Listen In: ARRL Launches a New Podcast for New Hams Page 70

QST
DIGITAL EDITION

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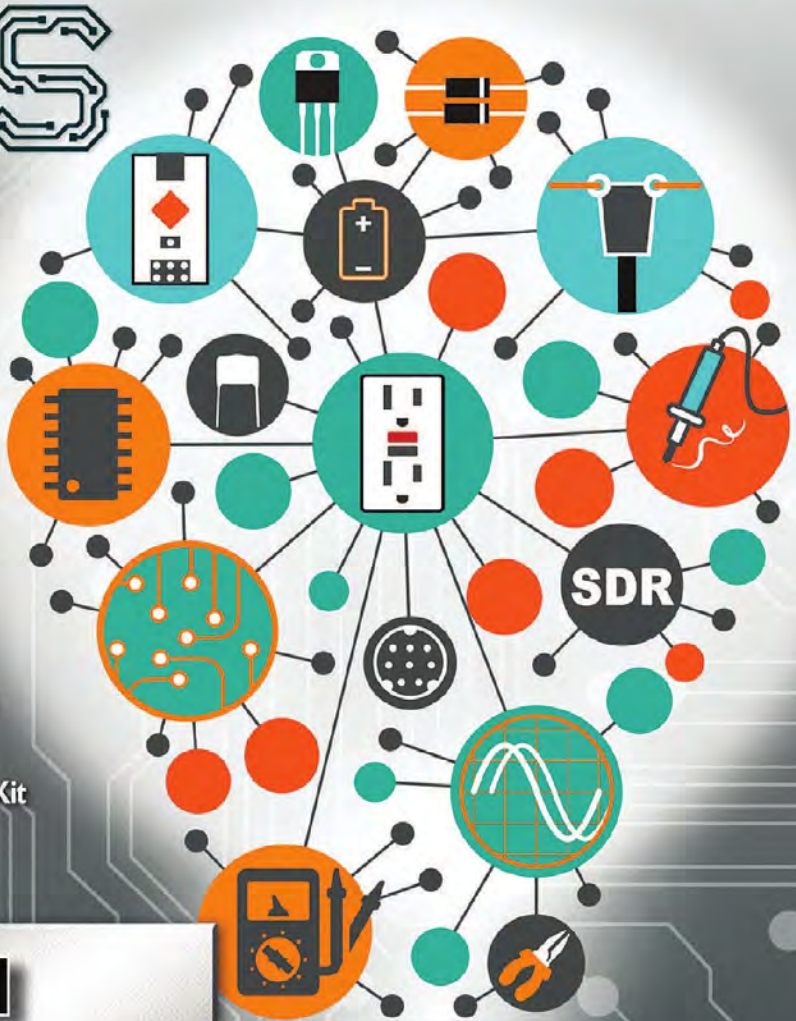
# WORKBENCH IDEAS




## QST Reviews

**Elecraft** KPA1500 Legal-Limit HF and 6-Meter Linear Amplifier

**Harger** Uni-Shot Exothermic Ground Connection Welding Kits

**W4OP** Magnetic Loop Antenna with Remote Tuning

**MFJ**-1708SDR and MFJ-1708B-SDR TR Switches

**Pacific Antenna** Low-Pass Filter Kit

**DIGITAL FEATURE**

49 | See our Video of the **Elecraft** KPA1500 Legal-Limit HF and 6-Meter Linear Amplifier.

The radio... YAESU

# The Conclusive Choice

## 1- Pulling out weak signals during extremely harsh band conditions

## VC-Tune

### Unparalleled damping characteristic of –70 dB maximum attenuation

**Newly developed VC-Tune RF Preselector with high precision stepping motor drive provides outstanding attenuation characteristics**

VC-Tune further improves the high performance RF μ-Tuning system design adopted in FTDX9000, using a remarkable miniaturization design while producing an unparalleled attenuation characteristic of maximum attenuation –70 dB. A high precision stepping motor drives a variable capacitor to continuously cover the band as it follows the movement of the selected frequency by the operator. Fine-tuning for optimum improvement point is also available by MPVD (Multi-Purpose VFO Outer Dial) placed outside the VFO dial.

**VC-Tune (7MHz, Span 20MHz)**

**Band Pass Filter (7MHz, Span 20MHz)**

**VC-Tune + Band Pass Filter (7MHz, Span 20MHz)**

**Maximum Attenuation: –70dB**
**–3dB Bandwidth:62kHz**

VC-Tune
(Variable Capacitor Unit)

*In Homage to the Founder of Yaesu – Sako Hasegawa JA1MP*

**FTDX101MP** 200W

HF/50MHz TRANSCEIVER

*The Ultimate*

**FTDX101D** 100W

HF/50MHz TRANSCEIVER

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.

YAESU
The radio


**YAESU USA**
6125 Phyllis Drive, Cypress,
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.

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 144/430 MHz Dual Band 50 W
Digital Transceiver

## FTM-7250DR

《 Heavy Duty 50 Watts High Power 》

C4FM/FM 144 MHz 65 W
Digital Transceiver

## FTM-3200DR

《 Genuine 65 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
6125 Phyllis Drive, Cypress,
CA 90630 (714) 827-7600

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Free Dealer/Catalog/Manuals/Instructions – Visit: www.cushcraftamateur.com or call 662-323-9538

Cushcraft...Keeping You in Touch Around the Globe

# Cushcraft Antennas

# R9

## 80-6 Meters! No Radials!

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

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

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

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

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

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

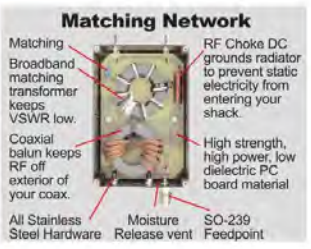
**Rugged Construction:** Thick fiberglass insulators, all stainless steel hardware and 6063 aircraft-aluminum tubing is double or triple walled at key stress points to handle anything Mother Nature can dish out.

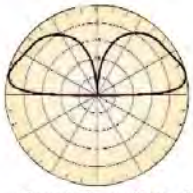
**31.5** feet tall, 25 lbs. Mounting mast 1.25 to 2 inches. Wind surface area is 4 square feet.

**R8, $539.95**. Like R9 antenna but less 75/80 Meters.

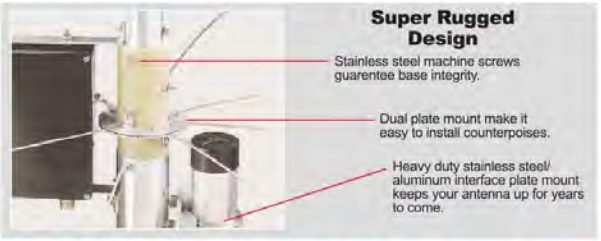
**R-8TB, $79.95**. Tilt-base lets you tilt your antenna up/down easily by yourself to work on.

**R-8GK, $59.95**. Three-point guy kit for high winds.



**Omni-Directional**
Low angle radiation gives incredible worldwide DX.




## Cushcraft...Keeping You in Touch Around the Globe!

**Cushcraft** **Amateur Radio Antennas** 308 Industrial Pk Rd, Starkville, MS 39759 USA
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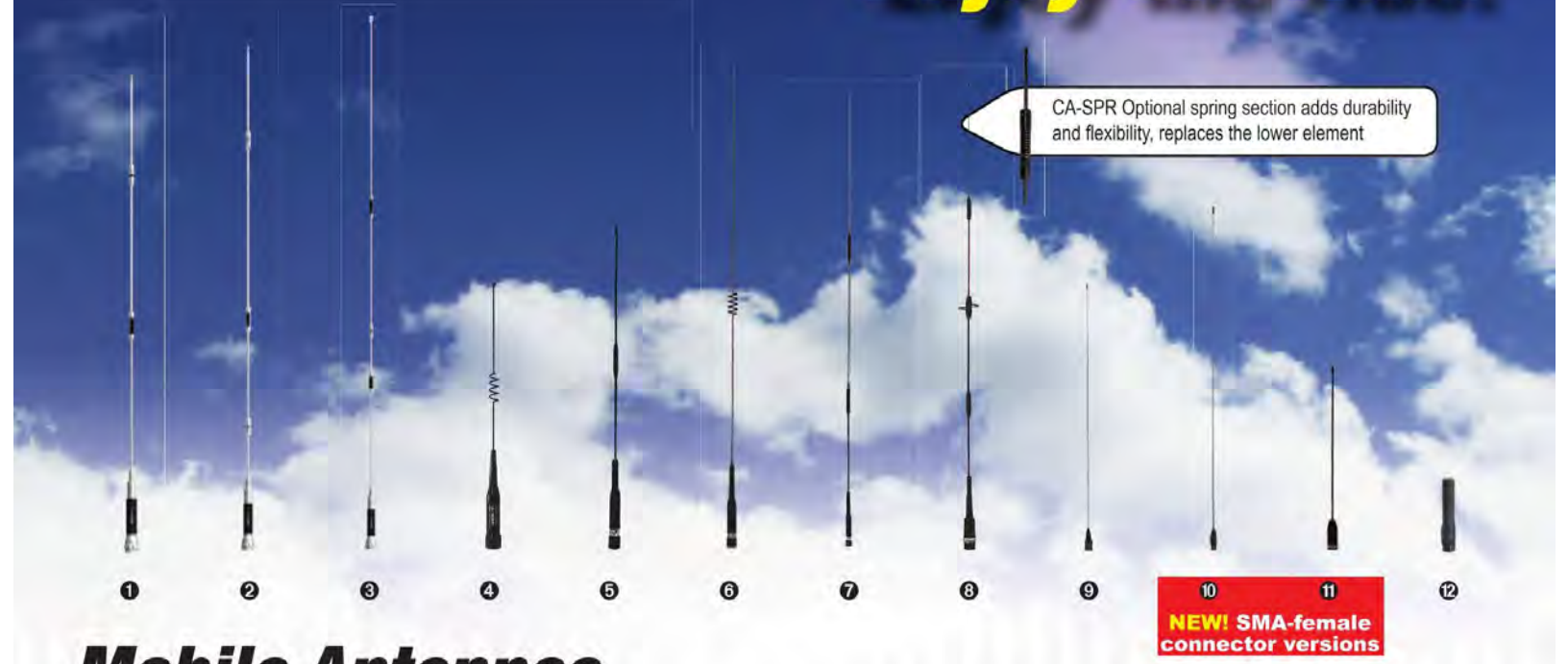
Add shipping. Prices and specifications subject to change. 2016 ©Cushcraft.

COMET®

# Life is a JOURNEY. Enjoy the ride!




## Mobile Antennas

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

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

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

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

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

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

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

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

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

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

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

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

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

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QST

# Contents

March 2019 ♦ Volume 103 ♦ Number 3

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Includes audio
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9 **Second Century**
Toward a More Secure Future

30 **An Arduino-Powered RF Detector**
**Teri Bloom, AC5YL**

32 **A Portable End-Fed Half-Wave Antenna for 80 Meters**
**Rick Littlefield, K1BQT**

34 **Build a 9 to 1 Unun Transformer**
**Stan Johnson, W0SJ**

36 **Improve Workbench Safety with GFCI and a Kill Switch**
**Allen Wolff, KC7O**

37 **3D-Printed Coax-to-Wire Connection Blocks**
**John Portune, W6NBC**

39 **Super Simple 6-Meter SDR Transceiver**
**James Forkin, WA3TFS**

44 **Soldering Surface-Mount Devices**
**Dino Papas, KL0S**

46 **Product Review**
**Mark Wilson, K1RO**
Elecraft KPA1500 Legal-Limit HF and 6-Meter Linear Amplifier; Harger Uni-Shot Exothermic Ground Connection Welding Kits; W4OP Magnetic Loop Antenna with Remote Tuning; MFJ-1708SDR and MFJ-1708B-SDR TR Switches; Pacific Antenna Low-Pass Filter Kit

65 **Youth at Sea Activate Market Reef — OJ0C**
**Pieter Ketsman, ON3DI, and Horia Ilie, YO3IMD**

68 **Canadian National Parks on the Air 2019**
**Sean Kutzko, KX9X**

70 **ARRL's New Podcast for New Hams**

71 **Lithuanian Radiosport**
**Henryk Kotowski, SM0JHF**

74 **Judging Regional Science and Engineering Fairs**
**Bill Vining, N5YZ**

77 **Choosing Gear for Portable Activations**
**T.J. "Skip" Arey, N2EI**

80 **Nominations Now Being Accepted for 2019 McGan Silver Antenna Award for Excellence in Public Relations**

89 **ARRL International Grid Chase Update**

90 **The 2018 IARU HF World Championship Results**
**Bob Raymond, WA1Z**

93 **The April 2019 ARRL Rookie Roundup — Phone**

## Columns


Classic Radio....86
Contest Corral....88
Correspondence....24
The Doctor is In....58
Eclectic Technology....64
Happenings....81
Hints & Hacks....62
How's DX?....94
Member Spotlight....13
Public Service....84
Technical Correspondence....60
Up Front....20
The World Above 50 MHz....96
75/50/25 Years Ago....102


## Departments


Amateur Radio Band Chart....101
ARRL Member Benefits....14
ARRL Section Managers....16
ARRL VEC Honor Roll....98
Convention and Hamfest Calendar....99
Feedback....79
Field Organization Reports....102
Ham Ads....140
Index of Advertisers....142, 143
New Products....38, 79
Officers, Division Directors, and Staff....15
QuickStats....130
Silent Keys....103
Special Event Stations....98
W1AW Qualifying Runs....100
W1AW Schedule....93

### Our Cover

This month, *QST* offers a wealth of workbench projects and ideas that involve everything from basics like soldering and electrical safety to leading technologies like SDR and 3D printing. Whether your approach to ham radio is old-school or cutting edge, this issue has something you can use.

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

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# HF ANTENNA MATCHING ACCESORIES

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**AT-600PROII**
600 Watts to Mid Size Amps
- Dual Bargraph
- 1.8 to 54MHz
- 600W SSB / 200W Digital

**AT-1000PROII**
QRO Auto Tuner to 1000W
- Switch L Network
- Dual Antenna
- 1000W SSB / 350W Digital

**AT-200PROII**
200 Watts Desktop
- Tunes 10:1 SWR
- 2 Year Warranty
- 250W SSB / 100W Digital

## Desktop

Stand alone desktop tuner - works with most 100W HF radios.

**AT-100PROII**
- Dual Bargraph
- Auto / Semi-Auto Mode
- 125W SSB / 30W Digital

## Balun / Unun

- RU 4:1 UNUN
- RBA 4:1 BALUN
- RBA 1:1 BALUN
- 200W SSB

## Icom

Tuner dedicated to Icom radios with seamless integration.

**IT-100**
- AH-3 & AH-4 Compatible
- Includes Interface Cable
- 125W SSB / 30W Digital

## Zero Power

Designed for portable and low power applications - zero current draw once tuned.

**Z-100 PLUS**
- Low Cost
- Highly Portable
- 125W SSB/30W Digital

**Z-11PROII**
- LED SWR Indicator
- 10:1 SWR
- 125W SSB/30W Digital

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

## Yaesu

Tuner with built in Yaesu/antenna tuner interface.

**YT-1200**
- 2000 Memories
- For FT-991A, FTdx-1200, FTdx-3000, FT-450 and FT-950
- 125W SSB/30W Digital

**YT-100**
- 2000 Memories
- For FT-100, FT-857 and FT-897
- 125W SSB/30W Digital

## Remote

Remote tuners mounted at or near the feedpoint minimize coax SWR losses.

- Includes Controller/Bias T
- Control Over Coax
- 600W SSB/200W Digital for RT-600
- 125W SSB/30W Digital for RT-100

RT-600 Shown

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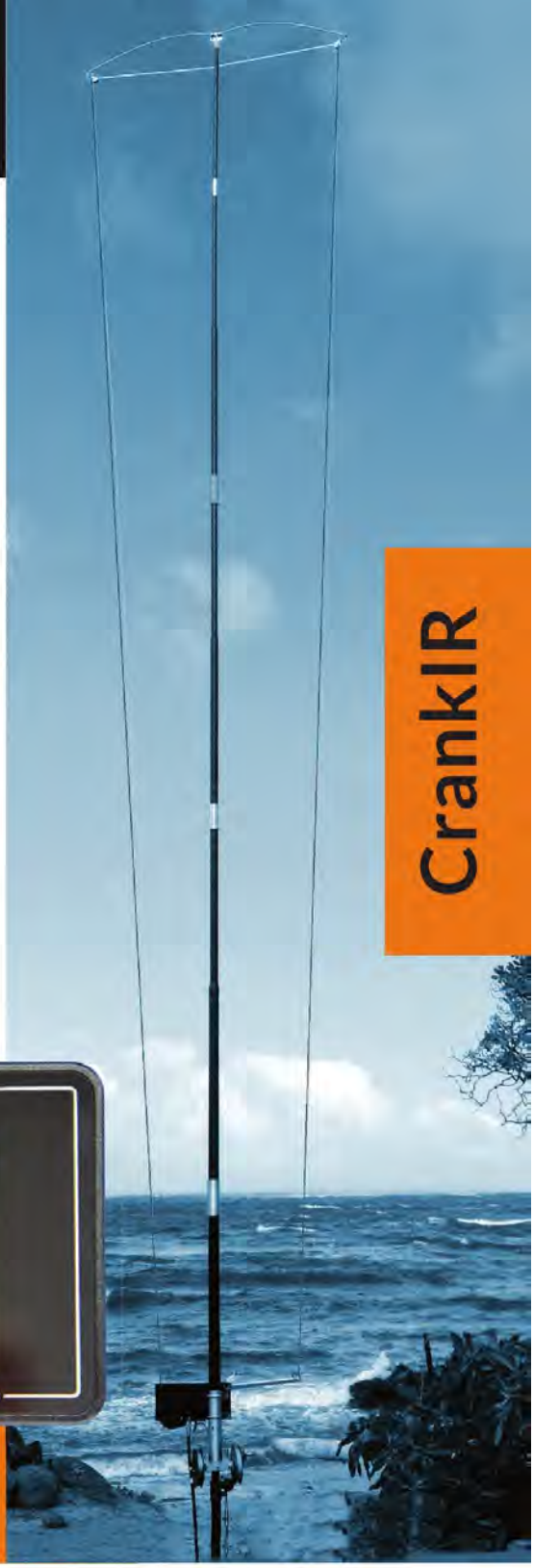
**Combine our manually tuned, ultra-portable yet high performance CrankIR Vertical with the SARK-110 pocket sized antenna analyzer!**

## CrankIR

A lightweight, high performance, extremely portable vertical antenna rated at 1500 watts key-down with fully manual operation (no electrical power or controller required). An optional portable tunable elevated radial system is available and its patented folded design allows for a 40% reduction in size with only 0.3dB reduction in gain performance when compared to a full sized antenna. With available versions that cover 80m-2m and 40m-2m (and every frequency in between), the CrankIR sets up quickly and provides flexibility to change the bands quickly. This antenna is the choice of amateur radio operators and emergency communications teams world-wide, in both portable and permanent applications. Consider purchasing one of our SARK-110 battery powered pocket sized antenna analyzers for use with the CrankIR – a custom 3D printed mounting bracket is available to secure the SARK-110 to your CrankIR!

## SARK-110

The SARK-110 antenna analyzer is a pocket-sized instrument that provides fast and accurate measurement of the vector impedance, VSWR, vector reflection coefficient, return loss and R-L-C. Typical applications include checking and tuning antennas (such as the CrankIR), impedance matching, component test, cable fault location, measuring coaxial cable losses and cutting coaxial cables to precise electrical lengths. The SARK-110 has full vector measurement capability and accurately resolves the resistive, capacitive and inductive components of a load. The SARK-110 is intuitive and easy to use, and utilizes four operating modes: sweep mode, smith chart mode, single frequency mode and frequency domain reflectometer (cable test).




***Ask us about our new 3D printed SARK-110 bracket, designed specifically for the CrankIR!*** *(Prototype holder shown)*

***"We introduced the CrankIR to be a world-class portable antenna – little did we know that scores of amateur radio operators would make this their home station antenna as well!"***

– John Mertel, WA7IR
CEO SteppIR Communication Systems

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# DIAMOND ANTENNA

**diamondantenna.net**

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

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

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

## 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!

Here is a small sample of our wide variety of antennas

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

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Howard E. Michel, WB2ITX, ARRL Chief Executive Officer, hmichel@arrl.org

## Second Century

# Toward A More Secure Future

*Four years ago, when I was President of IEEE, I wrote an editorial called "Toward a more secure future." It started: "History is littered with companies that did almost everything right, but nevertheless failed. Some of these organizations did not understand what their business was, or should have been."*

*I went on to say, "Companies like Eastman Kodak and Polaroid thought they were in the film business. They were in the business of capturing and preserving images. They ignored potentially disruptive innovations that would render their traditional film businesses obsolete."*

I believe that ARRL is in a situation similar to what transpired at Kodak and Polaroid. We are at a crossroads, and we need to look seriously at what we are and what we do.

In my January 2019 "Second Century" column, I talked about ARRL as a membership association, a business, and a public charity. All three of these entities must remain in balance for ARRL to function effectively. In order to begin to understand what this balance might require, let's take a closer look at ARRL's businesses.

**ARRL Business of the Future**

ARRL is a publisher, receiving revenue from the sale of books and magazines. ARRL receives additional revenue from advertising, membership dues, awards, and our VEC program. Revenue they generate funds and supports the tax-exempt purpose for which ARRL was created, and supports our five pillars: Public Service, Advocacy, Education, Technology, and Membership. But are these the right businesses for our second century?

ARRL is not just *QST*, the *Handbook*, DXCC, or the VEC program. We can't allow ourselves to continue to think within those traditional parameters. If we abstract from our current lines of operations and consider our core purpose as defined in our Articles of Association, we are members, volunteers, and staff creating information and building relationships — creating value; disseminating information and building organizations — using value; and advocating to advance the art and science of Amateur Radio. We are about relationships and information.

We are not about publishing books, for example, but about creating, curating, and disseminating information about Amateur Radio. Creation could happen by hiring a professional author to write text. Curation could involve staff and volunteers repurposing locally developed content. Dissemination could involve traditional publishing, but also creating a video, a series of magazine articles, or a presentation that a local club could use.

ARRL must be forward-looking. There are startups innovating in our space, whether that is publishing, membership, or advocacy. We must be ahead of them. We must invest in the future, while sustaining current operations and supporting our members. We must reuse and repurpose content, integrate it with a broad spectrum of external information, and deliver it in individualized and appropriate ways that engage everyone interested in Amateur Radio, and match the expectations people have today when they consume information.

Membership is not about getting hams to join ARRL; it is about engaging members and having them engage others. Every member should have an elevator speech — a 30-second talk to give to a complete novice — on what Amateur Radio means to them. Every member should find value in his or her unique form of engagement with ARRL. Should membership be redefined, not as having a membership card, but instead as having a level of engagement?

We have local club meetings and hamfests — face-to-face events that are periodic in nature. People have been gathering in their communities for eons. But today people are busy, and fixed agendas might not be convenient. And the definition of "community" is changing. People are communicating 24/7, 365 days a year around the globe. Are episodic face-to-face meetings becoming obsolete in the internet age? How can we engage local members when "local" is defined virtually?

For ARRL to remain relevant to Amateur Radio, it must evolve. That evolution, while it must be swift, can't be haphazard. Instead, there must be a comprehensive vision of what ARRL is as a community, and what we wish to be in the future. I encourage your comments to me at **wb2itx@arrl.org**.

Howard E. Michel WB2ITX

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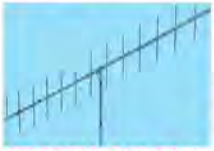

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|---|---|
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| 233/2-4X-10 | 10 |
| 233/2-4X-5 | 5 |
| 233/2-4X-3 | 3 |
| 233/2-4X-1 | 1 |

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| Part# | Length/Ft |
|---|---|
| 233/2-G4-10 | 10 |
| 233/2-G4-5 | 5 |
| 233/2-G4-3 | 3 |
| 233/2-G4-1.5 | 1.5 |

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| Attenuation per 100ft | Power Rating |
|---|---|
| 0.4dB @ 30MHz | 5.51KW |
| 0.5dB @ 50 MHZ | 4.24KW |
| 1.0dB @ 150MHz | 2.41KW |
| 1.7dB @ 450MHz | 1.35KW |
| 2.5dB @ 900MHz | 0.93KW |
| 2.9dB @ 1200MHz | 0.79KW |

**ABR213 (PN:2213A)** Mil-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 |

Stocked Lengths 1.5ft to 200ft
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**ABR316/U (PN:23316)**
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| 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 to150ft
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") Solid 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 |
|---|---|
| 0.7dB @ 30MHz | 3.33kW |
| 0.9dB @ 50MHz | 2.57kW |
| 1.5dB @ 150MHz | 1.47kW |
| 2.7dB @ 450MHz | 0.83kW |

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Custom assemblies and Testing services available.

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## Member Spotlight

# QRZ Founder Fred Lloyd, AA7BQ

Most radio operators know that hearing someone call "QRZ" means the sender is asking, "Who is calling me?" The Q code is still used regularly today, but in recent years those three letters in particular have taken on another meaning in the Amateur Radio community — they're the name of a website where you can look up call signs.

**QRZ.com** is used by hundreds of thousands of hams around the world, where they stay connected by posting to forums, reading the latest ham news, planning swapmeets, and more. Most importantly though, they can look up call signs maintained in a regularly updated database. Fred Lloyd, AA7BQ, founded the site, inadvertently becoming a part of ham radio history.

### Answering the Call

Fred first fell for ham radio when he met a ham operating mobile out of a sedan. He said, "I distinctly remember him revving his engine whenever he keyed the mic to get the maximum power output from the car's generator." Fred worked in a TV shop as an apprentice repairman at the time and was into all things electronics. However, he was intimidated by the Morse code requirement for getting licensed.

He passed his first-class radiotelephone exam in 1975, and briefly operated as a station engineer at WRXB in St. Petersburg, Florida. He didn't have time to apply himself to learning Morse code until 1986, when he got licensed. He later maintained that momentum by going from Technician to Amateur Extra-class in just 56 days.

Fred Lloyd, AA7BQ, visiting W1AW.

When Fred first got licensed, the call sign database was only available online from the FCC, for around $700. Fred paid the fee and re-sold the data to fellow hams to earn back the cost. This started essentially a mail-order database, where buyers would send Fred $20 and a self-addressed, stamped envelope and he would mail them copies of the database on digital tapes. Those tapes were the start of one of the hobby's most popular websites.

### Call Sign Lookup in the Digital Age

Tired of copying data onto tapes, Fred moved the call sign data to a CD-ROM format a few months later. The cycle continued every 6 months or so for years — purchasing updated data from the FCC, copying it onto CDs, and distributing it to interested hams. Fred's database naturally moved to the internet once it became possible to own domains. In 1993, **QRZ.com** was founded. "QRZ was one of the first 25,000 websites in existence," Fred said, "and was founded well before Google, Facebook, Yahoo!, and nearly every other website you can think of."

He didn't realize how much the site had taken off worldwide until he was vacationing in the South Pacific, idly listening to a portable shortwave radio, when he overheard two hams near South America talking. One said, "I'm good on QRZ," stunning Fred. He said, "It was at that moment that I realized QRZ had reached critical mass and that I had better do everything I could to make sure it provided the best service possible to the amateur community."

The site currently has over 750,000 users. Of his work on QRZ, Fred said, "It has seldom, if ever, felt like a job because when you enjoy what you're doing, it's not work." He is also grateful for the community volunteers on the website and QRZ's hard-working staff.

### Offline

Fred's current passion project is using his machine shop at home, where he builds things out of metal and repurposes scrapyard cast-offs into unique pieces of art. He said, "I've made a number of windmills and weather vanes, for example, out of exotic materials that can only be found in a scrapyard. These projects include machining, welding, grinding, and sometimes electrical components." He even produced a limited series of Morse code plaques sold on QRZ.

Fred is also a licensed pilot, plays guitar, and is always interested in electronics. To learn more about Fred, visit his QRZ page, **https://www.qrz.com/db/aa7bq**.

# Guide to Member Benefits

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## Interested in Becoming a Ham?

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## Connect with ARRL

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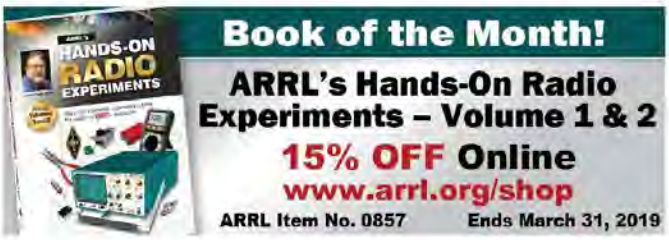


## The American Radio Relay League, Inc.

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

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

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

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

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

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

# Officers, Division Directors, and Staff

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

## Officers

**Founding President (1914-1936)**
Hiram Percy Maxim, W1AW

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

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

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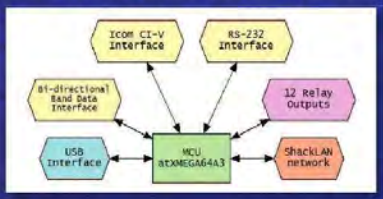
**The next generation of the popular BM-3 with direct USB support for FLEX Radios**

**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 CI/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 CI/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.**

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

| | |
|---|---|
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| OM4000HF MARS | MARS and Commercial HF |
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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 |
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| OM10C Combiner | Combiner for two OM amplfiiers |
| OM10C 4000HF MARS | Two OM4000HF manual tuned amps and combiner package |
| OM10C 4000A MARS | Two OM4000A automatic tuned amps and combiner package |

### OM4000A – OM4000HF
### OM2500A – OM2500HF

The A-series are automatic band change amplifiers.

The HF-series are manual band change and tuning amplifiers.

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

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### OM2000A+ – OM2000+

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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.

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1500 W CW/SSB on 50 MHz

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### Surge Arrestors

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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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# Up Front

## Amateur Radio as a Course Requirement

Dr. Eric Welch, WD5FTA, professor and chairman of the department of Electrical and Computer Engineering at Christian Brothers University in Memphis, Tennessee, has created a class in unmanned aerial systems (UAS), better known as drones. In addition to meeting the requirements to obtain an FAA Remote Pilot certification, students are also required to earn an Amateur Radio license.

According to Dr. Welch, "The Amateur Radio license allows students to experiment with a variety of communication systems associated with UAS. These include control systems, video cameras, and other telemetry systems. In addition, the license allows students to gain general experience with VHF/UHF radios and antennas commonly used in UAS activities." Eighteen students in Dr. Welch's spring 2018 class passed their Technician exams, with one student also obtaining his General-class license.

From left: Elizabeth Hayes, KN4JFY; Noah Vongphit, KN4JFS; Alex Santana, KG5YAX; Joe Lowenthal, WA4OVO (Director of Training, Delta Amateur Radio Club), and Dr. Eric Welch, WD5FTA. [Len Grice, W4MKS, photo]

## History Happened Here

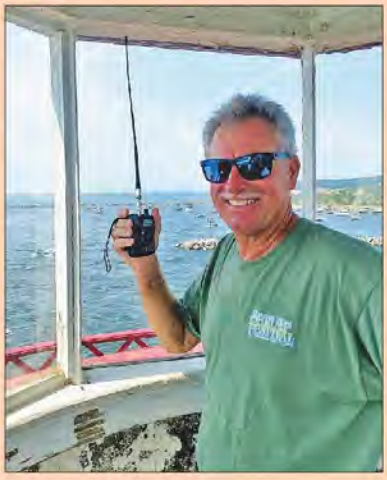
Tim Wright, K0BFR, had the pleasure of visiting K6TAL, the Amateur Radio club station at American Legion Post 519 in Palm Springs, California. The station is in the original sound booth used by Bing Crosby, Bob Hope, Jack Benny, and many other radio stars who did remote broadcasts from the facility during World War II.

## Jamboree on the Air in Puerto Rico

Edgaralexis Irizarry, WP4PXH, helped a young Scout make contact during last October's Jamboree on the Air event in Puerto Rico. According to Edgaralexis, the Scouts made contacts with troops in Africa, South and Central America, and Europe. They dedicated their operation to all the amateur operators on the island that assisted in the aftermath of Hurricane Maria.

## Working Across the Lake

Paul Gawron, KI4SPO, took a handheld transceiver to the top of the South Pierhead lighthouse in Muskegon, Michigan, and made contacts across Lake Michigan and well into Wisconsin, more than 80 miles away. Paul said he did this on several occasions but enjoyed his greatest successes on hot summer days when ducts formed over the cool waters. [Greg Gawron, WX8V, photo]



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***New! AX1 Dual-Band Whip Antenna***

- Covers 20/17 m
- Two-piece construction

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# Correspondence

# Letters from Our Members

## Always Submit Your Log

During contests, I run an Antenna Systems M² 2M12 with a 250 W amplifier and various preamplifiers at my station in DN82, a grid square that has only two to three active amateur operators. After placing 2nd in the ARRL 2017 June VHF contest, with a total of 609 points in the Nebraska Section, Single Operator, Low Power category, I noticed something strange. Looking carefully at the submitted logs and contest results, I saw that there had never been a log submitted for an FM-only single-operator entry in the Nebraska Section.

I devised a two-part plan. Part 1 was to try and use my usual SSB, FM, and digital modes with the full-featured IC-746 Pro, 250 W amplifier, and 12-element VHF Yagi for most of the January 2018 ARRL VHF contest and get as many stations as possible. However, I have recently noticed a very steep decline in VHF propagation. If that turned out to be the case during this VHF contest, I would revert to Part 2. This was to call the only active ham in town, KO0KS, and ask him to fire up his 5 W Baofeng handheld, and I would do the same.

We had a short contact on simplex, exchanging particulars just before the end of the contest. Thanks to him, I earned my 1 point on FM as a single operator. I submitted my log to ARRL and waited.

The first hint of success was in July 2018, from the preliminary results article published online by James R. Duffey, KK6MC, who summed up my score and wrote, "This was the first SOFM entry ever from the division, demonstrating that submitting a log, no matter how small, counts for more than one would think."

This is proof that you do not need thousands of dollars of equipment, an optimal location, many years of experience, or a team of operators to rank anywhere near the top in a contest. I proudly hold the all-time record and 1st place in the Nebraska Section, Single Operator, FM-only category with just 1 point. As of this writing, before the ARRL January 2019 VHF contest, my record still stands.

**Ken Weindl, N2VHZ**
Alliance, Nebraska

## It's All Ham Radio

FT8, digital mobile radio, 80 meters, EchoLink, CW, assisting in disaster preparation, ragchewing on 2-meter/70-centimeter analog repeaters (linked or otherwise) — these are all cool things I can do as a ham. They don't all require a 70-foot tower, a $10,000 radio, and a degree in RF theory, but they're all Amateur Radio.

This is such a wide-ranging hobby with so many things to do, but if we keep saying something "isn't *real* ham radio," we're going to drive people away. It's okay for people to try new, fun things because it keeps the hobby alive. If it transmits over amateur bands, for 4,000 miles or 4 inches, it's still Amateur Radio. If it requires a license and a call sign, it's still Amateur Radio.

So, take a minute to relax and watch the hobby grow by experimenting in all the cool things we can do together. "Back in my day" doesn't have a place in ham radio any more.

**Alex Hoffman, N3RDO**
Mesa, Arizona

## Amateur Radio in Sports

I noticed an interesting connection between myself and Michael Costabile, WD4MGP, who was featured in "Member Spotlight" in the December 2018 issue of *QST*. Similar to how his company, Precision Time Inc., is used by sports associations, my company, Scoreboard Enterprises, supplies scoreboards, video boards, and sound systems for high schools, colleges, and professional facilities across the US. We primarily deal with a company known as Daktronics Inc. who has had a worldwide impact on sports supplies, timing, and video equipment for the Olympics, NBA, NFL, MLB, and the NHL. I'm sure Michael has dealt with Daktronics along the way, as well.

Like Michael, I was able to follow this career through my Amateur Radio skills. As a high school student, I repaired radios and televisions to pay my way through college. I became licensed in 1964 as K1TLI, my original call. I taught high school math for 12 years and, during that time, the principal recognized my ability to fix things. He asked if I could fix the scoreboard in the gym. After successfully doing so, the athletic director suggested it would be a good business to get into. Before long, I was working at the Boston Garden and Fenway Park. My business is 45 years old now, and I am still at it!

It was the Amateur Radio connection that helped me develop my skills. Today, I restore older tube radio equipment and some military radios, as well. My website is **www.johnsonradioresto.com**.

**Chuck Hurley, K1TLI**
South Easton, Massachusetts

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

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### EAntenna

Exclusively offered in North America by DX Engineering, EAntenna is well known for its broad lineup of rugged HF and VHF antennas, including Yagi, log periodic, rotatable dipole and vertical models. These antennas combine cutting-edge computer modeling optimization with robust mechanical and electrical designs to deliver high performance at a budget-friendly price.

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Upgrade your old antenna control system with a state-of-the-art, fully programmable digital rotor controller. Features include variable speed control, easy-to-read green fluorescent display, automated PC control capability, and precision heading accuracy good to 1/10 of a degree. Choose from models pre-programmed for Hy-Gain or M2 rotators.

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### Universal Towers

Amateur Radio operators everywhere take advantage of Universal's finely constructed lightweight freestanding aluminum towers that deliver reliable performance and outstanding appearance, with no guy wires to get in the way. Made in the USA, Universal's standard and heavy-duty towers, from 30' to 100', are easy to assemble and backed by an experienced support team. DX Engineering also carries the full lineup of Universal tower accessories.

## We've Been There, and Can Do That

Dave N8NB Tom KB8UUZ George K3GP

### Prepare Your Station to Work the World

Don't let March slip by without making your best attempt at working DXpeditions to Lesotho, Niue Island, and South Cook Islands.

Here are just a few of the QSL cards from these entities belonging to DX Engineering staff: Customer/technical support specialist George K3GP contacted the 7P8C Lesotho DXpedition on 20 meter SSB in 2016; technical writer Tom KB8UUZ worked E6GG Niue Island on 20 and 40 meters CW in 2015; and technical support specialist Dave N8NB logged ZK1AQT South Cook Islands in 2004 on 10 meter SSB. Now's a great time to upgrade your DXing capabilities. Turn to the team that speaks your language—DX Engineering.

### Antennas for Any Environment and Use

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### Guy Line Rope

Mastrant ropes are perfect for wire antennas, supporting Yagi booms and elements, as well as guying verticals and antenna masts. This non-conductive rope is made from synthetic fibers that won't stretch, collect moisture or suffer from UV degradation.

