

QST



DIGITAL EDITION



ARRL The national association for
AMATEUR RADIO®

June 2019

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DEVOTED ENTIRELY TO AMATEUR RADIO

**FIELD
DAY
2019**



QST Reviews

Kenwood TS-890S HF and
6-Meter Transceiver

SharkRF openSPOT2
Multimode Digital Hotspot

PreciseRF HG-1 Magnetic
Loop Antenna

DIGITAL FEATURE



54 | See our Video Review
of the **Kenwood** TS-890S
HF and 6-Meter Transceiver.

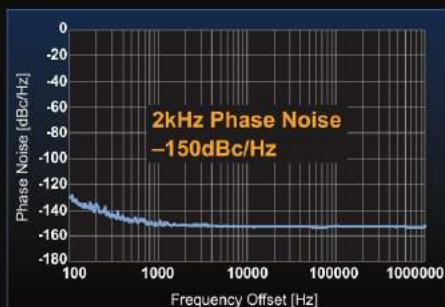
The Conclusive Choice

Transmit Signal Purity

High-Quality Transmission with Outstanding Phase noise characteristics

The excellent C/N characteristics provided by 400MHz HRDDS (High Resolution Direct Digital Synthesizer) used in the FTDX101 local oscillator circuit contribute significantly to the superb performance of both the receive and the transmitter sections. Yaesu conducted a thorough examination of each element in the transmission final stage such as clock distributor that divides/distributes the local signal from the 400MHz HRDDS circuit as a clock signal to each block, as well as FPGA, D/A converter, final power amplifier etc., and then carefully selected the latest circuit configuration to improve the C/N characteristics of the entire transmitter block. The transmission signal of the FTDX101 is generated directly from a 16-bit D/A converter without passing through the mixer circuit, therefore distortion and noise are significantly suppressed.

As a result, high-quality local signal characteristics are maintained without degradation to the final stage, and the transmission phase noise characteristics achieve an extraordinary -150 dBc/Hz at 2kHz separation. FTDX101 transceiver users will enjoy the outstanding performance as well as confidence and pride in the high-purity of their transmission signal.



TX Phase Noise (14MHz Band, Mode: CW)



TX Final Stage (MP Version)



In Homage to the Founder of Yaesu – Sako Hasegawa JA1MP

FTDX101MP 200W
HF/50MHz TRANSCEIVER

The Ultimate

FTDX101D 100W
HF/50MHz TRANSCEIVER

FTDX101MP: This device has not been approved by the FCC. This device may not be offered for sale or lease or be sold or leased until approval of the FCC has been obtained. The information shown is preliminary and may be subject to change without notice or obligation.

C4FM/FM 144/430 MHz
Dual Band 5W
Digital Transceiver
FT-70DR

« 700 mW Loud and Clear audio,
Commercial Grade Specifications »



C4FM/FM 144/430 MHz
Dual Band 5 W
Digital Transceiver
FT2DR

« Improved 66 ch
GPS receiver included »



System Fusion II

**C4FM Digital
Pursuing Advanced Communications**



C4FM/FM 144/430 MHz Dual Band 50 W
Digital Transceiver

FTM-100DR

« Improved 66 ch GPS receiver included »



C4FM/FM 144/430 MHz
Dual Band Dual Receive Digital Repeater

DR-2X



C4FM/FM 144/430 MHz Dual Band 50 W
Digital Transceiver

FTM-400XDR

« Improved 66 ch GPS receiver included »



C4FM/FM 144 MHz 65 W
Digital Transceiver

FTM-3200DR

« Genuine 65 Watts High Power »



C4FM/FM 144/430 MHz Dual Band 50 W
Digital Transceiver

FTM-7250DR

« Heavy Duty 50 Watts High Power »



C4FM/FM 430 MHz 55 W
Digital Transceiver

FTM-3207DR

« Heavy Duty 55 Watts High Power »



CW/SSB/AM/FM/C4FM
HF/50/144/430 MHz Wide-Coverage
100 W All Mode Transceiver (144/430 MHz: 50 W)

FT-991A

« Real-Time Spectrum Scope included »

System Fusion II Supports All C4FM Portables and Mobiles

• Firmware updates will enable System Fusion II compatibility with all existing C4FM products.

YAESU
The radio

YAESU USA
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CA 90630 (714) 827-7600

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

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

Cushcraft...Keeping You in Touch Around the Globe



MA-6B 6-Band Beam

Small Footprint – Big Signal

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

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

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

The unique MA-6B is a two-element Yagi on 20/17/15/12/10/6 Meters. It delivers solid power-

multiplying gain over a dipole on all bands. You get automatic band switching and a super easy installation in a compact 26-pound package.

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

MA-5B, \$529.95. Like MA-6B but five bands: 20/17/15/12/10 Meters. 12 and 17 Meters is a single element trapped dipole.

See cushcraftamateur.com for gain figures.

Cushcraft 10, 15 & 20 Meter Tribander Beams

Only the best tri-band antennas become DX classics, which is why the Cushcraft World-Ranger A4S, A3S, and A3WS go to the head of the class. For more than 30 years, these pace-setting performers have taken on the world's most demanding operating conditions and proven themselves every time. The key to success comes from attention to basics. For example, element length and spacing has been carefully refined over time, and high-power traps are still hand-made and individually tuned using laboratory-grade instruments. All this attention to



detail means low SWR, wide bandwidth, optimum directivity, and high efficiency – important performance characteristics you rely on to maintain regular schedules, rack up impressive contest scores, and



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

The 3-element A3S/A3WS and 4-element A4S are world-famous for powerhouse gain and super performance. **A-3WS, \$529.95**, 12/17 M. **30/40 Meter add-on kits** available.

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



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

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

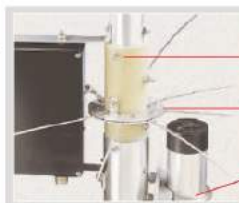
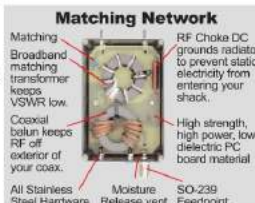
Its omni-directional low angle radiation gives you exciting and easy DX on all 9 bands: 75/80, 40, 30, 20, 17, 15, 12, 10 and 6 Meters with low SWR. QSY instantly – no antenna tuner needed.

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

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

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

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



Cushcraft Famous Ringos Compact FM Verticals

Cushcraft Dual-Band Yagis



One Yagi for Dual-Band FM Radios

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



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

Your New MFJ 2019 Ham Radio Catalog is HERE!

140 Pages of MFJ, Ameritron, Hygain, Cushcraft, Mirage and Vectronics Products! Visit www.cushcraftamateur.com to download your copy!



New from COMET!

CAA-500MarkII

Antenna Analyzer

1.8-500MHz

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

Functions:

In addition to the display of antenna properties, SWR curves are plotted quickly, easily and accurately!

Auto band-sweep function:

Switch to the amateur band of choice and press "Sweep Center". The chosen band is swept and the SWR graphed in seconds!



Manual band-sweep function:

Select the band, select the center frequency, and select the bandwidth. Manually sweep the chosen frequency range and display the SWR graph.



Multiple Manual Band-Sweeps

Manually graph the user defined bandwidth multiple times and see the results overlaid in 5 selectable colors! Make antenna length, position, height above ground, gamma match adjustments, etc...and graph each adjustment in seconds, in a new color, without losing the previous graph!

Features:

Operates on 8-16VDC external power, 6AAAlkaline or NiMH rechargeable cells • Trickle charger built in (only when using NiMH batteries) • Typical battery life: 9 hours of continuous operation • Battery level indicator • Selectable auto power-off time limit preserves battery capacity • SO-239 connector for 1.8-300MHz range • N-female connector for 300-500MHz range • Optional soft carry case sold separately: CAA-5SC

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

Call or visit your local dealer today!
www.natcommgroup.com | 800-962-2611



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Honorable Mention winner in the 2018 QST Antenna Design Competition.

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Honorable Mention winner in the 2018 QST Antenna Design Competition.

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Honorable Mention winner in the 2018 QST Antenna Design Competition.

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June 22-23, 2019

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Interested in Writing for QST?

www.arri.org/qst-author-guide
email: qst@arri.org



Our Cover

The biggest ham radio event of the year is coming! ARRL Field Day 2019 will be held June 22 and 23, in parks, campsites, and parking lots, on beaches, islands, and mountaintops — and more. This issue contains instructions for a portable vertical antenna for 20 meters, an exploration of electric vehicle power, and more Field Day fun. [Jerry Clement, VE6AB, photo]



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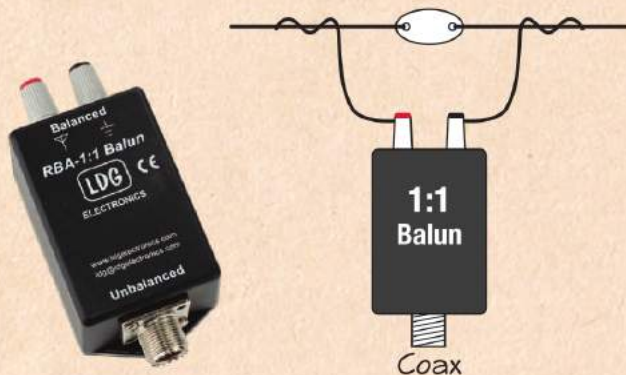
WHERE TO USE LDG BALUNS & UNUNS

LDG

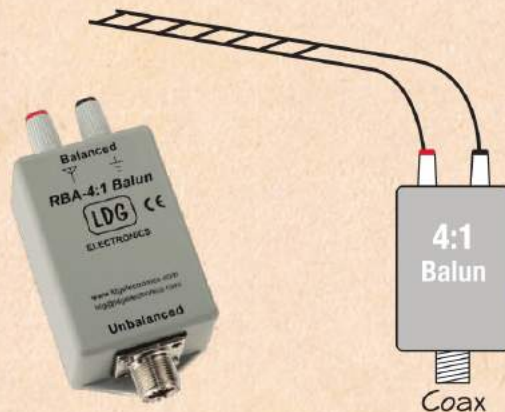
Not sure which balun or unun is right for your antenna? See our handy chart below to help you determine which is the best fit for your set-up. All LDG baluns and ununs handle up to 200 Watts PEP and cover frequencies from 1.8 to 30MHz. Visit us at www.ldgelectronics.com or see your favorite dealer today to learn more and to see our full line of products.

\$30 ea. | 200 Watts PEP
1.8-30MHz

DIPOLE
Length = $468/\text{freq}$

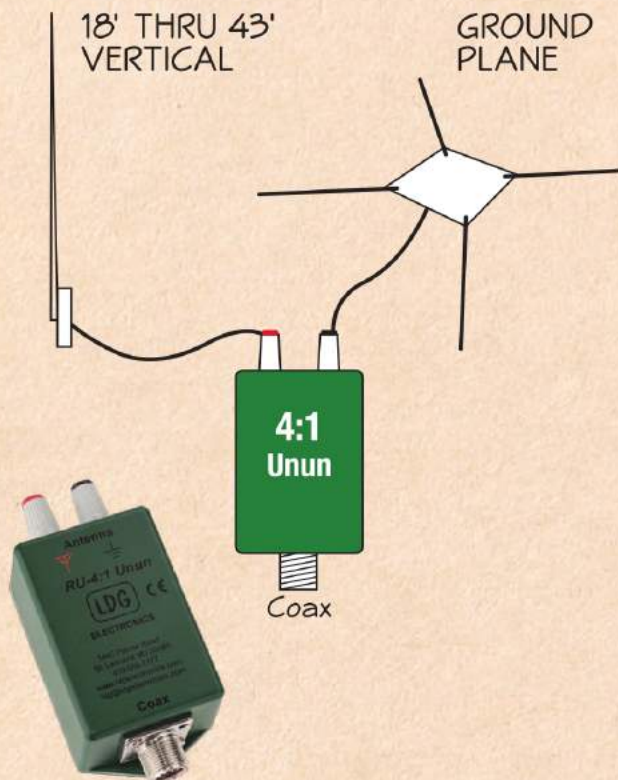


LADDER LINE/TWIN LEAD



18' THRU 43'
VERTICAL

GROUND
PLANE



END FED WIRE
30' - 135'



HOW TO TUNE A SteppIR

Changing frequencies on a SteppIR antenna is really easy – you can do it with a push of a button!

It's not so simple with a fixed-length, aluminum antenna.



Finger Credit – Brian Moran N9ADG

SteppIR antenna products allow the user to remotely adjust each active antenna element **to the exact length required**, so the antenna is optimized at every single frequency within its range, including non-ham band frequencies. In these current times of tough band conditions, having an optimized antenna can be the difference in whether you can hear a signal or not.

Throw away the hacksaw and step up to a SteppIR – it's a monoband antenna... on every frequency!



FOR DETAILS ON THESE PRODUCTS AND TO ORDER:
www.steppir.com 425-453-1910

DIAMOND ANTENNA

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When it comes to quality and performance, DIAMOND ANTENNA is the worldwide leader in VHF/UHF base and mobile antennas.

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

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

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

Here is a small sample of our wide variety of antennas

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

X700HNA Special Features:

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

The Standard By Which All Others Are Judged

NR770H Series

SG7900A

X300A / X50A

X700HNA



**RF PARTS
COMPANY**

Diamond Antenna is a division of RF Parts Company



Second Century

Field Day Thoughts

It's the June issue of QST, and naturally thoughts turn to ARRL Field Day. But just as there is a spectrum of hams, there is a spectrum of thoughts about Field Day.

My thoughts of ARRL Field Day always start with fond memories of my first club. I was a teenager, as were most of the members of the club. There were a few Elmers who really pulled the club together. We operated multiple stations simultaneously across the HF and VHF bands, all powered by the town's 25 kW emergency generator. I operated the 75/40 meter SSB station. But I was able to operate because others in the club kept the generator running, and cooked breakfast, lunch, and dinner for us. We operated as a team where each member's strengths were used to create something better than individual pieces.

Now when I think about Field Day, I think about the new banner ARRL is rolling out. It departs from previous campaigns in that "Radio Communications" takes the lead, not ARRL. If we are to grow Amateur Radio, we need to make Amateur Radio the message. And by growing Amateur Radio, we can grow ARRL.

And what aspects of Amateur Radio are we emphasizing? Skills, Service, and Discovery. These are ideas that should appeal to potential hams. These are ideas embodied in my Field Day memories. These are ideas that will take us forward.

"Back in the day," Amateur Radio required many skills. There was a skill in loading your final amplifier, alternating with dipping the plate, as you tried to coax every bit of power out of a pair of TV tubes not originally designed for that purpose. And to do it quickly so you did not melt the internal parts of the tube. But today, rigs are highly automated, and for normal operating, hams no longer think about changing frequencies from one end of the band to the other end.

But Amateur Radio still requires skills today. And everyone can take pride in mastering those skills. Hams need to understand the relationship between operating bands, conditions, and potential propagation distance. Hams still need to master the rules, regulations, and techniques for proper operating within a community of fellow hams and other competing interests for spectrum.

We are all familiar with "Part 97." Part 97.1 talks about the rules and regulations designed to provide an Amateur Radio Service, and 97.1(c) calls for the "Encouragement and improvement of the amateur service through rules which provide for advancing skills in both the communication and technical phases of the art." The FCC is encouraging us to improve our skills in operating and technology.

But skills to master something are hollow without a purpose. And that purpose is embodied in the second and third idea above — service and discovery. Many people today are motivated by service and discovery.

Discovery and service drive us on. Who can forget the kick they get after mastering something new, or the feeling of satisfaction they get when helping someone in need. Ham radio is a natural avenue for both service and discovery.

So, the next time you talk to a potential ham, talk to them about the skills, service, and discovery of Amateur Radio.

I encourage your comments to me at ceo@arrl.org.

Howard E. Michel WB2ITX



Where to Meet WB2ITX

May 31, June 1 – 2 SeaPac, Seaside, OR

<https://www.seapac.org/>

June 4 IEEE International Microwave Symposium,

Boston, MA. Howard will give the keynote address at

the Amateur Radio Social. <https://ims-ieee.org/>

June 7 – 8 HamCom, Plano, TX hamcom.org

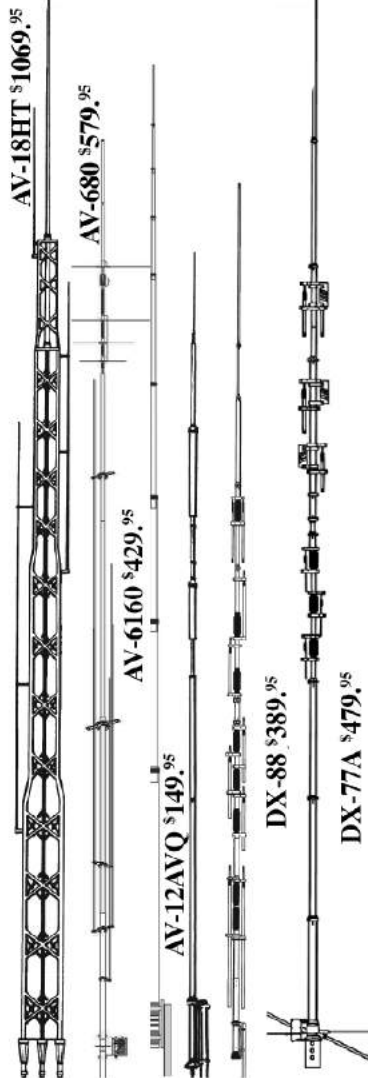
June 21 – 23 Ham Radio, Friedrichshafen, Germany

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The First Choice of Hams Around the World!

hy-gain® HF Verticals

Free Manuals!



hy-gain® Classics

All hy-gain multi-band vertical antennas are entirely self supporting – no guys required.

They offer remarkable DX performance with their extremely low angle of radiation and omnidirectional pattern.

All handle 1500 Watts PEP SSB, have low SWR, automatic bandswitching (except AV-18VS) and include a 12-inch heavy duty mast support bracket (except AV-18HT).

Heavy duty, slotted, tapered swaged, aircraft aluminum tubing with full circumference compression clamps is used for radiators.

Includes all stainless steel hardware. Recessed SO-239 prevents moisture damage.

hy-gain verticals go up easily with just hand tools and their cost is surprisingly low.

Two-year limited warranty.

Self-supporting – no guys required ... Remarkable DX performance – low angle radiation, omnidirectional ... Handles 1500 Watts ... Low SWR ... Automatic band switching ... Aircraft quality aluminum tubing ... Stainless steel hardware ... Recessed SO-239 connector ... Two year limited Warranty ...

AV-18HT, \$1069.95. (80,40,20,15,12,10 M, 160, 17 Meters optional). 53 ft., 114 lbs.

Standing 53 feet tall, the famous Hy-Gain HyTower is the world's best performing vertical!

Automatic band selection uses unique stub-decoupling which effectively isolates various sections of the antenna so an electrical 1/4 wavelength (or odd multiple) exists on all bands. 250 kHz 80 Meter bandwidth with 2:1 SWR. The addition of a base loading coil (**LC-160Q, \$119.95**), provides exceptional 160 Meter performance. **MK-17, \$99.95**. Add-on 17 Meter kit. 24 foot tower is all rugged, hot-dip galvanized steel and all hardware is iridited for corrosion resistance. Special tilt-over hinged base for easy raising & lowering.

AV-680, \$579.95. (80, 40, 30, 20, 17, 15, 12, 10, 6 Meters). 26 ft., 18.5 lbs.

No ground or radials needed.

Low 17 degree radiation angle and omni-directional gives world-wide coverage. 1500 Watts key down for two minutes. 1/4 wave stubs on 6, 10, 12, 17 Meters. Efficient end loading coil and capacity hats on 15, 20, 30, 40, 80 Meters. Wide low SWR bandwidth. End fed broadband matching unit wound with Teflon® wire. Auto band switching. Low 2.9 sq. ft. wind surface. Mounts on decks, roofs, patios. 65 mph wind survival. Aircraft aluminum tubing, stainless steel hardware.

AV-640, \$479.95. 40/30/20/17/15/12/10/6M.

25.5 feet, 17.5 pounds.

AV-620, \$369.95. 20/17/15/12/10/6M. 22.5 ft.

AV-6160, \$429.95. (160, 80, 40, 30, 20, 17, 15, 12, 10, 6 Meters). 43 ft., 20 lbs.

Low profile, self-supporting 43 foot vertical assemblies in less than an hour!

Blends in with sky and trees – barely visible. Entire length radiates for exceptionally low angle radiation 160-20 Meters with very good performance on 17-6 Meters. A wide range automatic or manual antenna tuner at your rig easily matches this antenna for all bands. No physical adjustments. Includes ATB-65 base mount. Optimized balun design allows direct coax feed with negligible coax loss.

AV-6110, \$319.95. 1.5 kW matching network improves efficiency on 160/80 Meters.

AV-12AVQ, \$149.95. (20, 15, 10 Meters). 13 ft., 9 lbs.

Automatic bandswitching, omnidirectional, low angle DX antenna. self-supporting. 1500 Watts. Hy-Q™ traps give full 1/4 wave performance with broadband top hat. SWR less than 2:1. Ground or roof mount. Requires radials.

AV-14RMQ, \$99.95 roof mount.

DX-88, \$389.95. (80, 40, 30, 20, 17, 15, 12, 10 Meters, 160 M optional). 25 ft., 18 lbs.

All bands are easily tuned with exclusive adjustable capacitors.

80/40 Meters tuneable from ground without lowering antenna. Super heavy-duty construction.

DX-88 OPTIONS:

KIT-160-88, \$219.95. 160 Meter add-on kit.

GRK-88, \$109.95. Ground Radials System.

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DX-77A, \$479.95. (40, 30, 20, 17, 15, 12, 10 Meters). 29 ft., 25 lbs.

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Off-center-fed Windom has 55% greater bandwidth than competitive verticals. Heavy-duty tiltable base. Each band independently tunable.

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235-5X-10	10
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Part #	Length/Ft
233/2-4X-12	12
233/2-4X-10	10
233/2-4X-5	5
233/2-4X-3	3
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Part#	Length/Ft
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233/2-G4-5	5
233/2-G4-3	3
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Custom lengths and Bulk available

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Attenuation per 100ft

2.0dB @ 30MHz
2.5dB @ 50MHz
4.4dB @ 150MHz
7.8dB @ 450MHz

Power Rating

0.70KW
0.54KW
0.31KW
0.18KW



ABR213 (PN:2213A) MI-SPEC (.405" diameter)
Stranded Center Conductor, 66% VP, 97% BC Braid,
Type II Jkt (Direct Burial) Available in Bulk or with PL259s,
BNCs, N Type, TNC, SMA, or 7-16 Din Connectors.

Attenuation per 100ft	Power Rating
0.6dB @ 10MHz	3.43kW
1.0dB @ 30MHz	1.95kW
1.4dB @ 50MHz	1.5kW
2.4dB @ 150MHz	0.83kW
4.5dB @ 450MHz	0.45kW

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Connector Options

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SMA Male to PL259
SMA Female to SO239
SMA Female to PL259
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ABR240-UF (PN:218XA) RG-8X size (.240") Stranded
Center Conductor, 85% VP, 95% TC Braid / 100 Foil, Type
II Jkt (Direct Burial) Available in Bulk, W/ PL259s, BNCs, N
Type, TNC, SMA, or Reverse Polarity Connectors.

Attenuation per 100ft	Power Rating
0.9dB @ 10MHz	2.16kW
1.6dB @ 30MHz	1.24kW
2.1dB @ 50MHz	0.96kW
3.6dB @ 150MHz	0.55kW
6.3dB @ 450MHz	0.31kW

Stocked Lengths 1.5ft to 150ft
Custom assemblies and Testing services available.



ABR400-UF (PN:24500F) RG-8/U size (.405")
Stranded Center Conductor, 86% VP,
95% TC Braid / 100 Foil, Type II Jkt (Direct Burial)
Available in Bulk, W/ PL259s, BNCs, N Type, TNC,
SMA, or 7-16 Din Connectors.

Attenuation per 100ft	Power Rating
0.8dB @ 30MHz	2.77kW
1.1dB @ 50MHz	2.14kW
1.8dB @ 150MHz	1.22kW
3.3dB @ 450MHz	0.69kW

Stocked Lengths 1.5ft to 200ft
Custom assemblies and Testing services available.



ABR400 (PN:24400) RG-8/U size (.405")
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95% TC Braid / 100 Foil, Type II Jkt (Direct Burial)
Available in Bulk, W/ PL259s, BNCs, N Type, TNC,
SMA, or 7-16 Din Connectors.

Attenuation per 100ft	Power Rating
0.7dB @ 30MHz	3.33kW
0.9dB @ 50MHz	2.57kW
1.5dB @ 150MHz	1.47kW
2.7dB @ 450MHz	0.83kW

Stocked Lengths 1.5ft to 200ft
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Member Spotlight

Christian Cudnik, KØSTH

Baltimore-born Christian Cudnik's, KØSTH, influences include Orson Welles, Paul Harvey, and, most importantly, his father. The broadcaster first became interested in radio when his father got into the citizens band (CB) in the 1970s. He was drawn to the immediacy of it and loved listening to his dad's scanner to hear what was happening in the neighborhood. Although it was not Amateur Radio, the seed was planted, and Christian pursued radio as a career.

Around August 2012, after two decades in the broadcasting industry, Christian got curious about what happened on the other side of the microphone. He began studying and received his Technician license, but he realized he still did not know how to get started in actual operation, and that's what led to his podcast, *100 Watts and a Wire*.

100 Watts and A Wire

Christian's first forays into radio broadcasting were at rock music stations in Baltimore and Philadelphia, following his passion for music. He then moved to St. Louis, where he spent some time as a host in the National Public Radio circuit. However, as commercial radio changed over time, Christian found he needed a new outlet for creativity. "Traditional broadcast radio wasn't giving me this outlet — it became more homogenized. Amateur Radio gave me a new avenue," he said.

Christian first got the idea for his podcast around 2015. As the working father of two young daughters, aged 4 and 8, he found he did not have a great deal of time to explore the

logistical aspects of operating. "I really hesitated because I didn't have the budget to just buy the wrong things, and I didn't have a built-in Elmering system," he said.

In a concept similar to ARRL's new podcast for beginner hams, *So Now What?*, Christian wanted to create a community for new amateurs where it was okay to not know everything. In his show, he frequently features specialized operators on the subject he wants to explore that week.

Described as a journal of experiences in the intersection between Amateur Radio and life, *100 Watts and a Wire* evolved into a three-part system. Following a new episode early in the week, listeners can visit the podcast's Facebook group (www.facebook.com/groups/100wattsandawire) for active mentorship and discussion, and at the end of the week, Christian encourages the community to join a Sunday evening net to apply what they've learned. However, he stresses that the main point is fostering an inclusive space for all radio amateurs to learn together.

Storytelling

When he wasn't working in radio, Christian pursued his love for storytelling by producing and directing eight documentaries, which have aired on PBS and earned him Emmy and Telly awards. Many explore the deep history of St. Louis, Missouri, such as *Seeking Freedom*, which tells the story of female slaves suing for their independence in the 1800s, and *Uncovering Ancient St. Louis*, which explores what can be gar-



Christian Cudnik, KØSTH, operating portable in Livingston, Montana.

nered about the area's first known inhabitants based on Native American oral tradition and archaeological excavations under modern downtown St. Louis.

Outside of work, Christian stays busy with his family and lets his daughters absorb the goings on of radio with him in his radio shack. His favorite things to do include building and hanging antennas, chasing contacts from parks, and what first struck him on his father's CB radio: listening. While he values the innovation of newer digital modes, he says his love will always be for HF. "Some silly little wire antenna can get you across the globe on a good day and I can talk to you in real time," he said. "I just think you can hear the world going around when you listen to HF."

100 Watts and a Wire is available wherever you get your podcasts. For more information, visit 100wattsandawire.com.

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The 15 Divisions of ARRL are arranged into 71 administrative *Sections*, each headed by an elected *Section Manager* (SM). Your Section Manager is the person to contact when you have news about your activities, or those of your radio club. If you need assistance with a local problem, your Section Manager is your first point of contact. He or she can put you in touch with various ARRL volunteers who can help (such as Technical Specialists). Your Section Manager is also the person to see if you'd like to become a Section volunteer. Whatever your license class, your SM has an appointment available. Visit your Section page at www.arrl.org/sections.

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600 Watts PEP/500W CW output, 160-6 Meters with automatic instant bandswitching from your transceiver. Fits on your desktop. 9³/₄W x 7H x 14¹/₂D in. and weighs 14.2 lbs., but is only 4 dB below 1500 Watts – less than an S-unit! ALS-606, \$2099, like ALS-606S but has transformer power supply. **New Lower price!** **ALS-600S, \$1799** with switching power supply. **ALS-600 \$1899** with transformer power supply.

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Suggested Retail

Desktop Kilowatt Amplifier



AL-80B
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Whisper quiet desktop amp plugs into 120 VAC to give full kilowatt SSB PEP output. Ameritron's exclusive *DynamicALC™* doubles average SSB power out and *Instantaneous RF Bias™* gives cooler operation. All HF bands. 850 Watts CW out, 500 Watts RTTY out, extra heavy duty power supply, 3-500G tube, 70% efficiency, tuned input, Pi/Pi-L output, inrush current protection, dual Cross-Needle meters, QSK compatible, 48 lbs. 14W x 8¹/₂H x 15¹/₂D in. **Two-year warranty.**

Near Legal Limit™ Amplifier



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New class of Near Legal Limit™ amplifier gives you 1300 Watt PEP SSB power output for 60% of price of a full legal limit amp! 4 rugged 572B tubes. Instant 3-second warmup, plugs into 120 VAC. Compact 14¹/₂W x 8¹/₂H x 15¹/₂D inches fits on desktop. 160-15 Meters. 1000 Watt CW output. Tuned input, instantaneous RF Bias, dynamic ALC, parasitic killer, inrush protection, two lighted cross-needle meters, multi-voltage transformer.

ALS-1306 1200W 1.5-5.4 MHz Amp



ALS-1306
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Ameritron's highest power solid state FET amplifier gives you automatic bandswitching! Get 1200W PEP output on all bands, including 6-Meters. No tuning, no warm-up, no tubes to baby and no fuss! Eight rugged MRF-150 power FET's give outstanding reliability. Just 100 Watts drive gives full rated power MHz. Compact 10W x 6¹/₂H x 18D in., just 22 lbs. **ALS-1300, \$2899.** Like ALS-1306 but less automatic bandswitching and 6-M coverage.

HF Amps with 3CX800A7 Tube



Suggested Retail
AL-800F
\$2095
1 tube, 1250 W

AL-800HF
\$2885
2 tubes, 1.5 kW Plus
AL-800, \$2679
AL-800H, \$4039
with Eimac® tubes

These compact desktop amplifiers with 3CX800A7 tubes cover 160-15 Meters including WARC bands. Adjustable slug tuned input circuit, grid protection, front panel ALC control, vernier reduction drives, heavy duty 32 lb. silicone steel core transformer, high capacitance computer grade filter capacitors. Multivoltage operation, dual lighted cross-needle meters. 14¹/₄W x 8¹/₂H x 16¹/₂D in.

AMERITRON full legal limit amplifiers

AMERITRON legal limit amps use a super heavy duty Peter Dahl Hypersil® power transformer capable of 2.5 kW!

Most powerful – 3CX1500/8877



AL-1500F
\$3565
3CX1500/8877 Tube
Suggested Retail

AL-1500
\$4720
Eimac® Tube
Suggested Retail

Ameritron's most powerful amplifier uses the herculean 3CX1500/8877 ceramic tube. 65 watts drive gives you full legal output – it's just loafing with a 2500 Watts power supply.

Toughest – 3CX1200/Z7



AL-1200
\$4599
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Get ham radio's toughest tube with the Ameritron

AL-1200 – the Eimac® 3CX1200Z7. It has a 50 Watt control grid dissipation. What makes the Ameritron AL-1200 stand out from other legal limit amplifiers? The answer: a super heavy duty power supply that loafs at full legal power – it can deliver the power of more than 2500 Watts PEP two tone output for a half hour.

Classic – Dual 3-500Gs



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This linear gives you full legal output using a pair of genuine 3-500Gs. Competing linears using 3-500Gs can't give you 1500 Watts because their lightweight power supplies can't use these tubes to their full potential.

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Protects rig from damage by keying line transients and makes hook-up to your rig easy!

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Oil-cooled. 50 Ohms. 1500 Watts/5 minutes. SWR< 1.2 to 30 MHz. Low SWR to 400 MHz.

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Whisper quiet fan, 2.5kW/1 minute on, ten off. 300W continuous. SWR< 1.25 to 30 MHz.<1.4 to 60 MHz.

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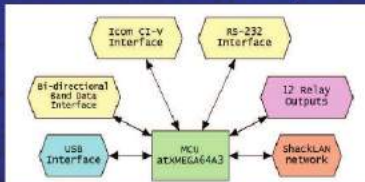
Announcing the new BM-5 BandMaster V

The next generation of the popular BM-3 with direct USB support for FLEX Radios

NEW!



The BM-5 BandMaster V is a full featured unit that contains a universal band decoder and antenna switch controller. It features five communication channels. All channels are active simultaneously and provide data translation for your station accessories. In other words, if you are using an Icom radio on the C/I/V interface the BandMaster V will output 4-bit band data as well as RS-232 data in Yaesu or Kenwood format. In reverse, when using a radio on the RS-232 interface the BandMaster V will output 4-bit band data as well as an Icom C/I/V data stream. The USB interface may be connected to your PC for radio control. **The USB interface may be connected directly to a Flex SDR with no additional cables or interfaces required.**



NEW! HF Triplexer and BandPass Filter Combinations

- 200W - ICAS
 - 100W - 100% Duty Cycle
 - Also available 3 kW
- Triplexers and Filters** Triplexer converts a single feed line from triband, multiband vertical or wire antenna into 3 independent bands allowing to transmit and listen on different bands the same time. It can be a valuable addition to the station in SO2R and Multi-Op contesting, Field Day operations, DX-peditions and in many other events.
- Triplexer together with band-pass filters allows you to transmit and listen on different bands simultaneously on a multiband antenna. We make the W3NQN design Elliptical / Cauer Filters, which have superior response to other designs. This Triplexer system is the best rejection and isolation on the market.



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Six antenna remote switch with rotary switch controller. Push button controllers available. HF and 50 MHz. Power rating 5 kW CW.

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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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The automatic amps can drive an antenna switch of up to 10 antennas and select up to ten bandpass filters applies to all automatic models

OM4000HF	Manual 160-10 m 4 kW
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OM2500A	Automatic 160-10 m 2.5 kW
OM2000+	Manual 160-6 m 2 kW
OM2000+ MARS	MARS and Commercial HF
OM2000A+	Automatic 160-6 m 2 kW
OM10C Combiner	Combiner for two OM amplifiers
OM10C 4000HF MARS	Two OM4000HF manual tuned amps and combiner package
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OM4000A - OM4000HF OM2500A - OM2500HF

The A-series are automatic band change amplifiers.

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OM4000: 4 kW SSB and CW, 3 kW RTTY, AM and FM

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OM2000A+ - OM2000+

The **OM2000A+** is the lightest and smallest 2000 W fully automatic HF/6 m power amplifier in the market. Its manual tuning version, the **OM2000+**, is our affordable unmatched best-seller.

Frequency coverage:

Amateur bands 1.8 - 29.7 MHz including WARC + 50 MHz

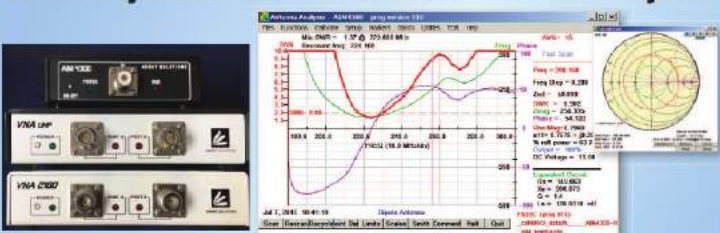
Power output: 2000+ W in SSB/CW on HF bands, 1500 W in RTTY 1500 W CW/SSB on 50 MHz



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

Power, Redefined.

Make Waves With The New Elecraft KPA1500 Amplifier



Our new KPA1500 solid-state amplifier won't take over your entire desktop: it's just 4.5 x 13.5 x 11.5" (HWD; 11.5 x 34 x 29 cm). The lightweight companion power supply can be placed on the floor or in any other convenient location.

The KPA1500 was designed with the serious operator in mind. Its no-nonsense front panel shows all important parameters at a glance, with a high-contrast 32-character LCD and fast, bright LED bar graphs. Band switching is instantaneous, via control inputs or RF sensing. Protection and monitoring circuitry is extensive and foolproof, letting you focus on the job at hand — breaking pileups and overcoming the most difficult operating conditions. And it wouldn't be an Elecraft amp without robust PIN-diode T/R switching. Like our KPA500, the KPA1500 offers fast QSK without a noisy relay.

The amplifier's rugged internal ATU can handle full power with load SWR up to 3:1, while a wider matching range is allowed at lower power, including up to 10:1 in standby mode.

When it's time to make waves, you can rely on the compact, quiet, highly integrated Elecraft KPA1500.

KPA1500 Features

- 1500 W
- Very compact design
- Fast, silent PIN diode T/R switching
- Built-in Antenna Tuner with dual antenna jacks
- Compatible with nearly any transceiver — custom cables available
- 160-6 meters



Separate remote-controlled power supply



In addition to the K3s, Elecraft's K-Line includes the P3 panadapter, KPA500 500 W+ amplifier, KAT500 500 W+, or the KPA1500 W amplifier with built-in automatic antenna tuner. All can be used with the K3S or with other transceivers. The P3 panadapter adds a visual dimension to signal hunting, with fast, real-time spectrum and waterfall displays of band activity. Its superior sensitivity reveals signals to the noise floor of the K3S. The KPA500 amp features instant RF-based band switching, plus remote band selection that tracks the band of the K3S. It has bright alphanumeric status display and LED bar graphs, and a rugged, internal linear supply. The compact KAT500 ATU uses a fast, accurate tuning algorithm. Saved matching network settings can be recalled automatically as you tune the transceiver's VFO.

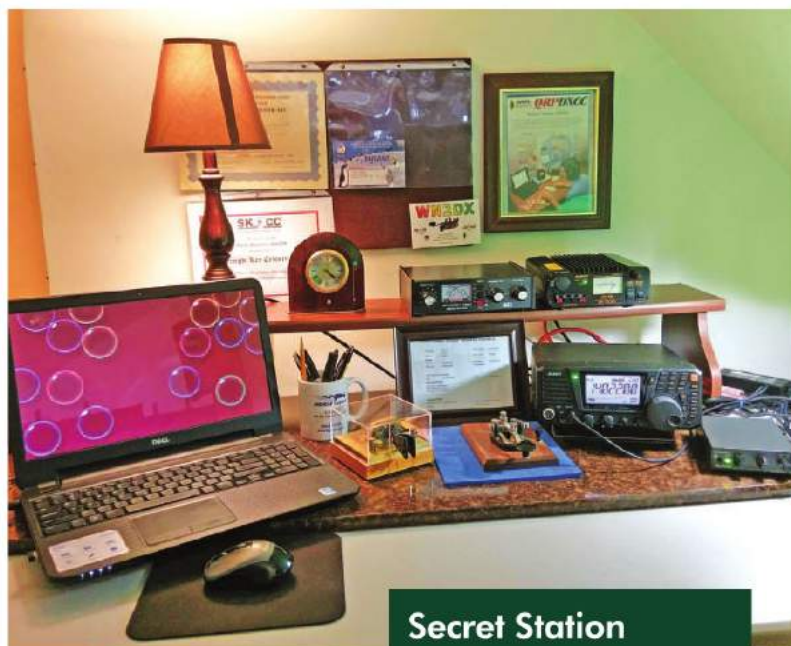
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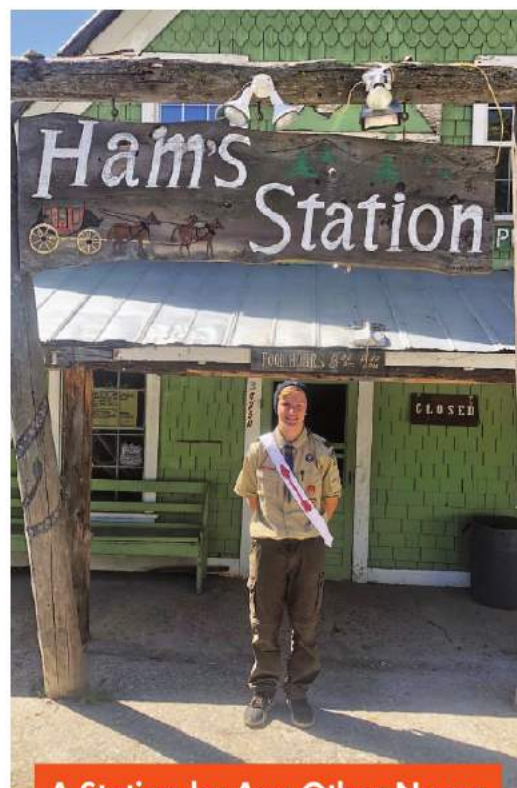
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Up Front



Secret Station

Martin Szumera, WN2DX, avoided restrictions in his community by setting up this attractive station in the back of his garage. A 20-meter dipole antenna is tucked away in the attic area above the garage.

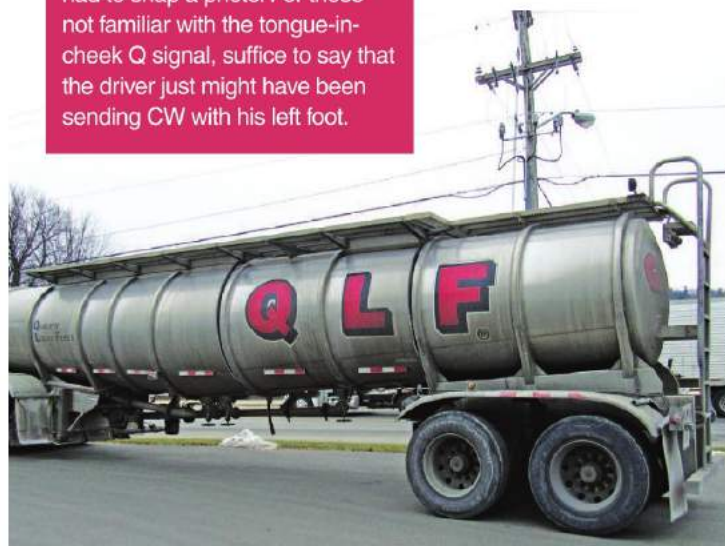


A Station by Any Other Name

Richard Karpinen, K6LJC, is the proud grandfather of Order of the Arrow Scout Matthew Zaech, who is shown here at the curiously named "Ham's Station." As it turns out, the "Ham" was Alonzo Ham, who purchased the property in the late 1800s to establish a stagecoach station in Amador County, California.

QLF?

Phil Van Heurck, W9XAN, spotted this tanker a while ago and had to snap a photo. For those not familiar with the tongue-in-cheek Q signal, suffice to say that the driver just might have been sending CW with his left foot.



Wouff Hong in the Sand

As Steve La Valley, WA7HAA, was walking along the beach in Maui, Hawaii, he came across this familiar-looking piece of wood, which immediately suggested the dreaded Wouff Hong of Amateur Radio legend. Steve said, "I admit I felt some fear at first, but when recounting my most recent operating practices, I realized that this may have just been a warning to continue to be a good ham."



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Letters from Our Members

Connecting Hams Online

Often while driving, I have the mobile radio set to scan the VHF/UHF repeater subbands in search of new repeaters. Because my focus is on driving, I am not always able to catch the frequency of the repeater on the display, so I rely on voice or CW identification. However, when I get home, I then desire to research more info about the newly discovered machine but find that the repeater owner has no info on either a website or a common search engine like **QRZ.com**.

Or I might hear an interesting comment during a contact and would like to discuss more with that ham via email, but I find that the individual does not have an email address listed on **QRZ.com**, nor does that ham have an ARRL alias on file.

Therefore, I urge all repeater operators to list the details about their machines, such as location, CTCSS tone, and offset frequency, in their bio on **QRZ.com**. This suggestion can also apply to any Amateur Radio operator who plans to operate a special event station or does things like conducting regularly scheduled nets. Let's be able to reach out to other hams via the internet and not just by direct radio contact.

Ken Slusher, N2DF
Jackson Heights, New York

More Disaster Response Information

I read Rick Palm's, K1CE, article, "Hurricane Michael: Epic Trial for New SEC," in the January 2019 issue of *QST* with great interest.

I would like to see lists of materials and supplies taken by people who participated in the amateur response to natural disasters. The internet and other resources are littered with lists of what you need to survive and be self-sufficient, but nothing specifically itemized from people who have been there.

For example, I get the rule of thumb of 1 gallon of water per person per day to drink, but I would like to know how that was carried (seven 1-gallon jugs versus 56 half-liter bottles). I'm also curious about specifics for what food, beverages, clothing, sunscreen, insect repellent, and types of fuel were packed, and what was used for laundry and sanitation. I'd like to know how much was left over for items, and how much ran short.

Based on my own limited experience, I can put together most of what I imagine would keep me going for 7 days, but it would be really comforting to see written lists from people who have been there. I realize conditions and requirements change according to location, event type, time of year, etc., but a comprehensive core list from real experience would be helpful.

Robert Judy, KD5FEE
Nacogdoches, Texas

Correction to "The Joy of Soldering"

Being an Association Connecting Electronics Industries-certified solder trainer and solder professional in the defense industry, I especially enjoyed Joseph L. Lynch's, N6CL, "The Joy of Soldering" article in the April 2019 issue of *QST*. However, I wanted to point out one issue at the end of the

article, which stated, "Lead/rosin solder has been outlawed and replaced with lead-free solder, which may be harder to work with, but is much safer."

Lead-bearing solder is banned in the EU, but is by no means banned in the US (except in plumbing applications) and is readily available from suppliers that I purchase it from.

Chris Waldrup, KD4PBJ
Tracy City, Tennessee

Chris, you are absolutely right. Thank you for sending in this correction. QST regrets the error. — Ed.

California ARES® Activations

Kudos to the Sacramento Valley Section Amateur Radio Emergency Service® (ARES) radio operators who responded to our need to support disaster communications during the Camp Fire. Many of these operators also responded when our call went out during the Carr Fire only a few months before. ARES activated at the request of our Director of Disaster Services, who was the Director of Operations for both responses.

He specifically wanted the radio operators at each of our shelters to augment communications should the day-to-day telecom infrastructure suffer an impact from the disaster. Their assignment was to pass daily shelter reports to our Disaster Operations Center via Winlink.

ARES more typically gets practice in message handling over phone circuits, but to facilitate our all-important partnership, I urge all ARES members to train using digital modes to handle longer message traffic.

Jim Piper, N6MED
Citrus Heights, California

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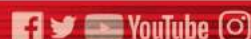
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It's Tuesday with Tim and Jeff! This week we have a visitor from the ARRL - the National Association for Amateur Radio, Ed Hare, W1RFL
Deal of the Week: <https://www.dxengineering.com/.../acom-1500-hf-6-meter-linear...>

Watch ARRL Lab Manager Ed Hare, W1RFL, and DX Engineering's Tim Duffy, K3LR, discuss Ed's work at www.facebook.com/DXEngineering/videos/353443038598325, or on ARRL's Facebook page.



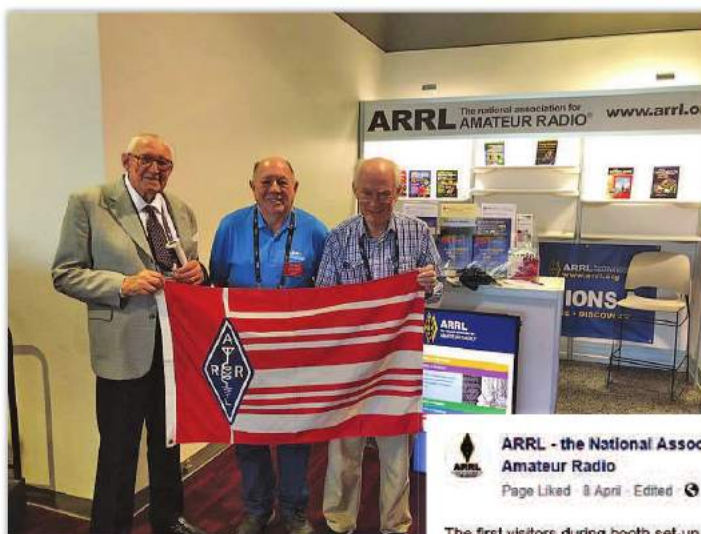
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3 8 15



ARRL attended the National Association of Broadcasters' NAB Show in Las Vegas this past April.

ARRL - the National Association for Amateur Radio
Page Liked · 8 April · Edited · 🌐

The first visitors during booth set-up were world re-known antenna expert and IEEE Life Fellow Valentino Trainotti LU1ACM (left) from Argentina and Donald Bainbridge VK3IT (right) from Australia shown here rallying around the flag. In the middle is John Bigley N7UR, ARRL Nevada Section Manager.

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ADS#15015



A Compact 20-Meter Vertical Dipole for Stealth and Portable Applications

This antenna earned an Honorable Mention in the 2018 QST Antenna Design Competition.

Steve Appleyard, G3PND

While thinking about the design of a new antenna for a 30 × 50 foot plot of land, I wanted the antenna to be easily erected/dismantled for both stealth and portable operation. I subsequently decided on a free-standing half-wave 20-meter vertical due to it having a reasonable antenna length and no need for a counterpoise. However, as a 20-meter vertical dipole is about 33 feet high, this would still be outside my design parameters. Therefore, I decided to design a shortened loaded vertical dipole by making the bottom section an almost complete helically wound inductance, and the top section a self-supporting conductor with an appropriate amount of inductive loading.

Design

As I wanted to keep the total antenna length about 16 feet, I chose the main two elements to be a 10-foot-long, 1¼-inch-diameter PVC tube and a 6-foot-long, ½-inch-diameter copper pipe. Using antenna design software for this project was beyond my capability, so I decided on a trial-and-error process, taking advantage of help from Norfolk Coast Amateur Radio Society (NCARS) volunteers — in particular, Bruce, G4KZT, and Phil, G4PQP.

