aspects of the solar cycle, and *QST* will follow suit next month. In the months to come, the magazines will also be offering wide-ranging activities you can undertake to further our understanding and contribution, much in the way we have developed an understanding about greyline propagation, as well as the effects during a solar eclipse. You'll recognize these articles from the "Cycle 25" logo (above) that we will will be using to brand the content!

So, here it comes! We are extremely excited! As always, get on the air. Be radio active! And if you have ideas, please drop me a note at **ceo@arrl.org**.

David A. Minster, NA2AA
Chief Executive Officer

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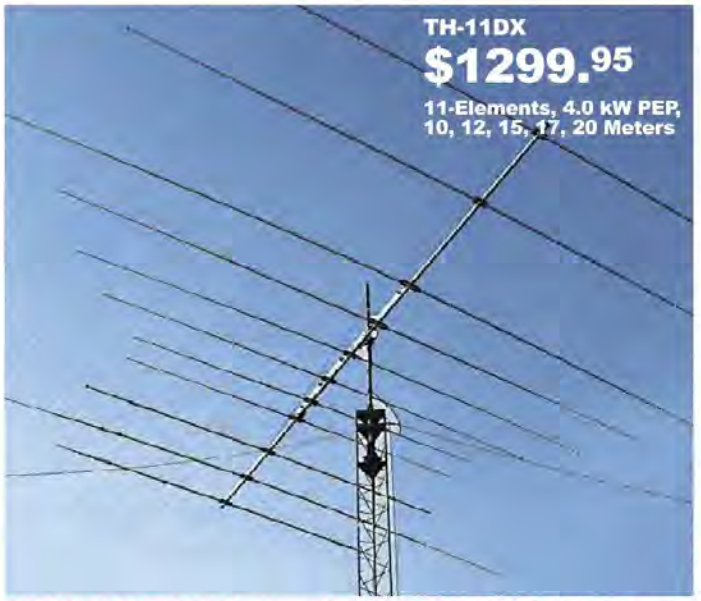

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Handles 2000 Watts continuous, 4000 Watts PEP.

Every part is selected for durability and ruggedness for years of trouble-free service.

Features a low loss logperiodic driven array on all bands with mono-band reflectors, BN-4000 high power balun, corrosion resistant wire boom support, hot dipped galvanized and stainless steel parts.

Stainless steel hardware and clamps are used on all electrical connections.

TH-7DX, $999.95. 7-element, 1.5 kW PEP, 10, 15, 20 Meters

7-Elements gives you the highest average gain of any hy-gain tri-bander!

Dual driven for broadband operation without compromising gain. SWR less than 2:1 on all bands.

Uniquely combining monoband and trapped parasitic elements give you an excellent F/B ratio.

Includes hy-gain's diecast aluminum, rugged boom-to-mast clamp, heavy gauge element-to-boom brackets, BN-86 balun. For high power, upgrade to BN-4000.

Compact 3-element 10, 15, 20 Meter Tri-Bander

For limited space...Installs anywhere...14.75 ft turning radius... weighs 21 lbs...Rotate with CD-45II, HAM-IV

Fits on light tower, suitable guyed TV pole, roof tri-pod

TH-3JRS, $419.95. hy-gain's most popular 3-element 10, 15, 20 Meter tribander fits on most lots! Same top performance as the full power TH3MK4 in a compact 600 watt PEP design.

Excellent gain and F/B ratio let you compete with the "big guns".

Tooled manufacturing gives you hy-gain durability with 80 MPH wind survival.

TH-5MK2, $879.95. 5-element, 1.5 kW PEP, 10,15, 20 Meters

The broadband five element TH5-MK2 gives you outstanding gain.

Separate air dielectric Hy-Q™ traps let you adjust for maximum F/B ratio on each band.

Also standard is hy-gain's exclusive BetaMATCH™, stainless steel hardware and compression clamps and BN-86 balun.

TH-3MK4, $549.95. 3-element, 1.5 kW PEP, 10,15, 20 Meters

The super popular TH-3MK4 gives you the most gain for your money in a full-power, full-size durable hy-gain tri-bander!

You get an impressive average gain and a whopping average front-to-back ratio. Handles a full 1500 Watts PEP. 95 MPH wind survival.

Fits on average size lot with room to spare -- turning radius is just 15.3 feet.

Four piece boom is ideal for DXpeditions. Rotates with CD-45II or HAM-IV rotator.

Features hy-gain BetaMatch™ for DC ground, full power Hy-Q traps, rugged boom-to-mast bracket and mounts on standard 2"O.D. mast. Stainless steel hardware. BN-86 balun recommended.

TH-2MK3, $449.95. 2-element, 1.5 kW PEP, 10,15, 20 Meters

The 2-element TH-2MK3 is hy-gain's most economical full power (1.5kW PEP) full size tri-bander.

For just $339.95 you can greatly increase your effective radiated power and hear far better!

Ruggedly constructed, top-performing, compact 6 foot boom, tight 14.3 foot turning radius. Installs almost anywhere. Rotate with CD-45II or HAMIV. BN-86 balun recommened.

EXP-14, $699.95. 4-element, 1.5 kW PEP, 10,15, 20 Meters

Revolutionary 4-element compact tri-bander lets you add 40 or 30 Meters! Has 14 foot boom and tight 17.25 feet turning radius. Fits on roof tri-pod, mast or medium duty tower.

hy-gain's patented broadbanding Para Sleeve gives you less than 2:1 VSWR. 1.5kW PEP.

BetaMATCH™ provides DC ground to eliminate static. Includes BN-86 balun. Easily assembled.

Truly competitive against giant tri-banders at half the cost!

QK-710, $199.95. 30/40 Meter option kit for EXP-14.

Tooled Manufacturing... Highest Quality Materials

1. **hy-gain's** famous super strong tooled die cast Boom-to-Mast Clamp
2. **Tooled** Boom-to-Element Clamp
3. **Thick-wall** swaged aluminum tubing

Tooled manufacturing is the difference between hy-gain antennas and the others -- they just don't have it (it's expensive!).

Die-cast aluminum boom-to-mast bracket and element-to-boom compression clamps are made with specially tooled machinery.

hy-gain antennas feature tooled swaged tubing that is easily and securely clamped in place. All tubing is deburred and cleaned for smooth and easy assembly.

Durable precision injection molded parts.

hy-gain antennas are stronger, lighter, have less wind surface area, better wind survival, need no adjustments, look professional and last years longer.

Model No.	No. of elements	avg gain dBd	avg F/B dB	MaxPwr watts PEP	Bands Covered	Wind sq. ft. area	Wind (mph) Survival	Boom feet	Longest Elem. (ft)	Turning radius (ft)	Weight (lbs.)	Mast dia O. D. (in.)	Recom. Rotator	Sugg. Retail
TH-11DX	11			4000	10, 12, 15, 17, 20	12.5	100	24	37	22	88	1.9-2.5	T2X	$1299.95
TH-7DX	**7**	**For Gain and F/B ratio–See...**		**1500**	**10, 15, 20**	**9.4**	**100**	**24**	**31**	**20**	**75**	**1.5-2.5**	**HAM-IV**	**$999.95**
TH-5MK2	5			1500	10, 15, 20	7.4	100	19	31.5	18.42	57	1.5-2.5	HAM-IV	$879.95
TH-3MK4	**3**	• www.hy-gain.com		**1500**	**10, 15, 20**	**4.6**	**95**	**14**	**27.42**	**15.33**	**35**	**1.9-2.5**	**CD-45II**	**$549.95**
TH-3JRS	3	• hy-gain catalog		600	10, 15, 20	3.35	80	12	27.25	14.75	21	1.25-2.0	CD-45II	$419.95
TH-2MK3	**2**	• Call toll-free 800-973-6572		**1500**	**10, 15, 20**	**3.25**	**80**	**6**	**27.3**	**14.25**	**20**	**1.9-2.5**	**CD-45II**	**$449.95**
EXP-14	4			1500	10, 15, 20 opt.30/40	7.5	100	14	31.5	17.25	45	1.9-2.5	HAM-IV	$699.95

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DPM6000 Power Meter

The DPM6000 SWR 2 channel power meter measures forward and reflected power over a 70dB range. A 0dBm 50MHz reference ensures high repeatability and accuracy. Range is .01uW to 2kW with a frequency response of 50KHz - 6 GHz depending on sensor. It displays SWR, Watt/dBm, peak power, return loss RL, RC (c), frequency and a bar graph.

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PG50PS Pulse Generator

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

SALE $775

TDR-Cable Radar®

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

T150 Step Attenuator

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

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SMT Station Monitor

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

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TTG1 Two Tone Generator

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

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DDS-1 Dual Directional Coupler

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

$175

HFS-1.5 HF Sampler -30dB

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

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RLB-E 500MHz Return Loss Bridge

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

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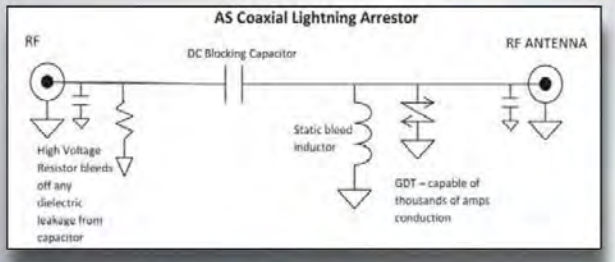
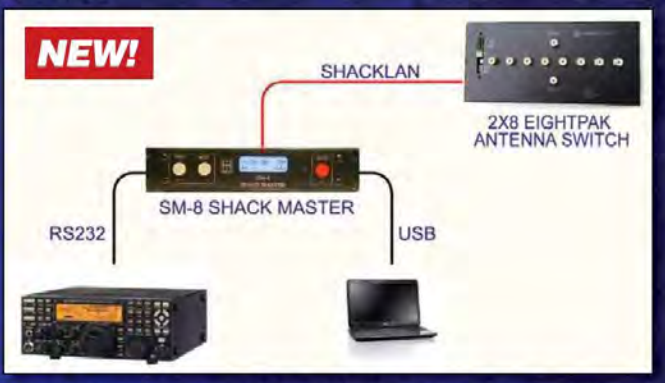
AS-303U



Hamation Station Automation

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

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



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

The Shared Apex Loop Array™!

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

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

Three models to choose from:

- AS-SAL-30 - optimized for VLF, BCB, 1.8-10 MHz
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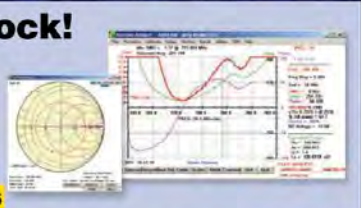

StackMatch

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

PowerMaster II

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

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Member Spotlight

Pat Barkey, N9RV

Growing up in Michigan in the 1960s, Pat Barkey was confronted with a problem. Every summer, his best buddy would ship out with his family to their cabin in the northern part of the state. Pat and his friend wanted to stay in touch during these times, but it seemed the only solution would be for both to buy Citizens Band radios. Pat's friend had a neighbor who seemed to own a lot of radio gear, so they decided to visit and get his advice about which radio they should purchase. Both boys were 11 years old at the time.

As Pat described the meeting:

> Jack Evans, K8DGK, must have been a poker player, because he didn't crack a smile as he led us downstairs to what turned out to be his amateur radio station. Before offering his purchasing advice, he picked up a microphone and made a call on 10-meter AM, making sure to point out that he wasn't using a CB rig. Within a minute, Jack was speaking with another station in Puerto Rico. This was clearly something way beyond ordinary CB. I was astonished!
>
> After Jack's impromptu introduction to amateur radio, I started showing up on his doorstep every day when he got home from work and he patiently taught me about electronics, antennas, and radio. I got one of the first 2-year Novice licenses (they had been 1-year up to that point) in 1967 and became WN8YVR.

The Contest Bug

Pat fell in love with contest operating while still in high school. As he described the moment, "One day, I tuned around after participating in an 80-meter CW traffic net and I discovered an ARRL Communications Department 'CD' contest taking place. After listening for a while, I knew I had found my next passion."

Pat is also a contest station builder. His four-tower station in Montana is the third multi-tower station he has built and owned.

The *NCJ* Years

Pat took the helm as the editor of the *National Contest Journal* (*NCJ*) from 2015 through 2017. "It was an unexpected opportunity to get to know the owners of many of the call signs in my contest logs," he said. "I also had an excellent relationship with the folks behind the scenes at ARRL who edit, lay out, publish, and distribute *NCJ*. They were wonderful to work with. My batting average for asking folks out of the blue to turn their thoughts into articles for the magazine was very high. There were no 'cold calls' to authors because we all knew each other."

During his tenure as *NCJ* editor, Pat made it his goal to communicate the message that contests are fun. He also used the magazine as a platform to pay homage to amateurs who advanced the growing popularity of radiosport. Now that *NCJ* is available to many more hams as an ARRL membership benefit, Pat thinks the future of the magazine is bright. "Under the new editorial leadership of Lee Finkel, KY7M, I think *NCJ* will continue to be a must read," he said.

Life Beyond Amateur Radio

Pat has spent his career as an economist, both in the public and private sectors. Since moving to Montana in 2007, he has worked as director of a medium-sized, university-based research center.

Pat is married with two adult children and four grandchildren, all living in the Chicago area.

Thoughts on the Future of Amateur Radio

Pat believes that while amateur radio in the US remains reasonably robust at present, its future is uncertain. He said, "The vast majority of our engaged amateurs are among the retired or near-retired population. People are living a lot longer these days, and middle-aged and older people are rediscovering radio as an interesting activity."

However, Pat said the days of middle and high school kids taking up the hobby in the numbers that his generation experienced are behind us.

Pat feels that radiosport may be part of the formula to alter this trajectory. He explained, "Sports and tournaments are fun — just look at electronic gamers to see this. And in places like eastern Europe, young people have embraced everything from high-speed code competitions to radio foxhunting events. We need to better communicate the enjoyment and competitive challenge amateur radio can provide to young and old. The alternative is to just sit back and accept our fate."

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

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

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

First Vice President
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85 High Street
Chelmsford, MA 01824
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Atlantic Division

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

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

Central Division

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

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

Delta Division

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

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

Great Lakes Division

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

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

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

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

Midwest Division

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

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747 Old Bonhomme Rd., University City, MO 63132, (314-225-5167); **k2dp@arrl.org**

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

Northwestern Division

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

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

Pacific Division

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

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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, KØRM
9975 Wadsworth Pkwy. K2-275
Westminster, CO 80021
(303-432-2886); **k0rm@arrl.org**

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

Southeastern Division

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

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

Southwestern Division

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

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

West Gulf Division

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

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

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

Central Division (IL, IN, WI)

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

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

Delta Division (AR, LA, MS, TN)

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

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Michigan: Jim Kvochick, K8JK, 10366 Greystone Ct., Brighton, MI 48114-7650 (810-229-5085); **k8jk@arrl.org**
Ohio: Tom Sly, WB8LCD, 1480 Lake Martin Dr., Kent, OH 44240-6260 (330-554-4650); **wb8lcd@arrl.org**

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

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

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

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

Alaska: David Stevens, KL7EB, 8521 Golden St., Apt. 4, Anchorage, AK 99502 (907-242-6483); **kl7eb@arrl.org**
Eastern Washington: Jack Tiley, AD7FO, 1806 S. Fawn Dr., Spokane Valley, WA 99206-3318 (509-951-7214); **ad7fo@arrl.org**
Idaho: Dan Marler, K7REX, 6525 W. Fairfield Ave., Boise, ID 83709 (208-914-8939); **k7rex@arrl.org**
Montana: Paul Stiles, KF7SOJ, 5427 Deadwood Dr., Billings, MT 59105 (406-671-7092); **kf7soj@arrl.org**
Oregon: David Kidd, KA7OZO, 21760 S. Larkspur Ave., Oregon City, OR 97045-9164 (503-320-3484); **ka7ozo@arrl.org**
Western Washington: Monte L. Simpson, W7FF, P.O. Box 3008, Silverdale, WA 98383 (360-633-7665); **w7ff@arrl.org**

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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, AHØA, 278 Kapiolani Blvd. #502, Honolulu, HI 96826 (808-955-2496); **ah0a@arrl.org**
Sacramento Valley: Dr. Carol Milazzo, KP4MD, P.O. Box 665, Citrus Heights, CA 95611-0665 (916-259-3221); **kp4md@arrl.org**
San Francisco: Bill Hillendahl, KH6GJV, P.O. Box 4151, Santa Rosa, CA 95402-4151 (707-544-4944); **kh6gjv@arrl.org**
San Joaquin Valley: John Litz, NZ6Q, 1434 Douglas Rd., Stockton, CA 95207-3536 (209-331-3078); **nz6q@arrl.org**
Santa Clara Valley: James Armstrong, NV6W, 2048 Paseo Del Sol, San Jose, CA 95124-2048 (408-679-1680); **nv6w@arrl.org**

Roanoke Division (NC, SC, VA, WV)

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

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Colorado: Robert Wareham, NØESQ, 300 Plaza Dr., Suite 200, Highlands Ranch, CO 80129 (720-592-0394); **n0esq@arrl.org**
New Mexico: Bill Mader, K8TE, 4701 Sombrerete Rd. SE, Rio Rancho, NM 87124 (505-250-8570); **k8te@arrl.org**
Utah: 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: Rene Fonseca, NP3O, Urb Santa Isidra 4 G8 Calle 6, Fajardo, PR 00738-4145 (939-579-4134); **np3o@arrl.org**
Southern Florida: Barry M. Porter, KB1PA, 14555 Sims Rd., Apt. 251, Delray Beach, FL 33484 (561-499-8424); **kb1pa@arrl.org**
Virgin Islands: Fred Kleber, K9VV, P.O. Box 24275, Christiansted, VI 00824-0275 **k9vv@arrl.org**
West Central Florida: Michael Douglas, W4MDD, 2527 Apple Blossom Ln., Wauchula, FL 33873 (863-245-4720); **w4mdd@arrl.org**

Southwestern Division (AZ, LAX, ORG, SDG, SB)

Arizona: Rick Paquette, W7RAP, 1600 W. Sunkist Rd., Tucson, AZ 85755-9561 (520-425-6877); **w7rap@arrl.org**
Los Angeles: Diana Feinberg, AI6DF, P.O. Box 4678, Palos Verdes Peninsula, CA 90274-9618 (310-544-2917); **ai6df@arrl.org**
Orange: 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: Steven Lott Smith, KG5VK, 125 Contest Ln., Ben Franklin, TX 75415-3830 (318-470-9806); **kg5vk@arrl.org**
Oklahoma: Kevin O'Dell, NØIRW, 1718 South Fairgrounds, Stillwater, OK 74074 (580-220-9062); **n0irw@arrl.org**
South Texas: Stuart Wolfe, KF5NIX, 303 San Jacinto Dr., Rockdale, TX 76567-2634 (512-660-9954); **kf5nix@arrl.org**
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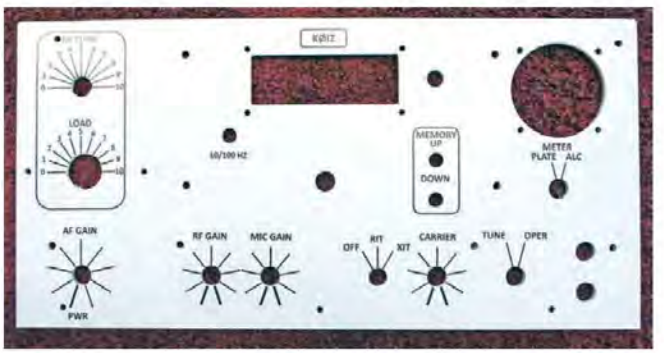
Up Front

Five Bands on a One-Band Mobile Antenna

Don Thomas, W6LRG, constructs homemade coils to convert single-band mobile whip antennas to operate on five bands, from 40 to 10 meters. These coil-modified antennas have higher "Q," and therefore, the bands are narrow. Even with the low sunspot cycle, Don has made mobile contacts with Australia, New Zealand, Japan, and Europe with these improved antennas.

A Vacuum Tube for Christmas

Jerry Svoboda, KB2QIU, often has his grandson, Nate, as an on-the-air guest when he visits. Jerry helped Nate discover how vacuum tubes work. Nate's favorite 2020 Christmas present was a display base for several vacuum tubes, among them a 6J6, a 1F4, a 6V6, and an acorn tube. It also came with two battery packs (a D cell and a 9 V cell, both with alligator connectors). All the tubes are removable from the wooden base, which is drilled out to accept their pin configurations. A dot of white paint marks the filament pins. Nate knows which filaments can't withstand the higher voltage, and he can already solder and breadboard modern circuits.



Building a Neo-Vintage Radio

John Raydo, KØIZ, built a high-performance 20-meter SSB radio using thermionic valves (tubes). John couldn't resist buying an old military test unit at a club auction. It had a wonderful dial and variable capacitor that he thought would make a good VFO. Ultimately, he built a "neo-vintage" radio for 20 meters, and he hopes the performance will be able to compete with modern radios.

▲The front-panel installation that John designed with waterslide decals and top-coated with matte clear finish.

◀John Raydo, KØIZ, with his finished retro-style radio.

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Letters from Our Members

Singing LoTW's Praises

Having been on the ham bands for over 50 years, I qualified for and received a number of operating awards, mostly DX-oriented. I realized I never paid much attention to ARRL's Worked All States (WAS) award. I had basic WAS, but nothing else. So, I got busy obtaining WAS on each band from 160 to 6 meters. Recently, I wrapped up the last states I needed. Of the 500 contacts needed for WAS on 10 bands, 499 of mine were confirmed via ARRL's Logbook of The World (LoTW). I had to send one QSL card to ARRL for verification. LoTW greatly simplified the application process and saved a ton of time and postage. Thanks for this tremendous member service!

David Greer, N4KZ
Frankfort, Kentucky

A New Sunspot Cycle is Approaching

Many of the older radio amateurs still remember and reminisce about the tail end of Sunspot Cycle 19, which occurred 55 years ago. I remember my neighbor in Portland, Oregon, talking weekly to the father of our South African exchange student on 20 meters (14.250 MHz). In 1965, at the end of Cycle 19, with a decent beam antenna on a tower and a bit of power, every country in the world was easily within reach. Even as teenagers we heard stories about 1958, when Cycle 19 was at its peak. Talking to Japan on 10 meters (30 MHz) using only 5 – 10 W AM and a 16-foot dipole antenna was like talking on an intercom. Ten meters has not been consistently usable since the mid-1960s, although 20 meters has been okay during maximums. The maximum sunspot number observed during Cycle 19 was 285 in March 1958.

Research predicts there's a new 11-year sunspot cycle, which could be one of the strongest on record. If the hypothesis proves correct, Sunspot Cycle 25 could bring tears to the eyes of many Quarter Century Wireless Association (QCWA) members. For more information on the predictions of Sunspot Cycle 25, visit **www.sciencedaily.com/releases/2020/12/201207142308.htm**.

Dennis Belles, WA7DRO
Lake Oswego, Oregon

Calling Daytime Operators

When I first got into ham radio at the age of 13, I only worked 80 meters with one crystal on the Novice band. I remember there being activity most days and especially on weekends. But for many years, I haven't heard any activity on 80 meters during the day. However, during that time, I was still able to make a few contacts on other bands.

I recently heard Ed Proctor, W4ELP, calling CQ, and we had a pleasant contact. He's almost 400 miles away from me in Virginia, and was running 200 W, while I was running 80 W to an inverted L antenna.

I urge my fellow amateurs to try a CQ on 80 meters during the day. Reverse Beacon Network will indicate your "footprint." You may be surprised at the results!

Jack Hubbard, NI8N
Milan, Ohio

The Vital Role of Emergency Communications

In December, there was news of the US government falling victim to serious and consequential computer hacking. Part of this hacking, attributed to foreign adversaries of the US, includes the ability to disturb industrial systems that maintain the integrity of our way of life. This may include disruptions of power grids, cell phone systems, the internet, as well as water systems and other infrastructure. This is in addition to the obvious threats to national security through knowledge of, and possible control of, offensive and defensive systems run by the government.

If the cell phone system is down and internet communication is disrupted, amateur radio operators can be organized into a backup communication system for the entire country. Although there are plenty of cheap walkie-talkies in the hands of non-hams, only we have the means to establish long-range, disciplined national and local networks to handle emergency and routine traffic.

I've been a ham for over 40 years and have often heard that ham radio is in danger of disappearing due to new technologies like cell phones and the internet. Now, we may become the best hope to keep America running should a national breach occur.

As hams, we should pay more attention to maintaining emergency networks, signing up new ARRL members, and training existing members frequently.

Jeff Rossio, N5EQ
Frederick, Maryland

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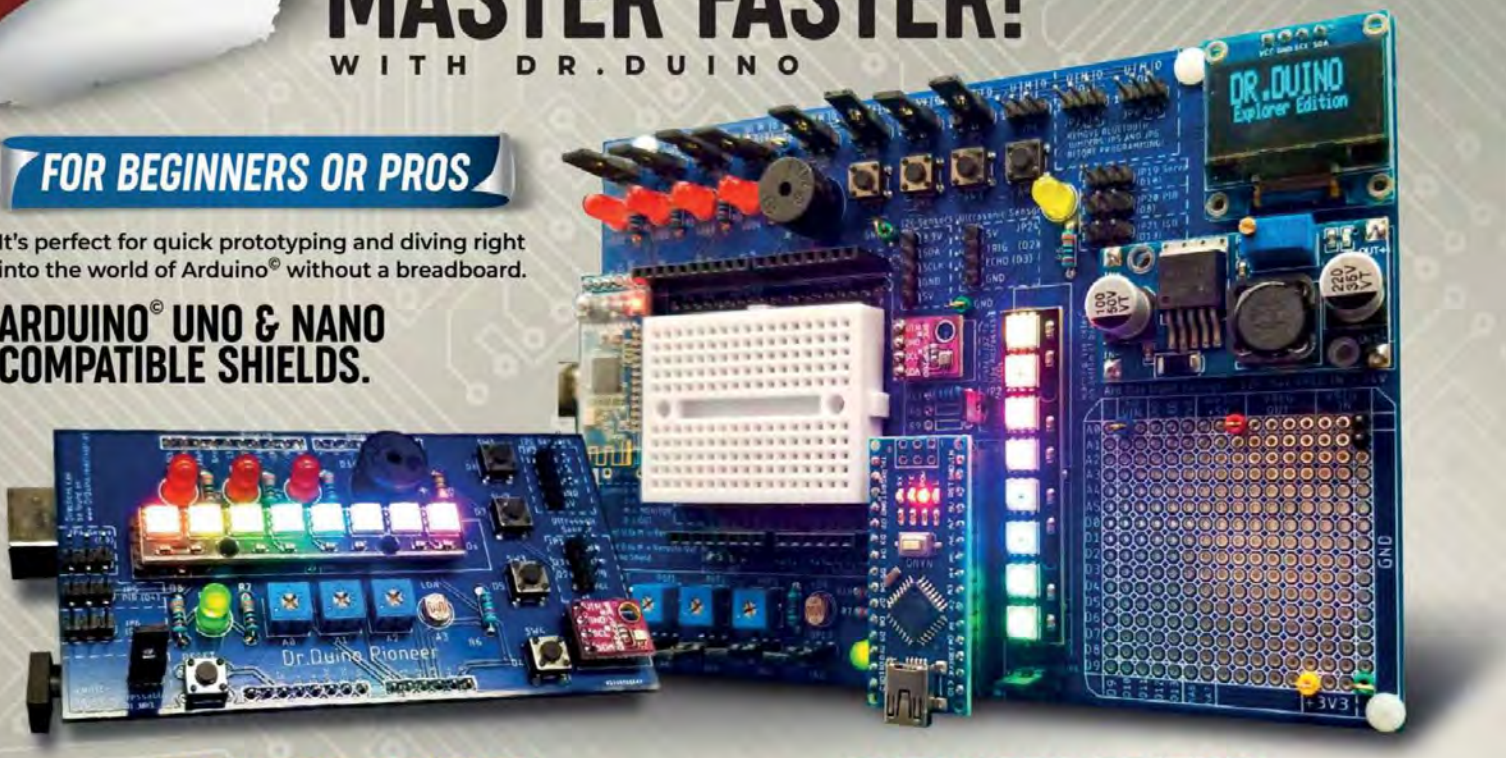

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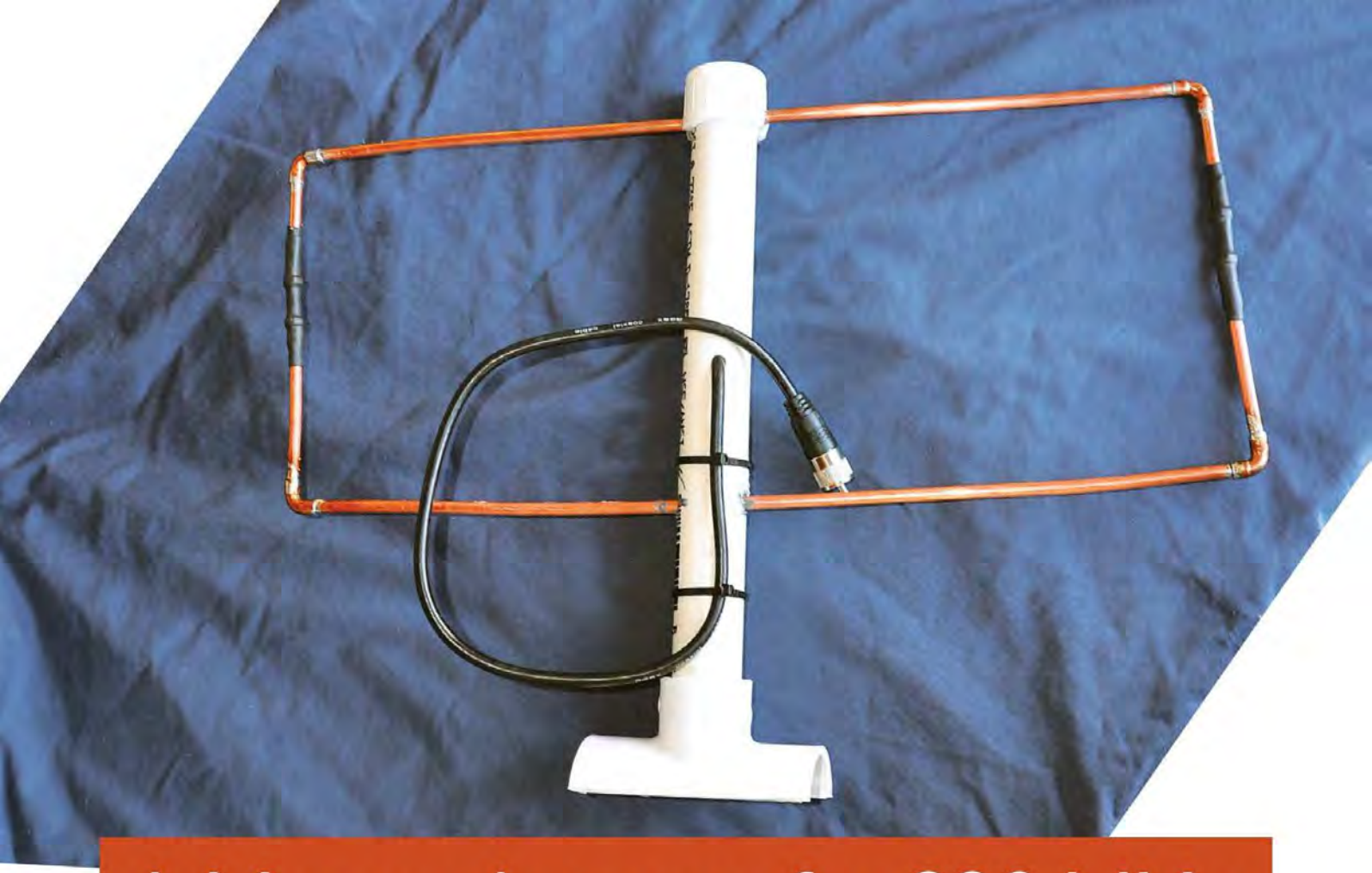

A Moxon Antenna for 220 MHz

Give this simple 220 MHz antenna design a try.

Glenn Morrison, WB6RLC

With the ARRL VHF Contest coming up in June, I thought it would be an ideal opportunity to get some mountain-fresh air, while operating on all bands from 50 – 450 MHz. My Icom IC-706 will provide FM and SSB operation on the 50, 144, and 440 MHz bands. I will use my Alinco DR-235 for 220 MHz FM. I have an M2 6-meter Halo and an Arrow 144/440 MHz dual-band corner reflector, but nothing for 220 MHz. After a bit of research, I settled on a Moxon beam, as it is inexpensive, compact, and easy to build.

Antenna Design

The design is based on the Moxon design calculator (see Figure 1) from **https://ac6la.com/moxgen1.html**, made available by Dan Maguire, AC6LA. The antenna is built using 5 feet of ¼-inch copper tubing, four copper elbows, three 2-inch #8 nylon screws, six #8 nylon nuts, a 1-inch outer diameter × 12-inch-long section of schedule 40 PVC tubing, a 1-inch PVC cap, a 13-millimeter section of heat-shrink tubing, and a 1- to 1½-inch PVC T, all of which are available at your local hardware store. Only a hack saw, a Dremel tool or file, and a hobbyist butane torch are needed for construction.

Construction

All dimensions are measured from the tubing center to center. The copper elbows add a quarter inch to the overall tubing length, so cut the reflector and director to 18¼ inches to preserve the Figure 1 dimensions. Then cut the director in half, and remove ¼ inch from each piece to provide a ½-inch gap at the feed point. Tin the two tubing sections at the feed point. Sections B and D also need to be shortened to

maintain the overall section E lengths. Spread a little liquid flux on the tubing prior to soldering the sections together. Use goggles, gloves, and work on a non-flammable surface. A simple jig to hold the tubing can be made by drilling a ¼-inch hole through a piece of 2 × 2 inch board.

To keep the element spacing correct, cut the heads off the nylon screws and install two nuts on each threaded shank. The spacing between the nuts can be adjusted to achieve the necessary gap dimension (see Figure 2). The leftover screw ends fit into the copper tubing and give some additional support. Some clear electrical grade silicon caulk keeps the nuts in place. Cover the entire gap assemblies with several layers of heat-shrink tubing to keep them weatherproof and add strength. I used the same nylon screw technique to maintain the ½-inch gap at the feed point.

The main boom is a 12-inch length of 1-inch schedule 40 PVC tube. At one end of the PVC tube (the director end) press on the PVC cap. Near the edge of the cap, drill a ¼-inch hole all the way through the cap and tube. Take care to ensure that the bit goes straight through the maximum diameter of the PVC tube. Remove the cap and use a Dremel tool or hack saw to cut down to the hole to form a deep notch on both the cap and tube. Next, measure 7.1 inches from this end of the PVC tube and drill another ¼-inch hole through the tube for the reflector, making sure it is parallel to the holes at the end of the tube. Cut a V-shaped notch in the tube down to the holes for the reflector. Save the cutout. Figure 3 details these PVC tube modifications.

Next, drill a ¼-inch hole in the boom, feed a length of RG-8X coax through this hole, and solder the RG-8X center conductor and shield to the previously tinned driven element tubes. Then slide the driven element into the slot at the end of the PVC tube (see Figure 4). Drop the reflector into the V, and glue

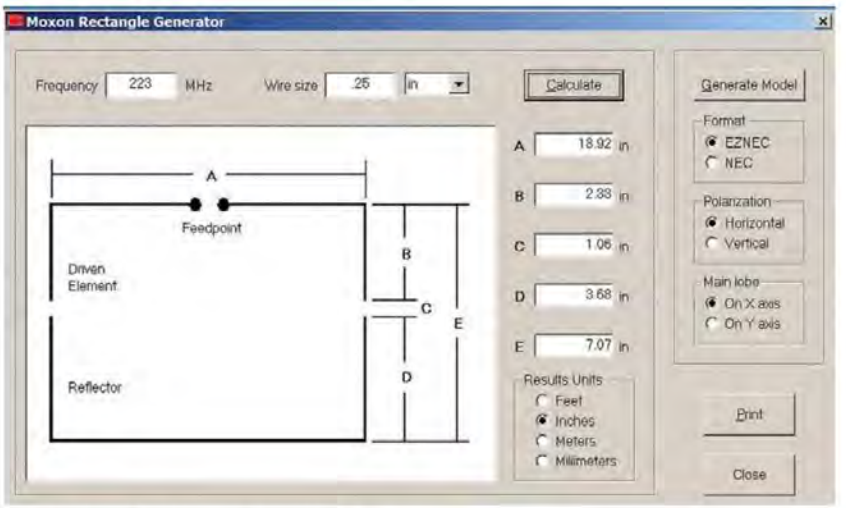

Figure 1 — The Moxon element calculator.

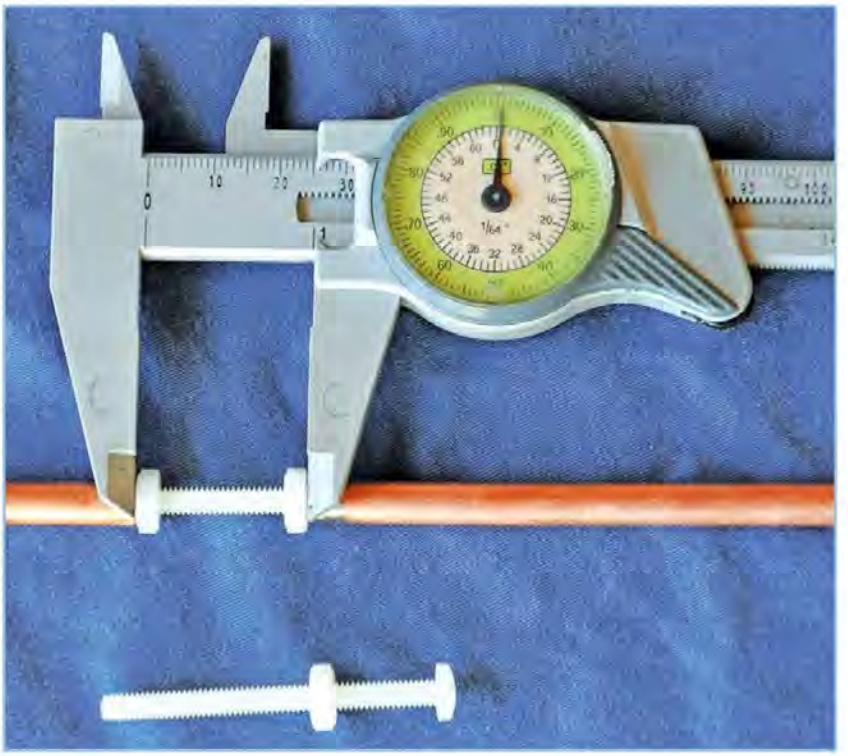

Figure 2 — The nylon spacer details.

Figure 3 — The general position of the slots cut in the PVC boom.

Figure 4 — The driven element installed in the PVC tube.

it to the PVC tube using the previously saved V-shaped cutout. Fill the PVC cap with silicon caulk, and seat it onto the end of the boom. This will hold the driven element securely. Use tie wraps for the RG-8X coax strain relief. Finally, cut in half the 1½-inch section of the 1- to 1½-inch PVC T and fit it to the 1-inch boom. This permits the entire assembly to be hose-clamped to most any mast. The lead photo shows the final 220 MHz antenna.

Results

This Moxon antenna is very broad-banded, and it shows a 1.2:1 SWR over the entire band. These antennas generally have a gain of 5 – 6 dBi with a front-to-back ratio of about 25 dB. It is a compact and portable design, and it weighs just over a pound.

All photos by the author.

Glenn Morrison, WB6RLC, was first licensed in 1966 at age 18. A USMC veteran, Glenn studied electronics technology at Chaffee Collage, marine science at Orange Coast College, and business at University Redlands. He retired from Parker Hannifin Corp. Aerospace Division, Electronics Research and Development Lab as senior research and development technician and is president of the Desert RATS ARC in Palm Springs, California. An ARRL member, a VE, and an AEC with ARES, Glenn also teaches amateur radio license classes. You can reach Glenn at **ticntoc@outlook.com**.

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

ARRL VEC Volunteer Examiner Honor Roll

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

If you are an ARRL VE, you can view your session stats online at **www.arrl.org/ve-session-counts**.
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George Brechmann, N3HBT	282	01-Apr-91
William Klepser, Jr., WB2AIV	215	09-Jun-99
Central		
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Allan Bukowski, N9ZD	320	01-Jun-92
Eldon Boehm, NK9U	316	21-Nov-86
Donald Hlinsky, N9IZU	308	01-Mar-91
Timothy Pechtold, AA9BV	277	01-Nov-92
Brian Eder, WB9UGX	277	01-Jan-92
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Jeffrey Goodnuff, W0KF	310	17-Jun-03
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E. Drew Moore, W2OU	449	01-Aug-90
Fritz Boigris, KB2O	437	26-Oct-84
Gerald Miller, Jr., AA2ZJ	402	05-Dec-95
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Kevin Naumann, N0WDG	642	17-Nov-02
Harry Steger, Jr., W0HMS	568	26-Aug-08
Roland Kramer, W0RL	529	21-Jun-01
Jeanette Nordman, AB0YX	460	21-Aug-03
New England		
*Bob Phinney, K5TEC	1,065	20-Jan-14
Paul Lux, K1PL	619	25-Jan-85
Robert Beaudet, W1YRC	391	01-Aug-90
Bruce Anderson, W1LUS	343	11-Feb-88
Lawrence Polowy, KU1L	338	02-Jan-85
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Richard Morgan, KD7GIE	450	11-Aug-00
Loren Hole, KK7M	381	06-Sep-84
S. Riley McLean, W7RIL	305	02-Sep-99
David Brooks, N7HT	303	10-Jun-87
Scott Robinson, AG7T	303	01-Aug-91
George Ftikas, N7TQZ	302	01-Dec-92
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Dieter Stussy, KD6LVW	424	27-Jan-94
Gordon Fuller, WB6OVH	353	06-Sep-84
Bill Nichols, NN7K	336	01-Sep-93
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David Snyder, W4SAR	250	01-May-93
Sheila Frank, KT4YW	221	30-Oct-96
Terry Sanner, WV8V	217	06-Sep-84
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Robert Hamilton, N0RN	392	19-May-87
Jeffrey Weinberg, W0QO	302	01-Apr-93
David Avery, N0HEQ	301	13-Jan-88
Donald Baune, AC0EX	259	19-Sep-06
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*Justin Lee Pike, KJ4AXF	1,280	12-Nov-12
*Ryan Krenzischek, W4NTR	1,216	04-Jan-13
*Anna Grogan Pike, KD4PCU	1,210	18-Aug-09
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Southwestern		
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Bruce Ziemienski, WA6BZ	321	25-Mar-02
Richard Buck, KC7OCT	312	21-May-97
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*Franz Laugermann, K3FL	1,044	01-Dec-91
Daniel Quigley, N7HQ	630	24-Apr-20
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*Denotes participation in more than 1,000 sessions.
**Congratulations to Gary Lee Pike, KA4KBX, from Roanoke, Alabama (Southeastern Division), the first VE to reach participation in 2,000 sessions!

Track down RFI with this compact, resistively terminated loop antenna.

Portable Flag Antenna for MF/HF Radio Direction Finding

Don Kirk, WD8DSB

I spend a lot of time tracking down RFI (radio frequency interference) in the MF (medium-frequency) and HF (high-frequency) bands. I often use bi-directional tuned loops, but the portable flag (see the lead image) is unidirectional and broad band, which is a great advantage. For more information, see my YouTube video, at **https://youtu.be/yIWY2KwoZ8w**.

Resistively terminated flags produce a unidirectional cardioid pattern (see Figure 1). Very small flags used on MF and HF have very large losses, but a preamp makes them very useful for direction finding because of their backside null.

My 2-foot-tall by 4-foot-long portable flag is as large as possible — to maximize gain — that would fit inside my car, but still small enough to maintain a cardioid pattern from 1.8 to 30 MHz. With an appropriate preamp, the flag is useful for direction finding even in the AM broadcast band.

General Details

I selected a ¼ W non-inductive 680 Ω termination resistor based on modeling in *4nec2* NEC-based antenna modeler (created by Arie Voors, **www.qsl.net/4nec2**). The front-to-back ratio is typically 12 to 21 dB, which is more than adequate for direction finding.

Figure 2 shows a diagram of my portable flag antenna. I used a BN73-202 binocular core (Fair-Rite 2873000202) transformer at the antenna feed point to match its high impedance to 50 Ω coax. Wind the matching transformer with a three-turn primary and 12-turn secondary using #30 AWG wire-wrap wire. A 10-foot section of RG-174A/U coax connects the matching transformer to the receiver/preamp. Measured SWR is less than 1.5 to 1 from 0.5 to 30 MHz. More details about SWR and gain are on the **www.arrl.org/qst-in-depth** web page.

The front-to-back ratio is typically 12 to 21 dB, which is more than adequate for direction finding.

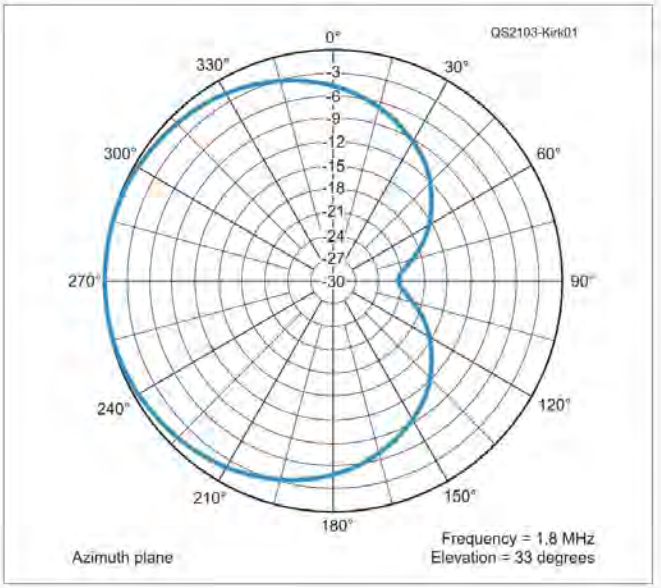

Figure 1 — The cardioid pattern modeled in *4nec2* at the maximum gain elevation angle.