DXE-3X10

DXE-2X7

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### Skyhawk™ and Skylark Multi-Band Yagi Antennas

The 20/15/10M Skyhawk features a trap free design to provide the best bandwidth and lowest loss. The use of aluminum and stainless steel hardware keeps the overall weight down to only 75 pounds. **DXE-3X10…$1,199.99**

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ADS#15015

# An Arduino-Powered RF Detector

**Teri Bloom, AC5YL**

A string of LEDs and a microcontroller become a wearable field strength meter.

One delight of hanging around my neighbor Glen Popiel, KW5GP, is the constant exposure to all things Arduino — a community based around open-source hardware and software projects involving microcontrollers. Glen has authored two books on the subject — *Arduino for Ham Radio*[1] and *More Arduino Projects for Ham Radio*[2] — and I helped him with some of the project ideas. But you still have to build a project to really understand how Arduino works.

While at Hamvention, as I watched everyone communicating with handheld radios, I wondered how much RF was really there. That's when I was inspired with the idea for a wearable RF detector built into a backpack. To begin, I adapted the project "RF Probe with LED Bar Graph" from Glen's *Arduino for Ham Radio*.

This Arduino project idea was going to be my first scratch build, and it turned out I learned more than I ever did from previous kits. I used Glen's in-home lab, many of his components, and his mentoring. My RF radiation monitor includes the Arduino Nano, 11 standard LEDs, and a 19-inch wire antenna optimized for the 2-meter band, all combined into a wearable, usable, functional, and eye-catching electronics package.

## Construction

I arranged the LEDs in the shape of a tower on a rectangle of copper-clad perfboard using a template made of heavy paper. Figure 1 shows my placement of the green, yellow, and red LEDs. Using the template,

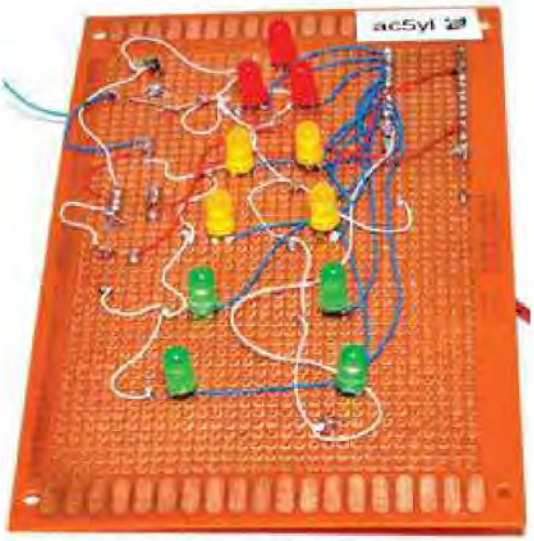


**Figure 1** — The front side of the perfboard shows the LED arrangement.

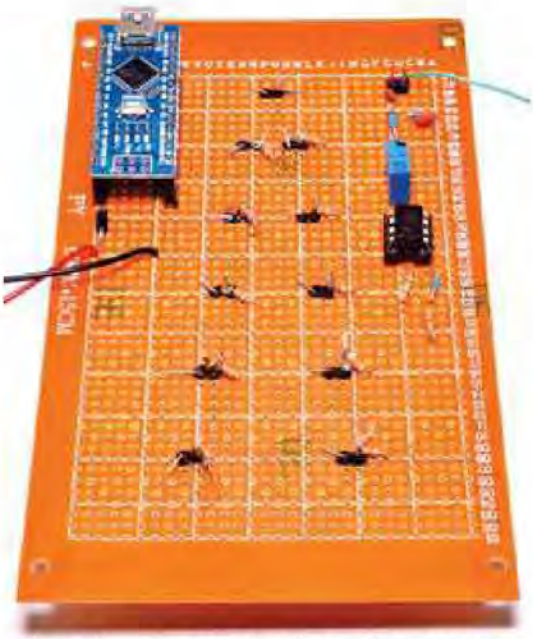

**Figure 2** — The back side of the perfboard shows the Arduino Nano in the upper left corner.

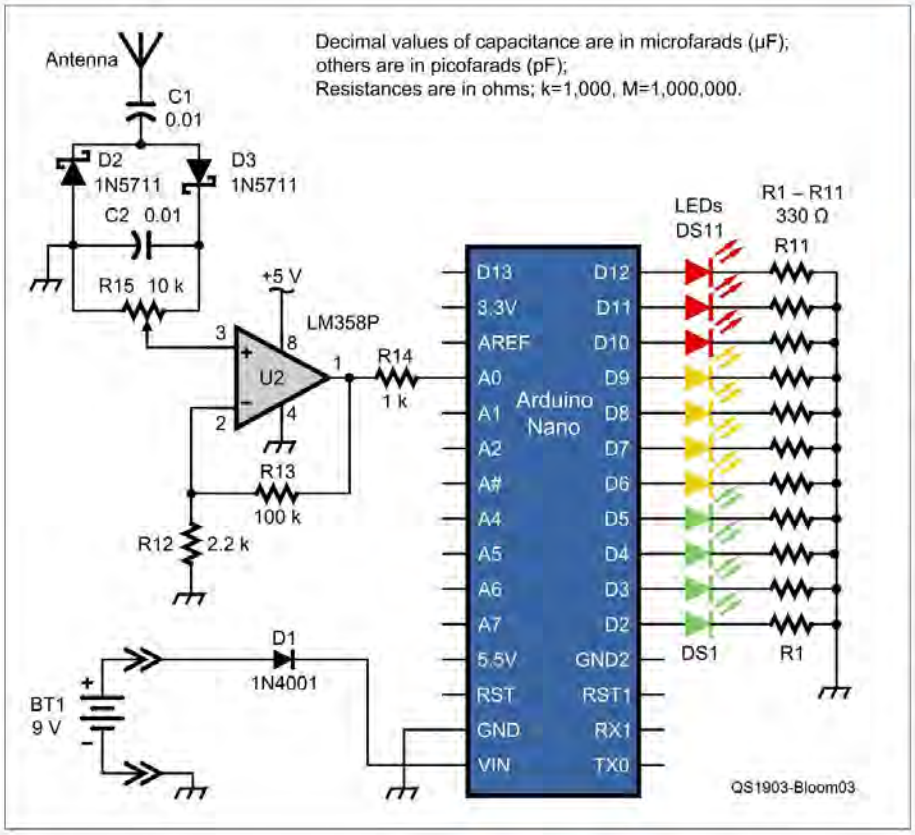


**Figure 3** — Schematic diagram of the project.

BT1 — 9 V battery
C1, C2 — capacitor, 0.01 µF
D1 — diode, 1N4001
D2, D3 — diode, 1N5711
DS1 – DS4 — green LED
DS5 – DS8 — yellow LED
DS9 – DS11 — red LED
R1 – R11 — resistor, 330 Ω
R12 — resistor, 2.2 kΩ
R13 — resistor, 100 kΩ
R14 — resistor, 1 kΩ
R15 — potentiometer, 10 kΩ
U1 — Arduino Nano
U2 — IC, LM358P op amp

I marked those LED locations on the perfboard and then soldered the LEDs, leaving space underneath for wires.

The current-limiting resistors are on the back side of the perfboard (see Figure 2) with the Arduino Nano in a corner of the board. This design allows the LEDs to be close to the material of the backpack while the rest of the components are safely out of the way. The schematic is in Figure 3. I used a standard Powerpole connector for the antenna so I could remove the project from the backpack as needed.

I snagged the sketch [A sketch is an Arduino program — *Ed.*] for the RF Probe project from Glen's book and adapted it to use standard LEDs, and to light the green LEDs first by twos, then the yellow LEDs, and, finally, the red LEDs all based on the strength of the detected RF signal. I hadn't done any programming in quite a while and had never written anything in Arduino's C++ style language, so this was a fun challenge. My Arduino sketch is on the **www.arrl.org/qst-in-depth** web page. Thank you, Glen, for your mentoring!

## The Backpack

After testing everything, I grabbed my backpack and mounted the project into an exterior zippered compartment. I used the template and a soldering iron to make the holes in the fabric for the LEDs. I also placed Styrofoam™ behind the board to hold it in place once it was inside the zippered compartment. The battery is held to the board and Styrofoam by a rubber band, to prevent its weight from breaking the wires at the solder joints. I made one more hole near the top of the zippered compartment for the antenna. Then I brought the antenna wire through the hole, bent it near the top of the backpack's seam, and hand-stitched it in place.

> *"You have to build a project to really understand how Arduino works."*

Now as I walk the aisles of hamfests, my RF Radiation Exposure Monitor lights up from green to yellow to red and back down again, depending on the strength of and distance from RF sources. It gets a lot of attention!

**Notes**

[1]Glen Popiel, KW5GP, *Arduino for Ham Radio*, ARRL Bookstore Item no. 0161. Available from your ARRL dealer, or from the ARRL Store, **www.arrl.org/shop/**; **pubsales@arrl.org**.

[2]Glen Popiel, KW5GP, *More Arduino Projects for Ham Radio*, ARRL Bookstore Item no. 0703. Available from your ARRL dealer, or from the ARRL Store, **www.arrl.org/shop**; **pubsales@arrl.org**.

Teri Bloom, AC5YL, became a ham in December 2009, upgraded to Amateur Extra class in 2010, and became a Volunteer Examiner. She has since retired to Mississippi where she attends a number of hamfests, meets many hams, and is as active as she can be. You can reach Teri at **ac5yl@amsat.org**.

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# A Portable End-Fed Half-Wave Antenna for 80 Meters

This easily constructed, 144-foot EFHW antenna and tuner covers 3.5 – 4.0 MHz with low SWR.

**Rick Littlefield, K1BQT**

While I designed this easy-to-set-up antenna primarily for 80-meter ARES® (Amateur Radio Emergency Service) operation, it covers all frequencies in the 75- to 80-meter bands equally well with the aid of a simple matching network, which also makes it a great choice for vacations, special events, and field days.

## Matching Network

End-fed half-wave (EFHW) antennas pose a matching challenge because the network must transfer RF energy from a 50 Ω source to a load resistance of several thousand ohms. For this application, I used a high-Q parallel-tuned LC network (see L1, C1, and C2 in Figure 1) in place of the ferrite-core transformer commonly used with multiband EFHWs (see Figure 1A). Although this choice restricts operation to a single band, it reduces losses and provides top-to-bottom band coverage by varying the value of C2.

The LC network components are mounted in a plastic project box to insulate them from the connection points (see Figures 1B and Figure 2).

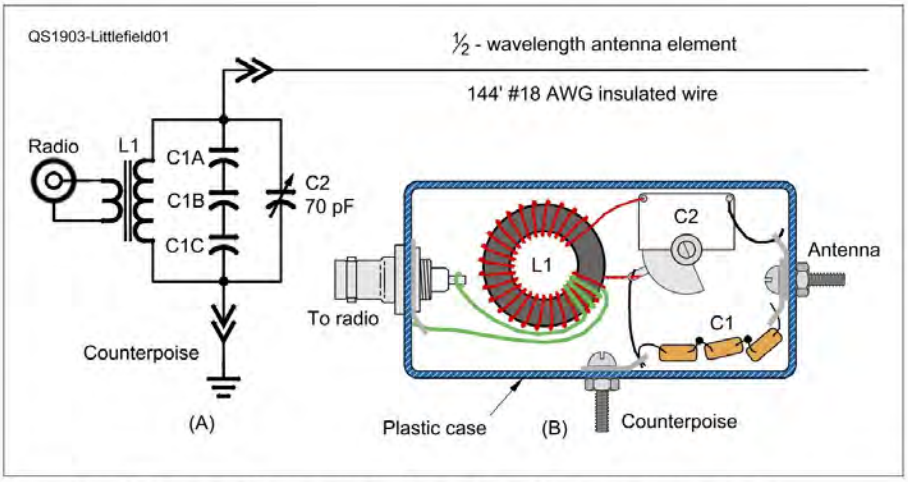


**Figure 1** — At (A), a matching network schematic. At (B), the component layout.

$C1_A$ – $C1_C$ — Three series-connected 500 V silver mica capacitors (see text)
C2 — 70 pF variable capacitor, 1,500 V rating
L1 — 12.9 µH, 31 turns of #18 AWG enameled wire wound on T-106-2 toroid with three-turn primary of #18 AWG insulated wire wound over secondary

**Figure 2** — An interior view of the matching network.

## Counterpoise

All coax-fed EFHWs require a counterpoise to provide a reliable RF voltage return path to ground. Because the impedance presented at the feed point is extremely high, the counterpoise requirement can usually be satisfied with a 3-foot rod driven into moist soil or by laying 20 feet of wire on top of the ground.

**Figure 3** — The matching network mounted directly to the ground rod with the antenna connection at the top of a plastic case and the coax feed connected at the case bottom. The tuning dial is calibrated to enable rapid setup and frequency adjustment.

## Power Limits

EFHWs make great portable antennas, but they can pose a safety hazard at high power levels. With the network's 100:1 impedance ratio, the peak RF voltage present at the antenna terminal will be ten times higher than at the network's 50 Ω input. For this reason alone, I recommend limiting transmitter power to 100 W or less. When transmitting, always make sure the matching network and wire are inaccessible to sniffing pets and curious onlookers.

C2 must adjust over a 70 pF range to cover the band and it must provide sufficient plate spacing to handle 1,500 V or more. To ensure operator safety, connect the capacitor's rotor terminal to the low-potential (counterpoise) side of the network, and install a plastic tuning knob on the shaft.

C1 trims the network's operating frequency so that C2's tuning range falls inside the band. The exact value can vary, depending on stray capacitance contributed by the other components. Somewhere between 60 and 80 pF is typical. I used another variable capacitor to find the optimum value and then replaced it with an equivalent capacitor comprised of a string of three series-connected 500 V silver mica capacitors ($C1_A - C1_C$). This approach gave me the non-standard value I needed while increasing C1's voltage rating. L1, a 12.9 µH inductor, is wound on a FT106-2 powdered iron toroid core using #18 AWG enameled wire. A three-turn 50 Ω primary is added at the counterpoise end of the winding.

## Radiating Element

The 144-foot radiator is made from lightweight #18 AWG wire to facilitate antenna setup. Maximum radiation occurs along the midsection of the element, so it's important to raise the center as high as possible. Be sure to use insulated wire! If foliage contacts a bare conductor, it can detune the element, and human contact can result in a nasty RF burn. For disaster communication operations or field deployment, consider using bright red or orange wire for high visibility.

## Setting Up

When scouting setup locations, look for a tree limb or structure 35 feet or higher to support the antenna's center, and make sure the far end conductor is out of reach to bystanders. At the network end, I've obtained excellent results driving a 3-foot aluminum rod into the ground for a counterpoise and mounting the matching network directly to it (see Figure 3).

During radio checkout, be alert for signs of RF feedback over the coax shield. If symptoms appear, add to the counterpoise. For portable operation, I try to keep the coax feed as short as possible and, for longer coax runs, I install a separate safety ground at the radio. Normally the antenna's 2:1 bandwidth will be around 100 kHz for any given capacitor setting with a minimum SWR of 1.2:1 or lower.

## Conclusion

Amateur Radio's emergency preparedness has never been better, thanks to today's high-tech array of compact equipment, alternative power sources, miniature computers, and digital operating modes. Adding this frequency-agile antenna to your go-kit allows you to leave your bulky tuner at home and lighten the load when mobility and performance count!

Photos by the author.

Rick Littlefield, K1BQT, was licensed in 1957 at age 13 and holds an Amateur Extra-class license. He graduated from Mass Radio in Boston and holds a BA in communication, plus an MEd in educational psychology from the University of New Hampshire. After a 17-year career in instructional technology and courseware development, his love of ham radio lured him into RF engineering and technical writing. He is currently retired, after working for MFJ enterprises, TEN-TEC, Cushcraft, and Laird Technologies. A prolific writer and builder, he was inducted into the QRP Hall of Fame in 1996. His wife, Terry, is a former editor at *Ham Radio* magazine and the founding editor of *Communications Quarterly* magazine. Rick continues to work on projects from his home lab in Barrington, New Hampshire.

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# Build a 9 to 1 Unun Transformer

A useful unbalanced-to-unbalanced transformer can be built with easy-to-find parts.

**Stan Johnson, W0SJ**

An end-fed long wire antenna is typically fed with a 9 to 1 impedance ratio unun. I used a Laird 28B1540-000 core (Digi-Key part number 240-2319-ND). It has a 1.54-inch outer diameter and a 0.66-inch inner diameter, is 0.875-inch long, and costs less than a couple of dollars.

My unun is wound with #16 AWG Teflon™ insulated wire. I used three pieces — two are 17 inches long and one is 20 inches. I used three different colors to keep the wires organized and make the connections foolproof while white shrink tubing from a Harbor Freight Tools assortment package holds the wires together.

The unun acts as a transformer with a 3 to 1 turns ratio (9 to 1 impedance ratio) as long as the windings are phased correctly. The dots in Figure 1 indicate the phasing of the windings.

## Step by Step

For additional detailed instructions with photos, please see the *QST* in Depth web page at **www.arrl.org/qst-in-depth**.

**Step 1**: Slip a ½-inch piece of shrink tubing over the three wires and position them up through the center of the core with the tubing centered on the outside. I placed the black wire on the left, white in the center, and longer blue on the right. Leave 2½ inches of wire sticking above the center of the core.

**Step 2**: Wrap a second turn and add another piece of shrink tubing. Make sure that the wires have not become twisted in the center of the core.

**Step 3**: Wind another two turns, adding shrink tubing and making sure the wires do not become twisted in the center of the core. Insert a piece of ½-inch plastic tubing in the center to hold the windings. Space all the windings at 90° to each other.

**Step 4**: The long end of the 20-inch blue wire goes to the antenna. The short end of the blue wire connects to the white wire that protrudes from the opposite end of the core. Trim and solder so that the wires remain snug against the core.

**Step 5**: Trim about ½ inch of insulation from the remaining end of the white wire. Cut the white insulation at the corner of the core and slide it about ¼ inch towards the wire end. Cut and trim the black wire from the bottom of the core, wrapping it around the white wire close to the core, and solder the connection.

**Step 6**: Add shrink tubing over the soldered connections. Install a zip tie around the unun to keep the windings pressed against the core.

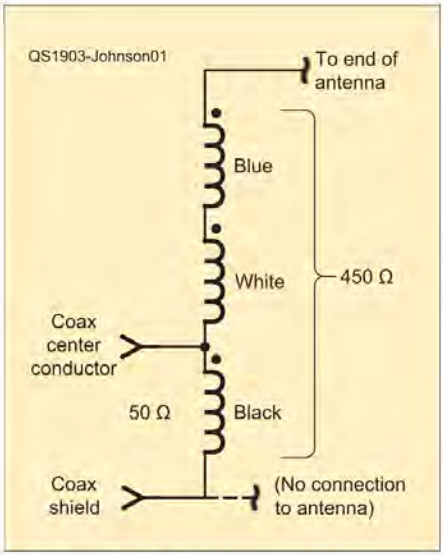


**Figure 1** — The unun is connected according to this diagram.

**Figure 2** — A test configuration using two identical ununs positioned back to back.

**Figure 3** — The unun mounted in an outdoor enclosure. Just the single blue wire connects to the end of the antenna.

## Testing

Solder the shield side of a coax connector to the black wire and the center conductor to the white wire. Connect a signal generator to the coax connector. Connect the first oscilloscope probe to the white wire and the second scope probe to the free end of the blue wire. Attach the probe ground clips to the PC board, as shown in Picture J on the *QST* in Depth page. You should see a voltage on the blue wire that is in-phase and three times the voltage on the white wire.

In another test, connect the unun to a 450 Ω resistor from the blue wire to the black wire (the shield connection). Measure the input impedance with an antenna analyzer. You should read around 50 Ω.

I tested the ununs at 100 W by connecting two ununs back to back in series. The first unun transforms the impedance to 450 Ω and the second transformed it back down to 50 Ω. Because the ununs are identical, I divided the measured power loss in decibels by two.

**Table 1**
**Insertion loss per unun**

| Band (meters) | Loss (dB) |
|---|---|
| 160 | 0.32 |
| 80 | 0.20 |
| 40 | 0.15 |
| 20 | 0.18 |
| 15 | 0.21 |
| 10 | 0.26 |

I connected the transmitter through a barrel connector to a 50 dB, 100 W attenuator and measured the RF power with a Hewlett-Packard 436A power meter, using an 8482A power sensor to get a reference power level in dBm. I then replaced the barrel connector with the two ununs (see Figure 2). The last step is to key the transmitter and record the dBm reading divided by two. Table 1 lists the unun measured losses across the MF-HF bands.

Figure 3 shows the finished unun in an outdoor enclosure.

All photos by the author.

Stan Johnson, W0SJ, was first licensed in 1961, and upgraded to Amateur Extra class in 1968. He has a degree in electronics from Iowa State University and a physics degree from the University of Northern Iowa. His career began at Bell Telephone Laboratories near Chicago and ended at the John Deere Product Engineering Center in Iowa as Scientist/Engineer. Since retiring in 2001, Stan enjoys building things, mostly out of junk. You can reach Stan at **w0scavengesjunk@gmail.com**.

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# Improve Workbench Safety with GFCI and a Kill Switch

An electrical safety upgrade that includes ground-fault circuit interruption, a bench power kill switch, and an auto-off latching relay for a soldering iron.

**Allen Wolff, KC7O**

A radio amateur's workbench can be a dangerous place. Aside from the obvious hazards posed by high-voltage power supplies, there are not-so-obvious shock hazards due to ground faults.

Ground-fault circuit interrupters (GFCIs) are designed to break the circuit when the current becomes unbalanced, saving many (including me) from electrical shocks, equipment overheating, and potential fire hazards due to leakage that is not enough to trigger a house circuit breaker.

## Adding GFCI Protection

If your bench is served by a single circuit breaker, you can change the breaker to a GFCI type and you are done. If you are not comfortable inside an electrical panel or do not want to incur the expense of an electrician's house call, you can swap one of the bench sockets for a GFCI socket.

GFCI sockets provide ground-fault protection to all the other sockets downstream from the GFCI socket, so you don't need to replace all the sockets to get total bench protection. If other sockets are on a different circuit breaker, then each string of sockets on a breaker will need a GFCI socket at the head of the string. Wiring directions are generally included inside (or as a part of) the packaging when you buy the socket. Another option is to use a portable unit that plugs into a grounded socket.

Photo courtesy of Tony Webster, **flickr.com/photos/diversey**.

## Adding a Kill Switch

Along with GFCI protection, I wanted to add a kill switch for my test bench so I could simultaneously turn off power to the whole bench. My series-connected outlets all come from one circuit breaker. I found it was easier and cheaper to put the kill switch in the first outlet in the string and a GFCI outlet in the second position in the string.

I replaced the first duplex outlet in the string with a switched receptacle. The receptacle, although switched, is not GFCI protected. In the second outlet after the switch, I placed a GFCI which feeds the rest of the string. Now when I leave the garage, I turn off the kill switch, powering off the test bench along with all test equipment plugged into it.

## Auto-Off for the Soldering Iron

As an adjunct to the kill switch, I added a soldering iron auto-kill latching relay (see Figure 1) to not have my soldering iron come on every time I turn on my workbench. When the normally open pushbutton is pushed, the relay latches and the soldering iron is powered on until the kill switch is turned off. The next time the bench is activated, the soldering iron remains off until the button is once again pushed.

Amateur Extra-class licensee and ARRL Life Member Allen Wolff, KC7O, has been an Amateur Radio operator for 54 years. He holds a Bachelor of Science degree in electrical engineering, RF communications from Drexel University in Philadelphia, Pennsylvania, and is retired from a career in aerospace manufacturing. In 1999, Allen was awarded the ARRL Herb Brier Instructor of the Year Award for his 17 years of teaching Novice and Technician classes that accounted for at least 450 new Amateur Radio licenses.

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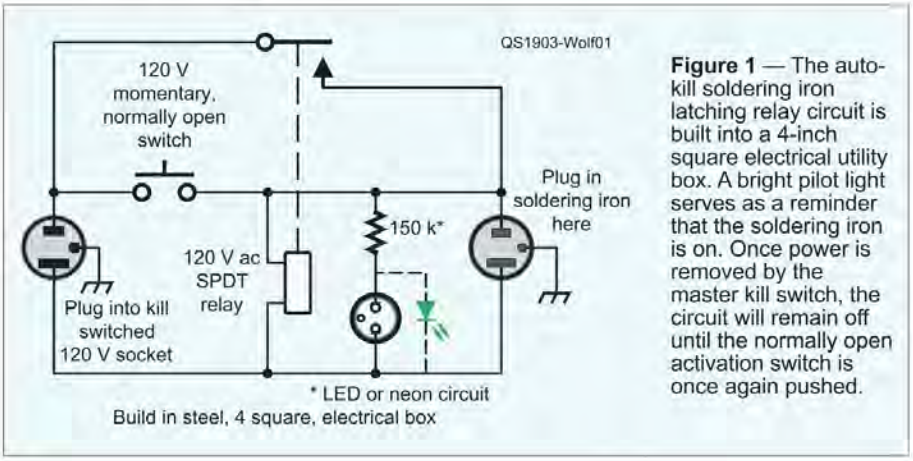


**Figure 1** — The auto-kill soldering iron latching relay circuit is built into a 4-inch square electrical utility box. A bright pilot light serves as a reminder that the soldering iron is on. Once power is removed by the master kill switch, the circuit will remain off until the normally open activation switch is once again pushed.

# 3D-Printed Coax-to-Wire Connection Blocks

Leave PVC pipe odds and ends at the hardware store and 3D print your own lightweight, weatherproof antenna center blocks.

**John Portune, W6NBC**

I do a lot of antenna experimentation and building, which often entails connecting coax ends to separate wires. If I'm in a rush to try out a new antenna design, the juncture of the feeder coax and the antenna wires often becomes a kludge of electrical tape, heat-shrink tubing, and gooey wire sealant.

The next best thing would be the classic radio amateur solution of using PVC pipe odds and ends. While certainly workable, the design is heavier than necessary and, unfortunately, looks like what it is.

Fortunately, 3D printing provides a third option for making our own custom designs with a professional appearance, as shown in the lead photo. For my latest project, I wanted something smaller, lighter, and less expensive than the heavy commercially available dipole center blocks.

## 3D-Printed Connection Blocks

For my purposes, a simple, inexpensive, direct wire-to-coax connection would suffice. I decided on three sizes of easily 3D-printable terminations for connecting ordinary hook-up wire directly to three different diameters of common coax cable (see Figure 1).

**Figure 1** — Three shell designs accommodate coax cables with diameters from 0.2 inches to 0.4 inches.

The connection block is comprised of two identical halves that clamp together and are held tight by zip ties. There is a center hole at the top for vertical suspension and a pair of "Mickey Mouse" ears on either side to use as strain reliefs for dipole wires.

There are many different filament materials available for 3D printing. For this application, which will generally be used outdoors, a UV-stable material such as ASA (acrylonitrile styrene acrylate) is best. However, the more common PLA filament is usable if the connection block is protected by a coat of exterior paint. The design files are available from my website (**www.w6nbc.com/3dfiles**) or the *QST* in Depth web page (**arrl.org/qst-in-depth**).

## Wiring

Strong and quick connections between the hook-up wire, coax braid, and center conductor are made with insulated crimp-type wire

### 3D Printing Availability

Don't be too concerned if you don't have a 3D printer. They are fast becoming less expensive and often there will be at least one person in a local Amateur Radio club who has one. There are also 3D printing services available on the internet, and even select UPS stores and public libraries have 3D printing available.

butt splices inside the connection block. Some may prefer to solder the connections, but I find properly crimped connections to be reliable and quick to make. The heat-shrink insulation on the crimp connector also provides an additional layer of weatherproofing for the connection.

I use common #14 AWG stranded vinyl-insulated primary hook-up wire for all three connectors. The #14 AWG wire is rated for 13 A rms, which is twice what's needed for 1,500 W PEP in 50 Ω line.

Use #16 – 14 AWG (blue) crimp butt splices for the two smaller connectors. Large diameter coax with its thicker shield bundle requires a #12 – 10 AWG (yellow) for the shield connection. For smaller hook-up wire or open-wire line, add one or two additional layers of heat-shrink tubing over the splice to create a tight fit in the connector. If you prefer, you can use the large connector for all sizes of coax, again by adding layers of heat-shrink tubing over the crimp splice.

All common varieties of coax are accommodated. The large connector is for coax with a 0.4-inch diameter outer jacket, such as RG-8, RG-213/214, or LMR-400. Coax with a 0.2-inch jacket, such as RG-58, uses the small connector. Mini-8 and RG-59, with a 0.25-inch jacket, use the medium connector. All connectors accept 300 Ω and 450 Ω open-wire line, again by adding layers of heat-shrink tubing to fatten the open-line wires.

## Assembly

First remove 1½ inches of the coax outer jacket, taking care not to nick the braid. Unweave the individual coax braid wires into separate strands down to the plastic jacket, then twist the strands into a single conductor. Trim the ends as shown in Figure 2. Next, expose ¼ inch of the center conductor, which should leave ⅜ inch of dielectric exposed.

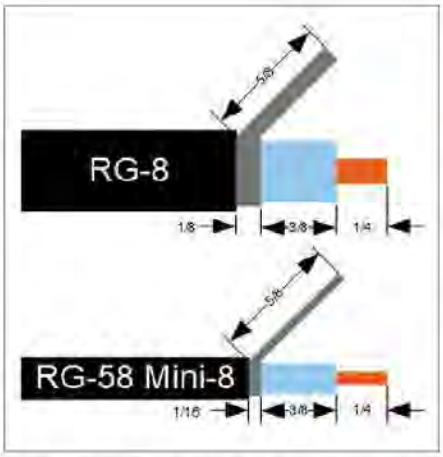


**Figure 2** — Coax cable end preparation for butt-splice crimp connectors.

After preparing the coax ends, make the connections to the antenna wires with appropriately sized butt-type crimp connectors (a proper ratcheting crimping tool pays off here). Before crimping, dry fit the assembly into the plastic shell to make sure that the coax jacket and hook-up wire insulation will be securely clamped by the connector. For a permanent installation, fill the inside of the connector with a suitable RF sealant before tightening the zip ties. I recommend clear RTV silicone adhesive, available at most hardware stores. Other common sealants may have poor RF properties. Silicone grease and commercial coax sealant are also suitable.

## Conclusion

Say goodbye to tape kludges with these lightweight, 3D-printed blocks, which are exceptionally handy while experimenting with a new antenna design during the initial tune-up and matching phase before adding a permanent connector. For permanent use, they make excellent dipole center blocks and are ideal for portable and backpacking antennas.

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 at **jportune@aol.com** or through his website at **www.w6nbc.com**.

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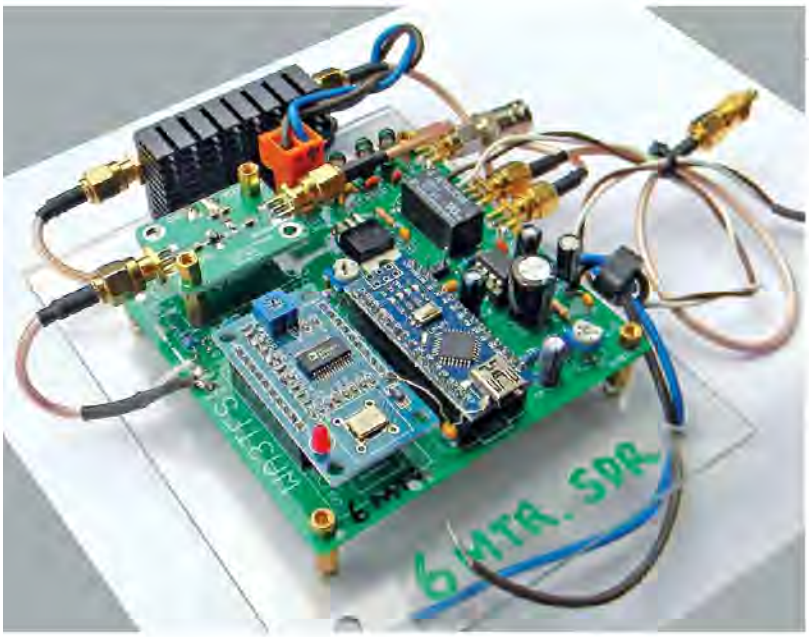
## New Products

### The S-BOX and S-BOX-USB by N6TV

The Serial Box (S-BOX) is a reconfigurable passive serial port splitter and amplifier interface designed to simplify simultaneous connections of a logging computer and peripheral devices to a transceiver's serial port, using only standard cables with molded connectors. The S-BOX-USB includes one internal FTDI USB-to-serial adapter, whereas the S-BOX-USB-2 includes two independent adapters. Supported peripheral devices include ACOM, SPE, and Elecraft HF automatic amplifiers, SteppIR controllers, serial port band decoders, serial port automatic antenna switches, the Kessler/Palstar AT-Auto Tuner, and more.

All models include four independent open-collector keying circuits that can provide computer-generated CW, FSK RTTY, and PTT keying to any supported transceiver, plus remote power-on ability for an Elecraft K3 via *RemoteHams* software. The S-BOX retails for $149, the S-BOX-USB for $169, and the S-BOX-USB-2 for $189. Prices include custom configuration and labeling. See **www.bit.ly/S-BOX** for more details.




# Super Simple 6-Meter SDR Transceiver

A complete software-defined transceiver from module components.

**James Forkin, WA3TFS**

A new 6-meter repeater was recently christened in my area and, finding myself without a 6-meter rig, I decided to build one. I've had great success with software-defined radio (SDR) transceivers in other projects, so I decided to use a similar approach for this project. I attempted a design using a minimum number of parts, but with the requirement of good performance in mind. The schematic in Figure 1 demonstrates the small parts count for this application. I used existing pre-wired modules to construct the simplest 6-meter FM transceiver possible.

## The Design Concept

I used a low-cost and readily available RTL2832 dongle for the receiver (see Figure 2). The dongle, along with the free downloadable *HDSDR* software, provides good performance when the RF input is low-pass filtered. It incorporates a 820T or 820T2 tuner. The supplied antenna is of little use, but the attached cable and connector can be used to connect the dongle to the transmitter board.

For transmitting, I used the inexpensive AD9850 DDS module. The frequency is controlled by an Arduino Nano. I programmed the Nano to set the DDS module output directly on the 6-meter band and adjusted the control program to frequency modulate the DDS module at the 6-meter frequencies. I control the DDS using the SPI interface in the Nano, but to do this, it is necessary to remove or disable the LED on the board. Simply remove the series-connected resistor to the LED as shown in Figure 3. This disconnects the LED marked **L** and allows the SPI function to work.

The only other required components are a microphone amplifier attached to an A-to-D input of the Nano, and transmitter RF amplifiers. The audio is converted to digital, and the digital audio modifies the control transferred to the DDS to produce an FM modulated signal in the 50 MHz ham band. This same design could also be used on the 10-meter band with a different low-pass filter design and modified software.

The audio amplifier is based on an LM386 integrated circuit (IC) with pre-emphasis added by R6 and C6 between Pins 1 and 8 of the IC. Pre-emphasis increases higher frequencies and suppresses lower frequencies within the voice band. This is generally necessary for best audio with frequency modulation. An inexpensive dynamic microphone works well with this amplifier.

I wired the Nano, DDS, and the LM386 microphone amplifier on some perfboard, and with some adjustments in the software, was able to obtain nice-sounding FM at the 6-meter repeater input frequency. The output level from the DDS is about –20 dBm at 51 MHz, so additional amplification is necessary.

## RF Amplifiers

Several MMIC-based amplifiers designed for low-level TV applications are available for use as a DDS buffer amplifier. I found a suitable module (see Figure 4) on eBay. It is identified as RF LNA with 30 dB gain, and operates from 9 to 15 V dc over the 10 kHz to 2 GHz range. It includes SMA female connectors. This buffer amplifier boosts the DDS output to just under +7 dBm. Depending on your RF amplifier, you may need an attenuator (see Figure 1) at the input of the buffer amplifier.