I began by erecting a full-size tuned 20-meter horizontal wire dipole with the center 7 feet above the ground. I then replaced the left-hand section of the dipole with my experimental bottom vertical section. After several iterations, I arrived at a dipole resonant at 14.128 MHz. Next, I replaced the right-hand dipole section with my first attempt at the top section. I adjusted the coil until I again achieved resonance. This gave me the basic pieces necessary for the vertical dipole.

Assembling the Compact Vertical Dipole

Originally, I was unable to achieve a low SWR at resonance. However, after much experimentation, I found that I needed to increase the winding separation closer to the feed point and then progressively reduce it down to the final 1-centimeter spacing. The coil winding details are

Parts List

- 10 foot × 1¼ inch PVC pipe
- 9-foot length of wood to insert in the PVC pipe to give it additional rigidity [A 1½-inch-diameter wood dowel, available in 6-, 8-, and 10-foot lengths from a hardware store, perfectly fit the inside diameter of 1¼-inch PVC pipe — Ed.]
- 6-inch length of wood with a ½-inch hole drilled vertically through it
- 6-foot length of ½-inch diameter copper pipe
- ½-inch hose clamp
- 15 A terminal blocks, three-way (Bussman TB300-03 or equivalent) and one-way (Cinch 1-142 or equivalent), as shown in Figure 2
- Masking tape, double-sided tape, self-amalgamating tape, and electrical tape
- 50 feet of copper wire; #12 AWG stranded insulated wire was used in the prototype, but smaller diameter wire has been used in subsequent antennas
- Appropriate length of coaxial cable, terminated with a PL-259 connector

shown in Figure 2 [For those without a metric ruler, 1 centimeter = 0.4 inches. — Ed.]. The main issue is the high voltage at the bottom of the lower helical winding, as maximum voltage occurs at the ends of a half-wave dipole. The risk of arcing was minimized by fitting a 30 A terminal block at the wire end to provide the rounded edges of the terminal barrel.

Using the materials in the “Parts List” sidebar, I began assembly following these steps:

1 Stick a 6 foot × 5 inch strip of masking tape along the length of the 10-foot PVC pipe from the end you designate to be the top of the dipole.

2 Mark the masking tape with each turn of antenna wire as shown in Figure 2, starting from the top of the antenna.

3 Stick double-sided tape alongside the masking tape to keep the antenna wire from slipping.

4 Insert the reinforcing wood into the tube, ensuring a 12-inch clearance from the top.

5 Fix the three-way terminal block with the center contact removed, as shown in Figure 2, using two wood screws.

6 After taping the wire to the pipe so that 4 inches extends from the end (this end will connect to the copper tube), start winding the antenna wire from the top end of the PVC pipe so that each turn coincides with the markings on the masking tape. Wind it as far as the terminal block and terminate it into the block. Tape the winding every 6 – 8 inches with electrical tape to keep it secure.

7 Terminate the remainder of the antenna wire into the other half of the terminal block and start winding the lower section of the antenna (see Figure 2). Tape the wire at the last turn and then tape a 16-inch straight section along the length of the tube.

8 Fit the 6-inch wooden insert into the top end of the tube and secure with a small wood screw through the plastic tube (see Figure 3).

9 Insert 6 inches of the copper pipe into the pre-drilled wooden insert and fit the hose clamp with the tail of the previously stripped back wire under it (see Figure 4).

10 Attach the coaxial cable to the terminal block with the shield connected to the bottom section of the antenna. Make one turn of the coaxial cable around the tube at the center of the terminal block and tape to hold.

Tuning the Antenna

Mount the antenna, using an umbrella base, at least 10 feet from nearby objects. The coaxial feeder should be brought away perpendicular to the antenna for at least 3 feet before it can drop vertically. As the feed is unbalanced, a 1:1 choke balun was used to suppress any common-mode current during testing. Subsequently, I have not bothered with the balun as the common-mode current doesn't appear to cause any problems, at least up to 100 W.

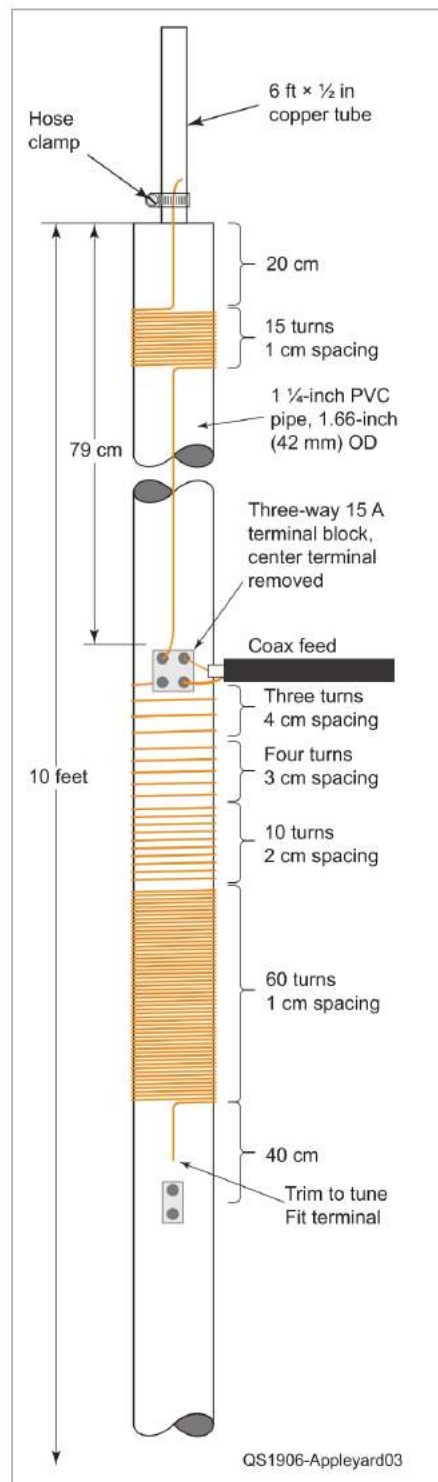


Figure 2 — Details of the dual coil assembly.

► Figure 3 — Drilled wooden insert installed in PVC pipe.



▼ Figure 4 — The copper pipe installed.



The antenna is tuned by trimming the bottom straight-wire section. The length is longer than required, so the antenna will be resonant below 14 MHz. It should not be necessary to trim more than 8 inches off this tail — it is important that at least 8 inches remain. If resonance is still below 14 MHz when 8 inches has been trimmed off, remove a turn from the bottom of the coil. At resonance, the SWR should be below 1.2. If it is not, then a small adjustment can be made to the top section by releasing the hose clamp and dropping the copper tube by a small amount. Strip back $\frac{1}{2}$ inch of insulation from the bottom of the antenna and fit a single-way 15 A terminal block.

Once tuning is complete, replace or cover the temporary electrical tape with self-amalgamating tape. This should also be put liberally around the terminal blocks and the hose clamp. The open top of the copper tube should also be made waterproof.

The final result is an antenna with an SWR of less than 1.2:1 at 14.128 MHz, and less than 2:1 across the full 20-meter band. Several antennas have subsequently been constructed with almost identical results. I have tested the antenna up to a maximum of 400 W, measuring the temperature at various points. There was no noticeable temperature rise.

Warning — High voltages exist at the two ends of the antenna. If there is any risk of a person touching the copper tube, a non-conductive plastic pipe can be placed over it. A larger diameter, non-conductive tube can also be fitted over the bottom section of the dipole (see the lead photo). These tubes will only have a minimal effect on the SWR of the antenna.

On-Air Testing

I am a great advocate of using the Reverse Beacon Network (RBN) to compare antennas.¹ I currently have a

¹S. Appleyard, G3PND, "Using the Reverse Beacon Network to Test Antennas," *RadCom*, Jun. 2018, pp. 26 – 30.

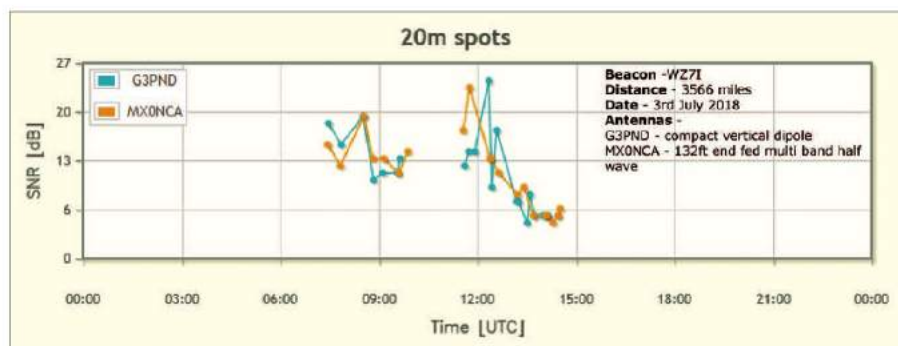


Figure 5 — An antenna comparison conducted on July 3, 2018.

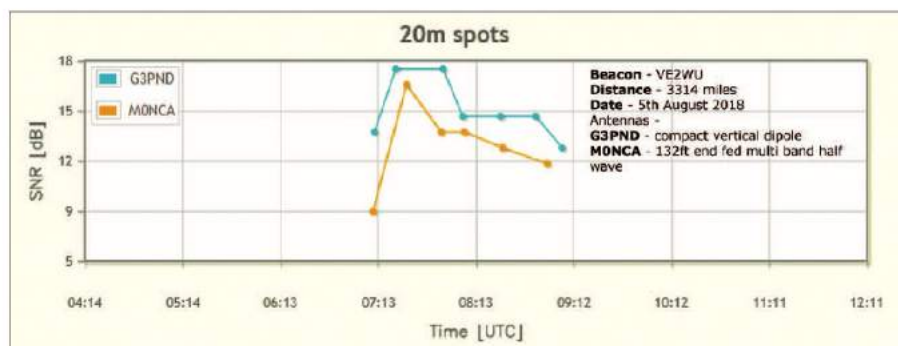


Figure 6 — An antenna comparison on August 5, 2018.

20-meter horizontal dipole with its center at 20 feet and a 130-foot multi-band end-fed antenna. Both antennas perform well given the conditions at the time. Tests on the compact vertical dipole were carried out from June 30 – August 5, 2018. In the tests, I used my call G3PND for the compact vertical and the NCARS calls MX0NCA and M0NCA for my existing antennas.

Given its small size, the compact vertical dipole performed amazingly well. For the most part, it matched the performance of the dipole and end-fed antennas and, on occasion, it was the best of the three. Figures 5 and 6 show a couple of the days during the testing period using the RBN Spot Analysis tool. The results from all the beacons that responded to the test transmissions are retained by the Reverse Beacon Network and can be accessed at www.reversebeacon.net. To do this, click MAIN on the opening page, then DX SPOTS, and fill in the date, the region, and the call signs to compare (e.g. G3PND, MX0NCA).

This antenna lends itself to further experimentation, such as determination of the optimum height above ground and versions for other HF bands.

Photos by the author.

Steve Appleyard, G3PND, was first licensed in 1961 while studying electronic engineering in college. He went on to work on the development of communication and navigation systems with the Marconi International Marine Company. In later years, he became the CEO of a number of electrical engineering companies. Now retired, he is secretary of the Norfolk Coast Amateur Radio Society. Steve edited the book *International Antennas*, published in 2017 jointly by ARRL and the Radio Society of Great Britain (RSGB), and he wrote the first chapter, "Using the Reverse Beacon Network to Test Antennas." He is co-author of *Getting Started in EME*, also published by the RSGB. You can contact Steve at sfappleyard@btinternet.com.

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



Mini Antenna for 630 Meters

This design earned an Honorable Mention in the 2018 QST Antenna Design Competition.

**David Day, N1DAY;
Ernie Hollingsworth, KC4SIT, and
Sid Hendricks, W4IOE**

This antenna operates on 630 meters from a 30- by 50-inch foot-print and incorporates a cage-vertical element that acts electrically like a fat wire that improves its efficiency. The antenna uses an upper coil to tune the radiating elements and a lower coil to tune the ground radial system. This results in less ground resistance loss and improved overall antenna performance.

Modeling using *4nec2* software¹ shows that the antenna has an omnidirectional pattern with a peak gain of -12 dBi at 20-degree elevation.

Construction of the Mini Antenna

The antenna (see Figure 1) comprises radials, coils, a cage-vertical radiator, and a capacitive top hat. Table 1 shows the list of parts.

The Coils

We used a 48-inch-long by 12-inch-diameter cardboard cement-forming tube for the coil form. We then cut 2-inch-wide by 18-inch-long slots at each end to accommodate tapping of the wires with alligator clips for changing coil inductance. We applied four coats of acrylic deck paint to the coil form. The bottom and top halves of the form were each wound with 95 turns (about 300 feet) of

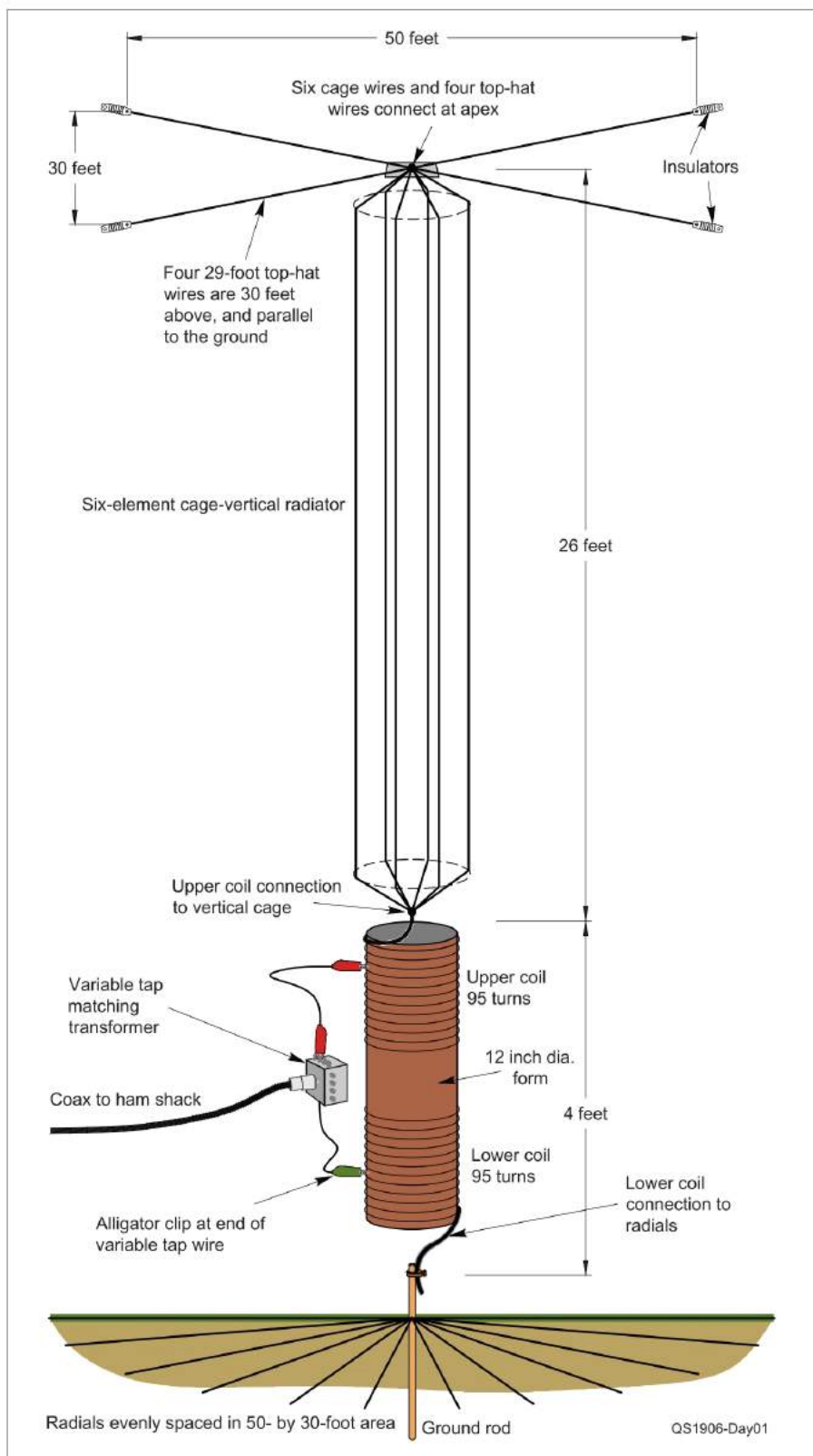


Figure 1 — Schematic of the 630-meter mini antenna.

Table 1
Parts list for the 630-meter mini antenna

Quantity	Item	Cost
2	500' rolls THHN #14 AWG stranded wire [1]	\$83.20
1	50' roll THHN #14 AWG solid wire [2]	\$12.99
1	12" x 48" cardboard concrete form tube	\$13.75
2	12" snap-on plastic bucket lids	\$5.96
1	8" PVC coupler [3]	\$17.63
4	Nylon insulators	\$9.99
1	500' Paracord 550	\$34.95
4	Alligator clips	\$5.66
1	Mix 77 toroid 61 mm x 35.55 mm x 12.7 mm	\$4.26
1	5' of 0.5" copper pipe	\$9.99
1	Junction box, 4" x 4" x 2"	\$7.09
1	SO-239 connector	\$3.89
4	Machine screw, #6-32 stainless-steel	\$1.08
4	Nuts, #6-32, stainless-steel	\$0.80
4	1/4" x 1 1/2" nylon bolts	\$2.60
4	1/4" nylon nuts	\$2.00
4	1/4" nylon washers	\$1.72
13	8" plastic stake	\$30.94
misc.	Various assembly supplies (solder, glue sticks, weatherproofing paint, etc.)	\$18.00
	Total cost	\$266.50

[1] Use a roll each for the ground and antenna coils, and remainders for the radials, the capacitance hat, and the vertical radiators.

[2] For the transformer coils and taps.

[3] Cut to length for apex wire junction.



Figure 2 — The upper coil tunes the radiating element, and the lower coil tunes the radial system. Each coil is comprised of 95 turns spaced one wire diameter apart.



Figure 3 — The bottom of the cage structure attaches to the top of the coil form.

#14 AWG stranded THHN coated wire, which was carefully spaced with one wire diameter. The wires were fixed in place using a hot glue gun. The wire at the base of the bottom coil attaches to the ground radial system, and the wire at the top of the upper coil attaches to the antenna radiating elements. The inner ends of the coils are left open. Once completed, we applied several coats of polyurethane for weatherproofing (see Figure 2).

The Radials

We laid out a 30- by 50-foot rectangle in an open area at David Day's, N1DAY, location, and drove a 5-foot-long, half-inch diameter copper pipe into the ground at the center of the rectangle to form the base of the radial system. Four radials extended 29 feet to each corner of the rectangle, then additional radials were evenly spaced around the perimeter of the rectangle. We staked and buried the ends of the radials 2 inches in the ground.

The Cage Vertical

We drilled six evenly spaced holes through the perimeter of a 12-foot plastic bucket lid, and an additional hole in the center. We also attached six 26-foot THHN #14 AWG stranded wires through each of the perimeter holes. The end of the upper coil wire was brought through the center hole. The lid was then attached to the top of the coil form and secured in place with hot glue. A wiring harness was formed just above the lid to create a common contact point for all six vertical elements. The end wire from the top coil was attached to this harness to serve as the feed to the radiating vertical element. A length of paracord rope was passed through the top of the lid, through the coil tube, and out through a hole in a second bucket lid, which served as the base for the coil form. The rope was eventually

secured to a plastic stake and drawn to allow about 3 inches of play (see Figure 3). This limits any tilting and lifting of the coil form on windy days.

The Capacitive Top Hat

We drilled six evenly spaced holes in a 4-inch-deep, 8-inch-diameter ring made from scrap PVC. The top ends of each of the six vertical element wires were threaded one wire to each hole through the PVC ring. Four additional holes were then drilled at 90-degree intervals in the PVC ring to accommodate four 29-foot-long wires that served as the capacitive top hat. This PVC assembly became the antenna apex point for the radiating elements when the antenna was raised.

Two $\frac{3}{8}$ -inch holes were drilled through opposite sides of the PVC ring, and approximately 150 feet of 550 paracord was threaded through these holes to support the antenna. Nylon insulators at the end of each top-hat wire were attached to trees.

The Transformer

This antenna has about $220\ \Omega$ total resistance, so it was fed through an impedance transformer made from a $2\frac{1}{2}$ -inch-diameter mix 77 toroid. The primary winding is 10 closely spaced turns of #14 AWG solid THHN wire, wrapped in electrical tape. The secondary winding is wrapped tightly on top of the primary winding, starting with 10 turns. After turn 11, each turn is tapped (see Figure 4). Then all taps are covered with liquid electrical tape and allowed to dry.

An SO-239 connector was attached to the $4 \times 4 \times 2$ inch junction box using stainless-steel bolts. Holes were drilled in the sides of the box for exiting the secondary coil taps. One end of the primary coil was soldered to the center of the SO-239 connector, and the other was firmly attached to one of the stainless-steel bolts and the SO-239 connector

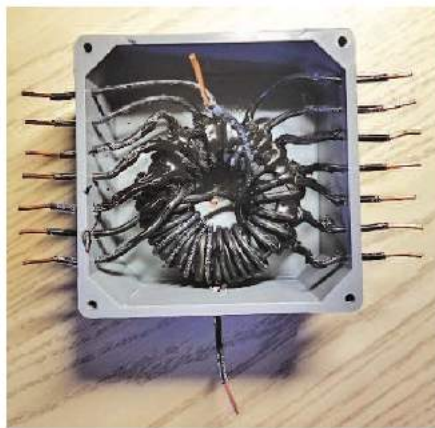


Figure 4 — The matching transformer has multiple secondary taps. All wires are stripped and connected to the coil taps via alligator clips.

frame. The last wrap of the secondary winding was then inserted through a hole to serve as the connector to the ground system coil. An alligator clip was soldered to the end of this wire. Alligator clips were then attached to each end of a 28-inch second wire, which connected any one of the transformer taps to the antenna coil. The transformer was secured to the coil form between the antenna coil and the ground coil (see Figure 2) using nylon bolts. The holes were sealed with liquid tape, both inside and out.

Tuning

Tuning and matching the antenna to $50\ \Omega$ coax was greatly simplified by using an antenna analyzer that displays R and $\pm X$ and SWR. Matching was by trial and error.

“The bottom and top halves of the form were each wound with 95 turns (about 300 feet) of #14 AWG stranded THHN coated wire, carefully spaced with one wire diameter.”

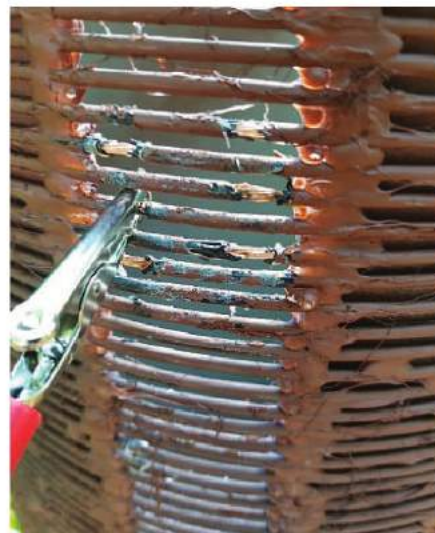


Figure 5 — Variable tap positioning on the loading coil. The wires are exposed on alternate sides of each coil turn, allowing a more secure alligator clip attachment.

We removed the insulation from a single wire at the midpoint of both the antenna and the ground system coils. We then attached the transformer ground wire to the ground coil and attached the antenna matching wire between the antenna coil and any one of the middle taps on the transformer. We attached the antenna analyzer to the SO-239 connector and generated a reading at 475 kHz. If X was negative, then we added inductance to either the antenna or ground system. If X was positive, we removed coil turns from the circuit.

Exposed wires on the coil (see Figure 5) allowed variable tap positioning. Once X was close to 0, we added coil turns to the ground side of the circuit while simultaneously taking coil turns out of the antenna portion of the circuit. An acceptable SWR of less than 1.2:1 could be found with a variety of tapping configurations. After minimizing X , we changed the transformer taps to bring the R as close to $50\ \Omega$ as possible.

Changes in ground moisture required retuning of the antenna. We observed that a finer tuning could be

Table 2

Power density improvement as inductance was moved from the antenna coil to the ground coil. The SWR ranged from 1.08 to 1.17:1.

Antenna coil tap turns; (est. μH)	Ground coil tap turns; (est. μH)	Power density, mW/cm^2
38; (421 μH)	0; (<1 μH)	0.006
14; (91 μH)	28; (264 μH)	0.020
9; (44 μH)	35; (372 μH)	0.020
3; (7 μH)	35; (372 μH)	0.040
0; (<1 μH)	37; (415 μH)	0.040

achieved by moving the tap on the antenna side coil just a turn or two at a time, whereas the ground side appeared to provide coarser tuning.

Testing and Measurement

We measured power density using a Heliognosis power meter positioned 30 feet from the antenna at the same level as the base of the vertical cage structure. We discovered that the RF radiated from the antenna could be improved by moving inductance out of the antenna coil and into the ground system coil (see Table 2). We don't know why, but we hypothesize that tuning the electrically short radial system through the ground coil did more to mitigate ground resistance losses than tuning the antenna solely through the antenna coil.

We configured the taps for a maximum power density response but left room in each coil for future tuning — three turns in the antenna coil and 35 turns in the ground system coil.

We estimated the effective isotropically radiated power (EIRP) of the antenna using methodology described on the NJDTechnologies² web page. Our estimates suggest an EIRP of 0.32 W, with a net transmitter power of 70 W.

Safety and End Comments

Be wary of potentially dangerous high voltages inherent to this compact antenna design. Because of the

potential for interference with high-voltage electrical transmission lines, the 630-meter operator must gain approval from the Utilities Technology Council (UTC) prior to initiating transmissions.

[RF exposure compliance distance should be carefully evaluated, and can be calculated using *4nec2*. Be sure to evaluate both the *total H*- and *total E*-fields. — *K. Siwiak, KE4PT, for the ARRL RF Safety Committee*]

Operating on 630 meters in a space-restricted environment is both challenging and fun. Have fun getting on the band with the 630-meter mini antenna, but above all, do it safely and obey the rules.

Notes

¹The *4nec2* NEC-based antenna modeler and optimizer, by Arie Voors, is available from www.qsl.net/4nec2.

²Estimating EIRP, njdtechnologies.net/trying-to-figure-out-how-to-measure-the-eirp-of-your-short-vertical-antenna-heres-how/.

David Day, N1DAY, has been a licensed Amateur Extra-class operator for 6 years. He also holds an experimental-class license to conduct low-band transmission research and participated in the testing of the 630-meter and 2200-meter bands prior to FCC approval for amateur use. Before retiring in 2012, David was employed in the pharmaceutical industry, where he developed and published database-driven evidence-based applications to assist healthcare professionals in individualizing medication therapies to treat a variety of diseases. He holds a Bachelor's and Master's degree in the pharmaceutical sciences from West Virginia University. You can reach Dave at davidlday@yahoo.com.

Ernie Hollingsworth, KC4SIT, has been an Amateur Radio operator for over 30 years. His radio activities center on the digital aspects of signal transmission and reception. He holds experimental license WI2XQU. Ernie was an early explorer of the 630-meter band and, with an ideal location atop the Eastern Continental Divide, continues to study propagation and antenna design for that band. He is an active lecturer on various aspects of digital radio communication in the Carolinas. His work includes SSTV transmissions through FM modes of operation and techniques for maximizing the ability to decode signal from both geostationary and low-Earth orbit satellites.

Sidney Hendricks, W4IOE, has been a licensed Amateur Radio operator since 2001 and inherited his call sign from his father. He is a retired truck driver and serves as a reference station in conjunction with local hams who conduct a variety of experiments on the 630-meter band. He has served as an officer in the Blue Ridge Amateur Radio Club and coordinates a number of the club's on-air activities.

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Feedback

■ In the article "State and Regional QSO Parties – Something for Everybody" by Hal Kennedy, N4GG, published in the April 2019 issue of *QST*, a photo caption states that the University of Michigan Amateur Radio Club was the winner of the 2014 Michigan QSO Party. This is incorrect. The Michigan State Amateur Radio Club was the winner of the Michigan QSO Party that year.

■ In the article "The Joy of Soldering" by Joseph L. Lynch, N6CL, published in the April 2019 issue of *QST*, an editor's note at the end of the article states that lead/rosin core solder has been outlawed and replaced by lead-free solder. This is inaccurate. While certain restrictions have been imposed in California, Europe, and other areas, the prohibition against lead solder in the United States applies only to its use in plumbing.

3D-Printed Fixture

Simplifies Ground-Plane Antenna Construction

A custom plastic framework supports the elements of a homebrew VHF/UHF antenna.

John Portune, W6NBC

Amateur Radio operators have a well-deserved reputation for the ability to repurpose everyday materials for the needs of our hobby. Now, with the wide availability of inexpensive 3D printers, small plastic parts such as dipole feed-point fixtures, antenna trap forms, and special mounting brackets can be purpose-designed and printed out at the amateur's desktop. Figure 1 shows such a fixture — a framework that supports all the elements of a VHF/UHF ground-plane antenna built around an SO-239 coax connector that also conveniently mounts the assembly atop a 3/4-inch PVC mast. I have adapted this design from the one published by Laagvlieger at www.thingiverse.com/thing:1938947. The design files are available for downloading from my website at w6nbc.com/3d.

Ground-Plane Antennas

The antenna is comprised of a half-wavelength ($\lambda/2$), center-fed vertical dipole with the bottom half ($\lambda/4$ monopole) fanned out into two or more radials. Gain and radiation patterns are essentially the same as a vertical dipole. A ground-plane antenna's attractive features include its small size, easy mast-mounting, and direct connectivity to coax.

In order to be directly connectable to coax feed line, the antenna's feed-point impedance is adjusted to that of the coax by varying the

angle between the vertical and radial elements.

A full-size $\lambda/2$ dipole in free space has a center impedance of roughly $72\ \Omega$. A ground-plane antenna, with its radial elements perpendicular to the vertical element, has a feed-point impedance of $36\ \Omega$. This is because with straight-out radials, the radial currents are equal in amplitude and phase but run effectively in opposing directions. Hence, radial currents oppose each other and do not contribute to the radiation or the feed-point impedance. Only the half-size monopole on top radiates with half the impedance.

However, if the radials are bent downward away from the vertical element, the radial currents begin to participate in the radiation and feed-point impedance. Think about it this way: If the radials were drooped all the way down, a ground-plane antenna would effectively be a $72\ \Omega$ dipole. So, if the radials are bent about halfway down, the antenna will exhibit a feed-point impedance of $50\ \Omega$, making it ideal for direct connection to $50\ \Omega$ coax.

This antenna has excellent bandwidth (see Figure 2), but if you use larger diameter elements than described here, the bandwidth will be modestly greater. Figure 3 compares the radiation pattern and gain of this antenna (red) to a vertical dipole or J-pole (blue), with both mounted 10 feet above average soil. With elements



Figure 1 — Purpose-designed and 3D-printed plastic framework for an SO-239 VHF/UHF ground-plane antenna. The cylindrical cap at the right is sized to slip over the end of a 3/4-inch PVC pipe mast. Four ground-plane radials bolt to the horizontal member at the left of the mast-mounting cap. The SO-239 coax connector bolts to the radial elements through the bottom of the radial mount with the antenna's vertical element soldered to the connector's center pin and projecting through the dome of the small cylinder atop the radial mounting plate. Silicone is injected through the small hole in the side of the radial mounting plate for waterproofing.

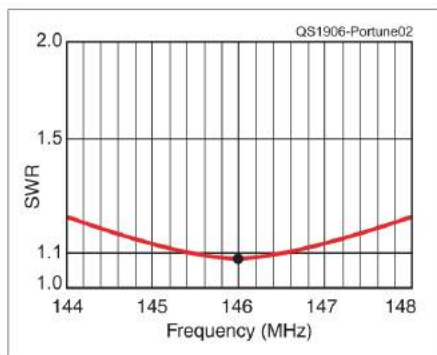


Figure 2 — SWR across the 2-meter band.

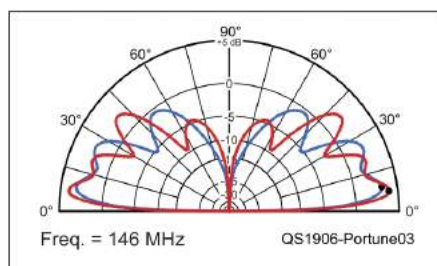


Figure 3 — Radiation pattern and gain of the ground-plane antenna (red) vs. a vertical dipole or J-pole (blue).

made of either wire or tubing, the efficiency is high.

Construction

There are many materials suitable for the whip and radials. The most convenient is solid copper wire, with or without insulation. The lead figure shows #10 AWG bare copper buss wire for the whip and #14 AWG insulated solid house wire for the radials. Attach the radials to the SO-239 connector with either crimp-on ring terminals or small loops bent at the ends.

Soft 1/4-inch copper or aluminum tubing also make excellent radial materials. Just flatten 3/8 inch of one end and drill a hole for a 6-32 screw, as shown in Figure 4.

The vertical whip generally needs to be copper or brass so it can be soldered to the connector's center conductor. It is, however, possible with acid flux and liberal scraping to tin the end of a stainless-steel whip for

soldering. Note that the plastic part is printed with a tiny hole for the vertical monopole, which must be enlarged to fit your choice of whip.

Four-hole chassis-mount Type N connectors also fit the printed part, and have the added advantage of being more weather resistant than SO-239 connectors. With either, complete the weatherproofing of the coax with vinyl electrical tape.

I added a six-turn 1:1 coiled-coax current choke balun onto the PVC mast (see the lead figure). Secure the balun coax with tie-wraps through 3/16-inch holes in the mast. Alternately, you may run the coax inside the mast and out through a hole in the side. In that case, small mix-61 ferrite beads can be used for the balun inside the mast. Also, as this is a VHF/UHF antenna, use a minimum of small-diameter coax.

Table 1 gives starting lengths by band for both the radials and whip. The lengths are greater than needed to allow for tuning. Some antenna references show different lengths for radials and whip. This helps with impedance matching on ground-plane antennas with non-drooping radials. Equal lengths work just as well with drooped radials. Impedance is easily set by adjusting the radial droop.

Matching and Tuning

Begin with the radials bent down from the horizontal at roughly 45°. Use an antenna analyzer to find the initial resonant dip, which will be below the band due to the overlong elements. The first step when tuning and matching almost any antenna is to achieve a low SWR (i.e., a good match). Simply adjust the droop angle of the radials to obtain the minimum SWR.

The SWR will change only a little with frequency adjustment. Next, set the frequency (i.e., tune the antenna) by



Figure 4 — Radials fashioned from 1/4-inch metal tubing and attached to the fixture with 6-32 hardware.

shortening the whip and radials in small increments, keeping all lengths equal. Note that each radial's 1-inch mounting screw is part of its length. As the last step, touch up the SWR by again adjusting the radial droop angle.

Conclusion

The 3D-printed fixture eases construction while serving to align and precisely mount all the antenna elements and provide a convenient mast mount. It makes a great teaching tool because its setup procedure is readily demonstrated to a group.

Photos by the author.

John Portune, W6NBC, is an ARRL member and frequent contributor to QST. He has been licensed for 53 years and has held an Amateur Extra-class license since 1972. John has a BS in physics and also holds FCC Commercial General Radiotelephone Operator and FCC Radiotelegraph licenses. He retired as a broadcast television engineer and technical instructor at KNBC in Burbank and then from Sony Electronics in San Jose, California. You can reach John via email at jportune@aol.com or through his website at www.w6nbc.com.

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Table 1
Starting Element
Lengths

Band (MHz)	Length (inches)
144	22
220	14
440	7

HF Magnetic Loop for 80 Through 20 Meters

This small HF loop received an Honorable Mention in the 2018 QST Antenna Design Competition.

Tuning System

The high Q of the antenna makes tuning a challenge. I used a vacuum variable capacitor and turned it with a precision stepper motor (see Figure 3) at 0.1 r/min. The low motor rotational speed was achieved with a 0.9° stepper motor, a 25,600 micro-step driver, and a low-frequency pulse from the stepper motor controller board. The resulting resolution provides very comfortable tuning.

The Tuning Capacitor

I purchased a Comet vacuum variable capacitor rated for 8 – 650 pF at 3.0/5.0 kV. That capacitor has a 10-turn ratio for up to a 3 – 17 MHz tuning range. You can see it at the top in Figure 3.

John Chappell, W3HX

This 5-foot-diameter small HF loop (magnetic loop) can be easily elevated to the roof line from an internal courtyard using a portable expandable mast. It can be tuned over its 80- to 20-meter operating range to an SWR of less than 1.4:1. With it, my signals in FT8 mode at 50 W are received by stations around the world. Careful tuning is needed because of the high quality factor (Q).

Design Details

I made the largest loop that I could manage for the target frequency range. It has a high-turn ratio vacuum variable capacitor to resonate the loop, and a stepper motor system with a micro-step driver and low-

frequency pulse controller rotating at 0.1 r/min. I feed the loop using a wire-winding coupling method (see Figure 1) rather than the more common secondary feeding loop.

The main loop (see Figure 2) is 15.7 feet in circumference, or 5 feet in diameter, and is tuned at the bottom with a wide-range capacitor.

The Feeding System

The loop is coupled to the feeding coax cable by a #10 AWG insulated stranded wire wound around the main loop over a span of 6 inches on each side of the top of the loop (see Figure 1). I used a total wire length of 38 inches — about 20% of the main loop circumference. When tuned to any frequency from about 3.5 MHz to 14.35 MHz, this feeding method results in less than 1.2:1 SWR when the antenna is elevated above ground. I had tried circular coupling loops but could not find a configuration that gave acceptable SWR readings over multiple bands.

“I made the largest loop that I could manage for the target frequency range.”



Figure 1 — Feeding arrangement for the loop.

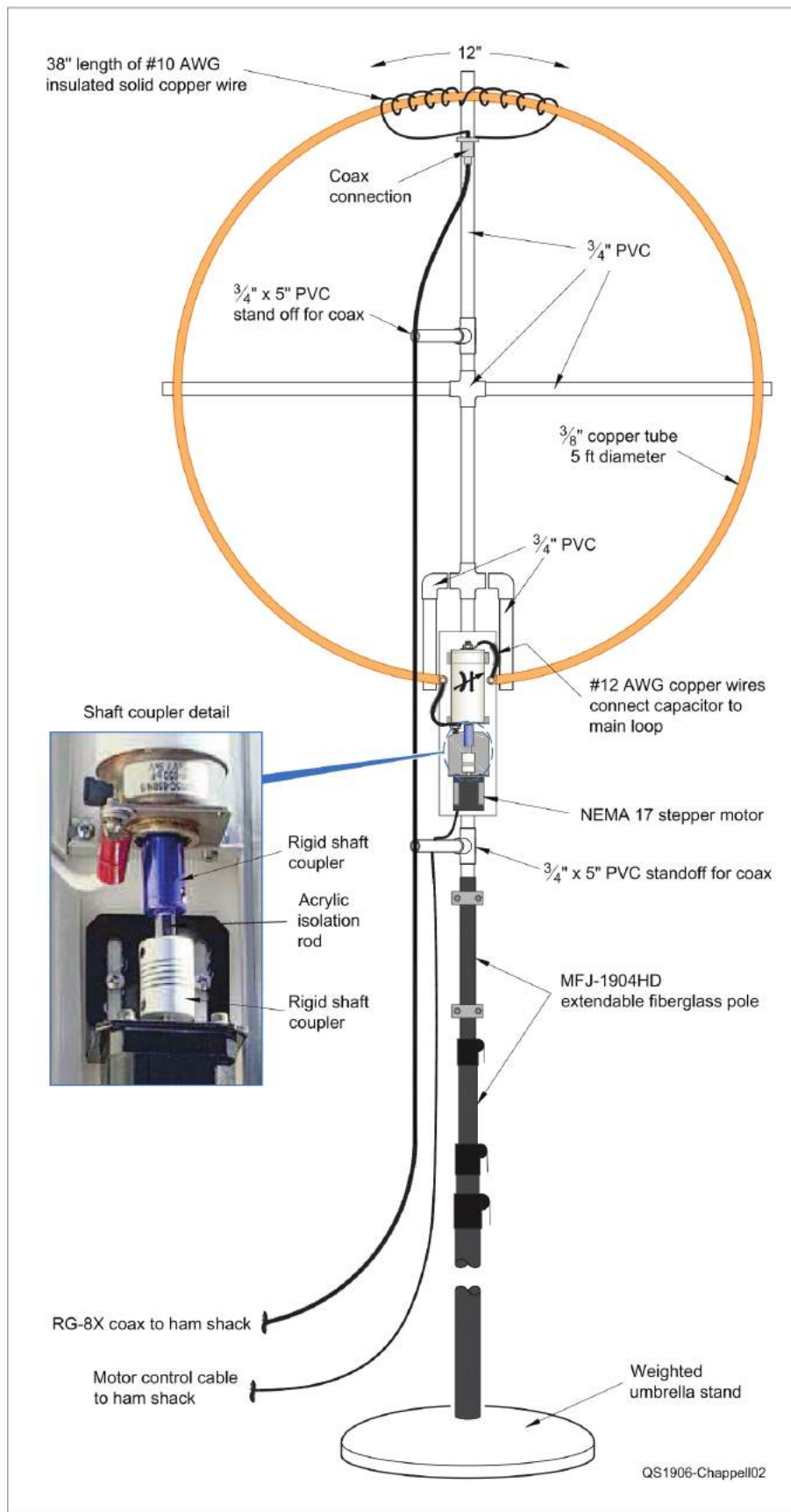


Figure 2 — Dimensions and details of the small HF loop.



Figure 3 — The stepper motor and coupling (blue) attached to the tuning capacitor assembly, and the lower portion of the loop.

Stepper Motor and Driver

My stepper motor has 0.9° step resolution, which, with a precision driver (see Figure 4) on the most sensitive setting of 25,600 steps, resulted in an acceptable slowing of the motor.

The stepper controller board (see Figure 5) has a speed potentiometer and two switches — one for on/off, and one to toggle up/down tuning. Adjust the potentiometer to the lowest setting for fine tuning. The potentiometer can be set to allow 3 or 4 r/min for gross tuning to another band.

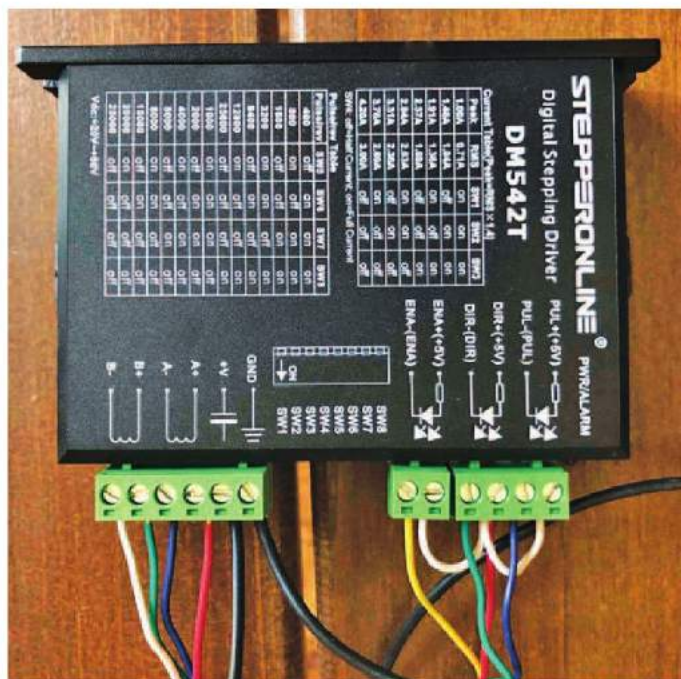


Figure 4 — Driver board for the stepper motor.

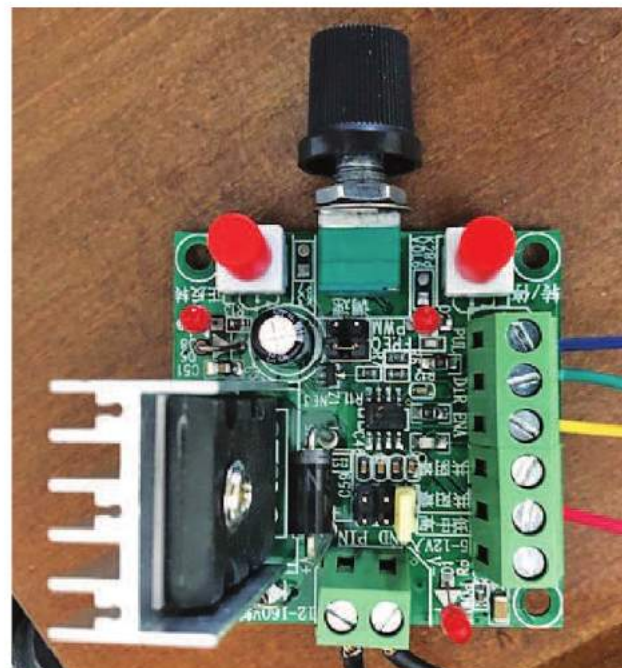


Figure 5 — The stepper motor controller has on/off and reversing switches, and a potentiometer for controlling the motor rotational speed.

Connections

The main loop is connected to the capacitor with #8 AWG solid copper wire, as seen in Figure 3. Isolation is needed between the motor and capacitor to prevent erratic swings in SWR. Typical flexible shaft couplers are undesirable because they produce significant rebound and erratic tuning when turning the shaft by the stepper motor. I used an acrylic rod connected to shaft couplers. Using

rigid shaft couplers with a very short section of acrylic rod (see Figure 3) gives very tight coupling between the motor and capacitor, resulting in smooth tuning.

I used RG-8X coax to connect the antenna to the transceiver. The SWR becomes unstable if the coax touches any part of the antenna, so standoffs on the PVC structure (see Figure 2), hold the coax away from the antenna, motor, and capacitor.

Metal parts must be minimized and isolated from the motor, capacitor, and loops. I used plastic and non-conductive materials everywhere, including the PVC structure, motor isolation, loop-securing brackets, and weather cover.

The SWR of the antenna near the ground was typically less than 1.4:1 and decreases when the antenna is elevated. The antenna should be kept away from rain gutters and other parts

Table 1
Materials List

Item	Description	Source
Main loop	3/8-inch-diameter flexible copper tubing	Home improvement store
Coupling wire	#10 AWG insulated	Home improvement store
Tuning capacitor	Vacuum variable 8 – 650 pF at 5 kV, Comet CV05C-650N/5	ebay.com
Stepper motor	NEMA17, 0.9° step angle	amazon.com
Capacitor and motor mount	0.5 × 3.5 × 10.5 inch piece of nylon sheet	amazon.com
Motor controller	Stepper Motor Controller PWM Pulse Signal Generator Speed Regulator Board, DC 15-160V/5-12V	amazon.com
Motor driver	STEPPERONLINE DM542T, digital stepping driver, up to 25,600 steps	amazon.com
Power supply	24 V dc power supply for controller board, stepper driver, and motor	—
Coax connector	SO-239	amazon.com
Coax	RG-8X	GigaParts
Frame structure	3/4-inch PVC components	Home improvement store
Weather cover	Plastic bin fit against the nylon sheet using weather stripping	The Container Store
Mast	MFJ-1904HD fiberglass pole	mfjenterprises.com
Mast base	Weighted umbrella stand	—



Figure 6 — The control box is to the right of the transceiver under the power supply. The two buttons activate loop tuning, while the potentiometer sets the tuning speed.

Table 2
Calculated Loop Data

Frequency	3.5 MHz	7 MHz	14 MHz
Efficiency	2.4%	22.1%	76.2%
3 dB bandwidth	5.18 kHz	9.2 kHz	42.5 kHz
Tuning capacitance	408 pF	92 pF	13.4 pF
Q	675	763	329

of the house. My antenna is located in an internal courtyard of a one-story house and is elevated to the roof line (limited to 25 feet) when in use. I used a heavy-duty MFJ Enterprises MFJ-1904HD expandable mast seated in a weighted patio umbrella stand. Table 1 shows the loop antenna materials list.

Performance

Figure 6 shows the tuning control box to the right of an HF transceiver. The box houses the driver and controller. The tuning components are powered by the 24 V dc supply on top of the control box.

A small vertically oriented loop antenna near the ground has a figure-eight pattern at low elevation angles, with the maximum radiation in the plane of the loop. [The polarization of a small HF loop is aligned with the main loop conductor; it is vertical on

the horizon and horizontal in the skyward direction. — *Ed.*] At higher elevation angles, the pattern becomes oval shaped, giving the impression of omnidirectional coverage.

Actual observed propagation seems fairly insensitive to antenna direction, implying that the propagation is via skywave from high elevation angles. Regardless of antenna direction, and with 50 W transmitted, my FT8 reports came from all directions and worldwide distances on 20 meters. It is similar on 40 meters, but over shorter propagation distances. Propagation on 80 meters covers the entire US regardless of antenna position, but very few propagation reports were received beyond the US.

The approximate costs of my antenna include \$159 for the mast, \$125 for the capacitor, \$60 for the stepper motor, driver, and controller, and

Design Calculations and RF Exposure Safety

I used the Small Magnetic Loop Antenna Calculator by Steve Yates, AA5TB, (available at www.aa5tb.com/loop.html) as modified by Dave Freese, W1HKJ, (www.w1hkj.com/magloop/) for the basic design. Table 2 summarizes the calculations.

[RF exposure compliance distance should be carefully evaluated on all three axes. For examples, see "RF Exposure Compliance Distances for Transmitting Loops, and Transmitting Loop Current (Technical Correspondence)," *QST*, May 2017, pp. 64 – 65. Compliance distances can be calculated using 4NEC2, but be sure to evaluate both the total H- and total E-fields on all three axes. — *K. Siwiak, KE4PT, for the ARRL RF Safety Committee*]

about \$100 for various home improvement store items, for a total of \$435. The antenna is completely invisible to neighbors.

John Chappell, W3HX, first held a General-class license in 1965. He took a long break, then renewed his license in December 2014. He holds a BS in mathematics and an MBA. During his professional career, he led various management positions within the medical device industry across manufacturing, engineering, quality, regulatory, and consulting departments. Recently, he has been designing and optimizing loop antennas, and operates FT8 to get feedback for testing system performance. You can reach John at jchappell@cericon.com.