I suppressed HF noise generated by my laptop running SDR software by placing a 31-material clamp-on ferrite core (Fair-Rite part 0431167281) near the end of the coax and winding four passes of the coax through the core (see Figure 3). Placing the ferrite core on the coax closer toward the antenna was less effective. The end of the coax terminates in a shielded phono plug (RadioShack part 274-0339 or Switchcraft part 3502A or equivalent) that connects to the receiver or preamp. I soldered the plug ground lug to the plug body after removing the plating with sandpaper or a file. File down the profile of the solder blob as needed to allow the shielded plug cover to fit.

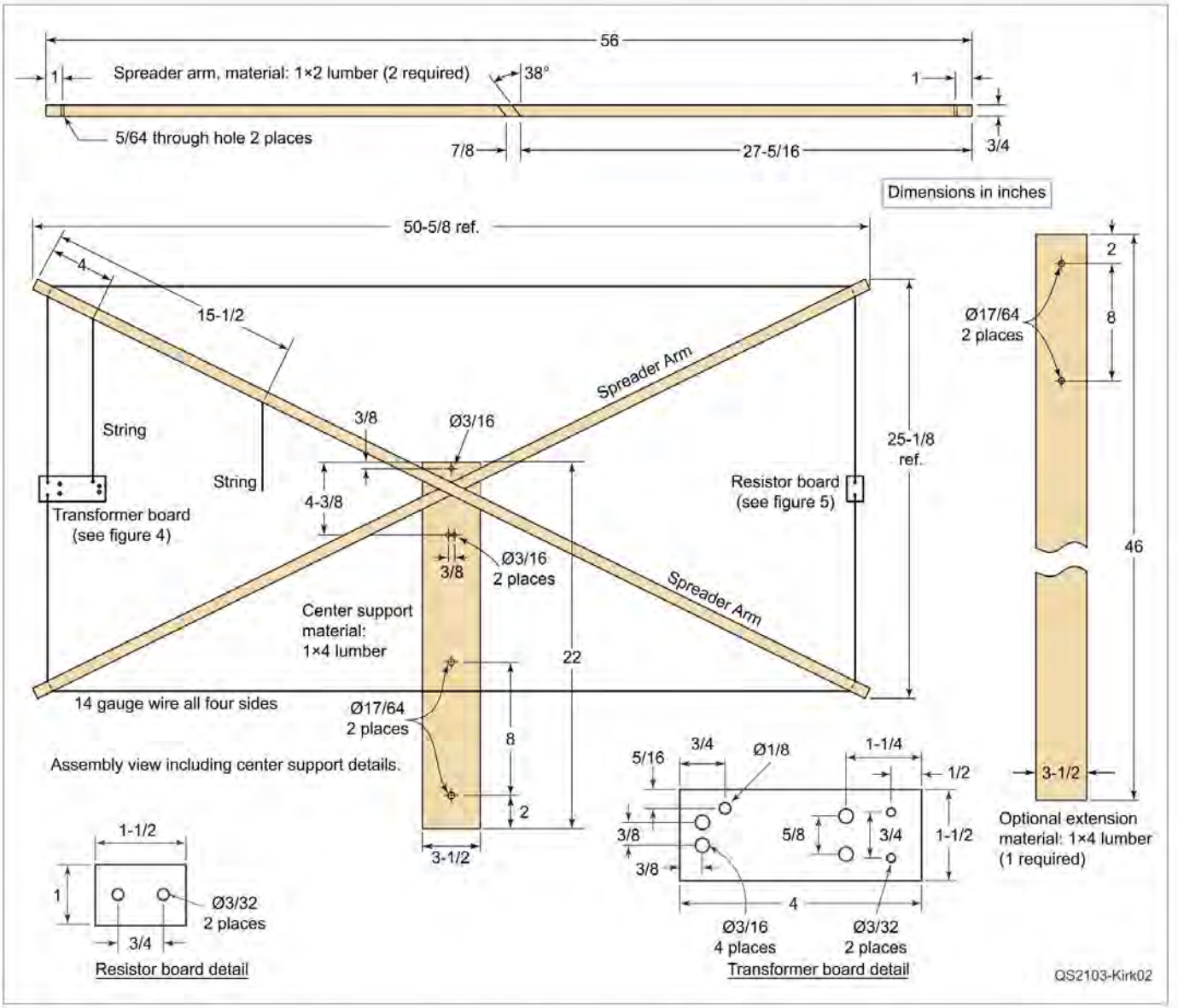

Figure 2 — The design sketch of the Portable Flag Antenna. Attach the extension to the center support using 1/4-20 nylon bolts.

Figure 3 — The clamp-on ferrite core with four passes of coax cable and shielded phono plug.

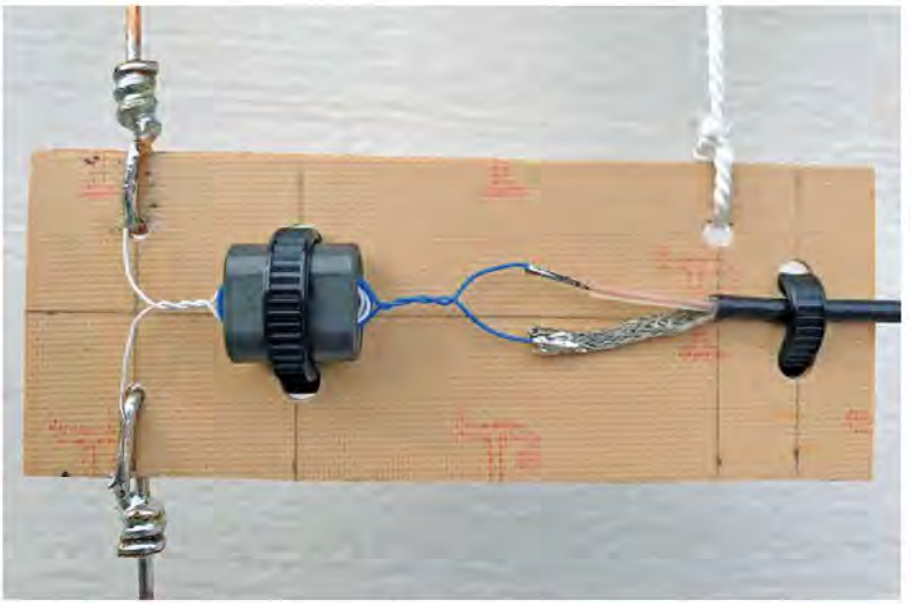

Figure 4 — The transformer board. Note the string support. Transformer three-turn primary connects to the coax.

Figure 5 — The resistor is mounted to the board with some slack in the resistor legs to avoid mechanical stress on the resistor body.

I used a 1/16-inch-thick single-sided circuit board — with the copper removed — at the transformer end (see Figure 4) and at the resistor end (see Figure 5) of the antenna. One board is 1.5 × 4 inches and the other is 1 × 1.5 inches. I removed the copper using a rotary tool with a sanding band. Drill holes into the two boards, as seen in Figures 2, 4, and 5. Always wear safety glasses when using power tools.

The antenna comprises #14 AWG bare copper wire. When soldering the resistor to the antenna wire, leave some slack in the resistor legs to avoid mechanical stress on the resistor body. Mount the resistor board in the center of one of the 2-foot vertical wires; mount the transformer board in the center of the other 2-foot vertical wire. The resistor end of the antenna is the back of the antenna, while the transformer end is the front of the antenna.

Use zip ties to secure the transformer and coax to the transformer mounting board (see Figure 4), and to also secure the coax to the vertical center support board.

I used a piece of string to prevent sag in the transformer mounting board, and another piece of string to prevent sag in the horizontal run of coax. Drill a 9/64-inch-diameter hole 4 inches in from the spreader tip that's above the transformer board, and a second 9/64-inch-diameter hole 15.5 inches in from the same spreader tip for the coax support string. Drill both of these holes perpendicular to the spreader arm.

When soldering the resistor to the antenna wire, leave some slack in the resistor legs to avoid mechanical stress on the resistor body.

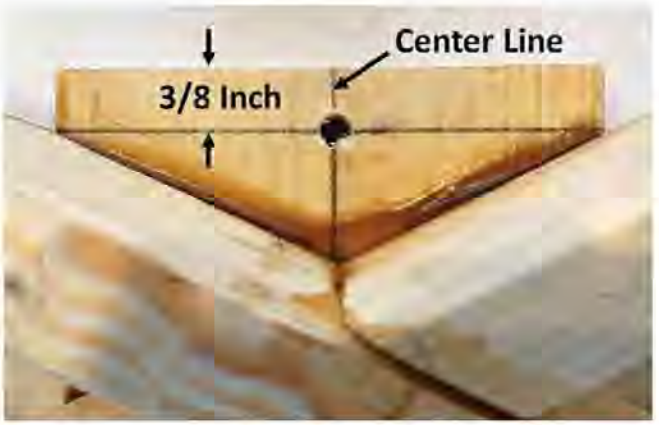

Figure 6 — The center support post showing alignment with the cross supports.

Frame Construction Details

Additional images of the lumber construction are available on the **www.arrl.org/qst-in-depth** web page. Cut two pieces of 1 × 2 lumber (actual size ¾ × 1½ inch) to a length of 56 inches to form the two spreader arms. I used a miter saw set at an angle of 38 degrees to cut a ⅞-inch-wide slot 27 5/16 inches in from the end of each board. I used a miter saw to remove the wood in the slots to a depth of at least halfway through each spreader arm. The slots allow the spreader arms to straddle each other when glued to the 1 × 4 (actual size ¾ × 3½ inch) center support board (see Figure 6).

Cut a piece of 1 × 4 lumber to a length of 22 inches for use as the center support, and another piece to a length of 46 inches for use as an optional extension seen next to my wife, Chris, in the lead photo.

Drill holes in each piece of wood, as shown in Figure 2. Drill the string support holes after everything is assembled.

Draw a line ⅜ inches in from the top of the 22-inch center support board, and another line in the center of this board. Apply wood glue to the surfaces in the slot of each spreader arm. Also apply wood glue to the surfaces of each spreader arm that will come into contact with the center support (see Figure 6). Clamp the spreader arms to the center support, making sure the spreader arms line up with the middle of the center support line, as well as where the ⅜-inch line intersects the outer edges of the center support. The distance between the top of the upper spreader arm tip and the bottom of the lower spreader arm tip should be approximately 25 inches. I used Titebond III wood glue and allowed it to harden for 24 hours before removing the clamp.

Preamps

I use a W7IUV broadband 20 dB gain preamp, which may be available as a kit (**www.mtmscientific.com/preamp.html**), and it is also easy to homebrew (**https://sites.google.com/site/rxpreamps**).

On 160 and 80 meters (where the antenna gain is –63 and –52 dBi, respectively), I sometimes switch to a higher gain dual-band preamp to hear weak levels of RFI. That preamp, designed by Doug DeMaw, W1FB (explained in the August 1988 issue of *QST*), offers more than 40 dB of gain. A 9 V battery powers the W7IUV and W1FB preamps. They work just fine down to 7 V.

As you approach the source of RFI, you will likely need to reduce the system gain to detect a null. You accomplish this by removing the preamp, reducing receiver gain, or switching in attenuation.

Summary

The portable flag has become a real game changer, and it is my antenna of choice for direction finding of RFI on MF and HF. It is unidirectional, broadband, portable, easy to walk with while direction finding, and easy to transport in a car.

The portable flag does a wonderful job leading me to arcing power line poles, but when close to the suspect poles I switch to a portable 136 MHz AM receiver, four-element beam, and typically 30 dB of attenuation to identify the faulty pole.

DX Engineering (**www.dxengineering.com**) offers a complete kit part number DXE-NOISELOOP that is based on this design. They also offer a broadband 30 dB preamplifier and attenuator, part number DXE-NL-PRE-ATT-1, designed for use with the portable flag.

All photos by the author.

Don Kirk, WD8DSB, was first licensed in 1976 at age 16, and currently holds an Amateur Extra-class license as well as a General Radiotelephone Operator license. He received an associate degree in applied science from Henry Ford Community College in 1983 and a bachelor's degree in Engineering Technology (electrical/electronic) from Wayne State University in 1985. Don has been employed for the past 35 years as a senior engineer by Magnequench, working in the rare-earth permanent magnetic materials industry. Don's technical passion is discrete electronics and microcontroller-based projects, and he enjoys chasing DX and contesting on 160-meter CW. You can reach Don at **wd8dsb@aol.com**.

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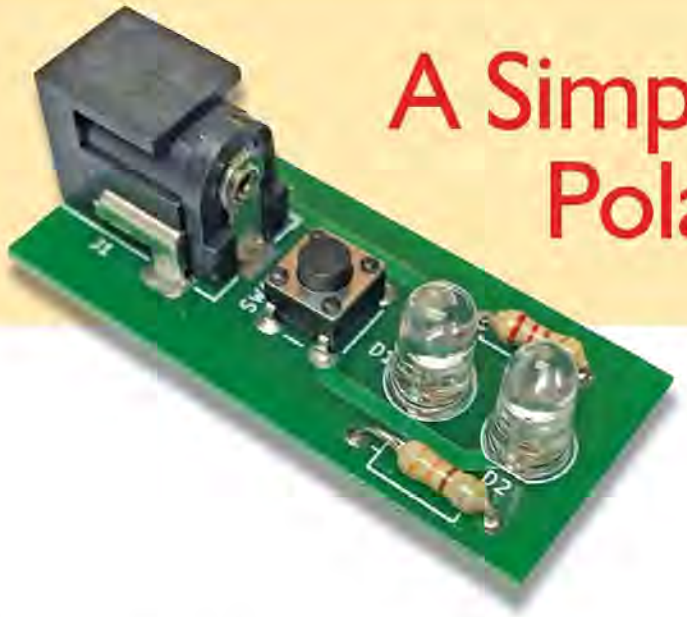
A Simple DC Power Polarity Checker



Save your equipment from reverse polarity disasters.

John Burnley, NUØV

One of the most common mistakes I make while building simple radios is incorrectly hooking up my power supplies. Adapter supplies sometimes have the polarity reversed. Some are even ac and not dc. I try to check the polarity with a volt ohm meter (VOM), but if I forget, there can be chaos.

My operating over the past 2 decades has been with homebrew QRP radio kits from clubs or vendors. These use the common barrel connectors that have powered amateur radios and accessories for decades. There are technologies like Anderson Powerpole connectors that would alleviate polarity issues, but the cost of the connectors and cables were more than the radios themselves. I needed an easy, inexpensive, and consistent solution.

A Simple Polarity Checker

The DC Power Polarity Checker is a simple circuit (see Figure 1), utilizing two light-emitting diodes (LEDs), two resistors, a momentary switch, and a barrel connector that fits your devices. Barrel connectors come in several different sizes, so you must make sure you are using the correct one. The most common ones seem to be 2.1 and 2.5 millimeters. This refers to the diameter of the center pin. The outer sleeve in both cases is 5.5 millimeters.

The device uses two colored LEDs to indicate proper polarity — green is correct, red is reversed. When a power source is connected to the checker, the momentary switch must be pushed to engage the circuit. If the polarity is correct, D1 (green) will be forward biased and conduct. R1 limits the current flowing through D1. D2 (red) is reverse biased and does not conduct. If the polarity is reversed, D2 is forward biased and conducts. R2 limits the current flowing through D2. D1 is reverse biased and does not conduct.

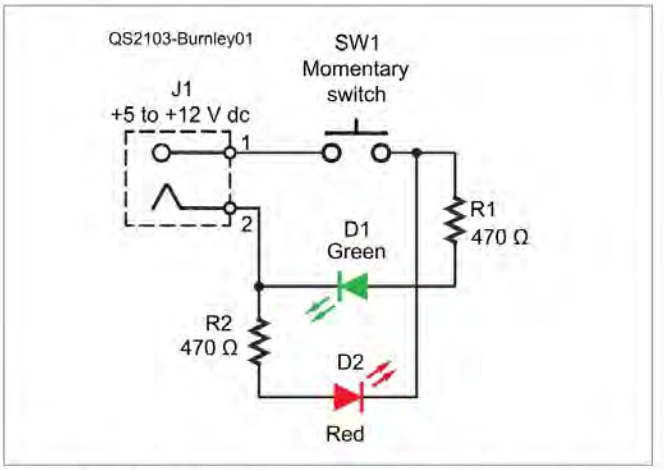


Figure 1 — The schematic diagram, showing the LEDs and current limiting resistors are parallel in the circuit. The polarity of D2 is reversed from D1, ensuring that one is always forward biased.

Table 1 — LED Voltages, Current Ratings, and Calculated Resistance

Source Voltage	Component	Forward Current	Forward Voltage	Calculated Resistor	Chosen Resistor	Adjusted LED Current
+12 V dc	D1	30 mA	2.6 V	313 Ω	470 Ω	20 mA
+12 V dc	D2	40 mA	2.4 V	240 Ω	470 Ω	20.4 mA

Note that the circuit uses the next higher standard 20% resistor value. Both resistors were set to the same value to make sourcing of parts easier. The reduced current will dim the LED slightly from the nominal maximum current.

Table 2 — Parts List

Component	Description	Vendor	Part Number
D1	Green LED	Jameco	333551
D2	Red LED	Jameco	152864
R1, R2	470 Ω, ¼ W carbon film resistor	Jameco	690785
SW1	Momentary switch	Jameco	153252
J1	2½ × 5½ millimeter barrel connector	Jameco	297570
Alternate J1	2.1 × 5½ millimeter barrel connector	Jameco	101178

The nominal values for R1 and R2 depend on the LEDs you have chosen. Characteristics of LEDs vary by color and manufacturer. Each LED has two important specifications. Forward voltage is the voltage drop required to turn on the LED. The remaining source voltage will appear across the current-limiting resistor, because the sum of the voltages across two devices in series must equal the applied voltage.

Forward current is the current that flows through the LED to produce normal illumination. This must be limited, as too much current through an LED will cause catastrophic damage to the component. Running an LED at less than its rated current is okay; it just dims the light a bit.

Resistor Values

When choosing resistor values, first check the datasheet (if available) and look for maximum forward voltage and maximum forward current. You'll use these values to calculate the resistance with Ohm's Law. If you use old LEDs, you can safely assume similar values for red and green LEDs. Table 1 lists the values for LEDs I had in my junk box and the calculated resistance values.

The resistance calculation is based on the Ohm's Law formula $R = E/I$, where R is the resistance in ohms, and E is the voltage to be dropped across the resistor and is calculated by subtracting the LED's maximum forward voltage, E_f, from the source voltage, E_s. I_f is the maximum forward current in amperes. The modified formula is $R = (E_s - Ef)/I_f$.

In all probability, your calculated value will not be one of the standard resistor values. In this case, simply choose a resistor that is the next standard value above your calculated value. If you chose a lower value, you could allow too much current to flow through the LED and damage the component when operating the checker. An LED failure can be quite spectacular, and very dangerous. If you want to check your calculations, you can use the online calculator at **https://www.pcboard.ca/led-dropping-resistor-calculator**.

It is good practice to check the power dissipated in any resistors in your circuits. Volts times amps gives the power in watts. For our design, the resistors will be dissipating less than 10 V × 0.0204 A (or 0.204 W), so a ¼ W or ½ W resistor is fine, especially because the duty cycle is very low.

Building the Checker

Construction is simple. First, install the barrel connector followed by the momentary switch. Next, install the LEDs, making sure to observe the correct polarity. The longer lead is the anode (positive) and the shorter one is the cathode (negative). Finally, solder the resistors in place. The longer lead is the anode (positive) and the shorter one is the cathode (negative). For further building instructions and additional calculations, visit the *QST* in Depth web page at **www.arrl.org/qst-in-depth**.

Figure 2 — The correct polarity lights the green LED.

Figure 3 — The reversed polarity lights the red LED.

Operation is equally simple. Plug the power cable under test into the barrel connector. Turn on the power source. Press the momentary switch. If the polarity is correct, the green LED will illuminate. Figure 2 shows a cable with the correct polarity. If the polarity is reversed, the red LED will illuminate as illustrated in Figure 3.

This was a fun project to put together and it has saved me countless headaches. A PCB is available from the author for those who would like to build the DC Power Polarity Checker.

John Burnley, NU0V, has been a licensed amateur for 50 years. He earned a BA degree from the University of Kentucky, and an MBA from the University of Iowa. He worked in information technology for over 30 years in technical, managerial, and executive leadership roles. He is a faculty member at Iowa State University and Des Moines University, teaching information technology courses at the undergraduate and graduate levels. He is a QRP enthusiast, operating low-power equipment. He can be reached at **nu0v@arrl.net**.

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Feedback

■Anthony Le Cren, F4GOH/KB1GOH, has added GPS capabilities to his WSPR beacon project, featured in his August 2020 *QST* article, "Program an Arduino to Transmit WSPR." The update is available on his website, at **www.hamprojects.wordpress.com/2019/06/02/wspr-beacon**.

■The November 2020 "How's DX?" column stated that the power limit for amateurs is 100 W effective isotropically radiated power (EIRP). The limit is actually 100 W to a half-wave dipole, described by the FCC as follows: "For the purpose of computing ERP, the transmitter PEP (peak envelope power) will be multiplied by the antenna gain relative to a dipole or the equivalent calculation in decibels. A half-wave dipole antenna will be presumed to have a gain of 0 dBd." This is explained in more detail on the ARRL Frequently Asked Questions page about operation on 60 meters, available at **www.arrl.org/60-meter-faq**.

■In "The ARRL February School Club Roundup" announcement, which appeared in the January 2021 issue, the caption for the photo should have read, "Winston Matson (left) and Margaret Clifford (right) operated as part of the N4SMS School Club Roundup team from Schofield Middle School in South Carolina. Winston's sister, Anna Matson, KN4IVD, acted as their mentor." *QST* regrets the error.

Steve Ford, WB8IMY, wb8imy@arrl.net

Eclectic Technology

FST4 — A New Family of Digital Modes

The current official version of the famous *WSJT-X* software suite is about to gain some fascinating new modes, possibly by the time you read this column. A few months ago, Steve Franke, K9AN; Bill Somerville, G4WJS, and Joe Taylor, K1JT, announced the debut of FST4 as part of the *WSJT-X* "release candidate" *WSJT-X 2.3.0-rc2*.

Not to be confused with FT4, the fast contesting mode, the new FST4 modes offer:

- ✔ WSPR-like, quasi-beacon transmissions on LF and MF bands.
- ✔ Two-way conversations with very weak signals on the LF and MF bands.
- ✔ Moonbounce modes for the VHF and UHF bands.

FST4 uses 4-GFSK modulation and offers transmit/receive sequence lengths of 15, 30, 60, 120, 300, 900, and 1,800 seconds. Those last three lengths aren't typos; they do indeed translate to 5-, 15-, and 30-minute transmissions!

There are submodes with different tone spacings to compensate for certain types of propagation. This will require some experimentation, not only with spacing, but the transmit/receive sequences as well.

Each transmission will consist of a sequence of 120 information-carrying symbols (2 bits each) interspersed with 40 synchronizing symbols. The underlying message payloads contain either 77 bits (the standard payload for FT4, FT8, and MSK144) or 50 bits.

In Figure 1, you can see an example of FST4W-300A signals received on 6 meters at NO3M on July 23, 2020. The weakest of these signals are close to the decoding threshold for this submode: –35 dB. Note that VK4YB's signal was decoded at nearly 15,000 kilometers distant.

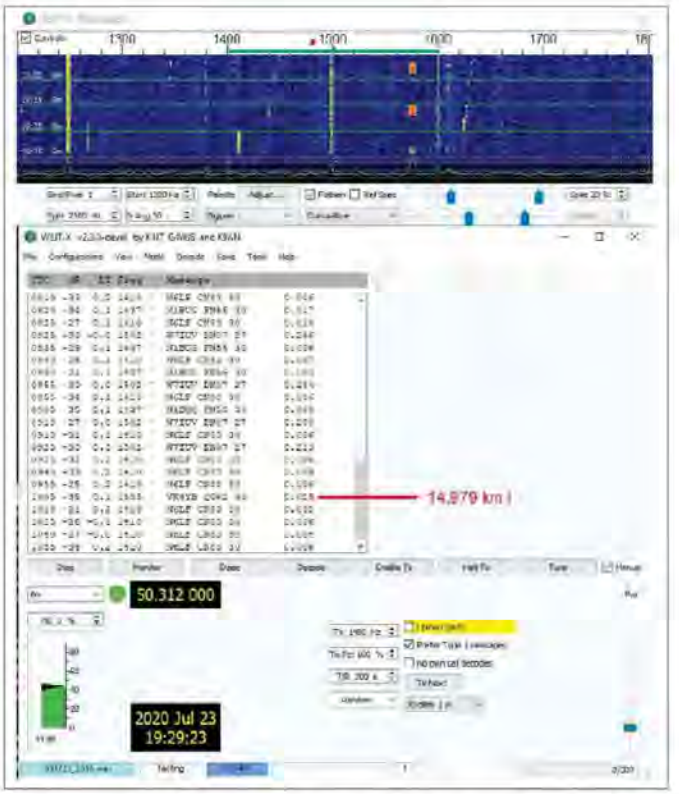


Figure 1 — NO3M testing FST4 on 6 meters. [Image courtesy of Joe Taylor, K1JT]

If *WSJT-X* version 2.3 is available, you'll find it on Joe Taylor's website at **https://physics.princeton.edu/pulsar/K1JT/wsjtx.html**. If version 2.3 is not yet ready, download the release candidate and give it a try.

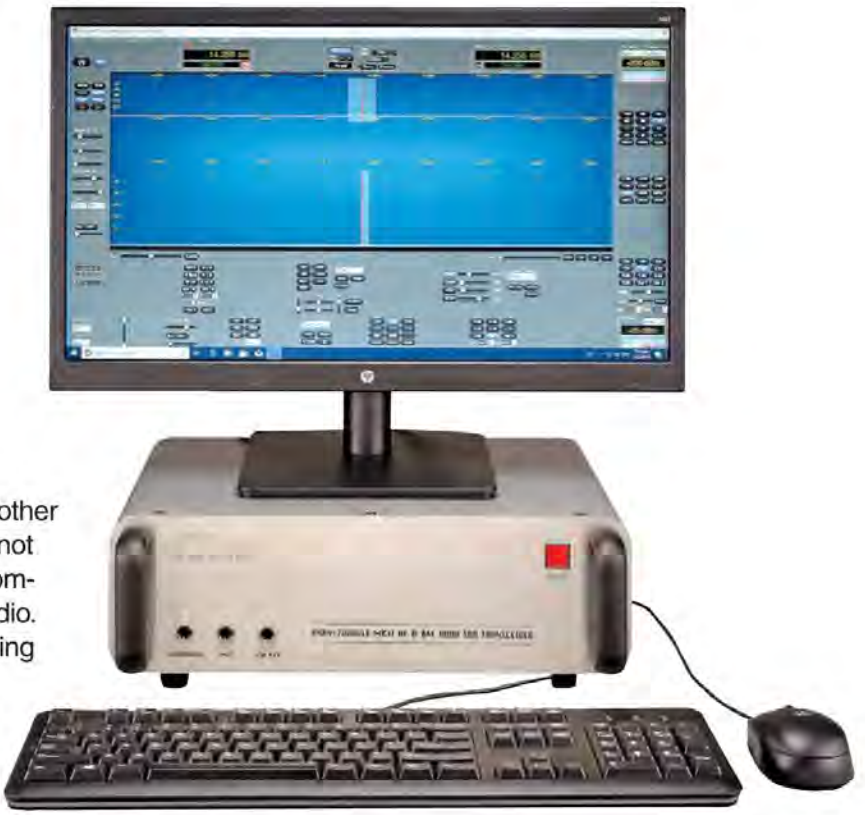
LF, MF, EME, and Beyond

The new FST4 modes are likely to find uses beyond moonbounce, LF, and EME. Hams have a long-established tradition of repurposing software for uses its authors never quite intended. Joe Taylor's JT65 mode was originally intended for moonbounce, until some curious hams discovered that it could do amazing things on the HF bands. It seems like an eternity ago that JT65 burst onto the scene, allowing hams with minimal HF stations to make contacts throughout the world. And then came FT8, and nothing was ever quite the same.

JT65 and JT9 have been showing up on our new 2200- and 630-meter bands as possible solutions for the low-power restrictions on those frequencies, not to mention the high noise levels. With the debut of FST4, we have new tools for these bands that should greatly expand their usability. Unlike JT65 and JT9, the FST4 modes are specifically designed to deal with noise while still offering excellent sensitivity. That said, I have a feeling it won't be long before we hear them on higher bands as well. Using the FST4 modes to combat challenging conditions on 160 and 80 meters comes to mind!

Product Review

Apache Labs ANAN-7000DLE MKII HF and 6-Meter SDR Transceiver with i7 CPU



Reviewed by Terry Glagowski, W1TR
w1tr@arrl.net

The ANAN-7000DLE MKII is a newer entry in the family of software-defined radio (SDR) transceiver offerings from Apache Labs. We reviewed the ANAN-100D in the October 2015 issue of *QST*, and the ANAN-8000DLE in the April and November 2018 issues.

Many hams are used to a traditional self-contained transceiver into which you connect power, an antenna, a microphone, a key, and other accessories, and you are on the air. They are not comfortable with using a separate personal computer to run SDR software that controls the radio. Apache Labs addressed that concern by offering versions of the ANAN-7000DLE MKII with a PC module built into the radio chassis. This internal PC eliminates the requirement for a separate computer, but the user supplies a monitor, a keyboard, and a mouse. The internal PC can be networked with other computers on a local area network (LAN), so that data can be exchanged, and the SDR can also be controlled by an external computer if desired.

The Apache ANAN series radios have always used open-source firmware and software. Microsoft Windows has been the dominant operating system, but versions for Linux are also available. We'll discuss the software later in this review.

There are some hardware changes for the ANAN-7000DLE MKII compared to previous ANAN transceivers. The version with the built-in CPU has a cabinet that is 5 × 15 × 13 inches, midway between the size of the '100D and the 8000DLE. The unit without the built-in CPU has a cabinet size similar to the '100D, which is about is 3.5 × 10.5 × 9 inches. The fan is quieter than my '100D, and the fan controller allows for an external fan for better cooling.

System Overview

The review transceiver includes the optional i7 PC module (CPU). It's an Intel NUC8i7BE embedded computer with 8 MB RAM and a 128 GB solid-state drive (SSD) running the 64-bit version of Microsoft Windows 10 Home. This device has Wi-Fi and Bluetooth built in. Apache Labs also offers the 7000DLE MKII with an internal i5 PC module, or no internal PC module.

Bottom Line

The Apache Labs ANAN-7000DLE MKII features improved hardware and software compared to previous models and can be equipped with an internal PC module, which eliminates the need for a separate PC to run the control software. Receiver performance is very good, and the Pure Signal predistortion feature provides an exceptionally clean SSB signal.

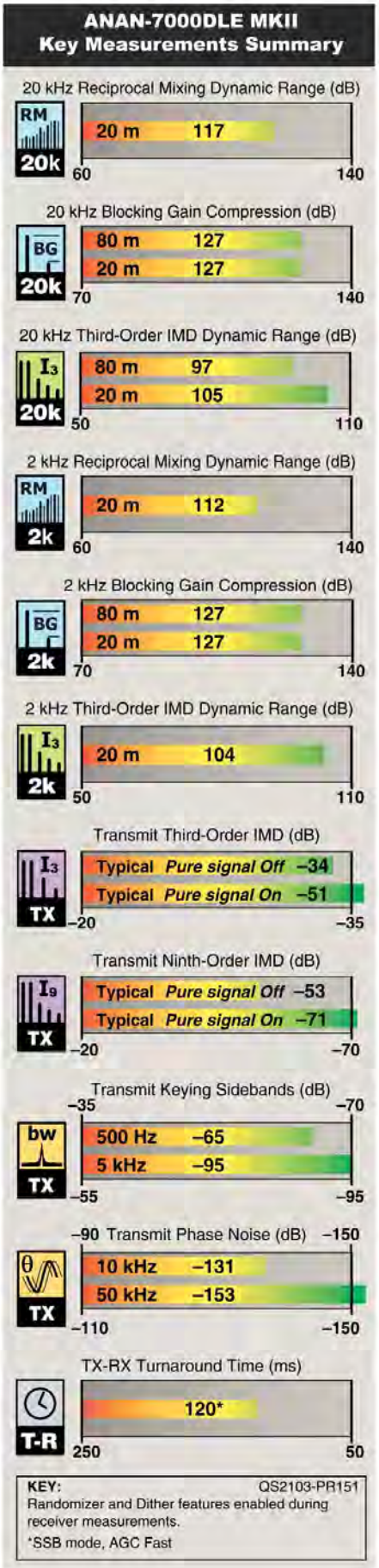


Table 1
Apache Labs ANAN-7000DLE MKII, serial number 7000DLEMKII0006

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Receive, 9 kHz – 61.44 MHz. Transmit, not specified.	Receive, 0.03 – 61.440 MHz;* 160 – 6 meter amateur bands.
Power requirement: Transmit, 30 A; receive, 3 A at 13.8 V dc.	Transmit, 17 A (typical) at maximum power output; 6.0 A (typical) at minimum power output. Receive, 2.6 A. Power off, <2 mA.
Modes of operation: SSB, CW, AM, FM, digital, RTTY.	As specified.

Receiver	Receiver Dynamic Testing**
Noise floor: Not specified.	Noise floor (MDS), 500 Hz bandwidth: 0.137 MHz –127 dBm 0.475 MHz –128 dBm 1.0 MHz –130 dBm 3.5 MHz –132 dBm 14 MHz –132 dBm 50 MHz –141 dBm
Noise figure: Not specified.	14 MHz, 15 dB; 50 MHz, 6 dB.
Spectral sensitivity: Not specified.	Panadapter: 14 MHz, –137 dBm, 50 MHz, –143 dBm. Waterfall: 14 MHz, –147 dBm, 50 MHz, –153 dBm.
AM sensitivity: Not specified.	10 dB (S+N)/N, 1 kHz tone, 30% modulation, 6 kHz BW: 1.0 MHz 2.23 µV 3.88 MHz 1.80 µV 29.0 MHz 5.07 µV 50.4 MHz 0.59 µV
FM sensitivity: Not specified.	29 MHz, 0.70 µV; 52 MHz, 0.22 µV.
ADC overload level: Not specified.	HF, –5 dBm; 50 MHz, –19 dBm.
Blocking gain compression dynamic range: Not specified.	Blocking gain compression dynamic range, 500 Hz bandwidth: 3.5 MHz 127 dB (20 kHz offset) 127/127 dB (5/2 kHz offset) 14 MHz 127 dB 127/127 dB 50 MHz 119 dB 119/119 dB
Reciprocal mixing dynamic range: Not specified.	14 MHz, 20/5/2 kHz offset: 117/115/112 dB.

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

Band	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR****
3.5 MHz	20 kHz	–132 dBm –97 dBm	–35 dBm –10 dBm	97 dB
14 MHz	20 kHz	–132 dBm –97 dBm	–27 dBm –10 dBm	105 dB
14 MHz	5 kHz	–132 dBm –97 dBm	–28 dBm –10 dBm	104 dB
14 MHz	2 kHz	–132 dBm –97 dBm	–28 dBm –10 dBm	104 dB
50 MHz	20 kHz	–141 dBm –97 dBm	–46 dBm –31 dBm	95 dB

Manufacturer's Specifications	Measured in the ARRL Lab
Second-order intercept point: Not specified.	14 MHz, +87 dBm; 21 MHz, + 87 dBm; 50 MHz, +17 dBm.
DSP noise reduction: Not specified.	NR1, 10 dB.
FM adjacent channel rejection: Not specified.	29 MHz, 79 dB; 52 MHz, 72 dB.
FM two-tone, third-order dynamic range: Not specified.	20 kHz spacing, 29 MHz, 51 dB; 52 MHz, 72 dB.† 10 MHz spacing: 29 MHz, 104 dB; 52 MHz, 111 dB.
Squelch sensitivity: Not specified.	29 MHz, 0.28 µV; 52 MHz, 0.09 µV.
Notch filter depth: Not specified.	Auto-notch, >60 dB. Attack time, 1 second (single tone and two tones).
S-meter sensitivity: Not specified.	S-9 signal, 14 MHz, 50.1 µV; 50 MHz, 10 µV (after calibration). Scaling, 6 dB/S-unit.
IF/audio response: Not specified.	Range at –6 dB points:‡ CW (500 Hz BW): 305 – 898 Hz; Equivalent Rectangular BW: 493 Hz; SSB (2.4 kHz BW): 101 – 2594 Hz; AM (6 kHz BW): 11 – 2982 Hz.
Receive processing delay time: Not specified.	57 ms at transceiver rear speaker jacks.
Transmitter	**Transmitter Dynamic Testing**
Power output: 100 W SSB, CW, FM, digital; 1 – 30 W AM.	SSB, CW, FM, AM, digital, as specified for 1.8 – 30 MHz. At 50 MHz, 0 – 100 W SSB, CW, FM, digital; 0 – 32 W AM. At 54 MHz, 56 W maximum output.
Spurious-signal and harmonic suppression: >43 dB (HF); 60 dB (50 MHz).	HF, 71 dB typical; worst case, 66 dB (20 m); 50 MHz, 69 dB. Complies with FCC emission requirements.
SSB carrier suppression: >80 dB.	>70 dB.
Undesired sideband suppression: >80 dB.	>70 dB.
Third-order intermodulation distortion (IMD) products: Not specified.	3rd/5th/7th/9th order IMD products 100 W PEP RF output, Pure Signal off: –34/–38/–44/–53 dB (HF typical) –27/–38/–39/–50 dB (worst case, 15 m) 100 W PEP RF output, Pure Signal on –51/–62/–67/–71 dB (HF typical) –31/–55/–52/–58 dB (worst case, 10 m) At 50 W PEP RF output, 14 MHz: –35/–39/–50/–58 dB (Pure Signal off) –57/–64/–70/–73 dB (Pure Signal on) At 50 MHz, 100 W PEP RF output: –30/–37/–42/–53 dB (Pure Signal off) –34/–49/–53/–65 dB (Pure Signal on)
CW keyer speed range: Not specified.	1 to 48 WPM, iambic mode B.
CW keying characteristics: Not specified.	See Figures A and B.
Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.	S-9 signal, AGC fast, SSB: 120 ms; CW, full break-in: 90 ms
Receive-transmit turnaround time (TX delay): Not specified.	SSB, 114 ms; FM, 62 ms (29 MHz), 60 ms (52 MHz).
Transmit phase noise: Not specified.	See Figure C.
RF output lag time versus amplifier key line open: Not specified.	0 ms (default settings).

Size (height, width, depth, with protrusions): 5.1 × 15.3 × 14.4 inches. Weight, 22 lbs.

Second-order intercept points were determined using S-5 reference.

*Reception is possible below 30 kHz, at a noise floor >1 µV.
**Randomizer and dither features enabled during noise floor and dynamic range measurements.
***Third-order IMD dynamic range measurements in a laboratory environment. Measurements shown represent the best case.
†Measurement is phase noise limited to the value indicated.
‡Default values; bandwidth is adjustable via DSP.

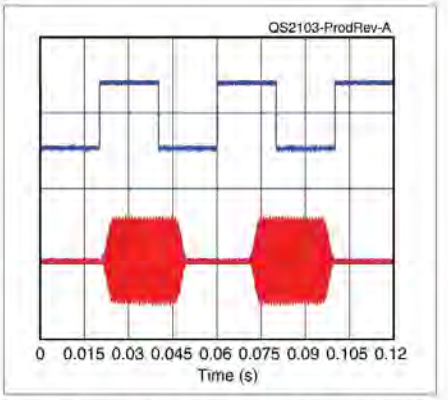


Figure A — CW keying waveform for the ANAN-7000DLE MKII shows the first two dits in full-break-in (QSK) mode using external keying. Equivalent keying speed is 48 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 ms. The transceiver was being operated at 100 W output on the 14 MHz band. As explained in the "Lab Notes" sidebar, at the normal test speed of 60 WPM, the RF output keying waveform could not keep up with the external keying device.

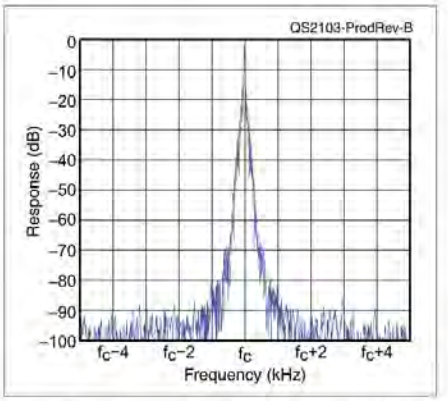


Figure B — The spectral display of the ANAN-7000DLE MKII transmitter is shown during keying sideband testing. Equivalent keying speed is 48 WPM using external keying. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 100 W PEP output 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 dB.

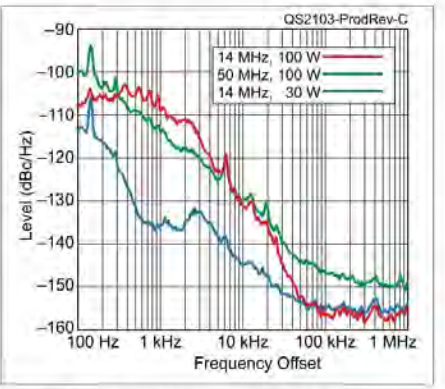


Figure C — The spectral display of the ANAN-7000DLE transmitter output is shown during phase-noise testing. Power output is 100 W on the 14 MHz band (red trace), 30 W on the 14 MHz band (blue trace), and 100 W on the 50 MHz band (green trace). The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 100 Hz to 1 MHz from the carrier. The reference level is –90 dBc/Hz, and the vertical scale is 10 dB per division.

Lab Notes: Apache Labs ANAN-7000DLE MKII

Bob Allison, WB1GCM

Initial testing of the Apache Labs ANAN-7000DLE MKII showed higher-than-anticipated transmit IMD on the 17- through 10-meter amateur bands, even with the Pure Signal function enabled. We returned the radio to the US service center, where they determined that four inductors in the low-pass filter sections for the affected bands required smaller cores. The replacements were installed in our unit, and all further units employ these new parts.

With the revised inductors, the review radio's transmit IMD improved dramatically. A good benchmark for reasonable third/fifth/seventh/ninth-order IMD products is 30/40/50/60 dB below PEP output. With Pure Signal enabled, the ANAN-7000DLE MKII typically measured 51/62/67/71 dB below PEP. This translates to very low transmitted distortion products and a clean, narrow signal that offers more elbow room for others operating near the transmit frequency.

During initial testing, we also found that the review radio did not comply with FCC spectral purity requirements because of a spurious emission when transmitting on the 6-meter band. This problem was fixed with the release of the Protocol 2 (*Thetis/Metis*) software and firmware.

Other transmit performance parameters are favorable, with reasonably low transmit phase noise and a nicely shaped CW waveform with narrow CW bandwidth. Like the ANAN-8000DLE reviewed previously, the maximum external keying speed of the transmitter is 48 WPM. Any higher speeds will result in character shortening.

The lowest of the three dynamic ranges in the review radio at 2 kHz spacing was two-tone, third-order IMD at 104 dB. This places the ANAN-7000DLE MKII in the top tier of performance. The only parameter that might cause an issue is two-tone, second-order IMD when operating on the 6-meter band. There is a small chance of phantom signals when two strong signals are present at the antenna jack, with the sum of the two frequencies falling somewhere in the 6-meter band.

Turnaround times (receive-to-transmit and transmit-to-receive) are about average for SDR transceivers. Receive processing delay time (the time between when a signal arrives at the antenna jack when it is heard in the speaker) is shorter than expected. At 57 milliseconds, it is faster than some of the other SDRs we have measured.

As the review was wrapping up, the 7000DLE MKII developed a heat-related problem with the video display using the internal i7 PC, although we could still control the radio using an external PC. We sent the radio for repair, and replacement of defective RAM fixed the problem.

A word of caution: prior to testing, I discovered the transmit inhibit function in the setup menu did not inhibit the transmitter. In the Lab, that can result in transmitting at high power into sensitive test equipment.

The unit comes with the software needed to run the SDR already installed, so the unit is ready to use out of the box. As tested here, *Thetis* software version 2.7.0 and *Metis* firmware version 2.0 have been installed. *Thetis/Metis* is also known as Protocol 2 and is the latest generation firmware and software available for the Apache Labs ANAN series SDR transceivers.

I was a little skeptical that 128 GB is sufficient storage, but with two SDR software versions and many third-party ham radio and MARS (Military Affiliate Radio System) applications loaded, my usage is 48 GB. There should be plenty of room for word processing, spreadsheet, and other applications, but anything with a very large database might be a challenge. Because the unit has the capability of Wi-Fi and ethernet LAN connections, external storage is always available.

The Apache Labs ANAN series radios, including the ANAN-7000DLE MKII, have the following major subsystems:

1) The mechanical and electrical chassis, including a heatsink and fans, with provisions for external fans.
2) The RF board containing the analog parts of the receiver and transmitter, the power amplifier, and the filters. The new RF board in the 7000DLE MKII offers better receiver dynamic range and better transmit Pure Signal (pre-distortion) support than previous hardware. (Pure Signal significantly improves the transmitted IMD products, as discussed in the "Lab Notes" sidebar.)
3) The digital board with a field programmable gate array (FPGA) to perform all the direct upconversion/downconversion (DUC/DDC) and digital signal processing (DSP) functions. In the 7000DLE MKII, it is an Orion II board.
4) The SDR firmware for the digital board (*Metis*).
5) The SDR software for the personal computer (*Thetis*).

Apache Labs manufactures the transceiver hardware, but open-source developers create the firmware and

software, which is freely available for anyone to use or adapt. The firmware is specific to the digital board used in the transceiver, with versions called Hermes, Angelia, Orion, and so on. The software is common to all the ANAN series transceivers. This article will focus on improvements in the hardware with the ANAN-7000DLE MKII and the Protocol 2 software/firmware.

Hardware Installation

The ANAN-7000DLE MKII requires a user-supplied monitor (HDMI) and USB keyboard and mouse for operation with the internal PC module. I used a wireless keyboard/mouse for testing, but wired units will work fine too. A USB hub may be required if additional USB devices are used. It is too bad that a front-panel USB jack is not available for USB thumb drives, but a USB hub or extension cable will solve that.