*"Good transmitter design requires an output low-pass filter to suppress harmonics generated by the transmitter."*

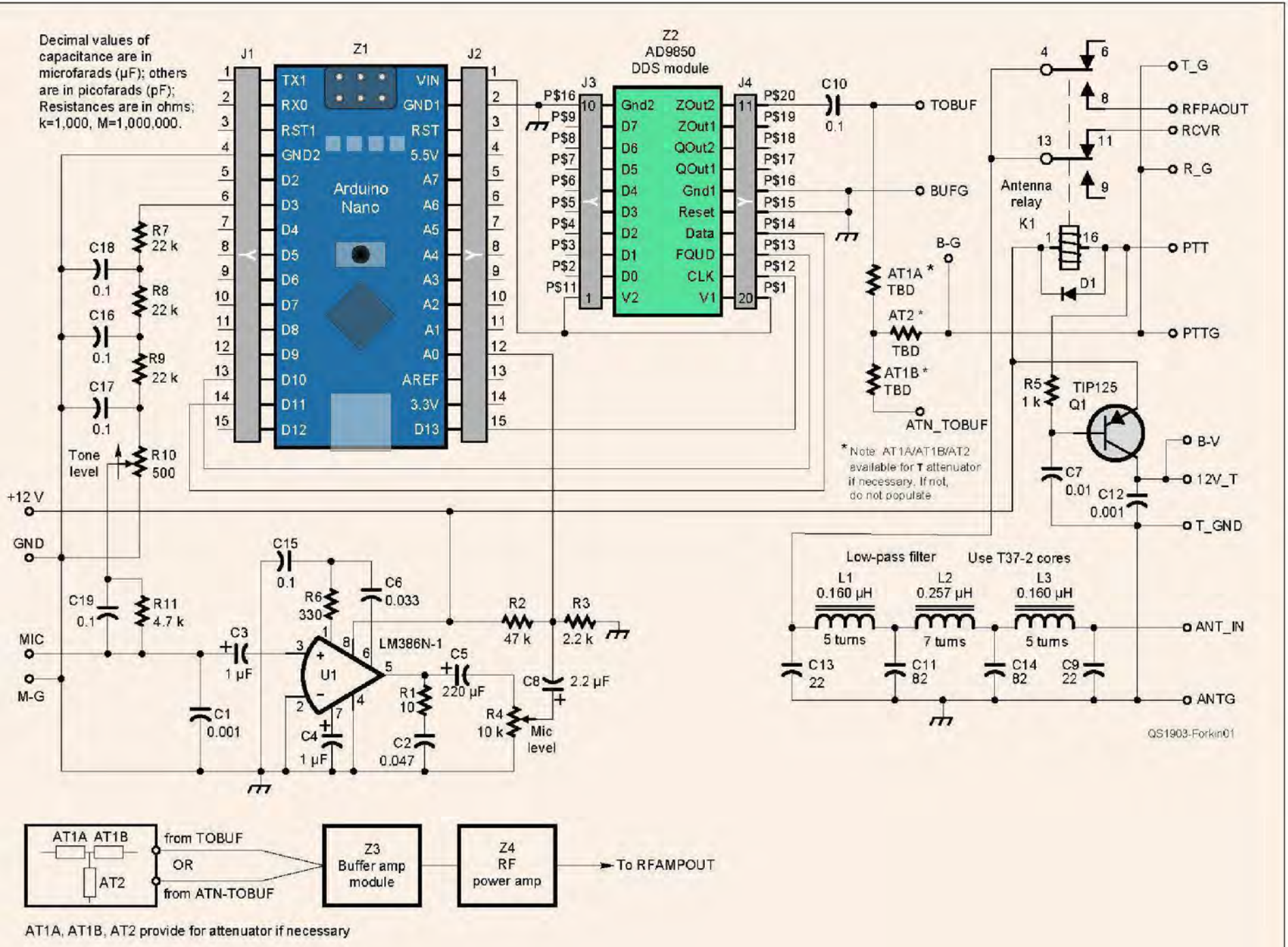

Decimal values of capacitance are in microfarads (µF); others are in picofarads (pF); Resistances are in ohms; k=1,000, M=1,000,000.
J1
Z1
J2
Z2
AD9850
DDS module
J3
J4
Arduino Nano
TX1
RX0
RST1
GND2
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
VIN
GND1
RST
5.5V
A7
A6
A5
A4
A3
A2
A1
A0
AREF
3.3V
D13
Gnd2
D7
D6
D5
D4
D3
D2
D1
D0
V2
ZOut2
ZOut1
QOut2
QOut1
Gnd1
Reset
Data
FQUD
CLK
V1
C10
0.1
TOBUF
BUFG
B-G
AT1A *
TBD
AT2 *
TBD
AT1B *
TBD
ATN_TOBUF
* Note: AT1A/AT1B/AT2 available for T attenuator if necessary. If not, do not populate.
Antenna relay
K1
D1
PTT
PTTG
T_G
RFPAOUT
RCVR
R_G
R5
1 k
TIP125
Q1
B-V
12V_T
T_GND
C7
0.01
C12
0.001
R7
22 k
R8
22 k
R9
22 k
R10
500
Tone level
C18
0.1
C16
0.1
C17
0.1
+12 V
GND
MIC
M-G
C19
0.1
R11
4.7 k
C15
0.1
R6
330
C6
0.033
C3
1 µF
C1
0.001
LM386N-1
U1
C4
1 µF
C5
220 µF
R1
10
C2
0.047
R2
47 k
R3
2.2 k
C8
2.2 µF
R4
10 k
Mic level
Low-pass filter
Use T37-2 cores
L1
0.160 µH
5 turns
L2
0.257 µH
7 turns
L3
0.160 µH
5 turns
C13
22
C11
82
C14
82
C9
22
ANT_IN
ANTG
QS1903-Forkin01
AT1A AT1B
AT2
from TOBUF
OR
from ATN-TOBUF
Z3
Buffer amp module
Z4
RF power amp
To RFAMPOUT
AT1A, AT1B, AT2 provide for attenuator if necessary

**Figure 1** — Schematic diagram of the simple SDR transceiver. (DigiKey part numbers)

C1, C12 — 0.001 µF 50 V ceramic BC1072CT-ND
C2 — 0.047 µF 50 V ceramic 399-4189-ND
C3, C4 — 1 µF electrolytic 50 V, 493-10419-1-ND
C5 — 220 µF electrolytic 50 V, P13131-ND
C6 — 0.033 µF 50 V ceramic, 399-4179-ND
C7 — 0.01 µF 50 V ceramic, BC2662CT-ND
C8 — 2.2 µF electrolytic 50 V, 493-10503-1-ND
C9, C13 — 22 pF 50 V ceramic, 399-9723-ND
C10, C15 – C18 — 0.1 µF 50 V ceramic, 478-3192-ND
C11, C14 — 82 pF 100 V ceramic, 490-7490-1-ND
C19 — 0.1 µF 50 V ceramic [place in parallel with R11], 478-3192-ND
D1 — 1N4148 switching diode, 1N4148FS-ND
J1 – J4 — pin header, cut to fit 10 position, male, 952-1905-ND
K1 — DPDT 12 V relay, PB384-ND
L1, L3 — five turns of #24 AWG on T37-2 Amidon Toroid Core/red
L2 — seven turns of #24 AWG on T37-2 Amidon Toroid Core/red
Q1 — PNP Darlington, TIP125GOS-ND
R1 — 10 Ω resistor ¼ W, CF14JT10R0CT-ND
R2 — 47 kΩ resistor ¼ W, CF14JT47K0CT-ND
R3 — 2.2 kΩ resistor ¼ W, CF14JT2K20CT-ND
R4 — 10 kΩ resistor/trimmer, 3319P-103-ND
R5 — 1 kΩ resistor ¼ W CF14JT1K00CT-ND
R6 — 330 Ω resistor ¼ W CF14JT330RCT-ND
R7 – R9 — 22 kΩ resistor ¼ W CF14JT22K0CT-ND
R10 — 500 Ω resistor/trimmer, 3306F-501-ND
R11 — 4.7 kΩ resistor ¼ W [place in parallel with C19], CF14JT4K70CT-ND
U1 — LM386N audio amp IC, 296-43960-5-ND
Z1 — Arduino Nano microprocessor, eBay
Z2 — AD9850 DDS module, eBay
Z3 — buffer LNA module, eBay
Z4 — RF power amp, eBay
Z5 — receiver dongle [see Figure 2], DVB-T-DAB+FM, eBay

**Figure 2** — SDR receiver dongle. Just the cable and connector are needed from the antenna assembly.

**Figure 3** — Remove the marked resistor from the Nano board to disable the LED.

With additional internet searching, I found some multi-stage amplifiers that produce 2 to 3.2 W output from 1 MHz, to 700 MHz at 35 dB gain, and required a +1 dBm to +7 dBm drive level (see Figure 5). These modules come with no schematic or parts identification, but you can just treat them as "black box modules" with input, output, and power connections. There are no tuning adjustments, but make sure that there is good airflow over the heatsink, and ground the shields of the cut cables to the adjacent grounded solder pads.

Good transmitter design requires an output low-pass filter to suppress harmonics generated by the transmitter. I designed one using Tonne Software (see Figure 1). This filter is used for both transmitting and receiving. The filter response and additional construction information are on the *QST* in Depth web page at **www.arrl.org/qst-in-depth**.

## Easy To Duplicate

My circuit board layout can be seen in Figure 6. I designed a printed circuit board to accommodate the various sections and modules. It is necessary to build only the microphone amplifier, low-pass filter, relay, and the interconnecting cables to complete the transceiver. PNP transistor Q1 handles the power switching, and in-line headers installed on the board allow you to plug in the Nano and DDS modules. The buffer amplifier is mounted on the circuit board using two ½-inch standoffs, and the power amplifier is mounted off the board due to the size and heatsink. My final board design measures 3½ × 3½ inches. The 12 V dc is necessary to power the transmitter and indicator LEDs. The Arduino Nano, the AD9850 DDS module, and the receiver are all powered by the USB connections to the computer.

## Software

The required software includes the SDR control program *TFS_6FM_SDR_R1_0.ino* supplied on the *QST* in Depth web page, the receiver program *HDSDR* available from **www.hdsdr.de**, and *TERMITE*, a simple USB serial terminal control program available from **www.compuphase.com/software_termite.htm**. Set up your serial port settings to send 9,600 baud, 8 bits, 1 stop bit, and no parity, and then select the proper USB port.

Download Arduino programming software, which is required to program and modify the SDR control program, from **www.arduino.cc/en/Main/Software**. Extensive help files and

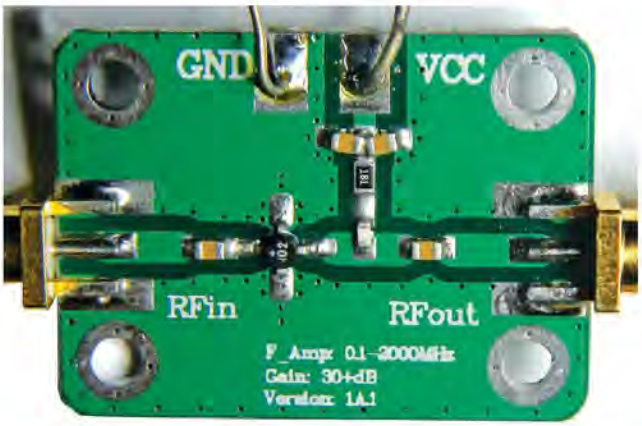



**Figure 4** — I found my DDS buffer amplifier on eBay, and other similar models are available online.

**Figure 5** — Additional RF power amps like this one are available online.

additional information are available for each software package on the respective sites. Be sure to select the versions that match your operating system.

## Initial Startup Procedure

1 After wiring up the circuit board, check that all external connections are in place and correctly connected. Trace the 12 V power through the power switch to the transmit control transistor.

2 Connect a 50 Ω dummy load to the transceiver RF connector. Do not operate the transceiver without an antenna or dummy load attached, as the RF power amplifier may be damaged. **Do not yet apply 12 V power**.

3 Plug a USB cable into the Nano module. The LED on the module will light, and the LED on the DDS module will also illuminate.

4 Attach another USB cable to the receiver dongle. An LED in or on the dongle will illuminate.

5 Download and install the *HDSDR* software. Follow the configuration instructions on the web page. Tune to some known VHF frequency like the weather broadcast (such as 162.55 MHz). After allowing a few minutes for warmup, calibrate the receiver.

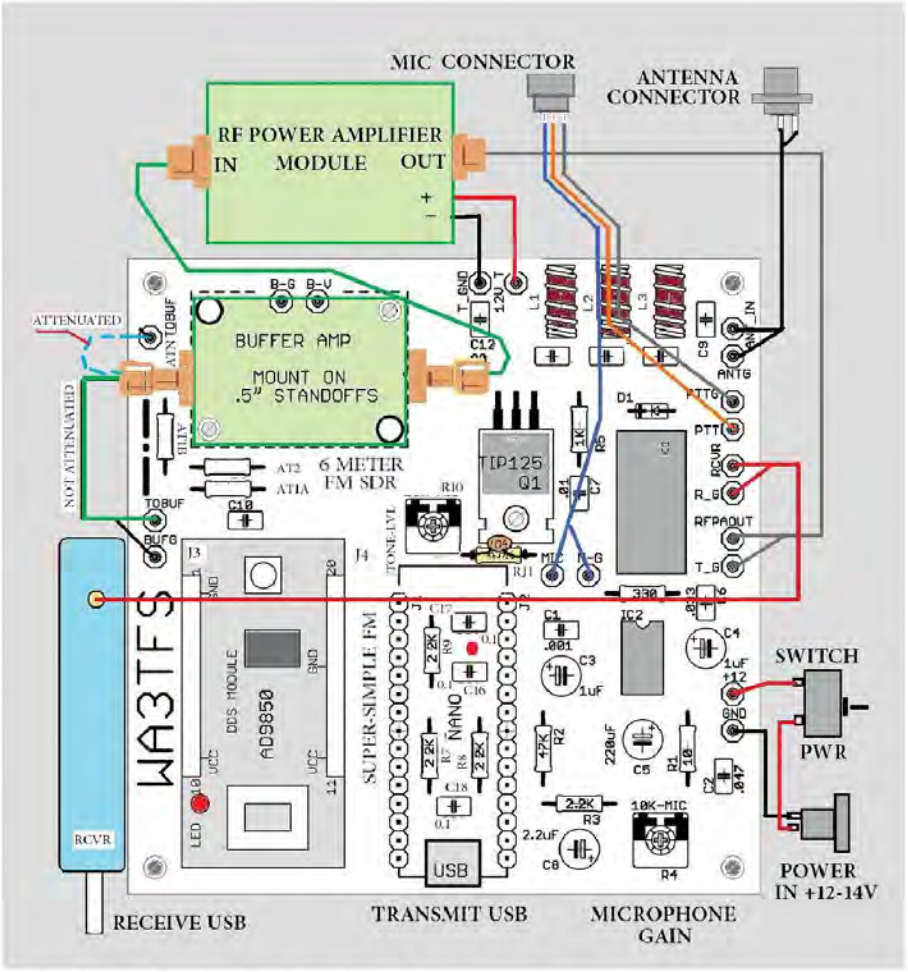



**Figure 6** — The modules are interconnected.

**Figure 7** — The Super Simple Transceiver in an enclosure.

6 Download and install the *TERMITE* program that will be used to control transmit frequency and select the USB port to communicate. You must always enter the frequency as eight digits. I decided to not incorporate automatic offsets, so you can set the frequencies as desired, thereby supporting repeater or simplex operation.

7 If all is well to this point, now apply the 12 V dc and turn on the power switch. Note that the Nano and DDS are always powered when attached via the USB cables to the computer.

8 On the receive display, you will be able to see the programmed frequency at a low level. Set the receive frequency and the transmit frequency to the exact same setting. If it is exactly on frequency based on your calibrated receiver, then no further adjustments are necessary. If it is not exactly on frequency, you must change the line in the SDR control software to calibrate the transmit frequency. Any error is due to oscillator frequency offset on the DDS module. Each higher number change lowers the frequency by approximately 52 Hz.

9 Press the PTT on the microphone and verify RF output.

10 While listening to yourself, set the microphone gain to the best-sounding output. Ensure that you have set the bandwidth to 15 kHz in the *HDSDR* software. The microphone level adjustment is not a deviation control, but only an audio level control. Excess audio level will distort your voice as the limits in the A-to-D converter will be exceeded. Deviation is set and controlled by the software. Do not be concerned by other signals that may appear in the display when transmitting; they are caused by overload in the receiver dongle because of the close proximity to the transmit circuitry.

11 The default sub-audible tone is set to 72 Hz but can be adjusted for any frequency. You can set the level at this time by observing the DDS signal in the display screen on the *HDSDR* software. With a microphone attached to the transmitter, adjust for a width of 200 – 400 Hz, which is compatible for most repeaters. Note that the frequency must be entered as a whole number because the Nano will not accept fractional numbers.

12 There are no other adjustments necessary at this point. Tune the *HDSDR* software to the receive frequency and the transmitter to the transmit frequency on the serial interface (*TERMITE*) software program. Connect an antenna, and the transceiver is now ready to use, so have fun!

## Conclusion

Output power is adequate for repeater operation and some simplex work. The RF level is sufficient to drive an external high-power amplifier. Using preassembled modules eliminates the need for detailed testing and adjustments and puts the project within the abilities of anyone with basic soldering and assembly skills. No test equipment is needed other than the receiver to set the transmit software on frequency. A wide variety of enclosures are available to finalize your project (mine is shown in Figure 7). The only front panel controls necessary are a power switch and, if desired, a power and transmit LED indicator and microphone connector. On the rear panel, provide access for two USB connections, a power input, a microphone connector, and an RF connector.

If you are interested in duplicating this project, I will have circuit boards available. Contact me at **jforkin@verizon.net** or **https://wa3tfs.com**.

James Forkin, WA3TFS, retired as an Electronics Design Engineer after more than 35 years developing analog and digital products for aerospace, telephone, medical, industrial, utility monitoring, and robotic applications. He specialized in electromechanical design and EMI suppression techniques. Jim learned Morse code as a Boy Scout working on his Eagle rank, but did not discover Amateur Radio until several years later. He was licensed as a Novice, WH6HOC, in 1971 while in the US Army stationed in Hawaii and made his first contact using a homebrew 5 W vacuum-tube crystal-controlled transmitter and vertical antenna on 15 meters. He has been designing and building amateur devices since he was first licensed. Jim has written articles for *Ham Radio Magazine* and *QST*. He is active on 40- and 20-meter SSB using homebrew transceivers. You can reach Jim at **wa3tfs@arrl.net**.

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

# Soldering Surface-Mount Devices

How to solder SMD components using a pair of soldering irons.

**Dino Papas, KL0S**

You can successfully build ham radio projects that use surface-mount devices (SMDs) with proper circuit board preparation and the right tools. My wife, Toby, KL0SS, and I won a banquet prize of two kits that were donated by Kanga Products, a supplier of do-it-yourself projects. One was a 30-meter CW low-power transceiver, and the other an SMD 50 Ω dummy load capable of dissipating up to 5 W. I thought the dummy load kit was a great candidate to install in my restored Heathkit HW-8 low-power transceiver as an internal load for transmitter tuning before connecting to an antenna.

The load consists of 40 parallel-connected 2 kΩ resistors, creating a 50 Ω load. The final measured resistance for my completed load is 50.09 Ω. A small additional diode detector circuit allows you to measure the rms voltage across the load so you can calculate the applied power. Figure 1 shows the first row of resistors installed at the top of the board, along with 10 SMD resistors shown above the board. All that is left is assembly.

## Tools

I have done SMD work before, so I looked forward to this challenge. Solder flux is one of the keys to any soldering job, and more so with SMD components. Flux comes in either a liquid or paste form, but liquid flux has a much longer shelf life. Another key tool is a good pair of tweezers with very sharp points for moving the parts around.

A big challenge to working with SMD parts is being able to see what you're doing with the small parts. I use the Carson Pro "Magnivisor Deluxe" Model CP-60 (see the lead image) that I bought for less than $30 on **amazon.com**. The unit has four interchangeable magnifying lenses — 1.5×, 2×, 2.5×, and 3× — and includes a very bright, adjustable LED lamp attached to the headband. You can wear your eyeglasses while you're using it and the visor allows you to flip the lens up out of the way when you're not actually soldering.

## Placing Parts and Soldering

Everyone has their favorite method of getting the SMD parts into place and holding them there while soldering the parts to the board. What I do is dab a bit of liquid flux onto the board solder pads, add just a hint of solder to one pad, and then use my tweezers to move the part into place. Once I'm satisfied with the orientation, I use a sharp pick tool to hold the component down and temporarily tack-solder that pin to the pad on the board to which I'd added solder. Then, I remove the pick and solder the other pin.

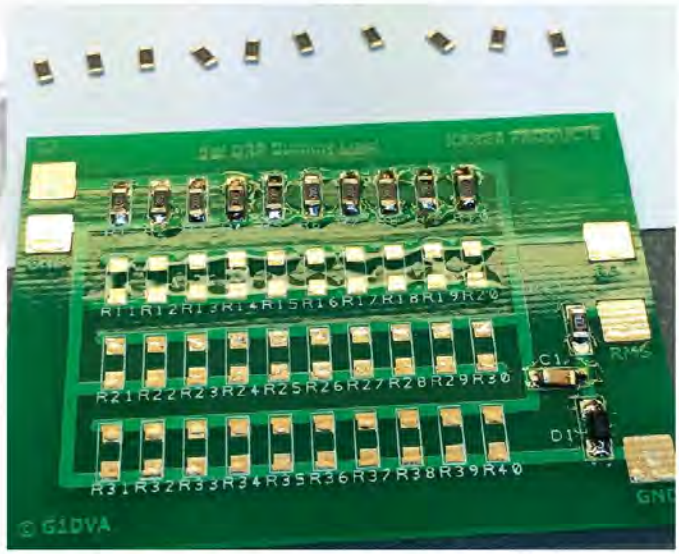



**Figure 1** — The first row of resistors are installed at the top of the board. Another 10 SMD resistors are shown above the board. [Dino Papas, KL0S, photo]

**Figure 2** — The Weller model WM120 Mini Iron is on the left, and the model WES51 soldering station is on the right. [Dino Papas, KL0S, photo]

Afterwards, I return to the first pin and re-solder the connection.

For general soldering, I use a Weller WES51 soldering station (on the right in Figure 2), but even the smallest tip available for that iron can make it tough to solder SMD-size connections correctly without creating solder bridges. For really fine work, I like to use my smaller Weller model WM120 Mini Iron (on the left in Figure 2), which has a very fine tip. You can see similar tips compared in Figure 3.

Keeping the soldering iron tip clean and properly tinned goes a long way to making good solder connections. With the number of resistors in this project and their proximity to one another, and because I have a soldering iron with a suitable tip, I decided it was quicker to do the project this way than it would be using my hot-air rework station for soldering.

**Figure 3** — The Mini Iron pencil tip (right) is preferred over a flat, wide soldering station tip (left). [Paul Cianciolo, W1VLF, photo]

Don't let projects with SMD parts scare you away. With a little practice, you can build some really cool ham radio projects.

Amateur Extra-class licensee and ARRL Life Member Dino Papas, KL0S, has been an Amateur Radio operator for almost 50 years. He holds a BSEE degree from the University of California at Davis and a Master's in engineering management from George Washington University. Dino retired as a colonel after 26 years of active duty in the US Army. He now resides with his wife Toby, KL0SS, a retired Army lieutenant colonel and ARRL Life Member, in Williamsburg, Virginia. He is president of the Williamsburg Area Amateur Radio Club. Dino and Toby host the club's Builders Group, a regular meeting of hams to homebrew together that was described in "Ham Radio Makerspace" in the February 2015 issue of *QST*. You can contact Dino at **kl0s@arrl.net**.

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## Product Review

# Elecraft KPA1500 Legal-Limit HF and 6-Meter Linear Amplifier

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

The Elecraft KPA1500 is a compact, solid-state, legal-limit desktop linear amplifier for 160 to 6 meters. While it was clearly designed to interoperate with the Elecraft K3 series radios, Elecraft provides optional cables for use with other brands of transceivers.

In my station, I have been using a K3 with a KPA500 500 W amplifier and companion KAT500 automatic antenna tuner. Together, the three units make a tightly-integrated amateur station that is a joy to operate. Changing the frequency on the K3 automatically sets the proper frequency, antenna, and tuning solution on the other two units. If the amplifier is in **OPERATE** mode, the K3 output power is automatically reduced to preset values for use with the amplifier — otherwise power is set to whatever level you use without the amplifier.

The KPA1500 includes a 1,500 W amplifier and auto tuner in the same box, providing the same operating integration with the K3 described above. The auto tuner in the KPA1500 is rated to handle 1,500 W continuously with a standing-wave ratio (SWR) of 3:1 on any band, and up to 750 W on HF with a 10:1 SWR. The manual provides a derating chart, indicating that it can handle about 1,200 W with an HF SWR of about 5:1. Ratings for 160 and 6 meters at an SWR above 3:1 are not as liberal.

This arrangement works well for my center-fed Zepp antenna, which has an SWR less than 10:1 on all HF bands. On most bands, the SWR is much less, and on some bands it is quite different depending on the band segment. The amplifier has two band-memorized antenna output ports, so I can cover all bands with my tuned triband plus 6-meter Yagi on one port and the Zepp on the other. The tuner will switch to bypass with low SWR (default 1.2:1, but settable).

The KPA1500 is packaged in two enclosures, as shown in Figure 1 — an RF deck and a power supply, each a bit larger than the K3. The RF deck weighs 22 pounds and the power supply weighs 17 pounds, a flexible and easy-to-handle arrangement.

## Hooking It Up

The KPA1500 comes with a well-written, spiral-bound 49-page *Owner's Manual*. It provides clear instruction on how to set up, interconnect, and operate the amplifier with your station equipment. A special section is dedicated to cable and interface requirements needed to automate interoperation with many recent transceivers from FlexRadio, Icom, Kenwood, and Yaesu. A "Theory of Operation" section provides a block diagram and discussion of how the equipment works, but no schematic diagram.

The separate power supply makes installation easier, but does add a few cables. The power supply is intended to be powered by a dedicated 240 V, 20 A ac circuit, and the attached cable comes with a common NEMA 6-20 plug. A dedicated 15-pin control cable interconnects the power supply and amplifier, as does a dc power cable with 75 A Anderson Powerpole connectors. Elecraft notes that, unlike typical 40 A Powerpole connectors, these connectors require an extra push, and a second audible click, to seat properly and make contact.

In addition to the power supply cables, the amplifier has SO-239 connectors for RF input and output, a keying line and supplied cable with

### Bottom Line

The Elecraft KPA1500 is a compact, highly integrated, legal-limit, 160 – 6 meter solid-state linear amplifier that can provide a significant boost to the typical transceiver. It is easy to install and interface in most any station, but is even more effective if used with the interoperation cables that are available for many transceivers.

phono plugs on each end, and a ground connection. An optional ALC line can be employed to avoid overdriving the amplifier with a misadjusted transceiver.

That completes what Elecraft refers to as a "basic interconnection" that allows full operation, with virtually any transceiver. The amplifier has a built-in frequency counter that will read the transmitted frequency and automatically switch bands and set the tuner to the antenna and tuning solution that has been memorized for the frequency.

For those using mechanically-tuned antennas, external antenna tuners, or other power-sensitive accessories, the KPA1500 supports a **KEY-LINE INTERRUPT** function that allows an antenna controller, for example, to open the **KEY** line so that amplifier power cannot be applied until the antenna has finished tuning. Appropriate cable adapters are provided to break the **KEY** line, if needed.

A more integrated interconnection can be made by using a special cable between the radio and amplifier. The optional KPAK3AUX cable can be used between a K3 transceiver and the amplifier to take full advantage of the interoperational capabilities. The amplifier will change band and antenna settings as soon as the transceiver frequency changes, and the transceiver will change output power as well. This means that, as you change bands, you will be listening with the correct and properly tuned antenna before you transmit. This is a big advantage in my view. You can even set up the tuner to work on bands on which you can't transmit.

Elecraft offers similar cables and connection arrangements for many other brands of transceivers. Other transceivers may not be able to do everything that an Elecraft-to-Elecraft interconnection will support, but they will do what's possible. Check the Elecraft website for details.

**Table 1**
**Elecraft KPA1500, serial number 0400**

| Manufacturer's Specifications | Measured in ARRL Lab |
|---|---|
| Frequency range: 1.8 to 54 MHz. | 160-, 80-, 60-, 40-, 30-, 20-, 17-, 15-, 12-, 10-, 6-meter bands. |
| Power output: 1,500 W PEP CW/SSB/data. | HF and 50 MHz, as specified, except 1,100 W PEP from 53 to 54 MHz. |
| Driving power required: 50 to 60 W typical for 1,500 W PEP RF output. | 38 to 45 W typical, see Figure 2. |
| Spurious and harmonic suppression: Not specified. | HF, 62 dB typical, 48 dB worst case (24.9 MHz); 50 MHz, 71 dB. Meets FCC requirements. |
| Third-order intermodulation distortion (IMD): Not specified. | 3rd/5th/7th/9th order products, (dB below PEP at full output): 14 MHz, –30/–40/–48/–58 dB. |
| Transmit-receive switching time: Not specified. | Unkey to key, 4.4 ms; key to unkey, 6 ms. |
| Power requirements: | 195 – 250 V ac, 20 A max. |
| Size (height, width, depth including protrusions): Power supply, 5.1 × 14 × 13.2 inches; RF deck, 5.1 × 14 × 13.5 inches. Weight: RF deck, 22 lbs and power supply, 17 lbs. | |

**Figure 1** — The KPA1500 power supply is in a separate cabinet and can be located out of the way.

## Navigating the Front Panel

The KPA1500 front panel offers comprehensive control and monitoring capabilities, but retains its simplicity of operation by being mostly automated — unless the operator wants to initiate a particular action.

On the upper left is a two-line LCD that is used for amplifier metering, menu navigation and settings, and many other functions. The default multimeter display indicates frequency band, power supply current, heatsink temperature, output power, and measured SWR. The display can be cycled through seven different combinations of potentially useful data, including the inductance and capacitance being used by the tuner on that frequency and fault information in case of a problem. Note that the displayed frequency has sufficient accuracy to allow antenna tuning, but it is not useful as an absolute frequency indicator.

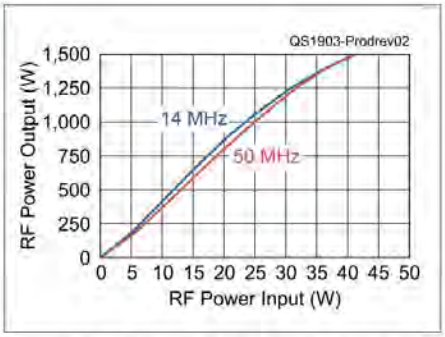


**Figure 2** — Elecraft KPA1500 RF input power versus output power.

To the right of the multimeter display is an LED power meter display with an indicator of output power in 50 W increments to 300 W, then 100 W increments to 900 W, and finally 200 W increments to 1,900 W. The

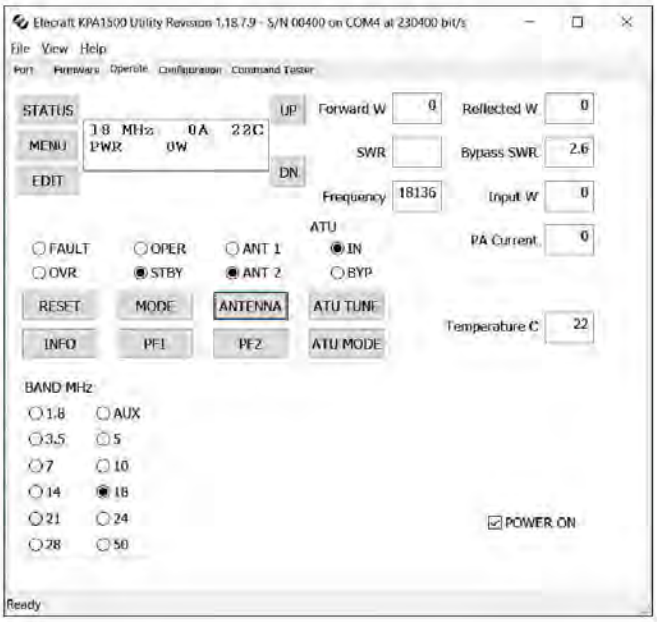


**Figure 3** —The *Elecraft KPA1500 Utility* software is needed primarily to update amplifier firmware, but this program can also be used to monitor status or change control settings from the connected PC.

**Figure 4** — The *KPA1500 Remote* software provides a virtual front-panel view of the amplifier and can be used locally or via a distant internet connection. In addition to this view, a miniature horizontal or vertical display can be selected to save screen space. Note the **POWER** button — the amplifier can be turned on and off remotely by either software platform.

LEDs are green until 1,500 W, then yellow and red if you exceed the US legal limit. This serves as a handy peak-reading display (peak-hold is available in firmware version 1.78 and later), and it is especially useful while transmitting in SSB mode. For detailed four-digit resolution, just shift your eyes left to the multimeter.

Below the power indicator LEDs are four groups of LED status indicators, with four dual-function control buttons beneath: **FAULT/INFO**, **MODE/PF1**, **ANTENNA/PF2**, and **ATU TUNE/ATU MODE**. **PF1** and **PF2** are user-programmable function keys. To the right of status indicators and buttons are LED SWR indicators, with four green LEDs for 1.0 to 1.5, two yellow LEDs to 2.0, followed by four red LEDs to 5.0:1. As with the power indictors, an eye shift to the multimeter provides a more precise digital readout.

On the bottom tier, there are two rows of six band-select buttons, including an **AUX** button for a possible future allocation. If your transceiver is connected to control the amplifier, you don't need to use those buttons. On the other hand, this interface works both ways, so the amplifier band-select buttons can be used to change both the amplifier and transceiver band — handy for K3 users, because the K3 doesn't provide a one-button band-select function. On the lower right of the front panel is a power **ON** switch, and a transmit (**TX**) indicator.

## The Built-In Antenna Tuner

The automatic tuner, together with the protection circuitry, makes sure you don't get in trouble. From the derating chart in the owner's manual, it looked like my antenna for 3,865 kHz, with an SWR of 4.8:1, could be run up to around 1,200 W output through the tuner, but the amplifier kept me honest. If I went much higher than 1,250 W, it would indicate a **HI POWER SWR** fault to let me know to back off.

The amplifier can put a 3 dB attenuator in the input to reduce drive to get the power output into specification range, or if you go too far, automatically bypass the amplifier altogether and switch to **STANDBY** mode.

It's likely kinder to the tuner components if you start close to the drive level appropriate to the allowed tuner power limit. You shouldn't see this error often because the K3 remembers RF power output settings for use with the amplifier.

## Computer Interconnection

The KPA1500 is happy to operate independently of a computer connection, but a 6-foot USB cable is provided to connect the amplifier to your PC. There are two programs from Elecraft that can be operated through this interface. As with most Elecraft products, the primary purpose of the basic *Elecraft KPA1500 Utility* program is to check for firmware updates, compare with the installed version, and facilitate updating if appropriate. As shown in Figure 3, the program can also be used to check operating status, as well as replicate all amplifier control and most indicator functions, providing a locally-connected remote-control capability. The utility program can also determine the amplifier's IP address — needed to be able to use the ethernet interconnection.

Another free program, added since the review amplifier manual was written, is the *KPA1500 Remote* software. This program, also available from the Elecraft website, can interconnect via the local USB connection, or via the

ethernet jack on the rear of the amplifier. (This software will also operate with the KPA500 amplifier and KAT500 tuner.) The ethernet interconnection can be used with a PC on your local network, or with the amplifier at a distant remote station through the internet and a security login. The basic screen is shown in Figure 4 and, while similar to the *Utility* software, adds dynamic bar graph **POWER** and **SWR** displays that simulate those shown by the LEDs on the amplifier front panel.

A particularly slick capability is that either program can remotely power the equipment on and off — important whether your amplifier is in another part of the house or another state. Note that this function only worked with the ethernet-connected remote function after I upgraded the firmware to version 1.78 (thanks to guidance from the Elecraft customer service team), which added a number of other enhancements. The amplifier also has a remote (**REM**) jack that can be tied into your remote power control system to power the amplifier on with 12 V dc applied and off if removed.

## Operating Impressions

I found the KPA1500 a joy to use. It fit right into my station in place of my KPA500 and KAT500 combination, and I'm sure the similarity reduced my learning curve.

One difference between the setups is that while the KAT500 has three **ANTENNA** jacks, the KPA1500 only has two. For me, that meant that my dummy load wasn't always available — not a major issue — but some may need to use an external coax switch to provide full access to their antenna farms. If multiple antennas are used on the same band, the tuner will memorize up to 31 tuning solutions per frequency and start with the last one used. This is useful for multiple antennas and can also deal with my window-line fed center-fed Zepp antenna, which requires different tuning if wet.

The power supply and amplifier are fan-cooled. The amplifier has five fan speeds, ranging from inaudible to vacuum-cleaner intensity. During my operations, including participating in some contests, I never found the amplifier fan noise objectionable, although during my regular long-winded 80-meter CW sked with George, W1WO, I did hear the fan speed increase to level two during my longer transmissions.

With headphones on, I could just barely tell that the fan had sped up. While the remote software indicates fan speed, I didn't have a way to determine what it was from the front panel until I upgraded to firmware version 1.78. The updated firmware also allows front-panel control of minimum fan speed. If you know you will be heating things up, you could set the minimum speed to one or two, and then it would likely stay constant until you set the minimum back to zero.

During my testing, Elecraft released an even newer firmware version, 1.87. This version changed the temperature thresholds for the fan speeds so that the first comes on at a lower temperature, resulting in less need to increase further. This was my experience during some long CW transmissions — it quickly went to speed one, then went no higher. (As this review went to press, firmware version 2.0 was available. Check Elecraft's website for the latest firmware and release notes.)

The amplifier/tuner always knew what band and segment the transceiver was tuned to. As I tuned the transceiver frequency or changed bands, I could hear the tuner, output filter, and antenna select relays clicking to keep up with me, ready to transmit — very nice. Without the transceiver interface connected, the amplifier would almost instantly read the transmit frequency when keyed. That means that while you are listening before transmitting, you may not have the correct antenna and tuner settings in play. Just push the appropriate amplifier **BAND** button to select the right antenna and/or tuner settings.

I found the break-in keying perfect, at least for my usual 30 WPM and lower keying speeds. The PIN-diode transmit-receive switching was silent, fast, and flawless. While the difference between 500 W and 1,500 W (4.8 dB) is less than one S-unit, I seemed to be able to work weaker DX stations than I would have expected with my KPA500. As you get closer to the noise floor at the far end, 4.8 dB can make a big difference. This amplifier goes a long way toward making up for my less-than-optimum antenna system.

*Manufacturer*: Elecraft, 125 Westridge Dr., Watsonville, CA 95076; tel. 831-763-4211, **www.elecraft.com**. Price $5,995.

**Visit https://youtu.be/e_vhAbN-LKA to see our review of the Elecraft KPA1500 Legal-Limit HF and 6-Meter Linear Amplifier on YouTube.**

# Harger Uni-Shot Exothermic Ground Connection Welding Kits

*Reviewed by Ward Silver, N0AX*
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In 2017, I installed a perimeter ground system around the outside of my station, using several ground rods bonded together with heavy wire and mechanical clamps. The ground rod for my ac service, telephone/DSL service, and the single-point ground panel (SPGP) for feed lines are all bonded together through this system. Last fall, I upgraded to welded connections.

## Why Welded Connections

With the growing awareness of amateurs about the need for solid ground systems, many are deciding that one lonely ground rod outside the station window isn't enough. To get the job done right, hams are working with new techniques, materials, and tools.

Most of us aren't that familiar with the techniques or materials used for heavy-duty ground connections and conductors. Digging and drilling are involved. Wires are thicker. Clamps and terminals are much bigger. That unfamiliarity can lead to poor or unreliable connections, especially those exposed to the weather and soil for a long time.

Connections between a ground electrode (usually a ground rod) and grounding conductors (heavy copper wires) are usually in direct contact with the soil, so corrosion and moisture damage are a constant problem. The connection might have to carry very high current without damage. Connections have to be mechanically strong, so that they aren't accidentally cut or torn loose by digging or soil motion.

Mechanical clamps, usually type-G ("acorn") or the two-part type-J, are often used to make connections between the heavy ground conductor and the ground rod, and I originally used acorn clamps, as shown in Figure 5. The clamp relies on compression to create a secure metal-to-metal contact. Some types of clamps are rated for direct burial. Even so, repeated thermal cycling and mechanical stress can cause the connection to loosen gradually, requiring inspection of the connection every so often. Wouldn't it be nice if a connection would never loosen or corrode?

**Figure 5** — A ground rod and acorn clamp securing stranded #6 AWG ground wire. This is typical of clamped connections that are replaced and upgraded by the welded Uni-Shot connections.

## Exothermic Welding

The answer is to weld the wire to the ground rod. Copper can be difficult to weld, but a special technique called *exothermic welding*, using thermite, works well. Thermite gives off tremendous amounts of heat when it burns. Mixed with copper powder in a ceramic crucible, a pool of molten metal is created — hot enough to partially melt the ground wires and rod. The result is a solid, welded connection.