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Double-Topped Flagpole HF Antenna

This multiband design received an Honorable Mention in the 2018 *QST* Antenna Design Competition.

Don Crosby, W1EJM

The double-topped flagpole HF antenna (DTFA) covers 80/75 meters to 10 meters (except 30 meters), often with the use of only a transceiver internal tuner. This antenna uses a vertical mast/flagpole as the feed line and two wires of unequal lengths to resonate the antenna on 75/80 and 40 meters (see Figures 1 and 2). The DTFA functions well with wire angles between 60° and 180° and over a variety of radial footprints. A key benefit of the design is that it avoids using highly visible coax or window-line feeder, insulators, baluns, isolators, or traps.

Designing the Antenna

EZNEC software¹ allowed me to determine the flattop lengths for my first prototype antenna. Its performance is shown in Figure 3. During further testing, there was good agreement between the computer models and the experimental data measured on four installed

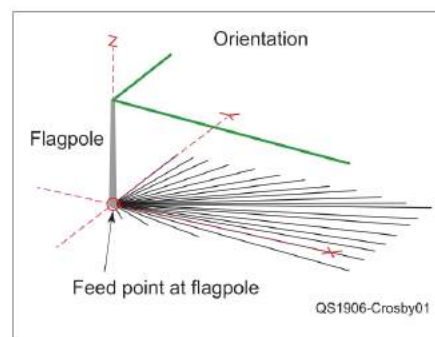


Figure 1 — The flagpole location. The thin horizontal wires are nearly invisible.

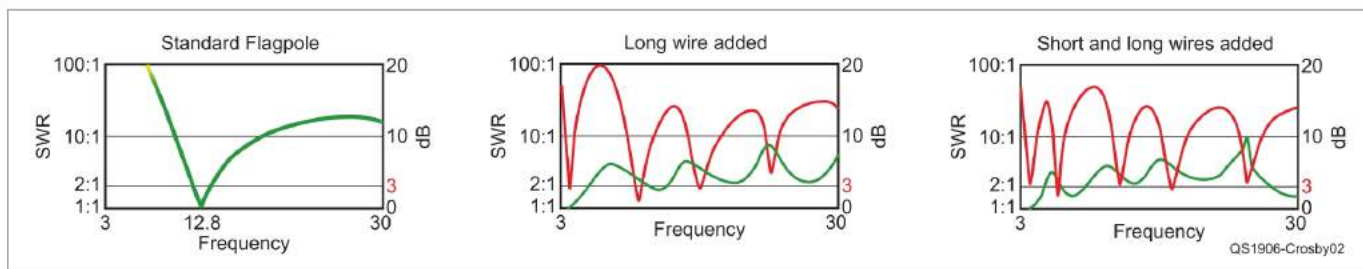


Figure 2 — The left curve shows a 20-foot flagpole with one SWR dip at quarter-wave resonance for a gain of 0 dBi (or less) on all bands. The middle graph shows the attachment of a 50-foot wire, creating four SWR dips (red curve), one in the 75/80-meter band and others harmonically related, with a gain (green curve) rising above 2 dBi on all bands above 5 MHz. On the right, 25-foot and 50-foot wires are attached, and a fifth SWR dip appears near 7 MHz, gain rising above 2 dBi on all bands above 5 MHz.

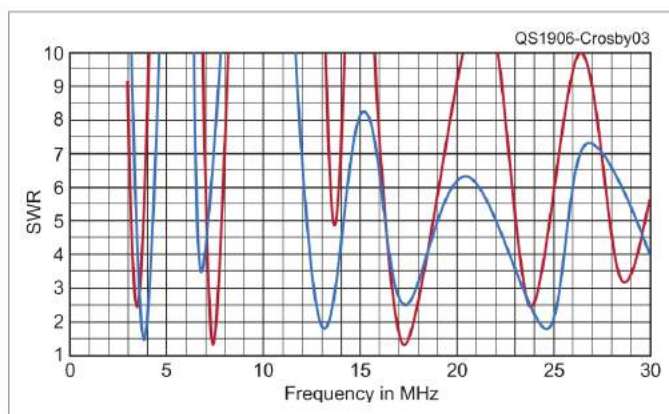


Figure 3 — The SWR at the base of the flagpole, as calculated by NEC, is shown by the red line. Actual measured values are shown by the blue line.

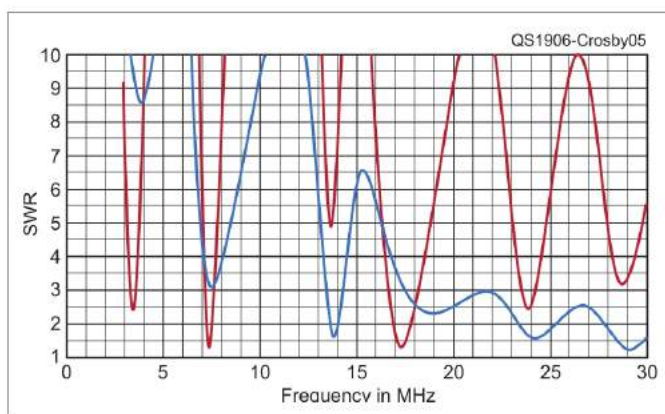


Figure 5 — The SWR feeding directly from a 50 Ω feed line is shown in red. The SWR as seen through a 50 to 200 Ω unun is shown in blue.

antennas. Various lengths for the top wires were explored using NEC simulations. Two unequal length wires could provide a six-band match on 75, 40, 20, 17, 12, and 10 meters.

There are four installations of the DTFA near my locale, each having variations in the mast/flagpole height and the radial footprints. Those variations are accommodated by trimming the flattop wires. See the “QST In Depth” web page, arrl.org/qst-in-depth, for the extensive test details and radial footprints.

For the 2018 QST Antenna Design Competition, maximum dimensions specified a 30 × 50 foot plot size with a 30-foot height limitation. The engineering test version of the DTFA used mast heights of 20 feet and 25 feet. The horizontal wires are not noticeable, being 0.03 inch in diameter. They are nominally 49.7 feet and 22.5 feet and ranged in separation angles of 30° to 180°. These thin wires handle the SSB legal-limit power with only about 0.2 dB in wire loss.



Figure 4 — The thin wires attach to the pole with a hose clamp, using soft sleeves to protect the wires.

The engineering test was conducted with 24 radials on ground within the competition-mandated 30 × 50 foot area. The mast/flagpole is insulated and fed at the base. Three driven ground rods 8 feet in length are also at the base.

Testing the Prototype

I standardized a 20-foot mast/flagpole height for use in the installations (see Table 1) where the antenna wires had an 85° to 110° angle between them to conform to the available plot size. I made my mast/flagpole from 2-inch-diameter aluminum with a .06-inch-thick wall that acts as a feed line for the horizontal wires. However, the mast can be any 20- to 25-foot-long conductive pole that is insulated from ground at the feed point, or a non-conductive mast with #16 AWG insulated wire as the vertical electrical member. The insulated base mounting is similar to that used in a previous project.² Stainless-steel hose clamps are used for connecting the horizontal wires to the mast (see Figure 4). Strain relief of the wires is important for reliability. Ideally, the wires are routed through 2-millimeter ID Teflon™ tubing, entering on the low side of the clamp. The bare wire ends must contact the mast. In use, the wire exits the clamp in the direction the wire would tend to run.

Table 1
Installed Dimensions, Feet

Location	Pipe height	Angle	Long wire length	Long wire end height	Short wire length	Short wire end height	Wire orientation
Site 1	21.25	110°	45.1	8.5	24.2	8.5	Slanted down
Site 2	20	80°	46	17	27	17	Slanted down
Site 3	25	180°	49.7	19.7	22.5	15	Drooping
Site 4	20	90°	50	10	26.5	20	Long droops, short flat

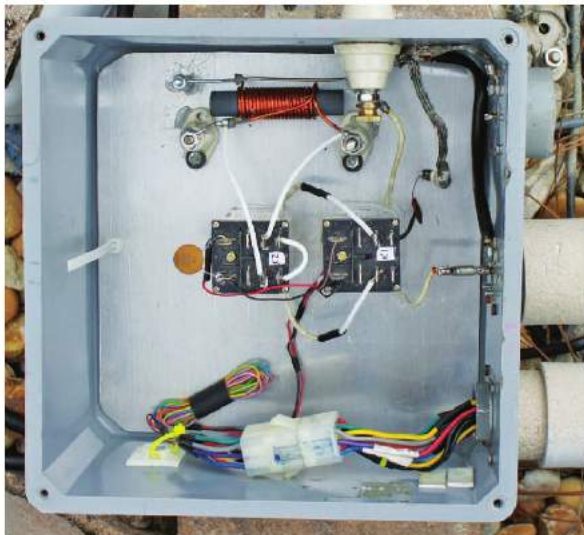


Figure 6 — The relays and step-up transformer are housed in a weatherproof box.

Safety Caution

Because high-voltage points and radiating parts of this antenna are close to areas where persons or pets might be present, danger from RF radiation must be considered. FCC rules require that an evaluation be performed if any antenna is used with more than 500 W PEP on 75 or 40 meters, 225 W on 20 meters, 125 W on 17 meters, 100 W on 15 meters, 75 W on 12 meters, or 50 W on 10 meters. Instructions for doing this evaluation can be found at www.arrl.org/rf-exposure. In addition, because direct contact with RF voltages can cause painful burns, unless provisions are made to prevent persons or animals from approaching the antenna during operation, the flagpole should be insulated up to a height of 10 feet and the ends of the wires should not be reachable from the ground. Place a low wall — such as that shown in the lead photo — to prevent close approach to the flagpole. This wall will conceal the switch box and insulating mount from view and make contact more difficult.

About 500 total feet of radials were installed within the available space. In three cases, the radials were installed in existing lawns by using an electric string trimmer to “scratch” a notch to the depth of the grass-earth level and the insulated radial wires were installed in the notch and held in place with radial anchor pins.

In the first prototype, I used 60 feet of direct burial 50 Ω coax with the center conductor connected to the mast/flagpole, and the sheath to the radials. The internal tuners in my transceivers (an Icom IC-7300 and Kenwood TS-570) were able to tune most bands (see Figure 3), but I opted to

add a 1:4 unun as a step-up transformer (relay selected) to improve the match on the high bands where the antenna impedance is nearer to 200 Ω , as shown in Figure 5. The unun allows higher power operation by lowering the SWR and the losses on the coax. A remotely located auto tuner is another good solution but is costly if using legal-limit power.

I used double-pole, double-throw power relays with 12 V dc coils and housed them with the step-up transformer in an 8 × 8 × 4 inch weatherproof box, available at most hardware stores (see Figure 6). The schematic

of the remote switch box and control switch is shown in Figure 7.

I used a RigExpert AA-55 Zoom Analyzer to collect data for various heights, angles, and wire lengths. The measured data confirmed that the angle between the wires can be varied between 180 degrees to as little as 60 degrees with minimal effect on the SWR curve. The ends of the flattop wires could be bent down to make the antenna fit into a smaller area. However, to prevent persons or pets from contacting a high voltage, wire ends would be kept at least 8.5 feet above the ground level (see the sidebar, “Safety Caution”). DTFAs are

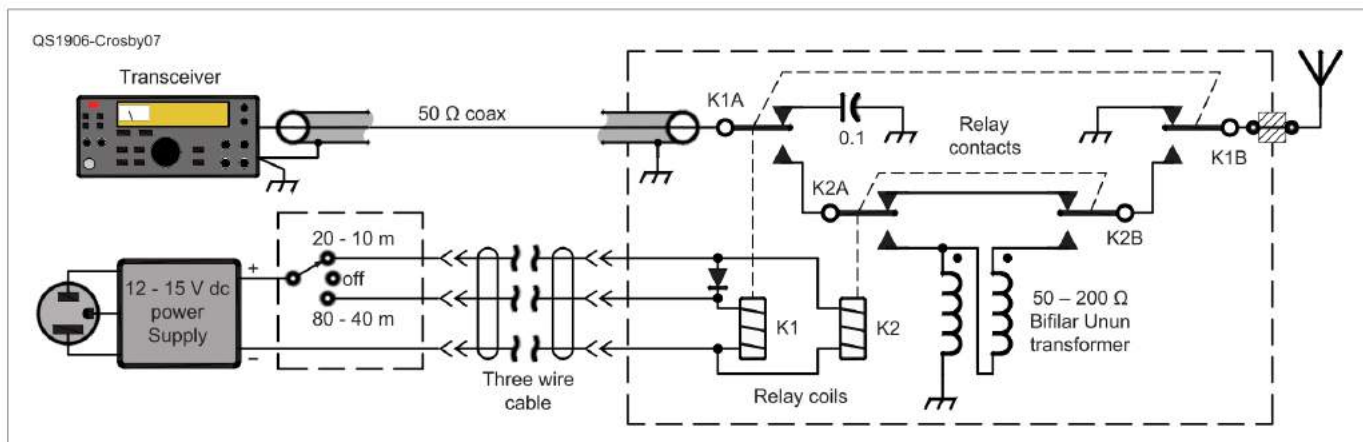


Figure 7 — Schematic diagram of the remote switch box and its control switch in the shack. The antenna and transceiver are grounded when the switch is off. The 80- to 40-meter position connects directly to the antenna. The 20- to 10-meter position connects via the 50 to 200 Ω transformer. Relay contacts are shown in the off position.

Trimming Procedure

1 Start with the 60-foot and 30-foot wire lengths. Lowering the wire at the far end, adjust the length and raise the wire back to position.

2 For the 75- or 80-meter frequency tuning, use an SWR meter to find the dip frequency, and write down the frequency and the wire length. Trim the long wire by folding it back on itself about 2 feet. Then find the new dip frequency and write that down. Continue until you are close to the desired dip frequency. Note that you should save your data in case a wire breaks someday.

3 For 40-meter frequency tuning, use an SWR meter to find the dip frequency, and write down the frequency and the length. Trim the short wire by folding it back on itself about 1 foot. Use the SWR meter to find the dip frequency and write it down. Then fold back 1 more foot of the short wire, and find and record the new dip. Continue until you are close to the desired dip frequency. Save the data.

4 Check the 75-meter frequency. It should not have changed by more than 10 or 20 kHz. If it is too high, unfold about 1 foot from the long wire and measure again. Repeat until you are on frequency on 75 meters. Save the data.

installed in our community as listed in Table 1. There are slight differences between them due to property limitations, but the performance is similar.

Calculated and Measured Performance

I compared the two-wire NEC model to the actual measured SWR for the prototype antenna using measurements from the Rig Expert AA-55 with a 50 Ω reference. The good agreement of the curves shown in Figure 3 showed that the antenna is working as expected. On 75/80 meters, the antenna functions with high currents in the mast and the long horizontal wire as a low current flows into the short wire. The longer wire length is used to set the center of the desired 200 kHz bandwidth within the 75/80-meter band. As with most 75/80-meter antennas, the band is wide compared to antenna bandwidth of about 200 kHz for low SWR. My in-shack tuner (Palstar AT2K) allows tuning anywhere in the 500 kHz band limits. On 40 meters, high current flows in the vertical mast and on to the short wire, which is used to resonate the antenna on 40 meters while

less current flows on the long wire. The antenna is broadband on 40 meters, so I trimmed the short wire to the middle of the band (see the sidebar, "Trimming Procedure").

For both 75 and 40 meters, a number of patterns were run on NEC with angles between the two top wires varying between 60 and 180°. The 80/75-meter DTFA patterns were nearly omnidirectional with radiation at both high angles for NVIS and lower angles for further distances. The azimuth and elevation angles did not vary significantly between the various patterns. For intermediate distances, the 75-meter signal will be about 0.5 dB stronger in the direction of the short wire. On 40 meters, the DTFA showed a broad pattern steered by the longer wire with about a 5 dB front to side ratio.

We conclude that the design is very tolerant of various wire angles and they can be chosen to fit on the property and to use available supports at the far end. The antenna is also tolerant of some variations such as lower end heights, droop in the wires, or a shorter metallic pole.

Many patterns for 20 – 10 meters were plotted from NEC with a 90° angle between the two top wires. The antenna exhibits multilobe gain and notch patterns on the higher bands. These patterns are consistent with off-center-fed half-wave or longer dipoles with more energy at lower takeoff angles. The gain increased from near 0 dBi to as much as 7 dBi, increasing with frequency. The highest gain lobes were in somewhat random directions. Plots of the patterns produced by these tests can be found on the "QST in Depth" web page at www.arrl.org/qst-in-depth.

Notes

¹I used *4nec2* and *Nec2Go* antenna modeling programs for detailed modeling and used EZNEC for display of currents in the wires.

²A similar antenna using this same flagpole is described in the May 2018 issue of QST, pp. 46 – 49. Details of the insulated base mounting are pictured there.

Photos by the author.

Don Crosby, W1EJM, first licensed in 1956 as KN2VVN, changed call district, and was assigned W1EJM in 1967. Don, a member of ARRL for 53 years, earned a BSEE from Fairfield University (BEI) in 1973 and holds two patents. Don's career was in the satellite optical system area, working on programs such as the pre-Apollo Lunar Orbiter mapping satellite cameras, the Hexagon Big Bird KH-9 Reconnaissance satellites, and the Hubble Space Telescope. Now retired, his ham interest has focused on stealthy HF antennas. Don and Marilyn reside in The Villages, Florida, have been married 56 years, and have two adult children. You can contact Don at w1ejm@arrl.net or through his website, www.w1ejm.com.

Don would like to thank Ken Olmstead, KA1NNR, for his contributions to this project. Licensed in 1985, Ken held a career in electronics and computer support, and is a hands-on problem solver. He provided hours of support on this and other antenna projects as a technical sounding board and measurement assistant.

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Product Review

Kenwood TS-890S HF and 6-Meter Transceiver

Explore the QST Product Review Archive
www.arrl.org/qst-product-review-and-short-takes-columns
Search reviews by year or issue of publication, or by manufacturer's name.

Reviewed by Mark Wilson, K1RO
QST Product Review Editor
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The TS-890S slots into the middle of Kenwood's home station transceiver family, although in features and performance it's closer to the top-of-the-line TS-990S than to the TS-590SG. It covers 160 through 6 meters with a high-performance receiver on all bands and a very clean 100 W transmitter. There is one receiver, and it's a conventional down-conversion design with selectable roofing filters and DSP signal processing. The TS-890S is a fairly big desktop radio with a 7-inch TFT color display and large, nicely spaced front-panel controls. Voice guidance, which announces a number of operating parameters, and a high-stability oscillator are built in.

Typical of today's high-end transceivers, the TS-890S offers an astonishing array of features and customizable settings. The printed instruction manual is thorough, although there were times when I needed to play with the controls a bit to understand how to do something.

To learn more about specific features of interest to you, I recommend downloading the *Instruction Manual* from Kenwood's website. It offers color illustrations, and searchable text helps with locating information. There's also an active online group devoted to this radio at groups.io/g/TS-890.

Initial Setup

The shipping box includes the TS-890S, a dc power cable, seven-pin and 13-pin DIN plugs for accessory jacks, a couple of fuses, a printed *Instruction Manual*, and a set



of schematic diagrams. This radio doesn't include a microphone, but many good choices are available.

The rear panel (see Figure 1) isn't particularly crowded. The two SO-239 antenna jacks are switchable from the front panel and remembered for each band. The **KEY** connector is for using a paddle with the internal CW keyer, or for connecting an external keying device. (This functionality is duplicated on the front-panel **PADDLE** jack.) The **EXT.SP** jack provides plenty of audio for an external 8 Ω speaker.

There's an **RX IN** phono jack for use with a separate receive antenna, and that can be paired with the **RX OUT** phono jack to install an external band-pass filter, preamplifier, or other device in the receive path. I used the **RX IN** jack for listening on the low bands with my K9AY loop antenna.

Bottom Line

Kenwood's TS-890S offers excellent RF performance on receive and transmit, and a wide range of features. The large front panel, nicely spaced controls, colorful display, and informative menus make it easy to interact with the radio.

Press the front-panel **RX ANT** button to switch between listening with the main antenna or receive antenna. The **ANT OUT** phono jack provides an antenna connection for a separate receiver. The **DRV** phono jack provides a low-level (1 mW) transmitter output for use with a transverter or for driving an external amplifier for the 630- and 2200-meter bands.

The seven-pin DIN **REMOTE** jack has connections for an external linear amplifier and is configured with the **LINEAR AMPLIFIER** menu. The solid-state switching option (Pin 7, **LKY**, on the **REMOTE** jack) is the one to use with modern amplifiers. Options are **ACTIVE LOW**, which will switch up to 50 V dc at 100 mA, or **ACTIVE HIGH**, which outputs 12 V at up to 100 mA.

If your amplifier control circuit exceeds those ratings, you can enable the transceiver's internal relay. Note that the TS-890S is silent when switching between transmit and receive using the solid-state amplifier switching, but clicking is audible when the internal relay is enabled.

The adjustable **TX DELAY** function introduces a delay between the time the amplifier control switches and RF output appears at the TS-890S

antenna jack. The delay setting should be longer than your amplifier switching time.

The 13-pin DIN **ACC2** jack provides connections for digital mode operation and includes an FSK RTTY keying input, PTT control, fixed-level audio input and output for sound card digital modes, and other functions.

The **DISPLAY** jack is a DVI connector for using an external monitor to show the contents of the TS-890S display. It looked great on my 20-inch wide-screen computer monitor using the 840 × 480 pixel setting.

The USB-A connector is used with a flash drive for saving radio configurations, recorded audio messages, and other data, or with an external USB keyboard for sending text or programming message memories on CW, RTTY, or PSK. There's a second USB-A connector on the front panel.

I didn't try the BNC connector for use with an external 10 MHz reference oscillator or the 3.5-millimeter **METER** jack for viewing S-meter and transmit metering levels on an external display.

Computer Control and COM Ports

The USB-B connector is for connection to your station PC. You can use it for radio control, digital mode audio input and output, interfacing with Kenwood's companion *ARCP-890* software, firmware updates, and so on.

To use the USB interface, before connecting the cable between radio and computer, you must download and install the Silicon Labs CP210x virtual COM port driver from Kenwood's website. Once this is installed, connect the TS-890S to your PC with a standard USB-A to USB-B cable and apply power to the radio. In your PC's **DEVICE MANAGER** screen, look under **PORTS (COM & LPT)** for **SILICON LABS CP210x USB to UART Bridge (COMxx)**. There will be two new virtual COM ports, one "standard" and the other



Figure 1 — The TS-890S rear panel.

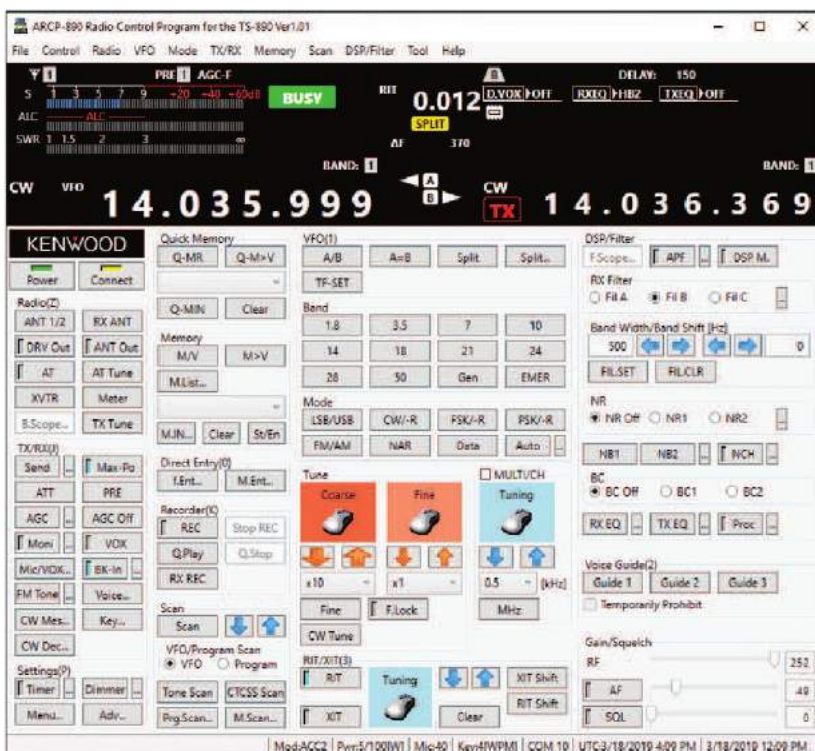


Figure 2 — The companion *ARCP-890* Windows software can be used for adjusting most transceiver features or operating the radio remotely.

"enhanced." Kenwood's online instructions show how to tell the difference.

I used the standard port (COM10 on my computer) and had no problems interacting with the radio using several logging and digital communications programs. The TS-890S also has a nine-pin RS-232 COM port that provides an alternative for computer control or interfacing with other station equipment, such as external antenna switches or band-pass filters. I used the USB connection with my station PC and the COM port for interfacing

with my SPE solid-state automatic power amplifier. It all worked together seamlessly.

The *ARCP-890* software (see Figure 2) allows changing and saving many of the radio's settings. In conjunction with the Kenwood's Network Command System (KNS), it also allows remote operation of the radio over a home local area network (LAN) or via the internet. The rear-panel **LAN** jack is for an ethernet connection to a PC or router. The 73-page *Kenwood Network Command System Setting*

Manual available online shows how to set up and use this feature.

“Split Transfer A” allows interconnecting the TS-890S with a TS-590SG or TS-590S and then using the other radio as an external sub-receiver for split operation or dual-frequency reception. The radios share frequency and mode information via the COM port, and the antenna is shared through the **ANT OUT** and **RX ANT** jacks. (Note that you need to update the TS-590 firmware to use this feature; see www.kenwood.com/i/products/info/amateur/software_download.html.) “Split Transfer B” is a similar feature for older Kenwood transceivers.

Interacting with the TS-890S

The 7-inch color display on the left side of the front panel shows a wealth of information about the radio (see Figure 3). There are several background color, function key label, frequency display font, and screen saver options available.

The meter in the upper left corner can be a very good virtual representation of an analog meter with a white or black background, or it can be a digital bar graph meter. Touch the screen on the meter face to run through the options. The meter presentation changes automatically to a space-saving bar graph when other features require screen space.

In addition to the usual frequency and mode information, there’s a “filter scope” in the upper right corner that shows signals in the receive filter passband, along with the filter characteristics. Response is quick enough to use it as a tuning aid for CW, PSK, or RTTY signals. The graphic changes as the filter bandwidth is narrowed or widened.

There are seven function keys along the bottom of the screen, and another seven along the right side. Labels for these keys are displayed on the screen, and their functions change when different modes of operation and other features are selected.

While exploring various menus and function keys, I pressed the **SWL** button and was rewarded with a display reminiscent of the classic shortwave receivers I grew up with (see Figure 4). Frequency labels are in “megacycles,” completing the retro look.

For many of the front-panel pushbuttons, press once to turn the function on and off, and press and hold to adjust settings for that function. For example, press the **AGC** button to switch among fast/mid/slow, and press and hold for a menu to adjust the time constant for each setting or turn AGC off.

Press the **MENU** button, and the lower half of the screen displays a series of menus that control the radio’s func-

tions and behavior. There are many choices in the menus, but descriptions are in plain English, and the top level has a useful list of the types of adjustments available in each group. After using it a couple times, I found navigating the menu system and selecting and changing menu parameters to be straightforward, using the function keys along the bottom and right side or the **MULTI/CH** knob.

Three **PF** (programmable function) keys can be customized for one-touch access to a wide variety of features from a very long list. For example, I set one **PF** key for the **TUNE** function (transmits an adjustable low-power carrier for tuning an amplifier or external antenna tuner).

Band Scope

The TS-890S band scope uses a separate SDR-type receiver at the first IF, ahead of the roofing filters. With a press of the **SCP** button, you can switch among spectrum scope, combination spectrum scope/waterfall, or an extended (taller) spectrum scope/waterfall. You can also touch the screen to select signals in the band scope and the transceiver will tune there. A small version is available when other windows are active.

Frequency span can be as narrow as 5 kHz or as wide as 500 kHz.

Waterfall scrolling speed is adjustable in four steps, taking about 45 seconds to fill the waterfall at the slowest



Figure 3 — The TS-890S display during SSB operation with the spectrum display/waterfall window set to show 50 kHz of the 20-meter band.

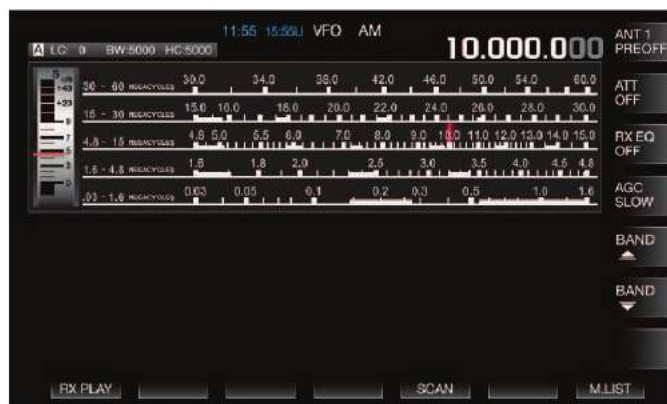
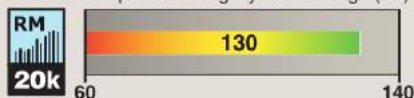


Figure 4 — Listening to WWV on 10 MHz with the display set to SWL mode, emulating a classic shortwave receiver.

Kenwood TS-890S Key Measurements Summary

20 kHz Reciprocal Mixing Dynamic Range (dB)



20 kHz Blocking Gain Compression (dB)



20 kHz Third-Order IMD Dynamic Range (dB)



2 kHz Reciprocal Mixing Dynamic Range (dB)



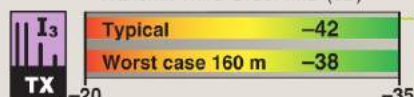
2 kHz Blocking Gain Compression (dB)



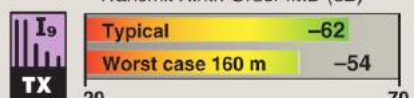
2 kHz Third-Order IMD Dynamic Range (dB)



Transmit Third-Order IMD (dB)



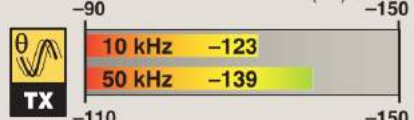
Transmit Ninth-Order IMD (dB)



Transmit Keying Sidebands (dB)



Transmit Phase Noise (dB)



KEY: QS1906-PR137

Measurements with receiver preamps off.
Bars off the graph indicate values over scale.

Table 1
Kenwood TS-890S, serial number B8830121

Manufacturer's Specifications

Frequency coverage: Receive, 0.03 – 60 MHz; transmit, 160 – 6 meter amateur bands, including 5.25 – 5.45 MHz.

Power requirement: Transmit, ≤22.5 A (maximum). Receive, ≤2.5 A at 13.8 V dc (±15%).

Modes of operation: SSB, CW, AM, FM, FSK, PSK, SSB-DATA.

Measured in the ARRL Lab

Receive and transmit, as specified.

At 13.8 V dc: Transmit, 18 A (typical), 10 A (AM) at maximum RF power output; 6.5 A at minimum RF output. Receive, 1.7 A (maximum brightness), 1.57 A (minimum brightness). Power off, 3 mA

As specified.

Receiver

SSB/CW sensitivity:
0.5 μV (0.13 – 0.522 MHz)
4.0 μV (0.522 – 1.705 MHz)
0.2 μV (1.705 MHz – 24.5 MHz)
0.13 μV (24.5 – 30, 50 – 54 MHz).

Noise figure: Not specified.

AM sensitivity: Not specified.
6.3 μV (0.13 – 0.522 MHz)
31.6 μV (0.522 – 1.705 MHz)
2.0 μV (1.705 – 24.5 MHz)
1.3 μV (24.5 – 30, 50 – 54 MHz).

FM sensitivity: Not specified.
0.22 μV (28 – 30, 50 – 54 MHz).

Spectral sensitivity: Not specified.

Blocking gain compression dynamic range: Not specified.

Reciprocal mixing dynamic range: Not specified.

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

Band/Preamp	Spacing	Measured IMD Level	Measured Input Level	IMD DR
3.5 MHz/Off	20 kHz	-131 dBm -97 dBm -68 dBm	-34 dBm -9 dBm 0 dBm	97 dB
14 MHz/Off	20 kHz	-131 dBm -97 dBm -60 dBm	-25 dBm -13 dBm 0 dBm	106 dB
14 MHz/P1	20 kHz	-141 dBm -97 dBm	-37 dBm -22 dBm	104 dB
14 MHz/P2	20 kHz	-143 dBm -97 dBm	-46 dBm -30 dBm	97 dB
14 MHz/Off	5 kHz	-131 dBm -97 dBm -60 dBm	-26 dBm -13 dBm 0 dBm	105 dB
14 MHz/Off	2 kHz	-131 dBm -97 dBm -60 dBm	-27 dBm -13 dBm 0 dBm	104 dB
50 MHz/Off	20 kHz	-129 dBm -97 dBm -61 dBm	-29 dBm -12 dBm 0 dBm	100 dB
50 MHz/P2	20 kHz	-143 dBm -97 dBm	-44 dBm -25 dBm	99 dB

Receiver Dynamic Testing

Noise floor (MDS), 500 Hz bandwidth, 500 Hz roofing filter:

Preamp	Off	1	P2
0.137 MHz	-130	-135	-137 dBm
0.475 MHz	-129	-135	-138 dBm
1.0 MHz	-113	-120	-122 dBm
3.5 MHz	-131	-139	-142 dBm
14 MHz	-131	-141	-143 dBm
50 MHz	-129	-140	-143 dBm

Preamp off/1/2, 14 MHz: 16/6/4 dB;
50 MHz, 18/7/4 dB.

10 dB (S+N)/N, 1 kHz tone,
30% modulation, 5 kHz BW:

Preamp	Off	1	2
1.0 MHz	14.9	6.68	5.30 μV
3.88 MHz	1.76	0.70	0.50 μV
29.0 MHz	2.02	0.62	0.45 μV
50.4 MHz	2.34	0.71	0.50 μV

For 12 dB SINAD, 3 kHz deviation,
15 kHz BW:

Preamp	Off	1	2
29 MHz	0.72	0.23	0.16 μV
52 MHz	0.86	0.32	0.20 μV

Band scope display, preamp off/1/2
14 & 50 MHz, -107/-122/-131 dBm.

Blocking gain compression dynamic range, 500 Hz BW:

Preamp	Off/P1/P2	5/2 kHz offset Preamp off
3.5 MHz	>141/146/132	>141/>141 dB*
14 MHz	>141/147/134	>141/>141 dB*
50 MHz	>139/148/137	>139/>139 dB*

14 MHz, 20/5/2 kHz offset: 130/128/125 dB.

Manufacturer's Specifications

Second-order intercept point:
Not specified.

IF and image rejection: IF, ≥ 70 dB.
Image, ≥ 70 dB (HF), ≥ 60 dB (50 MHz).

Noise reduction: Not specified.

FM adjacent channel rejection:
Not specified.

FM two-tone third-order IMD dynamic:
range: Not specified.

Squelch sensitivity: Not specified.

S-meter sensitivity: Not specified.

Notch filter depth: ≥ 70 dB.

IF/audio response: Not specified.

Audio output: 1.5 W or more at 8 Ω .

Receive processing delay time: Not specified.

Transmitter

Power output: 5 – 100 W (SSB, CW, FM);
5 – 25 W (AM).

RF power output at minimum specified
operating voltage: Not specified.

Spurious-signal and harmonic suppression:
 ≥ 55 dB (HF); ≥ 63 dB (50 MHz).

Third-order intermodulation distortion (IMD)
products: Not specified.

CW keyer speed range: Not specified.

CW keying characteristics: Not specified.

Transmit-receive turnaround time (PTT
release to 50% audio output): Not specified.

Receive-transmit turnaround time (TX delay):
Not specified.

Transmit phase noise: Not specified.

Amplifier key line closure to RF output:
Adjustable, 5 – 40 ms (CW/FSK/PSK);
5 – 50 ms (SSB/FM/AM).

Size (height, width, depth, including protrusions): 6.2 x 16.2 x 15.4 inches; weight, 34.8 lbs.
Second-order intercept points were determined using S-5 reference.

*Blocking dynamic range exceeds these values. No blocking was observed with up to
+10 dBm signal at the antenna jack, the maximum level used in ARRL Lab testing.

†Default values; bandwidth is adjustable.

Measured in the ARRL Lab

Preamp off/1/2:
14 MHz, +79/+67/+45 dBm
21 MHz, +71/+69/+81 dBm
50 MHz, +69/+69/+69 dBm

IF rejection: 7 MHz, 74 dB; 10.1 MHz,
66 dB; 14 MHz, 71 dB; 50 MHz, 69 dB.
Image rejection: 14 & 50 MHz, 72 dB.

For S-5 level, ≈ 8 dB; S-9 level, up to
25 dB.

Preamp 2 on: 29 MHz, 85 dB;
52 MHz, 82 dB.

Preamp 2 on: 20 kHz offset, 29 MHz,
73 dB; 52 MHz, 74 dB. 10 MHz offset,
29 MHz, 125 dB; 52 MHz, 121 dB.

FM, preamp 2 on: 29 MHz, 0.13 –
0.44 μ V, 52 MHz, 0.18 – 0.62 μ V.
HF squelch, 0.47 – 251 μ V.

S-9 signal, preamp off/1/2:
14 MHz, 79.4/19.3/5.24 μ V
50 MHz, 141/29.5/9.32 μ V
Scaling: 6 dB per S-unit.

Tunable notch filter, 50 dB; BC (auto
notch) > 70 dB; attack time 96 ms
for one or two tones.

Range at –6 dB points:†
CW (500 Hz BW): 355 – 845 Hz;
Equivalent Rectangular BW: 481 Hz;
USB (2.4 kHz BW): 242 – 2,594 Hz;
LSB (2.4 kHz BW): 242 – 2,595 Hz;
AM (5 kHz BW): 123 – 2,987 Hz.

1.93 W at 10% THD. 0.11% at 1 V_{RMS}.

16 ms.

Transmitter Dynamic Testing

SSB, CW, FM:
1.8 – 30 MHz, as specified;
50 MHz, as specified.
AM: 1.8 – 30 MHz, 4.6 – 24 W;
50.4 MHz, 4.2 – 22 W.

At 11.7 V dc: 14 MHz, 79 W;
50 MHz, 81 W.

HF, > 69 dB typical; 60 dB (worst
case, 12 m); 50 MHz, 70 dB.
Complies with FCC emission standards.

3rd/5th/7th/9th order, 100 W PEP:
–42/–42/–51/–62 dB (HF typical)
–38/–42/–46/–54 dB (worst case, 160 m)
–38/–48/–51/–55 dB (50 MHz)
At 50 W RF output:
–40/–47/–60/–70 dB (14 MHz)
–38/–48/–59/–70 dB (50 MHz)

4 to 60 WPM, iambic mode A and B.

See Figures 5 and 6.

S-9 signal, AGC fast, SSB, 30 ms;
AGC fast, CW, full break-in, 14 ms.

SSB, 16 ms; FM, 15 ms (29 MHz),
13 ms (52 MHz).

See Figure 7.

12 ms when set to CW default
value of 15 ms.

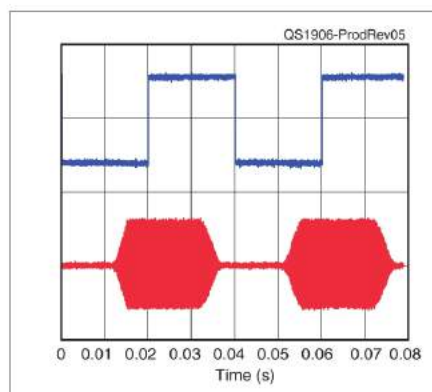


Figure 5 — CW keying waveform for the Kenwood TS-890S showing the first two dits in full-break-in (QSK) mode using external keying and the default rise time setting. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first 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.

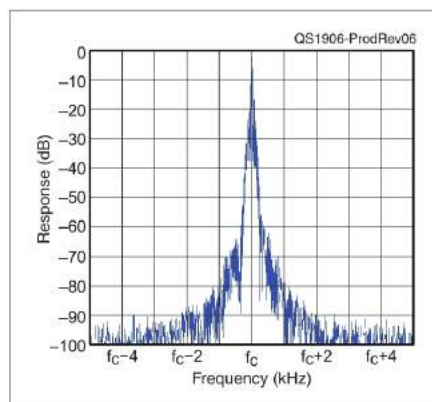


Figure 6 — Spectral display of the Kenwood TS-890S transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying and the default rise time setting. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 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 decibels.

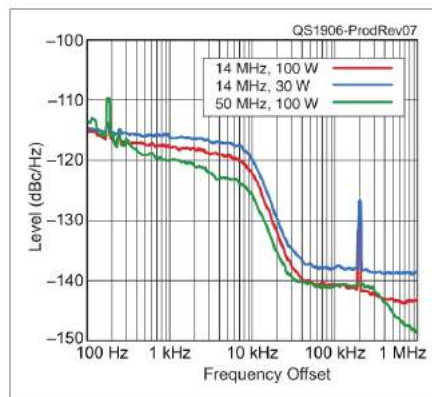


Figure 7 — Spectral display of the Kenwood TS-890S transmitter output during phase-noise testing. Power output is 100 W on the 14 MHz band (red trace), 30 W on the 14 MHz band (blue trace), and 100 W on the 50 MHz band (green trace). The carrier, off the left edge of the plot, is not shown. This plot shows transmitted phase noise 100 Hz to 1 MHz from the carrier. The reference level is –100 dBc/Hz, and the vertical scale is 10 dB per division.

speed and about 5 seconds at the fastest. Scrolling mode options include fixed frequency width, automatic scrolling as you tune, and a centered mode that keeps the cursor in the center and moves the display. The band scope has its own attenuator to adjust sensitivity.

I found the band scope to be very sensitive and responsive, and used it a lot. I tended to leave it in auto-scroll mode to follow along as I tuned around. I really liked that the signals in the waterfall didn't smear or otherwise distort as I tuned; the waterfall just moved left or right with existing signals intact. The wider frequency spans are useful when looking for activity at quiet times. On a crowded band, such as during a CW or RTTY contest, setting the span to 5 kHz gives a detailed look at the tightly-packed signals.

Filter width is highlighted in the waterfall while tuning, and the highlight disappears when you stop tuning (although it still shows up in the spectrum scope). Change the filter bandwidth setting, and the width of the highlight changes. I found I could quickly tune from station to station on any mode using the band scope and the filter scope.

Press and hold the **SCP** button, and the display changes to an audio scope that displays two views of the waveform of received and transmitted signals. The display on the left is similar to what you would see on a spectrum analyzer, and the one on the right is similar to an oscilloscope.

Receiver

The receiver is among the best measured in the ARRL Lab, as seen in Table 1 and described in the "Lab Notes" sidebar. It uses down conversion on all bands, with 15 kHz, 6 kHz, 2.7 kHz, and 500 Hz roofing filters standard (and 270 Hz optional).

Bandwidth filtering is adjustable at any time using the **HI/SHIFT** and **LO/WIDTH** controls, but it's convenient to set up filter choices for each mode and

Lab Notes: Kenwood TS-890S

Bob Allison, WB1GCM, ARRL Laboratory Assistant Manager

The Kenwood TS-890S transmitter greatly exceeds FCC spectral purity requirements, has narrow keying sidebands, and has relatively low transmit phase-noise characteristics. Transmit intermodulation distortion (IMD) is very good at full RF power output, as well as at half power — the 50 W typically needed to drive a linear amplifier. Though all linear power amplifiers generate their own distortion products, it is always desirable to have the cleanest possible exciter. At half power, the seventh- and ninth-order products are 60 and 70 dB below PEP, where they need to be the lowest to minimize interference to nearby stations.

The TS-890S dual-conversion receiver performance overall is excellent, with high reciprocal mixing (RMDR), blocking (BDR), and two-tone, third-order IMD (3 IMD DR) dynamic ranges. The lowest of the three dynamic ranges is 3 IMD DR, measured at 104 dB at 2 kHz spacing at 14 MHz. With the excellent blocking and reciprocal mixing characteristics, the TS-890S will hold up well during ARRL Field Day or other operating events when amateur transmitters are operating in close physical proximity.

In a quiet RF location (with low man-made noise), the Kenwood TS-890S will hear a pin drop on 6 meters, where sensitivity counts the most. AM sensitivity on the amateur bands is excellent, especially on 6 meters, where signals as low as 0.5 μ V are readable. On 630 and 2200 meters, there is plenty of sensitivity to work with, especially when using receiving loops that lack a preamp, as well as a 1 mW transmitter output from the **DRV** jack.

Of note, the total harmonic distortion (THD) of the receiver audio is only a small fraction of a percent at a normal listening level. In addition to pleasant listening, that's very desirable for extended operating sessions when audio distortion can cause fatigue.

The receiver processing delay time is only 16 milliseconds, and the receiver recovers quickly for high-speed, full-break-in (QSK) CW operation. The signal strength meter uses a scale of 6 dB per S-unit, though it reads a little low with a 50 μ V (S-9) signal at the antenna jack. Turning the preamp(s) on makes the S-meter read higher, but the induced signal voltage from the antenna is not higher. Finally, the current draw with power off is only 3 mA, which is very reasonable if using the TS-890S with a battery backup system.

switch among them using the **IF FIL** button. Pressing and holding that button brings up a configuration screen where you can specify roofing, IF, and audio filter bandwidths, as well as skirt shapes (sharp/medium/soft), for each of two or three filters (menu selectable) for each mode. You can change the preset filter bandwidth at any time with the **HI/SHIFT** and **LO/WIDTH** controls, and return to the preset values by pressing **FIL CLR** button.

The TS-890S offers adjustable DSP noise reduction, noise blanker, and notch filter features. I live in a rural area without much power line or other man-made noise, and so I was not able to give the noise blankers a good

workout. If noise is a problem for you, it would be worth checking comments from owners online at groups.io. The noise reduction worked well, although I heard some digital artifacts with the level turned up high enough to significantly reduce the background noise.

I found the automatic notch filter (called the *beat canceler*) to be very effective at reducing AM shortwave broadcast carriers on 40 meters in the evening. The manual notch filter is very effective in attenuating interfering signals in the passband. When it's engaged, a marker in the filter scope window shows the position of the notch in relation to the desired and interfering signals.

The 18-band receiver audio equalizer (EQ) settings can be different for each mode. There are a number of preset options (off, flat, high boost, and so on), along with three user-customizable settings. Touch the screen to slide the level control for each audio segment up and down, or use the +/- function keys or **MULTI/CH** knob.

Transmitter and Antenna Tuner

As shown in Table 1 and Figures 5, 6, and 7, the TS-890S transmitter is very clean, with low intermodulation distortion (IMD) products on SSB and very narrow CW keying sidebands. Transmitted phase noise is good. Note that the CW rise time is adjustable, and the waveform shown in Figure 5 is with the default 6-millisecond setting. As the rise time decreases, the keying waveform corners sharpen and the keying sidebands increase, potentially interfering with stations operating on nearby frequencies. Avoid the 1- and 2-millisecond settings.

The **POWER** control adjusts transmitter output power in 1 W or 5 W steps (menu selectable). Using the **MAX PO** feature, from a menu you can set the maximum power output separately for each band and for the SSB, CW, FSK/PSK, FM/AM, and SSB-DATA modes. For example, you might have a 6-meter amplifier that requires only 30 W drive maximum. Set the **MAX PO** limit for that band and you won't have to worry about accidentally overdriving it. The **TUNE** power described earlier is adjustable by band from this same menu.

The internal antenna tuner is rated for loads from 16.7 to 150 Ω (3:1 SWR). I had no trouble matching my antennas, most of which have an SWR of 2.5:1 or less across the band. My 160-meter inverted-V has an SWR close to 4:1 at the very top of the band, and the tuner matched that as well. Antenna tuner settings are memorized, so tuning is nearly instantaneous after the initial tune.

Voice and CW Operation

The TS-890S offers upper and lower sideband, AM, and FM operation. I got a number of good audio reports using the INRAD W1 headset reviewed last month. The transmit equalizer works nearly identically to the receive equalizer described previously, and after adjusting everything using the transmit monitor, I recorded my transmit audio in another receiver to make sure I was happy with it. Transmit equalizer settings are used for all voice modes, and automatically turned off for the SSB-DATA modes. Transmit monitor settings are separate for voice modes, data modes, and FSK/PSK, and these are separate from the CW sidetone.

On SSB, the transmit filter bandwidth can be set from about 2,000 to 4,000 Hz by adjusting the **LOW CUT** and **HIGH CUT** menus. I just used the default setting of 2,800 Hz (100 – 2,900 Hz). Transmit filter bandwidth can be set separately for the SSB-DATA modes, up to 4,000 Hz.

Voice-operated transmit control (VOX) settings are separate for the various audio inputs — microphone, rear-panel **ACC2** jack, USB, and LAN — and VOX is available in the SSB-DATA modes. VOX delay time can be changed quickly with the front-panel **DELAY** knob.

Although band conditions did not allow me to try it, the TS-890S is equipped for 10- or 6-meter FM operation. Split-frequency offsets can be applied by using the two VFOs, and CTCSS tone encoding and decoding are available for repeater access.

You can record up to six voice messages for transmission, with a maximum recording time of 100 seconds total. You can also record received audio, with storage in the internal memory or on an external flash drive. File selection and playback options are handled via menus and function keys. I didn't see a way to play back recorded audio on the air.

The TS-890S supports full-break-in (QSK) or adjustable delay, semi-break-in operation. The transmit-receive switchover is silent — no annoying relay clicking unless you enable the amplifier control relay as described earlier. The built-in keyer can be adjusted from 4 to 60 words per minute. The eight message memories can include incremental serial numbers for contests.

A built-in CW decoder displays received CW signals in a window that replaces the band scope. This feature also allows use of a USB keyboard for sending CW, and shows the CW message memories in a small window on the right. I found that the decoder works best on strong, well-timed CW signals, and there is a slight delay in displaying the decoded signal.

Digital Modes

The TS-890S offers a number of options for digital mode operation. The radio has an internal decoder for RTTY and PSK31 or 63, and you can plug in a standard USB keyboard to transmit on those modes. Connections are also available to use the radio with digital mode software running on an external PC.