The ANAN-7000DLE MKII front panel has stereo ¼-inch jacks for headphones, a CW key, and a microphone. The microphone jack tip and ring are configurable in software for audio or push-to-talk (PTT). Bias for an electret mic is also configurable in software. The microphone, headphone, and key jacks are mirrored on the rear panel with ⅛-inch phone jacks. Bluetooth capability opens the possibility of a wireless headset.

The rear panel (see Figure 1) is quite a bit busier. The radio requires 13.8 V dc at about 20 A, supplied via Anderson Powerpole connectors. (Note that the Powerpole orientation is backward compared to typical usage in the US.) There are BNC connectors for three antennas, a separate receive antenna, and a transverter input. The SMA connectors are for a 10 MHz reference input, a transverter output, and a Wi-Fi antenna (not supplied). There are also two ethernet jacks (SDR LAN and PC LAN), two USB-B and one USB-C ports, an HDMI jack for the monitor, speaker and audio input jacks, and PTT and CW key jacks. The speaker jacks are wired as balanced, tip to ring, with no ground to the sleeve. The embedded PC has a four-conductor headset connector for stereo audio out and monaural microphone in, similar to many laptop computers.

Figure 1 — The ANAN-7000DLE MKII's rear panel.

Controlling External Devices

Seven open-collector outputs available via the rear-panel DB-9 connector are configured using the transverters (XVTRS) and open collector (OC) setup tabs. The transverter local oscillator (LO) frequency offset and error can be programmed in, as well as the drive power required, and control of the transverter output and internal power amplifier. With external transverters connected and configured, your ANAN transceiver can act like a single transceiver from HF through VHF/UHF/microwaves.

The open collector outputs can be used for switching antennas, filters, and other external equipment. With one-hot wiring, seven different options can be selected or deselected. With binary decoding, up to 128 options can be selected. The latest *Thetis* software has separate setup forms for HF, VHF, and SWL bands.

Hardware Knobs, Sliders, and Buttons

The *Thetis* software has a configuration interface to use MIDI devices, such as the Hercules DJ controller series to make knobs, tuning wheels, sliders, and buttons available for those who prefer traditional front-panel controls. As a longtime ANAN SDR owner, I find a hardware controller very helpful for tuning frequency and for setting AF gain, AGC, and drive levels. Over the years, I have become more accustomed to using the on-screen controls for most everything else.

Network Installation

A number of network connection possibilities exist with this system. An air-gapped (standalone) system can be implemented, but wired and Wi-Fi connections to a local area network can be set up as well. The ANAN-7000DLE MKII can also be controlled by an external PC instead of the internal embedded PC, just like the other ANAN transceivers.

An air-gapped system with no connection to the outside world is of interest to Military Auxiliary Radio System (MARS) operators who may need additional security from internet intruders. A USB drive would be needed to install additional software or transfer files.

The 7000DLE internal PC can be connected to a LAN (and the internet) via Wi-Fi, and it can be accessed by other equipment if necessary. The computer would have two IP addresses, Automatic Private IP Addressing (APIPA) for the radio and computer ethernet, and a DHCP or static address for the Wi-Fi router. Use of Wi-Fi requires an external SMA antenna (not supplied, but readily available). If security is a concern,

Wi-Fi can be set up temporarily to facilitate software installation and updates, and then disabled to maintain air gap.

Bandwidth may be limited with Wi-Fi, but the 7000DLE can be hardwired to a router via the rear-panel ethernet jack. The radio and/or the computer can be set up with DHCP or static IP addresses as needed. It is possible to control the radio with an external computer instead of the internal CPU in the radio chassis with this arrangement. The external computer would be plugged into the ethernet switch along with the internal CPU and the radio.

The Software

The Apache Labs ANAN-7000DLE MKII comes with operating software and firmware already installed and configured, so further installation is not required. Because updates are made frequently, it's highly recommended that you check for the latest release online at **github.com/TAPR/OpenHPSDR-PowerSDR/releases**. Protocol 1 is the *PowerSDR OpenHPSDR mRX* software. Protocol 2 is for the latest *Thetis* software and *Metis* firmware, which we used for this review.

The display and controls for *Thetis* have not changed much from *PowerSDR OpenHPSDR mRX* software (see Figure 2). There are the usual panadapter/panafall/spectrum display, frequency and mode fields, and buttons and slider controls that drive the behavior of the unit. There are a number of setup tabs to configure less-often-used settings and controls. The main setup screen is shown in Figure 3, and details may be found in the user manual available online.

The signal display shown in Figure 4 is set up as a *panafall*, a combination of panadapter and waterfall, for both receivers. The panadapter shows the current spectrum occupancy, while the waterfall shows the spectrum occupancy over the last few seconds.

The frequency display shows both receivers, along with the transmit frequency when in split mode. It is possible to tune the radio by clicking on the pan-

Figure 2 — The main operating screen for the *Thetis* software.

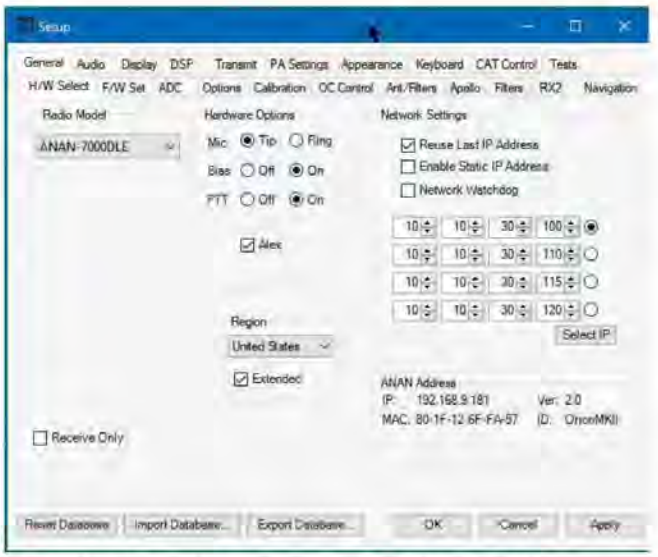


Figure 3 — The main setup screen for configuration of many hardware and software options.

adapter, using the mouse thumbwheel, or entering the frequency using the keyboard. You can drag the filter edges to change bandwidth.

The meter displays are very nice. The S-meter shows signal level in dBm as well as S-units (S-9 = –73 dBm, scaling is 6 dB per S-unit). I like the split power/SWR meter that shows forward power in watts and SWR simultaneously.

The Operational Status section of the main screen shows band, mode, DSP functions, levels, and other parameters. There is a mode specific section with controls relevant to the current emission mode. Memory channels can be given group and channel names.

Thetis DSP Features

The *Thetis* software offers a number of standard DSP features. The traditional noise reduction (NR) uses a standard algorithm. The advanced noise reduction algorithm (NR2) is really outstanding. It makes SSB sound like FM, and it plays well with digital modes, including FT8 and MIL-STD-188-M110a waveforms used in MARS.

The spectral noise blanker (SNB) causes signals to pop out of the background noise, while the automatic notch filter (ANF) effectively eliminates annoying heterodynes and carriers. The multi-notch filter (MNF) will attack multiple heterodynes. The CW audio peak filter (APF) offers additional filtering in the audio subsystem.

Audio equalizers are available for receive and transmit. Transmit bandwidth can be set up to 10 kHz for AM

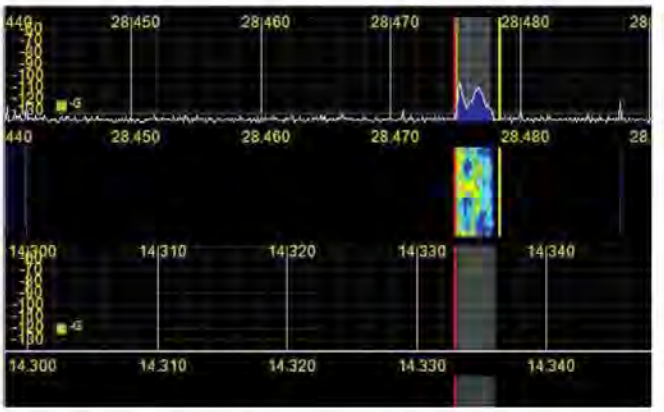


Figure 4 — A portion of the spectrum display in the panafall mode.

afficionados. The advanced continuous frequency compression (CFC) and controlled envelope single sideband (CESSB) processing features allow you to get that AM broadcast quality sound. Audio profiles can store settings for various activities, such as general conversation or contesting.

PowerSDR and *Thetis* have a feature where both VFOs are synchronized to the same frequency and phase locked. If receivers RX1 and RX2 are connected to separate analog-to-digital converters (ADCs) and each ADC is connected to a different antenna, the phase and amplitude of each receiver can be adjusted to enhance desired signals or to cancel unwanted noise and interference.

In *Thetis*, if you right-click on certain controls, you are directly vectored to the tab for settings related to that control. This is very handy for mic gain, VOX, compression, transmit audio profiles, and other frequently used settings.

Thetis offers a lot of flexibility for recording and playing back signals off the air, so you can show others what they sound like rather than having to describe it in words. There is a provision for setting up scheduled recordings as well, for one-time-only or periodic recordings of your favorite shortwave broadcast or ham radio net.

CW QSK Operation

When used with *Thetis* software, the ANAN-7000DLE MKII has full-break-in CW (QSK), which earlier units did not have. The CW QSK is a great step forward for the Apache Labs ANAN series and requires some trial and error setting up the AGC parameters to let the receiver recover from the transmit signal quickly enough. Transmit-receive switching uses relays, and clicking is clearly audible.

I had an issue with QSK operation because the monitor (which tracks the transmit signal) cannot be shut off to hear just the sidetone (which tracks the keyer paddle). As with other SDRs, there is a bit of latency — a slight delay — between the keyer paddle action and the transmitted signal, which is heard in the monitor. The delay is present even with low-latency filter settings. For some reason, you cannot disable the monitor (with latency) and only use the sidetone (no latency). I found it difficult to send without the proper audio feedback while using CW keyer paddles. If sending with keyer memories or a keyboard, this is not as important. I wish there were separate slider controls for monitor level and sidetone level, independent of the master AF gain.

On the Air

I had the luxury of spending quite a while using the ANAN-7000DLE MKII on the air. I used a wide variety of bands and modes, including many digital soundcard modes, such as PSK, RTTY, FT8, and MIL-STD-M110a. I got excellent signal and audio reports across the board.

The unit worked well on MARS frequencies, which are outside the normal ham bands. You need to use the **EXTENDED REGION** in the main setup tab to enable transmission on the MARS frequencies. (Watch the band edges if you operate with this feature enabled.)

The receiver is at least as sensitive as any of my other transceivers, and perhaps more sensitive on 6 meters. It receives better and copies digital transmissions better than any of my other transceivers. The laboratory results show that receiver performance is competitive, and the transmit IMD with Pure Signal enabled is second to none.

Conclusions

The Apache Labs ANAN-7000DLE MKII is the next refinement in a now mature SDR technology available from Apache Labs. I have an Apache Labs ANAN-100D that I acquired in 2014, and I can say the ANAN-7000DLE MKII is a noticeable improvement. This is a great radio. My only issue with it is the behavior of the sidetone and transmit monitor during QSK CW operation, as discussed.

Additional information and screen captures are available from **www.arrl.org/qst-in-depth**.

Manufacturer: Apache Labs Pty Ltd., 3 Pershing Way, Point Cook, VIC 3030, Australia; **www.apache-labs.com**. Available direct or from Ham Radio Outlet. Price: $4,295. With i5 CPU, $3,995. No CPU (Black Edition), $2,795.

tinySA — A Small Spectrum Analyzer

Reviewed by Phil Salas, AD5X
ad5x@arrl.net

In recent years, a number of inexpensive RF test devices have come on the market. The latest is the tinySA, a small spectrum analyzer with a 2.8-inch, 320 × 240 pixel color touchscreen. This $49 spectrum analyzer was developed by Erik Kaashoek, PD0EK, and is manufactured and distributed by Hugen. The tinySA looks like the nanoVNA I reviewed in the May 2020 issue of *QST*.

Description

The tinySA comes in a nice box and includes a small telescoping antenna, two 8-inch SMA-to-SMA test cables, an SMA-female-to-SMA-female adapter, a USB cable for charging the internal battery and for computer interfacing, and a carrying strap with a guitar-pick stylus (see Figure 5). The spectrum analyzer

Bottom Line

At about $50, the tinySA can put a surprisingly capable spectrum analyzer into the hands of many STEM students and home experimenters.

Figure 5 — The tinySA accessories.

has two inputs: a high-quality input covering 0.1 – 350 MHz, and a low-quality input that covers 240 – 960 MHz. Resolution bandwidth filters are manually selectable and automatically selectable from 2.6 kHz to 640 kHz for both input ranges. There is an accurate 0 – 31 dB input step attenuator for the 0.1 – 350 MHz input. The 240 – 960 MHz input has very limited image suppression, and its input attenuator is frequency dependent and varies from 25 – 40 dB.

As with any spectrum analyzer, to use this device, you will need some type of sampler or attenuator to reduce the signal to be measured to a very low level to avoid damaging the tinySA. The specified absolute maximum input level is +10 dBm (10 mW) with 0 dB of internal attenuation, and the maximum short-term input power is +20 dBm (100 mW) with 30 dB of internal attenuation. The specs also suggest keeping input power below –25 dBm for best measurement accuracy.

The tinySA has a built-in calibration signal generator for automatic self-test and low-frequency input range calibration. It can also be used as a signal generator for receiver alignment, with a sine wave output from 0.1 – 350 MHz, and a square wave output from 240 – 960 MHz. These output signals can be modulated for internal or external amplitude and frequency. You can even turn on a waterfall display to monitor a selected frequency range.

Finally, the tinySA can be connected to a computer for software updates. There is also computer interface software available that permits some screen captures, but this software was pretty minimal at the time of this review. The tinySA specifications are given in Table 2.

Table 2
tinySA Key Specifications

General Specifications
Manually selectable resolution bandwidth filters: 3, 10, 30, 100, 300, 600 kHz
Absolute power level accuracy after calibration: ±1 dB
Absolute maximum input level: +10 dBm with 0 dB internal attenuation
Maximum short term input power: +20 dBm with 30 dB internal attenuation
Suggested maximum input power: +5 dBm with internal attenuation in automatic mode
For best measurements keep input power below –25 dBm

Low-Frequency Input Specifications
Input frequency range: 100 kHz – 350 MHz (down to 10 kHz with reduced sensitivity)
1 dB compression point: +2 dBm with 0 dB internal attenuation
Lowest discernible signal when using 30 kHz resolution bandwidth: –102 dBm
Spur free dynamic range when using 30 kHz resolution bandwidth: 70 dB

Low-Frequency Signal Generator
Frequency range: 100 kHz to 350 MHz; selectable in 1 dB steps from –76 to –6 dBm
Sine wave output: Harmonics > –40 dBc
Modulation: AM, NBFM and WBFM, or slow sweep over selectable frequency span

High-Frequency Input Specifications
Input frequency range: 240 MHz to 960 MHz
Input impedance: Frequency dependent and deviates from 50 W
1 dB compression point: –6 dBm with no internal attenuation
Lowest discernible signal when using a resolution bandwidth of 30 kHz: –115 dBm
Spur free dynamic range when using a 30 kHz resolution bandwidth: 50 dB
Input attenuator: 25 – 40 dB, frequency dependent. Increases power level error ±10 dB
Note: Strong signals outside the 240 – 960 MHz range can cause distortion of signals

High-Frequency Signal Generator
Frequency range: 240 MHz to 960 MHz, in variable increments from –38 to +13 dBm
Modulation: NBFM and WBFM, or slow sweep over selectable frequency span

Reference Generator
Optional square wave output from **HIGH** SMA jack with –25 dBm fundamental
Frequency: 1, 2, 4, 10, 15, or 30 MHz.
See **www.arrl.org/qst-in-depth** for additional specifications.

Using the tinySA

I recommend joining the tinySA user group at **groups.io/g/tinysa**. Another important link is the tinySA wiki at **tinysa.org/wiki**. On this site, you can find a preliminary manual, firmware update information, and the Windows interface software.

Along the top side of the nanoVNA are a USB-C interface, a red charging LED indicator, an **ON/OFF** switch, a flashing blue operating LED, and a momentary rocker/pushbutton switch that's used for adjustments. Before using the tinySA for the first time, charge the unit with the supplied USB cable. The red charging LED turns off when the tinySA's battery is fully charged. Battery charge time is specified at 1 hour with a 500 mA minimum USB charger. A full charge provides about 2 hours of operation.

I suggest that you not attach any large coaxial adapters directly to the tinySA's SMA connectors. Always use the sup-

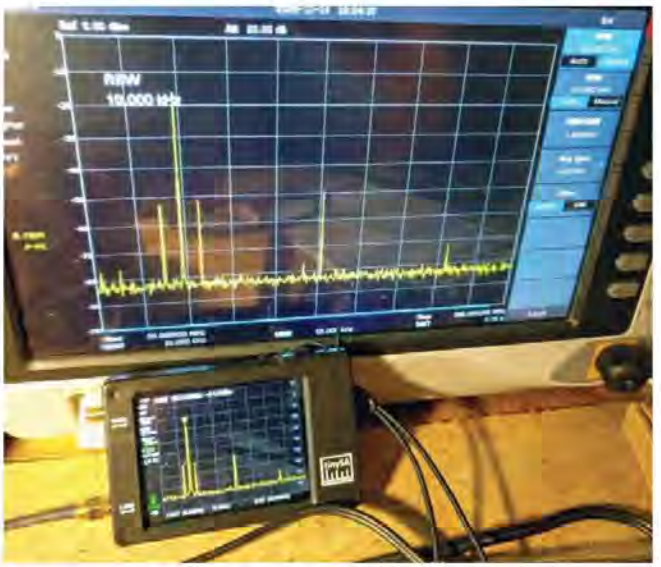


Figure 6 — The spectral output of a 6-meter transverter observed on the tinySA and a Siglent SSA3021X.

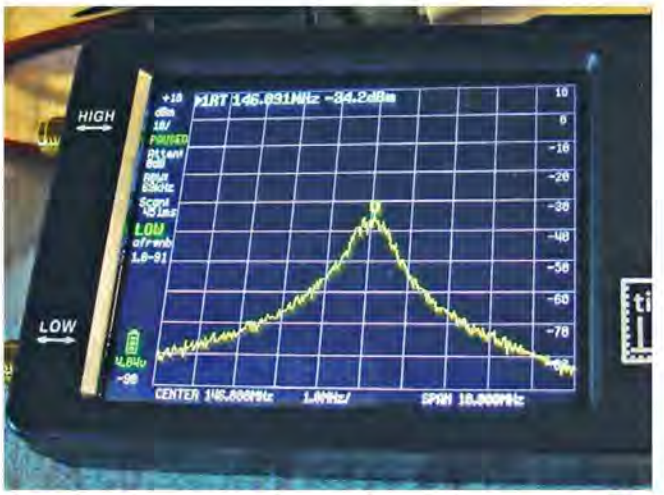


Figure 7 — A broadband noise source can be used to measure a filter's response.

plied 8-inch SMA-to-SMA cables. In order to interface with more common connectors, you can purchase SMA-to-N, SMA-to-SO-239, and SMA-to-BNC adapters — all readily available online. Further, because SMA connectors are specified for 500 mate/unmate operations, you may want to attach SMA-male-to-SMA-female adapters to the tinySA ports to protect the original SMA connectors.

Displaying Signals

I started by first connecting the supplied telescopic whip antenna to the 0.1 – 350 MHz input, as this is the default input and sweep range. It is interesting to see all the RF signals in this range. The 88 – 108 MHz broadcast spectrum is quite packed with visible signals — at least at my location. One default marker automatically finds the highest signal and reads out the signal's frequency and level (up to four markers are available). Touching the screen with your preferred stylus brings up the menu. While the tinySA screen is quite small, the supplied guitar pick stylus on the wrist strap works well. The rocker/pushbutton switch can also be used, especially for ease in moving the markers on the screen. But I prefer the touchscreen for the settings and menu selections.

When using the tinySA for the first time, the Self Test should be performed. This is accomplished by connecting the high and low connectors together with one of the supplied SMA cables. Click on the screen, select **CONFIG** and then **SELF TEST**. When these tests are complete, select **CONFIG**, **LEVEL CAL,** and then **CALIBRATE**. Once complete, this procedure results in measurement accuracy of 1 dB over the entire frequency range.

As I have a Siglent SSA3021X benchtop spectrum analyzer, I wanted to see how the tinySA compared. My first test involved a 28-to-50 MHz transverter with 10 W output. Figure 6 shows the transverter's output spectrum on both the tinySA and the SSA3021X up to the third harmonic of the transverter. Part 97 of the FCC rules requires that amateur radio transmitters from 30 – 225 MHz with a mean power of 25 W or less must attenuate any spurious emissions at least 40 dB below the mean power of the fundamental emission. As you can see in Figure 6, there is excellent agreement between the tinySA and the Siglent SSA3021X. Both devices show that the transverter's ±6 MHz spurs and the second harmonic (–37 dBc and –35 dBc, respectively) do not meet FCC requirements, and so this device requires an external band-pass filter of some sort to be used by US amateurs.

Another important test is the two-tone intermodulation distortion (IMD) performance of transmitters and amplifiers. Unfortunately, with the tinySA's minimum resolution bandwidth (RBW) of 2.7 kHz, it is impossible to display the desired spectral detail for the typical amateur SSB tests with audio tones of about 700 and 1900 Hz. (The ARRL Lab uses an RBW of 10 Hz when performing these tests.) I did look at a 10 kHz bandwidth AM signal at 50 MHz, where the 2.7 kHz resolution bandwidth does permit looking at the modulated spectrum and found that the tinySA did not properly display the AM signal. The sideband levels are incorrect, and the tinySA shows many other close-in sidebands that don't show up on the SSA3021X. (See **www.arrl.org/qst-in-depth** for a photo showing the comparison.)

Signal Generator

Next, I did some spot tests on the tinySA's signal generator output capability. I found the 0.1 – 350 MHz output to be a clean sine wave with harmonics greater than 50 dB down. Also, the output level tracked within 0.6 dB of the set level across the frequency range as measured with my calibrated Mini-Circuits power meter. As specified, the 240 – 960 MHz output is not a sine wave, and second and third harmonic outputs are about 10 – 12 dB down. The output level for this frequency range measured about 2 dB higher than the actual output setting.

Finally, I looked at the ability to tune filters with the tinySA. While the tinySA does not have a tracking generator, you can feed the output of an inexpensive broadband noise source (available from online auction sites) through the filter into the tinySA. Figure 7 is the tinySA display of a 2-meter band-pass filter's response with a broadband noise input.

You can also use a noise source and a directional coupler to measure return loss. Used Mini-Circuits ZFDC-series directional couplers are often available inexpensively from online auction sites. A block diagram and more information on performing this test are available from **www.arrl.org/qst-in-depth**.

Final Thoughts

At a price of $50, you can certainly find some uses for the tinySA in your station. With an appropriate sampler or attenuators, it is great for looking at spurious and harmonic performance of transmitters, transverters, and amplifiers. It can help to find unknown signals at your location. It can be used as a signal source for receiver alignment. And finally, with some inexpensive additional components, it can be used for filter design. Check out the tinySA Wiki (**www.tinysa.org/wiki/**) for more details on this device.

The review unit was purchased from R&L Electronics (**www.randl.com**) for $49. Check the Where to Buy link at **www.tinysa.org** for vendors in other countries.

MFJ-2010 Off-Center-Fed Dipole Antenna

Reviewed by Steve Ford, WB8IMY
wb8imy@arrl.net

There are several ways to get multiband performance from an HF dipole antenna. You can break up the antenna (electrically speaking) with traps, add more wires in parallel, or just feed the dipole with balanced feed line, such as window line and a balanced antenna tuner.

The off-center-fed (OCF) dipole design takes a different approach. Instead of feeding the dipole at the center (where the impedance is approximately 70 Ω) the OCF dipole moves the feed point off center. By doing so, it is possible to find a point where the impedance can be matched to 50 Ω coaxial cable through a 4:1 current balun. When fed in this fashion, the antenna will provide a low SWR at the lowest design frequency, as well as at frequencies on several higher bands.

Bottom Line

The MFJ-2010 off-center-fed dipole offers single-feed line operation on 40, 20, 10, and 6 meters at up to 300 W PEP (150 W continuous). Depending on your installation, an antenna tuner may be required for full-band coverage.

So if all goes as planned, what was formerly a single-band dipole becomes a multiband dipole.

The MFJ-2010 is an OCF dipole designed for use on 40, 20, 10, and 6 meters. Built with #14 AWG stranded copper wire, it is 67 feet long and rated for 300 W PEP (150 W continuous).

Installation and Tuning

The MFJ-2010 arrives preassembled. All you have to do is clip off the tie wraps and uncoil the wires (see Figure 8). The feed point balun is housed within a small, black ABS plastic enclosure with an SO-239 coaxial cable connector underneath (see Figure 9).

Figure 8 — The MFJ-2010, unpacked and ready to install.

Table 3
MFJ-2010 OCF Dipole in a Low-Height, Sloping Configuration

Frequency (MHz)	SWR	Frequency (MHz)	SWR
7.000	1.2:1	28.000	2:1
7.300	1.6:1	28.400	1.4:1
		29.700	1.9:1
14.000	1.8:1		
14.350	1.6:1	50.000	2.5:1
		50.500	1.9:1
		52.500	2.9:1

The end insulators are flat rectangles of flexible plastic, although they seemed remarkably strong.

The feed point is about 20 feet from one end of the antenna, which worked out well for me, because it meant the coax could drop directly to the cable entrance for my station without taking detours in various directions. An OCF dipole isn't necessarily designed for physical convenience like this, but sometimes the off-center arrangement comes in handy.

MFJ recommends installing the antenna with the feed point at a height of at least 35 feet. Because I didn't have two worthy supports, I was forced to use a sloping configuration, which placed the feed point at about 20 feet and the lower end of the antenna at only 8 feet above ground. The high end of the dipole was at 40 feet.

This is far from ideal for an OCF dipole. As a result, my initial SWR measurements indicated that the low-SWR points were beyond the high-frequency ends of several bands. The exception was 40 meters, where the lowest SWR was measured at 7.200 MHz.

I added 12 inches of wire to the lower end of the antenna — the end I could reach easily — and was pleasantly surprised to see the SWR drop to acceptable levels within each band (see Table 3). By "acceptable," I mean less than 3:1. That's low enough for any decent antenna tuner to handle, including the one in my transceiver. If you're feeding the MFJ-2010 with low-loss coax, any additional loss caused by the elevated SWR is inconsequential. It's likely that if I had been able to install the antenna horizontally, and at the recommended height, no length adjustments for SWR would have been necessary.

In OCF dipoles, the quality of the feed-point balun is critical for efficient performance, and to keep RF off the feed line. I often operate with 100% duty-cycle modes, such as RTTY with my 100 W transceiver, and I didn't encounter a problem.

Figure 9 — The underside view of the feed point shows the balun assembly.

I ran initial tests with the WSPR digital mode and was pleased. The MFJ-2010 seemed to perform slightly better than the 40/20-meter dipole it replaced, but now I had 10- and 6-meter capability as well.

I used the antenna during the JARTS RTTY contest in October and was able to work any station I could hear. During the month, 6 meters opened for some weak contacts using FT8, and I managed to get several stations in the log without difficulty.

Just for fun, I attached my antenna analyzer to the feed line to see how the MFJ-2010 design responded to signals above 6 meters. I was surprised to discover that the antenna presented SWR below 2:1 across the entire 2-meter band. Because I was feeding the antenna with relatively small-diameter coax (LMR-240), the loss at this frequency was high, but the antenna was still usable. The addition of 2 meters may have been a side effect of my odd installation, but it was a nice bonus nonetheless.

Manufacturer: MFJ Enterprises, 300 Industrial Park Rd, Starkville, MS 39759; **www.mfjenterprises.com**. Price: $69.95

The Best of "The Doctor is In"

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

Q Riley, K4ZDH, asks: I'm considering a complete feed line replacement in the near future. I also have several routing options, some of which are short but more difficult to implement. I've generated a table showing the loss for a variety of transmission lines. In order to help me make the best feed line and routing decision, I've included maximum and minimum length and SWR for the bands I operate.

While it's been a revealing and helpful exercise, I can't help but wonder, is the impact of feed-line loss on transmit the same as it is on receive?

A There are a number of parts to this question. First, if the line is feeding terminations matched to its characteristic impedance (Z_0) at each end, the loss will be exactly the same in each direction. Note, though, that the *effect* of the loss may not be the same. On transmit any loss will result in a reduction of signal-to-noise ratio (S/N) at the far end. If you have 3 dB loss, for example, that means that your signal will be ½ an S-unit weaker in the other station's receiver. The impact on your received S/N is not quite as simple. If you are operating on a band on which you are atmospheric noise limited (typically 20 meters and lower frequencies), even though your S-meter will read ½ an S-unit lower, your S/N will be almost unchanged. This is because the loss will reduce the atmospheric noise by the same amount as the signal, keeping the S/N the same.

This is why small receiving antennas can be so effective on the lower frequency bands. On bands in which the receiver noise is the limiting factor, such as on VHF, UHF, and sometimes the higher frequency HF bands, both the S-meter and S/N will be reduced by transmission line loss. If you want to check which noise is most important at a particular time, switch the input between a dummy load and your matched antenna system. If the noise is much higher with the antenna, you are in atmospheric noise limited territory.

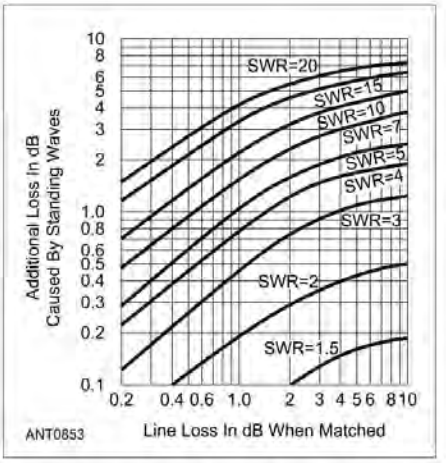


Figure 1 — Additional loss for mismatched transmission line. Note that the effect of mismatch is small if the matched loss is low, but lossy coax with high SWR makes for serious additional loss.

The mismatched case is somewhat more complicated. Most transmitters, either directly or through an antenna tuner, can drive mismatched antenna systems. The additional transmission line loss due to the mismatch will be higher with lossier transmission line, as shown in Figure 1. The total loss will reduce your transmitted signal, and thus your signal received at the far end.

While most transceivers are specified to have a nominal output impedance of 50 Ω, their receiver input impedance may not be exactly the same. That means that the SWR as seen on receive may be different. There will be two effects here. First, the impedance seen by the antenna on receive will not be matched, but will be the input impedance as transformed by the line. Unlike the transmitter end, the antenna will not deliver all of its received signal power to the line. In addition, the received signal will suffer the attenuation on the line due to its mismatch.

This effect may not be significant in most cases, but is something to consider. Again, in the atmospheric noise limited environment, reasonable loss will not impact received S/N. On the other hand, at VHF, the receive input impedance may be an important parameter.

Q Tomm, W2BFE, asks: As a holdover from the vacuum-tube era, I can understand operating various controls to match an antenna to a transmitter. One could use the receiver to tune for maximum noise or maximum signal strength to get a rough match. The final tune-up is then accomplished with low power applied to the antenna through the tuner. Now that we have automatic antenna tuners, the tuner sets its component parameters using a small amount of applied RF power to match the transceiver to the antenna. What if one only wants to listen? Can the intelligent tuner figure out what frequency a transceiver is tuned to?

A Some tuners can do exactly that, especially if they are designed to work with, and exchange information with, the connected radio. Of course, one problem with this approach is that it assumes that the tuner knows what to do at each frequency that the radio is set to. While this can be the case with frequencies across amateur bands that the tuner has adjusted to and memorized settings

for, generally it won't help with frequencies that haven't been transmitted on, such as in shortwave broadcast bands.

Some other "auto" tuners allow manual setting of L and C values independent of transmit power. This can be used to peak the signal, just as with a manual tuner. The settings are usually shown so they can be set in again the next time.

Note that in many cases on HF, the S/N is limited by atmospheric noise. Thus, if a tuner is not optimally tuned, or even if bypassed, the receive S/N may stay the same, making tuner settings less important. As the frequency gets higher (typically above the 15 to 20 MHz range) with mismatched antennas, a properly adjusted tuner is more likely to be of benefit on reception.

Q John, AJ4US, asks: I plan on installing separate 2-meter and 70-centimeter ¼-wave groundplane antennas in the attic to replace my dual-band vertical. They will be fed from a diplexer, because I only have one coax run going up to the attic. I use a diplexer at the shack end because my rig has separate connectors for the VHF and UHF antennas (see Figure 2). The maximum power on either band will be 50 W. I need to change to separate antennas because I plan to install an RF switched preamp in the line connected to the 70-centimeter antenna. I also plan on using snap-on ferrite cores (mix 43) on the coax cable at each antenna connection to act as common-mode chokes.

I have two questions. First, how far apart should the antennas be to prevent interaction?

Second, how many ferrite cores would be required at each antenna to effectively choke off common-mode current?

A Each diplexer will introduce about 0.5 dB loss, so having the preamp between the antenna and the first one will significantly reduce the loss of sensitivity due to both the diplexers and the coax loss — a good idea if you will be dealing with marginal signals, or have a long coax run.

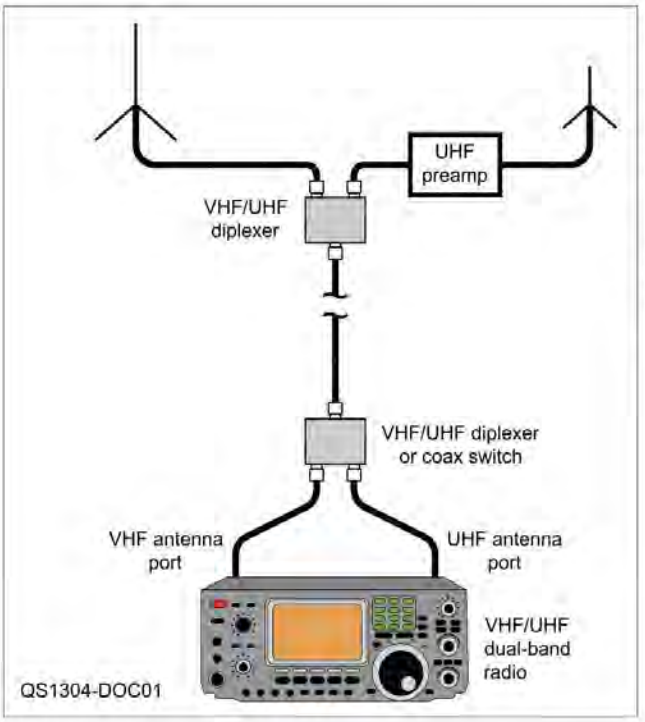


Figure 2 — Configuration of VHF and UHF antennas sharing a common feed line. It is important that they be separated enough so that the receiving equipment is not damaged by coupled RF. As discussed, having a switch instead of a diplexer at the radio end avoids the problem for the transceiver.

The biggest coupled signal will likely be the pickup of the 70-centimeter energy by the 2-meter antenna, since the 2-meter ground plane will act very much like a 3/2-wave monopole on 70 centimeters.

If you look at the "Doctor" column from November 2011 (available on the *QST* web archive), you will see the measured coupling between a pair of 2-meter antennas and a discussion of the possible effects on the non-transmitting radio. The key interaction I would be concerned with is that the non-transmitting radio could be damaged by excessive RF from the one transmitting.

Based on the data in that column, I would think about 20 feet would be safe, but we don't know for sure how susceptible your radio is. I would also remove power from your 70-centimeter preamp while using 2 meters, because equipment is more likely to be damaged while powered on. Of course, with a dual-band radio, you can't power down the part you aren't using.

One thing you could do is use an RF switch instead of the diplexer at the radio end. They cost about the same as a diplexer and have less insertion loss. Of course, if you want to monitor both bands at once, that won't work.

Regarding the balun, or really choke, a few beads should be enough. Actually, if the coax drops straight down from the ground plane, there shouldn't be much common-mode signal, but there will be some, and three should be plenty.

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**.

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Hints & Hacks

Meter Stands, Making Connectors for Old Gear, a Tool to Measure Battery Current, and More

A D-104 Mic Adapter

When it came time to connect my venerable Astatic D-104 microphone to my newly acquired Knight T-150 transceiver, the thought of changing the mic's four-pin connector to a standard ¼-inch plug required by the T-150 gave me pause. If I wanted to switch the D-104 back to my other rig, I would have to pull out the soldering iron and replace the four-pin connector. This prompted me to come up with a quick modification.

A quick check with the ohmmeter revealed which of the four pins was audio and which was ground. Looking at the D-104 plug from the female pin end, I noticed a notch. The pins are numbered clockwise from that notch, 1 through 4.

I cut an old mini banana plug cable in half. I inserted one banana plug into Pin 1 (mic audio) and soldered it to the "tip" contact on the ¼-inch mic plug. Then I inserted a second banana plug in Pin 4 (audio ground) and soldered it to the "sleeve" contact. Pins 2 and 3 are not used (see Figure 1). Now I can easily get the excellent D-104 audio on either of my rigs with just a quick swap of the adapter. — *73, Barry Fox, W1HFN,* **w1hfn@arrl.net**

Figure 1 — This simple adapter can be used to connect a multi-pin female audio connector to a ¼-inch phone plug. [Barry Fox, W1HFN, photo]

DIY Meter Stand

I have several digital multimeters that I'm constantly propping up, only to have them tumble off again. I decided to make a small stand for the meter, which solved my problem.

I wanted to make the stand foldable for storage. The viewing angle is set at 60 degrees. The stand consists of the following components (note that the base and support were made from scrap wood): base (½ × 3 × 5 inches); metal cabinet hinge (2½ inches); metal strap hinge (3 inches), and the meter support (½ × 3 × 6 inches). I nailed three small side pieces made from a paint-stirring stick to the support with ½-inch carpet nails.

I connected the support plate to the base using the metal cabinet hinge (see Figure 2). I used a round file to make a small notch to cradle the hinge pin, so the hinge lays flat on the base.

I used a small 3-inch strap hinge to hold the meter support plate at a 60-degree angle. I cut one end off and put a small bend in the other end to align with the angle. This hinge is installed so that the hinge strap is at 90 degrees to the base plate when the meter support is at 60 degrees.

Figure 2 — A rear view of the meter stand showing the support hinge.

Figure 3 — The finished stand supports a lightweight meter and folds up for storage.

I installed a small stop screw in the back of the support plate to set the angle. Note that the head of the screw may have to be filed down to a diameter that will easily enter the hole in the hinge strap. The finished stand is shown in Figure 3.

Because most multimeters are lightweight, I secured the meter to the support plate to avoid pulling it off the stand using a rubber band. Hook-and-loop fasteners or glue-on magnets may be other options. — *73, Michael Janis, KE3OQ,* **mjanis@ptd.net**

Vintage VFO Connector

Years ago, many of the popular outboard VFOs were supplied with adapter cables that plugged directly into an FT-243 crystal socket. You could also use the Mosley 301 twin-lead connectors that were a close fit. Sadly, the supply of both of those connectors has vanished. You can sacrifice an old FT-243 crystal to make the connector, but even those aren't always available from the junkbox.

I realized that there are Molex connectors available with 0.093 pins and I wondered if those might be pressed into service. I picked up some Molex 02-09-2118 male crimp pins and put together the cable end shown in Figure 4 for use with my Heathkit HG-10 VFO. It worked perfectly; the pins have good tension and stay securely in the socket. I just pinched the crimp ears with pliers and applied dabs of solder and a little shrink tubing. It took all of 10 minutes.

The 02-09-2118 pins are available from Digi-Key, Mouser Electronics, and many other vendors. Pricing is about $3 for 25 pins. — *73, Andrew Jarosik, K1APJ,* **k1apj@arrl.net**

Easier PL-259s

When installing PL-259 connectors on coaxial cable, it's often difficult to screw the shell onto the outer jacket. Next time, try wrapping Teflon tape on the cable first. Not only does this make putting the connector on easier, it also helps seal the connector against moisture. I find that it takes less than half the effort to install the connectors this way. — *73, Michael Melnyk, Jr., KD4KWP (SK)*

Center Pin Stabilizer

Pre-tinning the center pins of coaxial connectors can be a hassle. Instead, next time you open a bottle of wine, save the cork and cut it to a stable size. Insert the center pin and you have a stable, and somewhat insulated, cork base to perform any pre-soldering activities (see Figure 5). When attaching to the coax itself, the cork does not pull heat away from the pin like metallic pliers, so soldering takes less heat, which can also prevent melting of the heat-sensitive dielectric material. — *73, Al Rabassa, NW2M,* **nw2m@arrl.net**

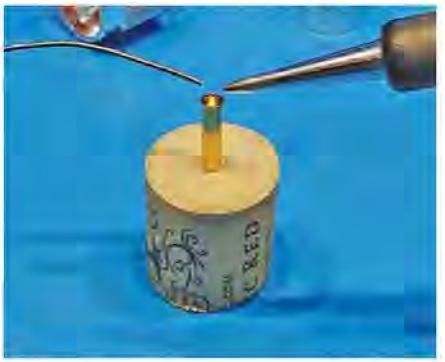

Figure 5 — Insert the center pin and you have a stable cork base to perform any pre-soldering activities. [Al Rabassa, NW2M, photo]

Figure 6 — Make a tool to measure battery current draw with a 1 × 2 inch double-sided printed circuit board and two banana backs. [Bob Tait, VK3XP, photo]

Measuring Current Draw in Battery-Powered Gear

I came up with this solution to prevent frustration when trying to hold the probes of my multimeter while testing current drawn by battery-operated equipment. Take a piece of double-sided printed circuit board and solder two banana jacks, one to each side, as shown in Figure 6. To measure the current draw, detach one battery terminal from the device, insert the board, and then move the battery back into position to apply pressure and make solid contact with both sides of the board. In the case of series batteries, spread one of the batteries apart from its neighbor and insert the board between them. Now connect your multimeter probes to the banana jacks and measure the current flow. — *73, Bob Tait, VK3XP,* **vk3xp@internode.on.net**

Figure 4 — A cable end for connecting a Heathkit HG-10 VFO made from Molex 02-09-2118 connector pins. [Andrew Jarosik, K1APJ, photo]

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

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

About High-Voltage Safety

Ward Silver, NØAX

For this article, I am considering any voltage high enough to pose a shock hazard to be "high voltage." The hazard from high voltage is created by current flowing through the body. If you can prevent current flow, you can prevent the shock hazard as well.

The path the current takes is also important. If the current path is from a fingertip through, say, your elbow, it will hurt, your arm muscles may contract suddenly (they'll be sore later, too), and you may have burn marks. More serious, though, is any path through or near your heart. For example, hand-to-hand or hand-to-foot current can cause your heart to stop entirely or go into fibrillation (uncoordinated muscle activity), either of which is frequently fatal.

Under unusual circumstances, voltages as low as 50 V can result in enough current through a human being to be hazardous — it only takes 5 mA on average to create the sensation of a shock with accompanying muscle movements (see Table 1). The most common hazardous voltage, though, is encountered in the familiar household ac outlet: "120 VAC RMS" translates to a peak voltage of about 170 V — clearly hazardous. If you've had a shock from ac line voltage, you know it's painful. Two hundred forty volts ac, as is used by amplifiers or the higher dc voltages in tube equipment, are even more serious. These voltages can be lethal.

At some point, your station may include a piece of vacuum-tube gear. Perhaps you'll add an amplifier for a stronger signal or maybe you'll acquire a taste for rebuilding vintage equipment. Either way, inside the cabinet you'll encounter voltages a lot higher than the usual 12 V dc that runs most transceivers and other ham electronics. These voltages pose risks, but by following some simple rules and maintaining a cautious approach, you can work safely.

Take Note and Stay Safe

Meter Voltage Ratings

Voltmeters themselves can be a source of danger. A maximum voltage rating is printed on your meter (see Figure 1). Heed it! That is the maximum voltage the probes, connectors, and body of the meter can withstand. A higher voltage may cause a flashover from the wiring to anything touching the case, such as your hand. Electrocution caused by using meters beyond their voltage rating happens regularly. In the photo, note that the probe connectors are recessed for extra insulation — use the right probes for the full rating.

Figure 1 — Voltage ratings are shown next to a voltmeter's probe jacks (1,000 V dc and 750 V ac). Exceeding these voltages can result in a flashover, presenting a severe electrocution hazard.

Table 1 — Effects of Electric Current in the Human Body

Current	Reaction
Below 1 milliampere	Generally not perceptible
1 milliampere	Faint tingle
5 milliamperes	Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
6 – 25 milliamperes (women) 9 – 30 milliamperes (men)	Painful shock, loss of muscular control*; the freezing current or "can't let go" range.
50 – 150 milliamperes	Extreme pain, respiratory arrest, severe muscular contractions. Death is possible.
1,000 – 4,300 milliamperes	Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death likely.
10,000 milliamperes	Cardiac arrest, severe burns; death probable

*If the extensor muscles are excited by the shock, the person may be thrown away from the power source.
Source: W.B. Kouwenhoven, "Human Safety and Electric Shock," Electrical Safety Practices, Monograph, 112, Instrument Society of America, p. 93. November 1968.

Use a special high-voltage probe, such as the Fluke 80K-40 or B&K HV44-A, for measuring the multi-kilovolt voltages found in vacuum-tube RF amplifiers.

Hams don't seem to throw anything away, especially test instruments and accessories. In the world of high voltage, this can be dangerous. As probes, test leads, fixtures, and connectors age, their insulation can become brittle and crack. That compromises the insulation, and you can even come in direct contact with the internal wires. Before beginning to work on a piece of equipment using high voltage, carefully inspect your test probes and other equipment. Make sure the insulation is clean, flexible, and not scuffed or cracked so it can protect you as you expect. Replace anything that doesn't look safe.

Interlocks

Interlocks are mechanical contacts that remove power from or discharge high-voltage circuits when a protective enclosure is opened. A common style of interlock allows a spring-loaded ground strap to contact the high-voltage power supply output when an enclosure cover or door is opened. Another type of interlock is a switch that removes ac input power when a protective cover is removed.