Electricians use exothermic welding all the time. (So do railroads — **www.youtube.com/watch?v=rNjosF789X4**.) As a result, there are many products available. The most common are single-use kits for ½- or ⅝-inch ground rods and two, three, or four ground wires at sizes starting at #8 AWG. While more expensive than a bronze clamp, connections made with thermite welding are secure and can be buried or covered without needing to be inspected in the future.

Kits are available wholesale from local electrical supply distributors and in smaller quantities from ham distributors. The kits I evaluated were supplied by KF7P Metalwerks (**www.kf7p.com/KF7P/HargerUniShot.html**).

## Ordering Kits

On the order page, there are a number of different kit configurations. It's important to get the right model. The Harger Uni-Shot kits are designed for ⅝-inch-diameter ground rods, and you need to know the number and size of wires to be connected. The ⅝-inch kits can be used with ½-inch ground rods if you use mold sealer, as described below. My ground rods are ½-inch diameter, and all ground wires are #6 stranded AWG. I needed eight two-wire kits and two three-wire kits. You should order at least one spare, particularly if you haven't used the kits before.

I also ordered the flint igniter tool to light the ignition powder and some

### Bottom Line

Using an exothermic welding kit rather than a mechanical clamp results in a secure ground connection that won't loosen or deteriorate over time.

**Figure 6** — The Uni-Shot in action with mold sealer around the ground rod and both wire sleeves. Clamping pliers support the crucible so it is vertical.

**Figure 7** — The final welded connection. An additional ground conductor is clamped to the rod. This connection will not be buried.

mold sealer for around the holes in the crucible. You can use fireworks sparklers to ignite the kit, but a sparking tool is more convenient. Mold sealer is clay putty that prevents the molten metal from leaking around the ground rod and the wires so that everything inside is completely heated. Mold sealer will help keep you from having to rework a connection. The mold sealer costs about the same as a kit, so if it saves you from wasting one kit, it's worth it. The pound of sealer is enough for dozens of connections.

## Using the Kit

The kits come with a fairly complete instruction sheet intended for use by electricians. The instructions and drawings are complete but terse. Read them completely, and carefully identify each part of the kit. Watch the video provided by KF7P Metalwerks at **www.kf7p.com/KF7P/HargerUniShot.html**. The segment of thermite igniting is not sped up — it happens in a couple of seconds.

I made a mistake the first time, either letting the powder leak out by not assembling the kit correctly, or I didn't have the ground rod aligned correctly. Treating the first one as a practice opportunity, I didn't have any trouble thereafter.

The welded connection shouldn't be hammered, so the ground rod must be driven in to its final position. If you're going to bury it, the top of the rod should be below ground level before you weld the connection. The ground rod's top will probably need to be filed or ground down to fit through the hole in the bottom of the crucible. A coarse file or portable grinder will do the job. (I used a file and that turned out to be the hardest part of the project.) Use a steel brush to clean the rod and the ground wires of any dirt and oxidation.

It is a good idea to practice inserting the wires into the sleeves and getting the crucible set up in a stable position on the ground rod. Note how the sleeves fit in the mold, and be sure the flared end is on the outside of the crucible. Using clamping pliers as a support is a good idea; heavy ground wires are stiff and can pull the crucible out of position. The wires should touch in the middle of the mold. Pack some mold sealer around the ground rod and all wire sleeves on the outside of the crucible.

Be sure that you put the ceramic insert and steel disc in the mold before the thermite powder. If you don't, the molten mass will pool below the wires, and the weld will be incomplete. Removing the powder once in the mold is pretty much impossible, and you won't be able to use that kit.

Be sure you know which portion of the powder tube has the thermite (the clear end) and which has the much finer starting powder (the orange end). They can't be mixed (or separated). Tap the powder tube before you open it to be sure the powder is not packed into a lump from shipping. Having the powders in separate compartments of the powder tube is helpful.

Pour in the thermite, put on the cap, then pour the starting powder into the cap's hole. Leave a little bit around the hole to catch the spark. If it's a windy day, block the wind or the fine-grained starting powder can blow away.

Put on safety glasses and heavy gloves before lighting the powder. It is tempting, but don't look at the molten mixture after ignition. Light the starting powder and in a few seconds, the thermite mixture will have turned into molten weld material. Let the mold cool for at least 10 minutes before touching it. Figure 6 shows the Uni-Shot kit just after ignition.

To remove the mold, tap it with a hammer and break it into pieces. You should see a round button of solid metal on top of the ground rod with the ground wires coming out of it (see Figure 7).

Except for the cooling period and breaking off the mold, the whole process takes about 5 minutes per connection. More time will be required if the wires or ground rod are dirty or corroded. I was able to update the whole ground system in a few hours.

I am glad I did change the connections to welds, because I found that a couple of the clamps I had originally installed had loosened. That was probably the installer's fault (me), but it's typical that hams won't have a lot of experience with installing ground systems. The extra expense compared to a clamp is a few dollars per connection and well worth not having to worry about the connections loosening up or corroding over time.

Now that I am more familiar with the kits, I will be using them from the start. They are the right tool for the job and in lightning country, knowing my ground system is secure is a good feeling.

*Manufacturer*: Harger, 301 Ziegler Dr., Grayslake, IL 60030; **www.harger.com**. Distributed by KF7P Metalwerks (**www.kf7p.com**). Kits priced from $10.95 to $14.95; mold sealer, $15.95; flint igniter tool, $10.95.

### Grounding and Bonding for the Radio Amateur

#### Learning the Terms

If you aren't familiar with the how and why of amateur station ground systems, you can read up on the subject. *The ARRL Handbook* covers the topic in the Safety chapter, and there are a number of articles in the ARRL website's Technology section (**www.arrl.org/safety**). Ward Silver's, N0AX, recent book *Grounding and Bonding for the Radio Amateur* (**www.arrl.org/shop/Grounding-and-Bonding-for-the-Radio-Amateur**), covers this and related subjects in detail and will explain unfamiliar jargon and abbreviations, like SPGP.

# W4OP Magnetic Loop Antenna with Remote Tuning

*Reviewed by Joe Everhart, N2CX*
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In a previous review, I discussed my experiences with the original manually tuned W4OP Loop sold by LNR Precision.[1] Since then, a new upgrade has been added to the product line incorporating a remote tuning function. Like the original W4OP Loop, the new version covers 40 through 10 meters (6-meter coverage is optional) and is rated at 15 W. This review will compare the new version to the original.

## A Small Footprint

Magnetic loops can be quite handy for use in locations where typical dipoles, long wires, or vertical antennas are not practical. These locations include portable ham operations and home stations where these larger antennas are not allowed, making a small loop antenna quite attractive. The additional capability to remotely tune the antenna adds to its convenience.

The same basic design of the original loop has been retained in the updated product. The loop itself is made of a length of semi-rigid coaxial cable fashioned into a 4-foot-diameter circle and connected to a tuning unit via PL-259 connectors. The loop is held in place by an aluminum support mast attached to the tuning unit. A smaller coupling loop is mounted on the top of the support mast near the main loop. The coaxial feed line attaches to this coupling loop and

### Bottom Line

The latest version of the W4OP Loop from LNR Precision adds the convenience of remote tuning from the operating position to the popular and effective manually tuned version. It's a good choice for those who operate portable in areas without access to antenna supports or for a home station when larger antennas are not possible.

[1]J. Everhart, N2CX, "W4OP Magnetic Loop Antenna," Product Review, *QST*, Oct. 2017, pp. 61 – 63.

runs to the radio equipment. The loop is tuned to the desired frequency via a variable capacitor in the tuning unit. Figure 8 shows the loop components, and Figure 9 shows a typical portable field setup.

## Tuning the Loop

The original W4OP Loop had a knob on the variable capacitor shaft, which the operator turned to set the operating frequency. In the updated design, the manual tuning shaft and knob have been replaced by an internal electric motor geared to slowly adjust the variable capacitor to allow fine tuning of the narrowband loop.

The motor is operated by the small handheld control box, shown in Figure 10. This control box is connected to the main tuning unit by a cable with connectors on each end and is powered by a standard 9 V battery. The rocker switch at the top of the unit (**UP** and **DOWN**) enables relatively fast tuning for large frequency changes. The **SLOW SPEED** switch is for fine tuning (press the pushbutton while using the rocker switch to move **UP** or **DOWN**). When the tuning capacitor reaches its upper or lower limit, the user is alerted by **UP STALL** or **DOWN STALL** LEDs. The battery has an internal boost circuit that will keep the motor circuit running as the battery deteriorates to 6 V dc. The boost circuit is active at all times, with a small power drain. There is no on/off switch, so the battery needs to be removed if the antenna is not to be used for more than a week or so.

A 25-foot remote cable comes standard with the W4OP Remote Loop to allow placing the antenna away from the operating position, and extension cables are available. This is convenient for semi-fixed installations where the antenna might be placed on a patio or deck while the operating position is indoors. Remote tuning also gets around the "body capacitance" detuning effect of manual adjustment, where the sharp loop tuning is affected by the proximity of the operator's body. Yet another feature of the redesign is that the tuning unit has been upgraded to add water resistance for extended outdoor use.

**Figure 8** — The remotely tuned W4OP Loop components break down for convenient transport. The main loop and coupling loop are at the upper left, with the tuning unit, remote control box, and cable below. The support mast sections, four plastic feet, and mounting clamp are at the right.

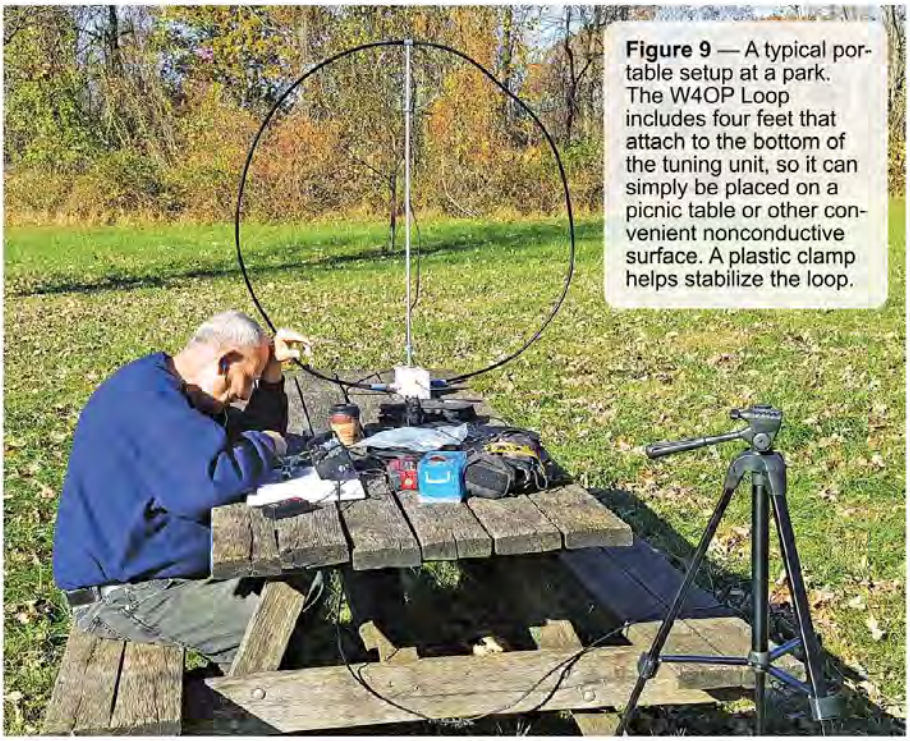

**Figure 9** — A typical portable setup at a park. The W4OP Loop includes four feet that attach to the bottom of the tuning unit, so it can simply be placed on a picnic table or other convenient nonconductive surface. A plastic clamp helps stabilize the loop.

As with the manual W4OP Loop, the antenna needs to be set up clear of surrounding metallic fences, wiring, and structures. It should be mounted at least 4 feet above ground to minimize losses. Four small feet are provided with the antenna and attached to the tuning unit. With the feet installed, the loop can be set on a wooden picnic table, park bench, or other convenient nonconducting surface. A plastic spring clamp is provided for extra stability under windy conditions.

For this review, we ordered the optional tripod adapter. This allows mounting the W4OP Loop on a standard camera tripod. I recommend this option for additional convenience.

## On the Air

I successfully used an original manually tuned W4OP Loop in a number of portable setups beginning with ARRL's National Parks on the Air (NPOTA) program in 2016. I enjoyed that so much that I've continued with

**Figure 10** — The handheld remote control with tuning buttons and indicators.

portable operations for the World Wide Flora and Fauna (WWFF-KFF, **wwffkff.wordpress.com**) and Parks on the Air (POTA, **parksontheair.com**) programs ever since. A magnetic loop is a great solution where larger antennas cannot be used, and it performs quite well. I set up the W4OP Loop with the provided stabilizing feet where convenient, and on a camera tripod where appropriate.

As a dry run, I tried a 1-day RaDAR (Rapid Deployment Amateur Radio) outing to prove the W4OP Loop's practicality. This type of effort involves setting up at multiple sites in succession with a minimum 6-kilometer (about 3¾-mile) drive between locations. I chose four parks eligible for both the WWFF-KFF and POTA programs, with the goal of completing the effort in 5 hours or less.

For fastest antenna setup, I transported the W4OP Remote Loop with the main and feed loops assembled to the remote tuning unit and support mast. All that was needed at each location was to attach the loop assembly to a tripod and run the feed line and control cables to my operating position. I allocated 30 minutes for on-the-air operation at each of the parks, and hoped to make at least 10 contacts at each location.

This test was quite successful in achieving all goals. I used the remotely tuned W4OP Loop with my Elecraft KX3 transceiver (10 W) for a total of 75 CW contacts on 40, 30, and 20 meters. I contacted stations from coast to coast in the US and several Canadian provinces. The loop proved to be very quick and easy to set up and take down at each site, with convenient band changes. It performed flawlessly, once the operator mastered the remote control tuning technique. The lead photo shows the antenna in use at one of the locations in Wilmington, Delaware.

## Lessons Learned

One lesson that applies to both original and new W4OP Loop models concerns use in windy conditions. Magnetic loops present a large wind load area, so proper precautions are needed. Along with the mounting feet, only one plastic clamp is supplied with the unit. A second clamp will provide added stability in windy locations. Clamps are readily available at any home center, and I have even seen them at a local dollar store. For a semi-permanent installation, it might be best to remove the feet and simply screw the tuning unit to a wooden railing or other flat surface.

Similar wind stability issues may occur when using the W4OP Loop on a tripod with the optional adapter. One fix that has been effective is to tie a weight onto the tripod leg support braces. This can be as simple as using an elastic bungee cord to attach a gallon jug full of water (about 8 pounds) to the tripod. Yet another method might be to tie the tripod onto a fence or signpost.

There is a definite learning curve in using the remote tuning feature. The basic method is the same as with manual tuning. If your transceiver has a built-in automatic antenna tuner, disable it. Then tune the loop roughly by tweaking the **UP** and **DOWN** tuning controls for maximum received noise on the desired frequency. Next, transmit into the loop on frequency and adjust for lowest SWR with the **UP** and **DOWN** rocker switch while holding down the **SLOW SPEED** button. There is some backlash in tuning, so it may take several iterations to get right on.

One thing that took me a while to learn was that the slow tuning takes 30 seconds or so to go from 20 meters to 40 meters, so you need patience. If you go too far, the **DOWN STALL** or **UP STALL** lights will illuminate when you reach the ends of the capacitor tuning range. Also note that, in bright sunlight, you might have to shade the remote tuning box in order to see the LEDs.

One final lesson learned was that the loop element is attached to the tuning box via SO-239 connectors. When you connect them, be sure not to cross thread the connectors. You need a very tight connection to ensure minimum loss. I have found that putting a very small amount of anti-oxidant compound or conductive grease on the box-mounted connectors aids in getting the connectors threaded on properly. It's messy, so don't use too much.

The W4OP Loop with remote tuning is a very well-designed and nicely manufactured device. It has proven itself in a number of portable uses where I could not set up a larger antenna. Typical of small portable magnetic loop antennas, it does have somewhat lower performance than a full-size antenna, but it also has important benefits. Its inherent narrow bandwidth gives significant rejection of off-frequency signals, even in the same frequency band, allowing simultaneous operation of multiple stations in close proximity. By its very nature, it also tends to significantly reject local electrical noise. Plus, its figure-eight pattern provides additional interference rejection broadside to the loop. And finally, the addition of the remote tuning feature makes a good design even better.

*Manufacturer*: LNR Precision, 1954 N. Fayetteville St., Asheboro, NC 27203; **www.lnrprecision.com**. Price: W4OPLoop Antenna (Remote Tuning), $443.74; case, $34.95; tripod adapter, $22.99.

# MFJ-1708SDR and MFJ-1708B-SDR TR Switches

*Reviewed by Mark Wilson, K1RO*
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In recent years, inexpensive standalone software-defined receivers (SDRs) have become popular. In addition to receiving many modes over a wide frequency range, SDRs include a panadapter (spectrum scope) and/or waterfall display to show band activity at a glance.

These small SDRs are popular add-ons for general listening or for adding panadapter capability when it's not built into the station transceiver. But if your transceiver has no provision for using an external receiver, you need a transmit-receive (TR) switch to share your station antennas between your transceiver and SDR without damaging something or swapping cables all the time.

## MFJ-1708 Series TR Switches

MFJ offers several different TR switches in the MFJ-1708 series. The original MFJ-1708 is a traditional TR switch for use with a separate transmitter and receiver, appropriate for use with classic gear. It has SO-239 jacks for antenna, transmitter, and receiver. Switching between receive and transmit is activated by grounding the **CTRL** phono jack, or you could rely on its internal RF-sensed switching circuit to handle the switchover automatically when RF is applied. An **AUX** phono jack provides switched contacts that could be used to operate a receiver's mute feature (to shut off receiver audio during transmit) or to control another device. Although there were some MFJ-1708s in the supply pipeline when this was written, the original model has been replaced by the MFJ-1708B. The B version offers much better performance at VHF and UHF, as well as additional isolation between receiver and transmitter to better protect the receiver front end from excessive RF levels.

The MFJ-1708SDR (see Figure 11) was developed with the use of a separate SDR receiver/spectrum display in the ham station in mind. Similar to the original MFJ-1708, it has SO-239 jacks for antenna, transceiver, and SDR. Switching between receive and transmit is activated by grounding the **PTT** phono jack, or automatically with RF-sensing. Although the manual does not show a frequency range, advertisements indicate that this TR switch is intended for HF and VHF use.

The latest version is the MFJ-1708B-SDR, shown in Figure 12. It has SO-239 jacks for an antenna, a transceiver, and an SDR receiver, and there's also a version with an SMA connector for the SDR antenna. Switching between receive and transmit is activated by grounding the **CTRL** phono jack, and like the other models, it has an RF-sensed switching circuit. Like the original MFJ-1708, it includes an **AUX** phono jack with a set of switched contacts for muting a receiver or controlling another device.

The biggest difference, however, is inside the box. The original MFJ-1708 TR switches used a single relay to switch the antenna. The B series switches use four relays, with components mounted on a PC board that uses 50 Ω transmission lines instead of wires for connections. The result is much better performance, particularly at VHF and UHF.

### Bottom Line

The MFJ-1708SDR and MFJ-1708B-SDR TR switches offer an easy way to share antennas between your transceiver and a separate inexpensive SDR for adding a spectrum display to your station or for wide-coverage listening. Although the B version costs about $20 more, the performance improvements are well worth the extra cost.

## Lab Tests

The ARRL Lab tested the MFJ-1708-SDR and MFJ-1708B-SDR switches, with results shown in Tables 2 and 3. The Lab looked at switching times, isolation between the various ports, and insertion loss.

**Table 2**
**MFJ-1708SDR TR Switch**

RF sense threshold: 10 – 14 mW typical.

Switching time (PTT or RF sense): 1.2 ms to transmit, 352 ms to 2.28 s to receive.

Power consumption at 13.8 V dc: transmit, 13 mA; receive, 31 mA.

Insertion loss (during receive, antenna port to XCVR and SDR ports):
14 MHz, 3.6 dB; 50 MHz, 3.94 dB; 144 MHz, 7.4 dB; 440 MHz, 19.6 dB.

Insertion loss (during transmit, antenna port to XCVR port):
14 MHz, 0.07 dB; 50 MHz, 0.28 dB; 144 MHz, 1.1 dB; 440 MHz, 4.0 dB.

Isolation XCVR to SDR port (during transmit, antenna port terminated):
14 MHz, 17.3 dB; 50 MHz, 11.2 dB; 144 MHz, 12.7 dB; 440 MHz, 0.8 dB.

SWR at XCVR port in transmit mode: 14 MHz, 1.0:1; 50 MHz, 1.05:1.

**Figure 11** — The MFJ-1708SDR.

**Table 3**
**MFJ-1708B-SDR TR Switch**

RF sense threshold: 16 – 18 mW typical.

Switching time (PTT or RF sense): 4.4 ms to transmit, 24 ms to 2.14 s to receive.

Power consumption at 13.8 V dc: transmit, 12 mA; receive, 155 mA.

Insertion loss (during receive, antenna port to SDR/XCVR ports):
JP2 installed: 14 MHz, 3.5 dB; 50 MHz, 3.5 dB; 144 MHz, 4.8 dB; 440 MHz, 7.7 dB.
JP2 removed: 14 MHz, 3.5 dB; 50 MHz, 3.5 dB; 144 MHz, 5.0 dB; 440 MHz, 6.8 dB.

Insertion loss (during transmit, antenna port to XCVR port):
14 MHz, 0.04 dB; 50 MHz, 0.09 dB; 144 MHz, 0.3 dB; 440 MHz, 1.5 dB.

Isolation, XCVR to SDR port (during transmit, antenna port terminated):
JP2 installed: 14 MHz, 56 dB; 50 MHz, 55 dB; 144 MHz, 51 dB; 440 MHz, 40 dB.
JP2 removed: 14 MHz, 56 dB; 50 MHz, 55 dB; 144 MHz, 51 dB; 440 MHz, 48 dB.

SWR at XCVR port in transmit mode: 14 MHz, 1.0:1; 144 MHz, 1.1:1; 440 MHz, 1.5:1.

**Figure 12** — The MFJ-1708B-SDR.

Switching time from receive to transmit for the MFJ-1708SDR is 1.2 milliseconds, using either the PTT control line or RF sensing. The MFJ-1708B-SDR was slightly slower, at 4.4 milliseconds, perhaps because of the additional relays. Both of these should work fine with PTT control from any transceiver because of the PTT-to-RF-output delay that transceivers have to prevent hot-switching a linear amplifier. (For example, my Kenwood TS-590S transceiver can be set to either 10 or 25 milliseconds delay, so either MFJ TR switch would have plenty of time to switch before I started transmitting.) The delay when returning to receive is adjustable up to about 2 seconds. Note that the transceiver is connected to the antenna when TR switch power is off.

With RF-sensed switching, both TR switches presented a power spike at the SDR port during the transition from receive to transmit. With the original MFJ-1708SDR, the power spike at the SDR receiver antenna jack was the full transmitter power (100 W) for 1.2 milliseconds, and we would not recommend using the RF-sensed switching function with this model. The MFJ-1708B-SDR incorporates some protection for the SDR antenna input, and during RF-sensed switching, limited the power spike to a measured +29.6 dBm (about 1 W) when used with the same 100 W transceiver. While that probably won't damage your SDR, we would highly recommend using the PTT connection from your transceiver with either switch, with RF sensing as a backup in case the mechanical connection fails.

Both TR switches use a hybrid splitter to provide some isolation between the transceiver and SDR on receive. At HF, that results in 3.5 dB insertion loss between the antenna jack and transceiver or SDR jack on receive, which is hardly noticeable on the air. As shown in the tables, insertion loss starts to climb at 50 MHz, and the B model is significantly better than the original above 2 meters. On transmit, at HF, the insertion loss between the transceiver and antenna jack is negligible with both versions. The improvements in the B version are obvious at 50 MHz and higher frequencies.

Isolation between the transceiver and SDR ports is improved significantly in the MFJ-1708B-SDR. At HF, it measured nearly 40 dB better than the original version, with even greater improvement at VHF and UHF. The instructions noted that isolation at VHF and UHF can be improved if jumper JP2 is removed, disabling the RF sensing function. With JP2 removed, the Lab measured an improvement of 8 dB isolation at 440 MHz, along with 1 dB lower insertion loss compared to measurements with the jumper in place. At HF through 144 MHz, isolation was about the same with the jumper installed or removed.

## On the Air

I tried both the original MFJ-1708SDR and the new MFJ-1708B-SDR in my station with a Kenwood TS-590S transceiver and an SDRplay RSP1 SDR. The added isolation in the B model was apparent immediately. With the original version, whenever I transmitted, enough signal was present at the SDR antenna jack to raise the receiver noise level significantly — even if the transceiver and SDR were tuned to different bands. Without a way to mute the SDR audio, I found the noise distracting.

With the MFJ-1708B-SDR, the transmitted signal was attenuated enough to not be bothersome with both radios tuned to the same band, and if they were tuned to different bands, I heard no trace of the transmitted signal. If this were a permanent installation, I would try to use the B version's **AUX** jack to mute the SDR audio while transmitting.

MFJ has made significant improvements with the MFJ-1708B-SDR, and it's well worth the $20 price difference to get the new version. It offers significantly greater protection for the SDR while transmitting, and works well on the bands above 6 meters.

*Manufacturer*: MFJ, 308 Industrial Park Rd., Starkville, MS 39759; **www.mfjenterprises.com**.
Price: MFJ-1708B-SDR, $99.95; MFJ-1708SDR, $79.95; MFJ-1708B, $99.95.

# Pacific Antenna Low-Pass Filter Kit

*Reviewed by Paul Danzer, N1II*
**n1ii@arrl.net**

A number of kit-based or home-built QRP (low-power) transmitters tested in the ARRL Lab have the same characteristic — high levels of harmonics or spurious emissions. In order to keep the transmitter as small and inexpensive as possible, output filtering is sometimes kept to a minimum. The FCC requires 43 dB suppression of these unwanted emissions, and as good amateurs, we must comply with FCC requirements, regardless of a transmitter's RF power output.

Pacific Antenna offers a number of radio and accessory kits under the **QRPkits.com** banner. The review looks at a standalone five-pole, low-pass filter that can be built for 20, 30, 40, or 80 meters and is rated for up to 100 W with a matched antenna. Invest a few dollars and a short evening at the workbench, and you can ensure that your low-power transmitter meets FCC requirements.

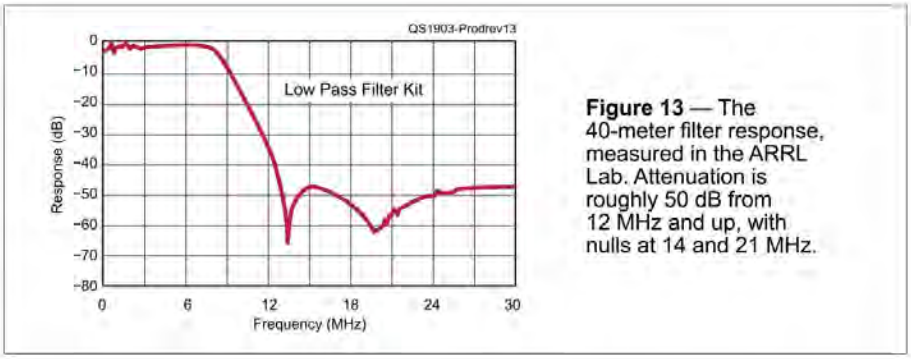


**Figure 13** — The 40-meter filter response, measured in the ARRL Lab. Attenuation is roughly 50 dB from 12 MHz and up, with nulls at 14 and 21 MHz.

## Easy to Build

The kit includes a 1.75 × 3.5 inch PC board and all parts for the specified band, but no enclosure. The comprehensive, well-illustrated, downloadable manual includes a table showing component values for each version. I built the 40-meter version, which uses seven capacitors and two toroidal inductors. The capacitors are legibly marked with codes, and I had no difficulty identifying them. For example, 271 means 27 followed by one zero or 270 pF.

The builder must wind the two toroids. Perhaps the simplest way is to cut the supplied enameled wire in half, one piece for each inductor. Then thread the wire through the center of a toroid core, and center the core on the wire. The 40-meter inductors require 16 turns, so starting from the center, I wound eight turns in one direction and eight turns in the other. To check your work, count the number of times the wire goes through the center of the toroid core — it should be 16 times for 16 turns.

Next, adjust the turns so they are evenly distributed on the core and cut the leads to about 1-inch long. Use a hot soldering iron or scrape the leads with a knife to remove the insulation, then solder the inductors in place.

The PC board is well made, with plated through-holes, a solder mask, and a part placement guide. If you find the holes a bit small for some component leads, clip off ¼ inch to remove a slightly thicker tinned surface at the ends of the leads.

The filter is symmetrical and either end can be used as the input or output. The supplied BNC connectors are optional. If you plan to incorporate the filter inside an existing transmitter, you can ignore them and connect the filter between the transmitter output and antenna jack with short pieces of coaxial cable.

Figure 13 shows the filter response. As you can see, insertion loss is low at 40 meters, and attenuation is around 50 dB at higher frequencies, with nulls at 14 and 21 MHz (second and third harmonics). The filter worked well as built, with no test equipment or adjustment required to get this performance.

*Manufacturer*: Pacific Antenna, P.O. Box 10301, Fayetteville, AR 72703; **www.qrpkits.com**. Price: 20, 30, or 40 meters, $15; 80 meters, $18.

## Bottom Line

Quick to assemble and inexpensive, this low-pass filter can help to keep your low-power transmitter compliant with FCC spectral purity requirements.

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

# The Doctor is In

# A Wire 80-Meter Dipole Won't Cover the Whole Band with a Low SWR

**Q Jeff, WA2HLM, asks: I have a two-band trap dipole for 80 and 40 meters. It operates well at 3.75 MHz, but I can only change frequency by about 30 kHz, after which my linear amplifier faults as the SWR rises. How can I match this antenna to my amplifier? Would an antenna tuner in line with the antenna help?**

A I would expect to see a wider bandwidth on 80 meters, so if you have an SWR meter or antenna analyzer, you should use it to characterize the antenna. Eighty meters is an unusual band in that it has a fractional bandwidth larger than most of our HF bands. While the usual half-wave dipole will cover most HF bands with an SWR of less than 2:1, this is not the case on 80 meters. It typically has a high SWR on the band edges, and actually takes about three full-size wire dipoles to cover the whole band with an SWR of less than 2:1.

I've never personally known anyone to install three to cover the whole band, although in years past, when we didn't have so many HF bands, it was not unusual for active hams to have separate dipoles for the phone and CW segments of 80 meters. Still, the loss in reasonable lengths of good quality coax is low enough on 80 meters that many deal with the issue at the station end, rather than at the antenna. Table 1 shows the loss of 100 feet of three popular types of 50 Ω coax feeding the antenna with the SWR shown in Figure 1, based on *Transmission Line Program for Windows* (*TLW*) software.[1]

Some have taken other approaches to making a single antenna that will cover the whole band without the need of the tuner. These include some we've discussed in previous columns. Included are the four-wire cage dipole, as used at the ARRL Headquarters station, W1AW; the window line-fed folded dipole with coupled resonator designed by Rudy Severns, N6LF; the coupled resonator antenna by Ted Armstrong, WA6RNC, and the use of different lengths of mismatched coax for matching, as described by Frank Witt, AI1H.[2–5] Each of these approaches can provide an SWR of less than 2:1 across the whole band. While the first three require a replacement of the antenna element, an advantage of the Witt approach is that it just requires specific lengths of different types of coax connected to your current antenna, in place of your current coax run.

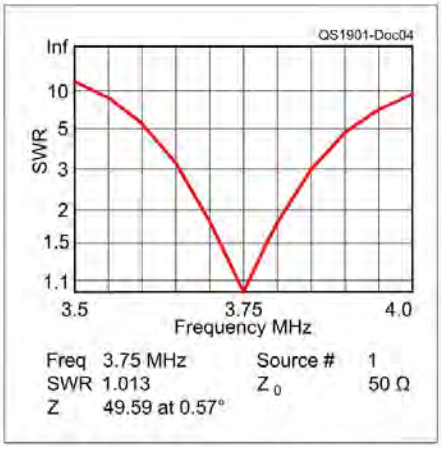


**Figure 1** — *EZNEC* predicted SWR of a model of an 80- to 40-meter trap dipole at 30 feet above medium ground. Note that the SWR rises to about 10:1 at the band edges due to the band's wide percentage bandwidth. The 2:1 SWR is 120 kHz. On 40 meters, the model shows an SWR of less than 2:1 across the band.

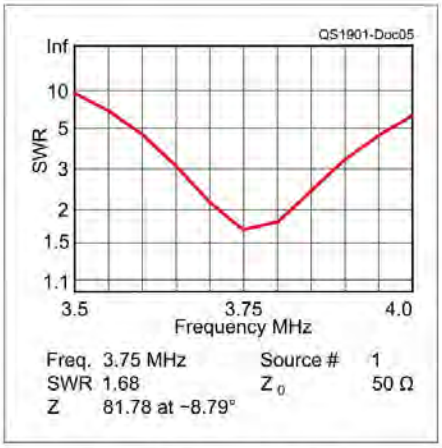


**Figure 2** — *EZNEC* predicted SWR bandwidth of the same antenna as in Figure 1, except its height has been raised to 70 feet.

**Table 1**
**Transmission-Line Loss (dB) of 100 Feet of Various Types of Coax Cable Feeding the Dipole Impedance in Figure 1**

| Frequency (MHz) | SWR | Impedance (Ω) | LMR-400 | RG-213 | RG-8X |
|---|---|---|---|---|---|
| 3.55 | 8.2:1 | 39.2 –*j*111 | 1.0 | 1.3 | 2.1 |
| 3.65 | 3.2:1 | 43.3 –*j*56.3 | 0.4 | 0.6 | 1.0 |
| 3.75 | 1.1:1 | 48.0 –*j*1.0 | 0.2 | 0.4 | 0.6 |
| 3.85 | 2.8:1 | 53.3 +*j*55.7 | 0.4 | 0.5 | 0.9 |
| 4.0 | 8.6:1 | 62.6 +*j*144 | 1.0 | 1.2 | 2.1 |

Your amplifier is specified (in terms of reflected power) to be able to drive an SWR of up to 2:1 at full power. I have plotted the *EZNEC* predicted SWR of a model of an 80- and 40-meter trap dipole at a height of 30 feet in Figure 1.[6] Note that the SWR at 3.75 MHz is almost exactly 1:1 at that height. The bandwidth for a 2:1 SWR is 120 kHz, so you should be able to go at least ±60 kHz from your tuned frequency without problems — or even more, because any transmission-line loss will make the SWR at the amplifier seem lower.

I selected that height because it was about optimum for match and SWR. If you make the height about a half wavelength (70 feet), a good height for longer distances, the match is not as good, with a minimum SWR of 1.7:1 (see Figure 2). Thus, it doesn't have that far to go to get to 2:1 and the bandwidth at that SWR is lower (110 kHz) as a consequence. Still, it should be somewhat better than what you observe.

As to an antenna tuner dealing with your problem, it is certainly possible, and probably the best approach. Most of what I call "wide-range" antenna tuners can safely tune antenna systems with an SWR of 10:1 to very close to 1:1 at the radio, so one of that type should be able to handle your antenna system across the whole band.

Be careful in selecting your tuner — some antenna tuners have a more restricted tuning range, perhaps a maximum SWR of 3:1. This is often (but not always) the case with antenna tuners that are built into transceivers or amplifiers. These can be useful for antennas that are being pushed just a bit, such as a 20-meter Yagi antenna tuned for the CW portion being used on SSB, and can even cover much of the phone band on 80 meters with your antenna. So, pick the right tuner that will solve your problem.

**Q Paul, W3GQ, asks: In your December 2018 column, you mention conductive grease. What is an example of a brand name? I was recently helping a friend replace the coax on his tribander. The final connection to his antenna was through a balun and the output of the balun was crimped on to small studs. A discussion arose as to the proper grease to use to prevent oxidation on the connections. The only grease available was axle grease and another helper insisted that was okay to use. The axle grease was applied to all parts before the final connection was made. Is this an acceptable thing to do? My concern was that it would act as insulation at the connections.**

A Axle grease may help avoid corrosion and make joints easier to get apart, however, it isn't sold as an insulating material, so its electrical properties are questionable. I suppose if it is graphite-based grease, it might be beneficial and, if the metals are in solid contact, it probably won't hurt.

Still, there are a number of brands of grease available specifically designed for the purpose, and I see no reason not to obtain and use one of them. I haven't found any at my local hardware stores, but any electrical supply house will have one, as will internet suppliers. My fairly local electrical supplier offered Ideal Noalox® (available at **www.idealindustries.ca/products/wire_installation/accessories/noalox.php**). Another popular brand is NO-OX-ID (available at **www.sanchem.com/electrical-contact-lubricant.html**). In addition, the company that makes Butternut antennas offered a special copper-based compound designed especially for antenna assembly called "Butter-its-not," but I don't see it listed anywhere. Perhaps a local Amateur Radio dealer will have some.

I don't have any way to evaluate the merits of each, but the two electrical ones are designed to extend conductivity of electrical connections in service boxes and other outdoor arrangements. They even say they will help avoid corrosion if dissimilar metals are involved.

According to the Ideal NoAlox website, benefits include:

- Anti-oxidant and anti-seizing compound.
- Reduces galling and seizing on aluminum conduit joints.
- Suspended zinc particles penetrate and cut aluminum oxide.
- Carrier material excludes air to prevent further oxidation.
- Improves service life of aluminum electrical applications.

**Notes**

[1] *TLW, Transmission Line Program for Windows*, software is provided on a CD/ROM with *The ARRL Antenna Book*.
[2] A. Harbach, WA4DRU, "Broad-Band 80-Meter Antenna," *QST*, Dec. 1980, pp. 36 – 37. See also *Feedback*, *QST*, Feb. 1981, p. 46.
[3] R. Severns, N6LF, "A Wideband 80-Meter Dipole," *QST*, July 1995, pp. 27 – 29.
[4] T. Armstrong, WA6RNC, "A Wideband Dipole for 75 and 80 Meters," *QST*, Mar. 2013, pp. 34 – 36.
[5] F. Witt, AI1H, "A Simple Broadband Dipole for 80 Meters," *QST*, Sep. 1993, pp. 27 – 30, 76.
[6] Several versions of *EZNEC* antenna modeling software are available from developer Roy Lewallen, W7EL, at **www.eznec.com**.