RTTY and PSK with the Internal Decoder

Press the **FSK/PSK** button once for RTTY or twice for PSK, then press **F3** to bring up the **DECODE** screen in the lower portion of the display (see Figure 8).

The left side of the screen displays received and transmitted text, with two lines of buffered text awaiting transmission below that. You can use the keyboard to compose your next transmission in the buffer while you are receiving a message, and then press **F12** to transmit when it's your turn.

You can also use the keyboard to program eight message memories, which are sent by pressing the corresponding function key on the keyboard or on the radio's front panel. This is perfect for routine information

such as location, name, equipment, and so on. You could also use it to store RTTY contest exchange information, although I didn't see a way to include an incrementing contact number for contests that require one. Message memories are separate for RTTY, PSK, and CW.

As characters are sent from the buffer window, they change from white to red and appear in the upper window. Each time you switch between transmit and receive, the radio adds a line showing the transition, and it can include date, time, and frequency (menu settable). You can save RTTY, PSK, or CW communication screen contents to internal memory or a USB flash drive by turning on the Communication Log function. The log is essentially a running transcript of whatever sent and received text appears on the decoding screen.

The right side of the screen has a tuning indicator that can be switched between an FFT/waterfall and tuning scope display. Switch between the tuning indicator styles by touching that area of the screen. You can show a small version of the band scope above the **DECODE** window, or press **F7 (EXTEND)** to increase the height of the **DECODE** window.

The internal RTTY and PSK features worked very well, decoding quickly and accurately. The tuning indicators were quite responsive and a joy to use. It took a few minutes to get used to tuning around for PSK stations, rather than clicking on signals in a wide waterfall using PC software, but the small spectrum scope above the **DECODE** window made it easy to locate stations on the band. Many operators will find the integrated features useful for RTTY and PSK conversations, as well as for DXing and casual RTTY contesting.

Digital Modes Using External Devices

You can connect an external computer or terminal unit to the TS-890S



Figure 8 — The PSK decoder screen shows up to seven lines of decoded text in green in the larger window, and two lines of text to be transmitted in white below that. The tuning indicator on the right can be switched to a vector scope. Note the small version of the band scope above the decode window, and the compact bar graph meter at the upper left.

radio through the **ACC2** connector on the rear panel. Connections for audio in and out, transmit-receive switching, and FSK RTTY keying are available. Audio levels can be set via menus and are independent of the mic gain and receiver volume controls. I used the **ACC2** connector to integrate the radio with my RTTY contesting setup, which includes *WriteLog* station management/logging software, *MMTTY* and *2Tone* software for decoding, and FSK keying through a COM port interface on my computer. The TS-890S default settings all worked fine, except that I needed to change the FSK keying polarity in a menu.

Through the transceiver's USB port, you can also set up a connection to the radio's internal sound card for digital modes, such as FT8, PSK, JT65, or AFSK RTTY, as well as SSTV — any of the "sound card modes." Setup couldn't be simpler. Install the virtual COM port software (as described earlier), then install a USB cable between radio and computer. When power is applied to the radio, Windows installs a driver and **USB AUDIO CODEC** shows up as a sound device on the computer. For FT8, I selected that device for receive and transmit audio in the **WSJT-X SETTINGS** menu, and set up the radio control screen. Then I checked the audio levels in **WSJT-X** and, if necessary,

adjusted the receive audio output level in the TS-890S menu system to get into the recommended range. Next, I set TS-890S mode switch to USB and pressed **D** for data, and enjoyed many FT8 contacts using this setup.

Wrapping Up

With its high-performance receiver, clean transmitter, and array of features for all modes, Kenwood's TS-890S appeals to a wide range of operators. The radio is highly customizable through its extensive menu system, and I found the default settings to be an excellent starting point. I could use the radio right out of the box, while I explored the many settings and options.

Manufacturer: JVC KENWOOD USA, Communications Sector, 1440 Corporate Dr., Irving, TX 75038; **www.kenwood.com/usa**. Price: \$3,900.



Visit <https://youtu.be/1gNFh160RpE> to see our review of the Kenwood TS-890S HF and 6-Meter Transceiver on YouTube.

SharkRF openSPOT2 Multimode Digital Hotspot

Reviewed by
Pascal Villeneuve, VA2PV
va2pv@arri.net

I've been using the original SharkRF openSPOT digital hotspot since August 2016, and I love it. (A hotspot is an internet gateway for digital-mode amateur transceivers, such as DMR, D-STAR, and System Fusion, so that they can connect to various amateur networks.) In the October 2017 issue of *QST*, I reviewed the original openSPOT, and in my conclusion, I mentioned my desire for a Wi-Fi interface. SharkRF heard user requests, and the new openSPOT2 includes Wi-Fi.

The openSPOT2 builds on the success of the original version. This standalone hotspot works on the 70-centimeter band, is simple to operate and small in size, has low consumption, and is reliable. The web interface is very well done and works on any platform — even on my iPhone. Figure 9 shows how it appears on a mobile device.

The original openSPOT and the openSPOT2 are similar in many ways, so in this review, I will cover only the main differences between the two versions. Please refer to the October 2017 review for more information on the features they have in common. Also, the SharkRF website has a lot of detailed information about the device, including an online manual and video tutorials.

Overview

The first thing I noticed about the openSPOT2 is that there is no ethernet port and no external antenna jack, and the power connector is now a USB-C type. This unit is very light and surprisingly compact. It's thin enough that a photo on the SharkRF website shows someone carrying it in the small watch pocket in a pair of jeans.

On the outside, there's only one control button. When you press and hold it for more than 3 seconds, it switches the openSPOT2 into Wi-Fi AP



(access point) mode (more on this later). If you hold the button for more than 30 seconds, it will reset the unit to its factory default.

The LED status indicator is hidden inside the white plastic enclosure. When you connect power, the LED glows and is visible through the case. Different colors are used to indicate the current status, and I found it intuitive. For example, when the device receives a signal, it turns green. When it transmits, it turns red. Other status indicators are well described in the manual.

Like the original model, the openSPOT2 supports multiple digital modes: DMR, D-STAR, and Yaesu System Fusion/C4FM. Two new modes were added: NXDN (a digital voice mode), POCSAG/DAPNET (a paging system), and P25 (another VHF/UHF digital wireless standard). They also added a special background connector for APRS, which can be

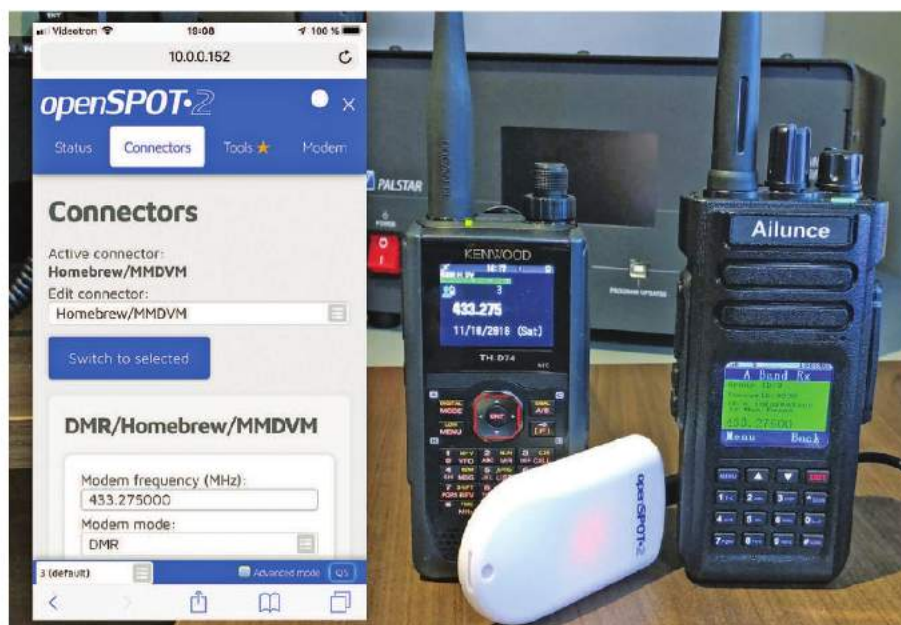


Figure 9 — The small SharkRF openSPOT2 in between two digital handhelds with the web interface running on my iPhone. The device is in DMR mode.

Bottom Line

Smaller and lighter than the original version, the SharkRF openSPOT2 multimode digital hotspot moves the antenna inside the case, adds a Wi-Fi interface, and simplifies operation.

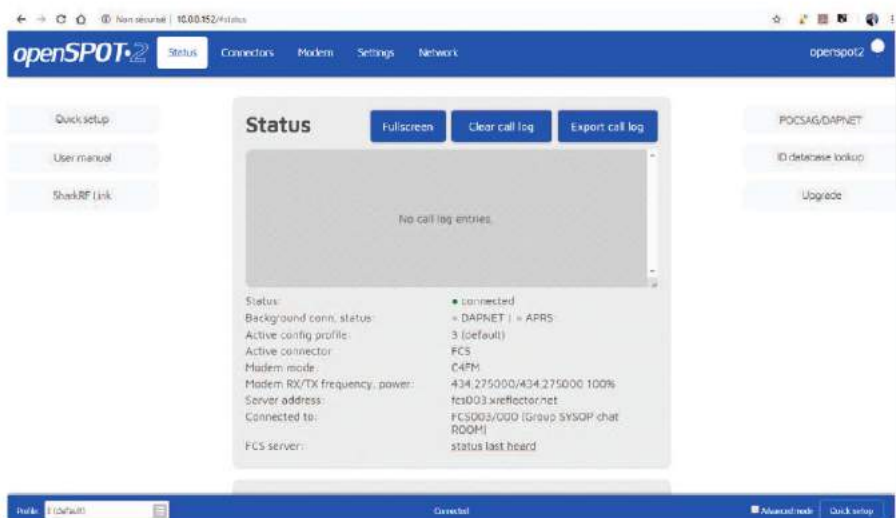


Figure 10 — The openSPOT2 web interface screen.

used for setting up a connection to the APRS network. This enables device location broadcasting, forwarding GPS data from transceivers, and messaging (APRS chat).

The new version still supports cross-mode contacts between DMR and C4FM, so you can talk from a 70-centimeter C4FM radio to a DMR reflector or the other way around (a reflector is the equivalent of a repeater in the IP world). This unit does not convert analog FM signals to any digital mode, so you need at least one digital radio to use it. Also, you can still create your own radio network using their open-source server application.

Setting Up the Device

When you receive the openSPOT2, by default, it will be in AP mode for Wi-Fi, and this is the only way you can access the web interface and do the initial configuration. You can use any internet device for the setup, such as a tablet, phone, or PC.

After connecting power to the openSPOT2, you set it up just like you would normally do with new Wi-Fi devices. Scan for a new Wi-Fi network and you will see **openSPOT2 AP** listed. After connecting to the unit, the first thing you have to do is connect the device to the internet via your home Wi-Fi router. Remember, without

internet access, the openSPOT2 is useless.

When connected to the internet, log in to your home router and look for the IP address assigned to the openSPOT2. I strongly suggest reserving this address for the hotspot, so it will never change. Then reconnect to the web interface using that address. It's also a good idea to upgrade the device the first time you connect to the internet.

Managing Multiple Wi-Fi Networks

After the initial setup, if you move out of reach of your initial Wi-Fi network, you simply use the button to switch the openSPOT2 back into AP mode, connect to the web interface directly with your phone or tablet, and select a new Wi-Fi network. Doing this does not affect your hotspot configurations, and you won't lose the other Wi-Fi setup as long as you do not hold the button more than 30 seconds (which resets the device).

You can also use the openSPOT2 as a mobile or portable hotspot with your cell phone Wi-Fi as an internet connection. You will need to press the openSPOT2's external button to switch the unit back in Wi-Fi AP mode, and then you can connect your cell phone directly to it and select the new Wi-Fi network.

You only need to go through the setup procedure the first time you connect to a new Wi-Fi network. After the first time, it will connect to the best available registered network automatically. You can store up to five Wi-Fi SSIDs (network names).

Web Interface

The main screen of the web interface, shown in Figure 10, is very similar to the original openSPOT, except for the left and right menus. All you need to use it is your favorite browser on any desktop or mobile device. Windows, macOS, iOS, or Android all work. This interface is used to configure the openSPOT2 for use with your transceiver and set up a connection to your digital network.

The menu at the left has buttons for **QUICK SETUP**, **USER MANUAL** (a link to the online manual), and **SHARKRF LINK**, for setting up access to the openSPOT2 via the web interface.

QUICK SETUP offers the simplest way to configure the openSPOT2 for your transceiver and connect to a network. You select your type of radio (such as DMR, D-STAR, or C4FM) and fill in some basic settings that vary with the mode of operation. Then you select a digital network and enter some settings, such as your call sign or network ID. Then click **CONNECT**, and you're ready to start using the network with your radio. Advanced users can select the **ADVANCED MODE** and have more configuration options.

On the right menu, you have **POCSAG/DAPNET** setup, **DMR ID DATABASE LOOKUP**, and an **UPGRADE** button for loading the latest firmware. Upgrading this device is easy. Just click **UPGRADE**, and it's all automatic. With the original version, you had to download a file and switch to bootloader mode.

Along the top, we have the same tabs — **STATUS**, **CONNECTORS**, **MODEM**, **SETTINGS**, and **NETWORK**.

STATUS Page

After you are logged in, this page is shown by default. You will find the latest activities, the hardware and software versions, and some other useful information, such as the uptime and network performance.

CONNECTORS Page

This is the page where you select the mode, local frequency, and reflector or gateway to connect. You have to enter your call sign, your DMR ID, and a frequency for each mode.

MODEM Page

This page is normally used to set up a sub mode to be used in cross-mode operations. There are more settings when the **ADVANCED MODE** is selected.

SETTINGS Page

This section is used for more advanced and specific configuration

of profiles, location, radio network settings, and other parameters.

NETWORK Page

Information about the Wi-Fi and internet connections, a traffic monitor, IP settings, and other parameters.

Every time you modify or select an option, click on the **SAVE** button. Then the web page will refresh to reflect the new configuration.

Conclusion

I really like the openSPOT2 and I think it is an ideal portable/mobile hotspot. You do not have to worry about damaging a microSD card because you didn't shut down properly — it doesn't have any. There's nothing to break outside the enclosure, as there's only one small button and a USB-C power connector, which is sturdier than a Micro USB port. The original openSPOT offered a wired

ethernet port (RJ-45) and an external antenna connector, but the new version is smaller, has Wi-Fi, and boots up very fast.

If you're looking for a simple and reliable mobile digital hotspot, this one is a great option, as it doesn't require any special skills to operate, uses a simple and easy-to-use web interface, and works with any device that has a web browser.

For more about digital voice operation and a detailed video showing the openSPOT2 during setup and operation, check out my YouTube channel, **Laboenligne.ca** (or search for VA2PV).

Manufacturer: SharkRF, Tallinn, Estonia; **www.sharkrf.com**. Available from the online shop, **shop.sharkrf.com**. Price: \$230.

PreciseRF HG-1 Magnetic Loop Antenna

*Reviewed by Phil Salas, AD5X
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Small magnetic loop antennas are popular for portable/QRP operation due to their small size and ease of deployment. A recent entry into this market is the PreciseLOOP HG-1 from PreciseRF.

Overview

The HG-1 is rated at 45 W PEP and covers 7 to 30 MHz. Optional 80- and 60-meter, high-voltage/high-current resonating capacitors are available, though the maximum power rating is reduced to 10 W PEP on those two



bands. The website cautions that the HG-1 is not waterproof.

The basic (Express) package includes a 38-inch-diameter radiation loop made from LMR400 coaxial cable; a copper tube induction loop; a manually adjusted loop tuning unit with a precision 6:1 reduction dial and calibrated dial marking (see Figure 11); a three-section PVC mast, and a basic carrying bag. The Deluxe package adds the 80M-1 resonator for operation on 80 meters; the MLA-1 desktop tripod with tripod adapter; a 12-foot coaxial cable feed line, and a premium padded nylon carrying case (see Figure 12) that easily fits the antenna and accessories.

Assembling the HG-1 takes just 1 to 2 minutes. If you wish to operate on 80 or 60 meters, simply plug the resonating capacitor assembly into the bottom of the tuning unit, as shown in Figure 13.

Bottom Line

For portable or low-profile home operation, the Precise RF HG-1 magnetic loop antenna offers ease of deployment, good performance and directivity at a low height, and easy tuning.



Figure 11 — The HG-1 manual loop tuning unit uses a 6:1 reduction drive with amateur bands marked on the dial.



Figure 12 — The Deluxe HG-1 package in the supplied carrying case. The entire package, including antenna, mast, tabletop tripod, and controller weighs about 8 pounds.



Figure 13 — The 80-meter resonating capacitor plugs into the bottom of the tuning unit.

A new addition is the HG-1 remote tuning unit, which permits tuning from a remote control head connected to the loop with up to 100 feet of CAT-6 cable (see Figure 14). The remote tuning option includes a dc motor assembly that mounts on the manual tuning unit, a pulse width modulated (PWM) motor controller, and 25-foot coax and CAT-6 cables. The controller shown in Figure 15 uses either an internal 9 V battery or an external 9 V dc wall power supply (included with the remote tuning unit).

Adding the remote tuning option requires removing the tuning knob and pointer, opening up the manual tuning unit, removing the vernier assembly mounting screws, and attaching the tuning motor assembly. It is not difficult and only requires a few minutes. The ARRL review antenna included the HG-1 Deluxe package and the remote tuning unit.

Operating the HG-1

Like all small transmitting loops, the HG-1 radiates a bidirectional signal with maximum radiation in the plane of the loop, and it exhibits deep nulls perpendicular to the loop when vertically mounted. I use this knowledge to position myself perpendicular to the HG-1 when I am in close proximity to it when transmitting. That can occur often with a manually tuned loop, as you must retune the antenna with even fairly small frequency changes due to the very narrow bandwidth of the antenna.

The Deluxe package include a desktop camera tripod that supports the HG-1 just fine, but I prefer a full-size tripod that places the HG-1 several feet above the ground without having to use a table. The picnic tables are all metal in the city park where I operated, and sometimes tables are not available. My 50-inch camera tripod collapses to 15 inches and easily fits within the padded carrying case. The PreciseRF tripod adapter works with any camera tripod, or you can build your own adapter (see the sidebar, "Making a Tripod Adapter").



Figure 14 — The remote-control motor on the tuning box replaces the manual tuning knob.



Figure 15 — The controller for the remote-tuned loop.

I first checked the SWR on the different bands. I began with the basic manual tuning unit, and then added the remote tuning option. I found that I could easily adjust the SWR to less than 1.5:1 on 40 through 12 meters. My best SWR on 80 meters (with the 80-meter resonating capacitor) was 2.2:1. On 10 meters, the best SWR I could realize was 2:1.

It was easy to tune the HG-1 by adjusting the tuning capacitor for maximum receiver noise, then transmitting a low-power CW carrier and touching up the tuning for best SWR,

Using the HG-1 on 80 Meters

Mark Wilson, K1RO

Phil, AD5X, didn't hear any signals on 80 meters in his noisy location in Texas, so I set up the HG-1 at my station in New Hampshire to give it a try. Over the course of two evenings, with 10 W and the HG-1 on a tripod outside my station window, I made a couple dozen 80-meter FT8 and CW contacts, mostly with stations in the eastern half of the US. The best DX contact was with V31MA in Belize. As you might expect, only the strongest stations copied me, and I generally got weak signal reports, but I thought the results were impressive for a 3-foot loop, 3 feet off the ground on 80 meters.

The HG-1 worked even better on receive. I heard a number of European stations on 80-meter CW and FT8, and I even decoded a couple of Australian FT8 stations at sunrise. Under the right conditions, 80 meters is viable with this antenna.

if necessary. And incidentally, I found that removing my hand from the tuning knob had no noticeable effect on the loop tuning.

Tuning the antenna with the remote option was also quite easy. The remote tuning controller provides stall warning lights when you hit the tuning capacitor extremes. Normally, I would tune the unit for a stall at the lower or upper end of the frequency range, and then tune up or down from that spot in order to obtain the receiver noise peak. The remote tuning controller has a **SPEED** control, which makes it easy to tweak the tuning once you get close to the desired frequency. With just a bit of practice, I was remotely tuning the HG-1 as easily as I could tune it with the manual unit.

I operated primarily on 40, 30, and 20 meters due to band conditions during the review period. Transmit power was 10 W with my Elecraft KX3 portable transceiver. On CW, I could pretty much work anyone I could hear. In fact, my first contact occurred when I

Making a Tripod Adapter

Phil Salas, AD5X

A standard camera tripod uses a $\frac{1}{4}$ -20 screw for mounting the camera. To build a tripod adapter for a magnetic loop, purchase the following from your local home center or online: a $\frac{1}{4}$ -20 \times $\frac{7}{8}$ inch threaded coupling nut and two in-ground sprinkler fittings — a $\frac{1}{2}$ -inch plastic barb coupling (Orbit part #94349) and a $\frac{1}{2}$ \times 6 inch plastic cut-off riser (Orbit part #37227).

Cut the 6-inch riser to 4 inches. Using a bench vise, press the $\frac{1}{4}$ -20 \times $\frac{7}{8}$ inch coupling nut into the $\frac{1}{2}$ -inch barb coupling, and then press this assembly into the $\frac{1}{2}$ \times 4 inch riser.

This assembly easily screws onto the camera tripod, and then you can slip the lower tube of the HG-1 support mast over the adapter. You may wish to wrap a few turns of electrical tape around the adapter to create a friction fit between the adapter and the HG-1 lower tube.



The parts for the tripod adapter are shown on the right, with the finished adapter on the left. (A standard $\frac{1}{2}$ -inch PVC barb is shown, and it had to be filed down to fit inside the riser without splitting it. Use a matching sprinkler system barb if available.)



The finished adapter on a camera tripod. The loop support mast slips over the adapter.

was just familiarizing myself with setting up the HG-1 in my ground-floor family room. I heard a station in Michigan calling CQ on 20 meters, so I answered him, and we had a surprisingly good contact. He said that my signal was peaking at S-6. SSB was challenging on 40 meters, though I did have success calling some strong stations. SSB contacts were much easier on 20 meters.

Conclusion

The PreciseRF HG-1 is an effective antenna worth considering for light-weight quick setup/tear-down portable operation at power levels up to 45 W. I particularly liked the remote tuning option, which keeps the high-intensity RF field well away from the operator, and would be convenient for tuning a balcony-mounted HG-1 from inside an apartment or condo. Finally, a

PreciseLOOP application note on the PreciseRF website provides detailed technical information on the HG-1.

[As this issue of *QST* went to press, PreciseRF announced the HG-1 WR remote tuner intended for outdoor use; a new HG-2 controller that replaces the HG-1 controller; and the AR-1 remote antenna rotator suitable for use with portable antennas. — Ed.]

Manufacturer: PreciseRF, 960 S. Gribble Rd., Canby, OR 97013; www.preciserf.com. **Price:** Express PreciseLOOP HG-1, \$299.50. Deluxe PreciseLOOP HG-1, \$435. HG-1 Remote Loop Tuner, \$195.50. 80-meter resonator, \$65. 60-meter resonator, \$65. CMB-300 common-mode 1:1 balun, \$65.00. MLA-1 desktop tripod with adapter, \$79. Tripod adapter only, \$19.95.

The Doctor is In

Current Draw is Only Half the Story

Q Bob, KK6YLW, asks: A book I'm reading said that for a single-operator station with a radio, 500 W power amplifier, dummy load, and tuner, a single 20 A, 120 V ac circuit should be sufficient.

However, my radio specs say that at 100 W output, the transceiver will want 21 A. How is it that when transmitting at that level, with or without engaging any of the other pieces of equipment, I'm not blowing the 20 A circuit breaker in my main panel all the time? Can you explain to me how one 20 A circuit will handle a 100 W radio, a 500 W amplifier, a dummy load/wattmeter, a tuner, a laptop linked to the radio, and an external monitor without blowing a gasket?

A The transceiver's 21 A spec is for the 13.8 V coming from the dc power supply, not directly from the ac socket (see Figure 1). I haven't found any input current requirements specified for power supplies that I've looked at. If we assume 75% efficiency, we have dc power supplied = $13.8 \text{ V} \times 21 \text{ A} = 290 \text{ W}$. If the supply is 75% efficient, that's 387 W. At 120 V ac, that is 3.2 A. This seems reasonable, because one 25 A supply I looked at is protected by a 5 A fuse.

Regarding the 500 W linear amplifier, my solid-state Elecraft KPA500 requires approximately 8.3 A at 120 V ac for 500 W output.

An Ameritron AL-811, 600 W vacuum-tube amplifier requires 8 A at 120 V, according to the manufacturer's specifications. Note that neither of these amplifiers requires the full 100 W drive from the transceiver to reach full output, so if using an amplifier, the transceiver will have a lower current requirement than the 3.2 A shown.

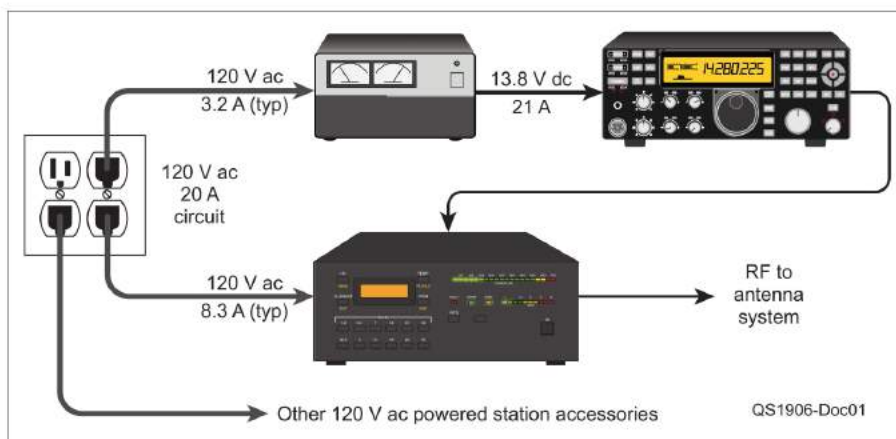


Figure 1 — Simplified power distribution diagram for a medium-power amateur station. It is important to keep track of the requirements of the different parts of the system separately.

So, we're up to 11 A for the transmitter and amplifier — add an auto tuner, a PC, and a light or two and you'll blow a 15 A circuit, but a dedicated 20 A should be feasible if you can keep other things off it.

A word about dedicated circuits may be in order. When I refer to a dedicated circuit, I mean one that starts at the power distribution box and ends at a single or dual outlet at your station. The fact that a circuit has nothing else in use when you check doesn't mean it will be fully available whenever you need it — in fact, most household 20 A circuits were installed, rather than the usual 15 A, for specific functions such as refrigerators or laundry areas. If you just jump on one of those by measuring it when not in use, for sure someone will start the washing machine just as you are about to try to break through a pileup!

I recently upgraded my station to support a linear amplifier. Because I needed to run a new dedicated circuit and had the breaker-box slots available, I opted to install a 240 V, 20 A circuit instead of a 120 V one. For the cost of an extra breaker and a run of four-wire #12 AWG, rather than three-wire, I not only have more headroom

in case I want to go to the legal limit someday, but because the key-down line current at 240 V is half what it is at 120 V, I have less voltage fluctuation during operation. A disadvantage is that I need to use a separate 120 V circuit for my other equipment, but I had that covered here.

Q Jack, N18N, asks: I have a friend who routinely uses two antenna tuners in cascade — one is the radio's internal automatic antenna tuner, the other a manual tuner. I have to think that this adds unnecessary loss to his signal. Is there a reason why this could be a good idea?

A A good question. Fortunately, tuner losses in most tuners, manual or automatic, are quite low. Still, if the tuners are in about the same place, your friend will have extra unneeded losses compared to using one or the other.

There is a major exception to this, and that is if the manual tuner happens to be near the antenna and the antenna SWR is high. In that case, if only the radio's tuner were used, the transmission line between the antenna and the tuner may have very

high losses. If a tuner were inserted at the antenna and got the SWR down to 2 or 3:1, compared to say 10:1, the loss in the extra tuner would be much less than the loss in the badly matched line.

Another consideration is operating convenience. Many internal tuners can't handle a wide SWR range; some, for example, are limited to 3:1. If your friend's SWR were higher than that, he could use only the manual tuner, but then may have to manually retune as he shifted frequency across the band, perhaps missing a contact in the process. By presetting the manual tuner for midband, it is likely that the automatic internal tuner can quickly trim up the SWR as he changes frequency, making the contact and accepting perhaps 0.5 – 1 dB of extra loss in the process — not a bad trade.

Q Dave, K6DHL, asks: I have a ground-mounted vertical monopole that can be continuously adjustable from 0 to 75 feet high. I've tried using it as a $\frac{1}{4}$ -wave monopole, but haven't seen much benefit, so I plan to stick with using it as a straightforward quarter-wave antenna covering 80 through 20 meters. Can I replace my current L-network with a 2:1 balun and just adjust the antenna length to achieve a 50 Ω match? It would be nice to get rid of the auto-tuner to simplify the system and eliminate any potential losses.

A That should work well, although I don't believe you will even need the balun. A direct connection to the coax should give a better match, however, a common-mode choke on your coax at some distance from the feed will help keep RF from your shack and act like an additional radial. If your ground system is perfectly lossless, the quarter-wave resonant vertical will have an impedance of 36 Ω for an

SWR of 1.4:1. With the balun, it will be 72 Ω for an SWR of 1.44:1. But with a real ground, any ground loss will add to the antenna impedance. Say you have a fairly typical loss resistance of 10 Ω — your quarter-wave antenna plus ground will have an impedance of 36 + 10, or 46 Ω , with an SWR of 1.09:1. With the balun, it will be 92 Ω , or 1.84:1.

I have had a number of amateurs express surprise and disappointment after adding radials to their ground system and observing a change in SWR from 1:1 to 1.5:1. In this instance, the slightly mismatched system with the better ground will make an improvement in their antenna performance. Continuing with the numbers in our example, to have that 1:1 SWR implies a ground-loss resistance of 14 Ω . This will result in an efficiency of 36/(36 + 14) or 72%, meaning that 28% of the transmitted power will warm worms instead of being radiated — a loss of 1.4 dB.

Q Dick, W1REJ, asks: I have a new tower that is ready to have antennas mounted. The problem is that it is about 160 feet from where the station is in the house. I have a run of low-loss LMR-400 coax all the way to the tower. Recently I read an article that stated it is not a good idea to run UHF antennas that far from stations due to coax losses. Can you please shed some light on this for me? I know there will be losses even with LMR-400, but I did not think it would be that restrictive. The 2-meter antenna would be on a 33-foot tower and is at the top of the hill behind my house with sloping land in all directions, which is why I would really like to take advantage of this location.

A All transmission line has loss, and the higher the frequency and longer the run, the more the loss. The serious V/UHF operator, such as

those involved with moonbounce or competitive contesting, would put power amplifiers and receive preamplifiers right on the tower and just run power and low-level signals back to the station, eliminating coax loss from the equation, but that is a big undertaking and probably not warranted for most of us.

Looking at your case, 160 feet of matched LMR-400 has a loss of about 2.5 dB at 145 MHz — less than half an S-unit. If much of what you do is line-of-sight limited, then raising the antenna above obstacles by putting it on your tower will have much more effect than a loss of about 44% of your power.

As an example, I had a 50 W 2-meter FM transceiver in the kitchen that I used to work into local repeaters. For an unknown period, the final amplifier module had failed, and it was actually only putting out 0.1 W. My roof-mounted vertical was still working fine into every repeater that I could hear — and that's 27 dB loss!

So I would go with it. If you decide you can't stand it, there are other solutions that may be less extreme, such as shifting up to LMR-600 (1.53 dB), or $\frac{1}{8}$ -inch heliax (0.74 dB). For casual and most contest operation, I think you will be very happy, and you can always improve if desired. Adding VHF and UHF preamps at the antenna with appropriately time-sequenced switching is not a big deal, and would significantly improve your receive sensitivity of weaker signals.

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

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



www.dxengineering.com

Hints & Hacks

An External Speaker for Field Day, an Antenna Sleeve for Handheld Users, and More

An Easy, Portable External Speaker

The internal speakers in radios need to be small enough to fit inside the radio enclosure and are often on the top or bottom of the radio, sacrificing a bit of sound quality due to the location. External speakers, however, are often used to improve the audio and have the option of a front-firing speaker, which can enhance audio and make it easier to hear.

I decided to construct an external speaker that was easy to take into the field for public service events or Field Day outings (see Figure 1). I planned out what I was looking for. A handle would help with easy portability, and a rugged enclosure would help keep the speaker from getting beaten up in the field. The parts to build the unit would have to be readily available at a reasonable cost. And, of course, it had to sound good.

First, I needed to find a speaker. I wanted a speaker that was self-

enclosed to make construction easier. I kept in mind how I'd be mounting it in the enclosure and the need for some sort of protective grill in front of the speaker cone to keep it from getting damaged. I found that Parts Express (www.parts-express.com) sold a 5-inch sealed back mid-range speaker (model number GRS 5SBM-8) that fit the bill. It also had a built-in mounting ring with holes to easily mount the speaker unit to the enclosure.

As for the enclosure, a small plastic ammo box seemed like a simple, inexpensive solution. The plastic would also make it easier to cut out the hole to fit the speaker into the box.

Finally, I needed to select a connector to connect the speaker to the radio equipment. I chose red and black binding posts from Parts Express (part number 090-475) for their versatility, and easily identifiable polarity (see Figure 2). They only required two $\frac{1}{8}$ -inch holes, spaced $\frac{3}{4}$ inch apart, to

mount them to the box. If desired, you could use a pigtail type of connection cable to attach the required connector to mate with the radio's external speaker jack. The pigtail could be stored in the ammo box enclosure when not in use. Of course, any other user-preferred connection could be employed to connect the external speaker to the radio equipment.

In summary, the project worked out well. The external speaker met my design goals and looks appealing. It's been used with different radio equipment and sounds good. It may fit your need for a portable external speaker for Field Day or for everyday use.

— 73, Don Varner, WB3CEH, wb3ceh@yahoo.com

Wooden Battery Pack Holders

Ever since becoming devoted to QRP, I found it difficult to make many CW contacts at my slow Morse speed. I decided to try and go for the Field Day bonus points awarded for alternative energy (i.e., my solar panel).

I bought lithium-ion batteries and found ten-cell holders at American Battery Company (www.americanbatterycompany.com). The holders needed some protection from my rough handling, so I constructed wooden boxes for them, about $6\frac{1}{2} \times 3\frac{1}{2} \times 1$ inches (outside dimensions). My solar panel's controller coincidentally had the same spatial needs, though a bit thicker. Its box is $1\frac{1}{4}$ inches high.

The boxes include space for dc power plugs. A lid was unnecessary



Figure 1 — The finished portable external speaker. [Don Varner, WB3CEH, photo]



Figure 2 — The red and black binding posts on the rear of the speaker unit connect the speaker to the author's radio equipment. [Don Varner, WB3CEH, photo]

Figure 3 — The author's homemade wooden boxes help protect the battery holders (left and right) and solar panel controller (center) from being knocked around during handling. [Charles Hooker, VE3CQH, photo]



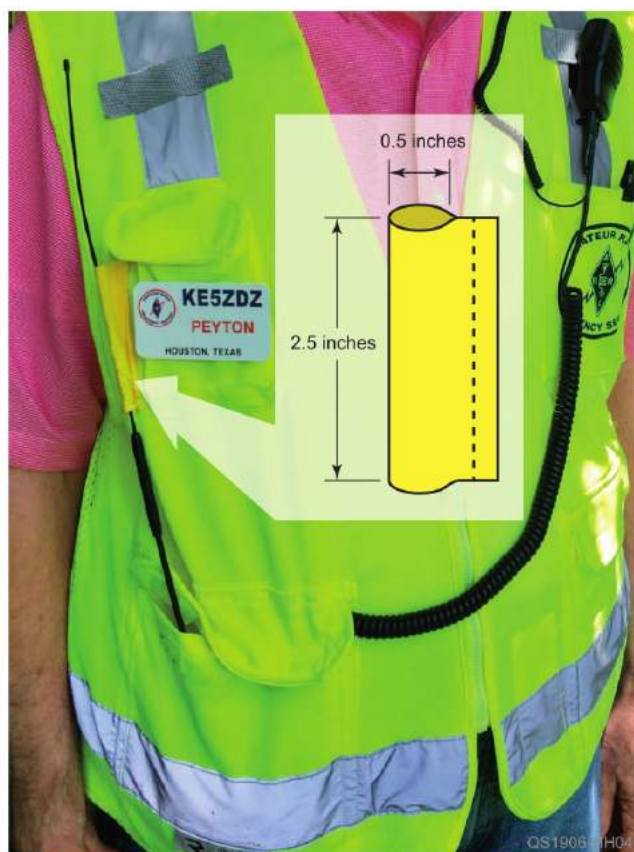
for my use. The patch cord for my tribanders is connected to one battery pack. These boxes have helped keep my battery holders and controller safe from bumping around too much (see Figure 3).

— 73, Charles Hooker, VE3CQH, chuckcynthia@gmail.com

A Safety Vest Antenna Sleeve

Amateur Radio operators need to wear safety vests when they volunteer in support of fun runs, marathons, and other public service

events. The vest not only provides personal safety, but also serves as the carrier for handheld radios when moving around the event. However, with the radio simply clipped onto the vest, the antenna is at risk of snagging on branches or hitting the operator in the face or eye. I wanted to find a solution that provided better security for my radio, a stronger signal, and prevented any eye injuries or antenna snagging. I came up with an antenna sleeve that allows the operator to keep their handheld secure in a vest pocket and use longer antennas without safety risks.



Construction of the antenna sleeve was easy. I fashioned an open-ended cloth tube — 2.6 inches long and ½ inch in diameter — from material similar to that of the safety jacket (see Figure 4). The sleeve is several times the diameter of the antenna to allow vertical movement and easy removal of the antenna. I sewed the tube

Figure 4 — A small antenna sleeve sewn alongside a vest pocket allows for the use of longer antennas without potential safety risks. [Peyton Barnes, KE5ZDZ, photo]

along a vertical line just lateral to the right breast pocket. With the radio in the lower pocket location, a longer antenna can be employed safely, providing a stronger signal. Also, a raincoat can be donned over the antenna and radio, protecting both while still allowing operation. This small sleeve holds the antenna in a vertical position, against the chest and away from the face.

In the field, this antenna sleeve allows me freedom of movement and effective communication. I hope this is useful for any amateurs who like to go out into the field this Field Day and during public service events throughout the year.

— 73, Peyton Barnes, KE5ZDZ, skaevola@hotmail.com

Protecting Antenna Support Rope from Wildlife

Like many hams, I use trees as antenna supports. After three unexplained line (rope) failures, I discovered that squirrels had been chewing through the line where it passed over the tree limb.

I solved this problem by using a 6-inch loop of small-diameter stainless-steel aircraft cable screwed to the tree holding a pulley for the antenna support rope. Alternatively, you could form the loop using ordinary stranded copper wire (such as #14 AWG) and either crimping or soldering the ends together.

While setting this up, it occurred to me that instead of using a single piece of rope through the pulley, I made it a loop. A rope through a pulley means that the bottom end is susceptible to running free out of the pulley unless it is always held. The rope loop ensures a bit more security.

The insulator is fastened with a heavy tie-wrap where the ends of the loop through the pulley are tied together. This allows me to lower the antenna



Figure 5 — Enlarge the diameter of the plug's clamping jaws. [Barry Shackelford, W6YE, photo]

from ground level for repairs or changes without climbing. Plus, the antenna support rope is now out of reach of the squirrels' sharp little teeth. — 73, Doug McCray, K2QWQ, k2qwq@comcast.net

Installing Heavy-Duty Power Plugs

Heavy-duty power plugs, such as the Leviton 5256-VY, typically feature a clamping piece or clamshell closure to effect a strong grip on the attached power cord. The halves of the closure are held together by two screws threaded into the opposing piece, which is typically nylon or plastic. When installing a heavy-gauge power cord, achieving a complete closure by means of the two screws alone is likely to be problematic.

I have found a procedure that ensures an easy and neat installation of heavy-gauge power cords. First, measure the diameter of the power cord and select a drill bit of the next smallest diameter. Next, enlarge the diameter of the plug's clamping jaws



Figure 6 — Use a vise and C-clamp to close the clamshell while screwing the halves together. [Barry Shackelford, W6YE, photo]

with the selected bit. It's best to hold the plug closed in a vise while drilling, with caution not to drill past the clamping jaws (see Figure 5). After connecting the power cord wires to the plug blades, use a vise and possibly an additional clamp to close the clamshell tightly around the power cord sleeve while screwing the two halves together (see Figure 6).



Figure 7 — The completed installation, snug and secure. [Barry Shackelford, W6YE, photo]

The result is a snug and secure fit to the power cord (see Figure 7).

— 73, Barry Shackelford, W6YE, w6ye@arri.net

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

QST invites you to share your hints with fellow hams. Send them to "Attn: Hints and Hacks" at ARRL Headquarters, 225 Main St., Newington, CT 06111, or via email to hh@arri.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.

New Products

Mastrant's New Size of Guy Rope

Mastrant introduces a new $\frac{3}{4}$ -inch-diameter rope for the Polyester product line (Mastrant-P). The new size of Mastrant-P rope fills the gap between the 2.6-millimeter-diameter (size 3) rope and the 4.4-millimeter-diameter (size 4) rope. It is called "size 3+" and has a 3.5-millimeter diameter ($\frac{3}{4}$ inches). The breaking strength is 300 daN (about 300 kilograms or 660 pounds), with a safe working load of 100 daN (about 100 kilograms or 220 pounds). Size 3+ is ideal for guying of vertical antennas, light masts, truss support, and heavier wire antennas.

It is available in standard Mastrant colors (black and blue), as well as the new camouflage tan and brown design. You can get it on spools of 102 feet (31 meters), 330 feet (100 meters), 660 feet (200 meters), and 1,650 feet (500 meters). Mastrant ropes are designed for guying — they are resistant to UV, any weather, acids, and alkali. They also have high strength and negligible elongation. For more information, visit www.mastrant.com.



Close Up Coaxial Connectors

This family portrait of coaxial cable connectors includes the most common versions in Amateur Radio use today. All the connectors shown here were provided by ABR Industries (www.abrind.com) and are designed for use with crimping tools rather than soldering.

A — Right-angle SMA

B — Female chassis-mount BNC

C — Male BNC

D — Female N

E — Male N

F — TNC chassis mount

G — Male PL-259

H — TNC



Eclectic Technology

ARM Radio

Alberto di Bene, I2PHD, developed a fascinating software-defined receiver based on an STM32F429ZIT6 "Discovery Board" manufactured by STMicroelectronics. These boards are designed for experimenters and even include color LCD displays. Best of all, they are surprisingly inexpensive. At the time of this writing, Digi-Key was selling them for only \$29.95 (part no. 497-16140-ND; www.digikey.com).

The board features an ARM microprocessor that sports three 12-bit analog-to-digital converters (ADCs), each capable of a sampling frequency of 2.4 MHz. Considering its capabilities, Alberto realized that the Discovery board could be turned into a software-defined radio receiver for low- and medium-wave frequencies. He needed to add only two outboard circuits, both of which are quite simple.

Anti-Aliasing and DAC "Reconstruction" Filters

You could connect the Discovery Board's ADC directly to an antenna, but it wouldn't work well. For proper operation, the board needs an anti-aliasing filter between the ADC input and the antenna. Alberto designed his filter to attenuate all frequency components greater than 893 kHz, which sets the upper limit of reception. He also included a 10 dB pre-amplifier. The filter consists of less than 20 components.

At the other end of the process, the audio output is intended to be fed to an amplified speaker. Before you can do that, however, the output of the digital-to-analog converter (DAC)



Figure 1 — Alberto di Bene's ARM Radio, an inexpensive software-defined receiver that covers 8 to 900 kHz. Full details are available at www.weaksignals.com. [Alberto di Bene, I2PHD, photo]

must be filtered to remove the sampling frequency component. Alberto calls this his "reconstruction filter." Once again, it is a simple design with less than 15 components.

Alberto has posted a detailed PDF on his website at www.weaksignals.com, where you'll find the filter diagrams and much more.

Software

On Alberto's website, you'll also find the source code (written in C) that enables the Discovery Board to work its magic.

Be sure to read the "Read Me First" file after downloading the code. In there, you will discover that you'll need to compile the code using a Keil MDK compiler, available at www2.keil.com/mdk5/, and add the legacy support packs. Once the object code is ready, you can load it to the ARM chip's flash memory using the ST-Link utility found at www.st.com/en/development-tools/stsw-link004.html#.

When the code is loaded, and power is applied to the radio, you're rewarded with an SDR receiver that covers from 8 to about 900 kHz, with AM, LSB, USB, and CW demodulation modes, narrow and wide bandwidths, and fast or slow automatic gain control. As you can see in Figure 1, the LCD touchscreen is nicely designed with pushbutton controls, a large frequency display, and an audio volume slider.

On his website, Alberto provides a few audio recordings so that you can hear how well his ARM Radio performs. In fact, Alberto entered the project in an ARM microcontroller design contest.

Depending on where you purchase your parts, you could probably build your own ARM Radio for less than \$100 — probably much less. It could even become part of a station for 2200 and 630 meters.

Welcome to 21st century homebrewing!

Hams Support A Carriage-Driving Competition

Bob Ballard, KG5SQJ

The 2018 North Texas Whip Sunrise Ridge Ranch Carriage Driving Competition, which took place on April 7 and 8, was the 15th year the Tri-County Amateur Radio Club has supported this event. The competition has three categories, with the dressage and cones driving course taking place on the first day, and the obstacle maneuverability course on the second day. Over the course of the 2-ham event, Mike Burns, KE5NCS, serves as the primary

Amateur Radio Communications Facilitator, coordinating 17 volunteer hams and two additional volunteers.

On Saturday, hams aided in covering the dressage course — where the competitors perform a series of pre-determined carriage movements — as well as the cones driving course — where carriage drivers move

Dwain and Caroline Gaus and their pony, Duke, at the North Texas Whip Sunrise Ridge Ranch Driving Trial Obstacle 1. [Tim Branam, N5SWG, photo]

through a series of 20 gates. On Sunday, eight additional Tri-County ARC volunteer hams were needed to cover the obstacle course, with stations at the start, the finish, and each of the six obstacles. The obstacle course occurs in a heavily forested area that prevents an open view of competitor progress. The primary duty of these additional hams was to report when each competitor exits the assigned obstacle, as well as to report any penalties, safety issues, or injuries that occurred at their location.



At a unique Texas event, hams volunteer to provide tactical net operations services.

Repeater Solution to Simplex Issue

While preparing for the 2018 event, we had to address simplex operation performance issues that had occurred during the 2017 event. Reportedly, several volunteers had difficulties with handheld-to-handheld communication using 2-meter simplex because of the topography of the course. Elevation differences, high-power electric service lines, and the dense forest around Sunrise Ridge Ranch adversely impacted simplex communications between handheld radios, which led to interference. The Net Control station's antenna was 36 feet and above the elevation barrier that disrupted handheld-to-handheld communication.

After considering several solutions, we settled on employing club member Paul Finch's, WB5IDM, 6 W, 70-centimeter repeater and duplexer. A week prior to the event, the repeater's output frequency, offset, and tone specifications were emailed to all club members to enable volunteer hams to program the necessary duplex memory channel into their handheld radios in advance. I also volunteered to arrive early on the first day to help volunteers manually program the duplex channel into their handheld radio, if necessary.

Net Control and Repeater Station Preparations

On Friday, April 6, Paul Finch, WB5IDM; Aaron Finch, KC5ZUC; Mike Burns, KE5NCS; Mike Heusser, KL7SG; Gayla Heusser, KL1WG, and I traveled to the Sunrise Ridge Ranch in Paradise, Texas. We configured the communications trailer for the Net Control station and mounted the club's 40-inch and 48-inch computer monitors to the interior trailer walls. The repeater station was then set up on the next-to-highest elevation point on the property. We deployed a N9TAX Slim Jim dual-band antenna mounted atop a 20-foot telescoping fiberglass mast.

Paul and Aaron configured the repeater and duplexer, also carefully sealing all the coax cable connections, and then anchored the cable to the mast with electrical tape. In preparation for expected wind and rain, we attached three guy ropes to secure the mast.

When we finished the setup, I tested the repeater using my handheld radio, once from directly under the antenna and again 200 yards away from the repeater station. Before leaving, we turned the repeater off and disconnected the batteries to reserve the power for the event.

Saturday's Weather and Simplex Operations

On Saturday, April 7, the weather had turned unusually cold — at 38° F — and rainy for April in north central Texas. Upon arrival, I discovered that the overnight temperature change and heavy winds had caused the repeater station's telescoping mast to collapse to a 6-foot elevation, shearing the electrical tape that was securing the coax cable. Fortunately, because the electrical tape applied directly below the antenna's coax connector remained intact, no damage occurred to the antenna or the coax cable. Because Saturday's activities all occurred within a 300-yard area, with clear line of sight between all stations, we decided to

employ only simplex operation that day, thus deferring re-erecting the repeater station's antenna until the next day.

Tri-County ARC hams (equipped with a handheld transceiver radio) were paired with event officials to serve as radio communications liaisons, providing real-time radio communications between all event officials. Despite the cold, the event's dressage and cones competitions went as planned, with our volunteers operating for 9 hours. Event officials were pleased with the Tri-County ARC's support keeping all officials constantly in touch.

Sunday's Duplex Operations

Sunday brought better weather, and upon arrival at the Sunrise Ridge Ranch, Mike Burns and Mike Heusser tackled cranking up the Net Control Station in the Tri-County ARC communications trailer for Sunday's operations. They mounted an Ed Fong dual-band 2-meter/70-centimeter antenna to the trailer's 36-foot telescoping mast. They then fed the coax cable into the trailer and connected it to the club's Icom ID-5100A dual-band 2-meter/70-centimeter radio that was programmed with the repeater's 70-centimeter duplex channel. They also activated the club's Kenwood TM-D710GA dual-

Figure 1 — Bob Ballard, KG5SQJ, in the Tri-County Amateur Radio Club communications trailer, where he served as Net Logger. [Bob Ballard, KG5SQJ, photo]





Figure 2 — Mike Heusser, KL7SG, explains how the obstacle course and ham location icons were configured to display over the Google Earth satellite photo. The ham's cell phones running the APRS.fi application enabled real-time monitoring of their physical location on Mike's integrated map. [Bob Ballard, KG5SQJ, photo]

band radio and configured it to operate on the simplex 2-meter frequency at 50 W. This second radio was connected to a Diamond dual-band 2-meter/70-centimeter antenna elevated approximately 10 feet. A Honda inverter generator powered the trailer, and the repeater used a 12 V automobile jump starter unit wired parallel to a large AGM battery.