Unless specifically instructed by the manufacturer's procedures to do so, never bypass an interlock. This is rarely required except in troubleshooting, and should only be done when absolutely necessary. Interlocks are there to protect you.

Isolation Transformers

It was once common for vintage equipment, particularly smaller receivers, to have the internal metal chassis connected to one side of the ac line. The chassis was insulated by a plastic or wooden enclosure and knobs. When out of the enclosure for repair or alignment, the "live" chassis can be quite hazardous!

To prevent coming into contact with the ac line, an isolation transformer is used. The primary is connected to the ac line and the secondary to the equipment being worked on. If you plan on working on a lot of old equipment, an isolation transformer is a good purchase and should have a power rating in VA (volt-amps) at least 50% higher than the equipment requires. Note that most variable ac autotransformers, also known by the trade name "Variacs," are *not* isolation transformers.

AC Line-Rated Capacitors

Some equipment has capacitors connected directly to the ac line for RF filtering. These must be X- and Y-type ac safety-rated components. X capacitors are connected from line to line and Y capacitors are connected from line to ground. (See **www.tecategroup.com/products/capacitors/ac-safety-capacitors.php** for an overview of these capacitors.) These capacitors are specially constructed to minimize fire or shock hazards.

Pay attention to which electrode is closest to the outside of the capacitor's insulation. This is often marked

Is Static Electricity Dangerous?

Static electricity, measured in kilovolts, doesn't present a direct hazard to humans, but it can pack enough punch to destroy sensitive electronics and upset the operation of equipment. Static-discharge equipment is not expensive, and it's a good idea to use it in your workshop and when working on equipment.

with a line on the capacitor's body. This is important because many capacitors are connected with one electrode tied to circuit common or chassis ground. If the capacitor fails shorted, connecting the outer electrode to the lower voltage point reduces the safety hazard.

Safety Rules

Hams and electronic techs have developed some simple guidelines for avoiding shock hazards. If you learn and follow the rules of working around hazardous voltages, you will avoid and reduce the hazards so you can work safely. If you aren't used to these techniques, it's a good idea to begin by working under the supervision and guidance of someone with experience.

- Keep one hand in your pocket or behind your back whenever adjusting or measuring equipment containing a voltage high enough to be a safety hazard. Most workbench shocks come from a hand or arm touching an energized component or wire. Don't create a current path to the other hand through your heart!
- Don't work on live equipment unless it's absolutely necessary and then take precautions and follow basic safety procedures at all times.
- Don't work alone, and know how to respond if someone else does get a shock or burn. CPR courses are often available through a public safety agency like police or fire at very low cost or for free. Electrical safety classes may be available through your power utility or an electrician's trade union.
- Know how to remove power, and show your friends and family how to remove power in your shop or station.
- Wear pants and shoes with insulating soles to prevent current from flowing through your legs and feet. Never work barefoot, especially on concrete, which is surprisingly conductive. If you have a basement or garage shop or workbench, sit on an insulating chair or lab stool, or stand on a plastic shop pad so you're not connected to the Earth.
- De-energize equipment before attaching the measuring instrument, such as a voltmeter or oscilloscope. Then turn on the equipment without touching the probe or getting near the live circuitry at all. Take the measurement, then power down the equipment before disconnecting.

High-Voltage Safety Rules

The following are adapted from advice by veteran builder Jim Garland, W8ZR. They apply to building any project involving high voltage. You'll find these and other safety guidelines in *The ARRL Handbook*.

1. Don't let your reach exceed your grasp. High voltage is not for beginners.
2. If you're a beginning builder, work with an experienced mentor.
3. Never work around high voltage when you're tired, stressed, or in a hurry.
4. Never work around high voltage after drinking alcohol. Even one drink can impair your judgment and make you careless.
5. Before working on a high-voltage power supply, always follow these steps:
   A. Unplug the ac power cord.
   B. Discharge any energy storage or filter capacitors, and verify that the voltage is truly zero.
   C. Use a grounding stick to make sure filter capacitors are completely discharged.
6. When working on a high-voltage power supply, remember that a dangerous time is after the power supply has just been turned off, but before the filter capacitors have fully discharged. Even with bleeder resistors, it can take a minute or more to discharge large capacitors fully.
7. When removing a recently discharged filter capacitor from a power supply, tie the two terminals together with wire. Large high-voltage capacitors can self-charge to dangerous levels if the terminals are left floating.
8. Don't stake your life on the expectation that bleeder resistors, fuses, circuit breakers, relays, and switches are always going to do their job. Even though modern components are very reliable, it is safe practice always to assume the worst.
9. Don't build high-voltage circuits if you don't understand how the circuit works. Builders must be knowledgeable enough to improvise, make component substitutions, and implement design changes.
10. It doesn't pay to be "penny wise and pound foolish" on projects that use high voltage. Use high-quality components throughout.

Grounding Stick

Veterans of broadcast and high-voltage applications may refer to a "grounding stick." Figure 2A shows a typical commercial model. These are a safe way to carry a heavy wire, connected to ground or circuit common on one end, to a point that you want to be sure is fully discharged.

To use the stick, turn off the equipment and wait for as long as a voltmeter shows significant voltage is present. This allows charged capacitors to be drained by bleeder resistors (high-value resistors connected directly across the capacitors). If practical, disconnect the power source for the equipment and ensure it can't be turned on again while you're working on it.

Once the meters show the power supply capacitors have discharged, open the equipment and attach the stick's ground lead to the power supply common. (Common is usually, but not always, the metal enclosure. Don't assume that it is — verify first.) Put on safety glasses. Holding the stick by the insulated portion (never hold the ground lead in your fingers), touch its tip to every point in the circuit where voltage can be present. Only then is the equipment safe to work on.

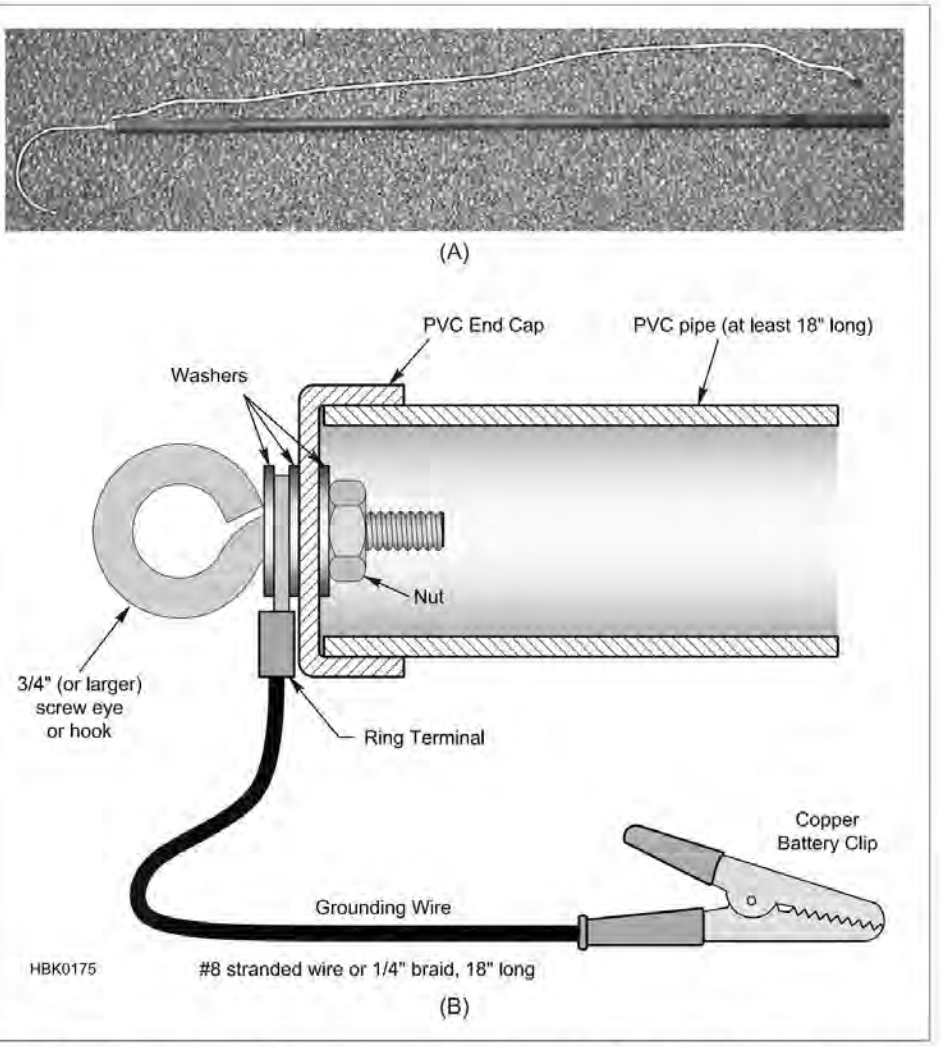

Figure 2 — The top photo (A) is a commercial grounding stick. The handle is a phenolic resin rod, approximately 2 feet long. The bottom drawing (B) shows how to build your own grounding stick. Be sure the ground wire is outside the handle, and use a heavy ground clip. Never touch the ground wire while using the stick.

If you don't have a grounding stick, you can make one, as in Figure 2B. Note that the ground lead is attached *outside* the PVC tubing. (Dry wood, fiberglass, or plastic rod will also work.) The ground wire should be extra heavy (stranded #8 AWG or larger) because it might have to withstand high current when a fully charged capacitor is discharged. Shorting out a charged capacitor will certainly get your attention!

Never use a screwdriver as a grounding stick. You don't know if the handle is a good insulator, and there may be small internal cracks that let current leak through. Screwdriver handles are often dirty or greasy, which creates a somewhat-conductive path from the blade to your hand. If you do happen to discharge a big capacitor, you'll probably ruin the blade with a big pit.

Be Smart

In closing, remember the number one rule for working with or around high voltage: Be extra cautious. Measure twice. Don't assume anything is off or discharged without verifying it. Make good use of that grounding stick. Be smart — you might not get a second chance.

Ward Silver, N0AX, has been licensed since 1972. He is Lead Editor of *The ARRL Handbook* and *The ARRL Antenna Book*, and is the author of all three editions of the *ARRL Ham Radio License Manual* and study guides. He released the well-received *Grounding and Bonding for the Radio Amateur* in 2017 and recently authored the third edition of *Ham Radio for Dummies*. You can contact Ward at **n0ax@arrl.org**.

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How to Create a Boy Scout Troop of Hams

These Scouts earned their ham radio licenses to assist with emergency communications.

Scott deMasi, KC5NKW, and David Godell, KG5VLY

Being prepared is the goal of hams and Boy Scouts everywhere. However, sometimes you learn that you aren't as prepared for a particular situation as you thought. When Hurricane Harvey hit the Texas coast in 2017, the small community of Kingwood in northeast Houston was decimated. Large portions of the subdivision were under up to 5 feet of water for several days. Troop 839, one of the local Boy Scout troops, had a few ham radio operators who jumped into action to help the community, but the troop as a whole was unprepared due to being separated by the water.

After the storm passed and things slowly got back to normal, Assistant Scoutmaster Scott deMasi, KC5NKW, thought it might help the community to have a trained team of ham radio-licensed Scouts in place. With the help of Assistant Scoutmaster David Godell, KG5VLY, a plan was made to increase the number of licensed hams in the troop. The troop has gone from four licensed operators to 37 (adult and youth combined), forming the Troop 839 Radio Club, KW9BSA.

The Scoutmasters and Scouts of Troop 839, KW9BSA.

Challenges

In spring 2018, a meeting was held to see who would be interested in becoming a ham radio operator. We started with the introduction of events like JOTA (Jamboree on the Air), teaching the Radio Merit Badge, and offering demonstrations at Winter Camp, where Scouts are introduced to new programs and merit badges. Interested Scouts were provided with testing dates and links to study materials. We offered to drive any Scout that wanted to take an exam to their exam location. We soon discovered that getting boys between 11 and 18 years old interested in ham radio was not an easy task. Some of the boys grew interested, but when they saw the materials to study, they quickly lost enthusiasm. Success was very slow at that point, and we gained only one licensed Scout.

Another challenge was Scout parents not knowing which radios to buy. Thankfully, the four hams who were already in the troop committed to donating a radio when Scouts got licensed. Additionally, when a Scout earned their license, they would have completed most of the requirements for the Radio Merit Badge as well. Radios then became the

Troop 839 Boy Scouts learning how to use radio equipment at a Scout meeting.

only electronic device allowed on campouts. With these three incentives, Scouts grew more enthusiastic about earning their ham radio licenses.

Now all they had to do was pass the test. The Scouts watched videos, attended classes, and received mentoring, but there was little success. We found an instructor to facilitate a full-day class, ending with the Technician-class license test. The class consisted of 8 hours of learning and studying, ending with a Volunteer Examiner (VE) testing session. Scouts, their parents, siblings, and friends were all invited to participate. The first round was very successful, with 12 Scouts and parents earning their Technician-class licenses. On subsequent testing dates, new hams were continually added.

As the group grew, we applied for a new ham club with the vanity call sign KW9BSA. All hams in the troop are automatically members. There are no dues; the only requirement is Scout participation.

Getting Scouts On the Air

One of the unforeseen obstacles for the growing group was getting on the air. There's little information in the radio community to help new hams do so effectively. To teach skills in scouting, we use what we call the EDGE method — Explain, Demonstrate, Guide, and Enable. We followed this method to teach our Scouts ham radio.

It was a concern that the Scouts wouldn't learn enough from the 1-day class. KW9BSA started providing training classes to teach troop hams how to use their radios. To get them comfortable on the air, we discussed how their radios work and the purpose of each feature. We reviewed phonetics, protocols, and basic rules. Once they were familiar with all of it, we paired them with another operator and separated them (across a parking lot). We then established a common simplex frequency, with the idea that youth are more comfortable speaking directly with someone they know, instead of through a repeater with opportunities for others to join the conversation. The Scouts then called out their call signs to one another. Once a connection was established, we helped them adjust to speaking into the microphone.

Once they were comfortable, we switched to using a local repeater monitored by a club member. The Scouts then made calls requesting a signal report (they always got a response). Once the response came in, they had a short conversation.

Luckily, two local groups were able to help — the South Texas ARES District 14 Northeast and Texas Emergency Amateur Communicators (TEAC). To encourage the Scouts to get into the weekly nets, they added them to the net script, stating, "If there are any Scouts listening today, please take a moment to check in. We would love to hear from you." They wait a little longer than usual to get a reply. Now, Scouts regularly check in to these nets.

During emergency communications drills, the Boy Scouts receive direction from net control.

Through service, Boy Scouts of America helped encourage youths to get on the air and become comfortable with public speaking. Hams in KW9BSA have already logged hundreds of hours providing community services that are unavailable to non-ham Scouts. In Houston, Texas, during Wreaths Across America, an event where Scouts lay remembrance wreaths on the graves of veterans, KW9BSA works with the Harris County Northeast District 14 ARES group to provide radio support. We also provided support during a triathlon, and then again at a local bike rally. During the bike rally, Troop 839 got some hands-on education, as we helped an ARES member lower his antenna tower for maintenance.

Preparing for Emergency Communications

It was important to prepare this group of radio Scouts for emergency communications. The KW9BSA team now has regularly scheduled drills, set up as a directed net with a Net Control Operator. During these drills, Scouts are given envelopes containing scenarios of what they have witnessed or are currently experiencing. These mock scenarios are based on real-life issues that Troop 839 hams dealt with during Hurricane Harvey in 2017. These scenarios include anything from people being trapped on a roof in a flooded neighborhood to simple questions about shelter. The idea of this exercise is to let the Scouts decide what information is imperative to pass on and the next steps. Most scenarios have a second piece that either adds questions or brings the issue to a conclusion. Once all the scenarios are complete, the group meets for pizza to do an after-action discussion. Their skills have improved with every drill.

In our opinion, a good scenario is one that the Scouts can see as a tangible or realistic possibility that they could experience. All of them were aware of hurricane-related emergencies, so they know these are all things they may encounter again.

Next Steps

The success of KW9BSA doesn't stop with Troop 839. Now that the idea has grown and is proving successful, we're working to take it to the next level through the local Scout district. The District Committee is already working with KW9BSA to expand the program. The goal is to demonstrate and share the success of KW9BSA with the other districts, strengthening communications and community service throughout the Houston area. By bringing the ham radio concept to other Scout units in the Kingwood area, not only will the Scouting community be strengthened, but the local radio club, TEAC, and the ARES group will be as well. What a tremendous success it would be to have hundreds of licensed Scouts in the area following the Scout motto to "be prepared."

A Boy Scout receives advice from a Scoutmaster regarding the features on his radio.

Troop 839 is sponsored by the First Presbyterian Church in Kingwood and is a member of the Flaming Arrow District in the Sam Houston Area Council. Troop 839 serves approximately 100 youth, and the Flaming Arrow District serves approximately 3,500 youth in the northeast Harris County/southeast Montgomery County area. The Sam Houston Area Council, the largest Scout council in Boy Scouts of America, serves over 46,400 youth, covering over 27 counties in southeast Texas.

All photos by the authors.

Scott deMasi, KC5NKW, is an Assistant Scoutmaster and a District Chair for Emergency Preparedness for the Boy Scouts of America Troop 839 in Kingwood, Texas. He has his General-class license and has been a radio operator since 2005. Scott serves as an Assistant Emergency Coordinator (AEC) for ARES District 14 Northeast, as well as a Volunteer Examiner. He's also the ARRL South Texas Youth Coordinator. Scott can be reached at **kc5nkw@arrl.net**.

David Godell, KG5VLY, has his Technician-class license and is an Eagle Scout for the Boy Scouts of America. David currently serves as the Committee Chair for Troop 839 and serves on the District Committee for local Scouts. He enjoys ham radio, camping, and spending time with his family. David can be reached at **davidgodell@kingwoodcable.net**.

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

The 2020 International Museums Weekend

This remote museum participated in the worldwide event while socially distancing during COVID-19.

Bob McLeod, VP8LP

While abiding by social distancing regulations due to the COVID-19 pandemic, radio amateurs in the Falkland Islands participated from their homes in the International Museums Weekend, held June 20 – 21, 2020. Although operators participate in the annual event from museums around the world, the Historic Dockyard Museum, located in Stanley, Falkland Islands, usually hosts the event for Falkland Islands participants, with an amateur radio station set up in the museum's Radiotelephone Hut.

Falkland Islands' Communication History

The Radiotelephone Hut used to be the center for communications across the islands, and radiotelephone played a major part in Falkland Islands life. The remote location meant that each farm around the islands had a radiotelephone set (primarily using 4.5 MHz and 2 MHz, depending on propagation) to call the islands' station daily, located in its only town — Stanley. First thing in the morning, the farms would pass weather reports, which were then collated and used by the local air service to route the day's flights. This was followed by a session with a doctor. If people living on the farms fell ill, they would report their symptoms over the radiotelephone to a doctor in town for diagnosis, and the medication would be prescribed and issued from the farm's medicine chest. Of course, none of this communication was private — everybody tuned in to 4.5 MHz on their shortwave radios to keep up with what everybody was doing, who was feeling ill, and what the cure might be.

After the doctor's roundup, the Stanley radiotelephone operator took messages, telegrams, store orders, etc., sending them to the appropriate shop in town. The operator also put phone calls through to remote areas where the single-wire-telephone system didn't reach. This system was superseded at the end of the 1980s, when the new national telephone system was installed: an automatic switch with new lines around town and radio links to each farm. Individual houses became connected privately for the first time in Falkland Islands' history.

During the 2019 International Museums Weekend, operators participated inside the Falkland Islands' Historic Dockyard Museum's Radiotelephone Hut, prior to COVID-19. From left to right: Paul Wade, VP8DPT; Mario Zuvic, VP8A, Bobby Short, VP8ADR; Janet McLeod, VP8AIB, and Charlie McKenzie, VP8ML.

The Stanley radiotelephone station was used for communications across the Falkland Islands before being replaced in the 1980s with an automatic telephone system.

Eventually, the now-antiquated Radiotelephone Hut was lifted off its foundations and relocated to the Historic Dockyard Museum. It's now filled with displays of radio equipment used on the islands throughout the years, along with an exhibit of sections of the old Stanley Telephone Exchange. Some photos of this history can be found on VP8HDM's **www.qrz.com** web page.

We are lucky to be allowed to use this historic hut for our special event station each year. In 2019, we connected two radios through a Quadplexor and filters to one coax running to a fan dipole for 17, 20, 30, and 40 meters, hanging from a mobile tower on the harborfront at the museum. A third station was remote controlled to antennas for 80 and 160 meters on Sapper Hill, directly behind Stanley.

Setting Up the Event

Due to the restrictions of the pandemic, we received special permission to use the regular event call sign, VP8HDM, with an "/A" suffix, and to work from our home stations with a logging network. A linked network meant that event participants would be able to see which band each person was operating on. As we were all using the same call sign, this was important to help us avoid using the same band or mode. Because the log on each station's computer would show contacts from all participants, we could also see whether operators were completing calls on their chosen band, helping with decisions on where the propagation might be good or bad.

With no experience in setting up a network like this, we started looking at free networking systems found on the internet. First, we tried *SoftEther VPN*. There were some great instructions to follow, both from the software and from hams who've used it, but due to our lack of networking experience, we just couldn't get it to work.

Eventually, after asking for help on forums, Larry Gauthier, K8UT, suggested LogMeIn Hamachi, and talked us through setting it up. With the server being in the cloud, each user only needed to create an account, download and install the app, and log in as a client. We used *N1MM+ Logger*, and it automatically recognized the stations on the network.

N1MM+ Logger requires a few basic settings to match for each user connected to the network, so we wrote ourselves a few notes on the settings needed to make it easy for each operator to get connected. Many of our contacts utilized *WSJT-X*, which was also easy to set up, and ran with no issues through the *N1MM+ Logger* interface.

Event Results

Five VP8 call signs participated in the event: Bob McLeod, VP8LP, with his FTDX5000 and three-element Yagi, plus inverted **V** dipoles for 60 and 80 meters; Janet McLeod, VP8AIB, operated in the same shack as Bob and used their FT450 and SteppIR vertical antenna; Mark Street, VP8DOB, erected a Hustler trap vertical antenna covering 40, 20, and 15 meters in his backyard; Mario Zuvic, VP8A, used his IC-7610 on a 60-meter inverted **V** antenna, and Bobby Short's, VP8ADR, beam was down for repair, but he still had a long wire and participated on all bands.

Just over 1,500 contacts from 85 different countries were made in total: 859 on FT8, 258 on FT4, and 403 on SSB. The FT8 contacts were dispersed over bands from 15 to 80 meters, FT4 was used when conditions were quite good on 17 and 20 meters, and we changed over to SSB at the peak of propagation on 20 meters. There were also a few SSB contacts on 40 meters in the evenings.

Janet McLeod, VP8AIB, ready to start operating on 40 meters from her home station during the 2020 International Museums Weekend.

The International Museums Weekend

Each year, during the third and fourth weekend in June, the International Museums Weekend is held with the intent of setting up special event stations at as many museums as possible around the world. The choice of the museum is entirely up to the operator, however, they are encouraged to find the largest and most unique site possible. The term "museum" is loosely interpreted, as throughout the years, participant locations have included ships, castles, air museums, Napoleonic war forts, wireless museums, racing museums, and more.

This event began in 2002, after difficulties holding the Mills on the Air event in the UK due to the country's foot and mouth epidemic in 2001. During Mills on the Air, operators set up stations in windmills and watermills throughout the UK as a means to celebrate National Mills Day, promoting the mills, as well as amateur radio.

While social distancing for this event, we missed having visitors at the museum come into the hut and get excited about hearing far-off stations talking to us. But all in all, it was a fun event and we learned a lot about networks (perhaps we can use this system for another special event sometime). Hopefully the next International Museums Weekend can be held at the museum.

For more information about the Historic Dockyard Museum, visit **www.falklands-museum.com**.

All photos by the author.

Bob McLeod, VP8LP, has been licensed since 1970. His first station was a National HRO receiver and Minimitter transmitter, before upgrading to a Yaesu FT-101. He's had a Yaesu transceiver ever since. Bob is now retired, with plenty of time to enjoy ham radio.

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

Congratulations

December 2020
QST Cover Plaque Award Winner

Bob Fontana
AK3Y

Bob's article, "The Tuna Tin 'S' — A Bare-Bones Synthesized QRPp Transmitter," describes a modern update to the classic Tuna Tin transmitter. The "S" signifies synthesized frequency control, greatly increasing chances of making a QSO by allowing replies to a CQ on the caller's frequency.

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

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The Tuna Tin "S" —
A Bare-Bones Synthesized QRPp Transmitter

This update to a classic design includes tunable frequencies and a digital display.

Bob Fontana, AK3Y

In the May 1976 issue of *QST*, Doug DeMaw, W1CER/W1FB (SK), developed a two-transistor QRPp — 'p' denotes less than 1 W — transmitter using a pair of 2N2222A transistors. Dubbed the "Tuna Tin 2," the transmitter was crystal controlled and produced a 250 to 350 mW output for a cost of less than $10. In the March 2000 issue of *QST*, Ed Hare, W1RFI, provided an updated version of Doug's original design.

Here, we take another step forward. The Tuna Tin "S" (for *synthesized*) keeps costs below $20, and is still small enough to fit within the confines of a tuna tin, but has an integral VFO, digital display, and a higher power MOSFET final.

An Arduino-Controlled Synthesizer

Crystal-controlled designs severely limit the ability of the QRP/QRPp operator to make a contact. You significantly increase the chance of making a contact if you can reply to a CQ on the caller's frequency.

The Tuna Tin "S" uses a Silicon Labs Si5351 configurable clock generator (**www.silabs.com/documents/public/data-sheets/Si5351-B.pdf**). It can generate frequencies up to nearly 200 MHz. Multiple vendors supply the Si5351 on a breakout board that contains the chip, a precision 25 MHz crystal reference, a 3.3 V low-dropout regulator, which permits operation with either 3.3 V or 5 V logic. There are SMA pads for three simultaneous outputs. The breakout boards, together with three edge launch SMA connectors, are available for as little as $3 each from several internet sources.

30 December 2020 QST

Rick Lindquist, WW1ME, ww1me@arrl.org

Happenings

FCC Reduces Proposed Amateur Radio Application Fee to $35

The FCC has agreed with ARRL and other commenters that its proposed $50 fee for certain amateur radio applications was "too high to account for the minimal staff involvement in these applications." In a late-December *Report and Order* (*R&O*), the FCC scaled back to $35 the per-application fee for a new license, license renewal, and vanity call sign, as well as special temporary authority (STA) and rule waiver requests. Administrative updates, such as a change of mailing or email address, are exempt.

As the FCC noted in its *R&O*, although some commenters supported the proposed $50 fee as reasonable and fair, "ARRL and many individual commenters argued that there was no cost-based justification for application fees in the Amateur Radio Service." The fee proposal was contained in a *Notice of Proposed Rulemaking* (*NPRM*) adopted to implement portions of the "Repack Airwaves Yielding Better Access for Users of Modern Services Act" of 2018 — the so-called "Ray Baum's Act."

"After reviewing the record, including the extensive comments filed by amateur radio licensees and based on our revised analysis of the cost of processing mostly automated processes discussed in our methodology section, we adopt a $35 application fee, a lower application fee than the Commission proposed in the *NPRM* for personal licenses, in recognition of the fact that the application process is mostly automated," the FCC said in the *R&O*. "We adopt the proposal from the *NPRM* to assess no additional application fee for minor modifications or administrative updates, which also are highly automated."

The FCC turned away the arguments of some commenters that the FCC should exempt amateur radio licensees. The FCC stated that it had no authority to create an exemption "where none presently exists." The FCC also disagreed with those who argued that amateur radio licensees should be exempt from fees because of their public service contribution during emergencies and disasters.

"[W]e are very much aware of these laudable and important services amateur radio licensees provide to the American public," the FCC said, but noted that specific exemptions provided under Section 8 of the "Ray Baum's Act" requiring the FCC to assess the fees do not apply to amateur radio licenses. "Emergency communications, for example, are voluntary and are not required by our rules," the FCC noted. "[T]he Amateur Service is not an emergency radio service.'"

The Act requires that the FCC switch from a congressionally mandated fee structure to a cost-based system of assessment. The FCC had proposed application fees for a broad range of services that use the FCC's Universal Licensing System (ULS) that had been excluded previously. The 2018 statute excludes the Amateur Service from annual regulatory fees, but not from application fees.

The effective date of the fee schedule had not been determined as *QST* went to press.

FCC Considers Expanding the Number of Volunteer Examiner Coordinators

The FCC is evaluating comments solicited early this year regarding whether the current 14 Volunteer Examiner Coordinators (VECs) in the US were sufficient to facilitate the efforts of their accredited Volunteer Examiners (VEs) in administering amateur radio examinations, or whether it should authorize up to five additional VECs. Comments were requested in a January 5 *Public Notice*. The FCC adopted rules in 1983 to allow volunteers to prepare and administer amateur radio examinations, and it established the system of VECs and VEs. The ARRL VEC is the largest of the 14 VECs in the US.

"VECs introduced consistency into the Volunteer Examiner program by centralizing accreditation of Volunteer Examiners, coordinating the dates and times for scheduling examinations, and managing the various administrative tasks arising from examinations," the FCC said. Authorized VECs may operate in any of the 13 VEC regions, but must service at least one region. The FCC pointed out that some VECs now offer remote examinations.

"The Commission has long maintained 14 VECs and now seeks to consider whether they continue to serve the evolving needs of the amateur community, or whether there are unmet needs that warrant considering expanding the number of VECs," the FCC said.

Major Hamfests and Conventions Continue to Fall Victim to COVID-19

For the second year, the largest US ham radio gathering, Dayton Hamvention®, has announced it will not be taking place. Hamvention was one of several major events citing coronavirus pandemic precautions. Sponsored by the Dayton Amateur Radio Association (DARA), Hamvention was set to take place May 21 – 23 in Xenia, Ohio.

"Hundreds of volunteers have been working to do everything necessary to bring this Hamvention to the many amateur radio enthusiasts and vendors who support the Dayton Hamvention," the Hamvention Committee said in January. "Vaccine distribution…is lagging behind what was planned. In addition, the emergence of a more communicable form of the COVID-19 virus increases the potential for further public health problems in the next few months. We make this difficult decision for the safety of our guests and vendors."

The Hamvention Committee said the show would return in 2022, and tickets deferred in 2020 would be deferred again. In November, Hamvention had announced that "The Gathering" was the theme for the 2021 show. Hamvention was the host of the ARRL National Convention for its last event held in 2019.

In Texas, Ham-Com President Bill Nelson, AB5QZ, cited difficulties caused by the COVID-19 pandemic and the rising costs of putting on a show in announcing the event's demise.

"The decision was not made lightly, but the safety and wellness of our volunteers, vendors, clubs, presenters, and attendees is our paramount concern," Nelson said on the Ham-Com website. Ham-Com has been held each June at the Plano Event Center in Plano, Texas.

"We sincerely thank each and every person for their support over the past years," Nelson said.

SEA-PAC, designated as the 2021 ARRL Northwestern Division Convention, also announced the cancellation of that event in June.

"The SEA-PAC Executive Committee has been closely monitoring the continuing COVID-19 pandemic situation and has determined that the safest course of action for all is to cancel the 2021 in-person event," SEA-PAC 2021 Chair John Bucsek, KE7WNB, announced in January. "This decision was based on the uncertainties of more COVID outbreaks, vaccine availability to all, and the probable social distancing requirements. But most important, it is based on our genuine concern for the health and safety of you, the attendees, vendors, and presenters. We firmly believe that providing our ham radio community with a safe and quality convention experience is paramount."

Last October, ARRL and the Orlando Amateur Radio Club (OARC) announced that the in-person ARRL National Convention and Orlando HamCation® — which was to host the convention — have been postponed until February 10 – 13, 2022. A virtual HamCation Special Edition took the place of this year's show.

WB9VPG, is 2021 Carole Perry Educator of the Year

Orlando HamCation® announced in January that ARRL Life Member Neil Rapp, WB9VPG, of Bloomington, Indiana, is the 2021 recipient of the Carole Perry Educator of the Year Award. The award recognizes an outstanding individual contribution in educating and advancing youth in amateur radio. It was first awarded in 2018 to its namesake, Carole Perry, WB2MGP, in honor of her work as an educator teaching students about ham radio. Rapp was ARRL 2004 Professional Educator of the Year. He's an Assistant Central Division Director and an ARRL VEC certified examiner.

An educational professional for more than 28 years, Rapp currently teaches chemistry at Bloomington High School South. He's also the school's amateur radio club sponsor and has introduced 3,600 students and parents to amateur radio through his involvement in the organization. Among his educational achievements, he was able to send an experiment involving protein crystallization to the International Space Station (ISS). He also mentored 2013 *Amateur Radio Newsline* Young Ham of the Year and ARRL William R. Goldfarb Memorial Scholarship recipient Padraig Lysandrou, KC9UUS.

Rapp got his license when he was 5 years old, and, at the time, was touted as the world's youngest ham. Now 50, he's the host and founder of the amateur radio podcast *Ham Talk Live!* He's also a member of AMSAT and was the youngest person to both join and be eligible for membership in the Quarter Century Wireless Association (QCWA). He contributes the "Next-Gen Contesters" column for *NCJ*. Orlando HamCation has been sponsored by the Orlando Amateur Radio Club since 1946.

Reverse Beacon Network Leveraging Yasme Foundation Grant for Expansion

The Reverse Beacon Network (RBN) is taking advantage of a grant from the Yasme Foundation, in cooperation with Amateur Radio Digital Communications (ARDC), to add 15 more nodes. RBN is a global system of software-defined radio receivers that monitor amateur radio bands and report CW, RTTY, and FT4/FT8 signals to a central, searchable database. In October, a Yasme-funded node was successfully installed in Tunisia, bolstering RBN representation in northern Africa. Additional nodes are planned for Algeria and Libya. The success of this small program led to the global 15-node project to expand the RBN into such under-represented areas as the Caribbean, the South Pacific, Central Asia, the Middle East, and South America. Selections were guided by the research community at HamSCI, whose website provides a forum for researchers and amateurs to interact and conduct studies and experiments.

"By adding stations in these areas, the network's data quality and coverage are improved to allow better analysis of events and openings beyond what was previously available," Yasme Foundation President Ward Silver, NØAX, said. "This large and growing database of records supports scientific research and allows hams to be more effective on the air and in planning operations and station design."

Silver said researchers are particularly interested in the RBN data because it covers such a wide area with so many stations, a capability unusual in research. "The RBN team deserves a lot of credit for creating an important asset that combines amateur radio and science in the best traditions of both," he said. "We look forward to helping keep that spirit alive and well." — *Thanks to Ward Silver, NØAX, and DX Engineering*

FCC to Require Email Address with Applications and on File

By June 29, 2021, amateur radio licensees and candidates must provide the FCC with an email address on all applications. If no email address is included, the FCC may dismiss the application as "defective." On September 16, the FCC adopted a *Report and Order* (*R&O*) on "Completing the Transition to Electronic Filing, Licenses and Authorizations, and Correspondence in the Wireless Radio Services." While many, if not most, amateurs have already provided an email to the FCC, this will now become a requirement.

Under Section 97.21 of the new rules, as amended, the holder of a valid amateur radio station license "must apply to the FCC for a modification of the license grant as necessary to show the correct mailing and email address, licensee name, club name, license trustee name, or license custodian name." For a club or military recreation station license, the application must be presented in document form to a club station call sign administrator who must submit the information to the FCC in an electronic batch file.

Under new Section 97.23, as amended, each license must show the grantee's correct name, mailing address, and email address. "The email address must be an address where the grantee can receive electronic correspondence," the revised rule will state. "Revocation of the station license or suspension of the operator license may result when correspondence from the FCC is returned as undeliverable because the grantee failed to provide the correct email address."

Licensees can log into the ULS License Manager System with their FRN and password to update their FCC license record, including adding an email address. For questions or password issues, call the CORES/FRN Help Line, (877) 480-3201.

In Brief...

- **Tom Sly, WB8LCD, became Ohio Section Manager on January 1.** He assumed the seat that Scott Yonally, N8SY, vacated when he became Great Lakes Division Vice Director, after serving as Ohio's SM since 2014. Sly was appointed by ARRL Radiosport and Field Services Manager Bart Jahnke, W9JJ, after consulting with Great Lakes Division Director Dale Williams, WA8EFK, to serve the remainder of Yonally's term, which extends through September 30, 2022. A radio amateur since 1968, Sly is an ARRL Life Member and has served as Ohio Section Affiliated Club Coordinator since 2017.

Rick Palm, K1CE, k1ce@arrl.net

Public Service

Wilderness Emergency Communications Protocols

The further I paddled my 14-foot kayak into the Okefenokee National Wildlife Refuge in Folkston, Georgia — the third largest national wilderness area on the east coast — the more I thought about emergencies and safety. Most people think of kayaking as leisurely floating down a river in a state park patrolled by rangers. However, there's another side to kayaking found in major wilderness areas, such as Georgia's Okefenokee Swamp, where for 3 days I encountered no one (rangers or otherwise) during a 31-mile solo winter solstice traverse of the swamp. Dangerous wildlife pose a risk, as does overturning your kayak and falling into the water. During the summer at a busy state park, this is simply an inconvenience, but in winter, it can be a life-threatening emergency when you're miles into the waterscape of the nearly 500,000-acre Okefenokee, where there's little land to crawl onto and no one close by to help.

Cell signals were nearly non-existent the farther I paddled. I checked a "local" repeater north of the refuge boundary and spoke with a ham who said he monitors the repeater 24/7 for emergency calls. Under the stars that night, I remembered a wilderness VHF FM simplex protocol.

Wilderness VHF FM Simplex Protocol

In the February 1994 issue of *QST*, Sierra Nevada hiker William Alsup, N6XMW, proposed "A Wilderness VHF FM Protocol" for effective simplex use of handheld radios in the backcountry, which was met with wide acclaim. The protocol called for hams in and near wilderness areas to monitor the national simplex frequency, 146.52 MHz, for emergency transmissions, as well as perform safety checks at 10 AM (when most explorers start moving),

Before Going Into the Wilderness

- ✔ Learn and pre-program the frequencies (including tone squelch) of repeaters on the periphery of the wilderness area where you'll be traveling. When on site, try making brief contacts on in-coverage repeaters and inform users of your location, route, and plan.
- ✔ Program the national calling frequency, 146.52 MHz, into your radio.
- ✔ Be informed of the LiTZ DTMF protocol and Wilderness Simplex VHF FM protocol calling times and frequencies.
- ✔ Plot your course by map or GPS coordinates. When traveling, always know your location by GPS coordinates, and natural and manmade landmarks, such as a lake or tent platform.
- ✔ Carry the basic operating manual for your radio.
- ✔ Keep all accessory plugs inserted when not in use, to preserve the water resistance of the radio.
- ✔ Keep your batteries warm in cold weather to preserve their power.
- ✔ Pack extra batteries. Preserve power by using the lowest power setting that yields successful communication.
- ✔ Bring the best portable antenna you can. I used a mag-mount ⅝ wavelength whip antenna that worked well in Okefenokee.

On a remote shelter platform in winter in the Okefenokee National Wildlife Refuge, Rick Palm, K1CE, used a handheld radio to inform a ham north of the swamp of his exploration route and plan. [Rick Palm, K1CE, photo]

1 PM (when most explorers stop to eat lunch), and 4 PM (when most explorers have stopped for the day and it's early enough for helicopter rescues). It also encouraged monitoring the frequency at the top of every hour for 5 minutes, when possible. The purpose of the protocol is to concentrate the chances for link-up. If a repeater is within range, the ham in the wilderness can report his access to it on the national simplex frequency.

Other proposals were discussed for installing amateur repeaters at ranger stations with links to government repeaters that could be activated in an emergency, and creating a net (or online forum) of wilderness traveler-hams to discuss implementation of the protocol and other wilderness emergency communications issues.

Long Tone Zero Protocol

Long Tone Zero (LiTZ) is another protocol for sending an alert during an emergency by pressing and holding the zero key on your dual-tone multi-frequency (DTMF) keypad, and transmitting it for at least 3 seconds. After sending the alert tone, briefly announce the nature of your emergency and your location.

Some repeaters are configured to respond to the LiTZ alert automatically, with prerecorded messages describing how to access the autopatch or other functions. Repeaters with LiTZ support may also alert the control operator and others to assist.

Other Emergency Communications Systems

Consider adding other systems to your wilderness communication assets as well. Brian Boschma, KK6FJ, suggests a registered Emergency Position Indicating Radio Beacon (EPIRB) unit. EPIRBs are monitored by satellites worldwide. He noted that in a potentially life-threatening situation, the device can be tracked accurately, even in remote areas. The mere activation of an EPIRB transmitter is a declaration of an emergency. Satellites and other monitoring stations receive the signal and immediately relay the information to authorities.

Amateur radio has its place in wilderness emergency communications, safety, and even search-and-rescue, but don't rely solely on the Amateur Radio Service as your lifeline.

A Recruitment Opportunity

As Alsup pointed out in his article, with handheld radios and growing use of the protocol, more wilderness travelers would be encouraged to obtain their amateur radio licenses. In the September 2016 issue of *QST*, Greg Waters, KJ6OUI, discussed how the Fresno Area Mentor and Elmer (FAME) program in Fresno, California, marketed amateur radio to outdoor enthusiasts, attracting a group of wilderness travelers to get licensed, in his article, "FAME in Fresno — A Success Story in Recruiting New Hams."

Conclusion

For safety and emergency communications in the wilderness, the more hams who use and promote the protocol, the more potential for lives saved, and meeting our statutory mandate of FCC rule §97.1(a): "Recognition and enhancement of the value of the amateur service to the public as a voluntary noncommercial communication service, particularly with respect to providing emergency communications."

Field Organization Reports

December 2020

Public Service Honor Roll

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

520
KW9EMG

510
N9VC

477
W7PAT

449
WA7PTM

430
WA3EZN

408
KE8BYC

345
KE8KOC

322
KB3YRU

270
ND8W

268
KD2LPM

240
WD8USA

230
KB2RTZ

225
KT2D

221
WA2CCN

220
AL0Y
W0PZD

200
KD2NMG

187
WM2C

176
KB9LX

170
W2PH
KM8V
W9GRG

163
W8DW

160
AI9F

156
W8IM

155
N8SY
W4DNA

154
KB8RCR

153
WA2BSS

150
W3GWM
WO2H

148
W9RY

145
KD0HHN
K8AMH
KI5GRH

140
WB9QPM
K0RCJ

137
KB9PGY

135
W8DJG
AB8M
W3YVQ
K4IWW

130
KC9FXE
W7EES
KY2MMM
AC0KQ
N1LL
KW1U
N2JBA
N4CNX
WK4WC

126
KV8Z

125
AG9G
WB9WKO
AD3J
N5MKY
KD8ZCM

123
AD8CM

122
KD2GXL

120
WA4VGZ

W4CMH
WC4FSU
K9LGU
KY2D
KC8WH
N2LC
KA9QWC
W0LAW
K2TV
N2WGF
K3JL
WA4VGZ
W4NWT
NA7G
N7IE
NA7G
N7IE

115
KF5OMH
AF2NC
N1TF
KC8YVF

114
AC8NP
N3KRX

110
W1KX
KA9MZJ
K6HTN
KF5IOU
KA5AZK
KG5NNA
KO4OL
KB2QO
N3SW
WA3QLW
WB8YLO
W8MAL
K8MDA
AB8MW
AB9ZA
N1IQI
W1RVY
K3IN
KI7TIG
WB8TQZ
K8BKM
WF2Y

106
NI2W

105
W2PAX
N2DW
K1XFC

104
KD2IWN

100
WB4RJW
KZ8Q

KE5YTA
K9GDF
KN9P
NX9K
KO4OL
W3CJD
WB6UZX
AC8RV
WB8SIQ
K3RC
N8CJS
AA3SB
KB2YAA
WS4P

99
WB8YYS
N1LAH
KC1HHO
K1HEJ

98
AB3WG

97
W9EEU
KB1NMO
WV5Q

96
WA1URS
W7PHX

92
K0FBS
AA7BM

90
KM4WHO
AA4XZ
N6IET
KA2HZP
W2AH
KB8PXM
K8KRA
KB8HJJ
KA1G
KD2JKV
KC1KVY
KC1MSN
N2TSO
AA3N
K3MIY
WX2DX
K8ED
WB8WKQ
WD0BFO

88
K8RDN

87
WA1LPM
K2EAG

86
AD4DO
K6JT
W4TTO

85
K1STM

84
N3JET

83
N3RB
W9BGJ
KE1ML

81
KE5DRF
W3ZR

80
W0DHG
KD8UUB
KL7RF
KD8UQT
N8MRS
N4ZM
KF7GC
K7OED
KG7QWR
KJ7BHO
KB1NAL

79
WB8R

78
KA2GQQ

77
WB4ZDU
KA9IKK
KB0DTI
W5XX

75
KT5SR
KA0DBK

73
AJ7B
K4FHR
WB2VUF
NV1N

72
K6RAU
KB8PGW

71
KF7LMJ
KA2JFU

70
K2MJF

The following stations qualified for PSHR in previous months, but were not reported in this column: (Nov.) K8AMH 250, KF5OMH 180, KI5GRH 175, KG5NNA 150, KF5IOU 120, KA5AZK 110, KE5YTA 100, K6JT 84, KF5IVJ 82.

Section Traffic Manager Reports

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

Section Emergency Coordinator Reports

The following Section Emergency Coordinators reported: AZ, ENY, IL, IN, KY, LA, MDC, MI, MN, MS, ND, NLI, NNJ, NTX, OH, OR, SCV, SJV, STX, SV, TN, VT, WI, WPA, WY.

Brass Pounders League

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

NX9K 1,745, N9CK 1,040, K6HTN 886, KW1U 782, WB9WKO 728, N1IQI 544.

The following stations qualified for BPL in October 2020, but were not reported in this column: WB9WKO 1,945, NX9K 1,399, N9VC 646.