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# Technical Correspondence

# Finding Interference with SDR

## Detect Interference Using SDR

I work in the information technology (IT) department of a biologics manufacturer. Recently, a major cell phone carrier informed us that four of the point-to-point wireless transceivers used to send data between buildings at our facility were creating interference in the 700 MHz band. These are off-the-shelf devices similar to those used for AREDN® (Amateur Radio Emergency Data Network). The carrier explained that the interference was limiting potential upload speeds, and they wanted the interference eliminated.

My initial reaction was disbelief. The point-to-point transceivers we use operate in the 5 GHz range, far above the offending frequency. The transceivers are small, less than 300 feet apart, and set to less than 1 W output power (see Figure 1). Plus, the carrier's cell antenna is on top of a water tower over a city block away (see Figure 2), so I didn't see how we could be creating this interference.

A field engineer from the cell phone carrier came to our site to prove that we were the source of the interference. He used a portable spectrum analyzer connected to a handheld directional antenna. When he pointed the antenna at any of the mini dishes for our point-to-point transceivers, a small but obvious spike displayed at 780 MHz. He explained that even a small signal spur like that could cause the entire channel to shut down, limiting upload speeds for their cell network.

Some online research directed us to the likely cause of the problem. Each point-to-point transceiver is basically a small computer with an internal clock. This clock circuit generates a harmonic at 780 MHz that is picked up by the IF circuitry in the transceiver, and then transmitted along with the desired 5 GHz signal. FCC rules allow this spurious emission, except when it interferes with licensed services like cell phone carriers.

Further research indicated that the solution for the problem was a firmware update from the manufacturer to slightly change the clock frequency of each point-to-point device. This would move the spurious emission out of the band impacting the cell phone carrier. Several versions of the firmware were available, however, so we had no obvious way to know whether installing a specific update would fix the problem.

We needed to be able to detect the spike at 780 MHz in order to confirm that the applied firmware update had actually solved the problem. It occurred to me that I already owned the perfect device for this task — a software-defined radio (SDR). In my case, I have an RSP1 made by SDRplay. It can receive signals up to 2 GHz, so it would easily cover the 700 MHz band. The *SDR-Console* software (I use version 3 pre-release) displays a nice spectrum view, so any spurious signals would be visible.

Next, I needed an antenna. I thought I would need a directional antenna similar to what the field engineer used. Making an antenna for 700 MHz was possible, but I couldn't easily find any pre-made designs. I observed that the band of interest

**Figure 1** — The facility's point-to-point transceiver, a small mini dish.

**Figure 2** — The cell phone carrier's antenna on a water tower, located one block away from the small transceiver causing the interference.

was formerly used by the UHF television band and thought maybe a standard UHF antenna was all we needed. A bow tie antenna is very broad-band, and I just happened to have one in my box of old TV antenna parts (see Figure 3).

I connected the bow tie antenna to the RSP1 radio using coax cable and a 75 – 300 Ω transformer. Like many software-defined radios, the SDRplay is powered by a USB cable connected to the PC, making it portable. I loaded the laptop PC, RSP1, and antenna into my car for a field test. I parked between the point-to-point transceivers, started up the computer, launched the *SDR-Console* software, and held the antenna out the window. I was pleasantly surprised to see a clear spike immediately below 780 MHz, just like the field engineer had detected (see Figure 4).

Later that day, the network solution provider who had installed the point-to-point system came and applied the suggested update to each transceiver. I monitored the signals while each update was installed. As we had hoped, the signal spur at 780 MHz disappeared after the update and we were confident we had resolved the problem.

The following day, the field engineer for the cell phone carrier verified that the spurious signals from our point-to-point transceivers had been eliminated. He thanked us for working with him to resolve the issue.

**Figure 4** — The offending noise spike, identified by the software-defined radio.

I learned several things from this event. I now understand that interference can come from some very unlikely sources, so it's always worth investigating, even when you don't think you are the source of the interference. My junk box came in handy, as a simple UHF antenna was all we needed to detect the spurious signal and verify that it had been eliminated. I was also glad for my Amateur Radio knowledge, because it was useful solving this real-world problem.

I wanted to share how a modern software-defined radio can be a useful piece of test equipment for tracking down interference. Its broad bandwidth and sophisticated software combined into an excellent tool to see what was really happening.
*— 73, Steve Kubis, KD0WUQ,*
**steve.kubis@outlook.com**

*All photos by the author.*

**Figure 3** — A UHF bow tie antenna was sufficient to help detect the spurious signal.

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## Hints & Hacks

# Upgrading an Analog Voltmeter and a Transceiver Auto Tune Tip

### Revamping an Analog Voltmeter's Power Supply

Even though I own several digital voltmeters, there's nothing like a big analog movement for fine tuning, which is why I often turn to my old-fashioned Heathkit IM-5228 vacuum-tube voltmeter (VTVM).

The Heathkit VTVM circuits were pretty much the same over several incarnations and, like other VTVMs of the day, used a C or D cell battery to power the resistance function. The Heathkits specified a zinc battery (versus a modern alkaline) that was supposed to provide a fairly accurate voltage to use in calibrating the meter. It seems those old cells were pretty good at keeping a value right around 1.52 – 1.54 V, which would stay close even as the battery aged. For cells today, the current draw in the resistance mode can go well over 100 mA, which can draw a battery down with heavy use. As I didn't look forward to having to open the box and replace the battery, I decided to make an adjustment.

I had a *Popular Communications* article that I held onto so one day I could change the circuit from a battery to a powered circuit adjunct — one that would consistently provide a stable reference voltage. It is a simple full-wave bridge circuit driving a LM317 voltage regulator with the voltage set using a couple of precision resistors.

I built the circuit on a terminal strip (see Figure 1) and when I fed it 6.3 V ac from the bench supply, I got nothing out the other side. I was confused, because there didn't seem to be anything wrong with my wiring. I replaced the regulator next, just in case it was bad, but there was still no change.

I finally checked the resistor values and saw that one was defective. When I put a new resistor into the circuit, I got a very nice 1.54 V dc out the other end of the regulator. I then mounted it in the VTVM (see Figure 2).

After that, I added a pin jack to the front panel so I could access the voltage whenever I needed to double-check the calibration of the meter. The function knob on my VTVM was cracked, so I super-glued it back into place. Finally, I checked the calibration of the meter against the Agilent digital multimeter and it turned out very close, which is good enough for me. — *73, Dino Papas, KL0S,* **kl0s@cox.net**

### Prevent Transceiver from Keying Amp During Auto Tune Cycle

*Note:* This hack only works in the semi-automatic tuning mode. Do not attempt to use this in the fully automatic tuning mode. Also, this circuit has been tested with the Icom IC-7300/Ameritron ALS-600/LDG AT-600 Pro II automatic antenna tuner configuration and may or may not be compatible with other configurations.

#### Overview

If the ALS600 amplifier switch is in the **OPERATE** position and **TUNE** is requested, the amplifier will be keyed on by the IC-7300 transceiver, and seeing an initial high SWR, the ALS600 will trip out. This transient has the potential to cause damage to the ALS600 and/or the LDG tuner, as well as causing the ALS600 to need a manual reset.

**Figure 1** — The terminal strip with the supply circuitry. [Dino Papas, KL0S, photo]

**Figure 2** — The terminal strip mounted in the VTVM, after replacing the defective resistor. [Dino Papas, KL0S, photo]

This circuit prevents the ALS600 from operating during the **TUNE** cycle by opening the **RELAY** line between the IC-7300 and the ALS600 during the LDG tuning cycle. After the **TUNE** cycle ends, the **RELAY** line is restored and the ALS600 will operate normally.

The circuit uses the **KEY** line in the tuner to control its operation. The Tuner Interface described the **KEY** line as follows: "The **KEY** line is pulled low to signal to the radio that a CW tuning carrier is requested. The **KEY** line will remain low for the duration of the tuning cycle." The notes also explained why this cannot be used with fully automatic tuning, saying, "Tuning cycles that are initiated because of fully automatic tuning (SWR exceeded preset threshold) will not activate the tune request (**KEY**) line."

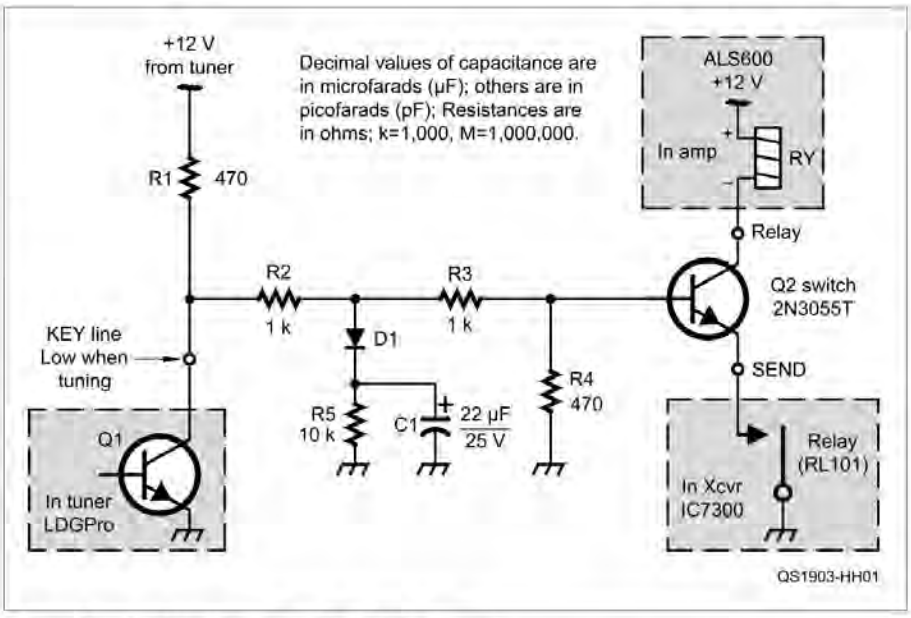


**Figure 3** — A schematic illustrating the circuit's use.
C1 — 22 µF at 15 V or greater
Q2 — NPN 2N3055T, TIP31, etc. type with a T0220 case
Resistors (R1 – R5) — ¼ W
Diode (D1) — 1N4001 or similar
Power jacks — Type N 2½-millimeter coaxial
Signal jacks — 3½-millimeter (⅛-inch) stereo type

## Construction

I constructed this circuit in a small aluminum box for RF shielding using an experimenter-type pre-drilled printed circuit board.

Originally, the LDG IC-PAC-6 power and signal cable went directly from the **TUNER** jack on the back of the IC-7300 to the LDG tuner. The dc 2 ½-millimeter coaxial jacks and the stereo 3½-millimeter signal jacks route the dc power and control signals from the LDG IC-PAC-6 cable through the box to the LDG tuner. The dc power and **KEY** signal for the keying preventer circuit were obtained by tapping onto the power and signal lines as they passed through the box. The RCA type **XCVR** jack connects to the **SEND** terminal on the IC-7300 and the RCA type amp jack connects to the **KEY** terminal on the ALS600. The two plugs (dc and signal) from the LDG IC-PAC-6 adapter cable from the IC-7300 **TUNER** jack connect to the box **XCVR** jacks. The dc and stereo cable jumpers from the box **TUNER** jacks connect to the LDG tuner.

## Operation

Q2 acts as a series switch in the **RELAY** line between the IC-7300 and the ALS600 (see Figure 3). When Q2 is on, it acts like a closed switch and the ALS600 relay RY is switched on or off by the IC-7300 relay **SEND** terminal. When Q2 is off, it acts like an open switch and the ALS600 relay RY cannot operate.

During normal operation, while not tuning, Q1 is turned off and R1 – R4 form a voltage divider providing the needed voltage and current to the base of Q2 for it to turn on, but it does not turn on until the **SEND** relay in the IC-7300 pulls the emitter of Q2 to ground. The **SEND** terminal on the IC-7300 going to ground turns Q2 on (closed switch), pulling the **KEY** line on the ALS600 low, activating the ALS600 relay RY. During this time, the capacitor C1 is charged to about 5 V through D1.

When **TUNE** is requested, Q1 turns on and the **KEY** line in the LDG tuner goes low, pulling the base of Q2 to nearly 0 V, turning Q2 off (open switch), in turn preventing the ALS600 relay RY from turning on. Also, during the tuning, D1 is reverse biased (off) and C1 discharges through R5 to 0 V.

At the end of the tune cycle, Q1 turns off and the LDG tuner **KEY** line goes back to high and D1 is forward biased (on) and C1 begins to charge. Because of the R3 and R4 voltage divider, C1 must charge to approximately 0.8 V through R1, R2, and D1 before Q2 can turn on again. This delay keeps Q2 off long enough to prevent the ALS600 from coming on until the IC-7300 RF output has stopped after the end of the tuning cycle.

Now, with the ALS600 amp set to the **OPERATE** position, the amplifier remains off during a semi-automatic **TUNE** cycle. — *73, Wayne Waller, W4TZB,* **w4tzb@comcast.net**

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Steve Ford, WB8IMY, wb8imy@arrl.org

## Eclectic Technology

# Here Comes Wi-Fi 6

The original Wi-Fi protocol debuted in the late '90s to great fanfare, and it seemed like a miraculous advancement at the time. Back then, the idea of a wireless data network in one's home was almost unthinkable. Of course, by today's standards, the first Wi-Fi was excruciatingly slow — with no wireless video streaming in the house — but our expectations were much different at the dawn of the internet age.

D-Link's AX6000 is among the first Wi-Fi 6 routers to reach the market, although it is presently running a draft of the Wi-Fi 6 protocol.

There have been gradual improvements since then, with data transfer rates ramping up each year. Consumers have been reaping the benefits with their household wireless networks and hams have had a field day (no pun intended) exploiting Wi-Fi routers and access points as high-speed digital transceivers for mesh networking and more.

This year, we'll see the debut of what is called *Wi-Fi 6*, which is a departure from the usual Wi-Fi naming convention. The differences are more than semantic, though. Wi-Fi 6 devices will support the new 802.11ax standard, which is faster than the current 802.11ac standard by a factor of four. A Wi-Fi 6 router, for example, may be able to hit peak speeds in the neighborhood of 3.5 *Gbps*. That is a lot of data flying over the airwaves.

But this speed boost won't be very impressive if the data signals are bogged down by interference. (Yes, QRM happens with Wi-Fi as well.) That's why the big Wi-Fi 6 improvements are not only in speed, but also efficiency.

Wi-Fi 6 performance in signal-dense environments — urban areas, stadiums, etc. — will be much more efficient thanks to the use of technologies like 8 × 8 MU-MIMO (multi-input, multi-user, multiple input, multiple output), which adds more antennas to serve more clients simultaneously. Wi-Fi 6 also borrows a technology from 4G LTE called orthogonal frequency-division multiple access (OFDMA), which breaks down frequency bands into tiny subchannels to serve more clients better.

Wi-Fi devices are spreading like proverbial wildfire (just look at how many people own smartphones) and spectrum congestion is beginning to become a major headache. An average home may have a wireless router that is sometimes choked with signals from a dozen Wi-Fi devices, all demanding their slices of spectrum and "attention." Think about this on your next flight when you notice that your Wi-Fi seems slow. Chances are you're wrestling for access with many of your fellow passengers.

Wi-Fi 6 promises to greatly ease this congestion, starting this year with a few expensive 802.11ax routers coming onto the market. Try to resist the temptation to be an early adopter, however. The routers and access points being sold this year will be using a draft version of the Wi-Fi 6 protocol. You're better off waiting for the final release to deploy. Besides, it will take a few years for smartphones, laptops, and other devices to catch up.

### Wi-Fi 6 and Amateur Mesh Networks

Amateur Radio mesh networks rely on the ability to load new firmware into Wi-Fi routers, turning them into dedicated mesh transceivers. Not all routers allow uploading of amateur mesh firmware, which is why groups such as the Amateur Radio Emergency Data Network (**www.arednmesh.org**) create firmware for use with specific equipment.

It is difficult to say how Wi-Fi 6 hardware will impact amateur usage in the coming years. With luck, the manufacturers who've already shown a willingness to allow homebrew firmware in their devices will continue to do so in Wi-Fi 6 equipment. If so, this could provide a major boost for ham networks.

And as consumers upgrade to Wi-Fi 6 and abandon their older gear, hams will be ready to snatch up the used devices on eBay and elsewhere. Buying used and repurposing is a time-honored Amateur Radio tradition!

# Youth at Sea Activate Market Reef — OJ0C

This island and its lighthouse were the location of the International Youth at Sea expedition in August 2018.

**Pieter Ketsman, ON3DI, and Horia Ilie, YO3IMD**

Market Reef (also known as Market Rock) is one of the smallest DXCC entities. Added to the DXCC List in 1969, it is located in Europe's far north, between Finland and Sweden in the Baltic Sea. Temperatures can go as low as –30 °C (–22 °F), and landings on the island are hazardous as there is no jetty and waves often wash over the entire rock.

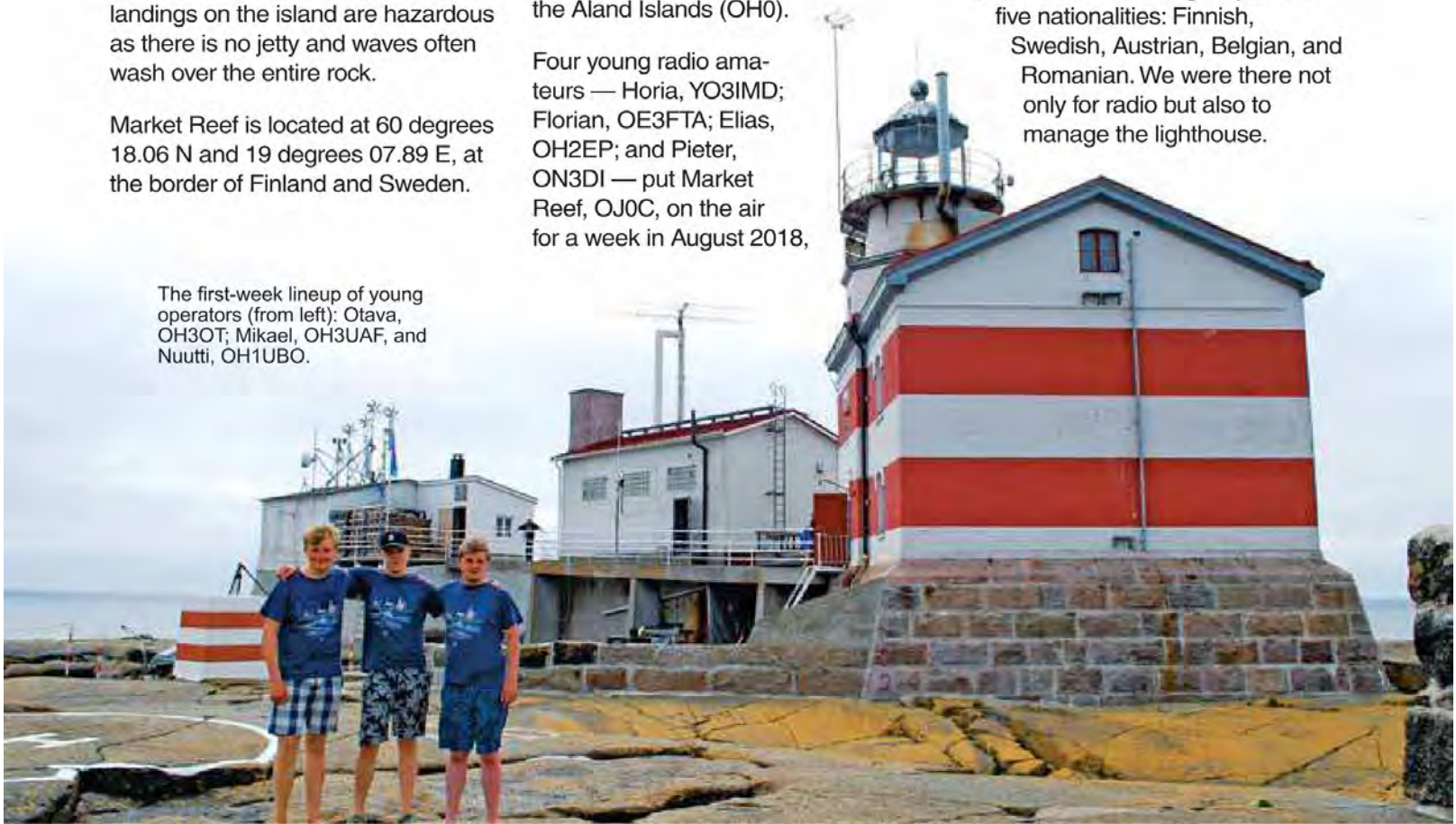
Market Reef is located at 60 degrees 18.06 N and 19 degrees 07.89 E, at the border of Finland and Sweden.

It is 350 meters (0.2 mile) long and 150 meters (0.1 mile) wide — the total area is 0.03 square kilometers (0.012 square miles). It is a low-lying granite rock with three attached lighthouse structures. The buildings are on the Finnish side of the island, and are administrated from mainland Finland — not from the Aland Islands (OH0).

Four young radio amateurs — Horia, YO3IMD; Florian, OE3FTA; Elias, OH2EP; and Pieter, ON3DI — put Market Reef, OJ0C, on the air for a week in August 2018, including the World Lighthouse Weekend, while enriching our lives at sea.

## Going to Market — Pieter's Story

Living on Market Reef meant going back to basics and relying on each other. Our team of eight spanned five nationalities: Finnish, Swedish, Austrian, Belgian, and Romanian. We were there not only for radio but also to manage the lighthouse.



The first-week lineup of young operators (from left): Otava, OH3OT; Mikael, OH3UAF, and Nuutti, OH1UBO.

During the night hours, pileups are mysterious and an experience of a lifetime.

Operating massive pileups can be fun if you have practiced the procedure. Here is Florian, OE3FTA, overseeing Pieter, ON3DI, while young Elias, OH2EP, gets up to speed.

Upon our arrival, our Finnish Lighthouse Society (FLS) hosts, Henri, OH3JR, and Pasi, OH3WS, gave us a tour. It was important that we understood the history of the place and knew how everything worked. The FLS tries to maintain the history of the structure. Our guides explained to us how the lighthouse has been used and that this piece of culture at sea cannot be lost. Judging by the number of summer visitors in private boats, we assumed that goal had been achieved.

We were surprised about the facilities on the island — the big generators, the solar system, and the water recycling installation. Even dirty water from the dishes was collected and recycled. Market Reef has no television and radio and internet access was very sporadic via smartphones, but that wasn't a problem — it made our stay more peaceful.

Nature controls life at Market Reef, and it can change quickly. Most of the time we had good weather, but one day strong wind resulted in most of the island being under water. At those moments, we felt really small in a world surrounded by water.

For us youngsters, the main goal was making OJ0C active on all Amateur Radio bands. So we did, interrupted only by occasional important orders, such as security drills. The FLS folks made sure we worked with the rescue boat. It was important that we could save ourselves in the event of danger. While we practiced on the boat, it was nice to view the island and antenna in another way.

The strength of the group was that it was a good combination of experienced people and some young people. Sure, a lot of our discussions were about radio and how to improve statistics or install another antenna. After a few days, though, conversations became more personal and we talked about how we lived in our home countries, our work or politics, and things that happened in our lives. Those talks ensured we became a close group that laughed a lot!

The whole rock is often washed over and only the lighthouse structure stands out from the water. To save the structure from severe northern rolling waves, there is a wave breaker protecting the lighthouse. Have you ever contacted a submerged DXCC entity? Maybe your OJ0C contact was one such QSO!

The operation's QSL card.

## Market on the Air — Horia's Story

It was an extraordinary radio week at Market Reef, an excellent opportunity to test our radio skills and knowledge. Although there were many challenges during our stay, the most challenging aspect was handling the OJ0C pileups in poor propagation, especially for DX, while being physically located in Europe.

Before departing to the rock, we had a very interesting and productive briefing by Martti, OH2BH, and Henri, OH3JR, in the Aland Islands. Martti made us aware of many facts and challenges of operating in DXpedition mode. I found that useful, as later during the week when we were up and running, we found ourselves in some situations exactly as he had described.

Although the pileups proved to be quite difficult at times, especially on the lower bands like 40 and 80 meters where most stations were from Europe, operating was great fun.

Split operation also became part of the routine, and the operators even had to work 5 – 10 kHz up at times in order to keep up the rate and keep the callers happy. We shared our experience with Elias, OH2EP, a 16-year-old Finnish boy who was very keen to learn new skills and tricks. By the end of our expedition, he was up and running on SSB as well as FT8 and we all felt very accomplished.

We had two radios — a Yaesu FT-950 running high power with an SPE amplifier and an Elecraft K3 running mostly data (FT8) with low power. For antennas, we used the Force 12 Yagi that was already up for the higher bands, and the team ran wire antennas for 40/80 meters from the top of the lighthouse. Working DX, especially North America, proved to be a challenge. I found it particularly difficult to get past the European stations in the pileup when calling for stations outside the EU. Unfortunately, people often don't listen to the instructions given by the operator (or don't understand them) and the process gets out of control. Even in these conditions, we concluded the expedition with more than 20,260 QSOs.

I found that patience is key when operating a pileup. I learned that when you feel overwhelmed by the number of stations calling, you should just take a break and let another operator take the microphone to keep the activity going. Overall, it was a great week with many things to learn. It really helped me as person and as radio operator.

We thank the Finnish Lighthouse Society (FLS), the Finnish Amateur Radio League (SRAL), OH-DX Foundation, and the Yasme Foundation for making this great adventure possible.

Pieter Ketsman, ON3DI, received his Basic license in 2007 at the age of 18. He got the ham radio bug from watching his dad, ON2WVD, make digital QSOs. Pieter works in orthopedagogics.

If you've made a contact with Pieter, the chances are good that it was during a contest. He likes to chase some records and most of the time he contests low-power (QRP) style. Some friends call him Mister 80 Meters because of several wins during CQ World Wide. Pieter has three major dreams. First, he would like to win all three CQ WW contests in one year. The second is gaining his full license, and the third is being part of other DXpeditions. Other interests are playing squash and travelling. You can reach Pieter at **on3di@outlook.be**.

Horia Ilie, YO3IMD, was first licensed in 2011 after being introduced to Amateur Radio by his childhood electronics tutor, Sandy, YO3ND. He studied science and informatics at the Mihai Viteazul National College in his hometown of Bucharest, Romania. He then studied at University in the UK. Horia holds a BEng in Electronic and Communication Engineering from the University of Huddersfield in England, and has returned to Romania to pursue a career in the telecomms industry. He is very keen on Amateur Radio activities, especially international SSB contests, activations, DXpeditions, and DXCC hunting. Other interests include traveling, technology, and swimming. You can reach Horia at **yo3imd@gmail.com**.

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

# Canadian National Parks ON THE AIR 2019

An overview of the year-long operating event that's modeled on ARRL's 2016 National Parks on the Air program.

**Sean Kutzko, KX9X**

If you turned on your rig at 0000 UTC on January 1 to celebrate the new year, you might have heard a slightly familiar phrase: "CQ Canadian Parks on the Air."

Inspired by the successful ARRL National Parks on the Air event, Canada is doing their own year-long operating project — CNPOTA. The program has been nearly 2 years in the making, and has officially started, thanks to some dedicated Canadian hams, Radio Amateurs of Canada (RAC), and Parks Canada (the equivalent of the National Park Service here in the US).

## From Concept to Reality

While meeting with local hams in Nova Scotia, Doug Grace, VE1DFG, of Sackville, mentioned that he was "truly impressed as to how the American NPOTA was working in the States," and brought up the possibility of bringing ARRL's program to Canada.

With a push from Bill Elliott, VE1MR, and Win Hartling, VE1WIN (now SK), Doug was able to get Parks Canada on board. He then called RAC President Glenn MacDonell, VE3XRA, and had RAC's approval in short order. The biggest problem in moving forward was resources; RAC relies heavily on volunteers. For software and programming support, Doug reached out to Sheldon Hartling, VE1GPY, who assembled a team of volunteer coders, including Ryan Hickman, VO1RCH, and Doug McComber, VE1FAL. Don Trotter, VE1DTR; Rob Ewert, VE1KS, and Bill Elliott, joined the CNPOTA team in other capacities.

Alicia Noakes, VA3KGZ, activated Point Clark Lighthouse National Historic Site (ON37) on January 1 as part of the Inverhuron Ham Radio Club, VE3IHR. [Rob Noakes, VE3PCP, photo]

*"With such early success, the Canadian National Parks on the Air is certain to become one of the major operating events for 2019."*

The initial goal was to try and get the project off the ground for Canada's 150th anniversary in 2017, but the team simply didn't have enough time. After over a year of work, the team of volunteers had a website, a database, and a logging system in place. Dalhousie University in Halifax agreed to host the site for free. Everything was ready to go by December 2018.

Veteran ARRL National Parks on the Air operator Pete Kobak, K0BAK, made just under 300 combined contacts from five different CNPOTA units on January 1. [Pete Kobak, K0BAK, photo]

## The Basics

The rules are nearly identical to ARRL's 2016 NPOTA event. There are two tracks: Activators (those who go to the parks to operate) and Chasers (those who collect contacts from Activators). You may pursue both simultaneously. As of January 1, there are 220 Parks Canada Administrative Units eligible for CNPOTA, including 48 National Parks and 172 National Historic Sites. All bands (except 4 meters and 60 meters), are permitted, including contacts made via satellite.

One difference between NPOTA and CNPOTA is that Activators for CNPOTA are given a bit more flexibility while being on Parks Canada property. The official rules state:

> [T]he Activator and all components of the Activator's Amateur Radio station must be physically present on the property of the claimed unit, or within 100 yards/meters of the gate, trail, or site. Activations from parking lots, visitor's centres, and other property of the specific unit are acceptable. Operations from public sidewalks are not permitted.

Activators must make a minimum of five confirmed contacts and upload their log to the CNPOTA website to receive credit for an activation. Chasers must upload their logs as well, to ensure the Activator gets credit for their activation. Some parks will require a permit to activate; be sure to read the rules in detail and cooperate with all Parks Canada rules and regulations.

## Get on the Air

The response to CNPOTA out of the gate was quite good; 47 logs were uploaded on the very first day! US hams are more than welcome to participate in park activations as well. Veteran NPOTA activator Pete Kobak, K0BAK, activated six different parks on January 1, including two parks simultaneously: Fort Henry National Historic Site (CNPOTA designator ON21), and Kingston Fortifications National Historic Site (ON29). Satellite operators Ron Bondy, AD0DX, and Mike Diehl, W8LID/VE6LID, also joined in early, crossing the border to activate parks on the first day.

With such early success, the Canadian National Parks on the Air is certain to become one of the major operating events for 2019.

"It is unbelievable what we offer to the world and it was stunning for us to put this together and experience what Canada has in natural wonder," said Doug Grace. "I was simply in awe with the beauty of the parks and the history of the nation."

If you don't have vacation plans yet, grab your gear (and your passport), and discover what Canada's parks have to offer, including 18th-century forts, frontier trading posts, UNESCO World Heritage Sites, and many more. There is an amazing history and beauty to explore.

Check out the complete rules, a calendar of activations, and other critical information, available at **cnpota.ca**. You can follow CNPOTA on Twitter at **@CNPOTA** or **#CNPOTA**, and a Facebook group is available at **www.facebook.com/groups/cnpota** (registration required).

Sean Kutzko, KX9X, is a freelance social media and public relations consultant. An avid portable HF and satellite operator, he was the creator and co-administrator of ARRL's 2016 National Parks on the Air program. You can follow him on Twitter and Instagram at **@SeanKutzko**.

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# ARRL's New Podcast for New Hams

Newly licensed hams who are wondering what to do with their privileges can tune in for answers to their pressing questions.

For those of you who are just getting started on their journey in Amateur Radio, ARRL is launching a new podcast aimed at answering your questions, as well as providing support and encouragement to help you get the most out of this hobby. The podcast, titled *So Now What?*, will launch in early March, and new episodes will be posted every other week (alternating weeks with the *ARRL The Doctor Is In* podcast). Episodes will be available on Apple iTunes and Stitcher.

The podcast will be co-hosted by ARRL Communications Content Producer Michelle Patnode, W3MVP, and W1AW Station Manager and ARRL Lab member Joe Carcia, NJ1Q. Presented as a lively and engaging conversation, Patnode (representing newer hams) and Carcia (representing veteran operators) will look at the questions that newer hams have, and the issues that keep them from being active participants in the hobby. In addition, some of the episodes will feature guests to answer questions on specific topic areas.

## Filling a Need

Topics to be discussed in the first several episodes include: getting started, operating modes available to Technician-class licensees, VEC and licensing issues, the need to be aware of sunspot activity, mobile operating, contesting opportunities, Amateur Radio in pop culture, and some negative sterotypes of Technician-class license holders.

"No other podcast is really aimed at this segment of the Amateur Radio community," noted ARRL Communications Manager David Isgur, N1RSN, who is executive producer of the podcast. "We believe that a critical segment of the hobby is being underserved, and is not getting the answers to the many questions they have," he said.

He believes that providing this information in a podcast format will be a very effective method of reaching out and engaging this segment of the market.

Patnode said she is excited to ask the questions she has about different aspects of Amateur Radio, such as how to incorporate Amateur Radio with newer technologies like Raspberry Pi and Arduino, and to learn more about the hobby right along with the podcast's audience.

Given the audience it is targeting, Carcia said he believes the *So Now What?* podcast will be a perfect complement to the podcasts that ARRL already offers — *ARRL The Doctor Is In* and *ARRL Audio News*.

The *So Now What?* podcast is being sponsored by LDG Electronics, a family-owned and operated business with laboratories in southern Maryland that offers a wide array of tuners and other Amateur Radio products.

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# Lithuanian Radiosport

## Contesting is alive and well in Lithuania, as is evidenced by the fact that a Lithuanian team won WRTC 2018.

**Henryk Kotowski, SM0JHF**

Located in the center of Europe, Lithuania is an agriculture-dominated region, and one of the three Baltic States along the east coast of the Baltic Sea. Despite being very small — about the size of West Virginia — Amateur Radio activity is much higher than elsewhere. Among the population of 2.8 million people, Lithuania has almost 900 licensed ham operators.

The secret of the exceptional radio activity may lie in the history of the school radio clubs started in the 1960s. During this time, Lithuania was a republic within the Soviet Union, and contacting the world was very attractive to younger operators. For instance, a group of enthusiastic students of Kaunas Polytechnic developed a very competitive contest station. Hundreds of engineers who had graduated from this institution came in contact with radiosport at high levels. These seeds sown many years ago keep producing good results.

Ricardas, LY2FN, on the roof of the Vitaus Magnus University in Kaunas. This is the club station LY3V, which is focused on microwaves and VHF.

A historical photograph of the original antenna farm belonging to the Kaunas University of Technology Radio Club, LY7A. This installation has recently been dismantled and the club is looking for a new location.

Now, Lithuania is known for its annual national hamfest, held each July since 1989. Even foreign visitors come to this meeting, including myself. Additionally, slightly more than one-third of the radio amateurs belong to the national organization LRMD, a member-society of the IARU. Within this organization, there is also a radiosport federation, as there are still many clubs with a focus on contesting, high-speed telegraphy, and Amateur Radio direction-finding.

The 2018 Lithuania Hamfest displayed Amateur Radio in a rustic style, with the radio shack in a log cabin on a small lake. The call sign for the official station of the LRMD organization at the 2018 Hamfest was LY2018RMD. The antenna was a multiband dipole array.

An excellent constructor, technician, and contester, Albertas, LY5R, lives in the northeastern part of Lithuania and studied in Kaunas. He is still a member of the LY7A club.

Rimas, LY3W, lives in Kaunas, the radiosport capital of Lithuania. Kaunas is in southern Lithuania and is a commercial and educational hub of the country. The capital city, Vilnius, is attractive and full of historical buildings and monuments.

Father-and-son team Jurgis, LY9Y, and Andrius, LY7Z, operate together from their contest shack located near Siaulai, Lithuania. Jurgis is 71 years old, is a member of Kaunas University of Technology Radio Club, has participated in WRTC 2006 and WRTC 2010, and has been on several contest DXpeditions. Andrius has been licensed since he was 14, has been on several contest DXpeditions, has competed in WRTC 2002, WRTC 2006, and WRTC 2010, and was a referee at WRTC 2014 and WRTC 2018.

One of many impressive antenna farms in Lithuania. This one belongs to Rolandas, LY4A, who moved to Siauliai, Lithuania, in 2015 and built directional antennas for all bands between 80 and 10 meters. He was first exposed to Amateur Radio in 1983, at the age of 11, both at school and at the radio club at the local factory.

One striking example of Lithuania's dedication to contesting is the recent success in the 2018 IARU HF Championship, with almost 10 percent of the Lithuanian ham community actively participating. Almost 50 logs were submitted by Lithuanian stations, and over 15 million points were scored by the headquarters station, LY0HQ. There was also great success at WRTC 2018, with the winners being Lithuanian operators Gediminas Lucinskas, LY9A, and Mindaugas Jukna, LY4L.

Inside the radio cabin of Rolandas, LY4A, which is in Siaulai in northern Lithuania. Rolandas (center) explains some technical solutions to visitors from the Yankee Clipper Contest Club (YCCC). Visitors include President of the YCCC Dennis (seated), W1UE; Fred (in back), K1VR, and Rich (on right), K1CC.

The highlight of the 2018 Lithuania Hamfest was watching Mindaugas, LY4L, receive medals for an outstanding feat in winning this demanding competition. He wore two wreaths, with one for his absent WRTC 2018 teammate. The award was presented by Simonas, LY2EN, from the national organization of LRMD. HF Manager and Chief of the 2018 Lithuanian Hamfest Rolandas, LY4A, accompanied them to congratulate Mindaugas.

Photos by the author.

Henryk Kotowski, SM0JHF, was born in Poland, where he got his first Amateur Radio license in 1960. At 30, he moved to Sweden and had to wait a few years before he could apply for a license. In 1992, while in Florida, he earned his Amateur Extra-class license with the call sign K6JHF, which he uses when visiting California. Henryk can be reached at **sm0jhf@gmail.com**.

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Judging local fairs can be a great way for your club to serve the community.

# Judging Regional Science and Engineering Fairs

**Bill Vining, N5YZ**

Every year, from October to April, kids around the nation compete in local science fairs. Traditionally, these science fairs culminate in awards given out in various categories across a relatively narrow range of scientific topics. For most people, the thought of attending a science fair generates feelings of apathy, but one local radio club has found a way to make the fair more interesting for judges and more impactful for students.

## Types of Awards

Regional science and engineering fairs (RSEF) prepare to present awards from local middle/high school districts during the late winter to early spring. Some of those honorees will move on to the state, national (USA SEF), and international (Intel ISEF) events. Within the RSEF scope, there are generally two types of awards presented: Category Awards and Special Awards.