My first assignment on Sunday was to get the repeater station working by re-elevating the mast and antenna, connecting the batteries, testing the station, and reporting it as operational. I then quickly hiked the 200 yards to the communications trailer Net Control station to prepare for my Net Logger assignment.

Room for Improvement

For logging data, I developed two Microsoft *Excel* spreadsheets to record our operational support. The time tracking log was meant to capture the data for carriage obstacle exit times and penalties in real time, while the communications activity log would simultaneously be used to record all other net traffic (see Figure 1). However, because of the disjointed incoming net traffic, I missed several carriages' obstacle course exit times and penalty reports. Fortunately, Jon Diner, N5JLD, and his daughter, Shelby, were recording

obstacle reports on paper, and together, we kept the data up to date in virtually real time.

As for the repeater solution, it was successful overall, with one exception at Obstacle 2, which was located in a low area. Net Control had trouble communicating with the assigned volunteer, Randy Thompson, KF5RRF. After several attempts to solve the problem, Net Control decided to use simplex operation during the remainder of the event to communicate with Randy.

Lessons Learned

In spite of a few hiccups, the Tri-County Amateur Radio Club's support of the 2018 event was effective, and we plan to apply what we learned while supporting future events. Multitasking is not effective, and because of so much simultaneous net traffic, we plan to assign one volunteer to each activity log next year. Additionally, fully testing the repeater from every obstacle on the course would have brought the duplex operations problem to our attention earlier, so we will fully test the repeater from every obstacle location, using a low-power handheld radio prior to the event. We also plan to deploy the repeater station to the top of the highest point on the ranch

property and to use a much higher-gain 70-centimeter antenna on the repeater.

Acknowledgments

The Tri-County Amateur Radio Club Tactical Net Operations support effort for this event was truly rewarding and enjoyable. Kate Morgan and other directors of the competition were impressed with our professional communications, as well as the utilization of the monitors to display the tracking log and the Google Earth map of the obstacle course (see Figure 2). Kate also thanked Jon, who had acted as Net Control, along with appreciation for all of the TCARC ham volunteers: Mike Heusser, KL7SG; Gayla Burns Heusser, KL1WG; Paul Finch, WB5IDM; Aaron Finch, KC5ZUC; Mike Hunter, KC5AMN; Tim Branam, N5SWG; Stacy Branam, W5ORD; Randy Thompson, KF5RRF; Richard Marx, KE5ZGZ; Jeff Rooks, K5JJR; James Tulloh, KG5PMN; Bob Overton, WD5ILB; Jay Cox, KG5BZW; Wayne Morris, KB5UQ; Mike Norton, KG5SRG; Bob Ballard, KG5SQJ; Rebecca Rooks, and Shelby Diner.

Bob Ballard, KG5SQJ, lives in Texas and is a retired Aerospace Information Technology Project/System Integration Manager. He was licensed in 2017 and now holds his General-class license. He is a member of the Tri-County Amateur Radio Club (WC5C.org), the Kilocycle Club of Fort Worth (W5SH.org), and the Amateur Radio Club of Parker County (W5PC.org). Bob has supported several community events as a radio amateur volunteer, and he has developed and conducted more than two dozen sessions of his hands-on radio training class for manually programming simplex and duplex memory channels into Baofeng handheld radios. He is excitedly preparing to take his Amateur Extra-class license exam.

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



As a result of a multi-pronged Kids Day effort, this Nevada club has taken on youth involvement with a passion, generating excitement for hams of all ages.

Kids Day at the Outfitters

Barry Bettman, K6ST

The Sierra Nevada Amateur Radio Society (SNARS) club is lucky to have families with kids in our Reno/Tahoe, Nevada-based club, but we wanted to engage more kids on a significant level.

Kids Day turned out to be the perfect launching point. We started planning about 7 weeks out from the January 5, 2019 Kids Day event, which coincided with the next SNARS meeting.

Making Connections, Shaping a Plan

The first step for launching our Kids Day effort was a banner on our club website (snars.org) that linked to the arri.org/kids-day web page. This allowed us to begin outreach to club members and the larger ham radio community in the greater Reno/Tahoe areas of the Sierra Nevadas. We also promoted Kids Day on our local nets and distance nets throughout the world, creating excitement for youth involvement in Kids Day.

As a result of the interaction among hams, we got in contact with a Scoutmaster and other Scouting troops that were interested in Kids Day. With a little coordination, a Scouts on the Air event about 30 miles away became part of our Kids Day celebration.



The SNARS setup at Cabela's was open and engaging, using signs, a sandwich board, Kids Day certificates, and welcoming volunteers to encourage kids to come learn about ham radio. [Chuck Farnham, WD6CHC, photo]



Greg, KG7DMI, helped one child get on the air, earning himself an ARRL Kids Day Certificate of Participation to commemorate his first contact. [Aline Dodge, N7JWL, photo]

We had three events planned for January 5:

- 1) SNARS club breakfast with a presentation about Kids Day
- 2) Kids Day pavilion at Cabela's
- 3) Scouts on the Air with Kids Day

Planning the Breakfast Meeting

SNARS offers a family membership, so the whole family can be part of Sierra Nevada Amateur Radio activities, including the breakfast meetings.



The ham volunteers from the Sierra Nevada Amateur Radio Society (SNARS) encouraged kids to get on the air during a Kids Day event. [Aline Dodge, N7JWL, photo]

At the January 5, 2019 SNARS breakfast meeting I gave an overview of youth involvement in ham radio, plus Kids Day itself, then I invited kids from the audience to talk to other kids on the air. Three kids took me up on the offer. One was not a licensed ham, one was a General-class license holder who was only somewhat active, and one was an active Amateur Extra-class licensee. I had previously set up two schedules during the breakfast meeting — one with Danielle Edgington, KE8JNU, who runs the Young Amateur Radio Digital Voice Net, and one with YACHT: Young Amateurs Communications Ham Team, K8KDZ.

Adventure at Cabela's

The Cabela's event began to take shape when I realized that an event out in the community would be great for engaging kids.

The SNARS club had previously used our local Cabela's parking lot for one of our ham swap meets. It made sense to have Kids Day there because, as an outdoor recreation retailer, Cabela's has a big following of families that come in to look at sporting and outfitting gear. After reaching out to our contact at Cabela's and a few phone calls to the store manager and the company's events specialist, we were approved to have the event.

Cabela's was very supportive of our event in general. When we realized a big winter storm coincided with our event, we talked to Cabela's management about conducting the event inside the store. They were very amenable. All it took was being respectfully communicative, and we obtained approval in less than a week. We didn't even have to pay a fee — all we had to do was set up, host our event, and clean up after — super easy!

Setting up at Cabela's took about 45 minutes. We had five hams doing most of the work, with other club members pitching in too. In the weeks prior to the events, we did have a few planning calls with the core Kids Day team, which included Wes, KG7QXE; Greg, KG7DMI; Subrina, KI7OAL; Brian, KG7PDC, and me.

At the Cabela's Kids Day pavilion, we had two radio stations — HF and VHF using a Yaesu FT-891 and FT-991 that were supplied by club members. For antennas, we had a Diamond VHF/UHF vertical and a Buddipole in a dipole configuration. We had CW practice oscillators — the old Boy Scout type with sounds and flashing lights, so they were quite engaging for the kids.

All About Kids Day

June 15 is 2019's second Kids Day — the time to get youth on the air to share in the joy and fun that Amateur Radio has to offer.

Kids Day begins at 1800 UTC and concludes at 2359 UTC. Sponsored by the Boring (Oregon) Amateur Radio Club, this event has a simple exchange suitable for younger operators: first name, age, location, and favorite color. After that, the contact can be as long or as short as each participant prefers.

Look for activity on these frequencies:

10 meters: 28.350 – 28.400 MHz
12 meters: 24.960 – 24.980 MHz
15 meters: 21.360 – 21.400 MHz
17 meters: 18.140 – 18.145 MHz
20 meters: 14.270 – 14.300 MHz
40 meters: 7.270 – 7.290 MHz
80 meters: 3.740 – 3.940 MHz

Repeater contacts are okay with permission of the repeater owner.

As with any on-the-air activity that includes unlicensed individuals, control operators must observe third-party traffic restrictions when making DX contacts. Additional details are on the ARRL website at www.arrl.org/kids-day.

The kids that came to our Cabela's Kids Day event were a combination of kids connected to the Sierra Nevada Amateur Radio Society club, and members of the public just coming into Cabela's on their own that day. Club members encouraged kids to come over as they walked into Cabela's.

We had sign-in logs for kids and adults, and we distributed ARRL youth material, including Kids Day certificates downloaded from www.arrl.org/kids-day. I put my contact info on all the materials, so kids and adults had a way to find when they were ready to take their next steps into the world of ham radio.

Scouts on the Air

Later in the day, we held our third Kids Day event with boy and girl Scouts at a regional fire department. Club members brought a Yaesu FT-736R for VHF/UHF analog and a Motorola XPR 4550 UHF DMR, along with two J-poles placed outside the metal building. The kids were able to make local and DX contacts. They really loved it and learned a lot.



SNARS volunteers explained how Morse keys worked and showed the kids how to use one. [Julie Dodge, N7JWL, photo]

The adult Scout leaders learned a few things, too. It turned out one of the adults was interested in getting back into ham radio, as he had been a ham many decades ago and had let his license lapse. We are working with the Scouts on several more projects. On the third full weekend in October 2019, we have an event coinciding with the Jamboree On The Air (www.scouting.org/jota/), where Scouts will have the opportunity to earn their Radio Merit Badge.

Further Interest, Weeks Later

This memorable Kids Day allowed SNARS club members to engage with youth in new ways. Several weeks later, the General-class youth who'd gotten on the air at the SNARS breakfast meeting upgraded to Amateur Extra, and the unlicensed kid became a Technician.

One week after the Cabela's event, we did an event at the Boys & Girls Club in Reno, Nevada, with 15 eager middle school students. I mentored them for a bit, acting as control operator on the SNARS Noon Net, and then got some of the kids on the air to act as net control. The hams checking into the net loved interacting with these kids. Four of the kids from the Boys & Girls Club wanted to get their license, so we are looking to bring a ham radio class to them.

Sierra Nevada Amateur Radio Society

Chuck Farnham, WD6CHC

SNARS (Sierra Nevada Amateur Radio Society), an ARRL Special Services Club based in Reno, Nevada, was formed in April 1968 by F. William Rett, III, WA7FBU; Ronald E. Cerveri, WA7EKN; John Reinhold, K7JJS; Ray Bass, W7YKN; Robert Dickerson, W7VD; Frank Cherne, WA7DUL, and Larry Oakley, W7AB.

SNARS has members and repeater coverage all over northern Nevada and the Sierras, with 25 repeaters under the W7TA call sign. The club meets the first Saturday of the month at the Boomtown Casino. There are 351 active members, 232 of which are ARRL members.

The club provides monthly educational classes on a variety of technology subjects, and it even has a lending library of the latest ham radio equipment that members can check out to see what fits their needs and budget.

Primary activities include ARRL Field Day, two swap meets, the Reno Air Races, and various bike and running events between Reno and Lake Tahoe that are staffed by SNARS members. Communication is provided by the club's repeater network.

SNARS is the host club and founder of the popular Nevada State Amateur Radio Convention, which is attended by hams from the surrounding states, as well as other counties, making it one of the premiere events for hams to attend every year.

Reach Out to Kids

The next ARRL Kids Day is June 15, 2019. SNARS has sent a proposal to the Discovery Museum in Reno, Nevada, asking for them to host Kids Day. Kids Day is a great opportunity for introducing ham radio to younger generations, but you don't have to wait for Kids Day. Engaging with youth can be done any time — now is a great time to begin!

Barry Bettman, K6ST, has been licensed for 46 years. He is a very active ham in contesting, is on the board of directors of the Sierra Nevada Amateur Radio Society, and serves as ARRL Nevada Section Youth Coordinator. Barry is an executive coach, helping clients with their goal, action plan, and positive mindset. He is passionate about giving back to the Amateur Radio community by supporting youth projects as a legacy to ham radio. Barry can be reached at k6st@arri.net.

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This event happens every 4 years, with 2019 marking the 24th World Jamboree.

Jim Wilson, K5ND

Taking place from July 22 to August 1, 2019, the World Scout Jamboree will be held at The Summit Bechtel Scout Reserve in West Virginia. Nearly 45,000 Scouts from over 160 countries will gather in the mountains to learn about other countries and cultures, to make new friends, and even to experience adventures like rock climbing and ziplining.

Demonstration Station NA1WJ

Hosted by a team of North American Scouting organizations, including Scouts Canada, Asociación de Scouts de México, and Boy Scouts of America, the demonstration station will use the call sign NA1WJ and will be on the air using 10 operating locations on HF, VHF, UHF, satellites, D-STAR, and Echolink.

Additionally, we'll be running Amateur Radio Direction Finding (ARDF) using 80 meters and 2 meters. Though it will mainly have simple courses meant to introduce newcomers to this aspect of the hobby, it will be open to all levels of experienced foxhunters.

We're also planning an ARISS contact with an astronaut on the International Space Station (pending successful scheduling), as well as contacts with LEO satellites. Plus, we'll be launching three Pico balloons with WSPR payloads that are expected to drift over the Atlantic during the Jamboree and perhaps around the world long after the Jamboree is over. We'll provide information on the launches and tracking from our website and social media. You can learn about our operation at na1wj.net and <https://groups.io/g/na1wj>, or via the real-time updates on our Facebook and Twitter pages.

NA1WJ Equipment

Stations are equipped with the Icom IC-7300, IC-9700, and ID-5100A, along with hex-beams, Yagis, verticals, and dipoles. But propagation is expected to be challenging.

The station will be staffed approximately 18 hours each day and operating using SSB, CW, and digital modes. Working the world will be a challenge, as we will only have 100 W, but we will be using directional antennas to enhance our signal as much as possible.



NA1WJ Staff

Of the 9,000 adult Scouts on the Jamboree's International Service Team (IST), 40 staff members have been allocated for the Amateur Radio team. All are active dedicated Scouting volunteers and nearly all of them are licensed operators from their home countries, which include the US, Australia, Canada, Chile, Finland, Germany, Liechtenstein, Malaysia, Nepal, the Netherlands, Norway, Taiwan, Japan, Switzerland, and the United Kingdom.

Thank You to Our Supporters

The NA1WJ World Scout Jamboree operation is powered by Icom America radios and repeaters; MFJ rotators, antennas, and headphones; DX Engineering antennas, cables, triplexers, and filters; JK Antennas Yagis; a portable Aluma Tower; GeoChron Digital 4K UHD, and the K2BSA Amateur Radio Association.



How You Can Help

We'll have one staff member operating each station, along with four or more Scouts listening in and getting on the microphone. We need you on the other side, engaging in questions about Scouting and the Jamboree, and commenting on your own experiences in Scouting.

Single stations will work great, but there is a great opportunity to get more Scouts on the air and talking to the NA1WJ station by scheduling a Scout summer camp, Radio Merit Badge Workshop, or a campout to match the days/times of the World Jamboree. For example, the Philmont Amateur Radio Association, K5PSR, will be using Amateur Radio to connect local Scouts on the Philmont Scout Ranch to those at the World Scout Jamboree.

Mark your calendars for July 22 to August 1, 2019, and help us introduce Amateur Radio to the next generation of hams across the globe.

Jim Wilson, K5ND, is a retired communications and publishing executive, serving in those capacities with Boy Scouts of America for more than 2 decades. He is a Scouting volunteer in all things related to Amateur Radio at the national and international levels. He can be reached at k5nd@arri.net.

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Electric Vehicle Power for ARRL Field Day

Janelle Brisbane, NØMTI

Since 1933, ARRL Field Day has given radio operators a chance to demonstrate Amateur Radio's science, skill, and service to the community. Participating groups are encouraged to use power sources other than commercial electric power. In the past, the St. Louis Metro Amateur Radio Emergency Service (ARES) team has experimented with solar power and alternate battery sources. For Field Day 2018, Norm Guittar, the husband of St. Louis Metro ARES member Dolores Guittar, KDØCIV, suggested using his 2013 Chevrolet Volt to power our station.

Setting It Up

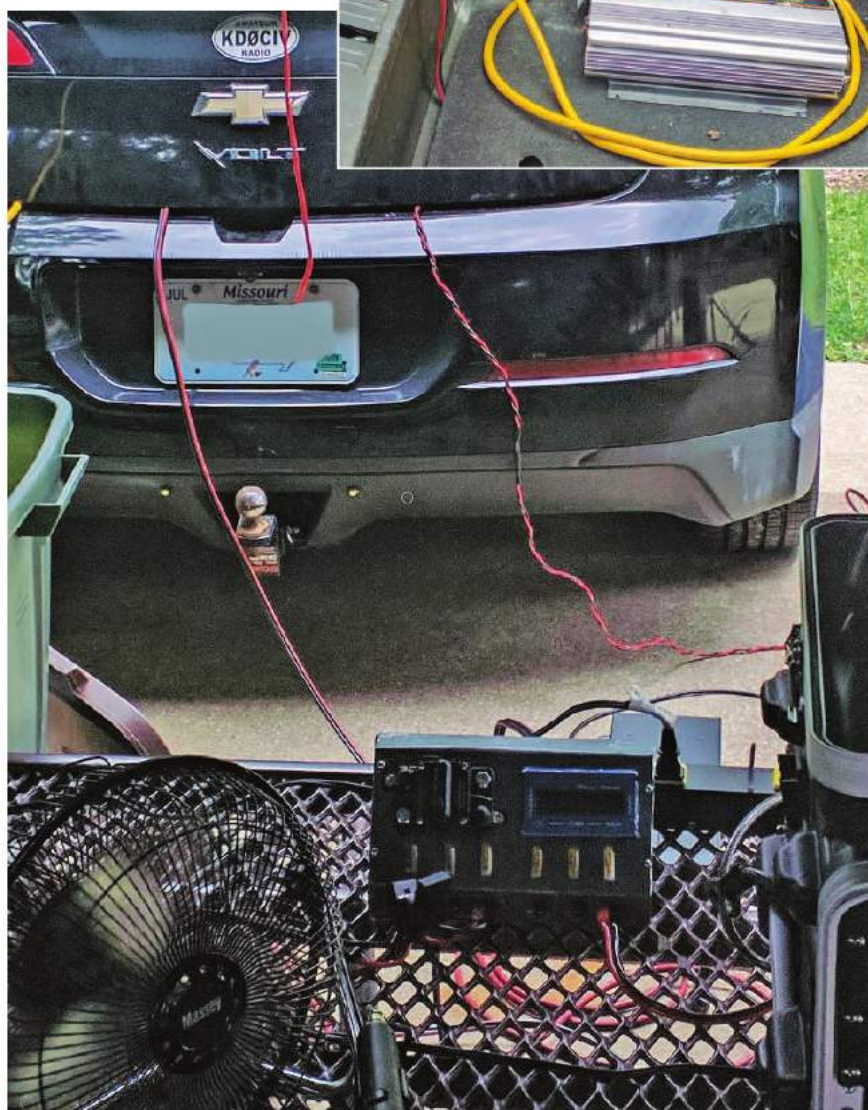
Attached to the 12 V battery under the trunk, Guittar had permanently wired in 300 A Anderson Power-poles® that power an inverter with 2,000 W continuous and 4,000 W peak power. The inverter supplies 120 V power, which would be used to cook our food on Field Day (see Figure 1). To generate power for the radios, Guittar attached additional alligator clips to the battery to route power to a distribution hub that included a wattmeter to monitor output from the car (see Figure 2).

The plan was to leave the car turned on, allowing the electronics to draw from the 12 V battery system. When power levels fell too low, the car would automatically recharge the 12 V system from the main battery pack that ran the car. When the main pack ran low, the car would start the backup generator, better known as the car's engine. But a safety feature of the car required the addition of the wattmeter to ensure radio operations wouldn't be knocked off the air.

A St. Louis ARES team uses ARRL Field Day as the stage for this experimental power setup.

► **Figure 1** — The inverter in the Chevy Volt's trunk to run our 110 V accessories.

▼ **Figure 2** — The electrical distribution from the Chevy Volt.



2018 Field Day Results

St. Louis Metro ARES operated under the call sign NØARS, powered by the Chevrolet Volt. Our 2018 ARRL Field Day team made 516 contacts, with 130 on Morse code or CW, and 386 on voice (see Figure 3).

A total of 44 people attended the event. We covered the event on three social media platforms. Two press releases were put out, and our setup received proclamations from the St. Louis Mayor, the St. Louis County Executive, and the Missouri Governor (see Figure 4).

Technical Challenges

One problem we faced was that, after an extended period of no movement, the car automatically turned off, allowing the 12 V battery to run down. To get around this problem, Norm provided the power meter on the power distribution panel to give a readout of the 12 V system. When the meter fell below 12 V, we had to turn the car back on.

We also had unexpected drains on the battery system. These power parasites, which included the air conditioner, the dome light, the headlights, and the car's dashboard display, tipped the energy usage upward until each was discovered and eliminated as much as possible.

Operating the radios with the varying power available from the 12 V system did impact radio performance. At full power, the radios exhibited some fluctuations and stability issues in output performance. Dropping the radios to about 80 W stabilized their performance when operating with less than 13 V applied.

Total available power at the start of the event was 4.4 kWh. A solar panel provided about 250 W to supplement the 12 V system. The car was restarted three times from when setup began around 9 AM on Saturday through teardown at 11 AM Sunday. The system maintained three radios operating on standby or actively transmitting throughout the event, as well as the appliances needed for cooking.



Figure 3 — The field station owned by Brian Oester, KEØEYA, who operated from the primary voice station for NØARS during Field Day 2018.

Future Modifications

The lessons learned in 2018 will likely result in a few changes for Field Day 2019. The St. Louis Metro ARES group is considering moving the power needs for the logging laptops onto the car's 12 V system as well. The computers could be recharged using their traditional 120 V charging cords connected to the inverter. However, to eliminate any possible power losses, Guittar suggested using Powerpole adapters and powering them directly from the power distribution panel.

Another improvement will be to keep the car off for the majority of the event to avoid the car's systems putting a load on the electrical system. This will require operators to monitor power levels throughout the event, while capping the transmit power on the radios. They appear to be fully functional at 80 W power, and the lowered power levels will draw more consistent performance when the battery levels start to drop off.



Figure 4 — Matt Gabrian from the St. Louis County Office of Emergency Management presented a St. Louis County Proclamation to Peter Brisbane, NØMTI, and Bob Gale, WA4GD. [George Siede, KDØPMW, photo]

The group is also considering a second tent reserved for low-power operations. The group may also have a location in St. Louis city to better showcase the group to served agencies.

Photos by the author unless stated otherwise. Amateur Extra-class licensee Janelle Brisbane, NØMTI, was first licensed in 2013. A former Emmy® Award-winning news producer, she holds a BA in Communications from the University of Northern Iowa, has completed the Professional Development Series with FEMA, and is working toward her Advanced Professional Series with Missouri State Emergency Management Agency. Janelle is the Public Information Officer for the St. Louis Metro Amateur Radio Emergency Service (ARES), a member of the St. Louis Amateur Radio Club (SLARC), and a member of the St. Louis and Suburban Radio Club (SLSRC). She also works on the Halloween Hamfest committee and serves the Cliff Cave VE Team. You can contact Janelle at n0mti.jh@gmail.com.

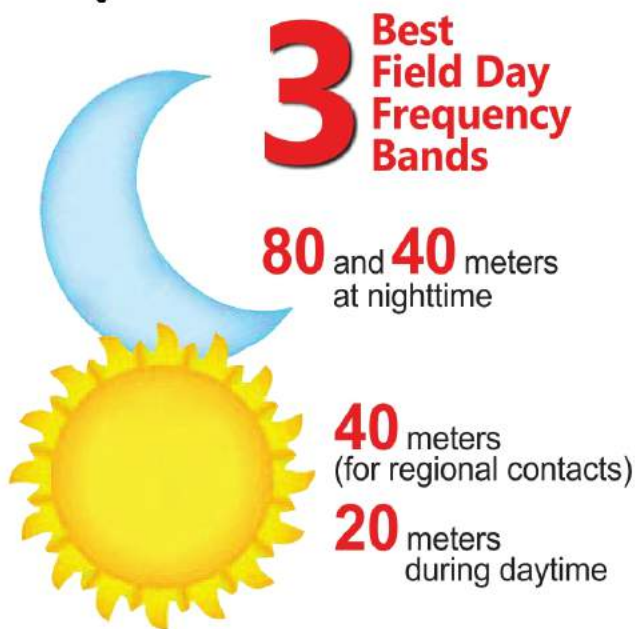
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ARRL Field Day



3 Best Field Day Frequency Bands

80 and **40** meters at nighttime

40 meters (for regional contacts)
20 meters during daytime

Fifteen and 10 meters are unlikely to be productive, although some daytime openings may occur on 15 meters. Be on alert for sudden long-range openings on 6 meters during daylight hours. (According to long-range propagation forecasts.)



Best FM Repeater Satellites for Field Day Bonus Points

SO-50, AO-91, and AO-92

Program these frequencies into your transceiver's memories so that you can compensate for Doppler shifting simply by changing memory channels. Just switch the memory channels for the strongest and least distorted signals.

For satellite pass predictions, see the AMSAT-NA website at www.amsat.org/track/.

SO-50

Time	Transmit (MHz)*	Receive (MHz)
AOS (start)	145.840	436.805
Zenith -3 minutes	145.845	436.800
Zenith (maximum)	145.850	436.795
Zenith +3 minutes	145.855	436.790
LOS (end)	145.864	436.785

AO-91

Time	Transmit (MHz)*	Receive (MHz)
AOS (start)	435.240	145.970
Zenith -3 minutes	435.245	145.965
Zenith (maximum)	435.250	145.960
Zenith +3 minutes	435.255	145.955
LOS (end)	435.250	145.950

AO-92

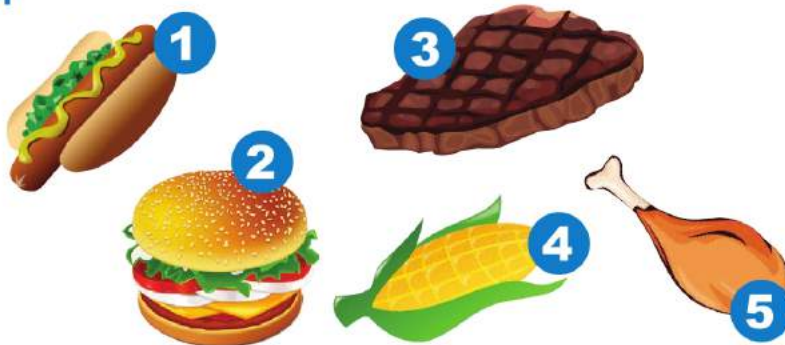
Time	Transmit (MHz)*	Receive (MHz)
AOS (start)	435.340	145.890
Zenith -3 minutes	435.345	145.850
Zenith (maximum)	435.350	145.880
Zenith +3 minutes	435.355	145.875
LOS (end)	435.360	145.870

*Transmit with a 67 Hz CTCSS tone.

5 Most Popular Outdoor Field Day Foods

(According to ARRL social media.)

- 1 Hot dogs
- 2 Hamburgers
- 3 Steak
- 4 Corn on the cob
- 5 BBQ chicken



By the Numbers

Best SSB/CW Satellites

for Field Day Bonus Points

You can work these sats with a minimal setup. Transmit using LSB on the uplink and receive using USB on the downlink. If you transmit at the high end of the passband, the satellites will repeat your signal at the low end of the passband.

	Uplink Passband (LSB)	Downlink Passband (USB)
FO-29	145.900 – 146.000 MHz	435.800 – 435.900 MHz
AO-73	435.150 – 435.130 MHz	145.950 – 145.970 MHz
XW-2A	435.030 – 435.050 MHz	145.665 – 145.685 MHz
XW-2B	435.090 – 435.110 MHz	145.730 – 145.750 MHz
XW-2C	435.150 – 435.170 MHz	145.795 – 145.815 MHz
XW-2D	435.210 – 435.230 MHz	145.860 – 145.880 MHz
XW-2F	435.330 – 435.350 MHz	145.980 – 146.000 MHz

4 Effective Mosquito Repellents

- 1 Off! Deep Woods Insect Repellent V
- 2 Repel Dry Family Insect Repellent
- 3 Sawyer Picaridin Insect Repellent Spray
- 4 Cutter Lemon Eucalyptus Insect Repellent

(According to research conducted by *Consumer Reports*; listed in descending order by overall effectiveness.)



3 Essential Web Pages

1 The Field Day page on ARRL's website has all sorts of resources, including the rules, entry forms, press kit, handouts, logos, PSAs, tips, and more at www.arrl.org/field-day.

2 Find Field Day operations near you with ARRL's Field Day Station Locator — www.arrl.org/field-day-locator.

3 The Field Day Facebook group is the place to promote your activation, exchange tips and solutions, and post photos. Share the fun of Field Day weekend at <https://www.facebook.com/groups/fd2019/>.

Tag your photos with #ARRLFD

6 Tips for Getting the Most Out of 6 Meters on ARRL Field Day

Find SSB activity

You'll hear SSB from 50.125 – 50.200 MHz. If the band is packed, you may hear signals as high as 50.300 MHz.

Check the CW beacons

Per FCC rules, the 50.000 – 50.100 MHz range is CW only. Listen for CW beacons from 50.000 – 50.080 MHz to see if the band is open.

Go digital

Find digital meteor-scatter FSK/MSK activity from about 50.250 – 50.290 MHz, and FT8 users between 50.300 – 50.330 MHz (with a primary focus on 50.313 MHz).

Give DXers space

Stay out of the DX window from 50.100 – 50.125 MHz. It's the courteous thing to do!

Be kind to the calling frequency

If you spin the dial and don't hear many callers, you can call CQ on the 6-meter SSB calling frequency, 50.125 MHz.

Take any resulting contact to a clear frequency above 50.125 MHz. Take care not to monopolize the calling frequency. If the band is open, find a clear frequency above 50.125 and call CQ there.

Know where to beam

If 6 meters is open, point your antenna in the direction of stations you're hearing. If there isn't a big opening, rotating your antenna in different directions every 15 minutes or so will increase your chances of being heard in different parts of the country. Under poor conditions, try to aim your antenna toward large population centers.

QEX Morse Input Design Challenge

The use of a paddle to input text to a personal computer in Morse format seems like a promising solution to the age-related and disabilities-related keyboard handicap. With that in mind, *QEX* — *QST*'s sister publication for experimenters — announces the **QEX Morse Input Design Challenge**.

Official Rules

1) Each entry must appear in the form of a *QEX* construction article that adheres to the *QEX* author's guide and must include:

- Detailed plans (hand drawings are acceptable) and schematics that implement the Morse key input, along with a control box or other adjunct implementing **SHIFT**, **BACKSPACE**, **ENTER**, **TAB**, and other non-Morse characters.
- A list of materials and sources.
- Copy of all software needed to implement the solution.
- Photographs of the completed Morse input solution.

2) The Morse input device and control box adjunct must be an independent device, not an integral part of another device such as a keyboard or a PC.

3) Only one entry per individual or team will be accepted. Entrants must be ARRL members. ARRL Head-quarters staff and commercial manufacturers, or those associated with commercial manufacturers, are not eligible.

Send your entry article electronic files (photos, text, drawings) to the postal address ARRL, 225 Main St., Newington, CT 06111, or via email to qex@arrrl.org with "QEX Morse Input Challenge" and your call sign in the subject line. Do not send zip files, as our email system will reject these.

4) Non-commercial designs only; Morse input devices must be the sole creations of the entrants.

5) Submission deadline: December 1, 2019.

6) Judging and prizes: The first five complete articles received (postmark for postal submissions, email time-stamp for electronic submissions), which satisfy all of the listed criteria,

will be awarded a 1-year subscription, or extension of your subscription to *QEX*, and will be considered for publication in *QEX*. The decisions

of the judges and *QEX* editorial staff are final.

7) Disclaimer: By participating in the competition, you are verifying that you are the owner and producer of the *QEX* Morse Input Challenge device and its software, and that no third-party ownership rights or patents apply to your design. ARRL acquires no rights to your design, but through your participation you are granting ARRL a perpetual, worldwide, non-exclusive, royalty-free right to publish your entry materials in all media now known or hereinafter created, anywhere in the world, for any lawful purpose.



A range of Amateur Radio articles and technical notes are coming up in the May/June 2019 and future issues of *QEX*.

- Maynard Wright, W6PAP, measures the characteristic impedance of coax cable.
- Grant Saviers, KZ1W, designs an antenna that covers the 160-meter band in four switchable band segments.
- Ryan Gedminas, WW6RAG, shows how to hunt and track weather balloons.

■ Stefan Scholl, DC9ST, describes a TDOA system for transmitter localization.

■ George Steber, WB9LVI, turns an arbitrary waveform generator into a WSPR transmitter.

■ Jim Koehler, VE5FP, measures crystal parameters using a vector impedance meter.

■ Scott Roleson, KC7CJ, constructs a receiver step attenuator.

■ John Westmoreland, AJ6BC, describes THEMIS, an experimental GPS-disciplined oscillator.

■ John Stensby, N5DF, calculates coax loss directly from impedance measurements.

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Happenings

ARRL and FCC Sign Memorandum to Implement New Volunteer Monitor Program

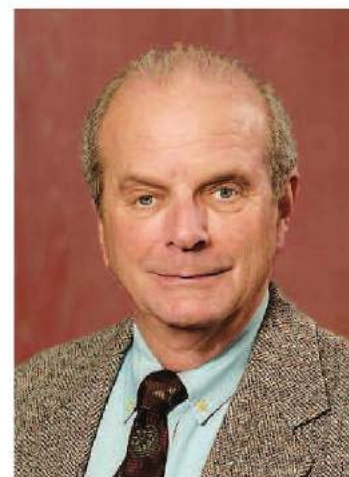
ARRL and the FCC have signed a *Memorandum of Understanding (MOU)* that paves the way to implement the new and enhanced Volunteer Monitor program. The memorandum establishes the Volunteer Monitors as a replacement for the Official Observers (OO) program. Current OOs have been encouraged to participate in the new program.

"We are excited by the opportunity to codify our partnership with the FCC and to work together to achieve our mutual interests of protecting the integrity of our Amateur Radio bands," said ARRL President Rick Roderick, K5UR. "This *Memorandum of Understanding* will serve as the foundation for a new level of partnership on this very important issue."

ARRL has contracted with retired FCC Special Counsel and former Atlantic Division Vice Director Riley Hollingsworth, K4ZDH, to oversee ARRL's role in the development and implementation of the Volunteer Monitor program.

Approved by the ARRL Board of Directors at the July 2018 Board meeting, the new Volunteer Monitor program is a formal agreement between

the FCC and ARRL in which volunteers trained and vetted by ARRL will monitor the airwaves and collect evidence that can be used to correct misconduct or recognize exemplary on-air operation. Cases of flagrant violations will be referred to the FCC by ARRL for action in accordance with FCC guidelines.



Riley Hollingsworth, K4ZDH.

The intent of this program is to re-energize enforcement efforts in the Amateur Radio bands. It was proposed by the FCC in the wake of several FCC regional office closures and a reduction in field staff.

"Under this program, the FCC will give enforcement priority to cases developed by the Volunteer Monitor program, without the delay of ARRL having to refer cases through the FCC online complaint process," Hollingsworth said.

Hollingsworth has identified three phases to the program: Development, Solicitation and Training, and Implementation. He has committed to FCC and ARRL officials to ensure the adequacy of training for the new positions, to review the quality and utility of Volunteer Monitor submissions to the FCC for enforcement actions, and to advocate for rapid disposition of cases appropriately submitted to the FCC.

ARRL officials have estimated that the first Volunteer Monitors will be in place and ready to begin their duties within 6 to 9 months.

“We are excited by the opportunity to codify our partnership with the FCC and to work together to achieve our mutual interests of protecting the integrity of our Amateur Radio bands.” — ARRL President Rick Roderick, K5UR

Petition for Rule Making Calls for "Amateur Digital Mode Transparency"

By mid-April, some 1,100 comments had been filed on a *Petition for Rule Making* (RM-11831) seeking to amend FCC Part 97 rules that require all ham radio digital transmissions to use techniques "whose technical characteristics have been documented publicly." The *Petition*, filed by Ron Kolarik, KØIDT, of Lincoln, Nebraska, expressed concerns that some currently used digital modes are not readily and freely able to be decoded, and it asks the FCC to require all digital codes to use protocols that "can be monitored in [their] entirety by third parties with freely available, open-source software," per §97.113(a)(4).

Kolarik said his petition also aims to reduce levels of amateur-to-amateur interference from automated controlled digital stations (ACDS) on HF. Kolarik wants the FCC to delete §97.221(c), which permits automatic control of digital emissions provided the station "is responding to interrogation by a station under local or remote control, and [n]o transmission from the automatically controlled station occupies a bandwidth of more than 500 Hz." The petition did not call for eliminating ACDS, however. Under current rules, ACDS are allowed in specific subbands.

In his *Petition*, Kolarik maintains that interference from ACDS continues to be "a major problem on the amateur bands." He suggested that an absence of formal complaints may be due to the fact that such stations are "difficult to identify."

The *Petition* also proposed to amend §97.309(a)(4) to ease monitoring of certain digital transmissions. "Without open, over-the-air interception capability for all transmissions in the Amateur Radio spectrum, there is no way to determine if there is commercial or other prohibited, inappropriate content in ongoing communications..." Kolarik's *Petition* asserted. He said problems arise when "protocols and devices used in commercial, government, and marine services are used in the Amateur Service with no adequate means to fully decode transmissions," thwarting any efforts at self-policing of such transmissions. He said simplifying the language "would remove ambiguity about what constitutes 'publicly documented technical characteristics' by requiring any protocol to be freely decodable," and lead to "amateur digital mode transparency, present and future."

Earlier this spring, the FCC accepted comments on three other Amateur

Radio-related *Petitions for Rule Making* (PRM):

♦ Jerry Oxendine, K4KWH, of Gastonia, North Carolina, wants the FCC to clarify that state and localities should have no authority to regulate Amateur Radio with respect to enacting "distracted driving" statutes. In his *Petition for Rule Making*, RM-11833, Oxendine contended that such statutes violate FCC rules on scope and operation of equipment by licensees; violate the intent of the FCC and Congress with respect to Amateur Radio's role in disasters, and hinder emergency operations using mobile equipment.

♦ Edward C. Borghi, KB2E, of Farmington, New York, in RM-11834, petitioned to prohibit vanity applicants from requesting call signs outside of their call sign districts. Exceptions would be made for call signs applied for under rules governing call signs previously held by family members.

♦ Jeffrey Bail, NT1K, of West Springfield, Massachusetts, submitted a similar *Petition*, RM-11835, asking that the FCC give residential preference in competing applications to applicants whose listed FCC address is within the same district/region as the applied call sign.

Department of Defense to Transmit Interoperability Exercise Info via WWV/WWVH

The US Department of Defense (DOD) has begun making use of a provisional time slot on WWV and WWVH to announce upcoming HF military communication exercises and how the Amateur Radio community can become involved in them. Such announcements will occur at 10 minutes past on WWV and at 50 minutes past on WWVH. WWV and WWVH transmit on 2.5, 5, 10, 15, and 20 MHz.

"DOD's use of the broadcast time slot on WWV/WWVH will benefit the MARS program's mission of outreach to the Amateur Radio community,"

said US Army Military Auxiliary Radio System (MARS) Program Manager Paul English, WD8DBY. "The actual messages to be broadcast are coordinated by the DOD Headquarters that the MARS program supports."

The initial announcements were set to coincide with the "Vital Connection" interoperability exercise to be held in Wisconsin in April and May. Future time slots will coincide with the Ohio Vital Connection exercise in June; DOD COMEX 19-3 in August, and the DOD COMEX 19-4 in October. Following the proof of concept this

year, DOD anticipates making use of the WWV/WWVH broadcast time slot full-time, year-round.



The messages will direct listeners to a specified website to provide reception reports and feedback. The reception report will also ask the listener to submit a survey that will be shared among DOD, MARS, and WWV/WWVH personnel. "We want to provide feedback to WWV/WWVH to improve situational awareness of who is using their service and how it's being used, as well as future considerations," English said.

FCC Agrees to 90-Day Pause in Consideration of WT Docket 16-239

It has been almost 6 years since the ARRL requested the FCC to consider changes to the Amateur Radio digital rules in Docket 11-708 and almost 3 years since ARRL filed comments in the resultant proceeding, identified by the FCC as 16-239. The Commission's proposed changes differed from the ARRL's initial filing and caused ARRL to be concerned about possible interference to current users resulting from the deletion of ARRL's requested 2.8 kHz bandwidth limitation. Due to those concerns, ARRL filed comments with the FCC opposing the deletion of the requested bandwidth.

Since ARRL's initial filing, many individuals and groups have commented to the FCC publicly regarding issues and potential consequences they passionately believe are implicated by the FCC's proposals embodied in 16-239/11-708.

Additionally, in the 6 years since the initial filing of 11-708, new information has been presented by individuals and groups who support and oppose the FCC's proposed adoption of 16-239. Due to the time that has elapsed since ARRL's initial digital rules change request, the new information that has become available, and the extent of both support and opposition to the proposed rules change, ARRL asked the FCC to grant a delay in its consideration of the proposed rules change to provide ARRL with the opportunity to clarify the issues and determine whether a consensus can be reached on some or all of the issues raised by the FCC's proceeding. At ARRL's request, the FCC staff has agreed to a 90-day pause in the consideration of WT Docket 16-239.

FCC Cites Amateur Service Rule Violations in Unlicensed Broadcasting Case

An FCC Enforcement Bureau *Notice of Unlicensed Operation (NoUO)* issued last fall to a California

Technician-class licensee for alleged unlicensed FM broadcasting on 95.7 MHz has now been upgraded to a *Notice of Violation (NoV)* that cites violations of the Part 97 Amateur Service rules. The March 15 *NoV* sent to Daryl Thomas, KE6MWS, of Carmichael, also specifically acknowledges Thomas as an Amateur Radio licensee — something not done in

last November's *NoUO*. The FCC Enforcement Bureau warned that it could progress to a *Notice of Apparent Liability for Forfeiture (NAL)*, "if warranted."

Last October 10, an Enforcement Bureau agent responded to a complaint of an unlicensed FM station operating on 95.7 MHz in Carmichael. The agent confirmed by direction-finding techniques that a signal on 95.7 MHz was emanating from a residence, and Thomas subsequently admitted that he was the operator of this station, the FCC said in the *NoUO*. Despite FCC warnings last fall, the transmissions apparently continued into this year.

On January 31, 2019, an FCC Enforcement Bureau agent monitored transmissions on 95.7 MHz from Thomas' station in the FM broadcast band and observed violations of §97.103 — not operating in accordance with FCC rules; §97.113(b) — prohibited transmissions, i.e., broadcasting, and §97.301 — operation outside frequency bands authorized for Amateur Radio. The FCC ordered Thomas to respond in writing within 20 days, explaining each violation and actions taken to correct them and prevent their recurrence.

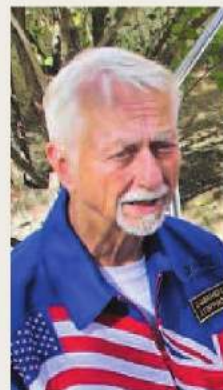


In Brief...

- **Robert B. "Bob" Famiglio, K3RF, of Media, Pennsylvania, is once again the ARRL Atlantic Division Vice Director.** Famiglio, an attorney, was appointed by ARRL President Rick Roderick, K5UR, to fill the vacancy left by the departure of Riley Hollingsworth, K4ZDH. He will serve with Atlantic Division Director Tom Abernethy, W3TOM. Famiglio, who was initially Atlantic Division Vice Director from 2015 until 2017, is a past Eastern Pennsylvania Section Manager and an ARRL Volunteer Counsel. He served as a District Emergency Coordinator from 2006 until 2011. Licensed since 1967, Famiglio is also an electrical engineer and former broadcast station owner and engineer.



- **Former US astronaut and radio pioneer Owen K. Garriott, W5LFL, died April 15 at his home in Huntsville, Alabama.** He was 88. Garriott's ham radio activity ushered in the formal establishment of Amateur Radio in space, first as SAREX (the Shuttle Amateur Radio Experiment), and later as ARISS (Amateur Radio on the International Space Station). While aboard *Spacelab-1* during a 1983 Space Shuttle *Columbia* mission, Garriott thrilled radio amateurs around the world by making the first contacts from space. Thousands of hams listened on 2-meter FM, hoping to hear him or to make a contact. Garriott ended up contacting stations around the globe, among them such notables as the late King Hussein, JY1, of Jordan, and the late US Senator Barry Goldwater, K7UGA.



Public Service

The Cornerstone Exercises: After-Action Report/Improvement Plan, and a Case Study

Last month, we discussed the design and execution of effective exercises, using the model of the 2019 Northern Florida “Viral Duo” exercise sponsored by Alachua County ARES®, the North Florida Amateur Radio Club, and the Santa Fe College Amateur Radio Society.

The 3-hour exercise was conducted in Gainesville on February 2 as part of the Northern Florida Amateur Radio Emergency Communications Conference. The scenario was two-fold: a deadly disease outbreak with the response aggravated by state-sponsored malware that downed the internet, cell service, and public safety communications on a wide scale. Amateur Radio operators were tasked with providing communications for two area shelters, led by strike team leaders reporting to shelter managers and a central Amateur Radio Service management team.

This month, we’ll discuss the “Viral Duo” exercise architects’ after-action report and improvement plan (AAR/IP) in the context of the Federal Emergency Management Agency’s (FEMA) vision of effectiveness for this critical portion of the overall result report.¹

The Florida exercise planners used FEMA’s published Exercise Evaluation Guides (EEGs) to accomplish several goals: to streamline data collection; enable assessments of the participant and team efforts;

capability developments, and overall preparedness gains.² Let’s see how they did.

Viral Duo After-Action Report/Improvement Plan

The AAR/IP, produced by the “Viral Duo” exercise architects and executors, includes an overview of the exercise, the incident briefing provided to team leaders and participants, the incident radio communications plan, medical plan, master scenario event list with specific objectives — all formatted on the appropriate ICS forms — initial tasks, rules of the game, exercise injects (contrived problems/issues presented to players to deal with in real time), and most important, the results

analysis. Results were assessed in terms of objectives categorized by core capabilities and eventually used as the basis for performance improvements.

Analysis of Core Capabilities

The report’s summary table (see Table 1) presented exercise objectives matched to core capabilities, with specific performance ratings based on observations during the exercise and determined by the evaluation team. There were four rating classifications: Performed without challenges (P); Performed with Some Challenges (S); Performed with Major Challenges (M), and Unable to Perform (U). For example, an objec-

Safety First

The first priority is always safety, which, appropriately, was covered at the outset of the results section of the “Viral Duo” AAR/IP: the exercise had been conducted with no known injuries, but the Safety Officer noted the importance of better marking antenna wires and ropes.

The “hotwash” — the immediate post-exercise discussion among participants and leaders — was covered, along with the participants’ individual written evaluations, which showed an enthusiastic response and overall satisfaction with exercise conduct.

The communications log (ICS form 309) was examined with particular attention given to transferred messages, including 30 voice and 48 digital, encompassing both informal and formal message traffic. An in-depth analysis of the messages and reporting requirements was conducted; for example, the following assessment was noted: “Email message notifying the FLSWIC [Florida Statewide Interoperability Coordinator] that Shelter #26 had one resident with a fever and painful neck, and was requesting assistance. This was a great example of an inject to the manager of Shelter #26, which evidently was passed to the Strike Team 2, and from there to the FARPOC [Florida Amateur Radio Point of Contact] and from the FARPOC to the FLSWIC — excellent work of moving critical information up the chain.”

Table 1 — Sample of Summary Table of Core Capability Performance

Objective	Core Capability	Performed without Challenges (P)	Performed with Some Challenges (S)	Performed with Major Challenges (M)	Unable to be Performed (U)
Programming VHF transceivers	Transact multiple types of information by radio	P			
Operate radios throughout the exercise without utility power	Provide electrical power for radios independent of commercial utilities		S		

tive was having the “ability to read and understand ICS-201, ICS-205, ICS-205A forms,” with its matching core capability being “functioning in an ICS Framework.” As reported in the “Viral Duo’s” summary table, the evaluation team determined this objective and corresponding capability earned an “S” rating. As another example, the objective of “deploying a VHF antenna” with the matching core capability being “creating antennas in a devastated deployment location” was met, receiving a “P” rating from the evaluation team. Other objectives (with ratings) included, but were not limited to, the following:

- Operating radios throughout the exercise without utility (commercial) power (S)
- Operating within a VHF FM net (P)
- Connecting to Winlink gateways (S)
- Transacting email in the Winlink system (S)
- Programming VHF transceivers (P)
- Transacting voice message traffic (S)

Strengths and Weaknesses, Areas for Improvement Identified

Tasks performed well, improvements indicated, and analyses were appropriately discussed. For example, one exercise objective was to “connect to Winlink gateways” (“S” rating), with

strengths and areas for improvement noted for the core capability of “transacting multiple types of information by radio.” The report stated one strength in this category being that the participants have a high capability level. Evaluators noted, “Multiple participants succeeded well at this, transferring dozens of messages of formal traffic.” Among areas for improvement to achieve the full capability level was, “Participants would be well advised to obtain higher speed modems, including VARA and PACTOR, for true disaster preparation.”

This analysis followed: “This was an area of strength in the participants of three out of four teams, with urgent inject material well communicated using WINMOR and other soundcard modes. PACTOR speeds are often twice that of soundcard modes, and connections are often made with far less signal required. [Participants] may wish to move to this preeminent digital protocol while keeping their competency at soundcard modes.”

An Improvement Plan summary table follows the in-depth analysis. The AAR/IP can be found online at <https://qsl.net/nf4rc/2019Conference/CreateSpaceViralDuoAARIP1.2BlackInk.pdf>.