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

Contest Corral

March 2021

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

Start - Finish Date	Time	Finish Date	Time	Bands	Contest Name	Mode	Exchange	Sponsor's Website
1	0000	1	0100	1.8-14	K1USN Slow Speed Test	CW	Max 20 WPM, name, SPC	www.k1usn.com/sst.html
1	1630	1	1729	3.5, 7	OK1WC Memorial (MWC)	CW	RST, serial	memorial-ok1wc.cz
1	2000	1	2130	3.5	RSGB 80-Meter Club Championship, Data	Dig	RST, serial	www.rsgbcc.org/hf
2	0100	2	0159	1.8-50	Worldwide Sideband Activity Contest	Ph	RS, age group	wwsac.com/rules.html
2	0200	2	0400	3.5-28	ARS Spartan Sprint	CW	RST, SPC, power	arsqrp.blogspot.com
2	1700	2	1900	3.5-14	RTTYOPS Weeksprint	Dig	Other's call, your call, serial, name	rttyops.wordpress.com
2	1900	2	2100	3.5	AGCW YL-CW Party	CW	RST, serial, name	alt.agcw.de/index.php/en
3	1300	3	1400	1.8-28	CWops Mini-CWT Test	CW	Name, mbr or SPC	cwops.org/cwops-tests
3	1700	3	2000	144	VHF-UHF FT8 Activity Contest	Dig	4-char grid square	ft8activity.eu/index.php/en
3	1900	3	2000	1.8-28	CWops Mini-CWT Test	CW	Name, mbr or SPC	cwops.org/cwops-tests
3	2000	3	2100	3.5	UKEICC 80-Meter Contest	Ph	6-char grid square	www.ukeicc.com/80m-rules.php
4	0300	4	0400	1.8-28	CWops Mini-CWT Test	CW	Name, mbr or SPC	cwops.org/cwops-tests
4	1800	4	2200	28	NRAU 10-Meter Activity Contest	CW Ph Dig	RS(T), 6-char grid square	nrrlcontest.no/index.php
4	2000	4	2200	1.8-50	SKCC Sprint Europe	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
5	0145	5	0215	1.8-21	NCCC RTTY Sprint	Dig	Serial, name, QTH	www.ncccsprint.com
5	0230	5	0300	1.8-21	NCCC Sprint	CW	Serial, name, QTH	www.ncccsprint.com
6	0000	7	2359	1.8-28	ARRL International DX Contest, SSB	Ph	W/VE: RS, SP DX: RS, power	www.arrl.org/arrl-dx
6	0000	14	2359	3.5-144	Novice Rig Roundup	CW	Name, QTH, rig, mbr	www.novicerigroundup.org
6	0600	6	0800	7, 14	Wake-Up! QRP Sprint	CW	RST, serial, suffix of previous QSO	qrp.ru/contest/wakeup
6	1800	7	1359	1.8-28	Open Ukraine RTTY Championship	Dig	State/province/canton/etc, serial	krs.ho.ua/openrtty
7	0700	7	1100	3.5	UBA Spring Contest, CW	CW	RST, serial, UBA section (if ON)	uba.be/hf/contest-rules
7	1200	7	2200	3.5	NSARA Contest	CW Ph Dig	RS(T), county (if Nova Scotia)	nsara.ve1cfy.net/?page_id=82
7	1800	7	2200	3.5	WAB 3.5 MHz Phone	Ph	RS, serial, WAB square or country	wab.intermip.net
10	1700	10	2000	432	VHF-UHF FT8 Activity Contest	Dig	4-char grid square	ft8activity.eu/index.php/en
10	2000	10	2130	3.5	RSGB 80-Meter Club Championship, CW	CW	RST, serial	www.rsgbcc.org/hf
10	2300	14	2300	3.5-14	AWA John Rollins Memorial DX Contest	CW	RST, eqpt type and year	antiquewireless.org
13	0000	13	2359	3.5-28	YB DX RTTY Contest	Dig	RST, serial	rtty.ybdxcontest.com
13	0500	14	1100	50-1296	SARL VHF/UHF Analogue Contest	CW Ph	RS(T), 6-char grid	www.sarl.org.za
13	1000	14	1000	3.5-28	RSGB Commonwealth Contest	CW	RST, serial	www.rsgbcc.org/hf
13	1200	14	1200	3.5-144	F9AA Cup, SSB	Ph	RST, serial	www.site.urc.asso.fr
13	1200	14	1200	28	South America 10-Meter Contest	CW Ph	RS(T), CQ zone	sa10m.com.ar
13	1200	14	2359	1.8-50	SKCC Weekend Sprintathon	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
13	1400	13	2000	3.5-28	AGCW QRP Contest	CW	RST, serial, class, mbr or "NM"	alt.agcw.de/index.php/en
13	1400	14	2100	3.5-50	Oklahoma QSO Party	CW Ph	RS(T), county or SPC	k5cm.com/okqp.htm
13	1500	14	1500	1.8	Stew Perry Topband Challenge	CW	4-char grid square	www.kkn.net/stew
13	1600	14	1600	3.5-28	EA PSK63 Contest	Dig	RSQ, province or serial	concursos.ure.es/en
13	1800	14	0559	3.5,7	Tesla Memorial HF CW Contest	CW	RST, serial, 4-char grid	www.radiosport.org.rs
13	1800	14	1800	1.8-50	QCWA QSO Party	CW Ph Dig	Year first licensed, name, SPC	www.qcwa.org
13	1900	14	1900	1.8-28	Idaho QSO Party	CW Ph	County or SPC	pocatelloarc.org/idahoqsoparty
13	2300	14	0300	3.5-14	North American Sprint, RTTY	Dig	Other's call, your call, serial, name, SPC	ncjweb.com
14	1400	17	0800	1.8-144	Classic Exchange, Phone	Ph	Name, RS, SPC, rig	www.classicexchange.org
14	1800	15	0100	All	Wisconsin QSO Party	CW Ph Dig	County or SPC	www.warac.org/wqp
15	0000	15	0200	1.8-28	4 States QRP Second Sunday Sprint	CW Ph	RS(T), SPC, mbr or power	www.4sqrp.com
15	1800	15	2059	3.5, 7	Bucharest Digital Contest	Dig	RST, serial	yo3test201x.blogspot.com
15	2000	15	2130	3.5	RSGB FT4 Contest Series	Dig	4-char grid square	www.rsgbcc.org/hf
16	1700	21	1700	3.5-28	CLARA Chatter Party	CW Ph	RS(T), name, SPC	clarayl.ca/chatter-party
18	0030	18	0230	3.5-14	NAQCC CW Sprint	CW	RST, SPC, mbr or power	naqcc.info
18	1930	18	2059	3.5	BCC QSO Party	CW Ph Dig	RS(T), t-shirt size	bavarian-contest-club.de
20	0200	22	0159	3.5-28	BARTG HF RTTY Contest	Dig	RST, serial, 4-digit UTC time	www.bartg.org.uk
20	1200	21	1200	1.8-28	Russian DX Contest	CW Ph	RS(T), oblast or serial	rdxc.org/asp/pages/rulesg.asp
20	1400	20	1800	144, 432	AGCW VHF/UHF Contest	CW	RST, serial, power, 6-char grid	alt.agcw.de/index.php/en
20	1400	21	2359	All	Virginia QSO Party	CW Ph Dig	Serial, county or SPC	www.qsl.net/sterling
20	2000	20	2159	1.8-28	Feld Hell Sprint	Dig	RST, mbr, SPC, grid	google.com/site/feldhellclub
21	0700	21	1100	3.5	UBA Spring Contest, SSB	Ph	RS, serial, UBA section or serial	uba.be/hf/contest-rules
21	2300	22	0100	1.8-28	Run for the Bacon QRP Contest	CW	RST, SPC, mbr or power	qrpcontest.com/pigrun
24	0000	24	0200	1.8-50	SKCC Sprint	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
25	2000	25	2130	3.5	RSGB 80-Meter Club Championship, SSB	Ph	RS, serial	www.rsgbcc.org/hf
27	0000	27	2359	1.8-VHF	FOC QSO Party	CW	RST, name, mbr (if any)	g4foc.org/qsoparty
27	0000	28	2359	1.8-28	CQ WW WPX Contest, SSB	Ph	RS, serial	www.cqwpx.com
31	2000	31	2100	3.5	UKEICC 80-Meter Contest	CW	6-char grid	www.ukeicc.com/80m-rules.php

There are a number of weekly contests not included in the table above. For more info, visit: **www.qrpfoxhunt.org**, **www.ncccsprint.com**, and **www.cwops.org**. All dates refer to UTC and may be different from calendar dates in North America. 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.*

Bob Raymond, WA1Z, bobraymondwa1z@gmail.com

The 2020 IARU HF World Championship Results

A record-breaking 5,684 logs were submitted from around the world for this popular contest, held July 11 – 12, 2020.

Max Stagg, VE6RST, was a guest operator at VE6SV in Alberta, Canada. He finished 9th place in the W/VE Single Operator Unlimited, CW Only, High Power category. [Gord Kosmenko, VE6SV, photo]

Full Results Online

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

The next IARU HF World Championship will be held the second full weekend of July (July 10 – 11, 2021).

2020 IARU Special Station Scores

Scoring of IARU station logs provided by World Wide Radio Operators Foundation (WWROF).

IARU Headquarters Stations

Call	Score
DA0HQ	25,676,392
TM0HQ	25,163,538
SN0HQ	20,696,780
OL0HQ	20,654,988
S50HQ	20,502,514
EF4HQ	19,423,947
LY0HQ	18,930,807
OH2HQ	18,816,875
GR2HQ	18,179,000
IO0HQ	16,849,550
9A0HQ	16,566,036
YT0HQ	16,270,824
OP0HQ	13,326,984
YL4HQ	12,882,114
OE0HQ	12,085,929
YR0HQ	11,823,012
OZ1HQ	11,082,610
R0HQ	10,670,040
HG0HQ	9,058,688
E7HQ	7,713,345
PA6HQ	7,631,028
EM5HQ	7,326,475
NU1AW	6,847,566
LZ0HQ	6,521,624
HB9HQ	6,060,430
W1AW	5,080,050
LX8HQ	4,596,584
LN2HQ	3,845,264
ER7HQ	3,317,311
Z30HQ	2,990,220
LR4HQ	2,917,472
SK9HQ	2,619,682
8N0HQ	2,576,665
VE0RAC	2,561,241
EI0HQ	1,968,918
UN1HQ	1,832,989
SX0HQ	1,625,025
DX0HQ	1,097,215
E2HQ	697,916
PW0HQ	573,835
7A1HQ	366,555
ES9A	352,800
CX1AA	321,958
ZL6HQ	197,808
XE1LM	136,945
CR5HQ	121,148
HC0T	109,905
A71HQ	109,858
LZ0AA	94,696
Z60A	54,978
AT1HQ	31,070
VK3WIA	27,240
BV0HQ	12,580
9H1MRL	5,330
VR2HK	1,548
ZS95SARL	603

IARU Administrative Council Stations

G5W	3,282,903
K1ZZ	2,901,984
LA2RR	2,004,600
VE6SH	29,541

IARU R1

PB2T	146,740
DJ3HW	85,792
SM6EAN	47,502
IV3KKW	11,319

IARU R2

XE1KK	23,280
PT2ADM	9,361
VE3YV	7,093

IARU R3

JA1CJP	178,596

Top Ten — US and Canada

Single Operator, Mixed Mode, High Power

KC1XX (WA1Z, op)	3,547,530
ND7K (N6MJ, op @ N6WIN)	2,818,446
NO6T (KI6RRN, op @ WA6TQT)	2,676,322
K5ZD	2,669,794
KM7W (KL9A, op)	2,538,032
VE3EJ	2,462,888
VE3AT	2,317,560
VE5MX	2,168,793
VE3DZ	2,094,357
KD4D	2,069,473

Single Operator, Mixed Mode, Low Power

NR4M (N9NB, op)	901,582
KX0C (IZ3EYZ, op)	768,040
KU1CW	747,950
N8II	552,946
W4KZ (KG5HVO, op)	488,474
WW4XX (LZ4AX, op)	477,020
K0DI	268,940
VE3TG	234,569
N2EM	194,752
K4EJ	151,071

Single Operator, Mixed Mode, QRP

K5KJ	60,320
W8UA	34,770
D1WA	28,991
WO9S	19,844
K2GMY	19,584
W7LG	16,200
N7JI	14,514
K8WU	3,234
AI6DO	1,800
N6HI	740

Single Operator, Phone Only, High Power

N1UR	1,264,224
W7WA	1,180,465
W6AFA	185,070
N3NR	155,325
W2JV	147,108
W7VO	143,364
N4MM	119,472
KE8FT	84,525
K9MWM	79,020
AB1EP	70,851

Single Operator, Phone Only, Low Power

K5DHY	52,437
KM8AM	49,496
WA5FWC (NM5M, op)	45,252
KW2J	32,651
WA3LXD	30,317
WZ8T	29,574
N6OKU	26,036
NG1M	24,820
NC4MI	24,644
KS2G	24,570

Single Operator, Phone Only, QRP

WW0WB	2,720
WE6EZ	2,530
KJ5MA	621
AB3RW	546
WD4IYE	392
VA3MYC (VE3LJQ, op)	72
KK7VL	6

Single Operator, CW Only, High Power

W1KM	2,631,980
VE3JM	2,428,790
K1KI	2,214,576
K5GN	2,020,320
N2IC	1,998,141
N4AF	1,648,212
N4OGW	1,235,376
AB3CX	1,102,335
NA8V	1,042,587
KZ5D	1,038,558

Single Operator, CW Only, Low Power

K7SV	845,952
AD5A	661,536
K0AD	439,332
WJ9B	366,156
W1QK	319,520
W1NN	294,424
K3MSB	247,923
WB4TDH	243,528
KG5U	238,249
VE3TM	225,885

Single Operator, CW Only, QRP

NX5M	150,156
N2WK	122,153
K8CN	69,174
N4IJ	48,000
N7RCS	42,947
KS0MO	41,904
NE5TH	40,136
WS1L	7,040
VE9BWK	4,625
W6GMT	4,218

Single Operator Unlimited, Mixed Mode, High Power

VA2WA	2,688,975
VA2EW	2,673,160
KO8SCA	1,161,000
W1GD	901,544
VE3RZ	823,284
K1AR	747,383
N6AR	738,304
WO4O	716,286
K9OM	669,088
K3MD	667,656

Single Operator Unlimited, Mixed Mode, Low Power

NN1C	1,202,149
NE9U	807,428
KE3X	540,285
N4XL	443,685
W1ARY	266,961
W9AV	222,887
K6GHA	141,501
N5DO	140,778
VE3GFN	129,168
W4LT	107,272

Single Operator Unlimited, Mixed Mode, QRP

K8ZT	58,497

Single Operator Unlimited, Phone Only, High Power

KK6P (W7IV, op)	651,645
NA4DA	256,920
K2RD	244,644
VE2NTT	235,081
W3LL	120,658
N5HC	116,014
WW5L	69,750
N7GCO	52,350
VA3WW	46,294
K6JAT	37,895

Single Operator Unlimited, Phone Only, Low Power

VE3PJ	219,687
KA2KON	43,935
VE3XNS	41,316
VE2CSM	29,360
KD2JOE	24,912
WB3BJU	20,104
KM4IAJ	17,784
KD4LEM	12,054
W4MTM	12,050
KE4YOG	8,869

Single Operator Unlimited, CW Only, High Power

AA3B	3,060,344
K8AZ (W2GD, op)	2,306,739
K9CT	1,797,476
VE9AA	1,764,720
K9NW	1,457,393
K1MK (@K1TTT)	1,383,393
NT6Q (N5ZO, op)	1,312,790
N5RZ	1,307,280
VE6SV (VE6RST, op)	1,176,496
N0AX	1,163,032

Single Operator Unlimited, CW Only, Low Power

K1XM	1,149,232
W1UE	678,216
W3KB	546,117
VE3MGY	371,180
WA1FCN	363,411
K7TQ	345,740
K4OAQ	335,420
KM4SII	296,510
AA4LS	258,582
VE3YT	257,527

Single Operator Unlimited, CW Only, QRP

K5NZ	19,788
KU4A	8,481
VE3GMZ	5,480
W3YJ	4,375
KC2WUF	2,664
W0GJ	1,079
AB8FJ	451

Multioperator, Single Transmitter, High Power

K0RF	1,927,884
K1IR	1,717,264
K1MM	1,336,392
K6EZ	1,293,672
N7AP	1,049,040
N6WM	1,026,267
W5EA	1,025,290
W0NA	890,841
NV9L	648,600
N4IQ	547,060

Top Ten — Worldwide

Single Operator, Mixed Mode, High Power

UW2M (UR0MC, op)	4,593,060
UB7K	4,210,956
RL3A (RA3CO, op)	4,137,192
LY7Z	3,772,158
E7DX (E77DX, op)	3,727,405
DJ5MW	3,683,934
KC1XX (WA1Z, op)	3,547,530
EI7M (GD4XUM, op)	3,523,632
RA9P	3,431,297
LZ5R (LZ1NK, op)	3,291,562

Single Operator, Mixed Mode, Low Power

UW5Y (US2YW, op)	2,052,934
LY9A	1,999,250
EC2DX	1,989,750
LY4L	1,802,560
S50W (S57K, op)	1,363,181
R8CT	1,294,600
LY9Y	1,238,445
NR4M (N9NB, op)	901,582
LZ0M (LZ2SX, op)	851,250
M3AWD (MM3AWD, op)	819,420

Single Operator, Mixed Mode, QRP

HA5BA	207,621
UT1DX	123,018
JH7UJU	83,678
K5KJ	60,320
UA6AK	49,691
UT5EOX	48,200
OP4A/P	45,384
RT5R	37,485
JM1MTE	36,790
DF7XR	35,728

Single Operator, Phone Only, High Power

ES6RW	1,731,772
OR1X	1,448,072
N1UR	1,264,224
W7WA	1,180,465
EA3CI	1,048,128
F8KGM	880,362
4X1DX	862,750
PY4BZ	835,016
US5D (UT7DX, op)	722,744
RM4HZ	718,148

Single Operator, Phone Only, Low Power

IW1FRU	847,645
PA2TMS	493,810
MI0I	403,155
OH6ECM	314,685
UA3BL	270,470
RC7KY	196,658
OE1HHB	187,532
F4BIV	170,550
OK6AB	157,785
SQ9LPO	146,550

Single Operator, Phone Only, QRP

UW8SM	157,644
LZ1DM	94,809
UA3OQ	59,392
HB9EGA	52,096
SP4LVK	47,502
UR7TV	27,840
9A4OP	20,412
M6OXO	19,809
PA0AWH	18,954
HA1TI	17,010

Single Operator, CW Only, High Power

EA8RM	4,032,924
ES5RR (ES2RR, op)	3,842,394
CR6K (CT1ILT, op)	3,539,424
EA2W	3,484,500
UW1M	3,370,995
KP2M (KT3Y, op)	2,859,643
RG6G	2,726,400
W1KM	2,631,980
R3ZZ	2,496,600
VE3JM	2,428,790

Single Operator, CW Only, Low Power

UT5EO	1,899,597
OL5Y	1,241,916
UP7L (UN6LN, op)	937,848
UF5A	897,440
K7SV	845,952
3V8SS	836,640
DM2I	811,155
4Z4AK	784,640
YL5W (YL2GN, op)	701,920
OM7RU	697,918

Single Operator, CW Only, QRP

LZ6E	466,089
LY5G	442,444
DK7HA	298,770
EU8F	269,269
JA6GCE	210,210
HG3C	207,825
UR5FEO	203,196
RM2D (SM6LRR, op)	176,220
OP6A (ON6PJ, op)	164,436
US5VX	158,920

Single Operator Unlimited, Mixed Mode, High Power

9A5Y (9A7DX, op)	4,122,108
ES7A (ES7GM, op)	3,646,692
IR1G (IZ1LBG, op)	3,615,093
OM3BH	3,588,530
HA3NU	3,535,068
9A3XV	3,284,512
LY5E	3,126,870
S53MM	3,078,560
EU1A	2,767,072
VA2WA	2,688,975

Single Operator Unlimited, Mixed Mode, Low Power

UW7LL	2,292,930
UZ3A (UX1AA, op)	1,950,184
OM0R	1,851,560
DL9EE	1,533,168
OR2F	1,505,412
DQ5M (DK6SP, op)	1,382,566
PC3T	1,232,058
NN1C	1,202,149
LZ3FN	1,155,635
RO7C (RG5A, op)	1,151,488

Single Operator Unlimited, Mixed Mode, QRP

DK3WE	957,390
DD0VS	236,778
YU1LM	159,082
LZ5Y (LZ1YE, op)	149,352
YO8BSE	112,256
K8ZT	58,497
JK1TCV	27,780
IZ3IBL	24,072
EW1FM	12,100
SP6EIY	5,412

Single Operator Unlimited, Phone Only, High Power

RA5A	2,368,996
PX2A (PY2LED, op)	1,235,392
CR6T	1,098,922
SO7G	1,092,212
OL7T (OK2BXU, op)	789,447
S54ZZ	754,273
RM8A	727,814
KK6P (W7IV, op)	651,645
A42K (A41CK, op)	640,584
G3Q	503,542

Single Operator Unlimited, Phone Only, Low Power

HG0R (HA0NAR, op)	684,152
IK4LZH	596,808
HG6V (HA6IAM, op)	307,748
EW7BA	298,584
UA9R	232,484
YO7SR	229,146
VE3PJ	219,687
SP6DVP	208,572
SQ3M	207,900
OK1K (OK1XOE, op)	187,017

Single Operator Unlimited, Phone Only, QRP

YP8A	39,243
YU3LAX	7,552
HA5BGG	5,100
JG1LFR	4,452
IC8SCI	1,128
YD9UW	154
YD1DGG	11

Single Operator Unlimited, CW Only, High Power

P3X (5B4AMM, op)	5,917,230
SN7Q (SP7GIQ, op)	4,344,384
UA4W	3,563,648
SE5E (SM5AJV, op)	3,264,734
AA3B	3,060,344
RT9A	2,926,506
LY6A	2,863,344
OL8M	2,848,461
LY5R	2,785,104
YT6W	2,660,952

Single Operator Unlimited, CW Only, Low Power

HA1SN	1,785,564
SN7O (SP7IVO, op)	1,694,610
HG5D (HA8QZ, op)	1,589,046
HA1XU	1,488,080
LY5W	1,458,185
UR6EA	1,252,420
OM3RM	1,247,832
WP3C	1,227,534
K1XM	1,149,232
OM7JG	1,062,324

Single Operator Unlimited, CW Only, QRP

YL2QN	562,010
EA3O	277,573
SF0A (SM0LPO, op)	256,284
DM7AA	217,288
G4ZFE	130,060
US5EFU	109,949
PE2K	95,064
HB9BXE	83,916
GW4W (GW4EVX, op)	80,598
OK1NG	60,358

Multioperator, Single Transmitter, High Power

RM9A	6,287,125
UP2L	5,502,825
RU1A	4,811,476
UA4M	4,608,640
IR4M	4,231,626
RT4G	3,377,715
HG6N	3,184,689
HG7T	2,955,399
HG8A	2,725,478
RT2C	2,483,898

Regional Leaders

Boxes list call sign, score, and class: MSHP = Multioperator, Single Transmitter, High Power; SO-CW-HP = Single Operator, CW Only, High Power; SO-CW-LP = Single Operator, CW Only, Low Power; SO-CW-QRP = Single Operator, CW Only, QRP; SO-MIX-HP = Single Operator, Mixed Mode, High Power; SO-MIX-LP = Single Operator, Mixed Mode, Low Power; SO-MIX-QRP = Single Operator, Mixed Mode, QRP; SO-PH-HP = Single Operator, Phone Only, High Power; SO-PH-LP = Single Operator, Phone Only, Low Power; SO-PH-QRP = Single Operator, Phone Only, QRP; SOU-CW-HP = Single Operator Unlimited, CW Only, High Power; SOU-CW-LP = Single Operator Unlimited, CW Only, Low Power; SOU-CW-QRP = Single Operator Unlimited, CW Only, QRP; SOU-MIX-HP = Single Operator Unlimited, Mixed Mode, High Power; SOU-MIX-LP = Single Operator Unlimited, Mixed Mode, Low Power; SOU-MIX-QRP = Single Operator Unlimited, Mixed Mode, QRP; SOU-PH-HP = Single Operator Unlimited, Phone Only, High Power; SOU-PH-LP = Single Operator Unlimited, Phone Only, Low Power, and SOU-PH-QRP = Single Operator Unlimited, Phone Only, QRP.

West Coast Region

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

ND7K (N6MJ, op @N6WIN)		
	2,818,446	SO-MIX-HP
NO6T (KI6RRN, op @WA6TQT)		
	2,676,322	SO-MIX-HP
KM7W (KL9A, op)		
	2,538,032	SO-MIX-HP
K7RL	1,679,940	SO-MIX-HP
K6XX	1,619,808	SO-MIX-HP
KU1CW	747,950	SO-MIX-LP
N2JNR	60,060	SO-MIX-LP
WA7BNM	38,584	SO-MIX-LP
VE6TN	17,346	SO-MIX-LP
W7MTL	14,208	SO-MIX-LP
K2GMY	19,584	SO-MIX-QRP
N7JI	14,514	SO-MIX-QRP
AI6DO	1,800	SO-MIX-QRP
N6HI	740	SO-MIX-QRP
W6NCB	200	SO-MIX-QRP
W7WA	1,180,465	SO-PH-HP
W6AFA	185,070	SO-PH-HP
W7VO	143,364	SO-PH-HP
KE8FT	84,525	SO-PH-HP
K6RO	60,784	SO-PH-HP
WZ8T	29,574	SO-PH-LP
N6OKU	26,036	SO-PH-LP
KL7HQR	23,836	SO-PH-LP
N6PGQ	19,008	SO-PH-LP
NF7E	18,486	SO-PH-LP
KK7VL	6	SO-PH-QRP
K6NA	896,714	SO-CW-HP
N7ZG	833,004	SO-CW-HP
W7YAQ	629,460	SO-CW-HP
W6AYC	622,859	SO-CW-HP
N7WA	586,560	SO-CW-HP
WJ9B	366,156	SO-CW-LP
W6ZL	74,334	SO-CW-LP
N7UVH	57,890	SO-CW-LP
K7SS	57,610	SO-CW-LP
W6JTI	53,466	SO-CW-LP
VE6EX	2,928	SO-CW-QRP
AA6OC	459	SO-CW-QRP
NN7SS (K6UFO, op)		
	69	SO-CW-QRP
W4FLL	6	SO-CW-QRP
W6SX	263,424	SOU-MIX-HP
W6TK	225,834	SOU-MIX-HP
WC6H	151,146	SOU-MIX-HP
NK6A	127,309	SOU-MIX-HP
N9NA	99,484	SOU-MIX-HP
K6GHA	141,501	SOU-MIX-LP
N7ZUF	44,352	SOU-MIX-LP
W7ZRC	6,930	SOU-MIX-LP
VE7LIO	5,060	SOU-MIX-LP
N7MU	1,717	SOU-MIX-LP
KK6P (W7IV, op)		
	651,645	SOU-PH-HP
K2RD	244,644	SOU-PH-HP
N7GCO	52,350	SOU-PH-HP
K6JAT	37,895	SOU-PH-HP
W7ZZ	29,000	SOU-PH-HP
VE7JMN	7,029	SOU-PH-LP
K7VAP	6,192	SOU-PH-LP
N5YJZ	1,653	SOU-PH-LP
WA7YXY	1,196	SOU-PH-LP
N6ABT	1,140	SOU-PH-LP
NT6Q (N5ZO, op)		
	1,312,790	SOU-CW-HP
VE6SV (VE6RST, op)		
	1,176,496	SOU-CW-HP
W6RW	1,013,376	SOU-CW-HP
K4XU	709,440	SOU-CW-HP
K7QA	546,206	SOU-CW-HP
K7TQ	345,740	SOU-CW-LP
K6WSC	136,944	SOU-CW-LP
AK6A	108,928	SOU-CW-LP
K7GS	87,156	SOU-CW-LP
VE7XT	60,198	SOU-CW-LP
K6EZ	1,293,672	MSHP
N7AP	1,049,040	MSHP
N6WM	1,026,267	MSHP
NX6T	495,672	MSHP
KT7E	468,718	MSHP

Midwest Region

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

VE5MX	2,168,793	SO-MIX-HP
N5NU	1,174,240	SO-MIX-HP
W0EWD	704,236	SO-MIX-HP
W0EA	125,952	SO-MIX-HP
KV0I	102,196	SO-MIX-HP
KX9C (IZ3EYZ, op)		
	768,040	SO-MIX-LP
KØDI	268,940	SO-MIX-LP
KØTRL	119,658	SO-MIX-LP
NGØC	92,035	SO-MIX-LP
KØHX	85,288	SO-MIX-LP
K5KJ	60,320	SO-MIX-QRP
KJ5T	60	SO-MIX-QRP
K9MWM	79,020	SO-PH-HP
AA5H	29,016	SO-PH-HP
N5KWD	26,163	SO-PH-HP
W5RJJ	19,693	SO-PH-HP
N5DN	7,316	SO-PH-HP
K5DHY	52,437	SO-PH-LP
WA5FWC (NM5M, op)		
	45,252	SO-PH-LP
N7MZW	21,528	SO-PH-LP
N5DTT	18,283	SO-PH-LP
NØYO	12,330	SO-PH-LP
WW0WB	2,720	SO-PH-QRP
WE6EZ	2,530	SO-PH-QRP
KJ5MA	621	SO-PH-QRP
K5GN	2,020,320	SO-CW-HP
N2IC	1,998,141	SO-CW-HP
N3BB	716,688	SO-CW-HP
KØNM	372,790	SO-CW-HP
N5AW	320,460	SO-CW-HP
AD5A	661,536	SO-CW-LP
KØAD	439,332	SO-CW-LP
KG5U	238,249	SO-CW-LP
N5JR	93,696	SO-CW-LP
AAØAW	89,557	SO-CW-LP
NX5M	150,156	SO-CW-QRP
KSØMO	41,904	SO-CW-QRP
NE5TH	40,136	SO-CW-QRP
W6GMT	4,218	SO-CW-QRP
AEØEE	9	SO-CW-QRP
W7CXX	347,184	SOU-MIX-HP
KEØUI	274,964	SOU-MIX-HP
KØBJ	258,492	SOU-MIX-HP
K8TE	177,371	SOU-MIX-HP
K7UT	172,608	SOU-MIX-HP
N5DO	140,778	SOU-MIX-LP
KI5MM	57,552	SOU-MIX-LP
KE5LQ	10,263	SOU-MIX-LP
KS5Z	7,638	SOU-MIX-LP
KJØP	3	SOU-MIX-LP
N5HC	116,014	SOU-PH-HP
AG5RR	10,438	SOU-PH-HP
K5AVY	2,014	SOU-PH-HP
K9TWW	90	SOU-PH-HP
KEØITC	7,875	SOU-PH-LP
KØFJ	5,202	SOU-PH-LP
KBØHP	5,190	SOU-PH-LP
NAØED	2,074	SOU-PH-LP
KJ4EBE	1,650	SOU-PH-LP
N5RZ	1,307,280	SOU-CW-HP
NØAX	1,163,032	SOU-CW-HP
NØAT	487,445	SOU-CW-HP
K5CM (W5CW, op)		
	436,406	SOU-CW-HP
W5GN	407,305	SOU-CW-HP
KØVBU	199,888	SOU-CW-LP
KØMPH	107,160	SOU-CW-LP
WØVX	78,288	SOU-CW-LP
K5TA	71,071	SOU-CW-LP
N5NAA	62,025	SOU-CW-LP
K5NZ	19,788	SOU-CW-QRP
WØGJ	1,079	SOU-CW-QRP
KØRF	1,927,884	MSHP
KG5VK	144,480	MSHP

Central Region

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

VE3EJ	2,462,888	SO-MIX-HP
VE3AT	2,317,560	SO-MIX-HP
VE3DZ	2,094,357	SO-MIX-HP
W9RE	1,470,184	SO-MIX-HP
K9ZO	563,859	SO-MIX-HP
VE3TG	234,569	SO-MIX-LP
VE3UZ	84,680	SO-MIX-LP
VE3AQ	48,069	SO-MIX-LP
ND3N	29,120	SO-MIX-LP
W8KTQ	23,034	SO-MIX-LP
W8UA	34,770	SO-MIX-QRP
WO9S	19,844	SO-MIX-QRP
K8WU	3,234	SO-MIX-QRP
VA3ZNQ	63,546	SO-PH-HP
W9NZ	28,674	SO-PH-HP
WB9ONU	7,068	SO-PH-HP
VE3ETE	3,179	SO-PH-HP
KE8NBC	2,599	SO-PH-HP
KM8AM	49,496	SO-PH-LP
VA3NW	22,650	SO-PH-LP
VE3IDT	21,692	SO-PH-LP
VA3TPS	18,460	SO-PH-LP
VE3RVZ	18,090	SO-PH-LP
WD4IYE	392	SO-PH-QRP
VA3MYC (VE3LJQ, op)		
	72	SO-PH-QRP
VE3JM	2,428,790	SO-CW-HP
NA8V	1,042,587	SO-CW-HP
K8GL	684,854	SO-CW-HP
WI9WI	369,152	SO-CW-HP
VA3AR	287,205	SO-CW-HP
W1NN	294,424	SO-CW-LP
VE3TM	225,885	SO-CW-LP
VA3FF	207,681	SO-CW-LP
K4YJ	171,600	SO-CW-LP
KV8Q	142,800	SO-CW-LP
VE3IGJ	3,900	SO-CW-QRP
W8DXU	3,740	SO-CW-QRP
K8RJW	1,034	SO-CW-QRP
VE3GTC	282	SO-CW-QRP
N8VWY	18	SO-CW-QRP
VE3RZ	823,284	SOU-MIX-HP
K9OM	669,088	SOU-MIX-HP
N2BJ	168,480	SOU-MIX-HP
WT2P	144,540	SOU-MIX-HP
KV8O	80,372	SOU-MIX-HP
NE9U	807,428	SOU-MIX-LP
W9AV	222,887	SOU-MIX-LP
VE3GFN	129,168	SOU-MIX-LP
AB8OU	62,300	SOU-MIX-LP
WD8S	56,420	SOU-MIX-LP
K8ZT	58,497	SOU-MIX-QRP
VA3WW	46,294	SOU-PH-HP
VA3LR	8,688	SOU-PH-HP
KG9Z	4,329	SOU-PH-HP
N8DXR	3,440	SOU-PH-HP
VA3ROC	3,094	SOU-PH-HP
VE3PJ	219,687	SOU-PH-LP
VE3XNS	41,316	SOU-PH-LP
NR9K	6,336	SOU-PH-LP
WS6K	5,780	SOU-PH-LP
VA3AUW	5,250	SOU-PH-LP
K8AZ (W2GD, op)		
	2,306,739	SOU-CW-HP
K9CT	1,797,476	SOU-CW-HP
K9NW	1,457,393	SOU-CW-HP
VE3NNT	1,092,372	SOU-CW-HP
W8CAR	812,910	SOU-CW-HP
VE3MGY	371,180	SOU-CW-LP
VE3YT	257,527	SOU-CW-LP
VE3UTT	240,149	SOU-CW-LP
AB9YC	233,632	SOU-CW-LP
N8VV	214,416	SOU-CW-LP
KU4A	8,481	SOU-CW-QRP
VE3GMZ	5,480	SOU-CW-QRP
AB8FJ	451	SOU-CW-QRP
NV9L	648,600	MSHP

Southeast Region

(Delta, Roanoke, and Southeastern Divisions)

K4AB	1,141,607	SO-MIX-HP
AJ3AA	572,800	SO-MIX-HP
AI4WW	67,689	SO-MIX-HP
WA8KAN	36,000	SO-MIX-HP
W4BXI	5,713	SO-MIX-HP
NR4M (N9NB, op)		
	901,582	SO-MIX-LP
N8II	552,946	SO-MIX-LP
W4KZ (KG5HVO, op)		
	488,474	SO-MIX-LP
WW4XX (LZ4AX, op)		
	477,020	SO-MIX-LP
K4EJ	151,071	SO-MIX-LP
N4MM	119,472	SO-PH-HP
AA4CS	24,656	SO-PH-HP
AK4TC	19,500	SO-PH-HP
KA8Q	19,175	SO-PH-HP
W4ANT	19,062	SO-PH-HP
WA3LXD	30,317	SO-PH-LP
NC4MI	24,644	SO-PH-LP
N1XL	21,294	SO-PH-LP
WC4Y	12,804	SO-PH-LP
KB8VND	11,988	SO-PH-LP
N4AF	1,648,212	SO-CW-HP
N4OGW	1,235,376	SO-CW-HP
KZ5D	1,038,558	SO-CW-HP
NN7CW	1,008,351	SO-CW-HP
N4CW	547,785	SO-CW-HP
K7SV	845,952	SO-CW-LP
WB4TDH	243,528	SO-CW-LP
W4YE	125,618	SO-CW-LP
AA4XG (W4ATL, op)		
	118,146	SO-CW-LP
WN4AFP	117,390	SO-CW-LP
N4IJ	48,000	SO-CW-QRP
N7RCS	42,947	SO-CW-QRP
KC4IM	2,780	SO-CW-QRP
K2EKM	2,227	SO-CW-QRP
KH6KG/W5	850	SO-CW-QRP
N8AR	738,304	SOU-MIX-HP
WO4O	716,286	SOU-MIX-HP
N1RM	599,130	SOU-MIX-HP
NO9E	473,025	SOU-MIX-HP
NF4A	266,913	SOU-MIX-HP
N4XL	443,685	SOU-MIX-LP
W4LT	107,272	SOU-MIX-LP
WA4IPU	46,574	SOU-MIX-LP
WT8WV	38,988	SOU-MIX-LP
K1KNQ	23,556	SOU-MIX-LP
NA4DA	256,920	SOU-PH-HP
WW5L	69,750	SOU-PH-HP
K4ELI	27,240	SOU-PH-HP
K4VTE	17,952	SOU-PH-HP
KD4RH	17,272	SOU-PH-HP
KM4IAJ	17,784	SOU-PH-LP
KD4LEM	12,054	SOU-PH-LP
W4MTM	12,050	SOU-PH-LP
KE4YOG	8,869	SOU-PH-LP
WU0B	4,884	SOU-PH-LP
N4BP	735,878	SOU-CW-HP
N1LN	659,475	SOU-CW-HP
N4EEB	598,272	SOU-CW-HP
W4PM	469,273	SOU-CW-HP
N2YO	422,966	SOU-CW-HP
WA1FCN	363,411	SOU-CW-LP
K4OAQ	335,420	SOU-CW-LP
KM4SII	296,510	SOU-CW-LP
AA4LS	258,582	SOU-CW-LP
K2SX	205,296	SOU-CW-LP
K1MM	1,336,392	MSHP
W5EA	1,025,290	MSHP
W0NA	890,841	MSHP
N4IQ	547,060	MSHP
N4UU	173,524	MSHP

Northeast Region

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

KC1XX (WA1Z, op)		
	3,547,530	SO-MIX-HP
K5ZD	2,669,794	SO-MIX-HP
KD4D	2,069,473	SO-MIX-HP
N2NT	1,834,784	SO-MIX-HP
K3MM	590,248	SO-MIX-HP
N2EM	194,752	SO-MIX-LP
KE2I	30,478	SO-MIX-LP
N3TE	22,458	SO-MIX-LP
K3KU	13,846	SO-MIX-LP
N1GSA	10,234	SO-MIX-LP
W7LG	16,200	SO-MIX-QRP
N1UR	1,264,224	SO-PH-HP
N3NR	155,325	SO-PH-HP
W2JV	147,108	SO-PH-HP
AB1EP	70,851	SO-PH-HP
KB3UVG	13,328	SO-PH-HP
KW2J	32,651	SO-PH-LP
NG1M	24,820	SO-PH-LP
KS2G	24,570	SO-PH-LP
VE1SQ	14,400	SO-PH-LP
N1GB	13,260	SO-PH-LP
AB3RW	546	SO-PH-QRP
W1KM	2,631,980	SO-CW-HP
K1KI	2,214,576	SO-CW-HP
AB3CX	1,102,335	SO-CW-HP
K3ZO	746,550	SO-CW-HP
KU2M	614,601	SO-CW-HP
W1QK	319,520	SO-CW-LP
K3MSB	247,923	SO-CW-LP
WT3K	211,836	SO-CW-LP
KA1IS	163,944	SO-CW-LP
W1FJ	153,162	SO-CW-LP
N2WK	122,153	SO-CW-QRP
K8CN	69,174	SO-CW-QRP
WS1L	7,040	SO-CW-QRP
VE9BWK	4,625	SO-CW-QRP
WA2NYY	176	SO-CW-QRP
VA2WA	2,688,975	SOU-MIX-HP
VA2EW	2,673,160	SOU-MIX-HP
KO8SCA	1,161,000	SOU-MIX-HP
W1GD	901,544	SOU-MIX-HP
K1AR	747,383	SOU-MIX-HP
NN1C	1,202,149	SOU-MIX-LP
KE3X	540,285	SOU-MIX-LP
W1ARY	266,961	SOU-MIX-LP
AA1SU	99,412	SOU-MIX-LP
WA2JQK	81,810	SOU-MIX-LP
VE2NTT	235,081	SOU-PH-HP
W3LL	120,658	SOU-PH-HP
KA2K	26,062	SOU-PH-HP
K2ANZ	21,645	SOU-PH-HP
W3JJL	20,460	SOU-PH-HP
KA2KON	43,935	SOU-PH-LP
VE2CSM	29,360	SOU-PH-LP
KD2JOE	24,912	SOU-PH-LP
WB3BJU	20,104	SOU-PH-LP
W2MSA	4,814	SOU-PH-LP
AA3B	3,060,344	SOU-CW-HP
VE9AA	1,764,720	SOU-CW-HP
K1MK (@K1TTT)		
	1,383,393	SOU-CW-HP
N3AD	1,111,908	SOU-CW-HP
N3RS	1,060,000	SOU-CW-HP
K1XM	1,149,232	SOU-CW-LP
W1UE	678,216	SOU-CW-LP
W3KB	546,117	SOU-CW-LP
WO1N	234,630	SOU-CW-LP
VE1RSM	230,144	SOU-CW-LP
W3YJ	4,375	SOU-CW-QRP
KC2WUF	2,664	SOU-CW-QRP
K1IR	1,717,264	MSHP
K3CCR	415,719	MSHP
W2Z	259,280	MSHP
K1RQ	180,796	MSHP
WA2CP	142,008	MSHP

The April 2021 ARRL Rookie Roundup — Phone

1800 UTC – 2359 UTC, Sunday, April 18

The Rookie Roundup is an event to encourage newly licensed operators to get on the HF bands and experience competitive amateur radio. This is a great way for clubs to get their newer members on the air, and the perfect opportunity to mentor new licensees.

Rookies make as many contacts as possible during this 6-hour event. Rookies work everyone and non-Rookies work only Rookies. The exchange is your name, call sign, a two-digit year, and state (US or Mexican), Canadian province, or "DX."

You can enter as a Rookie if:

- You made or will make your first-ever contact this year or during the previous three calendar years (send the last two digits of the year of your first contact in your exchange); or
- You haven't made any contest contacts using the contest mode (CW) before (send the last two digits of the current year in your exchange).

If you are a non-Rookie, send the last two digits of the year of your first license.

Rookies can enter as a Single Operator or invite Rookie friends over and operate as Multioperator. Up to five Single Operator Rookies can also enter from their individual stations and submit their total score as a team.

Non-Rookies can join the fun by calling "CQ Rookies," encouraging the Rookie operators to call you.

All scores must be reported within 72 hours after the event. No late entries will be accepted.

Jarod Manning, KI5FHT; Jorge Duarte, W3JDG, and Thomas Hays, KI5AIF, participated in the 2019 ARRL Rookie Roundup. They received first place in the Multioperator category for the RTTY event. [Thomas Hays, KI5AIF, photo]

Complete rules, logging sheets, and links for submitting your score can be found at www.arrl.org/rookie-roundup

Write for *QST*

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

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

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

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

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

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

W1AW Schedule

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

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

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

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

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

Code bulletins are sent at 18 WPM.

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

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

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

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

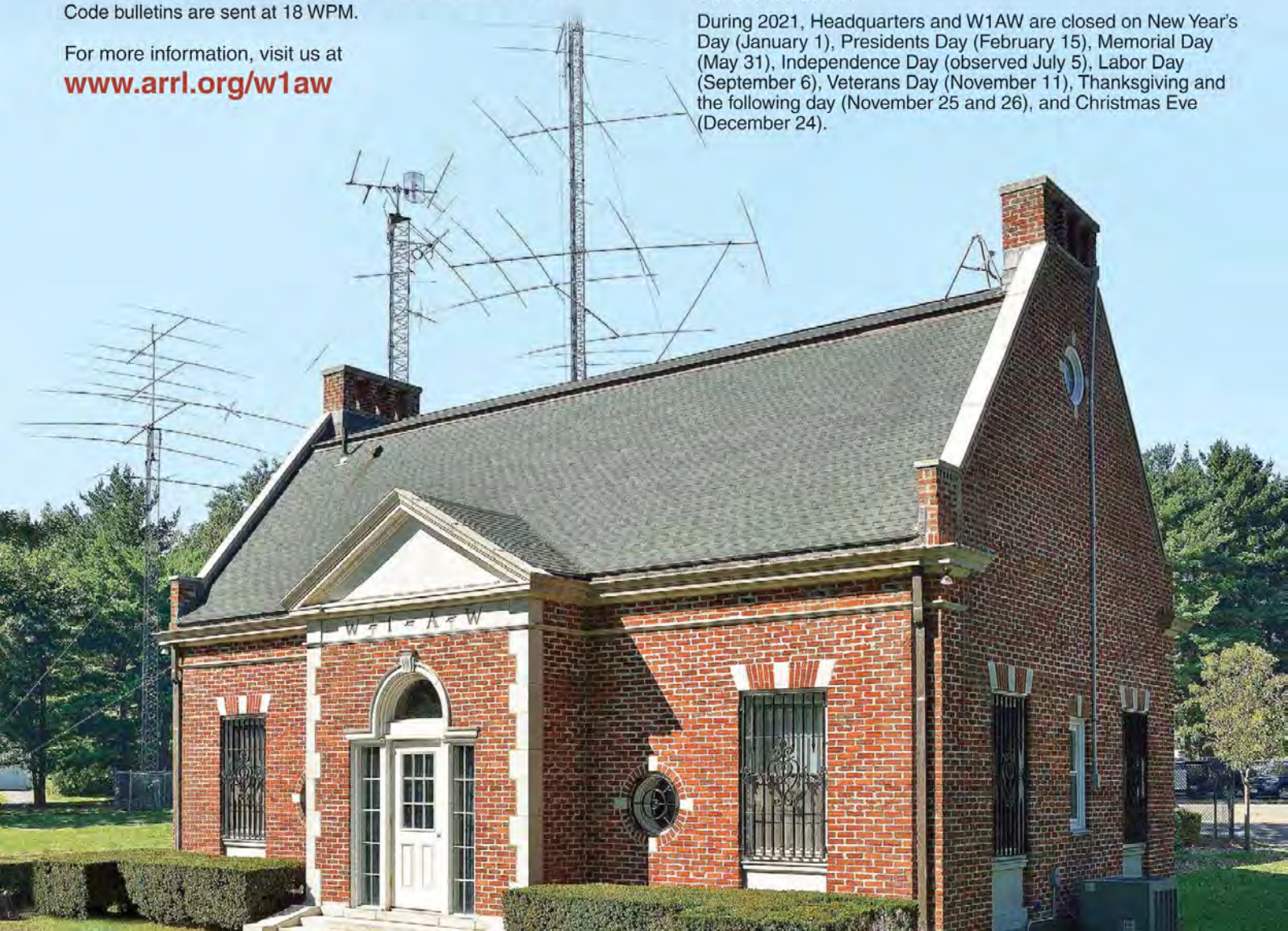
Keplerian elements for many amateur satellites will be sent on the regular digital frequencies on Tuesdays and Fridays at 6:30 PM Eastern time using Baudot and PSK31.