Category Awards span both traditional scientific categories as well as non-traditional categories that focus on arts, creativity, and technology. Category Award recipients will be moved on to state-level competitions, where they will face the winners from other regions.

Special Awards are presented by members of local and national organizations to participants whose projects typically fit a specific area of interest and best fit specific criteria predetermined and judged by the local organization.

### The McKinney Amateur Radio Club

On February 14, 2018, the McKinney Amateur Radio Club (MARC) celebrated their 50th anniversary of ARRL affiliation, and the group has received the ARRL Special Service Club designation. MARC has sponsored a Special Award at our local regional science and engineering fair for the last 6 years. With 135 current active members, the club is able to provide communications assistance for local charitable marathons, bike events, and community celebrations.

McKinney Amateur Radio Club members who are serving as judges survey the projects at the Dallas Regional Science and Engineering Fair.

Katherine Forson, KT5KMF, was congratulated by MARC President Bill Vining, N5YZ, after she presented her award-winning project at a club meeting.

Though recipients can receive a variety of prizes as recognition, in the forms of ribbons, certificates, plaques, or even scholarship money, recipients are not guaranteed advancement to state-level competitions.

The McKinney Amateur Radio Club, our local ARRL Special Service Club (see sidebar), presents a Special Award in the form of an engraved plaque at our annual RSEF to the entry that best promotes the study, knowledge, or participation in the operation of communication equipment and radio technology. We also award VE vouchers for students who may choose to get licensed or seek upgrades. Three to six members of our local club serve as judges, spending a few hours at the fairs and talking to students about their projects in order to select the award winner.

The judging of these events is a fun and rewarding process for everyone. Club members get to know and recognize the achievements of the community's young people, encouraging them in their science and engineering endeavors. Clubs are also promoting ARRL's principles of public service and support of youth learning activities. A bonus is that the winning student will have another item to add to their pre-college resume.

## Your Turn

If you are looking to participate and ultimately improve radio communications and technology, start by contacting your local Amateur Radio club and encourage their participation in your area's RSEF event as a Special Award sponsor. Once your local club decides to participate, you will need to determine where and when your RSEF occurs. You can conduct an online search using your state and "science and engineering fairs" as keywords. Other resources for finding out about local fairs include teachers, assistant principals, principals, or science fair coordinators.

Your next step will be to outline the criteria for your Amateur Radio club's sponsored award, as determined by your club, not the RSEF. Keep the requirements simple, because as you begin this process, you will find not many science fair entries address the areas of radio communication and radio technology. However, as your club becomes more involved with the fair over the years, you will find that more projects geared toward communications and technology tend to appear.

After determining the award's criteria, you will need to make it official with your RSEF by meeting all the sponsor requirements. This includes paperwork, fees, or financial contributions. For that reason, budget decisions are necessary to cover the typical fees (usually only a small contribution) and the cost of the award itself, whether it's a certificate, ribbon, or plaque. Additionally, if you choose to include a monetary element, such as a scholarship, it may behoove your club to inquire about the possibility of a discretionary scholarship. This is a scholarship that your club can give to a student who meets certain specific (and possibly stringent) criteria, but the club is not required to give the scholarship if it deems there is no worthy recipient.

After making the award official with the RSEF organization, you'll need to recruit club members as judges. There aren't any specific education or scientific requirements, but they should have an Amateur Radio license. Additionally, I suggest not limiting the judges to looking at any one category of project. Sometimes a project that is initially deemed unrelated to radio communication and technology can surprise you. Discussions with the students are an important part of judging.

The engraved plaque and voucher given to the McKinney Amateur Radio Club-sponsored Special Award winner at the Dallas Regional Science and Engineering Fair.

All identified judges should be given a copy of the RSEF rules and regulations well in advance of the event date. An understanding of these rules and regulations is vital, because they will stipulate what types of questions may be asked of the students, as well as information regarding the Family Educational Rights Protection Act of 1974 (FERPA). Make sure that permission has been granted to take a picture of a project, and especially of a student.

Once your award recipients have been selected, report that information to the RSEF administrators. They will then notify the winning students of their awards. It is not your responsibility, nor your privilege, to tell a student that she/he is winning an award. Doing so may result in your organization no longer being allowed to participate.

## Award the Students, Award Yourself

Alongside the personal gratification that comes with participating in a public service activity that promotes radio communication and technology, you and your fellow judges will enjoy talking with the RSEF students. It is a perfect opportunity to learn more about what the next generation of hams are working on in the science and technology field.

Taking this opportunity one step further, the rest of the club members can share the experience if the award winner(s) are invited to attend a club meeting to present their project. For example, one of two the McKinney Amateur Radio Club's 2018 Special Award winners, Katherine Forson, KT5KMF, presented her winning project to our group at a meeting. Members were excited to learn how she explored the effects of time of day on signal propagation on the 20- and 40-meter bands.

Get your club involved in the local RSEF, and embrace the opportunity to reward student winners, club judges, and the club as a whole.

Bill Vining, N5YZ, is current club president of the McKinney Amateur Radio Club. He first became involved in science and engineering fairs over 30 years ago, as a category judge, and has since been associated annually with both the Dallas RSEF and the Fort Worth RSEF. He may be reached at **n5yz@arrl.net**.

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# Choosing Gear for Portable Activations

Guidelines to help you join in the fun of activating new places.

**T.J. "Skip" Arey, N2EI**

One of the biggest challenges (and most exciting aspects) of portable operation is using less power and less efficient antennas than you would in your home station (see the lead photo). The key to portable operation is power management. This can range from a handful of AA cells, the power system of your vehicle, a portable generator, or even the main power source from the portable location. Once you understand your limits and how many electrons you can bring to the game, you can determine your operating capabilities.

The manual for the transceiver you intend to use should list power requirement and consumption figures for both receiving and transmitting. If you are using batteries, you will also need to know the minimum voltage at which the transceiver will cease to operate properly. This information will help you determine how long you can operate and at what power level.

In general, if an electronic device (transceiver or otherwise) draws 1 A of power and you have a 10 Ah battery, it would seem that you could run your device for 10 hours, but that's not the case, because different types of cells have different voltage drop curves. For example, a lead-acid battery's voltage goes down at a different rate than nickel-cadmium (NiCad) batteries.

If your radio is designed for 12 V operation but can operate down to 10 V before failing to put out a good signal, you need to more carefully consider your power requirements. For an estimation of what you'll need, you can compare your operating time against the rig's power requirements and double the capacity. So, if I want to operate a device like the one in the above example for 10 hours, I need a battery pack that is rated at 20 Ah. Though this only gives you an estimate, knowing about the capabilities of particular cells will keep you on the air and lengthen the life of your rechargeable cells.

**Figure 1** — The Hendricks PFR-3 is a self-contained portable transceiver designed for backpacking and hiking.

**Lead photo (above)** — Skip Arey, N2EI, operating portable from a campsite in Freeland, Maryland, with an Elecraft KX2 into an MFJ-1778M G5RV Jr. strung up in the trees.

There are so many battery choices that it is important to understand the proper charging rates and cycles for any battery in question. Also, if you're operating using your vehicle's battery as your power source, remember to leave enough energy to start the car. No sense making your portable operation a more permanent one.

## Transceiver Choices

If you're just giving portable operation a try, there is no need to buy a dedicated portable rig just yet. It's often possible to make use of your home transmitter out in the field. Most modern equipment with up to 100 W power levels have provisions to operate off a nominal 12 V, provided you pay attention to the power rating of the radio. Further, with some experimentation, lowering the transmit power level can bring down the required power rating significantly. Again, let the manual be your guide.

If you decide that portable operation is worth a more serious investment in equipment, there are many transceivers designed specifically for portable operation. The Elecraft KX2 and KX3, as well as the Yaesu FT-818ND, lead the pack among active portable operators, and there are numerous QRP kits for building your own portable transceiver.

The size and weight of your transceiver (and the rest of your equipment) only become a factor if you are doing an activity such as hiking or backpacking (see Figure 1). If you are operating from a trailer or RV, home station-type equipment can do just fine. Many hams devote their older home rigs to this purpose.

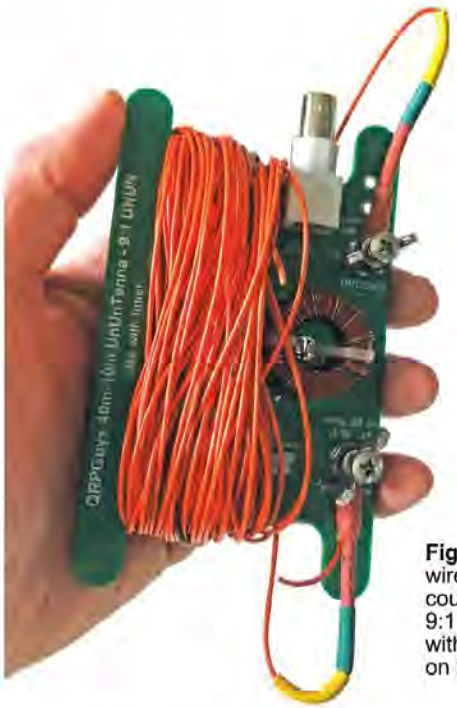


**Figure 2** — A 41-foot wire antenna, a 36-foot counterpoise, and a 9:1 un-un will work well with an antenna tuner on bands.

## Antennas

Following the standard guidelines for antennas, you still want your portable antennas to be higher and properly tuned, but operating portable allows for more experimentation in getting on the air.

Field antennas are usually a compromise, but understanding your equipment can help you get creative with your antenna setup. One of the simplest and most effective antennas is a 41-foot wire with a 36-foot counterpoise wire connected through an antenna tuner. This will usually work fine on most bands, but you might also try adding a 9:1 un-un to bring the impedance down to a more friendly level (see Figure 2). Then all you have to do is toss the wire into a tree, lay the counterpoise on the ground, and tune up.

End-fed dipoles have become very popular with portable operations, because they work well with a single support and can be purchased commercially or homebrewed. If your site location does not lend itself to putting wires into trees, you can consider magnetic loop antennas or free-standing helically loaded dipoles or verticals.

Don't forget whips that are designed for mobile use, which can be a very effective setup on or off your vehicle.

No matter what you choose, you want to use an antenna that is easy to set up and take down (see Figure 3).

## Location

For the first few times out, try going somewhere simple, like a local park or public venue that you already have some knowledge about. You'll already have some idea about spots that might be convenient for your setup.

**Figure 3** — The Elecraft K1 with internal batteries and a simple wire antenna makes an excellent portable station.

As you develop your portable operating skills, break out the atlas and try some new places. It can also be fun to combine activities. Hiking, cycling, kayaking, and camping can all be easily combined with ham radio.

## Portable Accessories

When operating portable, keep things simple. For example, many of us have become used to logging using computers. While convenient, a laptop, smartphone, or GPS introduces another point of failure, usually in terms of battery consumption. Always keep a compass and map on you for navigating, and use paper and pencil for logging.

For battery-powered operations, always make sure you have spares, whether they match the capacity of your primary power source or not. You may just need enough energy to finish a contact and end your session.

Carrying cases that keep equipment dry and dust free are always in order. Several manufacturers make weather-proof cases designed for cameras that easily adapt to Amateur Radio use. This is not the place to cut costs; you want your equipment well packed and safe from the elements.

Bug spray, sunscreen, a small first aid kit, and plenty of water should be part of every portable excursion.

## Obey the Rules

If you are going to be operating from a public park or a private campground, take the time to know the expectations of the location. Respect any environmental concerns, quiet hours, and any other guidelines that may apply. These can almost always be discovered on the location's website or by making a phone call.

## Get on the Air

There has never been a better time for portable operations. Parks on the Air, Summits on the Air, World Wide Flora & Fauna, and other activities are all looking for your portable activations. Once you send CQ from the field, you're going to make a lot of new friends.

T.J. "Skip" Arey, N2EI, was first licensed as WN2GHA in 1976. He served as the Southern New Jersey Section Manager from 2015 – 2018. He has been a freelance writer on the subjects of radio and technology for over 30 years. His main interests are CW and QRP operation. He can be reached at **skipn2ei@gmail.com**.

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

# Feedback

## Product Review Update: HecKits FET Dip Meter Kit

The Product Review of the HecKits FET DIP Meter Kit (February 2019, pp. 55 – 56) pointed out the ease of assembly and the clever design. Using a miniature digital counter to display frequency, it eliminates the need to calibrate a rotary dial. However I observed and commented on the lack of a pronounced dip at resonance, especially at the lower frequencies.

The kit developer, Darrel Heckendorf, WA7OIB, has now developed a small modification to the circuit to address this issue. The changes include replacing a resistor with a wire jumper, replacing a diode, and changing a resistor to a different value. Darrel sent me a modified FET Dip Meter and it now works very well, with a pronounced dip at resonance, similar to other dip meters I have used.

New orders of the kit will include these parts and revised instructions. In addition, HecKits will be contacting previous purchasers of the kit with information about the modifications. FET Dip Meter kits are available from **www.heckits.com**. — *Paul Danzer, N1II*

# New Products

## Digital Radio Amateur Work Station from Northwest Digital Radio

Northwest Digital Radio has announced the general availability of the Digital Radio Amateur Work Station (DRAWS™) HAT for Raspberry Pi.

The DRAWS™ HAT is the newest addition to a line of products, evolving from the Universal Digital Radio Controller (UDRC and UDRC II) platform. It combines a high-quality audio CODEC, integrated GPS with PPS and RTC, and a 12 V dc to 5 V dc power supply in a single HAT for the Raspberry Pi. The HAT exposes two radio interfaces, using the mini DIN-6 Amateur Radio standard for connecting radios for various sound card modes of operation, including audio in, audio out, PTT, and squelch detect. It also provides a GPIO interface for monitoring and control of external devices. Northwest Digital Radio provides a Raspbian Linux image for the Raspberry Pi, preloaded with software including *Dire Wolf* packet modem, *fldigi*/*flrig*, *WSJT-X*, *YAAC*, *Xastir*, *Linux RMS Gateway*, D-STAR repeaters, and other Amateur Radio and general Raspbian Linux applications.

For more information, visit **https://nwdigitalradio.com** or Julian's, OH8STN, video for the DRAWS™ HAT at **https://www.youtube.com/c/oh8stn**.

# Nominations Now Being Accepted for
# 2019 McGan Silver Antenna Award
## for Excellence in Public Relations

This annual award honors successful volunteer efforts to keep Amateur Radio in the news.

ARRL Public Information Officers (PIOs) and other volunteers are working hard every day to keep Amateur Radio visible in their communities by publicizing special events, writing press releases, or doing interviews for radio, television, or newspapers to highlight the value and service Amateur Radio provides. Those efforts benefit us all.

In appreciation of those efforts, ARRL is soliciting nominations for its 2019 Philip J. McGan Memorial Silver Antenna Award, which is presented annually to an Amateur Radio operator who has demonstrated success in his or her public relations efforts on behalf of Amateur Radio, and who best exemplifies the volunteer spirit of Phil McGan.

Journalist Philip J. McGan, WA2MBQ (SK), served as the first chairman of ARRL's Public Relations Committee, which helped reinvigorate ARRL's commitment to public relations. To honor him, members of the New Hampshire Amateur Radio Association joined with the ARRL Board of Directors to pay a lasting tribute to the important contributions he made on behalf of Amateur Radio.

Public relations activities for which the McGan Award is presented include efforts specifically directed at bringing Amateur Radio to the public's attention (and often the media's) in a positive light. This may include traditional methods, like sending out news releases or arranging interviews, or non-traditional methods, such as hosting a radio show or being an active public speaker.

E. Gordon Mooneyhan, W4EGM (left), Public Information Officer for the Grand Strand Amateur Radio Club in Myrtle Beach, South Carolina, accepts the 2018 McGan Silver Antenna Award from Roanoke Division Vice Director Bill Morine, N2COP.

Recent winners of the award include:

- E. Gordon Mooneyhan, W4EGM (2018)
- Dennis Moriarty, K8AGB (2017)
- Tom "Tex" Ritter, WY7KY (2016)
- Randy Thompson, K5ZD (2015)
- Brian Short, KC0BS (2014)

The ARRL Board of Directors will choose the winner at its July 2019 meeting, based on recommendations from the ARRL Public Relations Committee, which has responsibility for reviewing the nominations and accompanying submitted material.

The winner of the Philip J. McGan Memorial Silver Antenna Award will demonstrate volunteer public relations success on behalf of Amateur Radio at the local, state, or national level, and will live up to the high standard of achievement exemplified by Philip J. McGan.

To be eligible, a nominee must be a full ARRL member in good standing at the time of nomination. The award is given only to an individual (not a group), and a nominee may not be a current ARRL officer, Director, Vice Director, or paid staff member, or a member of the current selection committee. A nominee must not be compensated for any public relations work involving Amateur Radio (including payment for articles).

Nominations must be received at ARRL HQ in Newington *by the end of business on Friday, May 17, 2019*. Nominations must be on an official entry form, which can be found and downloaded from **www.arrl.org/phil-mcgan-award** as a PDF. Anyone may make a nomination.

*Note:* Please make sure that the nominee's work fits the definition of public relations, which is fundamentally getting a message out to people, while public service is providing a service. Also, the McGan Award is for promotion of Amateur Radio to the *non-amateur radio community*; it is not awarded for work done within a club or organization that primarily benefits the Amateur Radio community.

Rick Lindquist, WW1ME, ww1me@arrl.org

## Happenings

# Court Rules Excessive Antenna Application Fees Violated Reasonable Accommodation

Long-pending Amateur Radio antenna litigation that ARRL helped to fund finally concluded in favor of the radio amateur. The Supreme Court of the State of New York, Appellate Division: Second Judicial Department has ruled in the case of Myles Landstein, N2EHG, that the Town of LaGrange, New York, not only overstepped its state-granted authority by assessing excessive fees, but also violated the limited federal preemption PRB-1 in the process. PRB-1 requires municipalities and states to "reasonably" accommodate Amateur Radio antennas and to apply the "minimum practicable regulation" in handling Amateur Radio antenna applications. Landstein had wanted to erect a 70-foot antenna support structure for a multioperator station; the Town of LaGrange has a 35-foot height limit.

"This case, which goes back to 2013, was about applying PRB-1 to a situation in which a municipality attempted to thwart the installation and maintenance of ham radio antennas by imposing excessive permit application costs on the ham applicant," said communications attorney Chris Imlay, W3KD, who is familiar with the case. Imlay said the FCC has refused to clarify the cost-prohibition issue as it relates to PRB-1's "minimum practicable regulation" and reasonable accommodation provisions of PRB-1.

The Town attempted to have Landstein reimburse more than $17,000 in legal consulting fees — later reduced to about $6,000 — before ruling on his applications, and maintain a $1,000 escrow, the court decision recounted.

"We hold that, because the Town did not limit the consulting fees charged to the petitioner to those necessary to the decision-making function of the Town's Planning Board and Zoning Board of Appeals, the Town exceeded its state-granted authority by requiring payment of the consulting fees and, moreover, violated a rule promulgated by the [FCC]," the court concluded.

New York is the only state that doesn't consider Amateur Radio antennas a "normal accessory use" to residential real estate. ARRL decided to fund the case because it dealt with both the accessory use issue and that of cost prohibitions in the permitting process. Landstein lost at trial, and an appeal was filed around 2015, for which ARRL provided memoranda of law about the cost-prohibition issue.

The court concluded that the Town "may not use its land-use regulatory authority to construct 'hoop after hoop' for the petitioner to jump through in order to erect his radio antenna tower [and] cannot impose unreasonable expenses so as to create an insurmountable financial barrier."

## ARRL's Logbook of The World Tops 1 Billion QSO Records

In December, ARRL's Logbook of The World (LoTW) attained the major milestone of logging more than 1 billion contact records. The one billionth record was uploaded by 7X3WPL, the Sahara DX Radio Club, at 2332 UTC for a 20-meter SSB contact with Davide Cler, IW1DQS, that took place on December 28, 2016. The upload resulted in a match (QSL).

While that testifies to LoTW's success, an even more important statistic may be the more than 190,000 contacts confirmed over LoTW's 15-year history.

LoTW debuted in 2003 after a lot of behind-the-scenes planning and development. Initially, it was a slow start. User numbers gradually grew to about 5,000, but a lot of hams didn't fully understand what LoTW was or how it worked, and opening an account could be cumbersome.

LoTW continued with few major changes until October 2011, when a large intake of logs after the CQ World Wide DX Contest intersected with a freak snowstorm that knocked out power for more than a week in most places.

"When the system came back online, it was overwhelmed with the amount of data coming in and could not keep

up," said Field Services and Radiosport Department Manager Norm Fusaro, W3IZ. The disaster was a blessing in disguise, though, because it revealed weaknesses in the LoTW software and hardware.

Fusaro said ARRL spent tens of thousands of dollars for new hardware. IT Manager Mike Keane, K1MK, implemented code changes to expedite log processing by giving priority to small- to medium-sized logs and inserting mega-files as openings occurred. Fusaro said a lot of the large files contained duplicate data, bogging down the process so much that users were resending logs already in the queue. Through all of this, not a single contact record was lost due to LoTW's redundant backup process.

A LoTW users' group reflector and a queue-processing status page were set up. With better communication, Fusaro said, the system attracted additional numbers. "The service still has room for a lot of improvement, but it continues to grow, and is the preferred method of confirming QSOs because it strives to protect the integrity of DXCC and all awards," Fusaro said.

Today, LoTW has nearly 114,000 users in all 340 DXCC entities, and 75% of all DXCC applications are filed via LoTW, which accounts for 86% of confirmations applied.

## FCC News

■ **The US Senate confirmed Geoffrey Starks and Brendan Carr to full 5-year terms as FCC commissioners on January 2.** Starks, who most recently served as assistant chief of the FCC Enforcement Bureau, fills the Democratic seat vacated last spring by Mignon Clyburn. Republican nominees have a 3 – 2 advantage on the Commission. Commissioner Jessica Rosenworcel is the other Democrat on the FCC. Carr, a Republican initially nominated by President Donald Trump to fill the seat left vacant by the departure of former FCC Chairman Tom Wheeler, was confirmed last August and has been serving on the Commission; he was reconfirmed for a full term in January. He previously served as FCC general counsel. In addition to Pai and Carr, the other Republican on the FCC is Michael O'Rielly. The FCC is now back to its full complement of five members.

Geoffrey Starks. [FCC photo]

Brendan Carr. [FCC photo]

■ **Attorney Jane Hinckley Halprin is the FCC's new Administrative Law Judge (ALJ).** She succeeds Judge Richard Sippel, who retired on December 1 after 32 years of service. For the past 14 years, Halprin has served in the FCC Office of General Counsel as an Ethics Counsel and, for the past year, has led the agency's ethics team as Assistant General Counsel for Ethics.

■ **The FCC has issued a *Notice of Unlicensed Operation* (*NoUO*) to Daryl Thomas, KE6MWS, for allegedly operating an unlicensed FM radio station.** Last October 10, an Enforcement Bureau agent responded to a complaint of an unlicensed FM station operating on 95.7 MHz in Carmichael, California, where Thomas lives. The agent confirmed by direction-finding techniques that a signal on 95.7 MHz was emanating from a residence, and Thomas, a Technician licensee, subsequently admitted that he was the operator of the station, the FCC said in the November 7 *NoUO*. The agent measured the field strength of the signal and found that it exceeded the maximum permitted Part 15 (unlicensed) level of 250 µV per meter at 3 meters. "Unlicensed operation of this radio station must be discontinued immediately and must not resume," the *Notice* warned.

■ **The FCC has approved use of the European Galileo global navigation satellite system in the US.** The European Commission had asked the FCC to waive its rules so that non-federal devices in the US might access specific Galileo signals to augment the US Global Positioning System (GPS). The *Order* permits access to two of the Galileo system's satellite signals: the E1 signal transmitted in the 1,559 – 1,591 MHz portion of the 1,559 – 1,610 MHz Radionavigation-Satellite Service (RNSS) band, and the E5 signal transmitted in the 1,164 – 1,219 MHz portion of the 1,164 – 1,215 MHz and 1,215 – 1,240 MHz RNSS bands. The *Order* does not grant access to the Galileo E6 signal, transmitted over the 1,260 – 1,300 MHz frequency band, because the band is not allocated for RNSS in the US, nor does it use GPS. The omission of the E6 signal means that radio amateurs would not have to protect Galileo receivers from interference on 23 centimeters, which is a significant issue in Europe.

## Nominations Solicited for Six ARRL Awards

ARRL invites nominations for awards that recognize educational and technological pursuits in Amateur Radio. Nominations are also open for ARRL's premier award to honor a young licensee.

**The Hiram Percy Maxim Award** recognizes a radio amateur and ARRL member under age 21 whose accomplishments and contributions are of the most exemplary nature within the framework of Amateur Radio activities. Nominations for this award need to be made through your ARRL Section Manager, who must then forward the nomination to ARRL Headquarters by March 31, 2019.

**The ARRL Herb S. Brier Instructor of the Year Award** honors an ARRL volunteer Amateur Radio instructor or an ARRL professional classroom teacher who uses creative instructional approaches and reflects the highest values of the Amateur Radio community. The award highlights quality of, and commitment to, licensing instruction. Nominations are due by March 15, 2019.

**The ARRL Microwave Development Award** pays tribute to a radio amateur or group of radio amateurs who contribute to the development of the Amateur Radio microwave bands. The nomination deadline is March 31, 2019.

**The ARRL Technical Service Award** recognizes a licensed radio amateur or group of radio amateurs who provide Amateur Radio technical assistance or training to others. The nomination deadline is March 31, 2019.

**The ARRL Technical Innovation Award** is granted to a radio amateur or group of radio amateurs who develop and apply new technical ideas or techniques in Amateur Radio. The nomination deadline is March 31, 2019.

**The Knight Distinguished Service Award** was established to recognize exceptionally notable contributions by a Section Manager to the well-being and vitality of ARRL. The nomination deadline is April 30, 2019.

The ARRL Board of Directors selects recipients for these awards, with winners typically announced following the Board's July meeting. More information is on the ARRL website at **www.arrl.org/arrl-award-nominations**, or by contacting Steve Ewald, WV1X, at **wv1x@arrl.org**, or by telephone, (860)594-0265, at ARRL Headquarters.

## In Brief...

- **Southern New Jersey got a new Section Manager (SM) on January 1.** Eight serving SMs also began new 2-year terms on New Year's Day. In Southern New Jersey, Section Emergency Coordinator Tom Preiser, N2XW, of Manahawkin, was the only candidate to succeed Skip Arey, N2EI, who decided not to run for another term after serving since January 2015. The following Section Managers faced no opposition and will continue in their respective offices: Tom Walsh, K1TW (Eastern Massachusetts); Cecil Higgins, AC0HA (Missouri); Matt Anderson, KA0BOJ (Nebraska); Jim Mezey, W2KFV (New York City/Long Island); Thomas Dick, KF2GC (Northern New York); Marc Tarplee, N4UFP (South Carolina); Darrell Davis, KT4WX (West Central Florida), and Joe Shupienis, W3BC (Western Pennsylvania).

- **The 2017 ARRL Bill Leonard W2SKE Audio Reporting Award was presented on December 6 to the producers and staff of the radio program "The Takeaway."** The program, a joint production of Public Radio International (PRI), WGBH, and WNYC, aired a number of stories about Amateur Radio's role in supporting disaster relief agencies in Puerto Rico following Hurricane Maria. ARRL Emergency Preparedness Manager Mike Corey, KI1U, presented the Leonard Award for Audio Reporting. "The Takeaway" had interviewed Corey about how radio amateurs were supporting the American Red Cross's efforts to convey "safety and wellness" messages from the island commonwealth to relatives on the US mainland. The annual Leonard Award is named for late CBS News President Bill Leonard, W2SKE, an avid radio amateur and advocate for the service. It honors outstanding professional audio, visual, and print/text journalism that highlights the enjoyment, importance, and public service value of Amateur Radio.

ARRL Emergency Preparedness Manager Mike Corey, KI1U, presents the 2017 Leonard Award for Audio Reporting to executive producer Arwa Gunja and the staff of "The Takeaway." [Tanzina Vega, photo]

- **The 2018 Philip J. McGan Award for outstanding efforts in public relations on behalf of Amateur Radio was presented on December 3 in South Carolina.** E. Gordon Mooneyhan, W4EGM — the Public Information Officer (PIO) for the Grand Strand Amateur Radio Club — received the award plaque in a presentation by ARRL Roanoke Division Vice Director Bill Morine, N2COP. Mooneyhan was credited with adapting and applying "innovative strategies to emerging social media" in promoting Amateur Radio and events. Morine noted that Mooneyhan was selected from among 512 PIOs for his innovative campaigns incorporating traditional and social media. Mooneyhan expressed gratitude to the club for its support and to the media for considering his news releases as an opportunity to inform the public about Amateur Radio. The award's namesake, journalist Philip J. McGan, WA2MBQ (SK), served as the first chairman of the ARRL's Public Relations Committee.

Rick Palm, K1CE, k1ce@arrl.org

## Public Service

# Public Service in Paradise: The US Virgin Islands

The Territory of the US Virgin Islands (USVI) is comprised of three islands: St. Thomas, St. John, and St. Croix. St. Thomas (population 40,000) is one of the busiest Caribbean cruise-ship destinations, with some 1,500,000 annual passengers. St. John (population 5,000), just east of St. Thomas, is nearly as large, and only accessible by ferry. Two-thirds of St. John is a national park, and hence lacks significant development. St. Croix (population 40,000), is the largest of the three islands and lies 35 miles south of St. Thomas. There is a robust amateur community, with repeaters, nets, and clubs on each island. The USVI was incorporated into the ARRL Field Organization as the ARRL Virgin Islands Section in 1982, and its current Section Manager, Fred Kleber, K9VV/NP2X, has served since 2012.

With the USVI's closest mutual aid responders some 1,000 miles away, Amateur Radio has historically played a vital role. As category 5 hurricanes Irma and Maria pummeled the Caribbean, Amateur Radio provided a critical communications link for the territory. Territory ARES® hams supported local and federal partners, including communication with US Navy aircraft and vessels. Following the devastation from Hurricane Irma, first responders' priorities were rescue, medical evacuation, hospital recovery, damage assessment, port repairs, and shelters.

On the heels of Irma, hurricane Maria's outer eyewall crossed St. Croix at category 5 intensity with 185 MPH sustained wind and 200+ MPH gusts. Maria caused catastrophic damage to St. Croix. The majority of buildings were damaged or destroyed. Some 95% of the utility poles in St. Croix had fallen, and the majority of cellular telephone sites were out. St. John was especially hard hit with eight of nine cell sites inoperable.

The St. Croix Amateur Radio Club (SCARC) and USVI ARES supported the Virgin Islands Territorial Emergency Management Agency (VITEMA) acting under ESF-2 (Communications) from September 5 through October 2, 2017. From the St. Croix EOC, SCARC acted as net control, relying heavily on the shared 60-meter band to conduct nets involving territorial, federal, and non-governmental agencies. Traffic was passed between the EOC, responding agencies, Puerto Rico, the Hurricane Watch Net (14.325 MHz), and the Friendly Net (7188 kHz). VI ARES coordinated many medical evacuations, supply flights, and other logistics.

Although not ultimately required, Kleber planned to deploy wireless mesh network nodes to provide data connectivity between key USVI government locations. The team of 13 dedicated VI amateurs provided a total of 2,232 volunteer man-hours. Commercial power restoration exceeded 100 days in some locations. Understandably, Amateur Radio filled a huge telecommunications gap.

### More Than Just Hurricane Response

Amateur Radio operators serve other public safety functions across the islands. On October 3, 2018, St. John Rescue members Larry Pruss, NP2LP, and Jennifer Pruss, NP2QT, were attending the monthly meeting of the volunteer organization, when a request for assistance came in from the VI Police Department, who had received a report of a small empty vessel that had washed up on the rocks in Reef Bay. St. John Rescue members commenced the maritime portion of the search. The severely injured and dehydrated boater was found alive, huddled amidst the treacherous rocks. For Larry and Jennifer Pruss, it was a family affair, with their daughter, Tia, NP2RE, making the initial call for assistance

ARRL Field Day participants at Cramer's Park — the St. Croix VITEMA mobile EOC. [Fred Kleber, K9VV/NP2X, photo]

**Figure 2** — New licensees after passing their exams at a St. John Rescue test session. [Fred Kleber, K9VV/NP2X, photo]

using her newly acquired license and traffic-handling skills. Following the successful rescue, both daughters, Tia and Skylar, NP2QS, radioed the reports that the mariner had been located.

Following Hurricanes Irma and Maria, a devastated St. John community awoke to the critical value of the Amateur Service. Through the assistance of the Pruss family, Gilly Grimes, NP2OW, St. John Rescue, and two Technician-class sessions, the region gained 23 new hams in just 6 months. These new licensees include members of the community, St. John Rescue, the National Park Service, the Fire Service, and four youths under 13 years old. Five have completed the requirements to become ARES members.

Additionally, one of the Pruss' initial examinees, Dr. Henry Smith, NP2QP, is nearly finished teaching a new crop of a dozen future Technician licensees on St. Thomas. Local experienced hams are assisting new licensees with antenna-building classes, public service opportunities, and Field Day-style exercises.

## Hurricanes Aftermath: Enhance Amateur Infrastructure

After the 2017 storms rocked the territory, FEMA employees, US Army Corps of Engineers, National Guard, US Army, private consultants, linemen, National Park Service, and other relief agencies helped the USVI rebuild. Kleber said, "The territory is forever indebted to these individuals and their organizations."

As for Amateur Service hardware, the territory ham repeater network was damaged. The sole on-air repeater (NP2VI) provided handheld coverage to the helicopter landing zone and other critical locations. Kleber reported, "Through one of our new relief friends, we were introduced to a philanthropic opportunity to purchase new repeaters, controllers, link radios, PV panels, and batteries."

Kleber is happy to report the USVI interisland repeater system is now connected with resilient UHF links. Additional linked repeaters are currently being installed on all islands. When commercial power is lacking, PV panels and batteries power the systems. There are plans in progress to add Echolink/IRLP capability, as well as linking to Puerto Rico, and to link to a five-island system, with coverage reaching south to Dominica.

## Hams and Territorial Entities Work Together

It wasn't long ago that St. John personnel got word that the Mamey Peak radio tower — home to critical repeater antennas serving the Rescue service and the Virgin Islands National Park Service — was being shut down. Rescue members and park employees had used the tower repeater antennas to assist police, fire, and emergency medical services. With the help of the National Park Superintendent, a new physical location for a tower was found atop Lizard Hill and technical challenges were overcome. Gilly Grimes, NP2OW, oversaw the successful project, which was an excellent example of government agencies and organized volunteer radio amateurs working together.

Logistical communications on behalf of public safety for triathlons, walk-a-thons, and water-based events continue to provide venues for new hams to practice their communications and technical skills.

The 2018 ARRL Field Day also provided a great opportunity for new and veteran hams to exercise the new amateur systems, operators' experience, training, and the resulting new response capabilities. Kleber acknowledged a great promotional effort spearheaded by USVI Section Emergency Coordinator Daryl Jaschen, NP2QD, that resulted in the attendance of the media and many staff and officials from local partner agencies, such as VITEMA, the VI National Guard, St. Croix Rescue, and the American Red Cross.

## Going Forward

For their efforts in post-storm response, Kleber and fellow USVI amateurs were awarded the ARRL 2018 International Humanitarian Award, and Kleber was lauded for his individual efforts with the YASME Excellence Award.

VI hams frequently attend ICS classes and training exercises, which help form a foundational bond with partner agency personnel. With the influx of new hams, grants, and the expertise of longtime hams, the territory amateurs are well positioned to support future responses. To follow future developments, please visit **www.vihamradio.org**.

Alfred J. "Al" Wasielewski, WA2VJL, wa2vjl@yahoo.com

## Classic Radio

# The EICO 720 Transmitter

When Novice operators had to be crystal controlled and limited to 75 W input in the late '50s and '60s, the EICO 720 CW transmitter was a popular choice for many hams — myself included (see the lead photo). The EICO 720 first appeared in an advertisement in the 1959 edition of the *Radio Amateur's Handbook* and was available in three versions: factory-built by EICO, in kit form for amateurs to construct at home, or used from places like AES, where I picked one up for under $25 (see Figure 1).

In 1965, the EICO 720 got my station on the air, combined with a Hammarlund HQ-110 ac receiver, some crystals at about 50 cents each, and a 40-meter dipole. Oddly enough, the transmitter could even be seen in the sheriff's office on *The Andy Griffith Show*, with an EICO 777 CB transceiver beside it, although the characters weren't shown using them.

**Figure 1** — The front panel of the EICO 720. Note the 75 W mark on the meter, for Novice operators of the era.

## Specifications and History

EICO started in New York City around 1945 as a radio repair business run by Harry Ashley. His primary goal was to produce electronic test instruments in kit form. The company started producing audio equipment in the early '50s and mid '60s, and debuted EICO Amateur Radio by the end of the '50s.

The EICO 720 was a five-tube CW transmitter capable of 90 W CW input, with a special marking on the meter for the Novice-class 75 W limit. It was built on a heavy, copper-plated steel chassis, with a 6146 tube as the class-C RF final amplifier. A switch on the rear of the unit provided the means for crystal or VFO control. An eight-pin octal socket was provided for the addition of the EICO 730 modulator for AM operation, a relay, or VFO.

The 720 utilized a 6CL6 tube as an electron-coupled Colpitts oscillator and a 6AQ5 as a class-A buffer multiplier (see Figure 2). Another 6AQ5 was used as a clamp tube and a GZ34/5AR4 rectifier. The power supply provided the 600 V and filament voltage. A swinging choke and two 40 µF capacitors provided good CW regulation. The octal receptacle provided 117 V and 6.3 V ac. The user needed to add a jumper for CW operation.

## User Experience

For those preferring to build their own transmitter, the manual was well written, with detailed step-by-step instructions and large pictorial diagrams showing where the parts should be placed. Alignment was easily achieved by adjusting coil L1. EICO even included a troubleshooting chart. If it didn't work, the buyer could send it back to EICO for a repair charge of $12.50, plus parts.