Personal Conclusions

I played a small part in this exercise as a communicator on Strike Team 1 at Shelter #10. This exercise brought

to life the material from the many FEMA Independent Study courses, the lessons from the ARRL’s *Introduction to Emergency Communications* course, and the DHS/OEC’s Auxiliary Communications (AUXCOMM) 3-day course. Every participant, from the exercise planners and leaders to the small players, met the challenges of setting up antennas, running cables and powering on radios, getting on the air quickly, and passing messages among the two shelters and the central management team stations, all while operating under the Incident Command System. The multiple injects of likely real-world problems and issues to be resolved on the fly ratcheted up the stress — and the fun!

Thanks go to the conference/exercise leaders and my fellow communicators in the trenches who made the experience so valuable, not only to the radio amateurs and ARES members involved, but also to the stakeholding agencies, including the state and local county EMAs, and the Red Cross. The exercise contributed to a better, more prepared amateur community in Florida, a disaster-prone region.

Notes

¹<https://preptoolkit.fema.gov/web/hseep-resources/evaluation>

²<https://preptoolkit.fema.gov/web/hseep-resources/eeqs>

Classic Radio

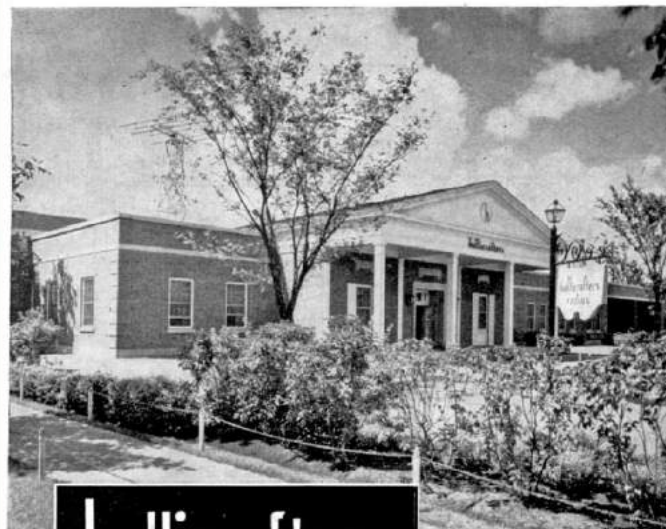
The Hallicrafters S-76 Receiver

The Hallicrafters S-76 was the first receiver to use a very low-frequency last intermediate frequency (IF) to facilitate getting good selectivity with conventional inductor/capacitor components. It sold for \$169.50 when it came out (see the lead photo). Produced from 1951 – 1954, the S-76 used a 50 kHz last IF, which was well below the more common 455 kHz IF at the time. The S-76 was a dual-conversion receiver using a 1650 kHz first IF, which helped provide better image rejection than a single 455 kHz IF would. Hallicrafters and other manufacturers used the low-frequency IFs with good results for some time. The later Hallicrafters SX-101, SX-117, and other models still used the 50 kHz final IF.

The S-76 covered the AM broadcast band from 535 kHz to 1580 kHz and general coverage short-wave from 1720 kHz to 32 MHz with ham bandspread. The gap was due to the use of 1650 kHz as the first IF frequency. The ham bandspread dial added 15 meters during the production life of the S-76, as 15 meters became a ham band during the early 1950s.

Distinctive S-Meter

The most distinctive feature of the Hallicrafters S-76 was the very large S-meter on the front panel. The S-meter only operated on AM reception, as the S-76 did not have a product detector for SSB and CW, and had no automatic gain control (AGC), except when receiving AM. Product detectors were not found on any ham radio receivers in 1951, when the S-76



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An original ad from the April 1951 issue of QST for the Hallicrafters S-76, with its famous "giant" S-meter.

came out. SSB was virtually unknown for ham radio operation at the time. Collins Radio's A-line and V-line radios operated on CW and AM only. The company didn't begin to promote SSB until about 5 years later. Central Electronics was ready to bring out their first SSB transmitters and receiving adapters in 1952, one year after the S-76 came out.

CW reception was handled by using a BFO to produce a beat note with the CW signal. Getting good-quality reception of CW signals was much less difficult than getting good-quality audio with SSB signals. The selectivity offered by the S-76 provided improved results on CW signals and was easier to get good results from than the single crystal filters offered as a selectivity tool on many high-end receivers in the early 1950s.

Tubes

The Hallicrafters S-76 used a mixture of seven-pin miniature tubes and octal-based tubes. A gaseous VR-150 octal regulator tube was used to regulate the plate voltage for the local oscillator to improve stability in light of variations in the 115 V ac power line. The high voltage to operate the vacuum-tube circuitry was rectified using a 5Y3GT octal tube. Octal tubes were used in the audio preamplifier, audio output stage, and the BFO oscillator. All the tubes in the RF and IF stages were seven-pin miniature types.

The S-76 used an RF amplifier stage using a 6CB6 pentode. The first mixer and the tunable local oscillator used two separate tubes — a 6BE6 as the mixer and a 6C4 triode as the tunable oscillator. Two 6BA6 pentodes were used as 50 kHz IF amplifiers. As with most Hallicrafters receivers, an external loudspeaker was required. Hallicrafters recommended the large model R-46 speaker, which was also recommended for the premium model SX-71.

Design Influence

The S-76's revolutionary use of the 50 kHz last IF led to other manufacturers adopting a similar design. R.L. Drake Company started producing receivers specific to ham radio in 1957, and made all their early receivers using a final IF of 50 kHz. The historic Drake 1A, along with the 2A, 2B, 2C, and the popular 4-line family of receivers all used a 50 kHz final IF in a triple-conversion design to provide very good, versatile selectivity for CW, SSB, and AM reception. Several ham radio manufacturers — including Barker & Williamson and Central Electronics — produced receiving adapters to make older high-quality receivers work better receiving SSB and CW.

Hammarlund created the HC-10 receiving adapter, which used a 60 kHz last IF. Hammarlund also used a last IF of 60 kHz on their HQ-160, HQ-170, and HQ-180 receivers. National used a similar triple-conversion design on their NC-300 and NC-303 receivers, with a final IF of 80 kHz. RME used a 57 kHz low-frequency IF on their attractive model 6900. Collins Radio seemed to avoid using a low-frequency IF, relying instead on their own invention — the patented mechanical filter often working at 455 kHz — to provide excellent selectivity. The crystal lattice filter soon became the most popular means of getting very good selectivity for most manufacturers by the mid-1960s. However, Collins continued to use their mechanical filter and Drake stuck to low-frequency IFs for their receivers.

Strays

Following Radio to Space, College, and Beyond

Seventeen-year-old Laura Floyd, KC3GWL, recently finished her high school research project, which involved using radio telescopes to try and detect exoplanets — planets beyond our own solar system. The 4-year project culminated in Laura's front yard being filled with radio telescopes for 2 weeks. Her research was funded in part by her local Amateur Radio club, the Warminster Amateur Radio Club, K3DN, of Warminster, Pennsylvania. Laura's findings will be presented at Penn State in May.

Laura is also part of a group of students invited to present their research about a radiation-proof vest to NASA this spring for potential use on the International Space Station. In the fall, she will attend Valparaiso University on a full scholarship, majoring in Engineering and Physics, in addition to receiving a Secondary Education teaching certification and a German language major.



Laura Floyd, KC3GWL, in her yard with her radio telescopes. [Sarah Floyd, photo]

Contest Corral

June 2019

Check for updates and a downloadable PDF version online at www.arrl.org/contests.

Refer to the contest websites for full rules, scoring information, operating periods or time limits, and log submission information.

Start - Finish		Date-Time		Bands	Contest Name	Mode	Exchange	Sponsor's Website
Date	Time	Date	Time					
1	0000	2	0200	1.8-28	PVRC Reunion	CW Ph	PVRC Member: 1st year of membership, name, SPC, call sign when joined PVRC; non-member: name, SPC	pvrc.org/reunion
1	0000	2	2359	28	10-10 International Open Season PSK Contest	Dig	Name, SPC, mbr	www.ten-ten.org
1	0400	2	2000	3.5-28	DigiFest	Dig	RST, 4-char grid square	www.mixw.net
1	0600	1	0800	7-14	Wake-Up! QRP Sprint	CW	RST, serial, suffix of previous QSO	qrp.ru/contest/wakeup
1	1200	2	1200	3.5-28	SEANET Contest	CW Ph	RS(T), serial	www.seanet2019.com
1	1300	2	1300	50	UKSMG Summer Contest	CW Ph Dig	RST, serial, 6-char grid square	uksmg.org
1	1400	2	0200	1.8-144	Kentucky QSO Party	CW Ph Dig	RS(T), county or SPC	www.kyqsoparty.org
1	1500	2	1459	1.8-28	IARU Region 1 Field Day, CW	CW	RST, serial	darc.de/der-club/referate/conteste
1	1500	2	1500	7-50	Dutch Kingdom Contest	CW Ph	RS(T), serial	dkars.nl
1	1500	2	1500	1.8-28	RSGB National Field Day	CW	RST, serial	www.rsgbcc.org/hf
4	0100	4	0300	3.5-28	ARS Spartan Sprint	CW	RST, SPC, power	arsqrp.blogspot.com
6	1700	6	2100	28	NRAU 10-Meter Activity Contest	CW Ph Dig	RS(T), 6-char grid square	nrau.net/activity-contests
6	1900	6	2100	1.8-28	SKCC Sprint Europe	CW	RST, SPC, name, mbr or power	www.skccgroup.com
7	1900	7	1959	3.5-7	HA3NS Sprint Memorial Contest	CW	RST, mbr or "NM"	radioamator.honlapepites.hu
8	0000	9	1559	3.5-28	DRCG WW RTTY Contest	Dig	RST, CQ zone	www.drcg.de/drcgww
8	0600	9	0600	3.5-28	VK Shires Contest	CW Ph	RS(T), VK shire or CQ zone	wia.org.au/members/contests
8	1100	8	1300	14-21	Asia-Pacific Sprint, SSB	Ph	RS, serial	jsfc.org/apsprint/aprile.txt
8	1200	9	1200	3.5-28	Portugal Day Contest	CW Ph	RS(T), CT district or serial	rep.pt/portugal_day_contest
8	1200	9	2359	1.8-50	SKCC Weekend Sprintathon	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
8	1500	9	1500	3.5-28	GACW WWSA CW DX Contest	CW	RST, CQ zone	www.wwsatest.org
8	1600	9	1600	50	REF DDFM 6-Meter Contest	CW Ph	RS(T), serial, 4-char grid square	concours.r-e-f.org
8	1800	10	0259	50 and up	ARRL June VHF Contest	CW Ph Dig	4-char grid square	www.arrl.org/june-vhf
9	1700	9	2200	All	Cookie Crumble QRP Contest	CW Ph Dig	RS(T), SPC, cookie #, name	w3atb.com/cookie-crumble
10	0000	10	0200	1.8-28	4 States QRP Group Second Sunday Sprint	CW Ph	RS(T), SPC, mbr or power	www.4sqrp.com
10	1900	10	2030	3.5	RSGB 80-Meter Club Championship, Data	Dig	RST, serial	www.rsgbcc.org/hf
12	0030	12	0230	3.5-14	NAQCC CW Sprint	CW	RST, SPC, mbr or power	naqcc.info
15	0000	16	2359	50	SMIRK Contest	CW Ph	Mbr, 4-char grid square	www.smirk.org/contest.html
15	0000	16	2359	1.8-28	All Asian DX Contest, CW	CW	RST, 2-digit age	www.jarl.org/English
15	1200	16	1159	3.5-28	Ukrainian DX Classic RTTY Contest	Dig	RST, 2-letter oblast or serial	urdx.org/rtty/eng.htm
15	1200	16	1200	1.8-28	ARR BPSK63 Contest	Dig	RST, serial	ct1arr.org
15	1400	15	1800	144-432	AGCW VHF/UHF Contest	CW	RST, serial, power class, 6-char grid	agcw.org/index.php/en
15	1400	16	1400	50	IARU Region 1 50 MHz Contest	CW Ph	RS(T), serial, 4-char grid	concours.r-e-f.org
15	1500	16	1500	1.8	Stew Perry Topband Challenge	CW	4-char grid square	www.kkn.net/stew
15	1600	16	0400	3.5-28	West Virginia QSO Party	CW Ph Dig	RS(T), county or SPC	qsl.net/wvsarc/wvqp/wvqp.html
15	1800	15	1959	1.8-50	Feld Hell Sprint	Dig	RST, mbr, SPC, grid	sites.google.com/site/feldhellclub
15	1800	15	2359	3.5, 7, 14, 18, 21, 24, 28, 14	ARRL Kids Day	Ph	Name, age, QTH, favorite color	www.arrl.org/kids-day
16	0800	16	1400	50	WAB 50 MHz Phone	Ph	RS, serial, WAB square or country	wab.intermip.net
17	0100	17	0300	1.8-28	Run for the Bacon QRP Contest	CW	RST, SPC, mbr or power	qrpcontest.com/pigrun
19	1900	19	2030	3.5	RSGB 80-Meter Club Championship, CW	CW	RST, serial	www.rsgbcc.org/hf
20	0030	20	0230	3.5-14	NAQCC CW Sprint	CW	RST, SPC, mbr or power	naqcc.info
22	1200	23	1200	3.5-28	Ukrainian DX DIGI Contest	Dig	RST, 2-letter oblast or serial	www.izmail-dx.com
22	1200	23	1200	1.8-28	His Majesty King of Spain Contest, SSB	Ph	RS, EA province or serial	concursos.ure.es/en
22	1800	23	2100	All	ARRL Field Day	CW Ph Dig	Number of xmters, operating class, ARRL/RAC section or "DX"	www.arrl.org/field-day
24	1300	25	0400	1.8-28	QCX Challenge	CW	RST, name, SPC, rig	www.qrp-labs.com/party.html
26	0000	26	0200	1.8-28	SKCC Sprint	CW	RST, SPC, name, mbr or power	www.skccgroup.com
27	1900	27	2030	3.5	RSGB 80-Meter Club Championship, SSB	Ph	RS, serial	www.rsgbcc.org/hf
29	0000	29	2359	1.8-50	Feld Hell Sprint	Dig	RST, mbr, SPC, grid	sites.google.com/site/feldhellclub
29	0000	29	2359	7-28	Battle of Carabobo International Contest	CW Ph Dig	RS(T), YV state or serial	www.radioclubvalenciaac.org.ve
29	0600	29	1700	3.5-28	UFT QRP Contest	CW	RST, QRP/QRO, mbr or "NM"	uft.net/reglement/eng.pdf

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 WATBNM 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, WATBNM, in providing this service.

2018 ARRL November Sweepstakes — Phone

Last year's ARRL November Sweepstakes phone weekend was held November 17 – 19, 2018.

Top Ten

Single Operator, High Power

K5TR	355,738
W7RM (W7WA, op)	320,380
WC6H	280,374
NC11 (K9PW, op)	263,276
W2RQ	253,814
KD4D	250,328
N4OX	243,356
K5TA	241,032
K2PM	217,136
N9RV	215,496

Single Operator, Low Power

W4AAA (KK9A, op)	204,180
W0EWD	191,224
N4PN	178,284
N4OO	174,300
NP4G	163,016
AC0W	134,460
K9WZB	127,428
K9ZO	123,172
VE4VT	122,958
VE5SF	120,682

Single Operator, QRP

ND0C	48,048
W6YX (N7MH, op)	46,136
N5EE	43,450
VE6EX	31,144
KA8SMA	28,016
AA7V	25,650
KJ2G	18,144
N1XIH (GW0NVN, op)	16,714
N7JI	16,200
N7FLT	14,706

Single Operator, Unlimited, High Power

KH7XS (K4XS, op)	329,842
VY2TT	285,196
N5ZC	281,702
W7RN (WX5S, op)	279,378
K9CT	264,604
K3MM	248,004
W1SJ	246,178
N0XR	240,534
W6PZ	224,024
W3IDT	212,872

Single Operator, Unlimited, Low Power

WB2P	186,252
VE3PJ	117,588
KK7AC	104,814
KS4AA	93,440
W9XT	90,138
K5KJ	82,336
K0ACP	72,090
W9QL	70,356
K0NEB	69,822
K2DFC	67,732

Multioperator, Single Transmitter, High Power

K6AM	323,036
W0NO	302,784
K4OV	302,286
W0SD	280,706
W5WZ	279,292
W1XX	270,248
NV9L	242,858
ND8DX	230,076
N3OC	222,772
KR0P	216,132

Multioperator, Single Transmitter, Low Power

K7IR	179,908
K5KU	164,164
WW4LL	152,222
WZ8P	148,570
N0AT	145,632
K9KE	106,240
K0UK	90,200
WX4W	87,482
WR5O	86,994
K9DA	80,032

School Club

K0HC	196,876
W4AQL	169,818
W0EEE	69,700
KF5CRF	33,824
W8EDU	32,562
W9JWC	30,932
K5LSU	7,426
VE9UNB	6,952



Thirteen-year-old Aidan helped his grandfather, Albert Jr., KI9A, during the 2018 November Sweepstakes (phone weekend). During the contest, Aiden's first contact was with his great-grandpa, Albert Sr., AD9P. [Albert Schneebeil, Jr., KI9A, photo]

Full Results Online

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

The 2019 ARRL November Sweepstakes phone weekend will be held November 16 – 18, 2019.

Plaque Sponsors

ARRL is pleased to award a Sweepstakes Plaque to the Overall and Division Leaders in each category, thanks to Icom America and clubs and individuals who sponsor these awards. For more information on plaque sponsorship or to order a duplicate plaque, contact the ARRL Contest Branch at 860-594-0232 or contests@arrl.org. Plaques cost \$75, which includes all shipping charges.

Winner	Division	Category	Sponsor	Winner	Division	Category	Sponsor
K5TR	Overall	Single Operator, High Power	Icom America	N7WY	Midwest	Single Operator, High Power	Icom America
W4AAA (K49A, op)				W0EWD	Midwest	Single Operator, Low Power	Icom America
	Overall	Single Operator, Low Power	ARRL Contest Branch – Ken Adams, K5KA, Memorial	N5SEZ	Midwest	Single Operator, QRP	Icom America
			Icom America	N0XR	Midwest	Single Operator Unlimited, High Power	Icom America
ND0C	Overall	Single Operator, QRP	Icom America	K0NEB	Midwest	Single Operator Unlimited, Low Power	Icom America
KH7XS (K4XS, op)				W0NO	Midwest	Multioperator, High Power	Icom America
	Overall	Single Operator Unlimited, High Power	Icom America	K0TSA	Midwest	Multioperator, Low Power	Icom America
WB2P	Overall	Single Operator Unlimited, Low Power	Icom America	K0HC (W0BH, op)	Midwest		
K6AM	Overall	Multioperator, High Power	Icom America		Midwest	School Club	Icom America
K7IR	Overall	Multioperator, Low Power	Icom America	NC1I (K9PW, op)			
K0HC (W0BH, op)	Overall	School Club	Robert Tuttle, N8YXR, and Jennie Tuttle, KC0RBV		New England	Single Operator, High Power	Icom America
			Icom America	KC1SQ	New England	Single Operator, Low Power	Icom America
KD4D	Atlantic	Single Operator, High Power	Icom America	KJ2G	New England	Single Operator, QRP	Icom America
NM2O	Atlantic	Single Operator, Low Power	Potomac Valley Radio Club	W1SJ	New England	Single Operator Unlimited, High Power	Icom America
			Icom America	W1HS	New England	Single Operator Unlimited, Low Power	Icom America
WK3A	Atlantic	Single Operator, QRP	Icom America	W1XX	New England	Multioperator, High Power	Icom America
K3MM	Atlantic	Single Operator Unlimited, High Power	Icom America	WA1BXY	New England	Multioperator, Low Power	Icom America
WB2P	Atlantic	Single Operator Unlimited, Low Power	Icom America	W1YK	New England	School Club	Icom America
N3OC	Atlantic	Multioperator, High Power	Icom America	W7RM (W7WA, op)			
N03U	Atlantic	Multioperator, Low Power	Icom America		Northwestern	Single Operator, High Power	Icom America
K0PJ	Central	Single Operator, High Power	Society of Midwest Contesters	N7LOX	Northwestern	Single Operator, Low Power	Icom America
			Icom America	N7JI	Northwestern	Single Operator, QRP	Icom America
K9ZO	Central	Single Operator, Low Power	Society of Midwest Contesters	K7RL	Northwestern	Single Operator Unlimited, High Power	Icom America
			Icom America	W7ZRC	Northwestern	Single Operator Unlimited, Low Power	Icom America
AF9J	Central	Single Operator, QRP	Icom America	K21W	Northwestern	Multioperator, High Power	Icom America
K9CT	Central	Single Operator Unlimited, High Power	Society of Midwest Contesters	K7IR	Northwestern	Multioperator, Low Power	Icom America
			Icom America	WC6H	Pacific	Single Operator, High Power	Icom America
W9XT	Central	Single Operator Unlimited, Low Power	Society of Midwest Contesters	WB6POT	Pacific	Single Operator, Low Power	Icom America
			Icom America	W6YX (N7MH, op)			
NV9L	Central	Multioperator, High Power	Icom America		Pacific	Single Operator, QRP	Icom America
K9KE	Central	Multioperator, Low Power	Icom America	KH7XS (K4XS, op)			
W9JWC	Central	School Club	Icom America		Pacific	Single Operator Unlimited, High Power	Icom America
K0IDX	Dakota	Single Operator, High Power	Minnesota Wireless Association – in memory of Tod Olson, K0TO		Pacific	Single Operator Unlimited, Low Power	Icom America
			Icom America	K6GHA	Pacific	Multioperator, High Power	Icom America
AC0W	Dakota	Single Operator, Low Power	Minnesota Wireless Association – in memory of Jim Dokmo, K0FVF	NW6P	Pacific	Multioperator, Low Power	Icom America
			Icom America	N6ACL	Pacific	Single Operator, High Power	Icom America
ND0C	Dakota	Single Operator, QRP	Icom America	K4ZW	Roanoke		
K0CN	Dakota	Single Operator Unlimited, High Power	Minnesota Wireless Association	W4AAA (K49A, op)			
			Icom America		Roanoke	Single Operator, Low Power	Icom America
K4IU	Dakota	Single Operator Unlimited, Low Power	Minnesota Wireless Association	N4ZAK	Roanoke	Single Operator, QRP	Icom America
			Icom America	NN3W	Roanoke	Single Operator Unlimited, High Power	Icom America
W0SD	Dakota	Multioperator, High Power	Icom America	KS4AA	Roanoke	Single Operator Unlimited, Low Power	Icom America
N0AT	Dakota	Multioperator, Low Power	Icom America	K4OV	Roanoke	Multioperator, High Power	Icom America
K0EJ	Delta	Single Operator, High Power	Icom America	N2VA	Roanoke	Multioperator, Low Power	Icom America
WD5DJW	Delta	Single Operator, Low Power	Icom America	K5TA	Rocky Mountain	Single Operator, High Power	Icom America
N5EE	Delta	Single Operator, QRP	Icom America	KB0VHA	Rocky Mountain	Single Operator, Low Power	Icom America
KC4NX	Delta	Single Operator Unlimited, High Power	Icom America	N1XIH	Rocky Mountain	Single Operator, QRP	Icom America
WB0RJR	Delta	Single Operator Unlimited, Low Power	Icom America	K7UT	Rocky Mountain	Single Operator Unlimited, High Power	Icom America
W5WZ	Delta	Multioperator, High Power	Icom America	N7MZW	Rocky Mountain	Single Operator Unlimited, Low Power	Icom America
K5KU	Delta	Multioperator, Low Power	Icom America	NN5K	Rocky Mountain	Multioperator, High Power	Icom America
K5LSU	Delta	School Club	Icom America	K0UK	Rocky Mountain	Multioperator, Low Power	Icom America
K2PM	Great Lakes	Single Operator, High Power	Icom America	N4OX	Southeastern	Single Operator, High Power	Icom America
WB3WKQ	Great Lakes	Single Operator, Low Power	Icom America	N4PN	Southeastern	Single Operator, Low Power	Icom America
KA8SMA	Great Lakes	Single Operator, QRP	Icom America	KJ4M	Southeastern	Single Operator, QRP	Icom America
W8MJ	Great Lakes	Single Operator Unlimited, High Power	Icom America	KT4Q	Southeastern	Single Operator Unlimited, High Power	Icom America
K0ACP	Great Lakes	Single Operator Unlimited, Low Power	Icom America	K4QY	Southeastern	Single Operator Unlimited, Low Power	Icom America
ND8DX	Great Lakes	Multioperator, High Power	Icom America	N4SVC	Southeastern	Multioperator, High Power	Icom America
WZBP	Great Lakes	Multioperator, Low Power	Icom America	WW4LL	Southeastern	Multioperator, Low Power	Icom America
W8EDU	Great Lakes	School Club	Icom America	W4AQL	Southeastern	School Club	Icom America
				W6AFA	Southwestern	Single Operator, High Power	Icom America
W2RQ	Hudson	Single Operator, High Power	Icom America	W1PR	Southwestern	Single Operator, Low Power	Icom America
K52G	Hudson	Single Operator, Low Power	Icom America	AA7V	Southwestern	Single Operator, QRP	Icom America
KD2RD	Hudson	Single Operator Unlimited, High Power	Icom America	W6TK	Southwestern	Single Operator Unlimited, High Power	Icom America
K2DFC	Hudson	Single Operator Unlimited, Low Power	Icom America	KK7AC	Southwestern	Single Operator Unlimited, Low Power	Icom America
N2NC	Hudson	Multioperator, High Power	Icom America	K6AM	Southwestern	Multioperator, High Power	Icom America
NY6DX	Hudson	Multioperator, Low Power	Icom America	AB7YQ	Southwestern	Multioperator, Low Power	Icom America
				K5TR	West Gulf	Single Operator, High Power	Icom America
				WD5K	West Gulf	Single Operator, Low Power	Icom America
				AC5D	West Gulf	Single Operator, QRP	Icom America
				N5ZC	West Gulf	Single Operator Unlimited, High Power	Icom America
				K5KJ	West Gulf	Single Operator Unlimited, Low Power	Icom America
				KG5VK	West Gulf	Multioperator, High Power	Icom America
				WR5O	West Gulf	Multioperator, Low Power	Icom America
				KF5CRF	West Gulf	School Club	Icom America
				VE3YT	Canada	Single Operator, High Power	Icom America
				VE4VT	Canada	Single Operator, Low Power	Icom America
				VE6EX	Canada	Single Operator, QRP	Icom America
				VY2TT	Canada	Single Operator Unlimited, High Power	Icom America
				VE3PJ	Canada	Single Operator Unlimited, Low Power	Icom America
				VA2CZ	Canada	Multioperator, Low Power	Icom America
				VE9UNB	Canada	School Club	Icom America

Affiliated Club Competition

Club	Score	Entries
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Unlimited

Potomac Valley Radio Club	16,694,489	281
Society of Midwest Contesters	7,414,944	136
Yankee Clipper Contest Club	4,637,618	78
Minnesota Wireless Assn.	4,251,602	110
Frankford Radio Club	4,238,734	67
Northern California Contest Club	2,404,492	56

Medium

Mother Lode DX/Contest Club	4,139,454	48
Mad River Radio Club	2,650,330	43
Southern California Contest Club	2,550,090	37
Arizona Outlaws Contest Club	2,442,818	35
DFW Contest Group	2,240,248	35
Contest Club Ontario	2,226,064	43
Florida Contest Group	2,209,914	33
Western Washington DX Club	1,738,218	26
Tennessee Contest Group	1,548,996	28
Alabama Contest Group	1,478,500	19
Central Texas DX and Contest Club	1,321,838	18
South East Contest Club	1,029,556	17
Big Sky Contesters	931,920	12
Kentucky Contest Group	885,230	19
North Coast Contesters	859,972	13
Grand Mesa Contesters of Colorado	849,788	16
CTRI Contest Group	827,322	13
Hudson Valley Contesters and DXers	801,438	15
North Texas Contest Club	772,914	9
Georgia Contest Group	688,392	10
Willamette Valley DX Club	661,820	17
Niagara Frontier Radiosport	651,620	16
Sussex County ARC	577,216	5
Kansas City Contest Club	553,540	6
Orca DX and Contest Club	466,948	8
Radiosport Manitoba	342,864	5
Order of Boiled Owls of New York	276,566	9
Northeast Wisconsin DX Assn.	237,400	3
Delara Contest Team	197,722	3
Alberta Clippers	192,008	4
South Jersey Radio Assn.	188,576	9
Maritime Contest Club	188,186	7
Rochester (NY) DX Assn.	181,052	7
Sierra Foothills ARC	166,754	6
Swamp Fox Contest Group	161,618	7
Allegheny Valley Radio Assn.	159,990	4
Badger Contesters	133,388	3
Driftless Zone Contesters	126,558	4
Northeast Maryland Amateur Radio Contest Society	115,682	6
Texas DX Society	87,822	3
Mississippi Valley DX/Contest Club	65,884	5
Granite State ARA	62,568	4
Spokane DX Assn.	59,130	3
Carolina DX Assn.	47,064	3
Great South Bay ARC	24,396	3
Southern Berkshire ARC	9,448	3

Local

New Mexico Big River Contesters	1,159,734	10
Iowa DX and Contest Club	550,986	3
Radio Amateurs of Northern Vermont	492,454	4
Bristol (TN) ARC	299,382	9
Redwood Empire DX Assn.	193,372	3
Hilltop Transmitting Assn.	170,290	4
Metro DX Club	106,806	6
Silver Comet Amateur Radio Society	98,640	6
Medina 2 Meter Group	95,822	3
Alexandria Radio Club	48,926	4
Seneca Radio Club	46,902	6
Stoned Monkey VHF ARC	35,212	3
The Villages Amateur Radio Club	34,752	4

Division Winners

Single Operator, High Power

Atlantic	KD4D	250,328
Central	K0PJ	208,662
Dakota	K0IDX	146,610
Delta	K0EJ	129,120
Great Lakes	K2PM	217,136
Hudson	W2RQ	253,814
Midwest	N7WY	131,638
New England	NC1I (K9PW, op)	

Northwestern	W7RM (W7WA, op)	263,276
Pacific	WC6H	320,380
Roanoke	K4ZW	280,374
Rocky Mountain	K5TA	187,248
Southeastern	N4OX	241,032
Southwestern	W6AFA	243,356
West Gulf	K5TR	110,484
Canada	VE3YT	355,738
		137,280

Single Operator, Low Power

Atlantic	NM2O	106,108
Central	K9ZO	123,172
Dakota	AC0W	134,460
Delta	WD5DJW	53,682
Great Lakes	WB8WKQ	104,912
Hudson	K52G	36,354
Midwest	W0EWD	191,224
New England	KC1SQ	61,650
Northwestern	N7LOX	81,300
Pacific	WB6POT	72,226
Roanoke	W4AAA (KK9A, op)	204,180

Rocky Mountain	KB0VHA	33,136
Southeastern	N4PN	178,284
Southwestern	K9WZB	127,428
West Gulf	WD5K	107,568
Canada	VE4VT	122,958

Single Operator, QRP

Atlantic	WK3A	7,050
Central	AF9J	912
Dakota	ND0C	48,048
Delta	N5EE	43,450
Great Lakes	KA8SMA	28,016
Midwest	N5SEZ	4,224
New England	KJ2G	18,144
Northwestern	N7JI	16,200
Pacific	W6YX (N7MH, op)	

Roanoke	N4ZAK	46,136
Rocky Mountain	N1XIH (GW0NVN, op)	11,526
		16,714
Southeastern	KJ4M	8,976
Southwestern	AA7V	25,650
West Gulf	AC5D	10,670
Canada	VE6EX	31,144

Single Operator Unlimited, High Power

Atlantic	K3MM	248,004
Central	K9CT	264,604
Dakota	K0CN	143,664
Delta	KC4NX	182,574
Great Lakes	W8MJ	135,270
Hudson	KD2RD	207,168
Midwest	N0XR	240,534
New England	W1SJ	246,178
Northwestern	K7RL	163,836
Pacific	KH7XS (K4XS, op)	

329,842

Roanoke	N1LN	161,186
Rocky Mountain	K7UT	187,616
Southeastern	KT4Q	161,186
Southwestern	W6TK	155,210
West Gulf	N5ZC	281,702
Canada	VY2TT	285,196

Single Operator Unlimited, Low Power

Atlantic	WB2P	186,252
Central	W9XT	90,138
Dakota	K4IU	31,350
Delta	WB0RUR	63,246
Great Lakes	K0ACP	72,090
Hudson	K2DFC	67,732
Midwest	K0NEB	69,822
New England	W1HS	45,892
Northwestern	W7ZRC	43,608
Pacific	K6GHA	57,760
Roanoke	KS4AA	93,440
Rocky Mountain	N7MZW	67,340
Southeastern	K4QY	31,652
Southwestern	KK7AC	104,814
West Gulf	K5KJ	82,336
Canada	VE3PJ	117,588

Multioperator, Single Transmitter, High Power

Atlantic	N3OC	222,772
Central	NV9L	242,858
Dakota	W0SD	280,706
Delta	W5WZ	279,292
Great Lakes	ND8DX	230,076
Hudson	N2NC	213,974
Midwest	W0NO	302,784
New England	W1XX	270,248
Northwestern	KZ1W	207,846
Pacific	NW6P	209,756
Roanoke	K4OV	302,286
Rocky Mountain	NN5K	132,184
Southeastern	N4SVC	134,644
Southwestern	K6AM	323,036
West Gulf	KG5VK	166,460
Canada	VE4EA	135,456

Multioperator, Single Transmitter, Low Power

Atlantic	N03U	61,320
Central	K9KE	106,240
Dakota	N0AT	145,632
Delta	K5KU	164,164
Great Lakes	WZ8P	148,570
Hudson	NY6DX	51,356
Midwest	K0TSA	14,364
New England	WA1BXY	73,470
Northwestern	K7IR	179,908
Pacific	N6ACL	35,416
Roanoke	N2VA	53,464
Rocky Mountain	K0UK	90,200
Southeastern	WW4LL	152,222
Southwestern	AB7YQ	31,376
West Gulf	WR5O	86,994
Canada	VA2CZ	73,964

School Club

Central	W9JWC	30,932
Delta	K5LSU	7,426
Great Lakes	W8EDU	32,562
Midwest	K0HC	196,876
Southeastern	W4AQL	169,818
West Gulf	KF5CRF	33,824
Canada	VE9UNB	6,952

Strays

QST Congratulates...

John Reisenauer, KL7JR, on editing the "Arctic and Antarctic DX" (AADX) column, a supplement to the *Canadian International DX Club Messenger*, since the late 1980s. The column specializes in DX info, QSLs, stories, and news related to Alaska, Antarctica, and all other polar and sub-polar locations. For more information, see <https://swling.com/blog/2014/12/the-canadian-international-dx-club-cidx-messenger/>. You can join the distribution list for AADX by emailing John at johnkl7jr@gmail.com.

2018 ARRL 160-Meter Contest Results

Last year's contest was held November 30 – December 2, 2018.

Top Ten — DX

Single Operator, High Power	Single Operator Unlimited, Low Power
PJ2T (W8WTS, op)	120,640
ZF9CW	115,128
TM6M (F1AKK, op)	45,828
HG0R (HA0NAR, op)	21,600
GM4Z (GM4ZUK, op)	14,520
TF3SG	9,840
DF2PY	7,488
UY0ZG	5,974
RW3PZ	5,740
JH7XMO	5,580

Single Operator, Low Power	Multioperator, Single Transmitter, High Power
XE2MVY	7,280
R7NW	2,450
OK1CZ	1,672
OK6Y (OK2PTZ, op)	1,400
LY4ZZ (LY2BMX, op)	1,386
US8UA	1,320
DL5CL	1,302
JE1SPY	1,224
JA1BJI	986
PA0TCA	918
SP9FMP	918

Single Operator, QRP	Multioperator, Single Transmitter, Low Power
JK1TCV	20
RC7B	8
OL0A (OK1CZ, op)	2

Single Operator Unlimited, High Power
4M1K (YV1KK, op)
76,896
XE2S
53,250
P4/DL6RAI
50,544
OM3RM
46,726
OK7Z (OK2ZI, op)
29,052
G4AMT
28,050
XE2T
25,742
SK3W (SM3SGP, op)
23,358
F6AGM
21,708
UX1UA
18,308

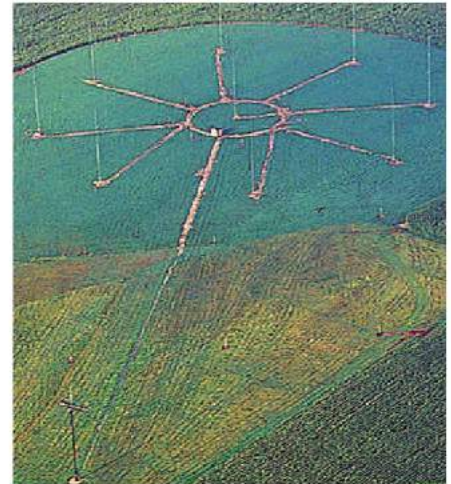
Top Ten — US and Canada

Single Operator, High Power	Single Operator Unlimited, Low Power
VY2ZM (K1ZM, op)	695,556
NO3M	582,632
AA1K	533,596
VA2EW	487,080
K1KI	478,035
K1LT	423,500
WF2W	418,572
NA8V	392,868
W3BGN	342,672
K3ZO	333,114

Single Operator, Low Power	Single Operator Unlimited, QRP
K9PG	193,076
WB8JUI	156,980
K7SV	143,170
W0UO	135,300
KG9X	128,520
WD8DSB	126,795
K9IG	123,660
NJ3K	119,972
AC0W	115,866
W1QK	110,320

Single Operator, QRP	Multioperator, Single Transmitter, High Power
W3TS	57,053
N7IR	54,375
W8GP	46,438
N3CO	41,600
K1EP	16,946
KN1H	12,578
K4WY	12,267
N5EE	11,184
W9CC	10,906
K6EI	9,880

Single Operator Unlimited, High Power	Multioperator, Single Transmitter, Low Power
VE3EJ	556,640
NN2DX (K07SS, op)	441,462
NR4M	427,050
KV0Q	402,570
K3WW	378,852
N3QE	361,368
W8MJ	353,256
K0RF	350,625
WB9Z	342,773
AB3CX	309,034



The K9DX ultimate nine-element 160-meter array is no longer in place, but it remains a dream of many hams. Read more about it at https://nidxa.org/memberWWW/k9dx_antennas.htm, or its related presentation from the 2008 Dayton Hamvention Contest Forum, available at https://www.kkn.net/dayton2008/contesting_with_28_miles_of_feedline. [NIDXA and K9DX, photo]

Full Results Online

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

Affiliated Club Competition

Club	Score	Entries	Grand Mesa Contesters of Colorado	665,084	8	Orca DX and Contest Club	169,232	6
Unlimited			Kentucky Contest Group	651,227	9	Maritime Contest Club	160,613	4
Potomac Valley Radio Club	7,252,431	92	Tennessee Contest Group	544,863	12	Delara Contest Team	145,960	3
Frankford Radio Club	6,711,488	67	Western Washington DX Club	482,073	10	Rochester (NY) DX Assn.	132,401	6
Yankee Clipper Contest Club	5,492,214	65	Florida Contest Group	468,382	14	Northeast Wisconsin DX Assn.	88,326	3
Society of Midwest Contesters	4,227,350	59	Central Texas DX and Contest Club	422,131	8	Northeast Maryland Amateur Radio		
Minnesota Wireless Assn.	2,603,300	56	Big Sky Contesters	385,323	5	Contest Society	85,105	4
Medium			DFW Contest Group	383,278	10	Spokane DX Assn.	76,175	4
Contest Club Ontario	2,212,305	26	Mother Lode DX/Contest Club	378,409	7	Swamp Fox Contest Group	39,925	3
North Coast Contesters	2,109,797	17	North Texas Contest Club	321,193	4	Driftless Zone Contesters	27,068	3
Mad River Radio Club	1,634,587	11	Southern California Contest Club	309,084	12	Local		
Arizona Outlaws Contest Club	918,326	23	Alabama Contest Group	301,361	3	Central Virginia Contest Club	514,067	6
Hudson Valley Contesters and DXers	756,285	9	South East Contest Club	290,628	9	CTRI Contest Group	406,667	7
Northern California Contest Club	688,560	24	Willamette Valley DX Club	262,515	6	Niagara Frontier Radiosport	403,392	5
			Georgia Contest Group	250,709	4	Bristol (TN) ARC	150,060	5
			Kansas City Contest Club	214,904	5			

Continental Winners

Africa

Single Operator Unlimited, High Power EA8DO 4,620

Asia

Single Operator, High Power JH7XMO 5,580
 Single Operator, Low Power JE1SPY 1,224
 Single Operator, QRP JK1TCV 20
 Single Operator Unlimited, High Power RA0FF 10,496
 Single Operator Unlimited, Low Power JQ1EPD/1 16
 Single Operator Unlimited, QRP JG1LFR 12

Europe

Single Operator, High Power TM6M (F1AKK, op) 45,828
 Single Operator, Low Power R7NW 2,450
 Single Operator, QRP RC7B 8
 Single Operator Unlimited, High Power OM3RM 46,726
 Single Operator Unlimited, Low Power IK2CLB 6,552
 Single Operator Unlimited, QRP DL2SAX 260
 Multioperator, Single Transmitter, High Power LY7Z 25,648

North America

Single Operator, High Power ZF9CW 115,128
 Single Operator, Low Power XE2MVY 7,280
 Single Operator Unlimited, High Power XE2S 53,250
 Single Operator Unlimited, Low Power XE2B 1,748
 Multioperator, Single Transmitter, High Power VP2MSK 54,002
 Multioperator, Single Transmitter, Low Power VP9I 47,200

Oceania

Single Operator, High Power VK2GR 286
 Single Operator, Low Power VK3IO 200

South America

Single Operator, High Power PJ2T (W8WTS, op) 120,640
 Single Operator, Low Power HK6J 384
 Single Operator Unlimited, High Power 4M1K (YV1KK, op) 76,896
 Multioperator, Single Transmitter, High Power PP5JR 16,356



AC7ZN/VP2MZN, manned the VP2MSK station at sunset, looking out over the ocean. VP2MSK (with operators VP2MSK, VP2MLB, VP2MSA, and VP2MZN) won 1st place in the DX, Multi-Single, High Power category in the 2019 ARRL 160-Meter Contest. [Louis Barrett, K7NM, photo]

Division Winners

Single Operator, High Power

Atlantic NO3M 582,632
 Central K9NR 279,896
 Dakota NE0U 183,635
 Delta WD5R (N5ECT, op) 108,936
 Great Lakes K1LT 423,500
 Hudson K2XA 297,360
 Midwest K1OI 37,204
 New England K1KI 478,035
 Northwestern WJ9B 185,442
 Pacific N6TQ 30,814
 Roanoke N4XD 301,698
 Rocky Mountain WD5COV 165,480
 Southeastern KV4FZ 332,580
 Southwestern W6AYC 133,472
 West Gulf K5RX 156,600
 Canada VY2ZM (K1ZM, op) 695,556

Single Operator, Low Power

Atlantic NJ3K 119,972
 Central K9PG 193,076
 Dakota AC0W 115,866
 Delta K3IE 57,618
 Great Lakes WB8JUI 156,980
 Hudson W2EG 33,464
 Midwest NZ0T 30,837
 New England W1QK 110,320
 Northwestern K7QBO 31,280
 Pacific N6NF 23,551
 Roanoke K7SV 143,170
 Rocky Mountain K6XT 40,625

Southeastern WA1FCN 50,991
 Southwestern AC7A 38,640
 West Gulf W0UO 135,300
 Canada VE3VSM 105,300

Single Operator, QRP

Atlantic W3TS 57,053
 Central W9CC 10,906
 Dakota ND0C 616
 Delta N5EE 11,184
 Great Lakes W8GP 46,438
 Hudson W2JEK 1,374
 Midwest W0YJT 1,804
 New England K1EP 16,946
 Northwestern K6EI 9,880
 Pacific K6MI 2,880
 Roanoke K4WY 12,267
 Southwestern N7IR 54,375
 West Gulf N5OE 7,030
 Canada VE7VV 6,150

Single Operator Unlimited, High Power

Atlantic K3WW 378,852
 Central WB9Z 342,773
 Dakota K0KX 210,600
 Delta AD4EB 162,588
 Great Lakes W8MJ 353,256
 Hudson N2GC 223,288
 Midwest N0AV 166,963
 New England NN2DX (K07SS, op) 441,462
 Northwestern K4XU 197,395

Pacific N6RK 137,238
 Roanoke NR4M 427,050
 Rocky Mountain KV0Q 402,570
 Southeastern N4PN 154,562
 Southwestern WA7AN (K9DR, op) 94,095
 West Gulf W5TM 138,572
 Canada VE3EJ 556,640

Single Operator Unlimited, Low Power

Atlantic NY3B 107,015
 Central NE9U 229,020
 Dakota K0TI 101,736
 Delta W4TTM 33,350
 Great Lakes K8BL 81,650
 Hudson W2DPT 32,576
 Midwest K0VBU 8,077
 New England NC1CC (WA1BXY, op) 75,383
 Northwestern NR7RR 7,831
 Pacific N6GEO 11,544
 Roanoke AA4XA 121,800
 Rocky Mountain W0DLE 115,456
 Southeastern K3TW 10,948
 Southwestern N6BT 19,337
 West Gulf K5KJ 81,810
 Canada VE3MGY 205,712

Single Operator Unlimited, QRP

Atlantic NK8Q 29,952
 Central WE9R 8,880

Dakota N0UR 12,330
 Delta K2FF 180
 Great Lakes K8ZT 25,069
 Roanoke N3CZ 31,080
 Southeastern KP2DX (KP2BH, op) 3,450

Multioperator, Single Transmitter, High Power

Atlantic W2GD 619,190
 Central K9CT 391,356
 Great Lakes W5MX 404,500
 Midwest N0NI 495,618
 New England W3UA 388,212
 Northwestern W6OFM 7,062
 Pacific K6DAJ 183,400
 Roanoke N1LN 474,089
 Rocky Mountain N0KE 61,864
 Southeastern WA1T 335,916
 Southwestern NA7TB 352,110
 West Gulf K5ZO 218,960
 Canada VE2OJ 215,602

Multioperator, Single Transmitter, Low Power

Atlantic W2FU 258,944
 Central N9MT 2,520
 Delta W4GZX 36,608
 Hudson K1RQ 36,225
 New England N2KW 149,856
 West Gulf W5WTM 24,660

The 2019 ARRL
 160-Meter Contest will be held
 December 6 – 8.

The 2019 IARU HF World Championships

1200 UTC Saturday, July 13 – 1159 UTC Sunday, July 14

♦ The objective is to contact as many other amateurs (especially IARU member-society HQ stations) around the world as possible using the 160-, 80-, 40-, 20-, 15-, and 10-meter bands.

♦ Exchange is a signal report and your ITU zone.

♦ Single Operator entrants choose from High, Low, or QRP power and Mixed Mode, CW Only, or Phone Only.

♦ Stations from IARU member-societies all around the world will be active. How many HQ stations can you contact?

♦ New 5-day log submission deadline: Upload Cabrillo-formatted logs to the web app **contest-log-submission.arrrl.org** no later than 1200 UTC, July 19. Or mail paper logs (postmarked by July 19) to IARU HF Championships c/o ARRL Contest Branch, 225 Main St., Newington, CT 06111 USA.

Up-to-date rules, paper log forms, and ITU zone maps can be found at www.arrrl.org/iaru-hf-championship

Dave, 9A1UN, and Hrvoje, 9A6XX, prepared their 2018 WRTC station under the watchful eye of their referee, Kurt, W6PH. Dave and Hrvoje operated as Y81U and finished in 16th place. [Kurt Pauer, W6PH, photo]



W1AW Schedule

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



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

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

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

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

Code bulletins are sent at 18 WPM.

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

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

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

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

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

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

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

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

How's DX?

The South Orkney Islands

The South Orkney Islands are located in the South Atlantic Ocean, approximately 1,370 kilometers (850 miles) northeast of the Palmer Peninsula on Antarctica. Coronation Island is the largest island, measuring 46 kilometers (28 miles) long and between 5 – 15 kilometers (3 – 9 miles) wide. The highest peak on the island is 1,265 meters (4,150 feet). Looking on a world map, you can find the South Orkney Islands at 60° 32' S 46° 52' W.

The islands were discovered by British and American sealers in 1821. The group was originally named the Powell Group, after British sealer George Powell, and the largest island got its name, Coronation Island, in honor of King George IV, who was crowned that year. Other islands in the South Orkney chain include Inaccessible, Monroe, Signy, Mathews, Robertson, Powell, Fredriksen, and Laurie.

In 1823, James Weddell renamed the islands to the South Orkney Islands, after the Orkney Islands of Scotland, which are located at a similar latitude farther north. The islands were not thoroughly surveyed until 1903, by William Speirs Bruce, who worked from Laurie Island. A meteorological station was built and later sold to Argentina in 1904. The station, named Orcadas in 1951, is still open today as the oldest working research base in the Antarctic.

In 1908, the British declared sovereignty for areas below 50° S between 20° and 80° W, including the South Orkneys, which were later administered by the Falkland Islands Dependencies. In 1947, the British Antarctic Survey (BAS) set up a biological research station on Signy Island, which was staffed year-round until 1996, when the research



During the early 1980s, there were multiple Amateur Radio operators stationed at the British Antarctic Survey station on Signy Island. Shown are (from left to right) Ali, VP8AOG; Alan, VP8AOF (front row); Steve, VP8AOC; Steve, VP8AOB (second row); Nick, VP8AOD; Roland, VP8AOH; John, VP8AOE, and Dennis, VP8ZR (third row). [Photo courtesy of Steve Wilson, KØJW]

team switched to having a smaller crew only during summer in the Southern Hemisphere. The islands are currently claimed by the British Antarctic Treaty of 1962 and Argentina, and they are part of the Antarctic Treaty of 1959.

DXCC History of South Orkney Islands

The Orkney Islands appeared on the original post-World War II DXCC list dated November 15, 1945. Shortly after the DXCC program restarted following its wartime suspension, LU1ZA showed up on the air from Islas Orcadas del Sud (Laurie Island).