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

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

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

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



Bernie McClenny, W3UR, w3ur@arrl.org

How's DX?

Polar DX News from the Arctic and Antarctic

This month, we will be focusing on Polar DX news from both the Arctic and Antarctic regions, thanks to input from Volker Strecke, DL8JDX, a former operator at Georg Forster Base and Neumayer Base. With the most activity from the south, let's start with activity from the Antarctic region.

Progress Base — RIØ1ANT

As this column was being written, Alexey, RX6A, was on his way to the Progress Base and Vostok Base, where he is expected to be active with special call RIØ1ANT from Christmas Day 2020 until May 30, 2021. This will not be Alexey's first time operating from Antarctica, as he was previously active as 4K1B (1990 – 1992), 4K1C (1992), 4K1K (1992), and 4K1L (1992). He departed on December 6, 2020, and had been active as RX6A/MM aboard the Russian research icebreaker *Akademik Treshnikov* (UBXH3).

Vostok Base — RI1ANC

Alex, RD1AV, has been active on 30 meters FT8 as RI1ANC from the Vostok Base, Antarctica. QSL via RN1ON.

Mirny Base — RI1ANM

On June 21, 2020, there was a fire at the Mirny station (Antarctica), RI1ANM (more information can be found at **https://izwest.livejournal.com/5623654.html**). The radio shack was affected, so Alex, RX3ABI, has ended his operation. He will continue to be at the base until February 2021.

Syowa Base — 8J1RL

Taka, JA1AGS, and Hiro, JH7JCX, are part of the 61st Japanese Antarctic Research Expedition's overwintering team at the Syowa Station on East Ongul Island (AN-015), Antarctica. They have kept the station very active on CW and FT8 on 40, 30, 20, 17, and 15 meters and were there until January 2021. Takumi, JG3PLH, will be part of the Japanese Antarctica Research Expedition 62nd Crew and will be the operator at 8J1RL from February 2021 to January 2022. QSL cards can be sent via the bureau (JARL) or direct to JG2MLI. More details about the station can be found at **www.qrz.com/db/8J1RL**.

Neumayer III Base — DPØGVN and DP1POL

Teresa, DC1TH, has been part of the 41st wintering team at the German Neumayer III Base, located at Atka Bay on the Ekstrom Ice Shelf on Dronning Maud Land, Antarctica, since January 2020, and she will remain through February 2021. She has been operating at DPØGVN on the QO-100 satellite. Roman, HB9HCF, has also been active. On December 20, 2020, Felix, DL5XL, departed for the Neumayer III Station aboard the *Polarstern* operating as DPØPOL/MM on CW and digital modes. He expects to arrive by mid-January 2021 staying through mid-March and operating as DP1POL. QSL DP1POL via DL1ZBO. He may also operate DPØGVN. QSLs for DPØGVN go via DL5EBE.

Belgrano II Base — LU1ZG

Since early October 2020 Ramon, LU3HRS, has been operating from the Argentine Belgrano II Base, located at 77° 52' 15" South and 34° 37' 40" West, on Coats Land on Ross Island (IOTA AN-011), Antarctica. He is operating with club call sign LU1ZG. Activity has been almost exclusively on FT8 on 40, 20, 17, and 15 meters. The station is located at grid locator HB22qd. He can also operate on FT4 and JT65. Requests for QSLs go via Henry, LU4DXU, or via LU4AA, the Radio Club Argentino.

King Se-Jong Base — DT8A

Lee, DS4MNJ, headed back to the South Korean King Se-Jong Base, located in the South Shetland Islands. As a reminder, the South Shetland Islands (VP8/h) counts as a separate DXCC entity from Antarctica. Lee is expected to be here and QRV with the call DT8A from January through December 2021. On his way, aboard the *Araon* ship, he could be active as /MM operating maritime mobile. The mighty *Araon* is 111 meters long and 19 meters wide with a 7.6-meter draft, weighing some 7,487 tons, and it can cut through 1 meter of ice. The King Se-Jong Base is located at 62° 13' 26" South and 58° 47' 27" West, on IOTA AN-010 in ITU Zone

73 and CQ Zone 13. QSLs for DT8A go via DS5TOS.

Bouvet Island — 3Y/B

The Rebel DX Group is still planning to operate 3YØI from the second most-wanted DXCC entity, despite keeping many of the details close to the vest. As of the end of 2020, they are still going forward with their plans, as some of the team members were on their way to South Africa, presumably working out details. Keep an eye on Facebook and the Rebel DX Group website, or your favorite DX outlet.

Kerguelen and Crozet Islands — FT#X and W

Gildas, F4HQZ (ex-TU5KG), is a captain of the *La Reunion*, a fishing ship, which sails around the French Antarctic islands of Kerguelen and Crozet for up to 3 months at a time. Occasionally, in the past, Gildas has landed on one of these islands for an overnight and has operated for a few hours. That was not possible this last trip, as there were COVID-19 restrictions that prevented landing on these two rare DXCC entities. When you hear FT5XT/MM, work him and ask if he will be landing on one of the rare counters. Typically, he operates on SSB while maritime mobile and on CW when on one of the rare islands. For the record, Crozet ranks number three on the most-wanted list and Kerguelen is number 10. Crozet has not been on the air since November 2009 (FT5WO), while Kerguelen has been silent since October 2017 (FT5XT). The last big DXpedition to FT#X was FT5XO in March 2005, and there has never been a large-scale DXpedition to FT#W.

Halley VI Base — VP8HAL

As of press time (early January), Will, MØZXA, plans to be back at the British Antarctic Research Station Halley VI and operating as VP8DOI in his spare time during January and February 2021. He is part of the British Antarctic Survey. Seba, SQ1SGB (ex-VP8HAL), will also be there and might operate as either VP8/SQ1SGB, SQ1SGB/A, /ANT, or /P or VP8HAL. Activity will be on various HF bands for a limited time. QSL via EB7DX.

US Antarctic Bases — KC4

The American Amundsen Scott South Pole Station (KC4AAA), McMurdo Station Ross Island (KC4USV), and Palmer Station (KC4AAC) were all active this Antarctic Summer. Most of the activity has been on 20-meter SSB around 14.243 MHz. No word on who the operators are or how long they will be active. QSL all three of these stations via K7MT.

Jan Mayen — JX2US

In the Arctic region, Erik, LA2US, is working from Jan Mayen between October 2020 and March 2021. He is operating as JX2US in his spare time on 160, 80, 40, 30, and 20 meters, with concentration on the lower bands. Listen for him on CW and FT8. He is operating from the eastern side of the island in Olonkin City, which has good coverage to most of Europe and some to Asia, and North and South America. Listen for him on CW near the low end of the CW band or near the IOTA frequencies. Suggested frequencies on FT8 using Fox and Hound (F/H) submodes are as follows: 1843, 3577, 5357*, 7056, 10132, 14086, 18096, 21086, 24912, and 28086 kHz. (*60-meter FT8 is not using F/H). His station includes an FTDX-5000MP, RigExpert 5K, SPE Expert 1K-FA, and OCFD antennas. Contacts are being uploaded weekly to Club Log. QSL requests will only be done via Club Log OQRS, when he returns in April 2021. Contacts will also be uploaded to Logbook of The World (LoTW) after he gets back home in Norway.

Wrap-Up

A special thanks to DL8JDX and JX2US (LA2US) for helping to make this month's column possible. If you have any DX or IOTA news, photos, or club newsletters please send them to **bernie@dailydx.com**. Until next month, see you in the pileups!
— *Bernie, W3UR*

Erik Sommerseth, LA2US, is once again working in the Arctic region as JX2US from Jan Mayen. He will be there until March 2021. [Erik Sommerseth, LA2US, photo]

Erik, LA2US, is operating JX2US from this shack in Olonkin City, Jan Mayen. JX ranks number 79 on Club Log's Most-Wanted DXCC list. [Erik Sommerseth, LA2US, photo]

Jon Jones, NØJK, n0jk@arrl.org

Getting Started on 6 Meters

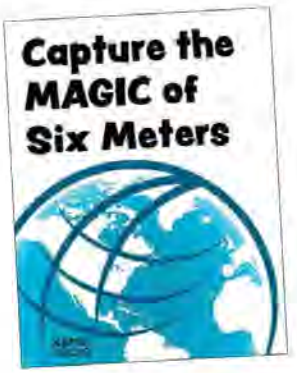
Inspired by Jim Wilson's, K5ND, ebook, *Capture the Magic of Six Meters*, I will be discussing getting started on 6 meters, including types of radios and antennas to use and propagation that will be encountered.

The 6-meter band is 50 – 54 MHz. The majority of weak-signal and digital activity is in the lower 500 kHz of the band. It is the lowest VHF band, above the 30 MHz HF band and below higher VHF bands, such as 2 meters. It shares some characteristics of the HF bands, such as 10 meters, and the VHF bands, like 2 meters. All propagation modes may be encountered on 6 meters, including sporadic E (the primary DX mode during the summertime), F2 propagation, back-scatter, aurora, meteor scatter, trans-equatorial propagation, tropospheric refraction, and EME (Earth-moon-Earth) reflection.

To get started, many of the HF radios now include 50 MHz. Examples are the Icom IC-9100, Yaesu FT-991A, and Kenwood TS-890S. In the past, operators used dedicated 6-meter radios, such as the Heathkit SB-110A, Swan 250, IC-575, and the Drake TR-6. The Drake TR-6 transceiver with Sherwood filters can still hold its own with SDR radios today. Jim mentions the 10 W MFJ-9406. I use one, and I made a contact at a distance of 26,000 kilometers from American Samoa to Tanzania on 6 meters in 2001. I modified it for use on FT8, and with it, I made a contact with NØLL in EM07 while he was on his grid expedition. For many people, your current radio may already have 6 meters.

Antennas

The simplest antenna for 6 meters is the dipole or ¼-wave ground plane. Dipoles are easy to build. I have had good success with one in the attic.



Antenna gain helps, so a two- or three-element Yagi is the next step. I use a home-built two-element Yagi for portable operation. K5ND likes the PAR Electronics Stress Moxon. It has the same gain as a two-element Yagi, but a higher front-to-back pattern. For three elements, you can build your own or buy a product from a vendor, such as M2. Five elements and up will perform better. These antennas will require a tower, rotator, etc.

Modes

SSB, CW, and FM used to be the primary modes for 6-meter operation. With the digital revolution, *WSJT-X* modes are now predominant on 6 meters. FT8 and JT65 are used for terrestrial propagation, and MSK144 is used for meteor scatter. JT65 is used for EME.

Power

When I first got on 6 meters, 10 W was a good starting point. Later, 100 – 200 W with a small amplifier became the norm. Nowadays, the HF+ 6-meter radios put you at the 100 W level. You can work many stations with 100 W, particularly with a good antenna. But there will be times when power will help you work the rare DX. An example was on April 15, 2020, when there was a major E_s-to-TEP opening. I copied many South American stations on FT8. But there were so many high-power North American stations calling them that making a contact was difficult. High power is also necessary for EME work. There are a number of good commercial amplifiers, such as Alpha and ACOM. KFØM uses a modified Heathkit SB-220 HF amplifier on 6 meters. Ken Neubeck's, WB2AMU, book, *Six Meters: a Guide to the Magic Band*, is a great guide to the Magic Band, and can be ordered on Amazon at **https://www.amazon.com/Six-Meters-Guide-Magic-Band/dp/B0045D6BP6**. Jim Wilson's, K5ND, free ebook is available at **https://www.k5nd.net/2020/08/capture-the-magic-of-six-meters-ebook**.

On the Bands

50 MHz. December is the peak month for the North American winter sporadic-E season. But December, overall, was slow for North American stations. One of the better days was December 12 – 13, which coincided with the ARRL 10-Meter Contest. Ten meters was wide open all Friday evening for contestants. Here in Kansas, I logged 10-meter contest contacts coast to coast on QRP. E_s was present on 6 meters as well. Ron, KF3R (FM18), starting at 0233Z worked stations in the southeast states to XE2YWH (DL92). He noted neighboring stations worked double-hop sporadic E to W6 and W7. Ron uses an indoor Moxon antenna.

Most 6-meter openings reported in December were single hop, but a few double-hop openings were noted. Jim, K5ND (EM12), worked KP4AJ (FK68) on double-hop E_s on December 11 at 1656Z. Later that day, K9RX (EM84) worked New Zealand, logging Rod, ZL3NW, at 2244Z. He said he peaked at +4 dB. This was likely an E_s–TEP–E_s opening. On December 15, NØLL (EM09) and I worked W4IMD (EM84)

on E_S. On December 23, I (NØJK in EM28) caught a brief E_S opening to Florida. I logged K4CVL (EL87) at 0222Z.

On December 30, KF3R worked four new states, including one contact with VE1JBC (FN73), starting at 1522Z during an hour-long band opening. NØJK (EM28) logged W7GJ (DN28) on FT8 later that morning.

The 2020 Geminid Meteor Shower. Activity was good during the Geminid meteor shower (see Figure 1). I logged WB9CIF (EM69) and NØKV (DM79) on MSK144 on 6 meters on December 14. Curt, K7ZOO (DM31), made six MSK144 contacts, including XE2AT. He ran about 40 W to a three-element Yagi. John, KFØM (EM17), worked KF4ZZ (EM70) on December 14.

Larry, NØLL, did another pop-up grid activation in rare grid EN01 for Fred Fish Memorial Award seekers on December 19 at the tail end of the Geminid meteor shower (see Figure 2). Larry reported that he had a rough outing, with many failed decodes and weak signal reports, but he still made 12 good contacts.

Figure 1 — NØJK MSK144 PSK map flags during the December 14 UTC Geminid meteor shower, including the contact with WB9CIF. [Graphic courtesy of PSK Reporter]

144 MHz. Jim, K5ND (EM12), picked up three new grids in the Geminids on 2 meters, including N2CB (EN75), KU4XO (EM84), and KA9FOX (EN43). He runs 100 W to a six-element Yagi on a 20-foot mast. Gedas, W8BYA (EN70), worked Cuba on MSK144 logging Raydel, CM2ESP (EL83). Gedas had been coaching Raydel on MSK144 techniques. Raydel runs just 25 W to a four-element Yagi. Gedas said:

> On December 14 (UTC), Raydel finally started to copy some decodes, and he was hooked. Raydel reported working four state-side stations via meteor scatter. I believe I was his best DX at 1,987 kilometers. He was hearing North American stations a lot better than we were hearing him due to the power difference. The contact with Raydel provided me with my fifth 2-meter country (non-EME) and my 395th grid.

Figure 2 — Larry Lambert, NØLL, had a portable setup for MSK144 6-meter activity in December. [Larry Lambert, NØLL, photo]

Here and There

To usher in the new year, on January 1, 2021, a big opening took place in the afternoon for North America to Australia, North Cook Islands, and New Zealand. W5KI (EM36) in Arkansas worked ZL4AS with just a SteppIR Yagi. K5CM (EM25) and W5LDA (EM15) in Oklahoma also made contacts into New Zealand with a sunspot of just 3. More on this. More on this opening next month.

Convention and Hamfest Calendar

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

Abbreviations

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

QSO TODAY VIRTUAL HAM EXPO

March 13 – 14, Online

D H S T

Sat. and Sun. 3 – 11 PM. *Spr:* KEG Media, Inc. dba QSO Today. Icom Virtual Exposition Center. *Adm:* Free. **www.qsotodayhamexpo.com**

Florida (Fort Walton Beach) — Mar. 19 – 20 D F H R V

Fri. noon – 5 PM; Sat. 7 AM – 2 PM. *Spr:* Playground ARC. NWF Fairgrounds, 1958 Lewis Turner Blvd. *TI:* 146.79 (100 Hz). *Adm:* $7. **www.w4zbb.org**

Levittown (New York) — Feb. 28 D S

9 AM – 1 PM. *Spr:* Long Island Mobile ARC. Virtual event. *TI:* 146.85 (136.5 Hz). *Adm:* Voluntary donation. **www.limarc.org**

ARRL OKLAHOMA STATE CONVENTION

April 9 – 10, Claremore, OK

D F H Q R S V

Fri. 4 – 9 PM, Sat. 8 AM – 3 PM. *Spr:* Green Country Hamfest Association. Claremore Expo Center, 400 Veterans Pkwy. *TI:* 147.09 +600, 88.5 FM and C4FM. *Adm:* Advance $8, door $10. **www.greencountryhamfest.org**

Tennessee (Sevierville) — Mar. 27 D F H R S T V

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

ARRL VERMONT VIRTUAL STATE CONVENTION

February 27, South Burlington, VT

D F H S T

8 AM – 5 PM. *Spr:* Radio Amateurs of Northern Vermont. Online event. *TI:* 145.15 (100 Hz) *Adm:* Free. **www.ham-con.org**

To All Event Sponsors

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

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

The deadline for receipt of items for this column is the **1st of the second month preceding publication date**. For example, your information must arrive at HQ by **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.

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Strays

■In November 2020, the Portage County Amateur Radio Service (PCARS) presented their annual donation to the Amelia DiGirolamo Center of Hope in Ravenna, Ohio. This year's donation amounted to $10,210.74, the largest ever in PCARS's 15-year history of supporting the Center of Hope. PCARS President Tom Sly, WB8LCD; PCARS Vice President Nick Wagner, AC8QG, and other PCARS members presented the donation to Mark Frisone, Executive Director of Family & Community Services.

The Center of Hope provides hot meals, groceries, and nutritional services to low-income residents of Portage County. Frisone stated that 2020 had been particularly tough on low-income citizens, and demand for the services provided by the Center of Hope were up substantially over previous years.

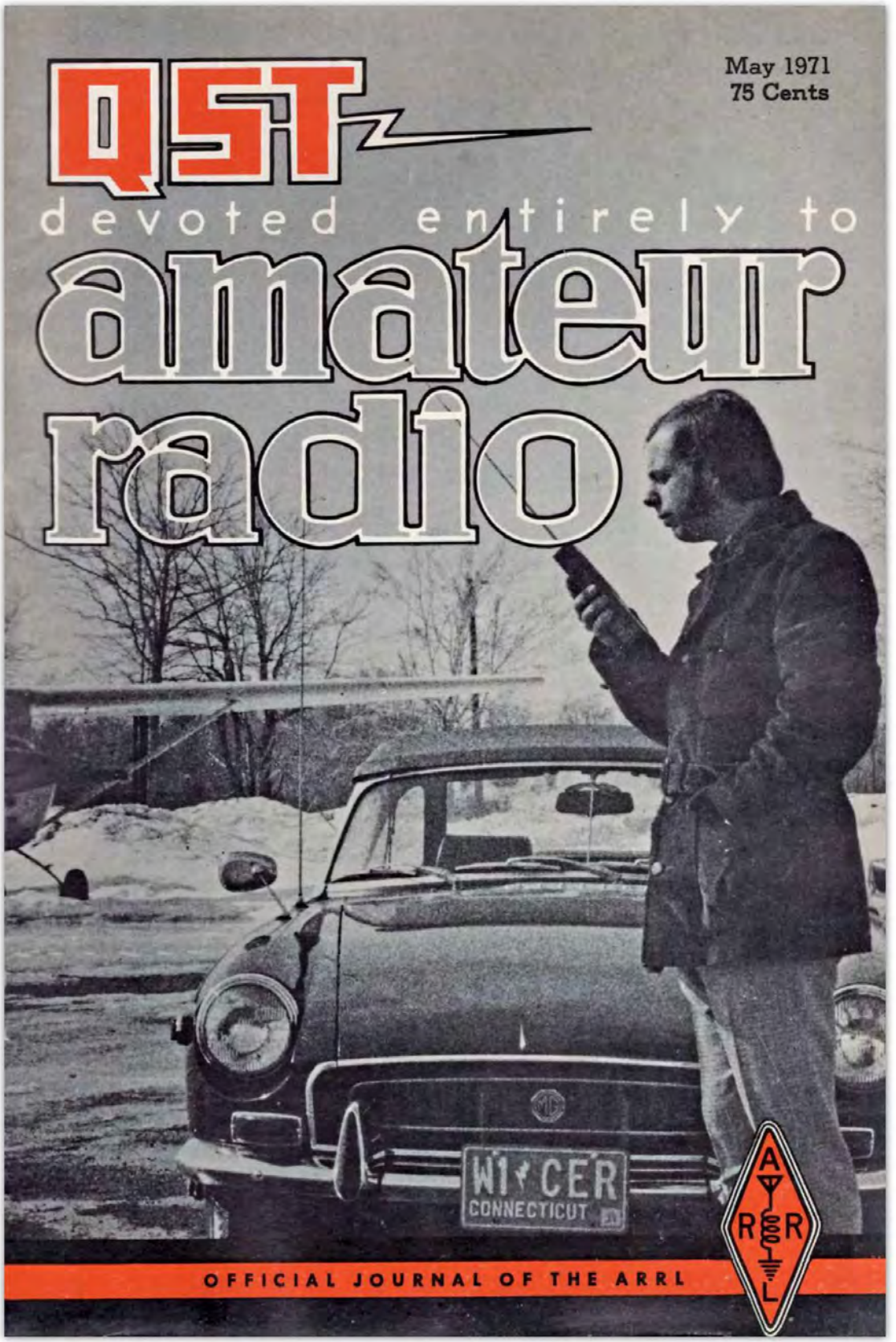
"I am proud to be a member of…PCARS, whose members have worked so hard to serve their community in so many ways," Sly said. PCARS meets the second Monday of each month at the Kent American Legion. They have a club radio station in Ravenna.

■Amateur Radio Digital Communications (ARDC) recently announced two new members of their Board of Directors — Bob McGwier, N4HY, and Keith Packard, KD7SQG. They joined the board in December 2020.

QST Congratulates…

■Vern Maine, AI1I, who published the *Salt Springs Series — Dragon Fighters Trilogy*. The 1970s-era adventure series features a rescue mission involving the use of CW. The series includes *North Until Dawn*, *Fear Not the Dragon*, and *There is a Tide*. They are available on Amazon.

A Look Back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Recent Equipment

To acquaint you with the technical features of current amateur gear.

Heath Model IB-101 Frequency Counter

THANKS TO the Heath Company and the manufacturers of solid-state components, amateurs and experimenters can measure frequency at moderate cost. The IB-101 counter comes in kit form, costs less than most amateur transmitting and receiving equipment, and can be assembled and calibrated by any person with a knowledge of soldering and the use of hand tools. It took but 5 hours, start to finish, to assemble and check out the unit described here. It is quite likely that persons with greater manual dexterity than that possessed by the writer could do the same job in considerably less time. The combination of large hands and miniature components does not always contribute to great efficiency during the assembly of kits. Nonetheless, the job went smoothly, and the equipment "played" the first time it was turned on!

This piece of test equipment can be used in many ways around the ham shack. Those who are interested primarily in operating can use the counter for keeping tabs on the operating frequency of the transmitter, be it crystal controlled or of the VFO-governed variety. Since the instrument is designed to measure frequency

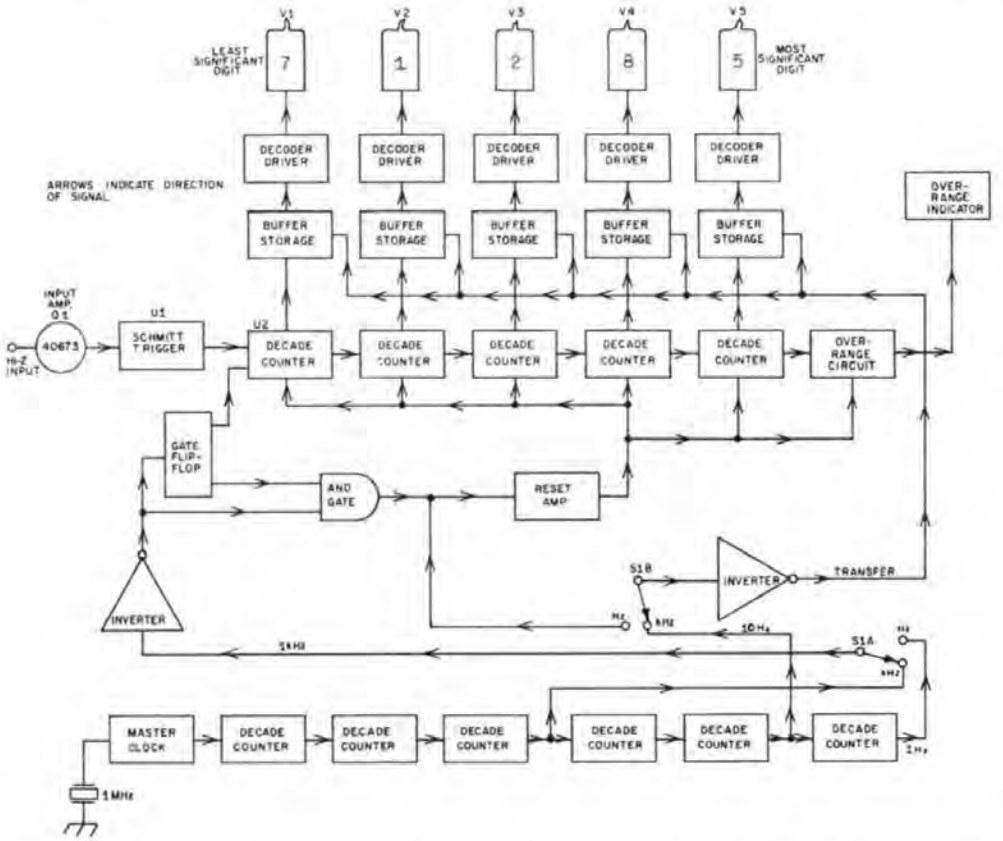

Fig. 1 — Block diagram of the IB-101 counter. The built-in ac power supply is not shown in this respresentation.

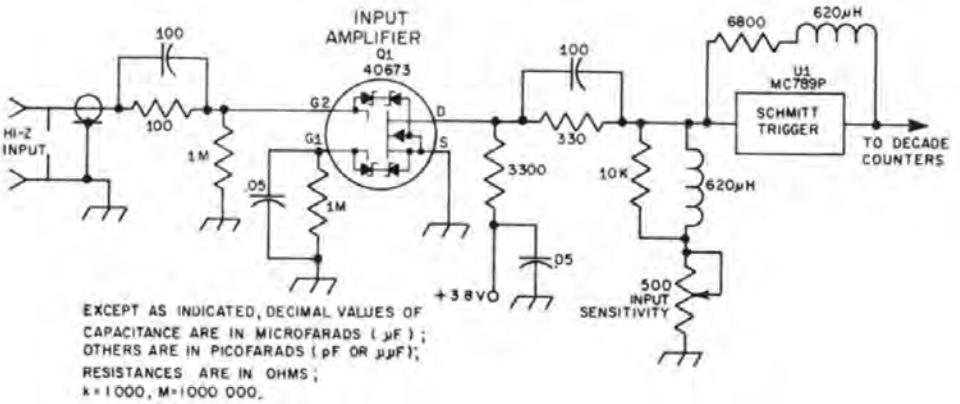

Fig. 2 — Schematic diagram of the dual-gate MOSFET input amplifier. The Zener-diode-protected gates can handle relatively high levels of input signal, as shown in the chart of Fig. 3.

from 1 Hz to 15 MHz, direct ham-band measurements can be made through 20 meters. Experience with the model shown here proved that the unit would work satisfactorily through 23 MHz by using slightly more signal input than is required for its guaranteed coverage range. This equipment should also be useful to experimenter-type amateurs who wish to calibrate oscillators and measure frequency drift on their homemade and commercial gear. A frequency counter soon becomes the right arm, so to speak, of the person who has grown accustomed to having the accessory on hand. Heath has recently announced the availability of an outboard prescaler which will extend the range of the IB-101 to 175 MHz, thus providing measurement capability well into the vhf spectrum. The prescaler kit is sold as the IB-102.

Circuit Information

The block diagram of Fig. 1 illustrates how the various stages are tied together. The solid-state devices that are used in the kit-builder's recipe consist of 7 bipolar transistors, 1 dual-gate MOSFET, 26 ICs, and 6 diodes. There are 5 readout display tubes, each containing separate anodes for the numbers 1 through 0.

The input stage of the counter employs a 40673 dual-gate MOSFET, Fig. 2, to provide a high-impedance input characteristic. This feature prevents loading of the circuits being tested. This device offers further benefits through its ability to accommodate a wide range of input voltages and waveshapes. The 40673 has Zener-diode-protected gates which protect the transistor from excessive input voltage.

A Schmitt trigger, U1, follows input stage Q1. This circuit shapes the input signal into a square wave so that it will be suitable for driving the logic that follows. Decade counters change the sequential input pulses from the Schmitt trigger into a binary-coded 8-4-2-1 output.

It would be difficult to explain, in depth, the function of the logic circuits without providing symbols and truth tables in this review, and such a presentation would be rather far beyond the scope of this write-up.[1] Following the initial processing of the input signal, as outlined in the foregoing, conventional logic techniques are used. The usual collection of decade counters, buffer storage circuits, decoder drivers, and display tubes are utilized. The instruction booklet covers the theory of circuit operation in considerable detail, and can serve well as a course in counter logic by itself.

Some Specifications

The time base for the IB-101 is a 1-MHz crystal-controlled oscillator. Its aging rate is less

[1]Principles of operation, and amateur uses of frequency counters were given in *QST*: Macleish, "A Frequency Counter for the Amateur Station," *QST*, October 1970.

It can be seen from this inside view of the frequency counter that the layout is very orderly and uncomplicated. The majority of the parts are mounted on a pc board. Power supply parts are installed on the main chassis, which is metal.

than 1 part per million per month after 30 days of operation. The ambient temperature stability is rated at less than ± 2 parts in 10^7/degree C, at 20 to 30 degrees C after 30 minutes of warmup, and ± .002 percent from zero to 50 degrees C. Overall accuracy is ± one count ± the time-base stability.

The gate times are 1 millisecond or 1 second, with automatic reset. Input sensitivity is rated at less than 100 mV (rms) from 1 Hz to 1 MHz, and less than 250 mV (rms) from 1 MHz to 15 MHz after a 30-minute warmup period. The input impedance is 1 megohm, shunted by less than 20 pF capacitance. Maximum safe input signal (ac only) is 200 volts rms from 1 Hz to 1 kHz. It is necessary to derate the input by 48 volts per frequency decade. A chart showing the voltage input limit versus frequency is given in Fig. 3.

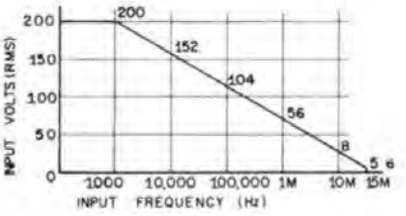

Fig. 3 — Chart showing the maximum allowable rms input voltage versus frequency. M = million.

Assembly Notes

Most of the components are mounted on a single circuit board. The power supply is built on the main chassis, and very few interconnecting wires are needed between the power supply and the circuit board. Similarly, there are not many connecting leads required between the panel controls and the circuit board.

The sockets for the ICs are made up by the builder from long strips of stock which are provided with the kit. The constructor must count the required number of pins per IC, cut off the length of stock needed, then solder it into the pc board. *Use caution during this part of the operation*! The metal is extremely brittle. Excessive flexing will cause the stock to break during installation, or when the ICs are inserted into the sockets. Luckily, in the writer's situation, there was a sufficient excess of stock to take care of two bull-in-the-China-shop errors which resulted from over-zealous attempts at fast assembly.

There was another part of the construction job that caused great consternation to the writer. The display tubes are supplied with plastic base mounts which are used to index the thin wire leads so that they mate with the proper holes in the tube sockets. The instructions call for the base mounts to be pushed up against the tube bases prior to the insertion of the tube leads into the pc-board sockets. With luck, this can be accomplished without difficulty. However, two problems were observed as a result of the plastic collars being used: The tubes would not remain securely seated in their sockets, thus leading to frequent intermittent operation of the readout tubes. This required the removal of the top cover of the counter and subsequent wiggling and pushing of the tubes to restore electrical contact. A second problem occured when one of the display tubes lost vacuum because its glass tip was somewhat longer than those of the other tubes, and this tip was broken off when the top cover was installed. The plastic base collars cause the tubes to sit quite high in the cabinet, thus the possibility of damage. The cure came when the collars were discarded and the tubes were placed in the sockets without them. This is a tricky undertaking, however, and one must be very careful to get the tube wires into the proper holes in the sockets. The balance of the assembly effort was fast and without incident.

Heath Model IB-101 Frequency Counter
Height: 3 3/8 inches.
Width: 8 1/4 inches.
Depth: 9 inches.
Weight: 4 1/2 pounds.
Power Requirements: 105 to 125 volts ac, or 210 to 250 volts ac, 50/60 Hz, 8 W.
Price Class: $200.
Manufacturer: Heath Company, Benton Harbor, MI 49022.

Final Comments

Checkout and alignment was simple and to the point. Two methods of alignment are given in the book. One requires separate test equipment, and the other calls for nothing more than a standard a-m radio set for calibration. Both methods were tried, and similar good results were obtained.

Indications to date are that all of the manufacturers specifications for the counter are as stated in the instruction book. The IB-101 should make a useful low-cost addition to any ham's workshop, and certainly reflects the current amateur state of the art for frequency measuring.

The cabinet of the IB-101 is finished in the new Heath colors – tan and brown, with chrome trim. The carrying handle doubles as a tilt-up stand when the equipment is being used. A test cable is included with the kit, and a UL-approved three-pin ac cable plug is used for connection to the mains. An adaptor plug for the older two-hole ac outlets is furnished. The adaptor has a ground wire which is common to the ground pin the three-connector plug. – *WICER.*

Strays

Antique wireless buffs will be interested to know that a permanent exhibit depicting the early Marconi station near Glace Bay, Nova Scotia, has been included in the Miners' Museum near Sydney. Although the museum is devoted primarily to coal mining, the Marconi station was an important landmark in the community of Glace Bay and part of the museum has been set aside to represent it in the form of photos and artifacts – *W2LT.*

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Filter Type	XF-9A	XF-9B	XF-9C	XF-9D	XF-9E	XF-9M
Application	SSB-Transmit.	SSB	AM	AM	FM	CW
Number of Filter Crystals	5	8	8	8	8	4
Bandwidth (6dB down)	2.5 kHz	2.4 kHz	3.75 kHz	5.0 kHz	12.0 kHz	0.5 kHz
Passband Ripple	< 1 dB	< 2 dB	< 2 dB	< 2 dB	< 2 dB	< 1 dB
Insertion Loss	< 3 dB	< 3.5 dB	< 3.5 dB	< 3.5 dB	< 3 dB	< 5 dB
Input-Output Z_t	500 Ω	500 Ω	500 Ω	500 Ω	1200 Ω	500 Ω
Termination C_t	30 pF	30 pF	30 pF	30 pF	30 pF	30 pF
Shape Factor	(6:50 dB) 1.7	(6:60 dB) 1.8 (6:80 dB) 2.2	(6:60 dB) 1.8 (6:80 dB) 2.2	(6:60 dB) 1.8 (6:80 dB) 2.2	(6:60 dB) 1.8 (6:80 dB) 2.2	(6:40 dB) 2.5 (6:60 dB) 4.4
Stop Band Attenuation	> 45 dB	> 100 dB	> 100 dB	> 100 dB	> 90 dB	> 90 dB
Price	$21.95	$30.25	$32.45	$32.45	$32.45	$23.00

HC-25/U crystals: 8998.5 kHz (USB), 8999.0 kHz (BFO), 9000.0 kHz (carrier) 9001.5 kHz (LSB). $2.75 each.

10.7 MHz filters with bandwidth: 14 kHz, 16 kHz (for 5 kHz freq. dev. FM), 32 kHz, 38 kHz (for 15 kHz freq. dev. FM) $30.25 each.

9 MHz crystal discriminators for max. freq. dev. of 1.5, 3 and 8 kHz. $17.95 each.

10.7 MHz crystal discriminators for max. freq. dev. of 10 and 20 kHz. $15.95 each.

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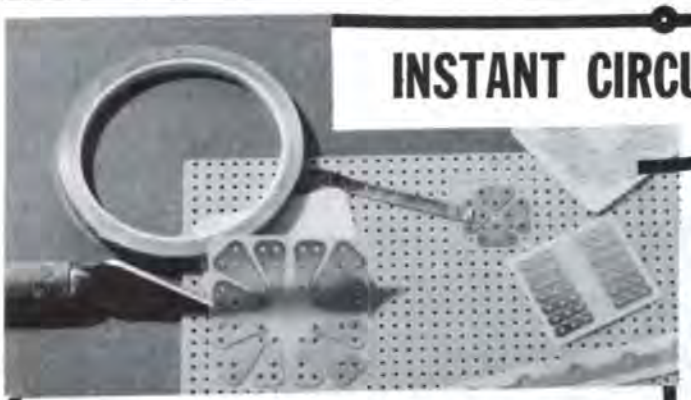

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Celebrating Our Legacy

50 Years of Radio Operation

On my 11th birthday in 1970, I earned my Novice-class license. I still have the original license I received from the FCC. I worked hundreds, perhaps thousands, of stations around the globe on a Heathkit HW-7 transceiver and a National NC-300 receiver. DXing was common with a wire dipole and if the band was marginal, there was always someone to talk to on 40 meters. That year, ARRL Field Day was unforgettable.

Scott Novotny, AAØEI, operating in the 1973 ARRL Field Day.

At the time, it seemed like everybody had a ham license, or at least an interest in it. I became an amateur radio operator because I enjoyed it, and because ham radio is a valued service to the community!

Scott Novotny, AAØEI
Chesapeake, Virginia

Ham Radio Around the World

I was exposed to amateur radio as a kid growing up in northeast Ohio, where my father knew a local radio station announcer who was also a ham. However, it wasn't until I was in college in the early 1970s that I saw ham radio in action. I participated in a mission trip to Uruguay and the two missionaries we worked with were hams. Being able to run phone patches to family in the US was a miracle, or so it seemed. It was that experience that confirmed my desire to get my license.

After graduating from college, I moved home to Wallingford, Connecticut. A friend and I went to Newington to visit W1AW several times. During one visit, we copied the 5 WPM bulletin that was being broadcast. The W1AW operator checked our copying skills and congratulated us on passing our Novice-class code exams! A few weeks later, we returned to do the written exams and passed those as well.

I began building a Heathkit station and finished it just in time to leave for a 3-year assignment with the Peace Corps in Africa. When I returned to the US in 1979, I moved to Kansas City, Kansas. Soon after, I earned my General-class license.

From 1982 to 2013, all of my operating was done overseas. I earned a reciprocal license in the UK and operated there until 1985. Then, I went to South Africa and was on the air for 4 years. After a year back in the US for graduate studies, I traveled to Swaziland and was on the air for 18 months before going to Mozambique at the end of the country's 16-year civil war. Thanks to a US Embassy communications officer and the local Motorola agent, the Mozambique Ministry of Transport and Communications agreed to reinstate amateur radio licenses, and I was able to get on the air as one of the first five amateurs licensed in the country for 18 years.

On return trips to the US, I was able to upgrade from my General-class license to an Amateur Extra-class license, and exchanged my Midwest call sign for a New England one. Six years ago, I returned permanently to the US and have finally been able to get a station set up and get back on the air.

I'm thankful to the operator at W1AW all those years ago, for helping to get me started with this enjoyable hobby of amateur radio.

Dave Restrick, W1DWR
Braintree, Massachusetts

An Unforgettable Mentor

I was 15 when I met my mentor and lifelong friend. I had recently received my Novice-class license and had built a one-tube transmitter from plans found in *Popular Electronics* magazine. My school bus route passed a house with a crank-up tower and an impressive tri-band Quad antenna on the roof. One Saturday, I rode my bike to the house and talked for a few hours with the owners, Karl Bretz, K9BGL, and his wife, Barbara. Karl gave me his old Multi-Elmac AF-67 transmitter to use until I saved up enough money to purchase my first real radio. I had already constructed a 40-meter dipole and strung it between two 20-foot poles, so I was ready to make some contacts. My Novice station also included a Hallicrafters S-53A receiver, a Heathkit Q Multiplier, and a homebrew electronic transmit-receive switch I built from plans in *The ARRL Handbook*. I contacted all 50 states and several countries with that station, running just 75 W.

Over the years, Karl mentored several young hams, and many of us went on to pursue careers in electronics, communications, and information technology. To this day, I still rely on his expertise in electronics and communications theory.

John R. Bechtoldt, WB9FHL
O'Fallon, Illinois
Life Member

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

George Misic, KE8RN, ke8rn@comcast.com

Classic Radio

The Clegg 66er and 22er Family

After some early success with 6-meter radios like the Clegg 99er, Thor VI, and the SSB Venus, Clegg decided to build the similar 6- and 2-meter Clegg 66er and 22er AM radios for fixed and mobile use (see Figure 1). Both radios included a 120 V ac and nominal 12 V dc negative or positive ground power supplies and speakers. The transmitter-receivers — not called transceivers because they did not transmit on the receive frequency — featured push-to-talk (PTT) operation that was missing from their model 99er. Both units used only crystal-controlled transmit; Clegg never made a VFO for these radios.

Jim Fisk W1DTY
RFD 1, Box 138
Rindge, N. H. 03461

The Clegg 66'er Six Meter Transceiver

Interested in 6 meters? The Clegg 66'er from Squires-Sanders does an outstanding job and is an ideal rig for the ham who operates on our 50-MHz band. This transceiver contains a stable and sensitive receiver and a 22-watt transmitter in one compact package. It was designed specifically for the six meter band and will cover the amateur frequencies as well as those for MARS, CAP and Civil Defense. In addition, both the 117 Vac and 13 Vdc power supplies are included in the package.

The dual conversion superhet receiver is extremely sensitive and less than 0.35 uV signal will provide a signal plus noise to noise ratio of 10 dB. The basic frequency range is 49.9 to 52.1 MHz, but for special applications, an expanded tuning range is available on special order. The two *if* frequencies of 10.7 MHz and 456 kHz provide 8 kHz selectivity and result in rejection of spurious responses by more than 60 dB.

The receiver is relatively straightforward with a 6EH7 in the front end, followed by a 6DJ8 converter to the 10.7 MHz *if* and a 6BA6 *if* amplifier. The injection frequency for the first conversion is provided by a 6KE8 VFO/buffer, this combination is quite satisfactory and results in less than 3 kHz drift per hour after a 20 minute warmup. The 10.7 MHz *if* signal is converted to 456 kHz in a crystal controlled 6BE6 converter and further amplified in another 6BA6 stage, followed by a 12AL5 detector, a 6AN8 audio amplifier and a 6AQ5 audio power stage.

The AGC voltage generated in the 12AL5 detector stage is applied directly to the two *if* amplifiers and the 2nd mixer and through a Zener diode to the rf amplifier; in this way no AGC is applied to the input stage until comparatively large signals exist. The other half of the 12AL5 is connected as a series gate impulse limiter; it is very effective in cutting down ignition and other types of impulse noise.

A semiconductor diode is connected as a series squelch diode between the output of the detector and the input to the first audio stage. Whenever the cathode of this diode is more positive than the anode, the audio sections of the receiver are effectively disconnected from the front end of the receiver. Since the anode of the squelch diode is connected to the screen voltage of the

90 73 MAGAZINE

Figure 1 — An advertisement for the Clegg 66er 6-meter radio. [Photo courtesy of the April 1967 issue of *73* Magazine]

Both units were the same size and weight (see Figure 2). They both measured 12 inches wide, 12 inches deep, and 6½ inches high, exclusive of knobs, connectors, and feet. They weighed 19 pounds. Clegg went on to make 22er FM radios when 2-meter FM became a popular mode. After the tube-type 22er FM radios, they went to solid-state radios for 2-meter FM, like the Clegg FM-27B.

Final Amplifier Stage

Both transmitters used a 2E26 tetrode vacuum tube in the final amplifier. The 2E26 was a smaller, lower-power version of the popular 6146 tube. The 66er ran an input power of 22 W input power. The 22er was rated at 20 W input power. Both transmitters produced about 50 – 65% of the input power. A single pi network output coupler was used in both the 22er and 66er. Built-in television interference (TVI) filters were used in both radios.

The grid circuit tuning was available on the front panel. There was no way to meter grid current because there was no separate means to properly tune the grid tuning. In the transmit mode, the panel meter indicated output power and was not calibrated in any way. The transmitter was set for maximum output, which was achieved by adjusting the controls for maximum meter reading.

Crystal Oscillator and Multiplier Stages

Both the 66er and 22er radios started out the transmitter with a type-6KE8, nine-pin miniature triode-pentode tube. The triode was used as a crystal oscillator, using crystals of about 8 MHz, 12 MHz, or 24 – 26 MHz. If 8 MHz crystals were used, the tube tripled the crystal frequency. If 12 to 13 MHz crystals were used, the oscillator doubled the frequency. The pentode portion of the tube doubled the frequency in the 66er with an output frequency of 49.9 to 52.1 MHz. In the 22er, the pen-

Figure 2 — The Clegg 22er and 66er pair. [David Thomas, KM4NYI, photo]

tode section of the 6KE8 was used as a frequency tripler to reach 72 to 74 MHz. Broadband couplers were used on both of these stages, so no tuning of the 6KE8 stages was needed in the first 2 MHz of the 6-meter band, or anywhere in the 2-meter band.