The 720 was advertised as a kit for $79.95 or factory built for $119.95. The 730 modulator cost about $50 in kit form and $80 wired, plus $4.50 for

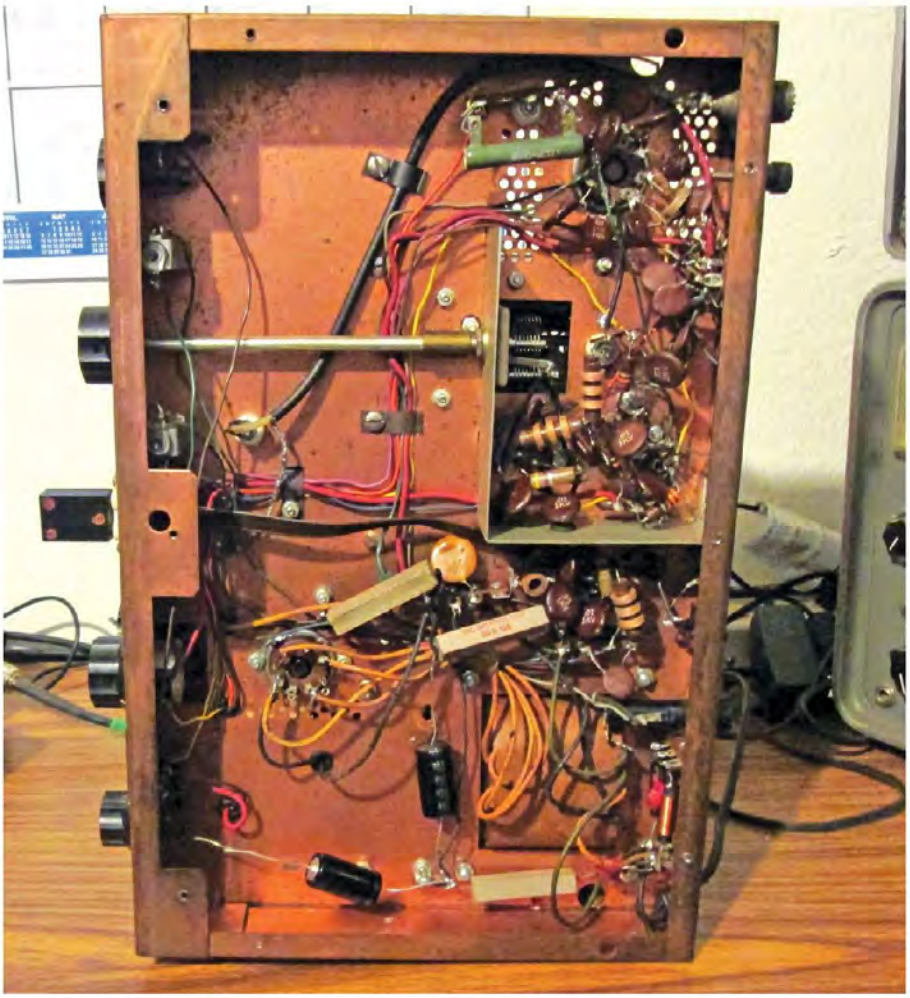


**Figure 2** — The interior of the 720 transmitter, with its many component parts.

the modulator cover, which was not included. The 722 VFO cost around $40. Competing against EICO at the time were the Heathkit DX-40, which included a screen modulator, and the WRL Globe Chief 90.

Operation was basic. The user simply preset the controls as the manual instructed, adjusted the grid, tune, and plate controls, and got on the air. The hard part was tuning the receiver and hoping someone would hear and answer on a frequency close to your crystal frequency.

## The End of EICO

By late 1970, EICO left the market and had its audio kits manufactured in South Korea. They withdrew from the electronics market later, and EICO officially came to an end in 1999, when the company liquidated at the request of its shareholders. Although the company is gone, its history survives in their products, which continue to be collected and sold by enthusiasts on the internet to this day (see Figure 3).

*All photos by the author.*

**Figure 3** — My classic radio station, featuring the EICO 720 front and center.

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

# Contest Corral

# March 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 | | | | Bands | Contest Name | Mode | Exchange | Sponsor's Website |
|---|---|---|---|---|---|---|---|---|
| Date | Time | Date | Time | | | | | |
| 2 | 0000 | 3 | 2359 | 1.8-28 | ARRL International DX Contest, SSB | Ph | W/VE: RS, SP. Non-W/VE: RS, power | www.arrl.org/arrl-dx |
| 2 | 0000 | 10 | 2359 | 3.5, 7, 21, 28, 144 | Novice Rig Roundup | CW | RST, QTH, name, class | novicerigroundup.com |
| 2 | 0600 | 2 | 0800 | 7-14 | Wake-Up! QRP Sprint | CW | RST, serial, suffix of previous QSO | qrp.ru/contest/wakeup |
| 2 | 1800 | 3 | 1359 | 1.8-28 | Open Ukraine RTTY Championship | Dig | 2-letter region (state/province/canton), serial | krs.ho.ua/openrtty |
| 3 | 0700 | 3 | 1100 | 3.5 | UBA Spring Contest, CW | CW | RST, serial, UBA section (if any) | www.uba.be/hf/contest-rules |
| 3 | 1200 | 3 | 1400 | 7 | SARL Hamnet 40-Meter Simulated Emergency Contest | Ph | RS, serial | www.sarl.org.za |
| 3 | 1200 | 3 | 2200 | 3.5 | NSARA Contest | CW Ph Dig | RS(T), county (if Nova Scotia) | nsara.ve1cfy.net/?page_id=82 |
| 4 | 2000 | 4 | 2130 | 3.5 | RSGB 80-Meter Club Championship, Data | Dig | RST, serial | www.rsgbcc.org/hf |
| 5 | 0200 | 5 | 0400 | 3.5-28 | ARS Spartan Sprint | CW | RST, SPC, power | arsqrp.blogspot.com |
| 5 | 1900 | 5 | 2100 | 3.5 | AGCW YL-CW Party | CW | RST, serial, name | agcw.org/index.php/en |
| 6 | 2000 | 6 | 2100 | 3.5 | UKEICC 80-Meter Contest | Ph | 4-char grid square | www.ukeicc.com |
| 7 | 1800 | 7 | 2200 | 28 | NRAU 10-Meter Activity Contest | CW Ph Dig | RS(T), 6-char grid square | nrau.net/activity-contests |
| 7 | 2000 | 7 | 2200 | 1.8-28 | SKCC Sprint Europe | CW | RST, SPC, name, mbr or power | www.skccgroup.com |
| 9 | 0000 | 9 | 2359 | 3.5-28 | YB DX RTTY Contest | Dig | RST, serial | rtty.ybdxcontest.com |
| 9 | 1000 | 10 | 1000 | 50-1296 | SARL VHF/UHF Analogue Contest | CW Ph | RS(T), 6-char grid | www.sarl.org.za |
| 9 | 1000 | 10 | 1000 | 3.5-28 | RSGB Commonwealth Contest | CW | RST, serial | www.rsgbcc.org/hf |
| 9 | 1200 | 10 | 1200 | 3.5-144 | F9AA Cup, SSB | Ph | RST, serial | www.site.urc.asso.fr |
| 9 | 1200 | 10 | 1200 | 28 | South America 10 Meter Contest | CW Ph | RS(T), CQ zone | sa10m.com.ar |
| 9 | 1200 | 10 | 2359 | 1.8-50 | SKCC Weekend Sprintathon | CW | RST, SPC, name, mbr or "none" | www.skccgroup.com |
| 9 | 1400 | 9 | 2000 | 3.5-28 | AGCW QRP Contest | CW | RST, serial, class, mbr or "NM" | www.agcw.org |
| 9 | 1500 | 10 | 1500 | 1.8 | Stew Perry Topband Challenge | CW | 4-char grid square | www.kkn.net/stew |
| 9 | 1500 | 10 | 2100 | 3.5-50 | Oklahoma QSO Party | CW Ph Dig | RS(T), county or SPC | k5cm.com/okqp.htm |
| 9 | 1600 | 10 | 1600 | 3.5-28 | EA PSK63 Contest | Dig | RSQ, EA province code or serial | concursos.ure.es/en |
| 9 | 1800 | 10 | 0559 | 3.5 | TESLA Memorial HF CW Contest | CW | RST, serial, 4-char grid | www.radiosport.org.rs |
| 9 | 1800 | 10 | 1800 | 1.8-50 | QCWA QSO Party | CW Ph Dig | Year first licensed, name, SPC or chapter | www.qcwa.org |
| 9 | 1900 | 10 | 1900 | 1.8-28 | Idaho QSO Party | CW Ph Dig | RS(T), county or SPC | idahoarrl.info/qsoparty |
| 9 | 2200 | 9 | 2300 | 1.8-28 | QRP ARCI Spring Thaw SSB Shootout | Ph | RS, SPC, mbr or power | www.qrparci.org/contests |
| 10 | 0000 | 10 | 0400 | 3.5-14 | North American Sprint, RTTY | Dig | Other station's call, your call, serial, name, SPC | ncjweb.com |
| 10 | 0700 | 10 | 1100 | 144 | UBA Spring Contest, 2 Meters | CW Ph | RS(T), serial, UBA section (if any) | www.uba.be/hf/contest-rules |
| 10 | 1800 | 10 | 2200 | 3.5 | WAB 3.5 MHz Phone/CW | CW Ph | RS(T) serial, WAB square or country | wab.intermip.net |
| 10 | 1800 | 11 | 0100 | All | Wisconsin QSO Party | CW Ph Dig | WI county or SPC | warac.org/wqp/wqp.htm |
| 11 | 0000 | 11 | 0200 | 1.8-28 | 4 States QRP Group Second Sunday Sprint | CW Ph | RS(T), SPC, mbr or power | www.4sqrp.com |
| 13 | 2000 | 13 | 2130 | 3.5 | RSGB 80-Meter Club Championship, CW | CW | RST, serial | www.rsgbcc.org/hf |
| 13 | 2300 | 17 | 2300 | 7-14 | AWA John Rollins Memorial DX Contest | CW | RST, equipment type and year | www.antiquewireless.org |
| 16 | 0200 | 18 | 0200 | 3.5-28 | BARTG HF RTTY Contest | Dig | RST, serial, 4-digit UTC time | www.bartg.org.uk |
| 16 | 1200 | 17 | 1200 | 1.8-28 | Russian DX Contest | CW Ph | RS(T), oblast or serial | www.rdxc.org |
| 16 | 1400 | 16 | 1800 | 144, 432 | AGCW VHF/UHF Contest | CW | RST, serial, class, 6-char grid | agcw.org/index.php/en |
| 16 | 1400 | 17 | 0200 | 1.8-144 | Louisiana QSO Party | CW Ph Dig | RS(T), parish or SPC | laqp.louisianacontestclub.org |
| 16 | 1400 | 17 | 2359 | All | Virginia QSO Party | CW Ph Dig | Serial, county or SPC | qsl.net/sterling/VA_QSO_Party |
| 16 | 2000 | 16 | 2159 | 1.8-28 | Feld Hell Sprint | Dig | RST, mbr, SPC, grid | sites.google.com/site/feldhellclub |
| 17 | 0700 | 17 | 1100 | 3.5 | UBA Spring Contest, SSB | Ph | RS, serial, UBA section (if any) | www.uba.be/hf/contest-rules |
| 18 | 0100 | 18 | 0300 | 1.8-28 | Run for the Bacon QRP Contest | CW | RST, SPC, mbr or power | qrpcontest.com/pigrun |
| 18 | 1800 | 18 | 2059 | 3.5-7 | Bucharest Contest | CW Ph Dig | RS(T), serial, county or country | yo3test201x.blogspot.ro/p/blog-page.html |
| 19 | 1700 | 24 | 1700 | 3.5-144 | CLARA Chatter Party | CW Ph | RS(T), name, SPC | www.clarayl.ca |
| 21 | 0030 | 21 | 0230 | 3.5-14 | NAQCC CW Sprint | CW | RST, SPC, mbr or power | naqcc.info |
| 23 | 0000 | 23 | 2359 | 1.8-VHF | FOC QSO Party | CW | RST, name, mbr (if any) | g4foc.org/qsoparty |
| 23 | 1200 | 24 | 1200 | 3.5-28 | UK/EI DX Contest, CW | CW | RST, serial, district (if UK/EI) | www.ukeicc.com |
| 24 | 0000 | 24 | 0400 | 3.5-14 | North American SSB Sprint Contest | Ph | Other station's call, your call, serial, name, SPC | ssbsprint.com/rules |
| 24 | 0600 | 24 | 1000 | 50 | UBA Spring Contest, 6 Meter | CW Ph | RS(T), serial, UBA section (if any) | www.uba.be/hf/contest-rules |
| 27 | 0000 | 27 | 0200 | 1.8-28 | SKCC Sprint | CW | RST, SPC, name, mbr or power | www.skccgroup.com |
| 27 | 2000 | 27 | 2100 | 3.5 | UKEICC 80-Meter Contest | CW | 4-char grid square | www.ukeicc.com |
| 28 | 2000 | 28 | 2130 | 3.5 | RSGB 80-Meter Club Championship, SSB | Ph | RS, serial | www.rsgbcc.org/hf |
| 30 | 0000 | 31 | 2359 | 1.8-28 | CQ WW WPX Contest, SSB | Ph | RS, serial | www.cqwpx.com |

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

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

# ARRL International Grid Chase Update

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

It's hard to believe a year of operating has gone by, yet the 2018 ARRL International Grid Chase (IGC) came to a successful finish on December 31, 2018. Keep an eye out for the full year-end synopsis, coming in the April issue of *QST*.

There will also be the addition of a "year summary" option to be added to the certificate generator page at **https://igc.arrl.org/leader-board.php**.

In the meantime, here's how December concluded.

## December Activity

Per the IGC leader board at **https://igc.arrl.org/leader-board.php**, submissions ended at a solid 23,953. Overall, confirmed IGC QSOs decreased about 6% across all bands as compared to November. Although December participation was slightly below November numbers (which was expected, due to winter decreases in MUF), December ended strong.

December's activity was a near match to October's event high of just over 24,000 Logbook of The World (LoTW) submissions (these are Logbook account uploads by station location). December activity decreased about 7% overall on the HF bands, while the VHF bands gained 36%.

As the new year rolled in and the Grid Chase concluded, many posted to the IGC Facebook group to bid the event farewell. Thank you to all those who took part in this exciting year-long event. Be sure to post your favorite photos and moments to the IGC Facebook page at **https://www.facebook.com/groups/IGC2018**, and they may be included in the final wrap-up article.

Remember: You can always find complete International Grid Chase information online at **www.arrl.org/international-grid-chase-2018**. Be sure to read the overall event summary in the April 2019 issue of *QST*, and on the ARRL website.

An aerial view of rare grid CM79, where Anthony, KG6LHW; Ben, KK6SYJ, and Carl, KM6LIQ, teamed up to operate on December 30, helping to wrap up the International Grid Chase. [Anthony Wiese, KG6LHW, photo]

**December 2018 ARRL International Grid Chase (IGC) Station Stats (630 meters through 3 centimeters)**

| Band | 630 m | 160 m | 80 m | 40 m | 30 m | 20 m | 17 m | 15 m | 12 m | 10 m | 6 m | 2 m | 1.25 m | 70 cm | 23 cm | 13 cm | 3 cm | Mode Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CW | 4 | 3,255 | 3,726 | 4,968 | 2,286 | 4,356 | 1,538 | 803 | 76 | 1,700 | 55 | 58 | 1 | 35 | 11 | 0 | 0 | 22,872 |
| Phone | 2 | 338 | 2,120 | 4,486 | 1 | 5,158 | 914 | 473 | 73 | 1,406 | 228 | 649 | 8 | 529 | 37 | 1 | 2 | 16,425 |
| Digital | 31 | 4,655 | 10,160 | 15,045 | 9,814 | 15,243 | 9,130 | 6,958 | 2,078 | 2,423 | 1,544 | 704 | 2 | 51 | 20 | 0 | 0 | 77,858 |
| Band Totals | 37 | 8,248 | 16,006 | 24,499 | 12,101 | 24,757 | 11,582 | 8,234 | 2,227 | 5,529 | 1,827 | 1,411 | 11 | 615 | 68 | 1 | 2 | 117,155 |

-December submissions: 23,953
-This report represents all IGC-eligible* QSOs matched in LoTW during December 2018, as uploaded to LoTW by 2359 UTC January 10, 2019.
*IGC-eligible LoTW matches occur only when both stations upload their QSOs to LoTW during the reporting month (by the 10th of the month following the reporting month), and both stations include their grid square in their LoTW TQSL station location(s).
-30-meter contacts may be a logging error, as phone is not permitted in the US.
-No contacts were reported to LoTW in December 2018 on 2200 meters, 33 centimeters, or on most microwave bands 13 centimeters or higher (except for 3 centimeters).

# The 2018 IARU HF World Championship Results

The championship was held July 14 – 15, 2018.

**Bob Raymond, WA1Z, bobraymondwa1z@gmail.com**

Team PX2A showed their national pride while celebrating their 1st-place South America and 8th-place worldwide effort. [Ricardo Rodrigues, PY2PT, 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 next IARU HF Championship will be held the second full weekend of July (July 13 – 14, 2019).

Olivier, ON4EI, won 1st-place worldwide in the Single Operator, Low Power, Phone category using this portable station from Ireland, operating as EI7T. His portable setup included (from left to right) the 15-meter-high antenna mast trailer not yet fully erected, with the Spiderbeam on top and the inverted **V** for 160/80/40 meters, a ¼-wave vertical with 16 radials, the TA-33-JR Mosley antenna at 12 meters high, and an inverted L for 160/80 meters with 24 20-meter-long radials. [Olivier Vandenbalck, ON4EI, photo]

## 2018 IARU Special Station Scores

### IARU Headquarters Stations

| Call | Score |
|---|---|
| TM0HQ | 22,916,663 |
| DA0HQ | 21,369,952 |
| EF4HQ | 20,319,926 |
| SN0HQ | 20,029,321 |
| OL8HQ | 19,693,278 |
| S50HQ | 18,185,401 |
| GR2HQ | 18,179,856 |
| 9A0HQ | 17,748,039 |
| EM5HQ | 17,334,384 |
| IO0HQ | 16,394,455 |
| YT0HQ | 16,030,800 |
| LZ7HQ | 14,656,655 |
| YR0HQ | 13,859,058 |
| OP0HQ | 13,544,184 |
| LY0HQ | 13,177,395 |
| HG0HQ | 12,799,920 |
| OE0HQ | 12,563,592 |
| YL4HQ | 11,918,434 |
| OH2HQ | 11,717,124 |
| OZ1HQ | 10,253,091 |
| PA6HQ | 9,227,823 |
| NU1AW | 5,783,301 |
| R3HQ | 5,706,300 |
| SX0HQ | 5,392,740 |
| LX8HQ | 5,026,131 |
| CQ3HQ | 4,843,944 |
| LU0HQ | 4,138,930 |
| Z30HQ | 3,850,620 |
| B0HQ | 3,183,104 |
| W1AW | 2,776,332 |
| UN1HQ | 2,745,905 |
| 8N0HQ | 2,426,880 |
| SJ8HQ | 2,082,234 |
| TF3HQ | 2,081,990 |
| ER7HQ | 1,622,910 |
| EI0HQ | 1,425,080 |
| DX0HQ | 1,229,460 |
| PJ2HQ | 1,087,448 |
| A47RS | 781,585 |
| E2HQ | 679,525 |
| HB0HQ | 677,853 |
| HC2GRC | 535,230 |
| IO6HQ | 523,820 |
| VA2RAC | 511,746 |
| YE0HQ | 344,844 |
| TC3HQ | 318,518 |
| P40HQ | 276,624 |
| VP9HQ | 189,900 |
| 3V8CB | 159,120 |
| ZF1A | 142,104 |
| VE9RAC | 134,199 |
| ZL6HQ | 121,880 |
| A71HQ | 73,476 |
| 4O1HQ | 59,880 |
| CX1AA | 51,696 |
| ZS9HQ | 42,893 |
| BV0HQ | 26,820 |
| V55HQ | 15,614 |
| VO1RAC | 4,512 |
| VR2HK | 611 |
| SP9PEE | 72 |

### IARU Administrative Council Stations

| | |
|---|---|
| G5W | 2,913,480 |
| LA2RR | 1,272,370 |
| PB2T | 135,818 |
| VE6SH | 79,065 |

### IARU R1

| | |
|---|---|
| F4GKR/P | 626,454 |
| DJ3HW | 280,980 |
| SM6EAN | 246,840 |
| IV3KKW | 17,850 |

### IARU R2

| | |
|---|---|
| YV5AM | 419,152 |
| PT2ADM | 46,729 |
| VE3YV | 32,422 |
| 9Y4X | 12,650 |

### IARU R3

| | |
|---|---|
| JA1CJP | 145,544 |
| VK3MV | 924 |

## Top Ten — US and Canada

### Single Operator, Mixed Mode, High Power

| | |
|---|---|
| VE3AT | 2,169,856 |
| N2NT (N2NC, op) | 1,445,994 |
| K0EJ | 1,277,545 |
| W6TK | 648,750 |
| AA1ON | 502,455 |
| K4PV | 398,924 |
| N4NO | 350,406 |
| N0IJ | 341,991 |
| K5TA | 316,080 |
| NS2N | 166,257 |

### Single Operator, Mixed Mode, Low Power

| | |
|---|---|
| KI6RRN (@WA6TQT) | 1,001,470 |
| N8II | 461,201 |
| WB8WKQ | 202,631 |
| K4YJ | 158,928 |
| WN6K | 140,112 |
| N6NF | 136,255 |
| VE3TG | 117,104 |
| AA4NU | 109,515 |
| K4EJ | 105,252 |
| WA2JQK | 75,705 |

### Single Operator, Mixed Mode, QRP

| | |
|---|---|
| N9EP | 70,810 |
| W5RZ | 69,388 |
| N7JI | 12,950 |
| VE3WZ | 10,222 |
| K2GMY | 8,100 |
| N3CI | 3,806 |
| WA7BME | 11 |

### Single Operator, Phone Only, High Power

| | |
|---|---|
| W7WA | 1,230,460 |
| NA3D | 348,612 |
| W6AFA | 179,654 |
| ND4Y | 161,120 |
| WV4P | 155,946 |
| N4MM | 147,320 |
| NC6R | 129,660 |
| W5GFI | 128,526 |
| K9MWM | 88,785 |
| KD3GC | 85,885 |

### Single Operator, Phone Only, Low Power

| | |
|---|---|
| KI6SYM | 113,620 |
| W1LX | 103,395 |
| KM4ZQE | 74,024 |
| WZ8T | 72,226 |
| VA3TPS | 69,615 |
| WA4JA | 46,320 |
| WT8WV | 37,037 |
| VA3GD | 33,867 |
| N2ESP | 30,456 |
| NC4MI | 29,716 |

### Single Operator, Phone Only, QRP

| | |
|---|---|
| KA8SMA | 10,340 |
| KK7VL | 210 |
| VO1RCH/VE9 | 168 |
| WD4IYE | 78 |
| KC9AMM | 72 |
| AD0BI | 52 |
| VA3MYC | 45 |

### Single Operator, CW Only, High Power

| | |
|---|---|
| W1KM | 1,934,748 |
| K1KI | 1,873,840 |
| NY4A (N4AF, op) | 1,789,896 |
| W9RE | 1,353,540 |
| W6YX (N7MH, op) | 1,316,453 |
| WX0B (AD5Q, op) | 1,308,277 |
| W5KFT (K5PI, op) | 1,296,114 |
| N4OGW | 1,251,300 |
| N3BB | 1,229,712 |
| W7RN (N6TV, op) | 1,214,580 |

### Single Operator, CW Only, Low Power

| | |
|---|---|
| K7SV | 685,056 |
| W1NN | 459,192 |
| WB4TDH | 346,830 |
| K0AD | 308,750 |
| W1QK | 301,301 |
| VA3SB | 285,000 |
| WI2E | 253,992 |
| N4IJ | 146,704 |
| K4ORD | 142,086 |
| W5RYA | 140,544 |

### Single Operator, CW Only, QRP

| | |
|---|---|
| W6JTI | 112,259 |
| K2YGM | 71,230 |
| K8CN | 52,390 |
| KB8V | 33,040 |
| NE5TH | 32,238 |
| N7RCS | 23,296 |
| W5LA | 19,721 |
| K1SX | 13,536 |
| KB8PGW | 12,384 |
| N3GD | 11,200 |

### Single Operator Unlimited, Mixed Mode, High Power

| | |
|---|---|
| N8OO | 2,342,312 |
| K1XM | 1,932,052 |
| N3QE | 1,656,648 |
| K7RL | 1,293,240 |
| W3UA | 1,155,855 |
| K3WW | 983,840 |
| WO4O | 887,276 |
| K9OM | 718,116 |
| VE3RZ | 686,192 |
| K0KX | 634,550 |

### Single Operator Unlimited, Mixed Mode, Low Power

| | |
|---|---|
| W9AV | 222,400 |
| N1EN | 182,189 |
| N8VV | 165,435 |
| KS1J | 142,870 |
| K6GHA | 127,421 |
| NU4E | 122,158 |
| K8GT | 88,755 |
| W4EE | 75,237 |
| VE3PJ | 75,205 |
| W4KAZ | 62,293 |

### Single Operator Unlimited, Mixed Mode, QRP

| | |
|---|---|
| NX5M | 248,240 |
| K8ZT | 73,358 |

### Single Operator Unlimited, Phone Only, High Power

| | |
|---|---|
| W3LL | 618,192 |
| AD5XD | 403,250 |
| NR6Q | 333,823 |
| K5LLA | 177,550 |
| N5HC | 167,600 |
| W7ZZ | 166,020 |
| N8BI | 120,734 |
| WT1A | 95,448 |
| W4KW | 69,819 |
| VE6AO (VE6TC, op) | 68,409 |

### Single Operator Unlimited, Phone Only, Low Power

| | |
|---|---|
| KI5MM | 82,450 |
| N7MZW | 49,096 |
| KG5LRP | 47,740 |
| KA2KON | 43,784 |
| K4SBZ | 42,543 |
| WU0B | 37,947 |
| K4ELI | 36,876 |
| KF4WLS | 32,832 |
| K4BBH | 29,920 |
| KM4VTE | 21,318 |

### Single Operator Unlimited, CW Only, High Power

| | |
|---|---|
| KO7SS | 1,932,322 |
| N3RS | 1,854,600 |
| K0RF | 1,699,785 |
| N5ZO | 1,358,325 |
| K5RT (NM5M, op) | 1,228,759 |
| AB3CX | 1,214,094 |
| N2YO | 1,162,752 |
| K1MK (@K1TTT) | 1,112,714 |
| VE3NNT | 1,046,622 |
| K1LT | 924,854 |

### Single Operator Unlimited, CW Only, Low Power

| | |
|---|---|
| W3KB | 438,615 |
| WA1FCN | 356,970 |
| K0ZU | 286,418 |
| K1DJ | 258,664 |
| K9WX | 229,368 |
| N4DW | 221,234 |
| AB9YC | 218,519 |
| VE3TM | 206,640 |
| KE2D | 205,896 |
| VE3YT | 187,407 |

### Single Operator Unlimited, CW Only, QRP

| | |
|---|---|
| W3YI (W3YJ, op) | 95,268 |
| KJ4M | 8,256 |
| N2CQ | 4,185 |
| KA8HDE | 4,012 |
| NX2PX | 150 |
| KC1DVT | 20 |

### Multioperator, Single Transmitter, High Power

| | |
|---|---|
| K5TR | 1,988,216 |
| K8AZ | 1,556,892 |
| N0NI | 1,452,816 |
| N7AP | 956,836 |
| K2LE | 943,365 |
| W1TJL | 850,080 |
| W1OO | 835,430 |
| VE3MIS | 727,260 |
| W2Z | 715,662 |
| W6PNG/VY2 | 626,301 |

## Top Ten — Worldwide

### Single Operator, Mixed Mode, High Power

| | |
|---|---|
| P33W (UT5UDX, op) | 6,691,344 |
| UA4S (UA4HTT, op) | 2,813,184 |
| VE3AT | 2,169,856 |
| ZF9DX (N5DX, op) | 2,123,311 |
| N2NT (N2NC, op) | 1,445,994 |
| LY9Y | 1,426,092 |
| K0EJ | 1,277,545 |
| EW1I | 1,229,695 |
| C4W | 1,173,788 |
| OM7RU | 1,052,929 |

### Single Operator, Mixed Mode, Low Power

| | |
|---|---|
| KI6RRN (@WA6TQT) | 1,001,470 |
| UY7C | 794,052 |
| 7Z1SJ | 757,996 |
| RA3Y | 729,932 |
| US0YA | 492,450 |
| N8II | 461,201 |
| UW8SM | 410,319 |
| EU3A | 369,764 |
| G4WGE/P | 362,672 |
| YL3AD | 325,500 |

### Single Operator, Mixed Mode, QRP

| | |
|---|---|
| LZ1YE | 418,424 |
| LY5G | 377,585 |
| DK7HA | 285,796 |
| LZ5QZ | 169,820 |
| EM9Q (UR9QQ, op) | 154,440 |
| HG6C (HA6IAM, op) | 147,628 |
| YU1LM | 132,435 |
| HA5BA | 130,950 |
| UT5EOX | 94,640 |
| RW3AI | 92,644 |

### Single Operator, Phone Only, High Power

| | |
|---|---|
| ES5RW | 2,559,624 |
| RK9AX | 2,278,472 |
| KH7XS (K4XS, op) | 1,780,800 |
| CR6K (CT1CJJ, op) | 1,676,072 |
| W7WA | 1,230,460 |
| HA3DX | 975,637 |
| US5D (UT7DX, op) | 882,960 |
| EA3CI | 862,950 |
| DM0Y (DL3BQA, op) | 808,320 |
| IR4K (IZ4JUK, op) | 734,068 |

### Single Operator, Phone Only, Low Power

| | |
|---|---|
| EI7T (ON4EI, op) | 1,261,002 |
| IW1FRU | 431,641 |
| F4VSE | 348,084 |
| ED7R (EA7GX, op) | 343,335 |
| UA3BL | 295,218 |
| PA2TMS | 292,908 |
| KP2/AA1BU | 250,635 |
| RU6YJ | 246,844 |
| 7Z1IS | 237,390 |
| UN7ZAF | 235,664 |

### Single Operator, Phone Only, QRP

| | |
|---|---|
| HA5NB | 114,660 |
| HB9EGA | 72,263 |
| HF100I | 40,071 |
| DL6MDG | 33,957 |
| 9A4OP | 26,598 |
| UR7TV | 24,992 |
| OV18FWC (SP2UUU, op) | 22,630 |
| PA0AWH | 21,420 |
| SQ8MFB | 17,628 |
| YO9XC | 17,160 |

### Single Operator, CW Only, High Power

| | |
|---|---|
| R3ZZ | 2,755,860 |
| RG6G | 2,734,814 |
| KP2M | 2,733,321 |
| UW1M (UR5MW, op) | 2,721,151 |
| OG2P (OH2PM, op) | 2,055,306 |
| W1KM | 1,934,748 |
| K1KI | 1,873,840 |
| NY4A (N4AF, op) | 1,789,896 |
| YT6W | 1,710,000 |
| R3XA | 1,658,935 |

### Single Operator, CW Only, Low Power

| | |
|---|---|
| IR4M (IK3QAR, op) | 1,851,554 |
| LY5R | 1,607,157 |
| RU6K | 1,398,256 |
| 4Z4AK | 1,287,612 |
| YL2QN | 957,348 |
| S51J | 923,970 |
| HA8BE | 845,728 |
| UA5F | 801,320 |
| RX9AF | 738,299 |
| K7SV | 685,056 |

### Single Operator, CW Only, QRP

| | |
|---|---|
| CT7AJL | 297,066 |
| UA6AK | 201,500 |
| DL/OL0A (OK1CZ, op) | 170,624 |
| YL3IZ/MM | 162,680 |
| OH5YU | 146,744 |
| HG3C (HA3HX, op) | 130,816 |
| S53AR | 125,356 |
| W6JTI | 112,259 |
| PA9CW | 80,080 |
| OK2HBY | 78,848 |

### Single Operator Unlimited, Mixed Mode, High Power

| | |
|---|---|
| R2AA | 4,242,793 |
| HA1AG | 3,657,798 |
| LY5E (LY2IJ, op) | 3,170,500 |
| UA4M (RL4R, op) | 3,048,878 |
| R8TT | 2,997,120 |
| UZ3A (UX1AA, op) | 2,434,656 |
| N8OO | 2,342,312 |
| OG7A (OH6MW, op) | 2,203,067 |
| OG6N | 2,016,550 |
| HA6P (HA6PX, op) | 1,943,128 |

### Single Operator Unlimited, Mixed Mode, Low Power

| | |
|---|---|
| 9A1AA | 890,178 |
| YU2A | 830,088 |
| RV9UP | 810,579 |
| EW1P | 759,525 |
| RL4A | 715,430 |
| OL5Y | 649,200 |
| SE4E (SM4DQE, op) | 539,172 |
| IQ5JA (IZ5ICH, op) | 502,600 |
| IT9RBW | 434,160 |
| HA4FB | 427,500 |

### Single Operator Unlimited, Mixed Mode, QRP

| | |
|---|---|
| HA5PP | 262,056 |
| NX5M | 248,240 |
| DL/UA9CDC | 107,416 |
| DL6OCH | 90,720 |
| RM3G | 77,179 |
| K8ZT | 73,358 |
| PE2K | 67,425 |
| LZ2AF | 42,570 |
| YO6LB | 35,862 |
| DM9KT | 35,370 |

### Single Operator Unlimited, Phone Only, High Power

| | |
|---|---|
| EF8R (RA5A, op) | 5,131,506 |
| 4M1K (YV1KK, op) | 2,320,178 |
| EU1A | 2,134,418 |
| EW6W | 2,029,272 |
| EA3PT | 1,843,704 |
| RJ4P | 1,614,354 |
| EF1W (EA1WS, op) | 1,515,618 |
| M0NKR | 1,234,620 |
| S54ZZ | 1,218,084 |
| RW0AR | 977,772 |

### Single Operator Unlimited, Phone Only, Low Power

| | |
|---|---|
| IK4LZH | 576,816 |
| UA9R | 431,148 |
| YO7SR | 428,460 |
| EC5NJ | 392,035 |
| YT5IVN | 374,210 |
| UT8EL | 237,474 |
| DL1MHJ | 197,492 |
| DM2BR | 171,336 |
| UT1DX | 148,444 |
| OE1GAQ | 136,000 |

### Single Operator Unlimited, Phone Only, QRP

| | |
|---|---|
| LZ1DM | 116,920 |
| SM5SYO | 10,560 |
| DG3YJB | 2,739 |

### Single Operator Unlimited, CW Only, High Power

| | |
|---|---|
| EF8U (UA5C, op) | 6,052,800 |
| RT9A | 3,240,321 |
| RC9A | 2,507,363 |
| LY6A | 2,187,000 |
| RT9S | 2,167,700 |
| S57DX | 2,094,224 |
| KO7SS | 1,932,322 |
| HA3LN | 1,881,390 |
| N3RS | 1,854,600 |
| RW9OW | 1,844,622 |

### Single Operator Unlimited, CW Only, Low Power

| | |
|---|---|
| UA4W | 2,231,138 |
| UT4LW | 1,682,070 |
| SP4JCQ | 1,134,045 |
| S53A | 1,095,390 |
| R7MM | 1,039,640 |
| R3QA | 935,740 |
| DL3DTH | 873,415 |
| LZ9R (LZ3YY, op) | 842,370 |
| UX1UX | 811,900 |
| RA9AP | 754,230 |

### Single Operator Unlimited, CW Only, QRP

| | |
|---|---|
| UR6EA | 604,960 |
| HG5A (HA5IW, op) | 590,083 |
| EA3KX | 250,393 |
| SM0LPO | 227,808 |
| UT3EK | 144,728 |
| W3YI (W3YJ, op) | 95,268 |
| US5EFU | 92,070 |
| OK2AP | 44,806 |
| PD2DX | 44,352 |
| UT5WAA | 41,268 |

### Multioperator, Single Transmitter, High Power

| | |
|---|---|
| RM9A | 5,184,428 |
| RU1A | 4,483,916 |
| HG6N | 3,137,673 |
| HG7T | 2,965,599 |
| OM7M | 2,808,895 |
| RM4F | 1,998,055 |
| K5TR | 1,988,216 |
| PX2A | 1,606,446 |
| K8AZ | 1,556,892 |
| RK3T | 1,504,808 |

## Regional Leaders

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

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

| | | |
|---|---|---|
| W6TK | 648,750 | SO-MIX-HP |
| WC6H | 129,779 | SO-MIX-HP |
| WA6URY | 82,215 | SO-MIX-HP |
| W6RKC | 45,890 | SO-MIX-HP |
| NU7J | 42,159 | SO-MIX-HP |
| KI6RRN (@WA6TQT) | 1,001,470 | SO-MIX-LP |
| WN6K | 140,112 | SO-MIX-LP |
| N6NF | 136,255 | SO-MIX-LP |
| WA7NWL | 38,055 | SO-MIX-LP |
| AD7XG | 8,649 | SO-MIX-LP |
| N7JI | 12,950 | SO-MIX-QRP |
| K2GMY | 8,100 | SO-MIX-QRP |
| W7WA | 1,230,460 | SO-PH-HP |
| W6AFA | 179,654 | SO-PH-HP |
| NC6R | 129,660 | SO-PH-HP |
| AI6LY | 32,200 | SO-PH-HP |
| K7STO | 24,662 | SO-PH-HP |
| KI6SYM | 113,620 | SO-PH-LP |
| WZ8T | 72,226 | SO-PH-LP |
| NF7E | 22,796 | SO-PH-LP |
| K7XE | 9,243 | SO-PH-LP |
| KE8FT | 9,204 | SO-PH-LP |
| KK7VL | 210 | SO-PH-QRP |
| W6YX (N7MH, op) | 1,316,453 | SO-CW-HP |
| W7RN (N6TV, op) | 1,214,580 | SO-CW-HP |
| K6NA | 763,040 | SO-CW-HP |
| WJ9B | 574,164 | SO-CW-HP |
| N7WA | 549,486 | SO-CW-HP |
| K6LRN | 43,807 | SO-CW-LP |
| W6ZL | 40,310 | SO-CW-LP |
| K7HBN | 33,184 | SO-CW-LP |
| KM6Z | 31,050 | SO-CW-LP |
| VA6WWW | 26,363 | SO-CW-LP |
| W6JTI | 112,259 | SO-CW-QRP |
| AC6YY | 8,642 | SO-CW-QRP |
| W6MZ | 3,900 | SO-CW-QRP |
| AA6OC | 2,784 | SO-CW-QRP |
| N6HI | 376 | SO-CW-QRP |
| K7RL | 1,293,240 | SOU-MIX-HP |
| W6SX | 293,514 | SOU-MIX-HP |
| K6RC | 186,501 | SOU-MIX-HP |
| VY0ERC | 152,048 | SOU-MIX-HP |
| N6WIN | 132,370 | SOU-MIX-HP |
| K6GHA | 127,421 | SOU-MIX-LP |
| KA7T | 49,800 | SOU-MIX-LP |
| K7JA | 36,024 | SOU-MIX-LP |
| WQ6X | 5,111 | SOU-MIX-LP |
| KE6QR | 3,990 | SOU-MIX-LP |
| NR6Q | 333,823 | SOU-PH-HP |
| W7ZZ | 166,020 | SOU-PH-HP |
| VE6AO (VE6TC, op) | 68,409 | SOU-PH-HP |
| W7GYM | 7,524 | SOU-PH-HP |
| NX6D | 6,601 | SOU-PH-HP |
| KD6TR | 15,850 | SOU-PH-LP |
| WA7YXY | 7,956 | SOU-PH-LP |
| W7CO | 5,075 | SOU-PH-LP |
| KB7JJG | 1,560 | SOU-PH-LP |
| KI6SCT | 252 | SOU-PH-LP |
| N5ZO | 1,358,325 | SOU-CW-HP |
| W6RW | 571,376 | SOU-CW-HP |
| VE7KW | 328,338 | SOU-CW-HP |
| K7QA | 218,815 | SOU-CW-HP |
| VE7XF | 214,926 | SOU-CW-HP |
| NX1P | 145,134 | SOU-CW-LP |
| K6WSC | 120,260 | SOU-CW-LP |
| K7JQ | 14,237 | SOU-CW-LP |
| K7GS | 6,195 | SOU-CW-LP |
| K7TQ | 5,208 | SOU-CW-LP |
| N7AP | 956,836 | MSHP |
| NX6T | 584,514 | MSHP |
| K7BTW | 471,639 | MSHP |
| AF6O | 448,476 | MSHP |
| K7ZS | 442,557 | MSHP |