As described in the September 1949 issue of *QST*, the LU1ZA QSL cards were rejected at first by the DXCC desk, citing "South Orkneys are officially a dependency of the Crown Colony of the Falkland Islands, and as such are under the direct jurisdiction of the British Commonwealth."

Afterwards, the DXCC desk received many queries. According to the July 1952 issue of *QST*:

...we have found that no claims of individual countries to the Falkland Islands Dependencies or any part of the Antarctic mainland are recognized by the US Government. Therefore, a ruling by the ARRL to be consistent with our government's stand, should provide for the crediting of all confirmations from this area, without regard to prefixes or nationalities of stations.

Afterwards, those rejected QSLs were accepted for DXCC credit.

VP8AP was probably the first accredited operation from the South Orkney Islands around 1948; however, LU1ZA operations took place during 1947. There have been at least two operations throughout every decade since the beginning of DXCC, including as many as 10 in the 1980s. The last big operation from the Orkneys was the 2011 VP8ORK Micro-Lite Penguin DXpedition team, who made 63,643 contacts, of which 17,679 were unique. Since then, there has been some sporadic activity. As of press time, South Orkney ranks number 16 on the Club Log DXCC Most-Wanted List.

2020 South Orkney Islands DXpedition

After the highly successful Perseverance DX Group's 2018 VP6D Ducie Island DXpedition (see Gene Spinelli's, K5GS, article, "VP6D Ducie Island DXpedition Recap," in the April 2019 issue of *QST*), the team has announced plans for its next DXpedition to Signy Island, in

the South Orkneys. The opportunity came much earlier than the team anticipated, as the MV *Braveheart* will be in the Falkland Islands area in January of next year.

As of press time, the team was securing landing permission, including an exact location to set up two extreme weather tents in efforts to preserve the island's natural habitat. The team has been receiving valuable assistance from Dr. Ralph Fedor, K0IR, a member of the 2011 Micro-Lite Penguin VP8ORK DXpedition.

The team consists of expedition leader Dave, K3EL; co-team leader Les, W2LK; co-organizer Gene, K5GS; Arliss, W7XU; Heye, DJ9RR; Laci, HA0NAR; Vadym, UT6UD; Walt, N6XG; Rob, N7QT; Rodolfo, PY2OT; Steve, W1SR, and Mike, WA6O. They will depart from Punta Arenas, Chile, in February of next year. The February/March 2020 South Orkney Islands DXpedition team pilots will be Thomas, KE4KY (NA and Chief); Mason, KM4SII (NA assistant); Björn, ON9CFG (EU); Al, 4L5A (EU and Russian-speaking); Hiroo, JA1WSX (Japan); Cesar, PY2YP (South America); Luke, VK3HJ (Oceania), and Andre, V51B (Africa).

The group plans to be on Signy for 15 days, from February 21 – March 5, and to be active on 1.8 through 28 MHz on SSB, CW, RTTY, and FT8. The team will have seven stations, Elecraft K3S transceivers, KPA-500 amps, SPE Linear amps, and OM Power amps. Antennas for this DXpedition will include two-element vertical dipole arrays (VDAs) for 14 – 28 MHz, two-element Yagis on 14 – 28 MHz at 10 meters above the

ground, a 30-meter four-square, a 40-meter four-square, and separate verticals for 160 and 80 meters. In addition, the team will have receive antennas for the low bands.

Budget

This DXpedition is budgeted at \$325,000 with the ship transportation being the most expensive, trailed by freight costs. The opportunity arose more quickly than the team anticipated, but the cost will be lower than if the MV *Braveheart* was going to be located farther away. The call sign for this DXpedition has not yet been decided and will be announced.

More South Orkney News

The team's website, www.sorkney.com, has more DXpedition information, including operator biographies, propagation forecasts, transmit frequencies, and details on support and donations. You can also follow the team on Twitter @SouthOrkneyDX and on Facebook at www.facebook.com/South-Orkney-DX-pedition-2020-312303479470837. Email the team with further questions at info@sorkney.com, and watch your favorite DX outlet for any future updates.

Wrap-Up

That's it for this month, with thanks to K5GS and the Perseverance DX Group for helping to make this month's column possible. Don't forget to send your DX news, photos, and club newsletters to bernie@dailydx.com. Until next month, see you in the pileups!
— Bernie, W3UR



The World Above 50 MHz

The Quiet Sun Roared

I discussed in last month's column how the sun has become quiet as we enter the minimum of Solar Cycle 24. But the sun decided to greet Spring 2019 with a bang! Sunspot AR2736 spawned a C-4 class solar flare with an Earth-directed CME on March 20 at 1118Z. Hopes were high for aurora and perhaps even some F2 propagation on 6 meters. On March 24 at 2151Z, the CME arrived, but it was brief, with only a glancing blow against the Earth's geomagnetic field. A weak G1-class geomagnetic storm took place; this was a big disappointment for aurora watchers and VHF DX operators. Unfortunately, the majority of CMEs are not Earth directed.

On the Bands

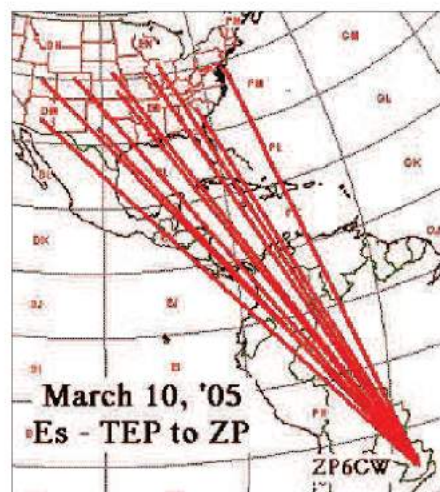
50 MHz. Sporadic E and any terrestrial DX were very scarce on 6 meters in March 2019. EME is workable year-round, as shown by Mike, K7ULS, who logged JG1TSG (QM05) via EME on March 10.

An interesting opening took place on March 12. Earlier that day, K7ULS (DN41) worked W5LDA (EM15) via E_s on FT8. E_s was observed from Florida to Puerto Rico that afternoon. TEP was present from the Caribbean to Brazil, as shown by PY2GTA spotting Frans, J69DS, via TEP (trans-equatorial propagation). Then an E_s -to-TEP link was set up. Graham, KW4BY (EL96), copied J69DS on E_s , and PT9FD, ZP5SNA, and PY2KP via an E_s -to-TEP opening, all on FT8, from 0030 to 0120Z.

Graham heard no beacons or stations on SSB or CW. "FT8 is amazing," he noted. PT9FD spotted Carl, WC4H, on FT8. WD4AB (EL95) spotted Jose, KP4EIT, "59" and Jose, KP4JLA, "55" on SSB via one-hop sporadic E at 0125Z. I suspect there was E_s present from Florida on to the northern TEP zone as well. TEP is a

robust mode and propagates 6-meter signals across the geomagnetic equator, even with a solar flux of only 70. With help from sporadic E, Gulf Coast stations were able to work interesting DX deep into South America. E_s is rare in March, but if present, it can set up interesting links. A review of a similar opening 14 years ago illustrates how.

On March 10, 2005, a much more extensive E_s -to-TEP opening took place. From 0020Z to 0200Z, strong



Sporadic-E trans-equatorial propagation to Paraguay on March 10, 2005.

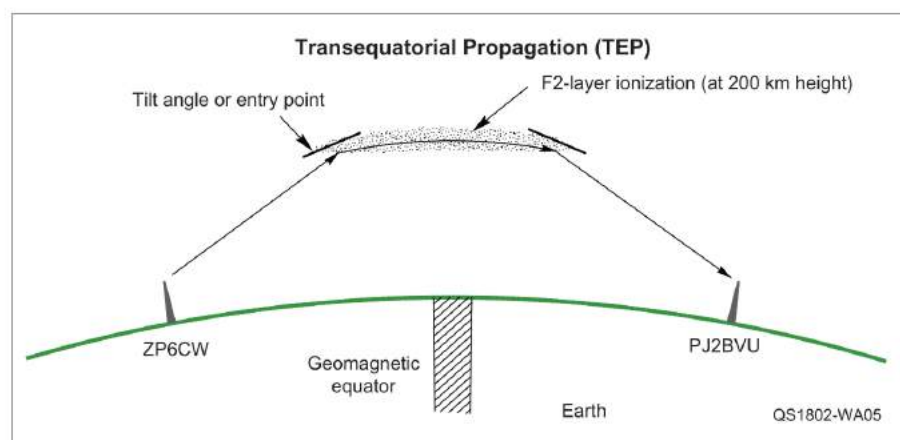
sporadic-E openings occurred across the southeast states and the Gulf of Mexico. Stations in the midwest were able to use the E_s to link on to TEP toward South America. Doug Wooley, ZP6CW, put rare Paraguay in many eager DXers' logs on 6 meters from Arizona to New York that evening.

Doug was operating on CW and worked many modest stations, including mine, which operates with 100 W and a small Yagi. The sunspot number then was higher at 77. On March 12, 2019, it was just 11. Remarkable openings like these can occur throughout the solar cycle, waiting for alert and observant DXers. FT8 can help you take advantage of these fleeting openings.

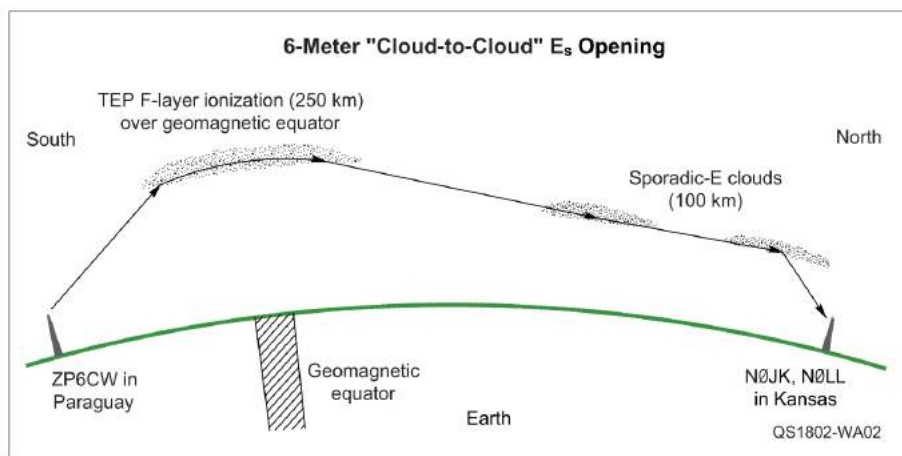
On March 20, Mike, K7ULS, worked Alex, EA8DBM, on JT65 EME at 2256Z with "-33 dB signals."

On March 21, Peter, WA2GFN (FN20), worked Howard, W4HLR (EM56), on SSB via E_s . This was only the second time Peter had worked E_s in March in his many years on 6 meters.

The morning of March 24, I (EM28) had a partial MSK144 meteor scatter contact with Gary, KE8FD (EM64).



ZP6CW's contact with PJ2BVU on 50.110 MHz via TEP on March 8, 2005. [Ken Neubeck, WB2AMU, graphic]



F-layer ionization over the geomagnetic equator (TEP) during a combination TEP and cloud-to-cloud E_s opening contact from the midwest US to Paraguay on 6 meters on March 10, 2005. [Ken Neubeck, WB2AMU, graphic]

There is some disappointing news for those seeking Hawaii on 6 meters this summer. One of the most active Hawaiians on 50 MHz, Jim Kennedy, KH6/K6MIO, will be moving to Florida by the time you read this. Jim related equipment issues that rendered FT8 inoperable during the Australia and New Zealand openings in January 2019. Jim had a great station north of Hilo on the Big Island. A new 6-meter station may be on from West O'ahu. Kimo Chun, KH7U, related that the

KH6YY/KH6J contest station may be on 6 meters this year. Plans are tentative to get a high, long Yagi.

Pat, KE3WN, sent the following account of his 6-meter activity from rare grid EM92:

I was vacationing at Edisto Beach, South Carolina, from January 18 to 27, 2019. I brought my RCI 5054 DX 6-meter 25 W SSB rig along with a magnet-mount

antenna on a Chevy Spark. I've always done this, ever since my wife and I began vacationing at Edisto 12 years ago (grid EM92). I had never experienced a 6-meter opening at Edisto until the late afternoon of January 20, 2019. I worked W1AIM in FN34, K1GUP in FN54, and WA1T in FN43, all on SSB, from 2140 UTC to 2201Z.

144 MHz. On March 2, Graham, KW4BY (EL96), worked tropo along the Atlantic Seaboard to Virginia, Pennsylvania (N3BBI, N3DT, K3HQS), and Georgia. Byron, W5FH, is now in EM21. He is putting up several tall towers with Yagi stacks on the VHF and UHF bands. He prefers operating with CW and SSB.

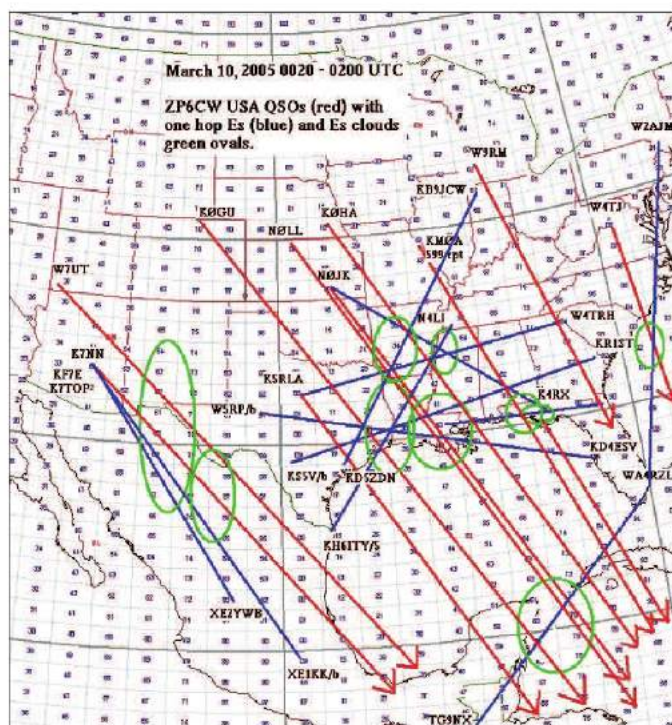
Here and There

With more 6-meter stations using FT8 these days, Rich, K1HTV, noted 50.313 MHz will be very crowded for DX during times when the 6-meter band is wide open. Consider going to 50.323 MHz. Russ, K6KLY, will be operating in the ARRL June VHF Contest from Bermuda (VP9GE's home station). Russ will be using a Yaesu FT-920 and 6M5X Yagi.

The Central States VHF Conference will be held on July 25 – 28, 2019, in Lincoln, Nebraska. Check the website, 2018.csvhfs.org, for further details. If you are interested in presenting at the conference, check out the guidelines. Suggested topic areas include operating, including contesting, roving, and DXpeditions.

The 2019 Six Meter International Radio Klub (SMIRK) contest will be held on June 15 – 17, 2019. This contest will be held in honor of Bill Tynan, W3XO/5. More information will be on the ARRL Contest landing page and the SMIRK website.

Sam, K5SW, also sent in a new link for the APRS VHF propagation page, at aprs.mennolink.org.



Special Event Stations

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

Mar. 1 – Jan. 1 (2020), 0500Z – 0500Z, various, West Central Florida. ARRL West Central Florida Section. **County Parks On The Air.** HF/VHF/UHF and satellite. Certificate. Darrell Davis, KT4WX, 6350 Mills Rd., Fort Meade, FL 33841-9584. See website for details. arrlwf.org/wcf-special-events/county-parks-on-the-air

Apr. 1 – Dec. 31, 0000Z – 2359Z, W5TAL, Sugar Land, TX. American Legion Amateur Radio Post 942. **The American Legion 100th Anniversary.** 14.275 14.225 7.275 7.225. Certificate. Bob Hawkins, 311 Ulrich St., Sugar Land, TX 77498. www.legion.org or www.legion.org/hamradio

May 17 – May 27, 0000Z – 2359Z, W9A, Wisconsin Rapids, WI. Wood County ARES/RACES. **EMS Week 2019.** 14.275 7.275 3.975; WI WX Tac-Brandmeister 31550. QSL. Wood County ARES, Attn: W9A, 3530 Bohn Dr., Wisconsin Rapids, WI 54494. w9wca@winlink.org or w9wca.com

May 26, 0300Z – 1100Z, K3DN, Warminster, PA. Warminster Amateur Radio Club. **Poland Through the Ages.** 14.225. Certificate. Warminster Amateur Radio Club, P.O. Box 113, Warminster, PA 18974. www.k3dn.org

June 1, 1400Z – 2000Z, W5WQ, Tylertown, MS. Southwest Mississippi Amateur Radio Club. **Walthall County, MS Dairy Festival.** 28.480 21.280 14.280 7.280. QSL. W5WQ, 2862 Wallace Dr. SW, Bogue Chitto, MS 39629. www.w5wq.net

June 1 – June 2, 0000Z – 2359Z, N1S, Groton, CT. Generations Amateur Radio Club. **First Nuclear Submarine USS Nautilus SSN 571;** Museum Ships Weekend Participant. 21.340 14.264 7.250 50.5. QSL. Via K3LBD bureau or direct to Generations ARC, 110 Vinegar Hill Rd., Gales Ferry, CT 06335. Nautilus information: www.ussnautilus.org. www.qrz.com/db/n1s

June 1 – June 2, 0000Z – 2359Z, W1M, Vergennes, VT. Lake Champlain Maritime Museum. **Museum Ships Weekend.** 14.260 7.260. Certificate. Robert A. Brown, W4YFJ, 5 Repa Dr., Essex Junction, VT 05452. <https://www.qsl.net/w/wa2tvs/museum>

June 1 – June 2, 0001Z – 2359Z, NJ2BB, Camden, NJ. Battleship *New Jersey* Amateur Radio Station. **Museum Ships Weekend Event.** 14.262 14.040 7.262 7.040. Certificate & QSL. Margaret Burgess, KB2BRR, 150 Schooner Ave., Barnegat, NJ 08005. *Those who work at*

least 15 different ships of those listed as participating will receive a certificate by sending a copy of their log entries. www.nj2bb.org

June 1 – June 2, 1100Z – 2100Z, K8E, Toledo, OH. Toledo Mobile Radio Association and National Museum of the Great Lakes. **Museum Ships Weekend.** 14.260 14.039 7.260 7.039. QSL. SS Col. James M. Schoonmaker, Team K8E, P.O. Box 9673, Toledo, OH 43697. www.tmrahamradio.org

June 1 – June 2, 1400Z – 2100Z, NB9QV, Manitowoc, WI. USS *Cobia* Amateur Radio Club. **World War II Submarine USS Cobia On the Air.** 14.240 7.250. QSL. Fred Neuenfeldt, W6BSF, 4932 S. 10th St., Manitowoc, WI 54220-9121. www.qrz.com/db/nb9qv

June 1 – June 2, 1421Z – 1417Z, W9I, Paoli, IN. Orange County Amateur Radio Club. **Initial Survey Point.** SSB: 14.250 7.180 3.820; CW: 7.055. QSL. Larry B. Jones, 1475 S. State Rd. 37, Paoli, IN 47454. www.wb9fhp.com

June 1 – June 2, 1500Z – 2000Z, NY3EC, Pittsburgh, PA. USS *Requin* SS 481 Amateur Radio Club. **Museum Ships on the Air.** 14.0481 7.250 7.0148. QSL. Art Mueller, WA3BKD, 1532 Millers Run Rd., McDonald, PA 15057. www.qrz.com/db/ny3ec

June 1 – June 5, 0000Z – 0000Z, W5T/W5C, Cleburne, TX. Club KC5NX. **Museum Ships Weekend.** 14.260 14.045 7.202 7.045. QSL. Club KC5NX, 9200 Summit Ct. W., Cleburne, TX 76033. kc5nx@gmail.com or www.qrz.com/db/kc5nx

June 1 – June 9, 1300Z – 2200Z, W2W, Baltimore, MD. The Amateur Radio Club of the National Electronics Museum (K3NEM). **W2W D-Day Commemoration.** 14.244 14.044 7.244 7.044; 80 meters (3.544, 3.844) and digital modes possible. Certificate & QSL. W2W D-Day, P.O. Box 1693, MS 4015, Baltimore, MD 21203. www.w2w-2.us

June 1 – June 10, 1400Z – 1400Z, K3J, Butler, PA. Butler County Amateur Radio Association. **Bantam Jeep Heritage Festival.** 14.074 7.230. QSL. BCARA, P.O. Box 1787, Butler, PA 16003. www.w3udx.org

June 1 – June 14, 0000Z – 2359Z, K4D, Dog Island Florida (EL79), FL. Dog Island DXpedition. **Dog Island IOTA DXpedition**

and VHF Party. 144.200 50.125 14.275 7.180. QSL. Bruce Brady, 208 Mt. Tabor Rd., Hot Springs National Park, AR 71913. *Digital modes and SSB on VHF for the ARRL VHF Contest. SSB/CW/digital modes all others during the time frame. Activating IOTA Island (NA-085) and rare grid EL79. Contacts uploaded to LoTW, send SASE for QSL.* rockradio1@aol.com or www.qrz.com/db/k4d

June 5 – June 9, 1500Z – 2359Z, K5TUP, Tupelo, MS. Tupelo Amateur Radio Club. **Elvis Presley Festival Special Event.** CW, FT8, and SSB on all bands, check the cluster. Certificate*. TARC, P.O. Box 3104, Tupelo, MS 38803. tupeloradioclub@gmail.com or www.tupeloarc.org

June 6 – June 9, 1200Z – 1700Z, WW2DDM, Bedford, VA. Old Dominion Chapter 202 QCWA. **75th Anniversary D-Day Invasion.** AM: 7.285 3.880; CW: 3.585; SSB 14.245. QSL. WW2DDM c/o H. A. Boaz, Jr., 1389 Budd Ln., Montvale, VA 24122.

June 8, 1300Z – 2000Z, KG4KRB, Rocky Mount, VA. Blue Ridge Emcomm. **30th Annual Rosebud Sioux Ministry Trip.** 14.620 14.250 7.250 3.925. Certificate & QSL. Ron Shiflett, KG4KRB, 805 Patti Rd., Rocky Mount, VA 24151. wawokiya@b2xonline.com or www.rosebudsiouxministry.org

June 8, 1830Z – 2030Z, W9ZL, Appleton, WI. Fox Cities Amateur Radio Club. **Appleton Flag Day Parade.** 14.246 145.33. QSL. FCARC, P.O. Box 2346, Appleton, WI 54912. www.fcarc.club

June 8 – June 9, 1400Z – 2100Z, K2M, Brooklyn, NY. Kings County Radio Club. **USS Missouri (BB-63) — 75th Anniversary of Her Commissioning.** 14.225 7.180 3.810. QSL. Lloyd Westerman, K2JVX, 80 8th Ave., Suite 1001, New York, NY 10011. www.kingscountyradioclub.com

June 8 – June 9, 1400Z – 2000Z daily, W3BMD, Indiana, PA. Indiana County Amateur Radio Club. **Jimmy Stewart Airshow.** 14.270 7.230. QSL. Indiana County Amateur Radio Club, P.O. Box B, Robinson, PA 15949. www.qsl.net/w3bmd

June 8 – June 10, 1300Z – 0000Z, W3W, Cumberland, MD. Mountain Amateur Radio Club. **Whiskey Rebellion/Cumberland Heritage Days.** 14.322 7.222 3.855. QSL. MARC, P.O. Box 234, Cumberland, MD 21501. *Contacts confirmed via LoTW; send SASE for QSL card.*

June 15 – June 16, 0000Z – 2359Z, K8H/K8O/K8S/K8W, Waynesville, OH. SouthWest OH DX Association. **W8DXCC DX Convention**. 14.245 14.074 7.245 3.535. Certificate & QSL. Bill Salyers, AJ8B, 8275 Cierra Way, Waynesville, OH 45068. *QSL for working each station, and a certificate for working all four.* www.w8dxcc.com

June 15 – June 21, 1800Z – 1800Z, K4C, Cookeville, TN. National Speleological Society. **78th Annual Convention of the National Speleological Society**. 14.285 7.195. QSL. Bill Frantz, AE6JV, 16345 Englewood Ave., Los Gatos, CA 95032. www.nss2019.caves.org

June 15 – June 30, 0000Z – 2300Z, N4T, Chattanooga, TN. Tennessee Valley DX Association. **30th Anniversary**. 14.250 14.045 7.190 7.040; all bands and frequencies as available. QSL. Howard K. Moll, Jr., WB4ZBI, 8174 Coventry Ln., Chattanooga, TN 37421-1120. molljr@comcast.net

June 16 – June 30, 0000Z – 2359Z, W1C, Newport, RI. Providence Radio Association. **Centennial Event 1919 – 2019 — W1C**. 14.250 7.250 3.850 7.025. QSL. Providence Radio Association, W1OP, 1 Ludlow St., Johnston, RI 02919. www.qrz.com/db/w1op or www.w1op.com

June 20 – June 24, 1900Z – 2359Z, N6R, Simi Valley, CA. Ventura County Amateur Radio Society, Simi Settlers Amateur Radio Club, and other area Amateur Radio Operators. **Field Day 2019, Commemorating the Lives of President Ronald and Mrs. Nancy Reagan**. 21.320 14.255 7.260 3.810. QSL. Peter S. Heins, 1559 Norwich Ave., Thousand Oaks, CA 91360. www.qrz.com/db/n6r

June 22 – June 23, 1800Z – 1800Z, W7U, Cedar City, UT. Rainbow Canyons Amateur Radio Club. **Field Day**. 14.225 7.235 3.925 3.530. QSL. Don Blanchard, 2666 North 400 West, Cedar City, UT 84721. blanchard@awinets.com or www.rcarc.info

June 24 – June 28, 1330Z – 1700Z daily, K2BSA/8, Lewis Center, OH. Delaware Amateur Radio Association, K8ES. **Simon Kenton Council, Delaware District, Cub Scout Day Camp**. 14.290 7.190. QSL. Ed Jones, 2965 Seaway Ct., Lewis Center, OH 43035. *We'll have hundreds of scouts on the air over the course of the week.* www.k8es.org

June 28, 1300Z – 2000Z, W8S, Sault Sainte Marie, MI. Eastern Upper Peninsula Amateur Radio Club. **Soo Locks Engineer's Day – 2019**. 14.240 7.220;

147.21 PL 107.2; 147.33 PL 107.2; other frequencies possible depending on conditions. QSL. W8S, Sault Area Contesting Klub, P.O. Box 533, Sault Sainte Marie, MI 49783.

June 29 – July 10, 1200Z – 0500Z, WO4L, East Berlin, PA. Bob Hess. **156th Anniversary of The Battle of Gettysburg**. 14.275 3.830 7.185 1.930. Certificate & QSL. Bob Hess, 74 Curtis Dr., East Berlin, PA 17316. *Please follow QSL instructions on website.* www.qrz.com/db/wo4l.

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

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

June 2019 W1AW Qualifying Runs

Earn your Code Proficiency certificate or endorsements by listening to W1AW Qualifying Runs. Legibly copy at least 1 minute of text by hand and mail the sheet to:

W1AW Qualifying Runs, 225 Main St., Newington, CT USA 06111

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

June Qualifying Runs will be transmitted by W1AW in Newington, Connecticut at 10 PM EDT on Wednesday, June 5 (0200 UTC on June 6) and at 7 PM EDT on Tuesday, June 18 (2300 UTC) at 1.802.5, 3.581.5, 7.047.5, 14.047.5, 18.097.5, 21.067.5, 28.067.5, 50.350, and 147.555 MHz. The West Coast Qualifying Runs will be transmitted by K6KPH on Saturday, June 29 at 2 PM PDT (2100 UTC) on 3581.5, 7047.5, 14047.5, 18097.5, and 21067.5 kHz. Unless indicated otherwise, sending speeds are from 10 to 35 WPM.

Life Members

Elected May 20, 2019

Gary W. Alberstadt, KA3FZO
Richard L. Altherr, KC8APF
Matt Ames, VK2LK
Mark A. Amorim, KC3IUN
David Andrews, KB1YHM
Robert C. Antal, KC3HRV
Thomas D. Antil, AB1GF
David J. Badley, KE7KJR
Stephen A. Baranowski, N1SB
Karen Barsamyan, EK6KB
Vince Bednarz, AC8XO
Doron S. Ben Chaim, K1DBC
Mark G. Bevan, WY1G
Christopher G. Bloxson, AA4CB
Candace Boggs, KA7NDI
Steven J. Bomba, K9IER
Lawrence R. Brandt, AA1EA
L. Glenn Brazzel, Jr., NQ5X
Tyson D. Brooks, K17FXJ
Charles W. Brown, WD6AOU
David Brown, N0BTC
Ronald R. Cade, W6ZQ
Clarence E. Canterbury, KB8ABJ
Terrance Castillo, KH6KC
Lucindia E. Claghorn, K14ZCJ
Wesley G. Clark, AC3DY
Jeremy R. Cook, K7VFO
Brooks M. Crenshaw, K4ATA
Robert E. Darlington, III, N3XKB
Satyajeet Dass, KK4CCA
Gordon A. Davids, WJ3K
Jason R. De La Cruz, K4FLY
Carlos De Los Santos, CX6DAM
Houston Dewey, W6BV
Shane H. Driskill, KG5SRO
Eric Farrow, W9EO

Raymond H. Ferreira, Jr., KH6GGC
David P. Finell, N7LRY
James G. Fisher, AJ3DI
Nathanael T. Fisher, N0ZYC
Jonathan D. Frisch, K8JDF
Yuriy Fuks, AC6A
Roger Garrett, Sr., KL4EC
Max George, NG7M
Dee L. Gordon, KI7NUR
Ronald M. Grossman, AF5Q
Andrew J. Gusek, NC4AG
Richard S. Harris, KF5EOX
Chuck Heath, K6ZIZ (SK)
William G. Heckerth, N7WGH
Bruce G. Hensler, W3GZ
Jeffrey D. Herman, KH6O
Phillip E. Hicks, KE0TK
William J. Howard, WB3V
Karl L. Hutchison, W7KLC
Frank S. Kaleyiasm, KV5FD
Sandra C. Kalman, AG5QJ
Eric Kaminsky, KD2JYQ
Brian Kanis, AK8BK
James W. Kelley, AC6XG
Sean W. Kelley, WM1L
Michael W. Keltner, K4MWK
Arnold J. Klein, WB6OEE
Taff E. Klepinger, KT1SGK
Gary R. Kloss, KU5FZN
Jamie R. Kriner, KC3NAP
Joseph S. Kriner, KC3NAQ
Robert K. Kuegemann, KC0IVW
Ray LaFrance, W1PDX
Justin A. Leishman, KC3BJT
Liz Leonhardt, K6LIZ
Peter M. Leonhardt, AE6PL
Brian Levens, KM4HCQ
Donald J. Lewis, III, KW4UP
Roy R. Lippin, KA2MME

James R. Litton, KE0VEZ
Luther R. Lloyd, II, KJ4RUA
Nathan J. Lockhart, KE0HTD
Joseph A. Lukaitis, Sr., KA3GEK
Jerry R. Lutgring, W5JRL
Kurtis T. Mabe, WH6KM
Dennis G. Major, N0ABC
Chuck Maris, W9KCM
Richard H. Marx, AF7RM
Joelle Maslak, N7XUC
John V. Matthews, N7MRM
Aaron E. McKnight, KD8ILV
Diane Meador, KD5QNN
William S. Merritt, KB4QAA
William A. Meyers, KE5HDY
Nicolas A. Middendorff, KB3PGV
Juan Munoz, TG9AJR
James R. Nash, Jr., KG4TKA
Charles R. Netherby, K16IIT
Robert L. Neyhard, KC3ICT
Mark M. Noble, KE8BZW
John W. O'Brien, III, N1NJI
Bohdan Olesnicki, KK6TJY
Michael D. Packett, KC3JIG
John C. Peterson, K0OUT
Frank E. Philipp, N0YKA
Steven E. Phillips, WA1ZKN
Larry Price, W7EWL
Aaron Quinto, AA0QQ
Lance E. Rasmussen, K7LER
Mark Rauen, W8MWR
Andrew E. Reid, KC2WUG
Erin Reid, WG0NZO
Aaron C. Renner, N8ACR
Carl J. Reynolds, N7CJR
Benjamin P. Richardson, II, K4ITQ
Jason Riddle, KC3CSV
Alexander J. Rosen, N2LR
David H. Rosenfeld, KG5NLA
Ari D. Rubinstein, KM6MQL

Scott Russell, N1SER
Gilbert D. Rymer, W5GLR
Ray Salaiz, AG6SB
Adam Sandler, KD2KYX
James E. Schwinn, KG5YPE
Craig B. Shackelford, W7FM
Steven D. Sherman, AE0CL
Barry L. Sherwood, N5HW
Michael A. Shuman, NP2AG
Douglas C. Sicker, AD0VT
Karl Simonson, KS9E
William E. Sousa, KM4JYL
John Spitznagel, Jr., KD4IZ
Wesley Stanaland, Jr., NS4CC
Evan Stinson, W0ERS
John E. Stone, KC9VGG
Nathan Tiller, K3DEJ
Jason K. Turner, W8LST
Jennie L. Tuttle, KC0RBV
Rik Van Riel, AB1KW
Robert B. Tuttle, N8YXR
Tighe V. Vroman, K7TVV
Dennis L. Wade, KG6ZI
Jeremy Wells, KC9WMV
Brandon L. West, K4BLW
Mark R. Wilson, KC7VZS
Paul T. Winter, KC6PDS
Albert R. Wolff, W6ELD
Richard A. Woodward, KA4JXY
John H. Wright
Charles Zurenko, N2TFS



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.

Convention and Hamfest Calendar

Abbreviations

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

Alabama (Helena) — June 14 – 15

D F H R S V
 Friday 4 – 7 PM, Saturday 8:30 AM – 3 PM. *Spr*: Shelby County ARC. Helena Sports Complex, 110 Sports Complex Drive. *TI*: 146.98. *Adm*: \$5. helenahamfest.com.

Illinois (Wheaton) — June 16

D F H Q R V
 7 AM. *Spr*s: Six Meter Club of Chicago. DuPage County Fairgrounds, 2015 Manchester Rd. *TI*: 146.97 (107.2 Hz), 146.52. *Adm*: Advance \$6, door \$10. www.k9ona.com.

Maryland (Upperco) — June 16

D F H Q R T
 7 AM – 2 PM. *Spr*: Baltimore ARC. Arcadia Fairgrounds, 16920 Carnival Ave. *TI*: No talk-in. *Adm*: \$5. <http://w3ft.com/>.

Michigan (Midland) — June 15

D F H S T V
 8 – 11 AM. *Spr*: Midland ARC. Salvation Army Building, 330 Waldo Ave. *TI*: 147.0. *Adm*: \$5. www.w8kea.org.

Michigan (Monroe) — June 16

D F H Q R T
 7:30 AM – 1 PM. *Spr*: Monroe County Radio Communications Assn. Monroe County Fairgrounds, 3775 S. Custer Rd. *TI*: 146.72/12 (100 Hz). *Adm*: \$6. www.mcrca.org.

New Jersey (Piscataway) — June 15

D F H Q R T V
 8 AM – noon. *Spr*: Raritan Valley RC. Piscataway High School, 110 Behmer Rd. (Lots 11 – 12). *TI*: 146.52, 146.625 (141.3 Hz). *Adm*: \$7. www.w2qw.org.

New York (Chaffee) — June 8

D F H R T V
 8 AM. *Spr*: Pioneer Radio Operators Society. Manion Park, 9999 Grove St. *TI*: 145.39. *Adm*: \$5. www.facebook.com/pioneerradiooperatorssociety.pros.

New York (Queens) — June 2

D F H Q R T V
 9 AM – 2 PM. *Spr*: Hall of Science ARC. New York Hall of Science parking lot, Flushing Meadows Corona Park, 47-01 111th St. *TI*: 444.2 (136.5 Hz). *Adm*: \$5. <http://hosarc.org/>.

North Carolina (Salisbury) — July 6

D F H R T V
 8 AM – 2 PM. *Spr*: Rowan ARS. Salisbury Civic Center, 315 Martin Luther King Ave. S. *TI*: 145.41 (136.5 Hz). *Adm*: Advance \$4, door \$5. <https://www.rowanars.com/events>.

Ohio (Austintown) — July 7

D F H Q R S T V
 8 AM – 1 PM. *Spr*: 20/9 RC, Inc. Austintown Senior Center, 112 Westchester Dr. *TI*: 147.315. *Adm*: Free. 20over9.org.

W8DXCC CONVENTION

June 15, Owensville, OH

D F H Q R S V
 1 – 6 PM. *Spr*s: SouthWest Ohio DX Assn. Clermont County Fairgrounds, 1000 Locust St. *TI*: 147.345 (123 Hz). *Adm*: \$10. <https://www.swodxa.org/w8dxcc/>.

Ohio (Owensville) — June 15

D F H Q R S T V
 8 AM – 1 PM. *Spr*: Milford ARC. Clermont County Fairgrounds Multipurpose Building, 1000 Locust St. *TI*: 147.345 (123 Hz). *Adm*: \$5. www.w8mrc.com.

Pennsylvania (Plains) — July 7

F H R T V
 8AM – noon. *Spr*: Murgas ARC. Polish American Veterans Club, 2 S. Oak St. *TI*: 146.61 (82.5 Hz). *Adm*: \$7. hamfest.murgasarc.org.

Tennessee (Knoxville) — June 15

D F H R S T V
 8 AM – 3:30 PM. *Spr*: Radio Amateur Club of Knoxville. Kerbel Temple, 315 Mimosa Ave. *TI*: 147.3 (100 Hz). *Adm*: Advance \$8, door \$10. www.w4bbb.org.

Texas (Texas City) — July 6

D F H Q R S T V
 9 AM – 1 PM. *Spr*: Tidelands ARS. Doyle Convention Center, 2010 5th Ave. N. *TI*: 147.14 (167.9 Hz), 442.025 (103.5 Hz). *Adm*: Advance \$4, door \$5. www.tidelands.org.

Virginia (Manassas Park) — June 15

D H Q R S T V
 6:30 AM – 2 PM. *Spr*: W4OVH Ole Virginia Hams. Manassas Park Community Center, 99 Adams St. *TI*: 146.97 (100 Hz). *Adm*: \$10. www.qsl.net/wa9tixe.

Washington (Dryden) — June 7 – 9

H R T
 Friday and Saturday 6:30 AM – 9 PM, Sunday 6:30 AM – noon. *Spr*: Apple Valley ARC. Dryden Gun Club, Saunders Rd. *TI*: 146.68 (156.7 Hz). *Adm*: \$7. applecityarc.com.

Wisconsin (Oak Creek) — July 7

D F H R
 7 AM – 1 PM. *Spr*: South Milwaukee ARC. American Legion Post #434, 9327 S. Shepard Ave. *TI*: 146.91 (127.3 Hz). *Adm*: \$5. www.qsl.net/wa9tixe.

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

To All Event Sponsors

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

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

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

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



ARRL VEC Volunteer Examiner Honor Roll

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

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

Examiner	Sessions	Accreditation Date	Examiner	Sessions	Accreditation Date	Examiner	Sessions	Accreditation Date
Atlantic			Hudson			Roanoke		
Jobst Vandrey, AC0LP	322	23-Jun-08	Paul Maytan, AC2T	624	06-Sep-84	Judy Friel, AC4RG	277	01-Feb-91
James McCloskey, NS3K	306	14-Nov-94	Stanley Rothman, WA2NRF	435	01-Mar-85	Alan Ronald Moeck, WA2RPX	255	27-Sep-94
Edward Genoino, WA2NDA	298	10-Jul-85	E. Drew Moore, W2OU	428	01-Aug-90	David Snyder, W4SAR	238	01-May-93
George Brechmann, N3HBT	270	01-Apr-91	Gerald Miller, Jr., AA2ZJ	398	05-Dec-95	Sheila Frank, KT4YW	221	30-Oct-96
Robert Benna, N3LWP	230	21-May-97	Fritz Boigris, KB2O	388	26-Oct-84	Terry Sanner, WV8V	202	06-Sep-84
Central			Midwest			Rocky Mountain		
Ed Wagner, AB9FN	318	01-Jul-02	David Bartholomew, AB0TO	699	22-Mar-02	Robert Hamilton, N0RN	371	19-May-87
Eldon Boehm, NK9U	303	21-Nov-86	Kevin Naumann, N0WDG	616	17-Nov-02	David Avery, N0HEQ	289	13-Jan-88
Allan Bukowski, N9ZD	300	01-Jun-92	Harry Steger, Jr., W0HMS	530	26-Aug-08	Jeffrey Weinberg, W0QO	281	01-Apr-93
Donald Hlinsky, N9IZU	291	01-Mar-91	Roland Kramer, W0RL	515	21-Jun-01	Philip O'Kunewick, AB0JR	274	24-Feb-00
Timothy Pechtold, AA9BV	268	01-Nov-92	Jeanette Nordman, AB0YX	460	21-Aug-03	Frank Goddard, W0AJY	267	01-Feb-92
Dakota			New England			Southeastern		
John Schwarz, Jr., AE0AL	298	26-Oct-94	Robert Beaudet, W1YRC	367	01-Aug-90	Victor Madera, KP4PQ	452	01-Mar-92
Jeffrey Goodnuff, W0KF	286	17-Jun-03	Lawrence Polowy, KU1L	331	02-Jan-85	Pablo Soto, KP4SJ	369	01-May-92
Shep Shepardson, N0NMZ	232	12-Mar-01	Paul Lux, K1PL	326	25-Jan-85	Val Jacyno, AK4MM	363	08-Nov-11
Daniel Royer, KE0OR	229	01-Jul-91	Stefan Rodowicz, N1SR	326	20-Nov-84	Robert Cumming, Sr., W2BZY	336	29-Jan-97
Dennis Ackerman, KB0OQQ	219	15-Jul-96	Bruce Anderson, W1LUS	325	11-Feb-88	Joseph Patti, N4UMB	314	01-Sep-90
Delta			James Mullen, KK1W	323	01-Mar-91	Southwestern		
Arthur Parry, Jr., WB4BGX	263	01-May-91	Northwestern			Bill Martin, AI0D	973	01-Nov-84
Glenn King, N5GK	233	05-Jun-86	Richard Morgan, KD7GIE	450	11-Aug-00	Fred Bollinger, AB7JF	513	17-Apr-95
Edward Scheufele, AB5RS	224	19-Jan-94	Loren Hole, KK7M	371	06-Sep-84	Steve Gurley, KY7W	408	19-Apr-96
Roger Gray, N5QS	222	01-Mar-93	George Fitkas, N7TQZ	294	01-Dec-92	Joseph Cutitta, W0SL	399	09-Nov-99
Joe Lowenthal, WA4OVO	218	25-May-06	David Brooks, N7HT	282	10-Jun-87	David Morrill, N7TWT	396	20-Jul-00
Great Lakes			S. Riley McLean, W7RIL	273	02-Sep-99	West Gulf		
Charles Hall, W8HF	272	01-Jun-92	Pacific			Franz Laugermann, K3FL	1,023	01-Dec-91
David Schmidt, KI4QH	250	15-Feb-85	Morris Jones, AD6ZH	455	27-Nov-01	Wilbert Cannonier, KK5JJ	454	03-Nov-95
Dale Pritchett, KC8HJL	223	26-Mar-98	Dieter Stussy, KD6LVW	387	27-Jan-94	Adolph Chris Koehler, K5VCR	444	29-Sep-95
Christian Anderson, K8VJ	217	09-Feb-90	Gordon Fuller, WB6OVH	330	06-Sep-84	Gerald Grant, WB5R	441	04-Jan-85
Archie Mack, Sr., AF4EB	215	19-Aug-97	Bill Nichols, NN7K	312	01-Sep-93	David Fanelli, KB5PGY	425	01-Oct-91
			Jim Brunk, N6BHX	266	13-Jul-95			

Strays

Founders Honored For 20 Years of Ham Radio University

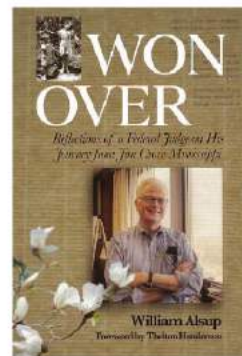
ARRL Long Island Section Manager Jim Mezey, W2KFV (center), presented special recognition awards to the founders of Ham Radio University (www.HamRadioUniversity.org) to mark the 20th anniversary of the annual day-long Amateur Radio educational conference. The event was established in 2000 for hams in the ARRL New York/Long Island Section and beyond to share ideas, knowledge, and fellowship. Held each January, Ham Radio University now

draws more than 300 attendees who benefit from over 30 presentations, forums, and hands-on workshops. Pictured are Neil Heft, KC2KY; Tom Carrubba, KA2D; George Tranos, N2GA; Diane Ortiz, K2DO; Phil Lewis, N2MUN, and Mel Granick, KS2G.



QST Congratulates...

Judge William Alsup, N6XMW, on the publication of his memoir *Won Over*. Alsup was born in Mississippi to parents who believed in segregation and grew up during the epic events of the civil rights movement, finding his way to the right side of history. Alsup graduated from Mississippi State, and went on to Harvard Law School, then to clerk for Justice William O. Douglas, and eventually became a United States District Judge in San Francisco. The book is available at Amazon.com and from other retailers. For more information, see www.newsouthbooks.com.



100, 50, and 25 Years Ago

June 1919

The Treaty of Versailles formally brought World War I to an end on June 28, 1919. *QST* resumed publication that same month, reporting on technical progress made during The Great War and where Amateur Radio and ARRL stand.

- The cover of this "Re-Opening Number" is a greeting from ARRL President Hiram Percy Maxim, W1AW, with the news that "the restrictions on amateur transmitting will be lifted as soon as the President of the United States announces that a state of peace exists."
- The editorial, "A.R.R.L. Loan," explains the plan to borrow working capital from the membership to get *QST* started again and to have a Headquarters office.
- "Receiving Permitted" announces that the federal prohibition against amateurs listening to their receivers has now been lifted.
- "New Developments," by Dr. Radio, explains the vacuum tube discovery made during wartime and how it can be used by hams.
- "The Old Man" returns to cathartically complain about operator problems, this time discussing "Rotten Starting."



June 1969

- The cover cartoon art shows how hams will be heading for the ARRL's National Convention in Des Moines, Iowa, later this month.
- The editorial reminds us how ARRL's "QSL Bureau" functions.
- Lewis McCoy, W1ICP, tells us to "Clean Up Your Harmonics!" so you won't get a dreaded FCC notice for spurious signals.
- Wayne Overbeck, K6YNB, discusses "Three Innovations for Field Day" — a battery-recharging system, a tilt-over portable tower, and an operating desk for a car.
- Following a growing interest in ultra-high frequencies, Dolph Vilardi, WA2VTR, describes "Easily-Constructed Antennas for 1296 MHz" to tackle feed-line efficiency concerns.
- Perry Klein, K3JTE, and William Tynan, W3KMY, give us a quick look at "AMSAT... The Radio Amateur Satellite Corporation," which took form early this year.



June 1994

- The cover photos show "Outdoors and Amateur Radio," while promoting ARRL Field Day and the June VHF QSO Party.
- The editorial discusses "Responsibility," following the FCC's relaxation of rules regarding repeater control operators' accountability for the message content originated by other stations, effective June 1.
- "St. Paul Revisited," by Fred Archibald, VE2SEI, describes how eight hams from Montreal put the Nova Scotian island on the air as CY9CWI, making 5,500 contacts.
- Alan Bloom, N1AL, describes his "Inexpensive Interference Filters," useful for multi-transmitter field days and other contest operations.
- In "Beginner's Boomers: Two Phased Vertical Arrays for 30 Meters," Gary Borich, W5UDV, and Robert Logan, N25A, tell us how to easily build low-profile antennas with gain.
- In "Simple, Effective, Elevated Ground-Plane Antennas," Thomas Russell, N4KG, tells us how to use our grounded towers as a vertical antenna on 160 or 80 meters.



Field Organization Reports

March 2019

Public Service Honor Roll

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

914 K9CSA	195 W02H	K9LGU KA8ZGY KW1U	109 K14UDZ	KM4VTK KM4WHO KD4EAQ
625 KD8TTE	190 W8IM	AD3J KA9QWC N1LL	106 KB3KYH W9EEU AA7BM	WA1LPM K8KRA N2TSO
455 WA3EZN	187 KE8CYC	N2JBA NA7G K4IWW	105 WD8USA N8CJS KC4BOK	WD0BFO WB3FTQ K3YAK
451 WA7PTM	186 KOIBS	125 K2TV	104 W9BGJ	WB0B WB8WKQ
420 W0KCF	184 AD5CQ	124 KA5DON N7IE	88 W8CPG	
417 W7PAT	179 WB8RCR	103 WB8QLT	86 KB8PGW	
354 WM8A	175 KT5SR AL0Y	102 K6JGL	84 WS4P	
315 WM2C	165 K3JL	101 K8AMH	82 KA0DBK KC5OZT KG5NNA	
305 WS6P	160 W4CMH AG9G W4DNA K7WXW	100 N7H WB4RJW KB28Q KN9P	81 KA9IKK KE5HYW	
260 KT2D KW9EMG	159 AD8CM	99 N9VC NX9K N1LAH KB8MAF	82 KD8KBX N3RB W4INK KN4AAG	
248 KD2PLM	155 WB9WKO WC9CW	118 K4VWK	80 AA4XZ KB4CAU K17RF	
235 KK4PUX WD8MWD KC5ZGG	150 AC0KQ WB9QPM	115 N1TF K0PTK KA53B K6JT KE5YTA	79 KC1HHO N6IET	
233 KK7TN	145 W2PH KC1CIC	113 N2DW	78 KA1G	
231 K16LNB	141 WA2BSS	111 WA4VGZ	75 K6RAU AB3WG	
225 W0PZD	140 W3CB KK3F WA2CCN	110 W1KX WD4FSU WA3QLW K4GK W1RVY N1IQI	97 KB1NMO KD8ZCM	
220 K8LPC	139 KD2IWN	109 WB8YLO K6HTN K3IN KA5AZK	96 K9DUR N12W	
218 KB5PGY	135 W3VYQ K8RDN	108 KF5IOU K04OL K2RMF	73 KD2MEN	
205 N8SY	132 N2LJM	107 KA2ZNZ WB8TQZ WB6OTS	71 N3JET	
200 N2WGF W0DSF	130 W5DY	106 W4TTO	70 KC7ASA	
		90 W2PAX		

The following stations qualified for PSHR in previous months but were not reported in this column: (Feb.) K16LNB 414, N3KRX 186, KC1CIC 140, KW1U 130, N1TF 115, N1IQI, W1RVY, KD2JVK 110, WB6UZX 100, N1LAH 99, WA1LPM 90, KC1HHO 78.