Straight-Through Stage

A unique feature in the design of both Clegg radios was the use of a straight-through driver stage using a 12BY7A tube. The tube in the 66er operated on the 6-meter band and assured the 2E26 got plenty of grid drive, without tuning the oscillator and doubler stages. The 22er employed this stage between the oscillator/tripler and doubler stages and operated at 72 to 74 MHz; as in the 66er, a type-12 BY7A tube was used in this stage. The extra gain when compared to other similar radios allowed Clegg to employ pass-band couplers in the early stages of the transmitter, while still generating enough RF to properly drive the 2E26 final amplifier.

The final doubler was only used in the 22er. It followed the straight-through amplifier stage, and it also used a 12BY7A tube to drive the final amplifier tube at 144 to 148 MHz. This tube was not used in the Clegg 66er transmitter-receiver.

Audio Circuitry

The audio output stage of both radios used two 6AQ5 audio output tubes. In receive, one of the 6AQ5 tubes was biased off when receiving, as one tube has plenty of power output for the receiver. To fully modulate the final at 20 or 22 W of input power, it took both 6AQ5s in parallel. The lower-level audio stages were a 12AX7 dual-triode in the 22er; the 66er used a 6AN8 triode-pentode. In the 66er, the 6AN8 triode was the microphone amplifier, and the pentode was the voltage amplifier stage for both the receiver and transmitter.

The two 6AQ5 tubes were in parallel to plate-modulate the 2E26 final amplifier. The audio transformer had a secondary winding to drive the speaker; the primary winding has the B+ fed to a tap on the winding; the two 6AQ5s are connected to one end and the plate and screen circuit of the 2E26 is connected to the other end.

A short jumper cable with a phono connector on each end connects the jack on the rear panel of the chassis and a second phono jack on the back of the cabinet connects to the internal speaker.

The 66er Receiver

There were a lot of differences in the receiver designs in the 66er and the 22er. The 66er is a double-conversion design. The 66er starts with a high-gain RF amplifier stage, using a 6EH7 tube. It is followed by a 6DJ8, operating as a mixer down to the first IF of 10.7 MHz. The tunable local oscillator is the triode portion of a 6KE8 triode-pentode. The pentode section is used as a buffer-amplifier to improve the stability of the local oscillator. The local oscillator covers 39.2 to 41.4 MHz to receive 49.9 to 52.1 MHz.

The first intermediate frequency (IF) uses the common 10.7 MHz. The second IF is identified as 456 kHz, rather than the more common 455 kHz. Back in the 1930s, the common IF was often called 456 kHz. The crystal used to convert 10.7 MHz to 456 kHz is an 11.156 MHz crystal. The 66er has one IF amplifier at 10.7 MHz and a second amplifier at 456 kHz; both stages use 6BA6 pentode tubes. The bandwidth of the last IF is specified as 8 kHz. With no filter devices, the selectivity of the receiver is suitable for its frequency stability.

The 22er Receiver

A triple-conversion design was used for the 22er receiver, which used a metal Nuvistor tube as the RF amplifier. The stage used a grounded grid design. The tunable local oscillator was tripled for the first conversion of the 144 to 148 MHz 2-meter band down to 44 to 45 MHz, using the tripled local oscillator covering 100 to 103 MHz. The first conversion used

the pentode portion of a 6KE8 as the mixer and the triode portion of the same tube as the frequency tripler. The 44 to 45 first IF was converted to 10.7 MHz with the fundamental frequency of the tunable local oscillator, which was 33.3 to 34.3 MHz. The second conversion used a high-gain 6EJ7 tube as the mixer. A 6KE8 was used for the tunable oscillator with the triode as the oscillator and the pentode as a buffer stage to improve stability.

The 10.7 MHz second IF was converted to the last IF of 455 kHz by a 6BE6 pentagrid converter stage using a 10.245 MHz crystal to generate the frequency needed for the final conversion. A 6BA6 served as the 10.7 MHz second IF amplifier and a second 6BA6 as the 455 kHz third IF amplifier. A 6AL5 diode served as the AM detector in the 22er. Automatic noise limiting (ANL) was provided using the second diode in the 6AL5, along with a squelch to make periods with no signal more pleasant.

Power Supply

The power supply operated off 120 V ac with an internal power transformer that supplies high-voltage dc to operate all stages in either radio and a filament winding providing 12.6 V ac for the tube filaments. The power supply also provided for 13.8 V dc nominal input for mobile operation with either positive or negative ground. Very few 12 V automobiles were positive ground. The Clegg 22er and 66er employed two transistors as an oscillator to make ac to operate the power transformer. The wiring of the S-312-CCT power socket that plugged on the back of the transmitter-receiver connected the power supply for 120 V ac or 13.8 V dc positive or negative ground. The jumpers used on the S-312-CCT configured the power supply for 120 V ac operation or 12 V dc positive or negative ground operation. When using dc power, the tubes were lit directly from the dc input power. Fuses were provided for both 120 V ac and 12 V dc input. There was no need to change the fuse in one fuse holder like on some ham radio equipment.

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

Special Event Stations

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

Feb. 13, 1700Z – 2359Z, NI6IW, San Diego, CA. USS *Midway* (CV-41) Museum Ship. **Raising Mt. Suribachi Flag**. 14.320 7.250; 14.070 (PSK31); D-STAR via PapaSystem repeaters. QSL. USS *Midway* CV-41 COMEDTRA NI6IW, 910 N. Harbor Dr., San Diego, CA 92101. **www.qrz.com/db/ni6iw**

Feb. 13 – Feb. 14, 0800Z – 1400Z, K4US, Alexandria, VA. Mount Vernon Amateur Radio Club. **George Washington's Birthday at Mount Vernon**. 14.260 14.074 7.040. QSL. MVARC, P.O. Box 7234, Alexandria, VA 22307. *Members will be operating remote stations this year due to COVID, with many operating from the original grounds of the former plantation of George Washington and his wife, Martha Washington.* **k4us@mvarc.org**

Mar. 13, 1700Z – 2359Z, NI6IW, San Diego, CA. USS *Midway* (CV-41) Museum Ship. **Launching of USS *Midway***. 14.320 7.250; 14.070 (PSK31); D-STAR via PapaSystem repeaters. QSL. USS *Midway* CV-41 COMEDTRA NI6IW, 910 N. Harbor Dr., San Diego, CA 92101. **www.qrz.com/db/ni6iw**

Mar. 14, 0000Z – 2359Z, N2RE, Princeton, NJ. David Sarnoff Radio Club. **Pi Day**. 14.250 14.050 7.200 7.050. QSL. Bob Uhrik, 104 Knoll Way, Rocky Hill, NJ 08553. *Famous Princetonian Albert Einstein was born on Pi Day.* **n2re.org**

Mar. 20 – Mar. 21, 1800Z – 0300Z, K7SWI, Middleton, ID. South West Idaho Amateur Radio Club. **Arrows from the Air**. 28.427 14.227 7.227 3.827. Certificate & QSL. South West Idaho Amateur Radio Club, 332 W. Dewey Ave., Nampa, ID 83686. **nq6s@att.net** *or* **www.qrz.com/db/k7swi**

Mar. 23 – Mar. 25, 1400Z – 2100Z, W4LX, Fort Myers, FL. Fort Myers Amateur Radio Club. **Honoring World War II Gunners at Buckingham Airfield**. 28.360 21.360 14.270 146.685. Certificate. W4LX Fort Myers Amateur Radio Club, P.O. Box 61183, Fort Myers, FL 33906. **www.fmarc.net**

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

Special Events Announcements: For items to be listed in this column, use the ARRL Special Events Listing Form at **www.arrl.org/special-events-application**. A plain-text version of the form is available at that site. You may also request a copy by mail or email. Off-line completed forms can be mailed, faxed (Attn: Special Events), or emailed.

Submissions must be received by ARRL HQ no later than the 1st of the second month preceding the publication date; a special event listing for **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 Events page. Note: All received events are acknowledged. If you do not receive an acknowledgement within a few days, please contact us. ARRL reserves the right to exclude events of a commercial or political nature.

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

Certificate of Code Proficiency Recipients

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

October 2020

Marc Beaupre, VE7TBP	10
Jeffrey K. Bowman, WY4G	10
Keith E. Brandt, WD9GET	10
Alfred M. Holt, WD4AH	10
Stephen J. Kellam, N4SJK	10
Edward W. E. Nijst, AJ6ET	10
Stewart W. Taylor, K7RPN	10
William A. Freeman, KE1G	15
Kirk S. Goddard, AG7YM	15
David Loveridge, AC9TA	15
Louis K. Yadevia, WA3EBS	20
David J. O'Farrell, WBØIXV	25
Albert H. Ziegler, KD2ST	25
William R. Gardner, KØUG	40

November 2020

Matthew J. Blauser, KT5WB	10
Christopher A. Doutre, KC9AD	10
Gregory S. Glenn, WB6MPH	10
Stephen F. Hersey, K7OFG	10
David D. Herzberg, K7MTD	10
Nyles McKeithan, KS4S	10
Bernd Peters, KB7AK	10
Glenn E. Sigler, N8IJY	10
George R. Anderson, W4GRA	15
Riley P. Grieb, KC9OP	15
Bernd Peters, KB7AK,	15
Robert J. Ramborger, K7JNV	15
David M. Tenenbaum, AB1KT	15
James E. Toler, N2ZUT	15
Thomas F. Miller, W1PDI	20
Joseph M. Rinella, KG0HG	20
Robert W. Wilson, N4XU	35

December 2020

Robert C. Dupuis, K7CJN	10
Bobby P. Hargrave, KN4UCN	10
Robert T. Marston, AA6XE	10
Steve M. Kuzyszyn, KB2WQ	15
Nyles McKeithan, KS4S	15
David J. Warwick, K4DJW	15
David Loveridge, AC9TA	20
Nelson F. Mikeska, Jr., KI5JF	20
Arvid W. Weflen, KL7YV	20

January 2021

David J. Redanz, N9HX	10

Congratulations to all the recipients.

March 2021 W1AW Qualifying Runs

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

March Qualifying Runs will be transmitted by W1AW in Newington, Connecticut at the times shown at 1.802.5, 3.581.5, 7.047.5, 14.047.5, 18.097.5, 21.067.5, 28.067.5, 50.350, and 147.555 MHz. The West Coast Qualifying Runs are tentatively scheduled to be transmitted by K6KPH on Saturday, March 27 at 2 PM PDT (2100 UTC) on 3581.5, 7047.5, 14047.5, and 18097.5 kHz. Unless indicated otherwise, sending speeds are from 10 to 35 WPM.

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

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

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

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

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

W1AW Code Proficiency Schedule — March 2021
(Times are in Eastern Standard Time; red denotes Eastern Daylight Time)

Monday	Tuesday	Wednesday	Thursday	Friday
3/1 4 PM – 2100Z 10 – 35 WPM	**3/2** 7 PM – 0000Z **(3/3 – UTC)** 35 – 10 WPM		**3/4** 10 PM – 0300Z **(3/5 – UTC)** 10 – 40 WPM	**3/5** 9 AM – 1400Z 10 – 35 WPM
	3/9 4 PM – 2100Z 10 – 35 WPM	**3/10** 7 PM – 0000Z **(3/11 – UTC)** 10 – 40 WPM	**3/11** 9 AM – 1400Z 35 – 10 WPM	**3/12** 10 PM – 0300Z **(3/13 – UTC)** 10 – 35 WPM
	3/16 9 AM – 1300Z 10 – 35 WPM	**3/17** 10 PM – 0200Z **(3/18 – UTC)** 35 – 10 WPM	**3/18** 7 PM – 2300Z 10 – 35 WPM	**3/19** 4 PM – 2000Z 10 – 40 WPM
3/22 10 PM – 0200Z **(3/23 – UTC)** 10 – 40 WPM		**3/24** 9 AM – 1300Z 35 – 10 WPM	**3/25** 4 PM – 2000Z 35 – 10 WPM	**3/26** 7 PM – 2300Z 10 – 35 WPM

Al Brogdon, W1AB

100, 50, and 25 Years Ago

March 1921

- The cover photo shows the neat and effective station of 6ZK, of Sunnyvale, California.
- The editorial, "Downward, Ho!", reminds readers to get their stations operational on wavelengths shorter than 200 meters.
- K. B. Warner wrote "The Story of The Transcons," sharing the excitement of ARRL's annual transcontinental message relayed that January.
- "6JD and Its Operator" shares how Vernice Bitz of Los Angeles, was the west coast end of a record-breaking chain in the recent Transcons.
- "The Power Tubes Arrive" reports that such tubes have now become available to amateurs, starting with the 5 W RCA UV-202, at $8.
- "A Description of 4XB, Savannah" provides details of the Georgia station's equipment and antenna setup. 4XB is Savannah Senior High School's station.

March 1971

- The cover photo is a partial view of the small 2-meter FM transmitter described in this issue.
- The editorial, "Upbeat," notes that the forecast of the demise of ham radio was wrong, and that the hobby and avocation are thriving.
- K. R. Klopf, KL7EVO, shares "A Bearing and Distance Calculator" to use with directive antenna work.
- E. W. Ljongquist, W4DWK/W1CQS, became frustrated with finding a source for replacement 7094 tubes for his Hallicrafters HT-41 transmitter, and discusses "Converting the HT-41 for 572-Bs."
- James Lawson, W2PV, describes his latest antenna, "A 75/80-Meter Vertical Antenna Square Array."
- Doug DeMaw, W1CER, presents "An FM Pip-Squeak for 2 Meters" that is compact and easy to build.
- "A 10-Watt, One-Tube Transmitter," by Lew McCoy, W1ICP, and Gus Wilson, W1NPG, uses a single 6T9 dual-purpose tube.
- In "Receiving FM," Douglas Blakeslee, W1KLK, explains how to use ICs developed for home entertainment products to build an FM receiver.

March 1996

- The cover photo, by K5FUV, shows one of the antennas at the DXpedition station XZ1A, with the ancient Shwedagon Pagoda in the background.
- The editorial discusses microwave bands, noting that activity is low, although equipment is readily available.
- "DXing from the Golden Land," by Bill Kennamer, K5FUV, tells the exotic story of the XZ1A DXpedition to Myanmar.
- Jay Craswell, WBØVNE, explains how to build the "Weekend DigiBrain," a tiny, programmed microcomputer to use with a DDS VFO.
- Grant Zehr, AA9LC, describes the "JVFAX APT Adapter," which can be used to see satellite views of Earth's weather patterns.
- Emil Pocock, W3EP, discusses "Transoceanic Ducting at VHF and Above."
- Richard Arland, K7YHA, reports on his and other hams' considerable success at "Low-Power Contesting."
- Frank Wolfe, NM7R, explains "A Worldwide Propagation Beacon Network" that helps spot good band openings for our HF DX work.

Silent Keys

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

WB1ARX **Gowash**, Francis P., Somers, CT
AC1BN **DeVries**, Frederick J., Jr., Reno, NV
K1CGZ **Cereste**, Paul J., West Bath, ME
W1CL **Corey**, Howard A., Randolph Center, VT
W1CSW **White**, Andrew B., New Castle, NH
N1DO **Olney**, Richard H., Cumberland, RI
• N1EGJ **Berube**, Edmond E., Fall River, MA
KA1EVN **Assard**, Gerald L., Bethlehem, CT
WB1GIK **Propfe**, Claus H., Torrington, CT
KB1HCC **Winslow**, Jonathan K., Sanford, NC
W1HRO **McCullough**, Thomas R., Warminster, PA
W1HTA **Wesner**, Michael D., Morton, IL
N1ITK **Hildebrandt**, Arthur E., Hudson, ME
K1JHB **Benson**, Jay H., Annapolis, MD
• K1KAL **Swett**, Jeremy F. "Jay," Grafton, MA
KC1KKF **Dayotis**, Anthony, Atkinson, NH
K1NNP **Lefrancois**, Donald N., Jewett City, CT
WA1TVS **MacDonald**, Carter M., Whately, MA
• KC1WA **Boothroyd**, John F., Maynard, MA
KQ2A **Arnone**, Victor J., Harpersfield, NY
WB2CUK **Capitman**, William A., Farmingdale, NY
KD2EGR **Adams**, Tim L., Ventnor City, NJ
N2FCZ **Bookout**, Henry W., Jr., Riverhead, NY
♦WA2FEF **Gero**, Anthony G., New York, NY
WU2H **O'Dell**, Robert R., Rochester, NY
K2HIZ **Parks**, Thomas W., Ithaca, NY
KB2HYQ **Foster**, Dale, Rochester, NY
WB2JQF **Fulton**, John D., Valatie, NY
KC2KBO **Beck**, John P., Mayville, NY
KB2LXP **Herbert**, Bruce D., Argyle, ME
W2MB **Bond**, Mark S., Washington, NJ
W2MTK **Schabinger**, Karl H., Waterford, NY
• KA2NMP **Seifridsberger**, Henrietta M., Delmar, NY
WA2OCG **Sealfon**, Michael S., Kent, WA
K2ON **Miskelly**, R. W. "Wayne," Millville, NJ
AC2RT **McNall**, Stephen M., Olean, NY
W2TDS **Blasko**, Stephen J., Glendora, NJ
WA2TTI **Harley**, Gerald H., Royersford, PA
KE2UO **Bauman**, William, Jamesburg, NJ
WA2URE **Kessler**, Marcella M., Rochester, NY
W2VLX **Freedman**, David D., Cinnaminson, NJ
N2WYU **Schumacher**, Michael J., Willingboro, NJ
K3ADP **Siroki**, Emil T., Drifton, PA
KM3B **Hogan**, Thomas C., Pittsburgh, PA
N3CNI **Capper**, Harry M., Harrisburg, PA
K3COV **Di Girolamo**, Nicholas A., Sr., "Nick," New Castle, DE
♦K3FME **Wieand**, Charles E., Easton, MD
KC3JJK **Rolison**, Timothy E., Drexel Hill, PA
W3JO **De Gregorio**, Joseph J., Aston, PA
KC3MSC **Zencak**, William D., Milford, DE
N3PF **O'Malia**, Martin J., Plains, PA
N3RUX **Nelson**, Eric T., State College, PA
• K3SLL **Yeastedt**, George E., Minersville, PA
K3TKQ **Collier**, George W., York, PA
W3TUF **Emerick**, Floyd B., Reynoldsville, PA
• KA3TVX **Wade**, William, Prospect Park, PA
K3UOC **Manafo**, Michael J. "Mick," Wesleyville, PA
K4AMD **Dillon**, Arnold M. "Matt," Supply, NC
KA4AQM **Melton**, Randall D. "Randy," Chesapeake, VA
KG4BSK **Tidwell**, Otis, Central, SC
KD4BXV **Aders**, Howard S., Princeton, IN
W4EBP **Parker**, Edward B., IV, Florence, AL
KG4EIP **Hill**, Donald J., Altoona, AL
KB4FCC **Seidel**, Joseph S., Bayonet Point, FL
KG4FDZ **George**, Sherri M., Russell Springs, KY
KO4FN **Johnson**, Earl G., Chesterfield, VA
KG4GOG **Brandenburg**, Amos, Newport, KY
KE4HJP **Bridgers**, Freddie W., Rocky Mount, NC
WB4HLD **Smolenski**, Stevens W., Toledo, OH
KI4KCL **Patterson**, Jere W., Sr., Decatur, AL
KA4KSB **Dickerson**, William A., New Bern, NC
WD4KYW **Burris**, James E., Sebring, FL
WD4LOV **Hedden**, George "Pat," Reynolds Station, KY
KD4NIH **Burnett**, Johnny B., Jr., Hartselle, AL
KC4OIX **Sherer**, Herbert E., Springville, AL
KF4PEV **Coffey**, Ricky L., Marble, NC
W4QEB **Carlton**, John C., Shelbyville, TN
KK4RDI **Leon**, Jerry L., Jacksonville, FL
K4TAG **Bowers**, Hayden, Sr., "Tag," Mocksville, NC
W4UFY **Burnett**, Allen, Orlando, FL
K4VAR **Gentry**, Charles K., Alabaster, AL
K4VZZ **Smith**, Gary E., Kingsport, TN
W4ZXB **Goff**, James E., Knoxville, TN
♦• K5AGI **Rivoire**, John R., Annandale, VA
KI5AZN **Hensley**, Tammy E., New Edinburg, AR
♦W5BPT **Kollatt**, Frank R., Jr., Hot Springs, AR
N5BRB **Becquart**, Bill R., Oklahoma City, OK
WC5E **Howard**, Robert L., "RL," Abilene, TX
W5EZD **Seamster**, John W., Omaha, AR
K5GQE **Stacy**, Carl J., Bartlesville, OK
N5HQS **Coleman**, Willa D., Belton, TX
W5HWQ **Goertz**, Joseph T., Jr., "Tommy," Slidell, LA
• N5JGN **Blanchard**, William G., McAlester, OK
KA5JNL **Redmond**, William M., Rocky Branch, LA
WA5OMD **Miller**, Thomas H., College Station, TX
♦AF5Q **Grossman**, Ronald M., Lawton, OK
AC5QS **Beeler**, Ed M., El Paso, TX
KB5T **Burdick**, Kenneth L., Chandler, OK
KE5TJS **Laughlin**, Scott E., Denham Springs, LA
♦W5TO **Johnson**, Robert H., Sherman, TX
N5TXN **Ellis**, William E., Jr., Ovilla, TX
W5UDX **Nolan**, Gregory F., Waller, TX
KD5VA **Smith**, Donald E., San Marcos, TX
WB5VCC **Compton**, Perry L., Krugerville, TX
KG5VIS **Bath**, Ronney L., Lewisville, TX
KE5VKL **Collins**, George C., Houston, TX
WB5VRM **McCarthy**, John D., San Angelo, TX
KF5WFI **Prati**, Joe, III, El Paso, TX
• AA6EL **Fox**, Frederick A., Fort Jones, CA
KI6GHI **Enos**, James A., Santa Maria, CA
• AA6HA **Ekiss**, John A. "Buster," San Jose, CA
♦W6IJ **Farr**, Thomas A., Denair, CA
KG6JMH **Bowman**, Leo R., Ventura, CA
KN6JV **Baker**, William B., Taylor, MO
N6RL **Leigh**, Robert E., Bellingham, WA
WJ6T **Gerner**, Robert F., Sr., Bakersfield, CA
W7BPK **Hanson**, William C. J., Gig Harbor, WA
W7BPR **La Vigne**, Richard R., Tucson, AZ
K7HSQ **Pace**, Philip H., Port Orchard, WA
♦WA7IZU **Welzbacker**, Robert A., Monmouth, OR
WB7NCP **Peterson**, Charlene W., Salt Lake City, UT
• WA7NQL **Hug**, John H., Sulphur Springs, ID
KD7QNW **Peterson**, Arman B., Salt Lake City, UT
K7SMT **Klovstad**, John W. "Jack," Whitefish, MT
K7TAZ **Klein**, Martin, Butte, MT
NC7Z **Wakefield**, Robert H., Tucson, AZ
WD8BDR **Grove**, Max A., Lansing, MI
KE8BLN **Rathbun**, Robert L., Fremont, MI
W8BW **Murphy**, Richard J. "Jim," Greenville, OH
N8CJK **Dahlstrom**, Gregory J., East Tawas, MI
WA8CTK **Martens**, Michael N., Muskegon, MI
N8EUJ **Rutherford**, Thomas G., Burton, MI
W8FGN **Pfau**, Lowell G., New Bavaria, OH
KD8HNF **Robinson**, Robert L., Lowell, MI
KA8HPW **English**, Jean E., Barnesville, OH
WX8JDM **Massie**, John D., Sr., Springfield, OH
N8LEL **Tender**, Billie J., Hebron, OH
♦WA8MHO **Lehman**, John H., Lexington, OH
♦K8NGV **Hoitenga**, Thomas J., Evart, MI
WD8OAW **Digiovine**, Donald R., Mentor, OH
W8PJ **Fleming**, Norman L., Brook Park, OH
♦K8SGM **Keltner**, George J., Sr., Parma, OH
WB8SSQ **Yeary**, John T., Springfield, OH
♦N8TC **Cox**, Brian J., Traverse City, MI
KC8TXO **Orso**, Anton J., Oscoda, MI
♦K8VJG **Borkey**, Ronald J., Sr., North Royalton, OH
W8VVE **Lanham**, James S. "Sam," Cross Lanes, WV
K9AKS **Roseman**, Curtis C., Moline, IL
KC9ARS **Sierakowski**, Melvin R., Chicago, IL
N9AXU **Turley**, Irvine A., Springfield, IL
WA9BXI **Haas**, Robert V., Tinley Park, IL
• WA9CVK **Hodgson**, Allen R., West Bend, WI
KD9DFB **Kasper**, Joseph, Turtle Lake, WI
♦WD9FPZ **Knasinski**, Frank S., Jr., Winchester, IN
W9GXT **Mitchell**, Robert E., Galesburg, IL
KA9JJX **Hayes**, Wilma J., Mount Vernon, IL
N9LVY **Baker**, Charles L., Bunker Hill, IL
W9LYV **Keister**, David C., Martinsville, IN
KB9MYL **Hinshaw**, Robert A., Richmond, IN
W9QEQ **Waggoner**, Jerry M., Springfield, IN
W9QMT **Gidlund**, Ronald J., Lemont, IL
• WA9UJQ **Steinberger**, Robert J., Sturgeon Bay, WI
KB9VNF **Jones**, Bruce G., Martinsville, IN
ND9Z **Keating**, Gary L., Kaukauna, WI
KC9ZUA **Moon**, Howard D. "Joe," Muncie, IN
K0BB **Baker**, William E., Independence, MO
K0CWW **Brazee**, James E., Lincoln, NE
N0DP **Polite**, Albert, Lincoln, NE
• K0EJJ **Jones**, Ernest J., Newton, IA
K0ESG **Pitt**, Raymond P., Beverly Hills, FL
K0EWT **Turnbow**, Eldon W., Saint George, KS
WD0GSY **McCrann**, Terence Mike, Saint Peters, MO
• AI0H **Davidson**, David S. "Pete," De Soto, MO
♦W0ME **Wiechman**, Alvin W., Salina, KS
K0MLY **Clark**, Lloyd W., Des Moines, IA
♦K0PCI **Garnett**, James D., West Des Moines, IA
KC0PTN **Joiner**, Olle K., Kansas City, MO
KA0QIQ **Poulter**, Richard M., Fort Madison, IA
WA0S **Hamilton**, Robert A., Jr., Saint Louis, MO
W0TW **Williams**, Terrance J. "Jim," Saint Augustine, FL
AE0W **Card**, Robert L., Colorado Springs, CO
K0WIU **Jennewein**, William N., Yankton, SD
W0YLS **Entringer**, Lester M., Dubuque, IA
W0YOB **Moses**, Scott C., Rapid City, SD
VE1JR **Aulenback**, Robert S., Lunenburg, NS, Canada
VE3DBA **Armstrong**, Donald B., Chatham, ON, Canada
VE3SLM **Marzetti**, David B, Pefferlaw, ON, Canada
VE6CS **Jordan**, Robert P., Qualicum Beach, BC, Canada
I8QJU **D'Avanzo**, Giuseppe, Napoli, Italy

♦ 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.

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

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

• Narrow Band and Direct Sampling SDR • Down Conversion, 9MHz IF Roofing Filters Produce Excellent Shape Factor • 5" Full-Color Touch Panel w/3D Spectrum Stream • High Speed Auto Antenna Tuner • Microphone Amplifier w/3-Stage Parametric Equalizer • Remote Operation w/optional LAN Unit (SCU-LAN10) • This device has not been approved by the FCC.

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

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

FTDX101D | *HF + 6M Transceiver*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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IC-7851 | *HF/50MHz Transceiver*

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

IC-R8600 | *Wideband SDR Receiver*

10 kHz to 3 GHz Super Wideband Coverage • Real-time Spectrum Scope w/Waterfall Function • Remote Control Function through IP Network or USB Cable • Decodes Digital Incl P25, NXDN™, D-STAR • SD Card Slot for Receiver Recorder

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

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

IC-7300 | *HF/50MHz Transceiver*

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

IC-718 | *HF Transceiver*

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

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

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

IC-7100 | *All Mode Transceiver*

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

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

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

IC-2300H | *VHF FM Transceiver*

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

ID-5100A Deluxe

VHF/UHF Dual Band Digital Transceiver

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

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

IC-V86 | *VHF 7W HT*

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IC-R30 | *Digital/Analog Wideband Xcvr*

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

ID-52A | *VHF/UHF D-STAR Portable*

• Bluetooth® Communication • Simultaneous Reception in V/V, U/U, V/U and DV/DV • Enriched D-STAR® Features Including the Terminal Mode/Access Point Mode • UHF (225~374.995MHz) Air Band Reception

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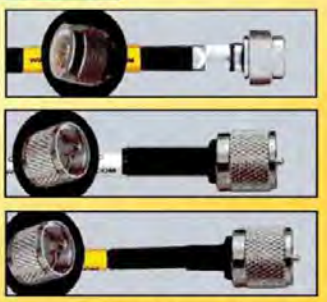

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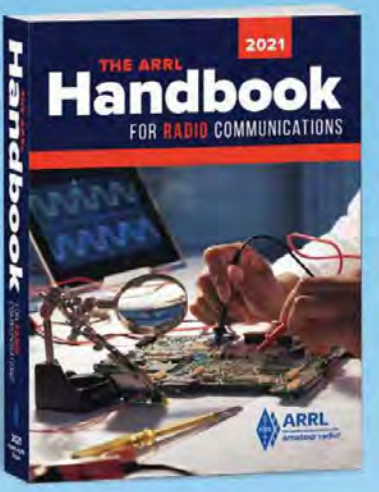

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- 20W DSP noise canceling EQ versions: EQ20-DSP, EQ20B-DSP* *Denotes Bluetooth on input

Dec 2019 review: *"easy-to-use device that improves the clarity of amateur signals"*

Dual In-Line

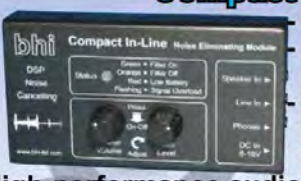
Fully featured amplified DSP noise canceling in-line module - Separate mono or stereo input and outputs - Headphone socket - Latest bhi DSP noise canceling technology - Suitable for all radios, receivers and SDR - Use with headphones and a speaker at the same time

New NES10-2MK4

New improved NES10-2MK4 - 5W audio power - Latest bhi DSP noise canceling - Up to 65dB tone reduction - Function switch on top of speaker for ease of use - Power on, filter on and audio overload LED

New improved DESKTOP MKII - 10W DSP noise canceling base station speaker - Now with latest bhi DSP noise canceling technology for even better receive audio - Easy to use rotary controls - 8 DSP filter levels - "Real time" audio adjustment - Suitable for all radios incl' SDR

Compact In-Line



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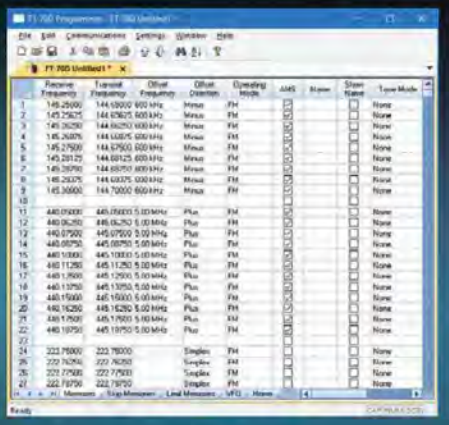

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- Easy access to repeater details from programmer. Radio Reference, RFinder, RepeaterBook and a Built in Frequency list with NOAA Weather Channels and more.
- Import data from other sources - the process in the programmer helps you adjust the data layout of your file so it matches what the radio needs.
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WT-67	11	$6,035
LM-237	20	$2,914
LM-354	18	$5,255
LM-354HDSP	45	$9,416
LM-470	24	$10,613
LM-584	13	$11,393
DX-70	45	$15,919
DX-70HD	70	$23,357
DX-86	26	$17,115
DX-86HD	38	$25,074
DX-100	24	$29,652
DX-100HD	40	$32,773
TM-370HD	28	$12,849
TM-490HD	42	$17,271
TM-5100HDR	32	$27,831

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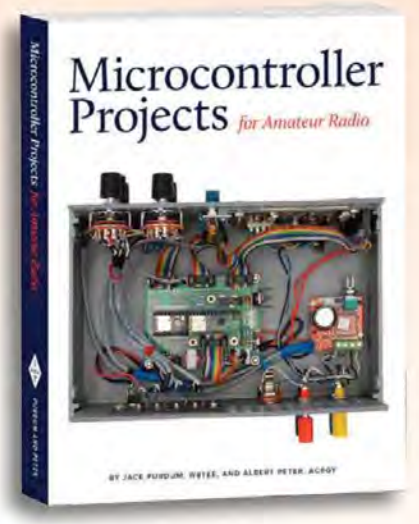
By Jack Purdum, W8TEE, and Albert Peter, AC8GY



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HAM-VI – $809.95 with DCU-2

HAM-VII – $959.95 with DCU-3

HAM IV and HAM V Rotator Specifications	
Wind Load Capacity (inside tower)	15 square feet
Wind Load (w/mast adapter)	**7.5 square feet**
Turning Power	800 in.-lbs.
Brake Power	**5000 in.-lbs.**
Brake Construction	Electric Wedge
Bearing Assembly	**Dual race/96 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	26 lbs.
Effective Moment (in tower)	**2800 ft.-lbs**

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For Large Medium Antenna Arrays up to 20 sq. ft. wind load.

Has 5-second brake delay, Test/Calibrate functions. Low temp grease, tough alloy ring gear, indicator potentiometer, ferrite beads on potentiometer wires, weatherproof AMP connectors plus 8-pin plug at control box, triple bearing race with 138 ball bearings for large load bearing, electric locking steel wedge brake, North/South center of rotation scale meter, low voltage control, $2^{1}/_{16}$" max mast. **MSHD, $139.95**. Above tower heavy duty mast support. T2X, HAM-IV, HAM-V, HAM-VI. Accepts $1^{7}/_{8}$-$2^{5}/_{8}$" OD.

T-2XD2 – $979.95 with DCU-2

T-2XD3 – $1039.95 with DCU-3

TAILTWISTER Rotator Specifications	
Wind Load Capacity (inside tower)	20 square feet
Wind Load (w/mast adapter)	**10 square feet**
Turning Power	1000 in.-lbs.
Brake Power	**9000 in.-lbs.**
Brake Construction	Electric Wedge
Bearing Assembly	**Triple race/138 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	31 lbs.
Effective Moment (in tower)	**3400 ft.-lbs**

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CD-45D2 – $599.95 with DCU-2

CD-45D3 – $659.95 with DCU-3

CD-45II Rotator Specifications	
Wind Load Capacity (inside tower)	8.5 square feet
Wind Load (w/mast adapter)	**5.0 square feet**
Turning Power	600 in.-lbs.
Brake Power	**800 in.-lbs.**
Brake Construction	Disc Brake
Bearing Assembly	**Dual race/48 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	22 lbs.
Effective Moment (in tower)	**1200 ft.-lbs**

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DCU-3 – $499.95

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

Press a memory button or dial in your beam heading or let *Ham Radio Deluxe* (or other) take control. Your antenna auto rotates precisely and safely to your DX.

DCU-3 automatically jogs your antenna free and safely unlocks it before rotating begins (*great for older rotators with "sticky" brakes*) then turns off your motor before reaching its final heading. Your antenna gently coasts to a stop before the brake re-locks -- greatly reducing damaging overshoots and extending rotator life.

Simply press *Left* and *Right* buttons for full manual control and fine tuning.

Bright blue LCD shows current, dialed in and computer controlled beam headings in one degree increments and your call.

Calibrate lets you accurately match your display to your true beam heading. Has USB/RS-232 ports for computer control. Adjustable LCD sleep time. Field upgradeable firmware. 8.5Wx4.3H x9D".

110 VAC. Order DCU-3X for 220 VAC.

DCU-2 Digital Rotator Controller – $459.95
Like DCU-3, but less programmable memories. 110 VAC. Order **DCU-2X**, for 220 VAC.

AR-40 – $399.95

For compact antenna arrays and large FM/TV up to 3.0 square feet wind load area.

Dual 12 ball bearing race. Automatic position sensor never needs resetting. Fully automatic control -- just dial and touch for any desired location. Solid state, low voltage control, safe and silent operation. $2^{1}/_{16}$ inch maximum mast size. MSLD light duty lower mast support included.

AR-40 Rotator Specifications	
Wind Load Capacity (inside tower)	3.0 square feet
Wind Load (w/mast adapter)	**1.5 square feet**
Turning Power	350 in.-lbs.
Brake Power	**450 in.-lbs.**
Brake Construction	Disc Brake
Bearing Assembly	**Dual race/12 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**5**
Shipping Weight	14 lbs.
Effective Moment (in tower)	**300 ft.-lbs**

Replace your Yaesu Rotator Controller

YRC-1 – $369.95

Hy-gain YRC-1 -- more features, more robust, far less prone to lightning damage. Costs less than repairing!

Easy-to-use -- dial in your beam heading and tap GOTO button. Exclusive 180 degree *AutoReversal*™ for fast longpath operation. All DCU-2 features. Bright blue LCD shows current, dialed-in, computer controlled beam headings, call. USB port for computer control. Extra heavy-duty AC power supply. Fast variable DC motor minimizes overshoot. Intuitive menu. Field upgradeable. For Yaesu G-800/1000/2800/G450/650. AC or DC motors.

YRC-3, $449.95. Like YRC-1 and adds 6 memories.

AR-500 Rotator/Controller – $169.95

UHF/VHF/6-Meter, MFJ-1886 Rotator/Controller and Remote. For use of small VHF/UHF, 6M, TV, FM, the MFJ-1886 wide band receiving loop and other lightweight ham antennas. Rotator is built in a weatherproof one piece cast aluminum housing with precision all metal gears, steel thrust bearings and automatic braking. Includes rotator, controller, remote, clamps, and all hardware.AR-500 remembers up to 12 directions even after a power outage! Use remote control or direct console. Displays location and relative position.

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75-Amps, $289.95

MFJ-4275MV high-current switching power supply gives 75A max/70A continuous. Great for ALS-500M amplifier. Adjustable output 4-16 VDC. 110/220 VAC. Binding posts, quick connects, *PowerPoles*™, cigarette lighter socket on front. Battery charger gives charging current of 20A max, 5A continuous. 9 3/4W x 5 1/2H x 9 1/2D". Only 10.5 lbs.

45-Amps, $169.95

MFJ-4245MV Switching power supply gives 45A surge/40A continuous. 9-15 VDC out. 85-260 VAC in. Low ripple, highly regulated. 5-way posts, cig lighter, quick connects. 5 lbs., 7 1/2W x 4 3/4H x 9D".

25-Amps, $119.95

MFJ-4225MV Switching power supply gives 25A surge, 22A continuous. Adjustable 9-15 VDC output, 85-260 AC input. Large 3" dual Amp/Volt meters, Binding posts, Cigarette lighter socket. 3.7 lbs. 5 1/4W x 4 1/2H x 6D inches.

MFJ-4230MV $99.95 30 Amp, 4-16 Volts Adjustable, Volt/Amp Meter, 5W x 2 1/2H x 6D"

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MFJ-4230MV is ham radio's best selling and most compact switching power supply – just 5W x 2 1/2H x 6 D" and 3 lbs. Takes up little room at your operating position and perfect for home station, Field Day, DXpeditions, camping, hiking, or for your next business trip or vacation.

MFJ-4230MV gives 25 Amps continuously or 30 Amps surge at 13.8 VDC. Voltage is front-panel adjustable from 4 to 16 VDC.

Selectable input voltage of 120 or 240 VAC at 47-63 Hz lets you carry it with you and use it worldwide.

Front-panel rocker switch lets you choose Amp or Volt meter for continuous monitoring. Cool operation with excellent 75% efficiency. Extra low ripple and noise is less than 100 mV.

It's quiet! Continuous air-flow gently cools the power supply and a heat sensor increases the fan speed if the temperature rises above 70 degrees celsius.

Over-voltage and over-current protection fully protects your transceiver and has ALARM LED. DC output is 5-way binding posts on the back so you can power your HF, VHF, UHF transceiver and accessories with ease.

Add a pair of *PowerPoles*™

MFJ-4230MVP, $119.95. *PowerPoles*™ on back.

MFJ-4230MPF, $109.95. *PowerPoles*™ on front.

MFJ-4230DMP, $159.95. Same as MFJ-4230MVP but has bright orange LCD digital volt/amp display.

35-Amps, $149.95

MFJ-4235MV switching power supply gives 35A surge and 30A continuous. 4-16 VDC with 1% voltage regulation. < 9 mV peak-to-peak ripple. AC input 90-125 or 200-240V. 7W x 4 1/4H x 8 3/4D", 4 lbs.

25-Amps, $99.95

MFJ-4125 gives 25A surge, 22A continuous. 13.8 VDC switching power supply has 5-way binding posts on front panel and quick connects on back. 3.5 lbs. Super compact 5 1/2W x 2 1/2H x 5 3/4D inches fits anywhere.

35-Amps, $169.95

MFJ-4035MV *19.2 lb. transformer* delivers 35A max, 30A continuous. 1-14 VDC out, 110 VAC in. Highly regulated, 1% load regulation. 1 mV ripple. 5-way binding posts, quick connects. 9 1/2W x 6H x 9 3/4".

25-Amps, $109.95

MFJ-4125P gives 25A surge, 22A continuous. 13.8 VDC switching power supply front has 2 pair of *Anderson PowerPoles*™ and 5-way binding posts on front. Quick connects on back. 3.5 lbs. Super compact 5 1/2W x 2 1/2H x 5 3/4D".

15-Amps, $79.95

MFJ-4115 Tiny! 17A surge, 15A cont. 13.8 VDC. 110/ 220 VAC. 3 3/4W x 2 1/4H x7 3/4D", 1.5 lb. 5-way posts. Switcher.
MFJ-4215MV, $79.95. 4-16 VDC, 15A surge, 13A cont., backlit volt/amp meters. 90-125V/200-240 VAC. Switcher.

28-Amps, $99.95

MFJ-4128 28A surge, 25A cont. at 13.8 VDC. AC input voltage 85-135/170-260 VAC. 5-way binding posts, cigarette lighter socket, 7W x 2 1/4H x 7 1/2D", 4 lbs.
MFJ-4218MV, $119.95. 0-24 VDC, 18A@13.8/9A@24 VDC. Backlit V/A meter. 110/220 VAC.

MFJ *PowerPole*™ Splitters

MFJ-1104, $54.95. *PowerPole*™ Splitter. 30 Amp fused input. Outputs fused at 25, 10, 5A. Open fuse indicator. 2 3/4W x 3 1/4H x 1 1/2D".

MFJ-1107, $59.95. 40 Amp fused binding posts input. 4 fused *PowerPole*™ outputs. Two 2.1 mm center positive power jacks.

MFJ-1106, $49.95. One in, six out *PowerPoles*™ 30A total. 7 sets mating connectors included.

MFJ High Current DC Multi-Outlet Strips

Power multiple transceivers/accessories from a single DC power supply

MFJ-1118, $99.95. Power two HF and/or VHF rigs and six accessories from rig's 12VDC supply. 35A high-current and 15A accessory binding posts, Voltmeter, on/off switch. Master fuse, RF bypass.

MFJ-1116, $69.95. Like MFJ-1118 but 15A total, 8 pairs 5-way posts. "On" LED, 0-25 VDC voltmeter.

MFJ-1112, $54.95. Like MFJ-1116 but 6 pairs 5-way binding posts, no meter or switch. 12 1/2W x 2 3/4H x 2 1/2D".

MFJ-1117, $79.95. High-current. Powers four HF/VHF radios simultaneously -- two at 35A each and two at 35A combined. 8W x 2H x 3D".

MFJ-1129, $139.95. 10 outlets. Installed fuses: two 1A, three 5A, three 10A, two 25A, one 40A. Outlets 1, 2, 4-8 are PowerPoles™. Outlet 3 is a 35A high current binding post, outlet 9, 10 are 15A binding posts. On/off switch, 0-25 VDC voltmeter. 12 1/2W x 1 1/4H".

MFJ-1128, $129.95. 12 fused *PowerPoles*™: three 1A, four 5A, four 10A, one 25A, one 40A. Switch. Meter.

MFJ-1126, $99.95. 8 fused *PowerPoles*™: One 1A, three 5A, two 10A, one 25A, one 40A. Switch. Voltmeter. 9W x 1 1/4H x 2 3/4D".

MFJ-1124, $79.95. Four pairs 35A *PowerPoles*™, two pairs 35A high current binding posts.

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Operate all bands 10 through 160 Meters with a single wire antenna!

***The famous** G5RV antenna is the most popular ham radio antenna in the world!*

It's an efficient, *all* band 102 foot long antenna – shorter than an 80 Meter dipole. Has 32.5 foot ladder line matching section ending in SO-239 connector for your coax feedline.

MFJ-1778
$69.95

Use horizontally or as Inverted Vee or Sloper with just one support. 1500 Watts.

Operate all bands 80-10 Meters with an antenna tuner and even 160M with ground.

Fully assembled with *ceramic* end and fiberglass center insulators. *Hang and Play*™ – add coax, rope to hang and you're on air!

MFJ-1778M, $59.95. *Half-size*, 52 foot *G5RV JUNIOR for limited space*. 40-10 Meters with tuner. Full 1500 Watts.

MFJ All Band Classic Doublet

MFJ 102 foot *all band* doublet covers 160-6 Meters with balanced line tuner. Super strong custom fiberglass center insulator relieves stress on 100 foot ladder line.

MFJ-1777
$79.95

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
$39.95

MFJ-919, $69.95. 4:1 current balun,1.5 kW.
MFJ-913, $39.95. 4:1 balun, 300 Watts.

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True 1:1 *Current Balun/Center Insulator* forces equal radiator currents in dipoles for true dipole radiation pattern. Reduces coax radiation and field pattern distortion – your signal goes where *you* want it. Reduces TVI, RFI and RF hot spots. *Don't build a dipole without one!* 50 hi-permeability ferrite beads on high quality RG-303 *Teflon®* coax and *Teflon®* SO-239. 1.5kW 1.8-30 MHz. Stainless steel hardware. 14 gauge stranded copper wire is *directly* connected to your antenna. 5 x 2 inches. Heavy duty weather housing.

MFJ-918
$39.95

2-Position Antenna Switch

MFJ-1702C, $49.95. 2-position antenna switch, lightning surge protection, center ground. SO-239s.

Lightning surge protectors

MFJ-270, $24.95. 400W. **MFJ-272, $34.95.** 1500 W. Gas discharge tube shunts 5000 amps peak.< 0.1 dB loss. 1 GHz. SO-239s.

MFJ-16C06, $9.45. 6-pack *glazed ceramic* end/center ant. insulators.

MFJ-16B01, $24.95. Molded high strength center insulator. SO-239.

MFJ-16D01, $9.95. 450 Ohm fiberglass end/center insulator with ladder line stress relief and SO-239 mount.

MFJ-18H100, $44.95. 100 feet, 450 Ohm ladder line, 18 gauge copper clad.

80-10 Meter End-Fed Half Wave antenna

Cover all bands with one single wire and no tuner!

MFJ-1982HP
$109.95

No tuner needed!
All band 80-10M EFHW antenna

Get-on-the air on all bands 80-10 Meters with just one wire and one support (pole or tree) and no tuner or long counterpoise.

Installs anywhere in minutes! Rugged *insulated*-wire radiator prevents detuning when contacting limbs/branches. "*No-snag*" end insulator slides over branches, leaves.

Toss over a high limb for inverted-V or sloper or go vertical with an inverted-L.

Dark jacketed wire is virtually invisible – *don't let antenna restrictions keep you off the air!* Great for emergencies.

EFHWs naturally resonate on the 1/2-wave fundamental frequency and odd/even harmonics. Covers 80/40/30/20/17/15/12/10 Meters without traps, stubs or resonators.

Broad-band matching transformer at feed point gives SWR so low you may never need a tuner. Compensating inductor optimizes SWR. 800 Watts SSB/CW. 132 feet jacketed antenna wire.

MFJ-1984HP, $89.95. Like MFJ-1982HP but 40-10M. 66 feet jacketed wire.

See www.mfjenterprises.com for 30 Watt QRP and 300 Watt models.

Dual Band Dipoles

MFJ-17758, $99.95. Operate 80/40 Meters with a short 85 foot dipole. Full-size on 40 Meters with ultra-efficient end-loading on 80 Meters. 1500 Watts. Super-strong custom molded center insulator with SO-239 connector and hang hole. Ceramic end insulators. 7-strand, 14 gauge hard copper wire. No tuner needed!

MFJ-17758
$109.95
80/40 Meters

MFJ-17754, $69.95. Like MFJ-17758 but is only 42 feet. Operate 40/20 Meters. Full-size on 20 Meters, ultra-efficient endloading on 40 Meters. 1500 Watts.

Single Band Dipoles

Ultra high quality center fed dipoles give years of troublefree service. Custom injection-molded UV resistant center insulator has built-in SO-239 and hanging hole. Glazed ceramic end insulators. 7-strand, 14-gauge hard copper antenna wire. 1500 Watts. Use horizontally or as sloper or inverted vee. Simply cut to length with provided cutting chart.

MFJ-1779A
$79.95
160M, 265 ft.

MFJ-1779B
$59.95
80-40M, 135 ft.

MFJ-1779C
$39.95
20-6M, 35 ft.

OCFD Dipoles

MFJ-2012
$89.95
1500 Watts

MFJ-2010
$69.95
300 Watts

No tuner needed!
MFJ *Off-Center Fed Dipoles* use MFJ's exclusive *ExactRatio*™ RF broadband transformer to give low SWR and maximum bandwidth on 40/20/10/6 Meters. A Guanella current balun kills feedline radiation, pattern distortion, SWR shifts, RFI and noise pickup. Install anywhere and get the same predictable performance regardless of feedline length. You get ground reinforced gain over verticals. Use horizontally, inverted vee, sloper. 98% efficient, 14 gauge, 7-strand copper wire, ceramic end insulators.

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MFJ Cobweb Antenna

6-Bands: 20/17/15/12/10/6 M...Outstanding Performance!

Restricted space spoiling your operating fun? MFJ Cobweb puts your call back on the map!

This six-band (20, 17, 15, 12, 10, 6 Meters) full half-wave *Cobweb Antenna* is perfect for restricted space or portable operation. Sky-gray fiberglass spreaders and *nearly invisible* wire elements (flat 9 x 9 x 1/2 feet square. 8 pounds), blend in with your surroundings while standing tough against nasty weather.

Outstanding performance! Horizontally polarized for less local noise pickup plus solid gain over verticals will allow you to work DX easily – even on QRP. Omni-directional. No radials needed! Works great at low heights. Low SWR is due to MFJ's exclusive *Spider-Match*™ broadband network. Use lightweight TV hardware to mount on your chimney, balcony, mast.

Low in cost, but big on performance. MFJ *Cobweb Antenna* turns your space problem into a stack of QSL cards from far away places.

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

MFJ-1838
$459.95

40-6 METER Cobweb Super Heavy-Duty, 1.5 kW

New! Super heavy-duty 40-6 Meter Cobweb Antenna. Built to survive harsh northern winters, heavy snow, ice and strong winds – has super-strong large diameter fiberglass and heavy-duty 14 gauge stranded hard copper wire. 8-bands: 40, 30, 20, 17, 15, 12, 10, 6 Meters, 1500 Watts. Turning radius: 12 feet, 23 lbs.

MFJ 20/17/15/12/10/6 Meter *Hexbeam*

New MFJ HexBeams deliver solid gain and directivity on 20/17/15/12/10/6 Meters with two elements on each band.

MFJ uses an updated G3TXQ element configuration for excellent gain, improved bandwidth, superior front-to-back ratio and low SWR!

MFJ takes the HexBeam`s unique balanced-tension framework to a new level with rugged mounting hardware, exceptionally durable spreaders and sliding antenna-wire guides – designed to ensure years of reliable service.

MFJ-1846, $559.95. 6 Bands: 20/17/15/12/10/ 6M, 2-elements per band, full 1500W. 25 lbs. 11 ft.turning radius.

MFJ-1848, $779.95. 8 Bands: 20/17/15/12/10/ 6M, 2-elements per band; 40/30M, single elements, full 1500W. 28 lbs. 14 ft. turning radius.

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3-Element Hexbeam

MFJ-1856 is ***six*** individually stacked monoband yagis!

6 Bands: 20/17/15/12/10/6M. Full 1500 Watts.

Three *full-size* elements on each band gives high gain, high front-to-back ratio and wide bandwidth. Works great at 20 feet. 30lbs. 17 feet turning radius. Ideal for a small rotator like hy-gain's CD-45II, $449.95.

MFJ Isolator and 1:1 Balun

MFJ-915, $39.95 Stop *RF* traveling down coax line, painful RF "bites" and erratic operation. 1.5 kW 1.8-60 MHz. 2W x 5H". SO-239s.

MFJ-918, $39.95 True 1:1 Current balun & center insulator forces equal antenna currents in dipole elements.

MFJ Dry Dummy Load

MFJ-260C, $49.95. Air-cooled, 300 Watt dry dummy load with a noninductive resistor in a perforated metal housing. SO-239 connector. Full load 30 seconds. Silk-screened derating curve to 5 minutes. SWR below 1.1:1 to 30 MHz, 1.5:1 from 30 to 650 MHz.

MFJ 2-Pos. Antenna Switch

MFJ-1702C, $49.95. 2-position antenna switch has center ground, auto grounding of unused position, handles 2.5 kW PEP and works to over 500 MHz. Lightning surge protection. Quality SO-239 connectors, heavy duty diecast.

MFJ-1704, $109.95. Like MFJ-1702C but has 4 positions.

MFJ G5RV Antenna

MFJ-1778, $69.95. G5RV antenna covers 160-10 Meters with antenna tuner. 102 ft. long. Inverted vee or sloper. Use on 160 Meters as Marconi. 1500 Watts. Super-strong fiberglass center/feed-point insulators. Glazed ceramic end insulators. Hand-soldered. Add coax, some rope and you're *on the air!*

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Kill Noise before it reaches your receiver!
Great for supressing power line noise, plasma TV noise & many other local electrical noises.

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MFJ Magnetic Loop Antennas

MFJ 36-inch magnetic loop antenna lets you operate 7 to 22 MHz or 10 to 30 MHz continuously -- including the WARC and MARS bands! Easily handles a full 150 Watts on SSB/CW/Digital for any transceiver.

Ideal for limited space. Apartments, small lots, motor homes, attics, trailers.

Work exciting DX with low angle radiation and local close-in contacts with high angle radiation when mounted vertically.

Super easy-to-use! MFJ remote control auto tunes to your desired band. Fast/slow tune buttons, Cross-Needle SWR/Wattmeter lets you quickly tune to your exact frequency. No control cable needed.

***World's** most efficient small loop antenna has all welded construction, welded butterfly capacitor with no rotating contacts, large 1.050 inch diameter aluminum radiator -- gives you highest possible efficiency.*

Every capacitor plate is welded for extremely low loss and polished to prevent high voltage arcing. Nylon bearing, anti-backlash mechanism, limit switches, continuous no-step DC motor gives smooth precision tuning. Heavy-duty ABS plastic housing has ultraviolet inhibitor protection.

MFJ-1782, $459.95. Like MFJ-1786 but has fast/slow tune manual control.

MFJ-1780, $369.95. 20-10 Meters, 150 Watt *Portable* *24x24x24" box fan loop with carry handle.* Fast/slow tune control. *See QST July 2019.*

***New* 40-15M and 30-10M 300W *High Efficiency* Welded Loop Antennas**

Carry it anywhere! Easy carry handle, fold-out feet, tripod mount bracket. Portable, lightweight 36x36x4". Deluxe semi-auto controller with SWR/Wattmeter, no control line needed. Welded Low loss *butterfly* air-variable capacitor. 300W SSB.

MFJ-1784, $699.95. 40-15 Meters.

MFJ-1783, $649.95. 30-10 Meters.

Build your own Mag loop!

Motorized Butterfly Capacitors

Super low loss butterfly capacitors, no rotating contacts, all plates welded with no mechanical electrical contacts. Anti-backlash mechanism. DC motor with gear reduction box. Handles at least 150 Watts SSB/CW/Digital.

1. p/n: 282-1786, $189.95. 11-128 pF.

2. p/n: 282-1788, $249.95. 15-260 pF.

3. p/n: 80-1786-2SM, $249.95. Auto band selecting remote controller with SWR/Wattmeter.

4. p/n: 80-1782-2, $79.95. Manual remote control, fast/slow tune buttons.

Butterfly Capacitors

5. MFJ-19, $79.95. 12-67 pF.

6. MFJ-23, $109.95. 18-136pF.

7. p/n: 729-0142, $19.95. 6:1 vernier gear reduction drive for loop tuning capacitor.

8. 36-inch Aluminum Circular Loop with Integrated welded capacitor and mast mounting brackets
p/n: 10-1786-11, $129.95. 1.05 inch OD heavy duty tubing.

MFJ Magnetic Loop Tuners, 150 Watts

Turns wire or coax into a small, high efficiency multi-band transmitting magnetic loop antenna!

Work the world 3.5 to 30 MHz with a *full 150 Watts* SSB/CW/Digital. No ground, radials or counterpoises needed.

New larger matching capacitor is 313 pF. Increases matching range. Butterfly capacitor has no rotating contacts.

Very quiet receiving antenna -- you'll hardly notice static crashes. High-Q reduces QRM, overloading, harmonics. Perfect for apartments, antenna restricted areas and portable operation.

A 13' wire loop covers 30-20 Meters (4' for 17-10M; 7' for 20-15M; 28' for 60-40M; 50' for 80M). Tune *any* shape loop -- circle, square, rectangle, *etc.*

A wire length gives about 1.5 to 1 frequency range (i.e.7-10, 18-28 MHz).

Easy-Carry handle. Mount for PVC Cross loop support on cabinet top. Included tripod/mast mount.

A. MFJ-936C, $349.95. Antenna current meter, Cross-Needle SWR/Wattmeter. 9¼Wx5½Hx9½D".

B. MFJ-935C, $299.95. Antenna current meter. 6¼Wx5½Hx9½D".

C. MFJ-933C, $249.95. 6¼Wx5½Hx9½D".

MFJ-58B, $59.95

PVC Cross Loop support. 60-40M 20-15M 17-10M loop wires, wire clips.

MFJ Low-Noise Receiving Mag Loop

Clearly hear signals 50 KHz to 30 MHz you never knew existed. Power line noise and static disappears. Rotating MFJ-1886 eliminates interfering signals or greatly peaks desired signals. Excellent antenna and preamplifier balance gives deep null. Gives excellent strong and weak signal performance without overload. Fully protected state-of-the-art push-pull Gali MMICs preamplifier gives you high dynamic range, low IMD and 25 dB of low noise gain. Use inside or outside.

QRP Mag Loop Tuner

MFJ-9232
$69.95

Turns wire around a bookcase, window, tree, etc. *into a small, high efficiency transmitting loop antenna!* Operate 40-10 Meters with included flexible wire loop (80/60 Meters with your bigger loop). No counterpoises, radials, ground needed. 25 Watts. Very quiet reception. Hi-Q reduces QRM, overload, harmonics. Great for apartments, antenna restrictions, portable ops.

VIDEOS: https://m.youtube.com/results?search_query=MFJ-9232

Antenna Rotator

Perfect for magnetic loops, VHF/UHF, small HF beams, TV, FM antennas. Weather-proof cast aluminum housing with precision all metal gears, steel thrust bearings and automatic braking. Includes rotator, controller, remote control, clamps, hardware. 12 Memories. Digital display. 110/220 VAC.

$169.95

MFJ Tripods/Masts

Strong, black *steel* triangular braced base. Non-skid feet, strong mast locks.

MFJ-1919, $109.95, Supports 100 lbs. Extends a *whopping* 7.8 ft. Base spreads up to 4.8 sq. ft. 1.4" dia. mast. Collapses to 54" by 6" diameter. 9¾ lbs.

MFJ-1919EX, $179.95. Tripod *plus* mast. 18' extended. 5' collapsed. 1/8" wall, 3/4" dia. top, 1½" dia. bottom.15 lbs.

MFJ-1918, $69.95, 6'extended. 38" collapsed, 6¾ lbs.

MFJ-1918EX, $109.95. Small tripod with extension mast. 9½', 3.8 ft. collapsed. ¾"top, 1" bottom. 6.5 lbs.

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MFJ Weather-Proof Window Feedthrough Panels

Weather-proof window feedthrough panels bring coax, balanced lines, HF/VHF/UHF antennas, random wire antennas, ground, rotator/antenna switch cables and DC/AC power into your hamshack without drilling through walls!

MFJ Weather-Proof Window Feedthrough Panels mount in your window sill. Lets you bring all your antenna connections into your hamshack without drilling holes through walls.

Simply place in window sill and close window. One cut customizes it for any window up to 48 inches. Use horizontally or vertically. Connectors are mounted on inside/outside stainless steel plates and attached to a 4 foot long, 3 1/2 inch high, 3/4 inch thick pressure-treated wood panel.

Real Western Red Cedar wood is naturally resistant to rot, decay and insects -- lasts longer, maintenance-free. Pitch and resin free for a wide range of beautiful finishes or leave it in its naturally beautiful raw finish. Edges sealed by weather-stripping. Seals and insulates against all weather conditions. Includes window locking rod.

Inside/outside stainless steel plates ground all coax shields. Stainless steel ground post brings ground in.

MFJ-4603 Universal Window Feedthrough Panel

MFJ-4603 **$109.95**

Four 50 Ohm Teflon® SO-239 coax connectors lets you feed HF/VHF/UHF antennas at full legal power limit.

A 50 Ohm Teflon® coax N-connector lets you use any antenna up to 11 GHz, including 450 MHz, UHF, satellite, moon bounce and 2.4/5.8 GHz Wi-Fi antennas.

A 75 Ohm, 1 GHz F-connector makes it easy to bring in television, Satellite, HD, cable TV and FM radio signals.

A pair of high-voltage ceramic feedthru insulators lets you bring in 450/300 Ohm balanced lines directly to your antenna tuner.

Has random/longwire antenna ceramic feedthru insulator.

5-way binding posts lets you supply 50 Volts/15 Amps DC/AC power to your outside antenna tuners/relays/switches.

Stainless ground post brings in ground connection, bonds inside/outside stainless steel panels together and drains away static charges.

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3 Coax, Balanced Line, Random Wire

Best Seller! 3 Teflon® coax connectors for HF/VHF UHF antennas. Separate high voltage ceramic feed-thru insulators for balanced lines and longwire/random wire, Stainless steel ground post.

MFJ-4602 **$79.95**

6 Coax

6 high quality Teflon® coax connectors for HF/VHF/UHF antennas. Stainless steel ground post. Full 1500 Watt legal limit.

MFJ-4601 **$69.95**

4 Balanced Line, 2 Coax

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

MFJ-4600 **$89.95**

5 Cables, any-size

5 Adaptive Cable Feedthrus™. Pass any cable with connector: 2 cables with large connectors up to 1 1/4 x 1 5/8 inches and 3 cables with UHF/N size coax connectors. Seals out weather.

MFJ-4604 **$114.95**

All-Purpose FeedThru/CableThru™

Stacks MFJ-4603 and MFJ-4604! Gives you every possible cable connection you'll ever need through your window without drilling holes in wall – including UHF, N and F coax connectors, balanced lines, random wire, ground, DC/AC power and cables of any size for rotators, antenna switches, etc.

MFJ-4605 **$179.95**

Bring cables through the eave of your house

MFJ-4616
shown with standard full size vent (not included) it replaces. For 6 Cables

$34.95

MFJ-4613
shown with standard half size vent (not included) it replaces. For 3 Cables

$19.95

Replace your standard air vents on the eave/sofitt of your house with these MFJ AdaptiveCable™ Air Vent Plates and...

Bring in coax, rotator, antenna switch, power cables, etc. with connectors up to 1 1/4 x 1 5/8 inches!

Sliding plates and rubber grommets adjust for virtually any cable size to seal out adverse weather, insects and varmints. Use existing vent hole, mounting screws and screw holes.

AdaptiveCable™ Wall Plates

MFJ-4614
For 4 Cables

$44.95

Bring nearly any cable -- rotator, antenna switch, coax, DC/ AC power, etc. -- through walls without removing connectors (up to 1 1/4x1 5/8 inches). Sliding plates and rubber grommets adjust hole size to weather-seal virtually any size cable.

Includes stainless steel plates for each side of wall, sliding plates, rubber grommets, weather stripping and screws.

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MFJ-4611
For 1 Cable

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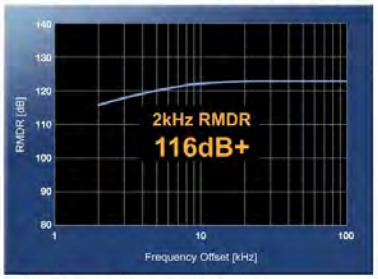

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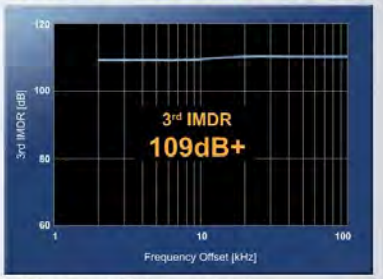
14MHz Band Blocking Dynamic Range (BDR)

- **2kHz 3rd IMDR 109 dB+**



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HF/50MHz TRANSCEIVER

FTDX 10

*External Speaker SP-30: Optional

As of Oct. 2020, this device has not been approved by the FCC. This device may not be offered for sale or lease until the approval of the FCC has been obtained. The information shown is preliminary and may be subject to change without notice or obligation.

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New and improved. Now covers 280 KHz to 230 MHz and 415 to 470 MHz and 2200 Meter band!

Instantly gives you a complete picture of your antenna.

Read SWR, return loss, reflect-ion coefficient, match efficiency at any frequency simultaneously.

Read Complex Impedance (100 KHz to 230 MHz) as series equivalent resistance and reactance (Rs+jXs) or as magnitude (Z) and phase (degrees). Also reads parallel equivalent resistance and reactance (Rp+jXp).

Determine velocity factor, coax loss in dB, length of coax and *distance to short or open in feet (it's like a built-in TDR).*

Coax Calculator™ calculates coax line length in feet given degrees and vice versa for any frequency, velocity factor.

New! MFJ-269D **$419.95**

Measure SWR and loss of coax with *any* characteristic impedance (280 KHz to 230 MHz) from 10 to over 600 Ohms.

Measures inductance in uH and capacitance in pF at RF frequencies, 100 KHz to 230 MHz.

High contrast LCD gives precision readings and two side-by-side analog meters make antenna adjustments smooth and easy.

12-bit A/D converter gives much better accuracy and resolution than common 8-bits -- *MFJ-269D exclusive!*

Built-in frequency counter, battery saver, low battery warning, Ni-Mh/NiCd charge circuit. 4Wx2Dx6¾", 2 lbs. Use ten aA batteries or 110 VAC with MFJ-1312D, $19.95.

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MFJ-269DPro, $459.95. Like MFJ-269D, but UHF range covers ***430 to 520 MHz***. For commercial work.

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New!

MFJ-259D **$319.95** ***New and improved, now covers 280 KHz-230 MHz!***

***World** famous* MFJ-259D gives you a complete picture of your antenna's SWR and Complex Impedance.

MFJ-259D is a complete ham radio test station including frequency counter, RF signal generator, *SWR Analyzer™*, RF Resistance/ Reactance Analyzer, Coax Analyzer, Capacitance/ Inductance Meter and more!

Read Complex Impedance as series resistance and reactance (R+jX) or as magnitude (Z) and phase (degrees).

Determine velocity factor, coax cable loss in dB, length of coax and distance to short/open.

Read SWR, return loss and reflection coefficient at any frequency simultaneously.

Read inductance (uH) and capacitance (pF) at RF frequencies.

Large easy-to-read two line LCD screen and side-by-side meters clearly display your information.

Built-in frequency counter, Ni-MH/Ni-CD charger circuit, battery saver, low battery warning, smooth reduction drive tuning.

Super easy-to-use! Just set the bandswitch and tune the dial -- just like your transceiver. SWR, Complex impedance displayed instantly!

Fully portable, take it anywhere -- remote sites, up towers, on DX-peditions. Use 10 AA or Ni-Cad or Ni-MH batteries (not included) or 110 VAC with MFJ-1312D, $19.95. Rugged metal cabinet, 4x2x6¾". **MFJ-249D, $299.95.**

MFJ-249D does everything MFJ-259D does with digital display only.

MFJ-223 1-60 MHz Color Graphic VNA Analyzer

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MFJ-223 **$319.95**

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- **Field-strength meter**
- **DDS generator** precision signal source
- **Vivid 1600-pixel/inch** color graphics on a 2x2 inch non-glare TFT screen

MFJ-225 1.5-180 MHz *continuous* Two-Port Graphic Analyzer

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MFJ-225 **$339.95**

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A. MFJ-29D/MFJ-39D, $24.95. Carrying Pouch for MFJ-259D/269D.

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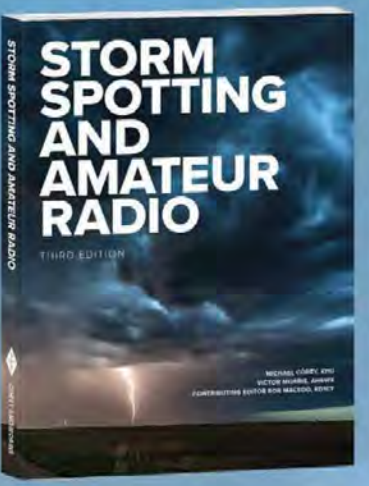

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Only the MFJ-998 gives you fully automatic antenna tuning for your legal limit amplifier Full 1500W SSB/CW/Digital!

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Instantly match impedances from 12-1600 Ohms using MFJ's exclusive IntelliTune™, Adaptive Search™ and InstantRecall™ algorithms with over 20,000 VirtualAntenna™ Memories.

Safe auto tuning protects amp
MFJ's exclusive Amplifier Bypass Control™ makes tuning safe and "stupid-proof"!

Digital/Analog Meters
MFJ-998 $739.95
A backlit LCD meter displays SWR, forward/reflected power, frequency, antenna selected, an auto-ranging bargraph power indication, and much more.

Has quick-glance auto-ranging Cross-Needle SWR/Wattmeter.

MFJ VirtualAntenna™ Memory
MFJ new VirtualAntenna™ Memory system gives you 4 antenna memory banks for each of 2 switchable antenna coax connectors. Select up to 4 antennas on each antenna connector. Each antenna has 2500 memories, 20,000 total. Has binding post for end-fed long wire antennas.

Download & Upgrade Remotely
Download from internet and upgrade your MFJ-998 firmware as new features are introduced.

Plus Much More!
Built-in radio interface controls most transceivers.

Automatically bypasses with excessive tuning power.

Use balanced line antennas with external **MFJ-912, $69.95**, 1.5 kW 4:1 balun.

Small 13W x 4H x 15D inches easily fits into your ham station. 8 pounds. Requires 12-15VDC at 1.4 amps maximum or 110 VAC with **MFJ-1316, $29.95**.

For 600 Watt amps
AL-811/ALS-600/ALS-500

MFJ-994B $379.95
For 600 Watt amps like Ameritron AL-811/ALS-600/ALS-500M. Matches 12-800 Ohms. 10,000 Virtual Antenna™ memories. Cross-Needle SWR/Wattmeter. 10W x 2.75H x 9D inches.

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

300/150W Best Seller
Digital Meter, Ant Switch, Balun

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The world's best selling automatic antenna tuner is highly acclaimed the world over for its ultra high-speed, wide matching range, reliability, ease-of-use! 300/150W on SSB/CW/Digital!

300 Watt Extra Wide Range
SWR/Wattmeter, 10000 VA Memories

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Extra-wide matching range at less cost. Exclusive dual power level: 300 Watts SSB/CW Digital. 6-1600 Ohms. 150W SSB/CW and Digital. SWR/Wattmeter.

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World's fastest compact auto tuner uses MFJ Adaptive Search™ and InstantRecall™ algorithms. 132,072 tuning solutions instantly match any antenna. 200W SSB/CW/Digital.

200 Watt *MightyMite*™ *Matches IC-706, FT-857D, TS-50S*

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Covers all bands, 160-10 Meters with antenna tuner. 102 ft. 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, $59.95.** G5RV Junior. Halfsize, 52 ft. 40-10M with tuner, 1500 Watts.

200W Weather-sealed
For Remote/Outdoor/Marine

Fully weather-sealed for remote Outdoor/Marine use! Tough, durable, built to last the elements for years.

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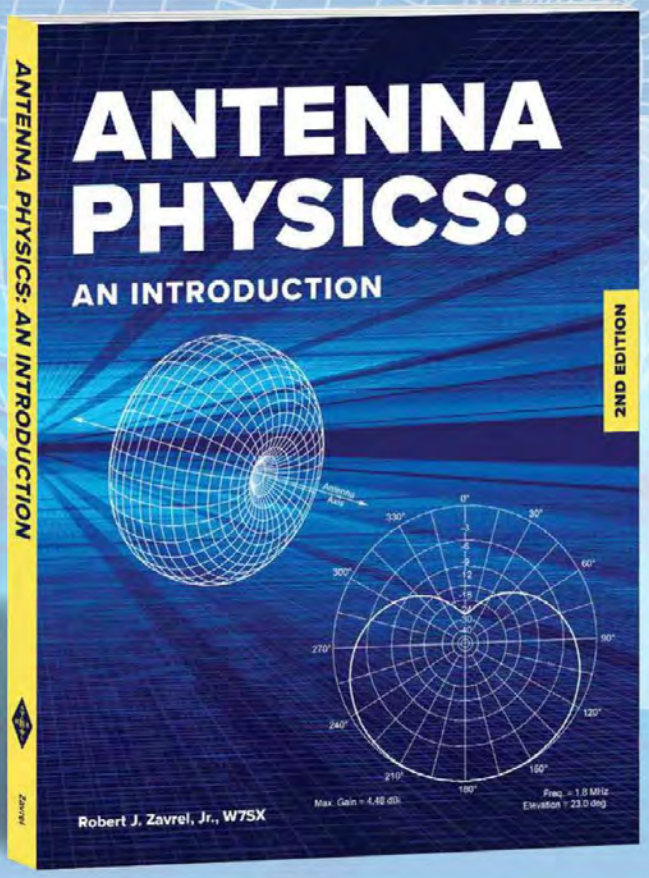

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Includes six position ceramic antenna switch, 50 Ohm dummy load, indestructible multi-color Lexan front panel with detailed logging scales and legends.

The MFJ-989D uses the superb time-tested T-Network. It has the widest matching range and is the easiest to use of all matching networks. Now with MFJ's new 500 pF air variable capacitors and new low loss roller inductor, it easily handles higher power much more efficiently.

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Two knob tuning (differential capacitor and AirCore™ roller inductor) makes tuning foolproof and easier than ever. Gives minimum SWR at only one setting. Handles 3 kW PEP SSB amplifier input power (1.5 KW output). Gear-driven turns counter, lighted peak/average Cross- Needle SWR/Wattmeter, antenna switch, balun. 1.8 to 30 MHz. 15W x $4^{1}/_{2}$H x $10^{3}/_{4}$D in.

MFJ-962D compact kW Tuner

MFJ-962D **$359.95**

A few more dollars steps you up to a KW tuner for an amp later. Handles 1.5 kW PEP SSB amplifier input power (800W output). Ideal for Ameritron's AL-811H! AirCore™ roller inductor, gear-driven turns counter, pk/avg lighted Cross-Needle SWR/Wattmeter, antenna switch, balun, Lexan front, 1.8-30MHz. $10^{7}/_{8}$W x $10^{3}/_{4}$H x $4^{1}/_{2}$D in.

MFJ-969 300W Roller Inductor Tuner

MFJ-969 **$259.95**

Superb, AirCore™ Roller Inductor tuning. Covers 6 Meters thru 160 Meters! 300 Watts PEP SSB. Active true peak reading lighted Cross-Needle SWR Wattmeter, QRM-Free PreTune™, antenna switch, dummy load, 4:1 balun, Lexan front panel. $10^{1}/_{2}$W x $3^{1}/_{2}$H x $9^{1}/_{2}$D inches.

MFJ-949E deluxe 300 Watt Tuner

MFJ-949E **$219.95**

More hams use MFJ-949s than any other antenna tuner in the world! Handles 300 Watts Full 1.8 to 30 MHz coverage, custom inductor switch, 1000 Volt tuning capacitors, full size peak/average lighted Cross-Needle SWR/Wattmeter, 8 position antenna switch, dummy load, QRM-Free PreTune™, scratch proof Lexan front panel. $10^{5}/_{8}$W x $3^{1}/_{2}$H x 7D inches. **MFJ-948, $179.95.** Economy version of MFJ-949E, less dummy load, Lexan front panel.

MFJ-941E Super Value Tuner

MFJ-941E **$169.95**

Most for your money! 300 Watts PEP, 1.8-30 MHZ, lighted Cross-Needle SWR/Wattmeter, 8 position antenna switch, 4:1 balun, 1000 volt capacitors, Lexan front panel. $10^{1}/_{2}$W x $2^{1}/_{2}$H x 7D in. **MFJ-941EK, $139.95.** Tuner Kit -- Build your own!

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MFJ-945E **$159.95**

Extends your mobile antenna bandwidth so you don't have to stop, go outside and adjust your antenna. Tiny 8W x 2H x 6D in. Lighted Cross-Needle SWR/Wattmeter. Lamp and bypass switches. Covers 1.8-30 MHz and 6 Meters. 300 Watts PEP. **MFJ-20, $9.95**, mobile mount.

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MFJ-971 **$149.95**

Tunes coax, balanced lines, random wire 1.8-30 MHz. Cross-Needle Meter. SWR, 30/300 or 6 Watt QRP ranges. Matches popular MFJ transceivers. Tiny $6^{1}/_{2}$W x $2^{1}/_{2}$H x 6D in.

MFJ-901B smallest Versa Tuner

MFJ-901B **$119.95**

MFJ's smallest (5W x 2H x 6D in.) and most affordable wide range 200 Watt PEP Versa tuner. Covers 1.8 to 30 MHz. Great for matching solid state rigs to linear amps.

MFJ-902B Tiny Travel Tuner

MFJ-902B **$129.95**

Tiny $4^{1}/_{2}$W x $2^{1}/_{4}$H x 3D inches, full 150 Watts, 80-6 Meters, has tuner bypass switch, for coax/random wire. **MFJ-904H, $169.95**. Same but adds Cross-needle SWR/Wattmeter and 4:1 balun for balanced lines. $7^{1}/_{4}$W x $2^{3}/_{4}$H x $2^{3}/_{4}$D inches.

MFJ-16010 random wire Tuner

Operate all bands anywhere with MFJ's reversible L-network. Turns random wire into powerful transmitting antenna. 1.8-30 MHz. 200 Watts PEP. Tiny 4W x 2H x 3D in.

MFJ-16010 **$79.95**

MFJ-9201 QRPocket™ Tuner

80-10 Meters, 25 Watts. 12 position inductor, tune/bypass switch, wide-range T-network, BNCs. 4W x $2^{5}/_{8}$H x $1^{1}/_{2}$D inches. **MFJ-9201, $49.95**

MFJ-9201 **$54.95**

MFJ-921/924 VHF/UHF Tuners

MFJ-921 covers 2 Meters/220 MHz. **MFJ-924** covers 440 MHz. SWR/Wattmeter. 8W x $2^{1}/_{2}$H x 3D in.

MFJ-921/924 **$109.95**

MFJ-931 Artificial RF Ground

Eliminates RF hot spots, RF feedback, TVI/RFI, weak signals caused by poor RF grounding. Creates artificial RF ground or electrically places far away RF ground directly at rig. **MFJ-934, $249.95**, Artificial ground/300 Watt Tuner/Cross-Needle SWR/Wattmeter.

MFJ-931 **$129.95**

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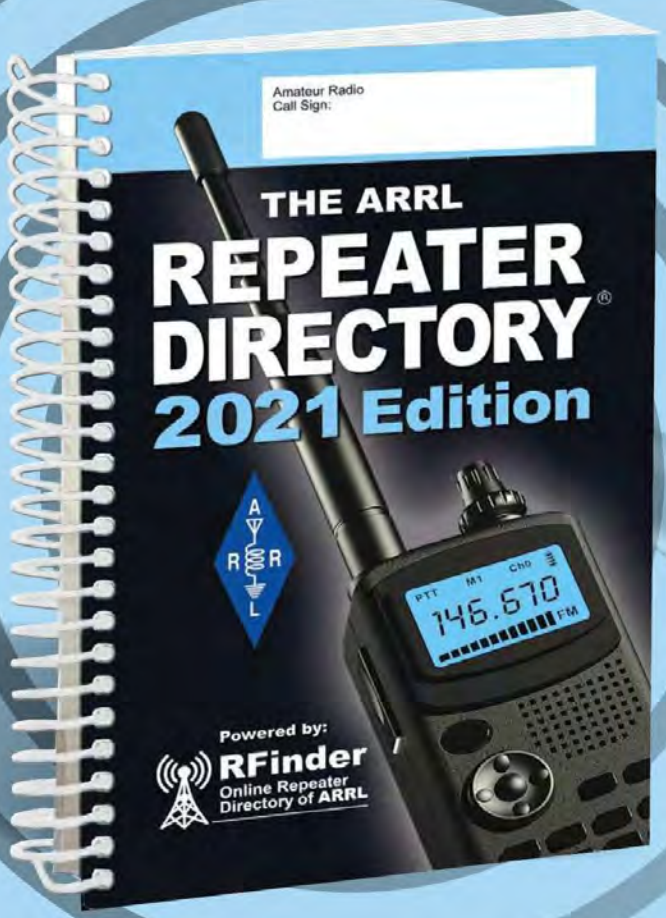

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Connects between rig and 12/ 24/50 VDC power supply/battery. Reduces RFI, hash, transients, motor noises, alternators, fuel pump whine, power windows, more! Binding posts/*PowerPoles*®.

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High attenuation above 40 MHz. 1.5kW, 1.8-30 MHz. SWR<1.3. Nine Chebyshev poles, *Teflon*® dielectric capacitors, high-Q inductors, ground plane shielding, RF tight.

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Instantly turn wire or coax into a small, high-efficiency multi-banded loop antenna. 150W, 5.3-30 MHz. Tripod/mast mount included.

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300 Hz - 2.8 GHz. 1 Hz resolution, 10-digit backlit LCD, signal strength bargraph, lithium battery.

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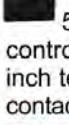

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Relative field-strength readings .1-500 MHz. Sensitivity control, 1¾ inch meter. 20-inch telescoping whip. Finger contact increases sensitivity.

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Receives 25-1300 MHz. Transmits 50-1300 MHz up to 200 Watts. Test various X-mitters on one coax. 50 ft. coax, stainless steel elements.

17-foot Telescopic Whip

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17-foot stainless steel whip collapses to 27". Full 1/4 Wave on 20/17 Meters, 30-160 Meter operation with loading coil. Fits any standard 3/8-24 threaded mount.

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MFJ-1906HD **$249.95**

Super-strong heavy-duty mast with *QuickClamps*™. 38 ft. ext., 6 ft. collapsed. 2½" OD bottom, 1" OD top. .125" thick wall. Supports "*real*" weight.

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Giant 2½ inch super bright LEDs -- see from across the street day or night. 12/24 switch, 110VAC, 9V battery backup.

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MFJ-4712 **$89.95**

MFJ 2-position *remote* antenna switch uses a *single* coaxial feedline to feed two antennas, DC power and control signals. Remotely switch HF and/or VHF antennas. Covers 1.8 MHz to 150 MHz and handles 1500 Watts. Impedance is 50-75 Ohms. Compact 4Wx2⅝Hx1½D". *Outside Switch Box* is fully enclosed and weather protected. Three quality *Teflon*® SO-239 connectors for transmitter, antenna one and antenna two. Stainless steel 1½" tall bracket with a U-bolt for masts up to 1½ in. O.D. *Inside biastee* control is 2¼Wx2½Hx1¼ in. Use 12 VDC or 110 VAC with MFJ-1312D, $19.95.

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By tuning out ground wire reactance RF hot spots disappear and your rig is at actual earth ground. Improve signals by resonating a wire into a tuned counterpoise.

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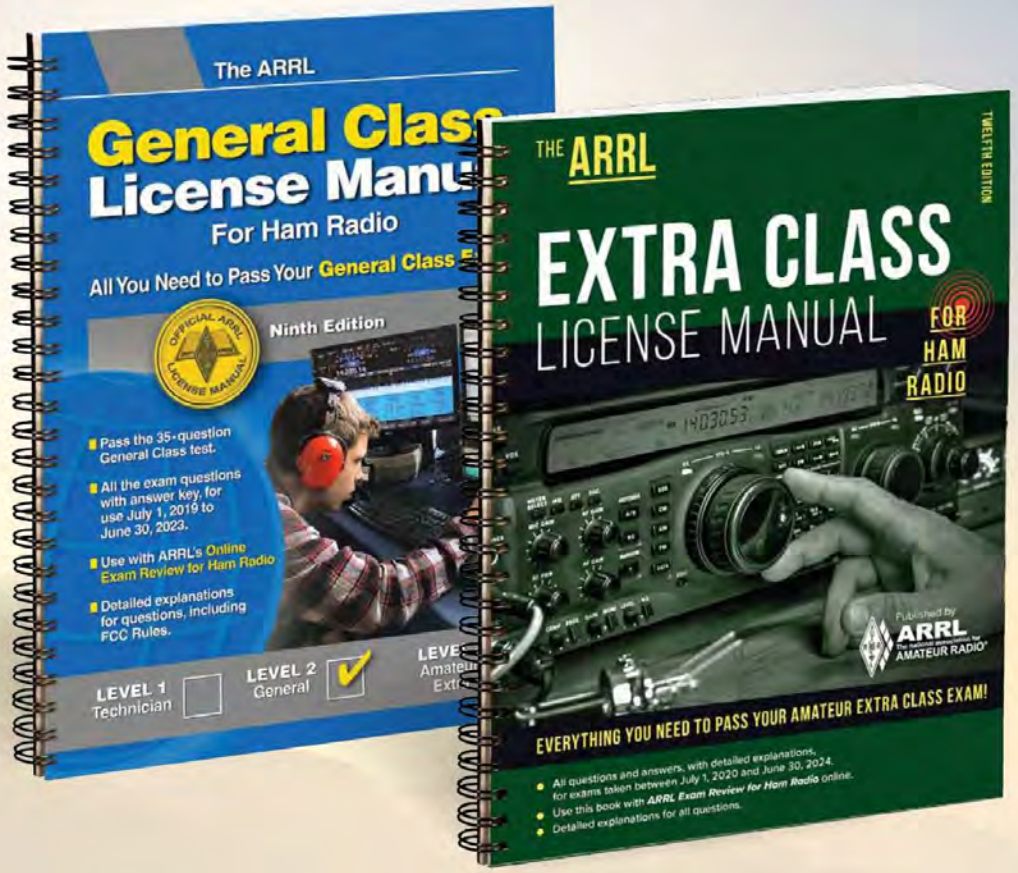

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MFJ-9232
$69.95

Drape a wire around a bookcase, window, tree or other object and attach both ends to this *MFJ QRPocket™ Loop Antenna Tuner. It instantly turns into a small, high efficiency multi-band transmitting loop antenna!*

Operate 40-10 Meters with included flexible wire loop (80/60 Meters with your bigger loop). No ground, radials or counterpoises needed. 25 Watts.

It's a very quiet receiving antenna. Its hi-Q reduces QRM, overload, harmonics.

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Adjust tuning and matching capacitors for minimum SWR and operate.

BNC for transmitter, wing nut posts for loop wire. Tiny 2¼Wx4Hx2¼D inches.

MFJ-9234, $69.95. Like MFJ-9232 but connects directly to your transceiver SO-239 antenna connector.

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QRP Antenna Tuner

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MFJ-1982LP, $54.95. Get on the air quick! 30W, 132' wire. No tuner needed.

33' Telescopic Portable Mast

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17' Telescopic Whip

MFJ-1979, $69.95. Stainless steel, collapses to 27".

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MFJ-4103, $69.95. Delivers reliable regulated 13.8 VDC at 2.89 Amps (40 Watts) to anywhere in the world (100-240 VAC/47-63Hz input). Overvoltage, over-current, overtemperature protected. Tiny 4⅛x2⅝x1⅜", 10 oz; 2.1 mm ID, 5.5mm OD coaxial DC connector. FT-817 adapter included. **MFJ-5513, $5.95.** 2.1 mm to *PowerPoles*™.

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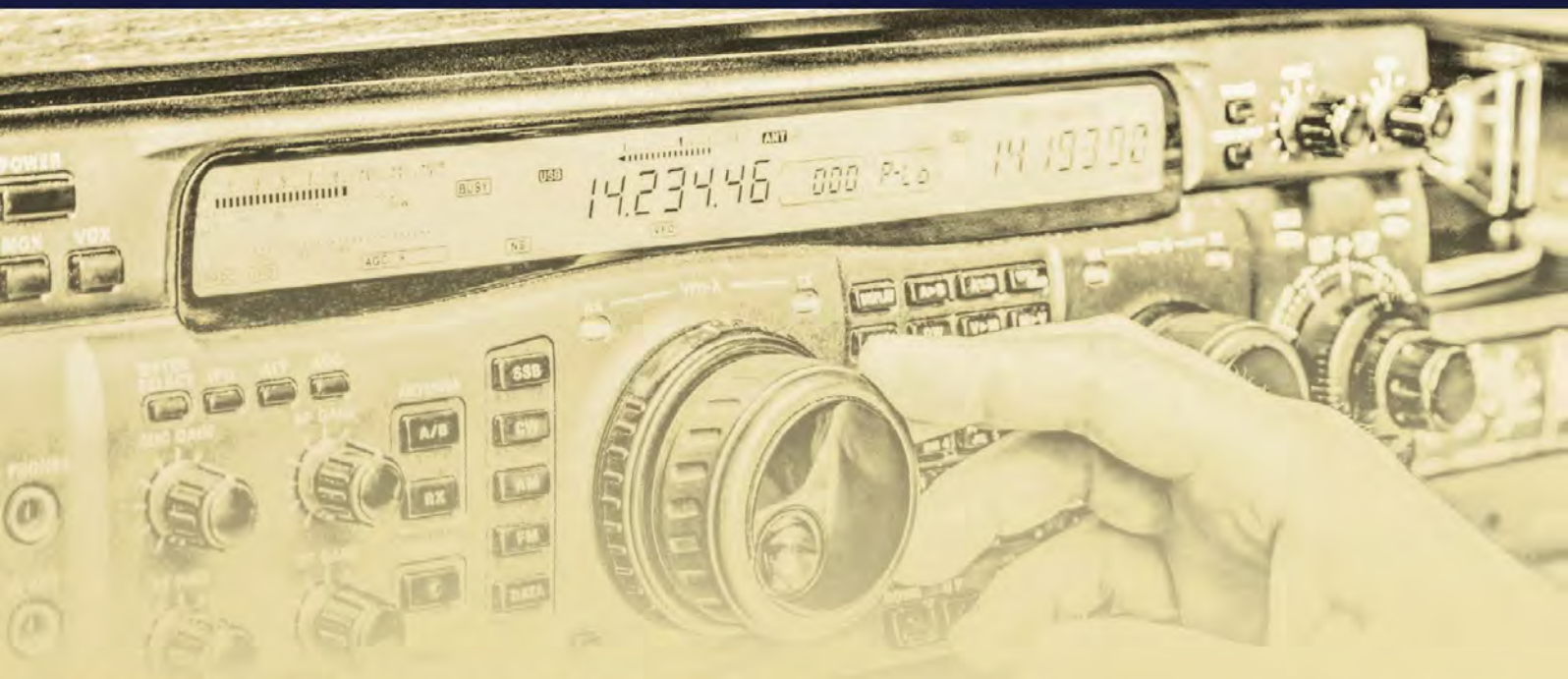

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