Section Traffic Manager Reports

The following Section Traffic Managers reported: AL, AR, AZ, CO, CT, DE, EM, ENY, GA, IA, IL, IN, KY, LA, LAX, MDC, ME, MI, MN, MS, MT, NC, NE, NFL, NLI, NM, NNJ, NTX, OH, OR, SC, SFL, SJV, SNJ, STX, TN, UT, VA, WCF, WI, WMA, WNY, WV, WY.

Section Emergency Coordinator Reports

The following Section Emergency Coordinators reported: AR, AZ, CT, DE, ENY, EPA, EWA, GA, IA, ID, IL, IN, KY, LA, MI, MDC, ME, MN, MO, MS, ND, NLI, NM, NNJ, NNY, NV, OH, OR, PAC, RI, SFL, SJV, SNJ, STX, SV, TN, UT, WCF, WI, WPA, WV, WWA.

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.

WS6P 2077, KK3F 1903, K6HTN 1056, NX9K 1047, WB9WKO 861, K10JO 713, WA3EZN 683, KE5YTA 541, N1LL 519.

The following stations qualified for BPL in previous months, but were not reported in this column: (Feb.) N1IQI 631, KW1U 517.

Silent Keys

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

W1AZG
W1BJ
W1CAN
K1CNC
N1CSQ
K1FFY
KB1FHJ
KC1IOX
W1IZQ
K1QS
WA1TKA
K2ARW
KA2EGV
K2EJN
N2GPP
V2NCB
KA2CHX
♦W3A
♦N3AZ
KB3CAB
♦KB3CGL
K3CKT
KC3EYL
N3FRO
W3FV
K3GBA
N3GT
♦W3LF
KA3RCS
W3STW
AB3TQ
WA4BZX
N4CBI
VD4DIH
K4DKQ
N4DYN
W4EIR
KG4FJR
♦K4HHZ
W4HFR
♦K4JAH
WA4LBI
AF4LG
♦NC4LR
W4LVL
♦WB4LYR
♦NAM
K4NSG
♦KB4CPV
KD4PER
AK4PI
NF4R
K4RBD
KA4RDY
WA4TFE
KA4TXY
K4UPX
♦W4W
W4YV
W4ZWE
KF5ARK
N5BFG
VD5CGS
N5DRA

Grossman, Marvin, Newton, MA
McCaffrey, Paul F., Dracut, MA
Hathaway, John W., Westford, MA
Hammond, Ernest H., Rockland, ME
Reynolds, Wayne H., Scarborough, ME
Adriano, Ronald J., Bradford, RI
Bursch, Lowell, Natick, MA
Conland, Henry H., Storrs, CT
Hyman, Harold, Acton, MA
Smith, Walter P., Naples, ME
Graham, John L., East Durham, NY
Sanford, George A., Norman, OK
Jenkins, Alvin E., Hopewell, VA
Lansing, David, Johnstown, NY
Rappaport, Charlotte A., Holmes, NY
Wantuck, Chris C., Red Bank, NJ
Lapetina, Joseph M., Albany, NY
Collins, Raymond A., Sterling, PA
Stowell, Frederick W., Famer, AL
Moore, Richard B., Fort Myers, FL
Hardy, William A., Georgetown, DE
Barrett, James I., Takoma Park, MD
Burton, David C., Pottstown, PA
Dalton, Simon, Elkton, MD
Bergey, Charles K., Bethlehem, PA
Smith, Samuel C., Jr., Rushland, PA
Slye, W. Russell, Millersville, MD
Murray, Randy, Millsboro, DE
Messerschmidt, Karl F., Myerstown, PA
Tribble, Alfred T., Westminster, PA
Mohler, Glenn R., Mohnton, PA
Williams, Thomas S., Pinellas Park, FL
Rich, Thomas G., Jr., Garner, NC
Smith, Tom H., Campbellsville, KY
Elder, James "Lem", Phenix City, AL
Little, John H., Stephens City, VA
Rhoden, Jess B., Maynard, MA
Feld, Marc L., Jeffersonstown, KY
Campbell, James S., Campbellsville, KY
Reidenbach, David R., Manassas, VA
Hurst, Jack A., Jr., Hudson, OH
Frey, James G., North Bend, OH
Randall, Gary D., Muncie, IN
Royster, Larry H., Raleigh, NC
Cull, Duncan E., Louisville, KY
Bryant, James E., Sr., Chatree, AL
Long, Madison M., Crozier, VA
Baker, William T., Jr., Saint Augustine, FL
Hunt, Jerry R., Yorktown, VA
Guy, Lyndell "Coley", Central City, KY
Modlin, Carol W., Jr., Savannah, GA
Hathaway, David A., Sr., Hodgenville, KY
Baldini, Ernest A., Rockledge, FL
Selby, Robert W., Shelby, NC
Berry, John P., Winfield, AL
Garrett, Stuart "Dave", Jr., Palm Coast, FL
McLemore, Garry S., Hampton, VA
Osborn, Hilary H., Jr., Loudon, TN
Brafford, Melvin "Mickey" G., Goode, VA
Shelton, Thomas B., Toney, AL
Haines, William C., Jr., Aransas Pass, TX
Johnson, Earl V., II, Dallas, TX
Skrogstad, Merin "Jim", Tulsa, OK
Saale, Maurice A., Sr., Elsberry, MO

W5GBX
N5IAG
W5JYJ
♦W5KPH
K5LD
♦W5LQU
♦W5PDG
N5SAC
♦W5TAW
W5TGM
KF5UJ
♦W5UNF
KF5WKL
K5WKR
KB5WMY
W6AN
WD6CKT
N6DKG
W6ERV
K6FK
WB6GMJ
N6JAE
K6LAK
K6LXH
N6MMF
AF6PZ
KR6R
NM6T
AA6TV
♦K6TJZ
KE6VRD
K7BNQ
♦W7DQM
K7KI
♦K7LS
W7MH
WA7NDD
N7ODN
KC7QRH
KG7QK
KF7SGM
K7VQF
WA7ZZZ
K8BAS
W8BYB
K8DT
♦W8EDR
K8HEP
♦N8KZX
♦K8LZ
N8MKU
W8NPU
N8OB
♦K8QMV
W8PT
WD8Q
KD8QE
KC8SGG
K8STK
♦K8TX
A8U

Breaux, Brandon G., Beaumont, TX
Thompson, Charles A., Dallas, TX
Lobaugh, Robert J., Jr., Sinton, TX
Van Der Weide, Sam W., San Antonio, TX
Carpenter, L. D., Garland, TX
Cummings, Forest M., Corinth, TX
Belham, John, Jr., Gulfport, MS
Le Friant, Andre L., New Orleans, LA
Graham, Donald E., Norman, OK
Domiano, Carlo J., Gretna, LA
Lambright, J. D., Montgomery, TX
Jensen, Arnold R., Houston, TX
Hill, Paul D., Cache, OK
Borgeson, Karl M., Garland, TX
McNair, Carl, Bossier City, LA
Nakamura, Yoshio S., Los Angeles, CA
Prader, Gary, Salinas, CA
Bullis, Danny E., Lake Havasu City, AZ
Sly, Ervin L., Spokane Valley, WA
Meyers, Andrew R., San Diego, CA
Leitzel, Gail J., Lake Havasu City, AZ
Stollar, Marvin D., Fresno, CA
Cameron, Wilfred "Al", Evergreen, CO
Rosenberg, Phillip A., Saint James City, FL
Law, Norma, Claremont, CA
Lovelace, Gerald M., Milpitas, CA
Mullett, Charles E., Santa Paula, CA
Bertacchi, Jerome J., Sacramento, CA
Apte, Donald R., Broomfield, CO
Girard, Paul W., Concord, CA
Elton, Le Rae, Lake Isabella, CA
Crossman, Clair "Sam" A., Burlington, WA
Maricle, James A., Bellingham, WA
Jorden, Bruce W., Jr., Tucson, AZ
Frank, Harold W., Valrico, FL
Heenan, Michael L., Modesto, CA
Griffith, James L., Rigby, ID
Myers, John "Jack" E., Bozeman, MT
Burns, James W., Fort Angeles, VA
Dombrosky, Richard M., Las Vegas, NV
Boswell, Randolph W., Poulso, WA
Gilbert, Ray T., Sequim, WA
Etchamendy, John B., Carson City, NV
Sheffer, Brent A., Westerville, OH
Busard, Roderick J., Livonia, MI
Panyard, Joseph L., Suttons Bay, MI
Campanella, Dr. Angelo J., Hilliard, OH
Lyke, Emerson "Ray", La Salle, MI
Slepecky, John, Jr., Brooklyn, OH
Gillispie, Stephen A., Hurricane, WV
Salem, William R., Brook Park, OH
Orr, William, Columbus, OH
Brown, Robert A., Marion, OH
White, Opal M., Mentor, OH
Shenk, William G., Interlochen, MI
Koenig, Henry L., Lucas, OH
De Verna, Stanley E., Lambertville, MI
Clem, Philip E., De Graff, OH
Creech, Thomas D., Kent, OH
Merrick, Dan, III, Reynoldsburg, OH
Degroat, John A., Bay City, MI

W8UGG
N8UW
KB8VCT
W8W
N8WMN
K8ZJU
AC8BW
KB8COH
♦KA8DOD
WB8GCU
♦WD8ITQ
KC8LSG
♦W8MLP
♦NN8O
WA8QJC
♦K9QA
K9RFX
W9RWS
W9VCS
N9ZFG
♦K9BE
K9EZ
♦K9DVZ
♦KA9QIT
W9KFS
KD9KHC
WB9OOL
WB9SFZ
♦WA9SON
KB9TLC
♦W9TCM
K9WGN
DL9DQW
GM9JJ
VE6BV

Wolfe, Paul B., Plain City, OH
Blair, Charles, Dayton, OH
Burton, Eddie D., Ironton, OH
Paar, Daniel L., Trezevant, TN
Cruce, Duane "Cof" H., Philadelphia, TN
Stoner, Beverley "West" M., Ann Arbor, MI
Lowney, Bernard "Bo" W., Waverly, NE
Bishop, Brenda, Mason, IL
Bleifield, Robert D., Morris, IL
Leatherman, Bob, Avilla, IN
Geiger, Robert H., Columbia City, IN
Anway, Dorothy, Superior, WI
Parrish, Martin L., Crystal Lake, IL
Pape, Earl E., Decatur, IL
Champion, Norman E., Rochester, IL
Lochner, Richard A., Knox, IN
Mejia, Paul A., Kalamazoo, MI
Smith, Richard W., Fort Atkinson, WI
Northern, Robert, Fishers, IN
Sherwin, Major W., Greencastle, IN
Heimerl, Donald A., Madison, MN
Wamhoff, Jon R., Longmont, CO
Scholten, John J., Ames, IA
Johns, James R., Jr., Tioga, TX
Hohlfeld, David H., Derby, KS
Barwick, William A., Denver, CO
Halley, James A., O'Fallon, MO
Holder, Roland, Hinton, IA
Foster, Norman D., Liberty, MO
Currie, Jim M., Sac City, IA
Brereton, Thomas F., Colorado Springs, CO
Thompson, Judith, Sun City West, AZ
Fendler, Reinhard, Buxdorf, Germany
Anderson, David, Dunfermline, Fife, United Kingdom
Frauscher, Hellmut, Calgary, AB, Canada

♦ Life Member, ARRL

• Former call sign

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

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

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

HAM RADIO OUTLET

WWW.HAMRADIO.COM

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- Super Sharp "Roofing" Filters • High Performance Yaesu Custom- designed 32-bit Floating Point DSP • True Analog Meter Precision



FTDX3000 | 100W HF + 6M Transceiver

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



FT-991A | HF/VHF/UHF All Mode Transceiver

- 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



FTDX1200 | 100W HF + 6M Transceiver

- Triple Conversion Receiver With 32-bit Floating Point DSP • 40 MHz 1st IF with selectable 3 kHz, 6kHz & 15 kHz Roofing Filters • Optional FFT-1 Supports AF-FFT Scope, RTTY/PSK31 Encode/Decode, CW Decode/Auto Zero-In • Full Color 4.3" TFT Display



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



FT-857D | Ultra Compact HF/VHF/UHF

- 100w HF/6M, 50W 2M, 20W UHF • DSP included • 32 color display • 200 mems • Detachable front panel (YSK-857 required)



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-100DR | C4FM FDMA/FM 144/430 MHz Xcvr

- Power Packed System Fusion Transceiver • High Audio Output Power • Rugged Powerful Transmitter • Integrated 66ch High Sensitivity GPS • 1200/9600 APRS Data Communications



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-2DR C4FM/FM 144/430 MHz Xcvr

- Analog/C4FM Dual Monitor (V+V/U+U/V+U) • System Fusion compatible • 1200/9600 APRS Data Communications • Integrated 66ch High Sensitivity GPS • Wide Band Receiver • Snapshot Picture Taking Capability With Optional MH-85A11U



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 Flash-light, Alarm and Quick Home Channel Access

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- Double superheterodyne with image rejection mixer



IC-9700 | All Mode Tri-Band Transceiver

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



IC-R8600 | Wideband Software Defined Receiver

- 10 kHz to 3 GHz Super Wideband Coverage • P25, NXDN™, dPMR™, D-STAR Mode • Large Dot Matrix LCD Display w/ Quick Spectrum Scope • SD Card Slot • Remote Control Function



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-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



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



IC-7700 | HF/50MHz Transceiver

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



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



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

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



IC-7610 | HF/50 MHz All Mode Transceiver

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IC-2300H | VHF FM Transceiver

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IC-R30 | Digital/Analog Wideband Xcvr

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



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-2730A | VHF/UHF Dual Band Transceiver

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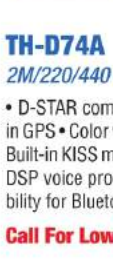


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- 65 Watt • 200 Memories • CTCSS/DCS • Mil-Std specs • Hi-quality audio

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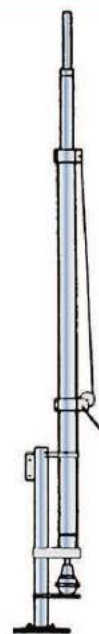
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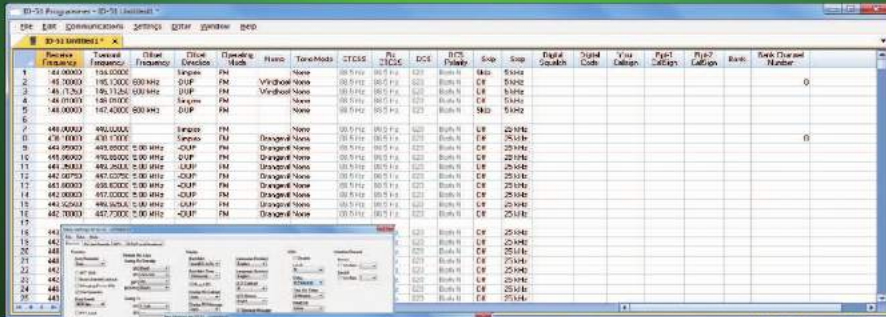
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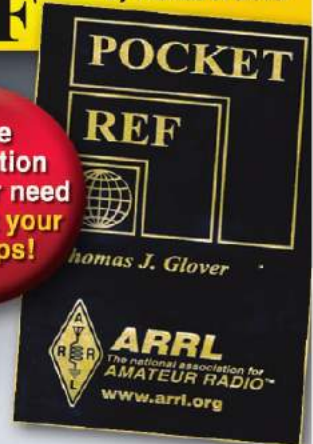
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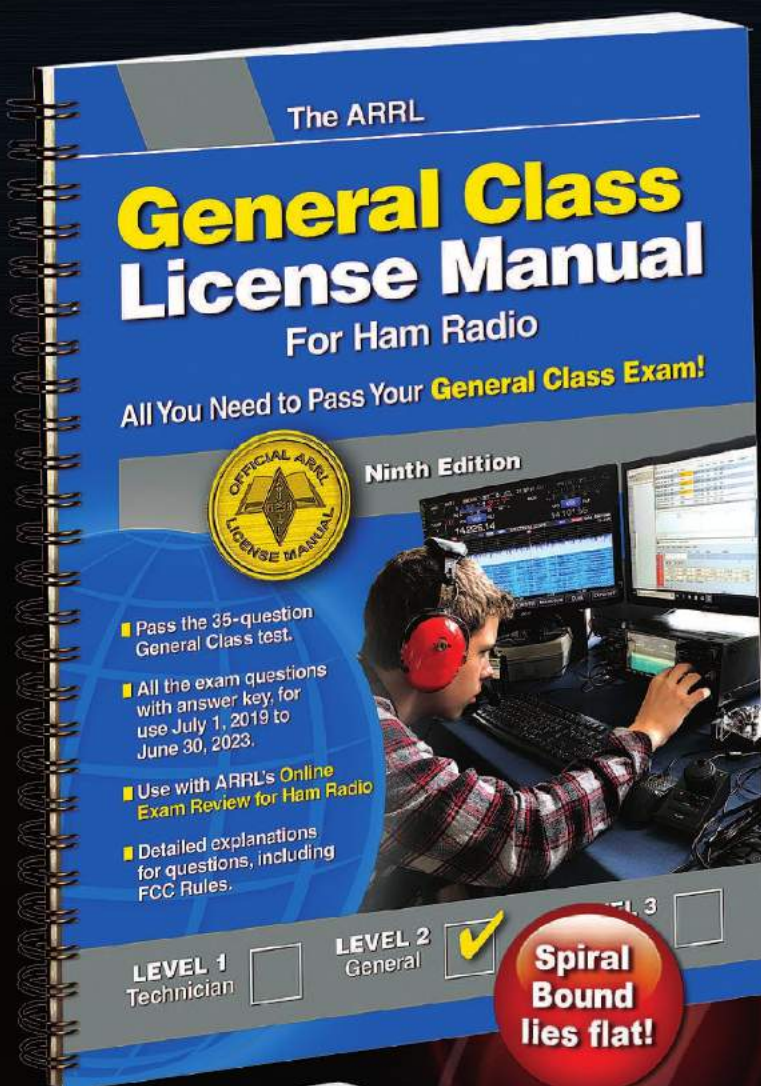
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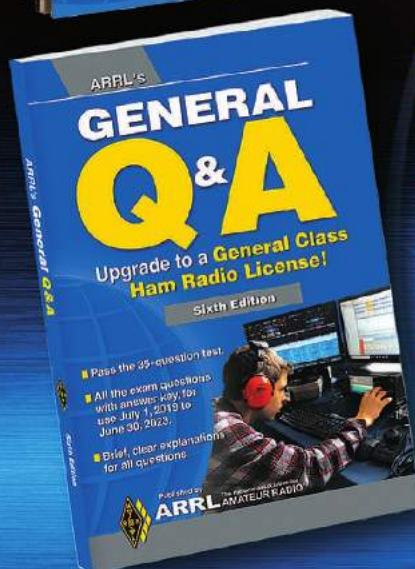
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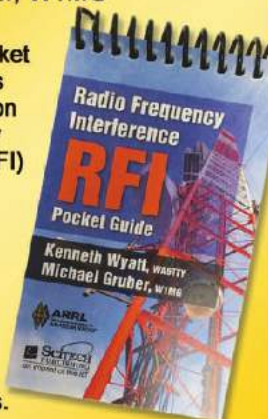
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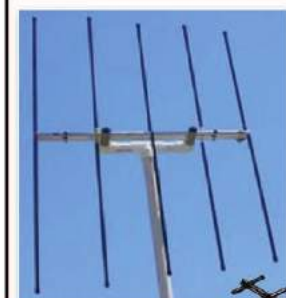
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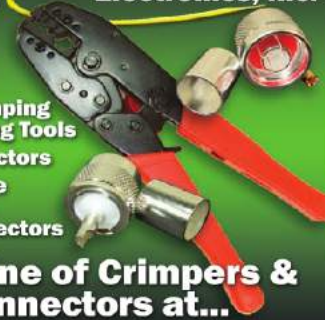
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Brake Power	9000 in.-lbs.
Brake Construction	Electric Wedge
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Control Cable Conductors	8
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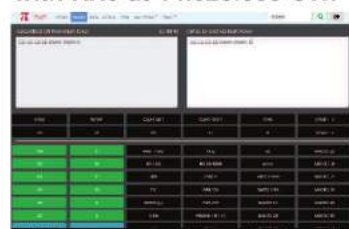
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RigPi Web: W1AW Data from QRZ XML subscription. Rig-Pi also has onboard FCC database.

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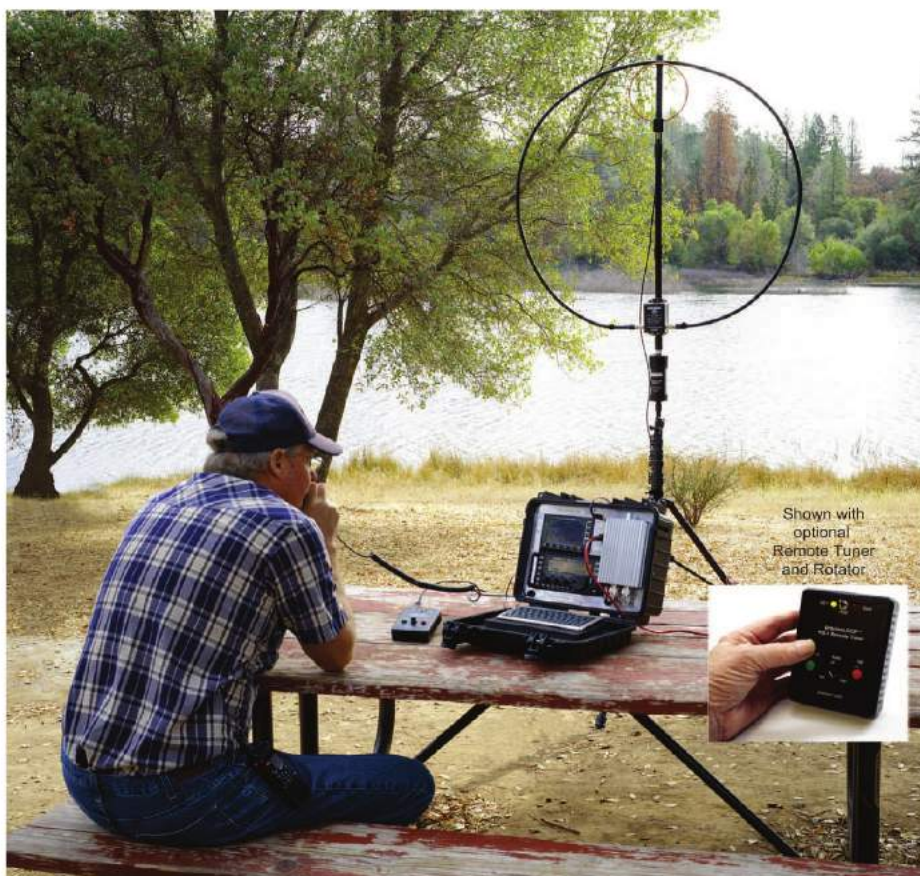
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TI-1 Introduction to Wireless Technology

Date	Location
July 15-19, 2019	Dayton Amateur Radio Assoc., Dayton, OH
July 22-26, 2019	ARRL Headquarters, Newington, CT

TI-2 Remote Sensing and Data Gathering

Date	Location
July 8-12, 2019	ARRL Headquarters, Newington, CT

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MFJ-1778 matching section ending in SO-239 connector for your coax feedline.
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Use horizontally or as Inverted Vee or Sloper with just one support. 1500 Watts.

Operate all bands 80-10 Meters with an antenna tuner and even 160M with ground.

Fully assembled with ceramic end and fiberglass center insulators. *Hang and Play™* - add coax, rope to hang and you're on air!

MFJ-1778M, \$49.95. 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
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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
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Cover all bands with one single wire and no tuner!

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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-sag" end insulator slides over branches, leaves.

Toss over a high limb for inverted-V or sloper or go vertical with an inverted-L.

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EFHWs naturally resonate on the 1/2-wave fundamental frequency and odd/even harmonics. Covers 80/40/30/20/17/15/12/10 Meters without traps, stubs or resonators.

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MFJ-1984HP, \$84.95. Like MFJ-1982HP but 40-10M. 66 feet jacketed wire.

See www.mfjenterprises.com for 30 Watt QRP and 300 Watt models.

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MFJ-17758
\$99.95
80/40 Meters

MFJ-17754, \$64.95. 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.

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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-1708B-SDR-S, \$109.95. SMA connector for your SDR.

MFJ-1708SDR, \$89.95. Original model for HF/VHF.

New B series improvements...

The original MFJ-1708 series used one relay and wires to connect the SO-239s. The new B-series uses four relays and connectors on a single pc board. This gives you > 50 dB isolation at 300 MHz and > 68 dB at 50 MHz.

SWR < 1.16:1 at 50 MHz and < 1.75:1 at 450 MHz at the transmit port. Mute output is a selectable short or open to ground. Use "boat anchors" or modern receivers or key a linear amplifier. Receiver input protection prevents overload from nearby high power signals and

from receive to transmit. A hybrid splitter on SDR models reduces loading effect and gives > 15 dB isolation between the SDR REC and XCVR ports to reduce interference. The original MFJ-1708 series is still available.

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Pull weak signals out of static crashes, atmospheric, man-made and power line noise!

Hear signals 500 KHz to 30 MHz cleaner, quieter than ever before! Power line noise disappears. Rotate its figure 8 pattern and its extremely deep null to completely eliminate an interfering signal or greatly peak a desired one. Fully protected state-of-the-art Gali MMICs in push-pull gives you a preamp with extremely high dynamic range, low IMD and 25 dB of low noise gain. Excellent performance on strong and weak signals without overload. 36-inch dia. loop. 1-in. OD 6061 aluminum.



MFJ wideband SDR Discone Antenna

Receives 25-1300 MHz

MFJ ultra wide-band Discone Antenna receives 25-1300 MHz. Perfect for all band SDR reception. Covers 10, 6, 2 Meters, 220 and 440 MHz and 33/23 CM ham bands and everything in between. It is excellent for monitoring multiple bands simultaneously using multiple SDRs and a multi-coupler. Also test any transmitter 50-1300 MHz using a single discone and single coax. Handles 200W. Includes 50 feet coax, stainless steel elements and mounting hardware.

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Make your SDR receiver come alive with HF signals, .3-40 MHz, while rejecting interference with MFJ-1020C tuneable indoor active antenna! Gain control, telescoping whip.

MFJ-1020C \$109⁹⁵

Untuned Indoor SDR Active Antenna

MFJ-1022, \$73.95.

Hear weak, noisy VLF to UHF signals. Noise-less feedback gives excellent low noise reception. Handles strong signals.

Active Outdoor Antenna

MFJ-1024 World Radio TV Handbook \$169⁹⁵

says "MFJ-1024 is a first rate, easy-to-operate active antenna, quiet, excellent dynamic range, good gain, very low noise factor,

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HF SDR Preselector

Tuneable

MFJ-1040C lets you copy weak, noisy SDR signals from 1.8 to 54 MHz. Greatly tunes out and reject out-of-band interference. Up to 20 dB gain. Has gain control. Cascode FET/bipolar transistor gives low noise, high gain without overloading. Switches for 2 antennas and 2 receivers. SO-239s. Has 20 dB attenuator. Automatically bypasses when transmitting or use PTT. 6 1/2" W x 2 1/2" H x 4 D inches.



MFJ-1040C \$129⁹⁵

MFJ LW/MW/SW SDR Preselector/Tuner

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MFJ-956 \$74⁹⁵



MFJ RF Sense Transmit/Receive Switch

Switches your antenna from receiver to transmitter using a relay. Shorts your receiver to ground during transmit. Use RF sensing with adjustable delay or PTT line. Has selectable open/short mute.

MFJ-1708B, \$109.95.



Auto switch XCVR between 2 antennas

Switches switches separate transmit and receive antennas on transceivers with only one antenna port. Example: Efficient 75M dipole for XMIT and MFJ-1708B low noise MFJ loop for receive -- *no static crashes!*

MFJ-1707B, \$109.95.



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Fast/slow tune remote control.

Highly efficient all-welded construction



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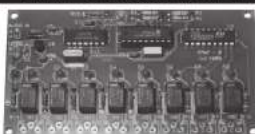


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 Sunday, 2 June 2019



Dr. Ir. Michael Peeters –
 Program Director, Connectivity +
 Humanized Technology, imec
**"Do the Networks of the
 Future Care about the
 Materials of the Past?"**

IMS Plenary Session Speaker
 Monday, 3 June 2019



Dr. William Chappell –
 Director of the Microsystems
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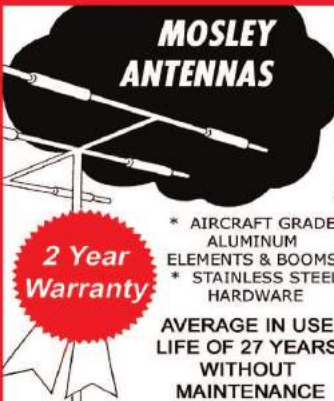


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MFJ-249C Analyzer

MFJ-249C, \$279.95

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



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MFJ VNA Antenna Analyzer

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

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- MFJ-5510C, \$12.95.** 12VDC cigarette lighter adapter.
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MFJ_269C_ANALYZERS2_061213_QST_040819DS

QST QuickStats

Online QuickStats Poll Results for January 1 through February 1, 2019.
Get on the web and vote today at www.arrl.org/quickstats!

Did you participate in ARRL Field Day in 2018?

Yes. 53%

No. 47%



If you operated during ARRL Field Day last year, were you alone or with a group?

Alone. 13%

With a group. 40%

I didn't operate Field Day last year. 47%



Have you begun planning for ARRL Field Day 2019?

Yes. 48%

No. 32%

I don't intend to participate in Field Day this year. 20%

[Robert Hamrick, WA4RH, photo]

If you've started making plans for this year, will you operate solo or with a group?

With a group. 42%

Solo. 6%

I haven't made plans yet. 32%

I don't intend to participate in Field Day this year. 20%



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You get a highly efficient L-network, 6-1600 Ohm matching at 300 Watts SSB/CW or extra wide 6-3200 Ohm matching at 150 Watts SSB/CW, 1.8-30 MHz coverage, Cross-Needle and digital meters, audio SWR meter, backlit LCD, remote control port, radio interface, heavy-duty 16 amp/1000V relays.

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MFJ-993B
\$269.95

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MFJ-994B \$359.95

Like MFJ-993B but handles 600 Watts SSB/CW, matches 12-800 Ohms, 10,000 memories. Does not have LCD display, antenna switch, 4:1 current balun, audio SWR meter/feedback. 10W x 2 3/4 H x 9D in.

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MFJ-998 \$699.95

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300 Watt Extra Wide Range SWR/Wattmeter, 10000 VA Memories



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200 Watt Compact Digital Meter, Ant Switch, Wide Range



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200 Watt MightyMite™ Matches IC-706, FT-857D, TS-50S



MFJ-939KIY \$159.95

No extra space needed! Just set your IC-706/7000, FT-857D, TS-50S on top of this matching low-profile automatic tuner – it's all you need for a completely automated station using any antenna! Just tune and talk!

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Fully weather-sealed for remote Outdoor/Marine use! Tough, durable, built to last the elements for years.

G5RV Antenna



MFJ-1778 \$59.95

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/feetpoint insulators. Glazed ceramic end insulators. All hand-soldered connections. Add coax, some rope and you're on the air! **MFJ-1778M, \$49.95.** G5RV Junior. Halfsize, 52 ft. 40-10M with tuner, 1500 Watts.



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New, Improved MFJ-989D 1500 Watt legal limit Antenna Tuner

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New, improved MFJ-989D legal limit antenna tuner gives you better efficiency, lower losses and a new true peak reading meter. It easily handles full 1500 Watts SSB/CW, 1.8 to 30 MHz, including MARS/WARC bands.

New, dual 500 pF air variable capacitors give you twice the capacitance for more efficient operation on 160 and 80 Meters.

New, improved AirCore™ Roller Inductor gives you lower losses, higher Q and handles more power more efficiently.

New, TrueActive™ peak reading Cross-Needle SWR/Wattmeter lets you read true peak power on all modes.



MFJ-989D \$439.95

Includes six position ceramic antenna switch, 50 Ohm dummy load, indestructible multi-color Lexan front panel with detailed logging scales and legends.

The MFJ-989D uses the superb time-tested T-Network. It has the widest matching range and is the easiest to use of all matching networks. Now with MFJ's new 500 pF air variable capacitors and new low loss roller inductor, it easily handles higher power much more efficiently.

New, high voltage current balun lets you tune balanced lines at high power with no worries.

New, crank knob lets you reset your roller inductor quickly, smoothly and accurately.

New, larger 2-inch diameter capacitor knobs with easy-to-see dials make tuning much easier.

New, cabinet maintains components' high-Q. Generous air vents keep components cool. 12¹/₂W x 6H x 11⁵/₈D inches.

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MFJ-986 Two knob Differential-T™



MFJ-986 \$389.95

Two knob tuning (differential capacitor and AirCore™ roller inductor) makes tuning foolproof and easier than ever. Gives minimum SWR at only one setting. Handles 3 kW PEP SSB amplifier input power (1.5 kW output). Gear-driven turns counter, lighted peak/average Cross-Needle SWR/Wattmeter, antenna switch, balun. 1.8 to 30 MHz. 15W x 4¹/₂H x 10³/₄D in.

MFJ-962D compact kW Tuner



MFJ-962D \$339.95

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. 10⁷/₈W x 10³/₄H x 4¹/₂D in.

MFJ-969 300W Roller Inductor Tuner



MFJ-969 \$244.95

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. 10¹/₂W x 3¹/₂H x 9¹/₂D inches.

MFJ-949E deluxe 300 Watt Tuner

More hams use MFJ-949s than any other antenna tuner in the world! Handles 300 Watts Full 1.8 to 30 MHz coverage, custom inductor switch, 1000 Volt tuning capacitors, full size peak/average lighted Cross-Needle SWR/Wattmeter, 8 position antenna switch, dummy load, QRM-Free PreTune™, scratch proof Lexan front panel. 10⁵/₈W x 3¹/₂H x 7D inches. **MFJ-948, \$179.95.** Economy version of MFJ-949E, less dummy load, Lexan front panel.



MFJ-949E \$199.95

MFJ-941E Super Value Tuner

Most for your money! 300 Watts PEP, 1.8-30 MHz, lighted Cross-Needle SWR/Wattmeter, 8 position antenna switch, 4:1 balun, 1000 volt capacitors, Lexan front panel. 10¹/₂W x 2¹/₂H x 7D in. **MFJ-941EK, \$139.95.** Tuner Kit - Build your own!



MFJ-941E \$159.95

MFJ-945E HF/6M mobile Tuner

Extends your mobile antenna bandwidth so you don't have to stop, go outside and adjust your antenna. Tiny 8W x 2H x 6D in. Lighted Cross-Needle SWR/Wattmeter. Lamp and bypass switches. Covers 1.8-30 MHz and 6 Meters. 300 Watts PEP. **MFJ-20, \$7.95**, mobile mount.



MFJ-945E \$149.95

MFJ-971 portable/QRP Tuner

Tunes coax, balanced lines, random wire 1.8-30 MHz. Cross-Needle Meter. SWR, 30/300 or 6 Watt QRP ranges. Matches popular MFJ transceivers. Tiny 6¹/₂W x 2¹/₂H x 6D in. **MFJ-971 \$139.95**



MFJ-901B smallest Versa Tuner

MFJ's smallest (5W x 2H x 6D in.) and most affordable wide range 200 Watt PEP Versa tuner. Covers 1.8 to 30 MHz. Great for matching solid state rigs to linear amps. **MFJ-901B \$109.95**



MFJ-902B Tiny Travel Tuner

Tiny 4¹/₂W x 2¹/₄H x 3D inches, full 150 Watts, 80-6 Meters, has tuner bypass switch, for coax/random wire. **MFJ-904H, \$159.95.** Same but adds Cross-needle SWR/Wattmeter and 4:1 balun for balanced lines. 7¹/₄W x 2³/₄H x 2³/₄D inches.



MFJ-902B \$119.95

MFJ-16010 random wire Tuner

Operate all bands anywhere with MFJ's reversible L-network. Turns random wire into powerful transmitting antenna. 1.8-30 MHz. 200 Watts PEP. Tiny 4W x 2H x 3D in.



MFJ-16010 \$74.95

MFJ-9201 QRPocket™ Tuner

80-10 Meters, 25 Watts. 12 position inductor, tune/bypass switch, wide-range T-network, BNCs. 4W x 2⁵/₈H x 1¹/₂D 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 2¹/₂H x 3D in.



MFJ-921/924 \$99.95

MFJ-931 Artificial RF Ground

Eliminates RF hot spots, RF feedback, TV/IRFI, weak signals caused by poor RF grounding. Creates artificial RF ground or electrically places far away RF ground directly at rig. **MFJ-934, \$229.95.** Artificial ground/300 Watt Tuner/Cross-Needle SWR/Wattmeter.



MFJ-931 \$119.95



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For quick put-up and take-down, light-duty models have Twist & Lock sections and heavy-duty thick wall models use military style QuickClamps™ or stainless steel hose clamps.

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Use multiple telescoping masts to make loops, quads, rotatable dipoles even beams.

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So lightweight you can take them anywhere!

MFJ's most popular MFJ-1910 is 33 feet long, 3.3 lbs.

MFJ-1910, \$89.95. 33 ft., light duty w/top tie ring.

MFJ-1911, \$99.95. 20 ft., light duty w/top tie ring.

MFJ-1913, \$99.95. 28 ft., lightweight w/top tie ring.

MFJ-1915, \$149.95. 25 ft., for heavier duty use.

MFJ-1916, \$169.95. 34 ft., for heavier duty use.

MFJ-1917, \$179.95. 43 ft., heavier duty w/top tie ring.

Super-strong .125" Thick-Wall Fiberglass Masts

Use for temporary or permanent wire antennas, small beams or verticals. **Best seller** is 50 ft. long, just 26 lbs.

Heavy Duty Models: All have QuickClamps™

MFJ-1908HD, \$274.95 is 48 ext., 7.75-ft. collapsed, has 2 1/2" OD bottom, 1" OD top, seven 7.75-ft. sections, 24 lbs.

MFJ-1906HD, \$234.95 is 38' extended, 6 feet collapsed, has 2 1/2" OD bottom, 1" OD top, seven 6-foot sections, 24 lbs.

MFJ-1904HD, \$169.95 is 25' extended, 4 feet collapsed, has 2 1/2" OD bottom, 1" OD top, seven 4-foot sections, 14 lbs.

MFJ-1904H, \$149.95. 22' ext., 5' collapsed, 9 lbs. 2 1/2" OD.

MFJ-1902H, \$129.95. 10' ext., 38" collapsed, 5 lbs. 2 1/2" OD

Standard Models: H models have QuickClamps™

MFJ-1906, \$149.95/MFJ-1906H, \$199.95, 33 feet, ext., 6 ft. collapsed, six 6-ft. sections, 13 lbs. 2" bottom, 3/4" top OD.

MFJ-1908, \$189.95/MFJ-1908H, \$244.95, 41' ext., 7.75 ft. collapsed, six 7.75-ft. sect., 16 lbs. 2" bottom, 3/4" top OD.

Mast Accessories

MFJ-1900, \$74.95. Mount clamps mast to mounting pipe.

MFJ-13S, \$64.95. 5 Military QuickClamps™. Fit 3/4" to 2" OD.

MFJ-13HD, \$84.95. Extra set clamps, 1- 2 1/2" masts.

Mast Guy Ring Sets

Fits masts 3/4" to 1 1/4" dia OD. **MFJ-2830X, \$7.95, fiberglass;** **MFJ-2840X, \$8.95, aluminum.**

Left: Stainless Steel Hose Clamps recommended for permanent installations. Fiberglass is slotted.

Right: UV protected Military grade QuickClamps. Guy 2 levels when fully extended.

18' Telescopic Mast & Tripod

MFJ-1919EX, \$169.95.

Put your antennas up high anywhere with this super-strong 18 foot telescoping fiberglass mast and MFJ-1919 heavy duty steel tripod. QuickClamps™ lower mast to 5 feet. Mast has thick 1/8 in. wall, .75" top, 1.5" bottom dia. 15 lbs. Steel tripod has braced triangle base, non-skid feet, mast lock.

MFJ-1918EX, \$99.95.

MFJ-1918 tripod has super strong 9.5 foot telescoping fiberglass mast. 3.8 feet collapsed. QuickClamps™. Thick 1/8 inch wall, .75" top, 1" bottom diameters. 6.5 lbs.

Tripods Only

MFJ-1921, \$179.95, Giant

tripod base spreads to 8 feet! Supports massive antennas.

Adjustable length non-skid legs accommodates uneven ground surfaces. Optional foot

anchors MFJ-1905, \$29.95, see Tripod Anchors bottom right.

MFJ-1919, \$99.95, Large tripod base spreads to 4.8 feet.

Supports 100 pounds. 7.8 feet, 1.4 inch diameter mast.

4.5H x .5D feet collapsed. 9.75 lbs.

MFJ-1918, \$59.95, Smaller tripod base spreads to

2.75 ft. Support 66 lbs. 6 foot, 1" dia. mast. 3.2H x .3D ft.

collapsed. 6.75 lbs.

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Quarter wave performance on 40 Meters, halfwave on

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SSB/CW.

Use as temporary, portable or permanent antenna

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Includes four 12 foot radials. Current

balun reduces feedline radiation and pattern distortion.

MFJ-2980

\$109.95

40-6 Meters

MFJ-2982

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80-6 Meters

600 Watts

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Build your own

80-6 Meter mini-dipole using two HF mobile whips! Only

MFJ-347 mount isolates dipole elements and lets

you use a balun to give a true balanced dipole.

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aluminum. Use mast up to 1 1/4" OD.



MFJ-347
\$21.95

3/8-24 Hamstick

Mount 3/8-24 HF/VHF hamsticks vertically or horizontally on masts up to

1 inch. Built-in SO239 connector.

MFJ-342T \$11.95

MFJ Balcony Mount

Mount multiple HF/VHF hamsticks, verticals, dipoles vertically and/or horizontally on your apartment/condo balcony. High-strength aircraft

aluminum extends out 14". Two U-bolts mount up to 1 1/2" diameter.

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Securely anchor tripod to ground with these 3 stainless steel foot braces and your stakes. For high winds, un-level ground, tall antennas. Fits legs to 1 1/2" OD.

Tripod Anchors

Securely anchor tripod to ground with these 3 stainless steel foot braces and your stakes. For high winds, un-level ground, tall antennas. Fits legs to 1 1/2" OD.

MFJ-1905 \$29.95

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ARRL's **HF Dipole Antennas for Amateur Radio** is a collection of 20 HF dipole antenna designs published in *QST*, ARRL's membership journal, between 2000 and 2017. It includes innovative antenna projects for single- and multiband antennas, as well as antennas for portable applications.

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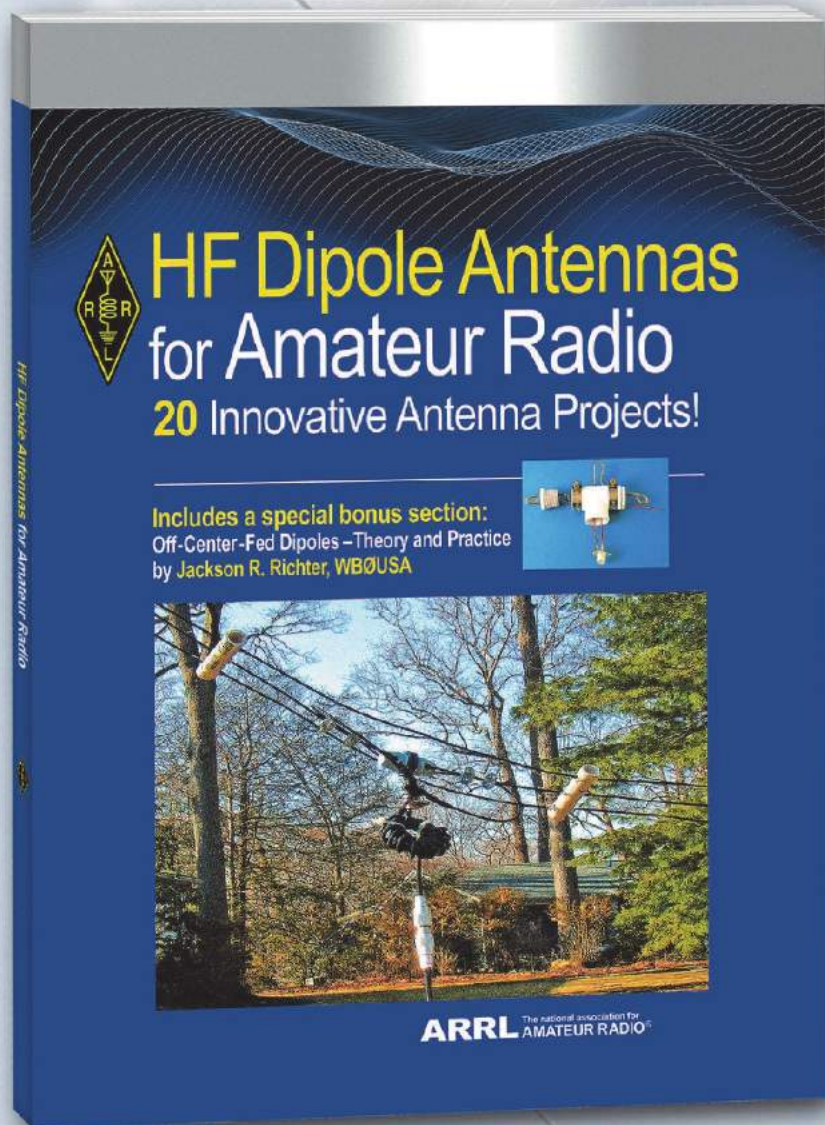
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- Six Band Loaded Dipole Antenna
- The Classic Multiband Dipole
- A Dipole Curtain for 15 and 10 Meters
- K8SYL's 75 and 10-Meter Dipole
- The N4GG Array

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- The W0IH Tunable 80 Meter Dipole
- A Coaxial Cable Vertical Dipole Antenna
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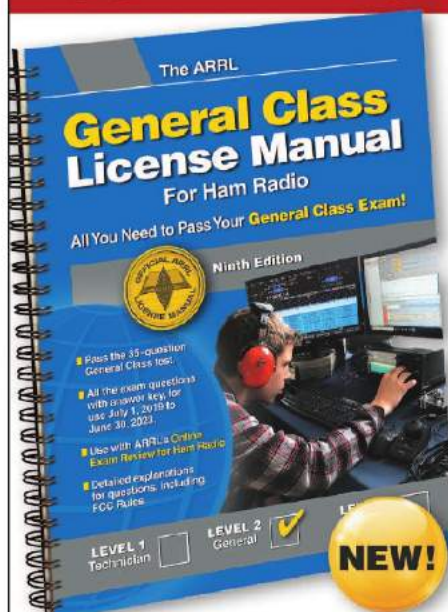
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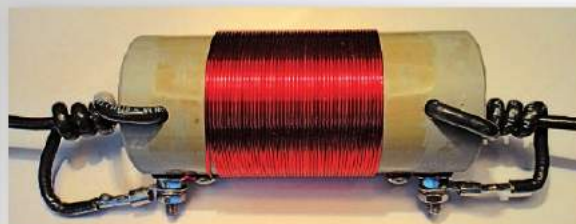
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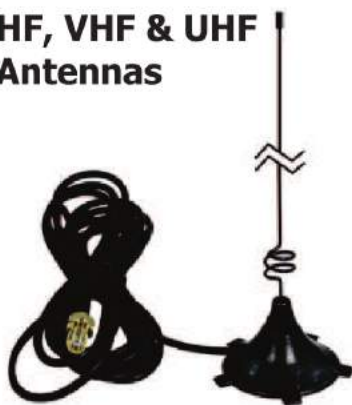
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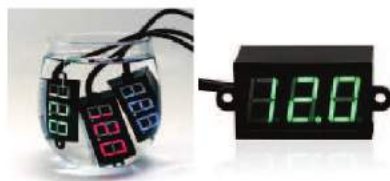
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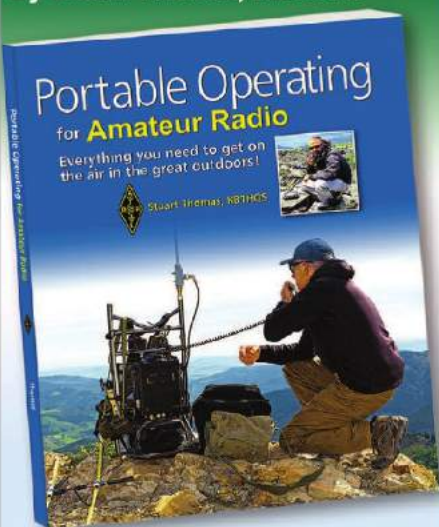
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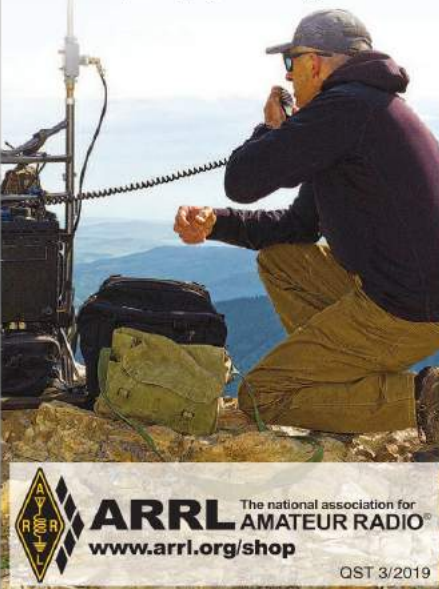


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Issue	Reservation Date	Materials Due Date
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August 2019 QST	Monday, June 10, 2019	Thursday, June 13, 2019

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