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

| | | |
|---|---|---|
| K5TA | 316,080 | SO-MIX-HP |
| K5ZG | 38,304 | SO-MIX-HP |
| AE5P | 297 | SO-MIX-HP |
| K0KR | 51,700 | SO-MIX-LP |
| AF5CC | 35,108 | SO-MIX-LP |
| WA5DSS | 33,465 | SO-MIX-LP |
| K0UK | 27,144 | SO-MIX-LP |
| WA5LFD | 22,896 | SO-MIX-LP |
| N3CI | 3,806 | SO-MIX-QRP |
| WA7BME | 11 | SO-MIX-QRP |
| W5GFI | 128,526 | SO-PH-HP |
| K9MWM | 88,785 | SO-PH-HP |
| KD0JLE | 21,168 | SO-PH-HP |
| AD8B | 18,270 | SO-PH-HP |
| WE6EZ | 13,452 | SO-PH-HP |
| N0EMU | 22,100 | SO-PH-LP |
| NW5Q | 20,984 | SO-PH-LP |
| K5LAD | 13,254 | SO-PH-LP |
| W7KAM | 11,286 | SO-PH-LP |
| K0SCO | 6,048 | SO-PH-LP |
| AD0BI | 52 | SO-PH-QRP |
| WX0B (AD5Q, op) | 1,308,277 | SO-CW-HP |
| W5KFT (K5PI, op) | 1,296,114 | SO-CW-HP |
| N3BB | 1,229,712 | SO-CW-HP |
| N0AT | 373,434 | SO-CW-HP |
| K0NM | 364,832 | SO-CW-HP |
| K0AD | 308,750 | SO-CW-LP |
| N4IJ | 146,704 | SO-CW-LP |
| W5RYA | 140,544 | SO-CW-LP |
| N5KWN | 137,530 | SO-CW-LP |
| AE5GT | 111,384 | SO-CW-LP |
| NE5TH | 32,238 | SO-CW-QRP |
| KE0TT | 4,028 | SO-CW-QRP |
| NW0M | 4,000 | SO-CW-QRP |
| K0KX | 634,550 | SOU-MIX-HP |
| K0MD | 452,892 | SOU-MIX-HP |
| N5ZC | 329,056 | SOU-MIX-HP |
| K7UT | 200,420 | SOU-MIX-HP |
| KI6QDH | 92,245 | SOU-MIX-HP |
| NX0I | 39,000 | SOU-MIX-LP |
| VE5SF | 37,582 | SOU-MIX-LP |
| WX0Z | 27,360 | SOU-MIX-LP |
| WD0GTY | 17,420 | SOU-MIX-LP |
| KE5LQ | 17,100 | SOU-MIX-LP |
| NX5M | 248,240 | SOU-MIX-QRP |
| AD5XD | 403,250 | SOU-PH-HP |
| K5LLA | 177,550 | SOU-PH-HP |
| N5HC | 167,600 | SOU-PH-HP |
| KB0VHA | 52,096 | SOU-PH-HP |
| K5AVY | 2,834 | SOU-PH-HP |
| KI5MM | 82,450 | SOU-PH-LP |
| N7MZW | 49,096 | SOU-PH-LP |
| KG5LRP | 47,740 | SOU-PH-LP |
| KD0IRW | 11,025 | SOU-PH-LP |
| K5LGX | 6,688 | SOU-PH-LP |
| K0RF | 1,699,785 | SOU-CW-HP |
| K5RT (NM5M, op) | 1,228,759 | SOU-CW-HP |
| N0AV | 670,176 | SOU-CW-HP |
| K5CM (W5CW, op) | 655,340 | SOU-CW-HP |
| AC4CA | 331,698 | SOU-CW-HP |
| K0ZU | 286,418 | SOU-CW-LP |
| K0VBU | 117,968 | SOU-CW-LP |
| W0GJ | 35,156 | SOU-CW-LP |
| K5TMT | 27,150 | SOU-CW-LP |
| W0SEI | 14,085 | SOU-CW-LP |
| KA8HDE | 4,012 | SOU-CW-QRP |
| K5TR | 1,988,216 | MSHP |
| N0NI | 1,452,816 | MSHP |
| W5FMH | 207,151 | MSHP |
| W7SU | 1,179 | MSHP |

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

| | | |
|---|---|---|
| VE3AT | 2,169,856 | SO-MIX-HP |
| N0IJ | 341,991 | SO-MIX-HP |
| K9LA | 12,423 | SO-MIX-HP |
| N8RY | 9,455 | SO-MIX-HP |
| WX8C | 3,820 | SO-MIX-HP |
| WB8WKQ | 202,631 | SO-MIX-LP |
| K4YJ | 158,928 | SO-MIX-LP |
| VE3TG | 117,104 | SO-MIX-LP |
| VA3EC | 70,728 | SO-MIX-LP |
| W8MET | 52,546 | SO-MIX-LP |
| N9EP | 70,810 | SO-MIX-QRP |
| VE3WZ | 10,222 | SO-MIX-QRP |
| ND4Y | 161,120 | SO-PH-HP |
| K8AO | 35,580 | SO-PH-HP |
| AA8DC | 27,404 | SO-PH-HP |
| WA9ZVF | 16,260 | SO-PH-HP |
| K9AMP | 5,236 | SO-PH-HP |
| VA3TPS | 69,615 | SO-PH-LP |
| VA3GD | 33,867 | SO-PH-LP |
| KB8UUZ | 26,418 | SO-PH-LP |
| K4TG | 14,560 | SO-PH-LP |
| N8JBR | 12,800 | SO-PH-LP |
| KA8SMA | 10,340 | SO-PH-QRP |
| WD4IYE | 78 | SO-PH-QRP |
| KC9AMM | 72 | SO-PH-QRP |
| VA3MYC | 45 | SO-PH-QRP |
| W9RE | 1,353,540 | SO-CW-HP |
| NA8V | 1,014,720 | SO-CW-HP |
| W5MX | 705,888 | SO-CW-HP |
| K8GL | 582,992 | SO-CW-HP |
| K8MP | 281,644 | SO-CW-HP |
| W1NN | 459,192 | SO-CW-LP |
| VA3SB | 285,000 | SO-CW-LP |
| N1RU | 69,092 | SO-CW-LP |
| W8TM | 69,020 | SO-CW-LP |
| AF8A | 53,900 | SO-CW-LP |
| KB8PGW | 12,384 | SO-CW-QRP |
| VE3IGJ | 2,280 | SO-CW-QRP |
| AB8FJ | 448 | SO-CW-QRP |
| K9OM | 718,116 | SOU-MIX-HP |
| VE3RZ | 686,192 | SOU-MIX-HP |
| N2BJ | 253,312 | SOU-MIX-HP |
| ND9G | 231,162 | SOU-MIX-HP |
| N4QS | 192,740 | SOU-MIX-HP |
| W9AV | 222,400 | SOU-MIX-LP |
| N8VV | 165,435 | SOU-MIX-LP |
| K8GT | 88,755 | SOU-MIX-LP |
| VE3PJ | 75,205 | SOU-MIX-LP |
| AB8OU | 23,919 | SOU-MIX-LP |
| K8ZT | 73,358 | SOU-MIX-QRP |
| N8BI | 120,734 | SOU-PH-HP |
| VA3ZNQ | 46,592 | SOU-PH-HP |
| VA3TIC | 34,580 | SOU-PH-HP |
| KG8I | 25,080 | SOU-PH-HP |
| KD8QBV | 8,184 | SOU-PH-HP |
| KF4WLS | 32,832 | SOU-PH-LP |
| VE3MXJ | 14,742 | SOU-PH-LP |
| N9VPV | 9,917 | SOU-PH-LP |
| N9UDO | 8,470 | SOU-PH-LP |
| NW8F | 936 | SOU-PH-LP |
| VE3NNT | 1,046,622 | SOU-CW-HP |
| K1LT | 924,854 | SOU-CW-HP |
| VE3UTT | 817,292 | SOU-CW-HP |
| N8BJQ | 593,216 | SOU-CW-HP |
| K8AJS | 303,795 | SOU-CW-HP |
| K9WX | 229,368 | SOU-CW-LP |
| AB9YC | 218,519 | SOU-CW-LP |
| VE3TM | 206,640 | SOU-CW-LP |
| VE3YT | 187,407 | SOU-CW-LP |
| VE3MV | 93,240 | SOU-CW-LP |
| K8AZ | 1,556,892 | MSHP |
| VE3MIS | 727,260 | MSHP |
| VE3YAA | 230,736 | MSHP |
| N8YXR | 65,946 | MSHP |
| W8DC | 5,103 | MSHP |

### Southeast Region
**(Delta, Roanoke, and Southeastern Divisions)**

| | | |
|---|---|---|
| K0EJ | 1,277,545 | SO-MIX-HP |
| K4PV | 398,924 | SO-MIX-HP |
| N4NO | 350,406 | SO-MIX-HP |
| N4CF | 79,200 | SO-MIX-HP |
| W4RTN | 33,784 | SO-MIX-HP |
| N8II | 461,201 | SO-MIX-LP |
| AA4NU | 109,515 | SO-MIX-LP |
| K4EJ | 105,252 | SO-MIX-LP |
| WA1PMA | 22,302 | SO-MIX-LP |
| K4VOZ | 19,061 | SO-MIX-LP |
| W5RZ | 69,388 | SO-MIX-QRP |
| WV4P | 155,946 | SO-PH-HP |
| N4MM | 147,320 | SO-PH-HP |
| KD3GC | 85,885 | SO-PH-HP |
| KA8Q | 72,590 | SO-PH-HP |
| AB4EJ | 33,174 | SO-PH-HP |
| KM4ZQE | 74,024 | SO-PH-LP |
| WA4JA | 46,320 | SO-PH-LP |
| WT8WV | 37,037 | SO-PH-LP |
| N2ESP | 30,456 | SO-PH-LP |
| NC4MI | 29,716 | SO-PH-LP |
| NY4A (N4AF, op) | 1,789,896 | SO-CW-HP |
| N4OGW | 1,251,300 | SO-CW-HP |
| K4RO | 1,174,080 | SO-CW-HP |
| KU8E | 615,438 | SO-CW-HP |
| W4CB (W2RU, op) | 412,965 | SO-CW-HP |
| K7SV | 685,056 | SO-CW-LP |
| WB4TDH | 346,830 | SO-CW-LP |
| K4ORD | 142,086 | SO-CW-LP |
| WA5SOG | 95,264 | SO-CW-LP |
| N4HA | 49,140 | SO-CW-LP |
| KB8V | 33,040 | SO-CW-QRP |
| N7RCS | 23,296 | SO-CW-QRP |
| W5LA | 19,721 | SO-CW-QRP |
| N3GD | 11,200 | SO-CW-QRP |
| W4ER | 1,575 | SO-CW-QRP |
| N8OO | 2,342,312 | SOU-MIX-HP |
| WO4O | 887,276 | SOU-MIX-HP |
| AD8J | 487,630 | SOU-MIX-HP |
| AA5AU | 421,104 | SOU-MIX-HP |
| N4WW | 304,722 | SOU-MIX-HP |
| NU4E | 122,158 | SOU-MIX-LP |
| W4EE | 75,237 | SOU-MIX-LP |
| W4KAZ | 62,293 | SOU-MIX-LP |
| N6DW | 45,045 | SOU-MIX-LP |
| KM4SII | 34,320 | SOU-MIX-LP |
| W4KW | 69,819 | SOU-PH-HP |
| NN2T | 53,737 | SOU-PH-HP |
| K4ADB | 51,405 | SOU-PH-HP |
| K4FX | 44,786 | SOU-PH-HP |
| K4HDW | 44,000 | SOU-PH-HP |
| K4SBZ | 42,543 | SOU-PH-LP |
| WU0B | 37,947 | SOU-PH-LP |
| K4ELI | 36,876 | SOU-PH-LP |
| K4BBH | 29,920 | SOU-PH-LP |
| KM4VTE | 21,318 | SOU-PH-LP |
| N2YO | 1,162,752 | SOU-CW-HP |
| N4BP | 844,277 | SOU-CW-HP |
| W4NZ | 764,884 | SOU-CW-HP |
| K3IE | 521,240 | SOU-CW-HP |
| K2SX | 388,675 | SOU-CW-HP |
| WA1FCN | 356,970 | SOU-CW-LP |
| N4DW | 221,234 | SOU-CW-LP |
| NN5O | 163,134 | SOU-CW-LP |
| W4PM | 154,429 | SOU-CW-LP |
| K2MK | 92,400 | SOU-CW-LP |
| KJ4M | 8,256 | SOU-CW-QRP |
| AD4ES | 604,808 | MSHP |
| NA5NN | 429,441 | MSHP |
| W5GAD | 89,320 | MSHP |
| WK1DS | 74,880 | MSHP |
| NN4SA | 30,866 | MSHP |

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

| | | |
|---|---|---|
| N2NT (N2NC, op) | 1,445,994 | SO-MIX-HP |
| AA1ON | 502,455 | SO-MIX-HP |
| NS2N | 166,257 | SO-MIX-HP |
| W1XX | 163,467 | SO-MIX-HP |
| WS9M | 112,800 | SO-MIX-HP |
| WA2JQK | 75,705 | SO-MIX-LP |
| WA2QAU | 62,128 | SO-MIX-LP |
| W1OP (NE1Y, op) | 42,813 | SO-MIX-LP |
| W8TOM | 42,581 | SO-MIX-LP |
| W3IUU | 41,230 | SO-MIX-LP |
| NA3D | 348,612 | SO-PH-HP |
| N2MUN | 19,393 | SO-PH-HP |
| 4U1WB (AJ3M, op) | 17,765 | SO-PH-HP |
| W1BDB (WA1OEZ, op) | 10,773 | SO-PH-HP |
| VE9PLS | 2,581 | SO-PH-HP |
| W1LX | 103,395 | SO-PH-LP |
| N3XZ | 17,112 | SO-PH-LP |
| KS2G | 15,105 | SO-PH-LP |
| N2MTG | 12,815 | SO-PH-LP |
| W3MBC | 11,970 | SO-PH-LP |
| VO1RCH/VE9 | 168 | SO-PH-QRP |
| W1KM | 1,934,748 | SO-CW-HP |
| K1KI | 1,873,840 | SO-CW-HP |
| WC1M | 1,191,726 | SO-CW-HP |
| VE9AA | 948,012 | SO-CW-HP |
| AA1K | 769,885 | SO-CW-HP |
| W1QK | 301,301 | SO-CW-LP |
| WI2E | 253,992 | SO-CW-LP |
| N2EM | 118,992 | SO-CW-LP |
| N2AN | 108,715 | SO-CW-LP |
| N8NA | 107,424 | SO-CW-LP |
| K2YGM | 71,230 | SO-CW-QRP |
| K8CN | 52,390 | SO-CW-QRP |
| K1SX | 13,536 | SO-CW-QRP |
| VE9HF | 9,022 | SO-CW-QRP |
| K6NR | 4,356 | SO-CW-QRP |
| K1XM | 1,932,052 | SOU-MIX-HP |
| N3QE | 1,656,648 | SOU-MIX-HP |
| W3UA | 1,155,855 | SOU-MIX-HP |
| K3WW | 983,840 | SOU-MIX-HP |
| K3AJ | 501,737 | SOU-MIX-HP |
| N1EN | 182,189 | SOU-MIX-LP |
| KS1J | 142,870 | SOU-MIX-LP |
| N3ZA | 60,606 | SOU-MIX-LP |
| VA2CZ | 58,621 | SOU-MIX-LP |
| VE2EBK | 54,905 | SOU-MIX-LP |
| W3LL | 618,192 | SOU-PH-HP |
| WT1A | 95,448 | SOU-PH-HP |
| WC3N | 31,122 | SOU-PH-HP |
| AB2DE | 18,975 | SOU-PH-HP |
| K4JDF | 18,144 | SOU-PH-HP |
| KA2KON | 43,784 | SOU-PH-LP |
| KC3INR | 9,261 | SOU-PH-LP |
| KC1ELF | 2,944 | SOU-PH-LP |
| KD2JOE | 2,640 | SOU-PH-LP |
| KC2OSR | 1,067 | SOU-PH-LP |
| KO7SS | 1,932,322 | SOU-CW-HP |
| N3RS | 1,854,600 | SOU-CW-HP |
| AB3CX | 1,214,094 | SOU-CW-HP |
| K1MK (@K1TTT) | 1,112,714 | SOU-CW-HP |
| N2GC | 730,455 | SOU-CW-HP |
| W3KB | 438,615 | SOU-CW-LP |
| K1DJ | 258,664 | SOU-CW-LP |
| KE2D | 205,896 | SOU-CW-LP |
| AB1J | 172,672 | SOU-CW-LP |
| W2IY | 140,070 | SOU-CW-LP |
| W3YI (W3YJ, op) | 95,268 | SOU-CW-QRP |
| N2CQ | 4,185 | SOU-CW-QRP |
| NX2PX | 150 | SOU-CW-QRP |
| KC1DVT | 20 | SOU-CW-QRP |
| K2LE | 943,365 | MSHP |
| W1TJL | 850,080 | MSHP |
| W1OO | 835,430 | MSHP |
| W2Z | 715,662 | MSHP |
| W6PNG/VY2 | 626,301 | MSHP |

# The April 2019 ARRL Rookie Roundup — Phone

## 1800 UTC – 2359 UTC, Sunday, April 14

Rookies will attempt to make as many contacts as possible during this 6-hour event. Rookies work everyone and non-Rookies work only Rookies. If you were first licensed in 2019, 2018, or 2017, you can enter as a Rookie.

Rookie entries are limited to operators who have either:

- Made no contacts at all or have made their first Amateur Radio contact during 2019, 2018, or 2017;
- Or have never made any contacts on the phone contest mode before this Rookie Roundup contest. Operators may enter in this category only one time and must send the current year in their exchange.

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

The exchange is your name, the last two numbers of the year you were licensed, and your state, province, or "DX" if you're outside the US and Canada.

This is a great way for clubs to get their newer members on the air, and the perfect opportunity to be a mentor to new licensees. Non-Rookies, join the fun by calling "CQ Rookies," to encourage the Rookie operators to flock to you.

The Nashua Area Radio Society, N1FD, finished 1st-place Multioperator (call area W1 and overall) in the 2018 Rookie Roundup SSB event. From left to right are mentors Anita Kemmerer, AB1QB, and Jamey Finchum, AC1DC, and Rookies Andrea Perdicaro, KC1JDX; Abby Finchum, AB1BY; Keith Sangillo, KC1IMK; Mark Sangillo, KC1IML; Jerry Doty, K1OKD, and Bobby Hazelton, KC1JEE. [Anita Kemmerer, AB1QB, photo]

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

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

## W1AW Schedule

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

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

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

Slow Code = practice sent at 5, 7½, 10, 13, and 15 WPM.
Fast Code = practice sent at 35, 30, 25, 20, 15, 13, and 10 WPM.
Code bulletins are sent at 18 WPM.

- W1AW Qualifying Runs are sent on the same frequencies as the Morse code transmissions. West coast qualifying runs are transmitted by various west coast stations on CW frequencies that are normally used by W1AW, in addition to 3590 kHz, at various times. Underline 1 minute of the highest speed you copied, certify that your copy was made without aid, and send it to ARRL for grading. Please include your name, call sign (if any), and complete mailing address. Fees: $10 for a certificate, $7.50 for endorsements.
- Digital transmissions: Frequencies are 3.5975, 7.095, 14.095, 18.1025, 21.095, 28.095, 50.350, and 147.555 MHz.

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

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

- Voice transmissions: Frequencies are 1.855, 3.99, 7.29, 14.29, 18.16, 21.39, 28.59, 50.350, and 147.555 MHz. Voice transmissions on 7.290 MHz are in AM double sideband, full carrier.
- Notes: On Fridays, UTC, a DX bulletin replaces the regular bulletins. W1AW is open to visitors 10 AM to noon and 1 PM to 3:45 PM Monday through Friday. FCC-licensed amateurs may operate the station during that time. Be sure to bring your current FCC amateur license or a photocopy. In a communication emergency, monitor W1AW for special bulletins as follows: voice on the hour, teleprinter at 15 minutes past the hour, and CW on the half hour.

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

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

Bernie McClenny, W3UR, w3ur@arrl.org

## How's DX?

# A Review of DX in 2018

Last year, the sun had 221 spotless days, meaning we are "at the deepest part of the solar cycle minimum with no evidence yet of significant new sunspots from the next solar cycle," according to Frank Donovan, W3LPL. Frank expects many more spotless days during 2019 and possibly during 2020, too. Despite being so close to the bottom of the sunspot cycle during 2018, 288 DXCC entities were reported on the air, leaving 52 of the 340 DXCC entities not on the air. That is the same as last year, and just slightly above the average over the last decades. Here are some of the highlights from 2018.

### January

The year began with Kosovo finally being added to the DXCC list, and a multinational team and locals operating Z60A. Ken, LA7GIA, and Adrian, KO8SCA, teamed up in Somalia as 6O6O.[1] Alex, UA1OJL, was using special call RI50ANO, celebrating the 50th anniversary of the Bellingshausen Station in the South Shetlands. Pat, N2IEN, went to Bhutan where he was active as A52PD. Harald, DF2WO, did one of three trips to XT2AW in Burkina Faso. CW operators contacted Ulli, DL9WVM, at the ET3AA club station. Zorro, JH1AJT, led a DXpedition to Eritrea as E31A. A group from the UK activated ZC4A with an emphasis on the low bands. An Italian team started operating as D68I from the Comoros Islands, a DXpedition that would continue until February. The greatest frustration of the year had to be the failure of the 3Y0Z Bouvet Island DXpedition.

### February

February began with a team from the UK operating from The Gambia as C5DX. Michael, CE0Y/DF8AN, went back to Easter Island. Wim, ON6DX, was back in Grand Popo as TY1TT. Mome, Z32ZM, went next door to Kosovo, operating Z68M. DJ9RR, DK2AMM, DL6JGN, and PA3EWP were on Rotuma Island as 3D2EU. John, G4IRN, made a surprise visit to the Andaman Islands, operating VU4G. At the end of the month, YL2GM headed up a team from Latvia to operate from Equatorial Guinea as 3C3W.

### March

After their 3C3W stint, YL2GM went on to Annobon Island as 3C0W. Simon, HS0ZIB/G6JFY, was able to secure XZ2A from Myanmar. A team from Germany put XR0YD, Easter Island, on the bands. LA7THA, LA7WCA, and LA9VPA focused on the low bands from Zimbabwe as Z2LA. After 7 years of no activity from XF4 (Revillagigedo), Mark, XE1B, started using 4B4B. 9M0W[2] was a multinational team operating from the Spratly Islands, and a French team was in Benin as TY7C. Toni, EA5RM, headed up an international team in the Congo as TN5R. Sarath, VU3RSB, teamed up with a group from Brazil in Macao as XX9B. Zorro, JH1AJT, made his first of four operations from Bhutan as A5A. Several times, Take, JG8NQJ/JD1, was working on Minami Torishima and active in his spare time. TJ2TT was the Italian DXpedition Team operating from Cameroon. Members of the newly formed EI DX Group were in Malawi as 7Q7EI. Champ, E21EIC, made several trips to Laos, where he was working as XW1IC.

### April

This month saw Philip, KH9/N7NVK, begin a 3-month work rotation schedule on Wake Island. Seb, F5UFX, led a French multioperator team to St. Brandon as 3B7A. PE7T and 9V1YC/N1YC made a surprise visit to Christmas Island (VK9X). The OK DX Team gave us Z66D from Kosovo. Ken, KH6QJ, operated a few contests from East Kiribati as T32AZ. Finally, AI5P, N0KV, W0ZA, and WD0E made it to St. Barthélemy (FJ).

### May

We found out that S79LD was operating VK4EF from Mahé and La Digue. Bruce, 3W3B, was back in Laos at XW4XR. At the end of the

The VP6D team made over 112,000 contacts from Ducie Island during their October 2018 DXpedition. [Photo courtesy of K3EL and K5GS]

month, Randy, WW6RG/KH9, was on for a few hours. Pasi, OH3WS, made it back to the Rock as OJ0W. Lastly, Kay, WA0WOF, and Kyoko, JR3MVF, operated A52YL in Bhutan.

## June

As we moved into summer, David, EB7DX, went to Sao Tome to operate S9ZZ. After a more-than-15-year hiatus, a multinational team went to Baker Island as KH1/KH7Z.[3]

## July

Gordon, K7TRB, began a work assignment in East Timor and was active as 4W/K7TRB in his spare time. PY7RP, Renner, went back to PY0F Fernando de Noronha, keeping a close ear on 6 meters. The Kosovo International Friendship Consortium was especially active on FT8 as Z66X.

## August

Alain, F8FUA, was in Burkina Faso operating as XT2BR. Jose, NP4G, did a holiday-style CE0Y/NP4G activity from Easter Island. Rounding out the month, the CanAm group went to the Austral Islands and used special call TX5T.[4]

## September

The DXpedition calendar heated up as fall began in the Northern Hemisphere, with another Zorro, JH1AJT, operation as A5A in Bhutan. Steve, G4EDG, took a month-long stint on Tristan da Cunha as ZD9CW. Uli, DL2AH, went to T32AH, and DL3DXX led a team to Market Reef as OJ0DX. The Maldives was the place to be as 8Q7EC (op OE3DEC), 8Q7IP (op HA3JB), and 8Q7SD (op JF2SDR) all took on single-operator efforts. A Czech team went to Mayotte as TO6OK. C21GJ was a 6-meter Earth-Moon-Earth DXpedition by Lance, W7GJ. The Italian DXpedition Team was back in Africa at 9X0T in Burundi.

## October

Uli, DL2AH, was in American Samoa as WH8/DL2AH. Also going to KH8 was VK4MAP. The Quake Contesters, from New Zealand, went to Niue as E6Y in both the CW and SSB Oceania DX contests. Ken, LA7GIA, was on the air for about 24 hours as TT8KO in Chad before being shut down and prevented from leaving the country for well over a week. Stu, K4MIL/KG4SS; Bill, W4WV/KG4WV, and Allan, W6HGF/KG4HF, all went to Guantanamo Bay. A team from Japan activated ZL7X in the Chatham Islands. Five G's from the 6G group were at VK9XG on Christmas Island. DF3FS was back in the Ivory Coast at TU5MH. A multinational team operated from Ducie Island as VP6D. OH2BH wrapped up the month by making the most of 30 meters, working some 800+ North American stations as A52BH in Bhutan. Elham, 5A0YL, became Libya's first female licensed Amateur Radio operator. Ali, EP3CQ, is now working for the United Nations in Somalia and licensed as 6O1OO. Pierre, HB9AMO, surprised us in Niger as 5U9AMO.

During the December 2018 Youngsters On The Air (YOTA) event, OE3FTA, YO3IMD, DK6SP, and HA8RT were operating from Kosovo, the newest DXCC entity, as Z66DH. [Photo courtesy of OE3FTA]

## November

Mike, DF8AN, went to both Cocos (Keeling) and Christmas islands operating as VK9CH and VK9XQ. A Russian team activated Islands On The Air AS-189 for the first time as EP6RRC.

## December

Ken, K4ZW, and Bob, W9XY, were helping the ET3AA club station during the 2018 YOTA (Youngsters On The Air) event using special call ET3YOTA. Cezar, VE3LYC, and Adrian, KO8SCA, activated IOTA OC-297 (Morane) for the first time ever as TX0M, followed by TX0A from OC-113. Diya, YI1DZ, is back on the air as Z81D in South Sudan for at least the next 6 months. Finishing up 2018, a youth team from Europe was on from the year's newly added Kosovo as Z66DH.

**Notes**

[1]K. Opskar, LA7GIA, and A. Ciuperca, KO8SCA, "6O6O, a Two-Man DXpedition to Somalia," *QST*, Apr. 2018, p. 92.
[2]H. Milosevic, YT1AD, "2018 9M0W Spratly Islands DXpedition," *QST*, Sep. 2018, p. 92.
[3]D. Greenbaum, N1DG, "KH1/KH7Z Baker Island DXpedition Recap," *QST*, Nov. 2018, p. 95.
[4]M. Jonas, W5MJ, "The 2018 CanAm Group's DXpedition to the Central Pacific," *QST*, Dec. 2018, p. 92.

### Wrap-Up

The top 10 most inactive DXCC entities in order are CE0X, BV9P, KH3, KH7K, EZ, 3Y/P, BS7H, YV0, 3Y/B, and KP5. Their length of inactivity ranges from 16 to 10 years. In order to get on the ARRL DXCC Honor Roll, you need to have worked at least 331 on the current list. That means if you have been DXing and worked every country that has been on the air in the last 11 years, you may qualify for the DXCC Honor Roll. Thanks to W1JR and W3LPL for their input this month. Until next month, see you in the pileups! — *Bernie, W3UR*

Jon Jones, N0JK, n0jk@arrl.org

## The World Above 50 MHz

# Operating *WSJT-X* with Legacy Radios

Most people operate the popular *WSJT-X* modes, such as JT-65, FT8, and MSK144, using radios with a digital input or software-defined radios that handle digital communications through the PC. When my primary *WSJT-X* radio developed problems, I began to wonder if it was possible to operate *WSJT-X* using older radios that do not have a digital interface. While it was being repaired, I tried to use my backup 6-meter radio — an MFJ-9406. It can operate SSB and CW, but it has no digital input or output. However, I was further confused because I was able to put it on FT8 for the winter $E_s$ season.

Lance Collister, W7GJ, had some helpful suggestions on his EME page (**www.bigskyspaces.com/w7gj/JT65.pdf**):

> Even if you do not have any special computer interface, you can operate digital modes (provided you have no amplifier and external relays to sequence on and off). Just follow these steps:
>
> 1. Download and install the free *WSJT* program onto your computer.
> 2. Connect an audio line from your radio's headphone jack to your computer sound card **LINE IN** (or **MIC IN** if there is no **LINE IN** provided).
> 3. Place your radio microphone on the computer speaker (or taped up tightly against headphones connected to the computer sound output), and set the radio to transmit in **VOX** mode on USB.
> 4. Set your computer clock accurately to UTC.
> 5. Follow the steps on this page to properly choose the settings for JT65 mode when you run *WSJT*.

The MFJ-9406 does not have a headphone jack, though. So, I placed a free-standing microphone (an Insignia) close to the radio's speaker and held the radio microphone next to the laptop speaker. The room needed to be quiet, so external noise did not hinder receiving decodes or transmit extraneous noise. Another consideration was the MFJ's lack of a digital frequency readout. It has an analog dial that is not very precise. I located 50.313 MHz during a strong $E_s$ opening, when there were audible FT8 tones. I then marked the dial with a pencil mark to return to it. I use the fine tune on the radio to center the FT8 passband.

### Surprise Winter 6-Meter Opening

After a lackluster December for sporadic E on 6 meters, an amazing DX opening took place from North America to Australia on January 2, 2019 (see Figure 1). Six meters opened for sporadic E around 1600Z across North America. Unlike many winter sporadic-E openings that are short and limited in scope, this opening grew larger and stronger.

Numerous double-hop sporadic-E contacts were reported between the west and east coast. At 1913Z, Chip, K7JA (DM03), worked W4IMD (EM84) on double hop. In Australia and New Zealand, strong seasonal summer sporadic-E openings were taking place. N0LL (EM09) was working stations in Arizona and California.

Around 2330Z, $E_s$ links to afternoon trans-equatorial propagation across the geomagnetic equator set up an opening between North America and Australia. VK3OT, VK3DUT, VK4MA, and others appeared suddenly on the JT65 and FT8 modes in North America on 50 MHz. VK4MA worked as far east as Illinois (KA9CFD) on FT8. Jay, KA9CFD, said his only Australian contact was with VK4MA at 2345Z.

The Australian stations were spotted into North America for over 2 hours. K7JA said VK5SIX decoded him, which was the first VK5 reception since 1989! The Australians that had the best success working North

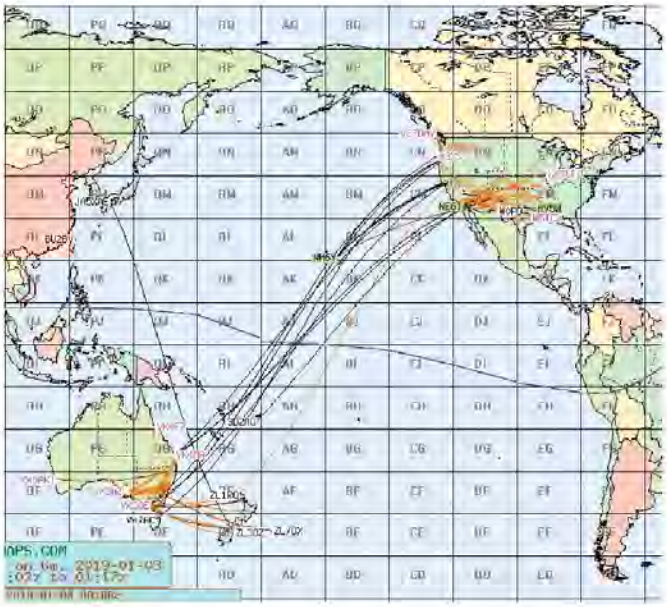


**Figure 1** — The 6-meter opening between North America and Australia/New Zealand that took place on January 2, 2019. [**dxmaps.com**]

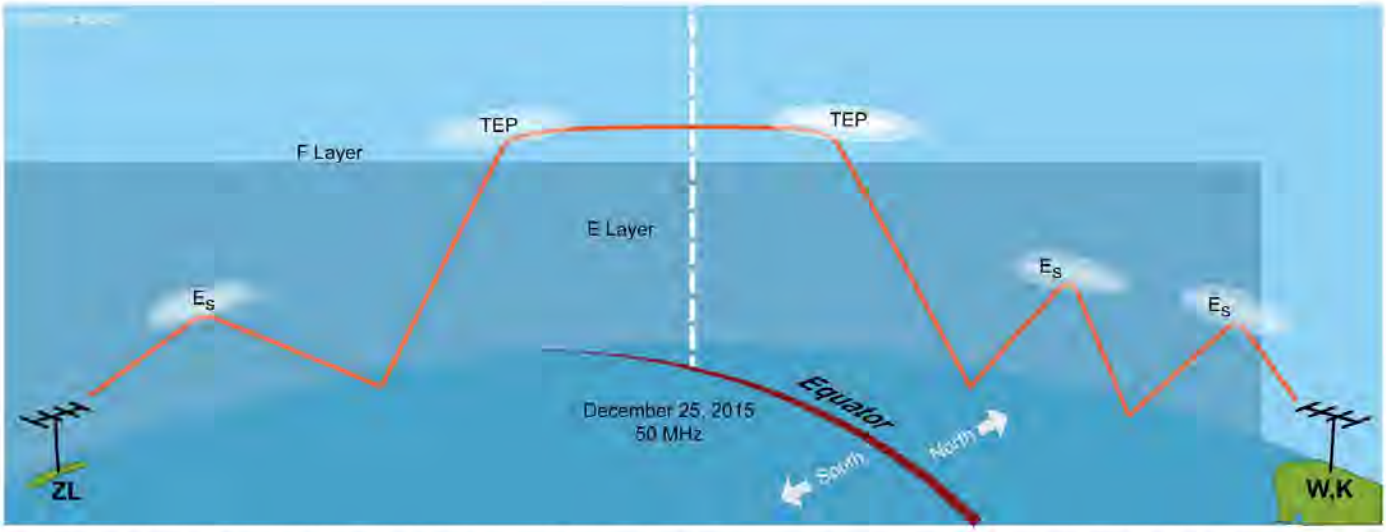



**Figure 2** — The incredible propagation that filled logs in December 2015 was probably the result of double-hop $E_s$ on the American side that coupled to TEP at the equator, which, in turn, coupled to single-hop $E_s$ on the New Zealand side of the path and double-hop $E_s$ to Australia.

America were using FT8. Quite a few VK and ZL stations still use JT65 for terrestrial sporadic E, despite FT8 being more successful with its 15-second sequences.

Sporadic E also occurred over the more northern Pacific Ocean. This part of the opening was new and different than past ones. N0LL worked NH6Y (BL10) on FT8 around 0100Z. I copied one decode on NH6Y on FT8. The Hawaiian stations made contacts as far east as Florida. K7SMA in DN13 worked NH6Y using just a halo antenna! WA6OSX reported working VK6ZK at 0105Z on January 3. From Maui, Tom Worthington, NH6Y, noted:

> On January 3, 2018 at 0048 UTC, the band opened from Hawaii to the mainland. I ended up with 103 FT8 contacts in my log in the next 3 hours, when the band again got quiet. Most were west coast, but some were as far east as Florida, Texas, and Kansas. I also logged six VK stations toward the end. I saw two other Hawaii stations making contacts: Doug, KH6U, and Gus, K2GT/KH6. The last station I worked was VK6AKT in OF78. That's the far southwest of Australia, almost 7,000 miles away.

The 6-meter openings from North America to VK/ZL have taken place in past years, almost always between Christmas and New Year's. One of the best was on December 26, 2015 (see Figure 2). The solar flux was 133 then, thus the maximum usable frequency (MUF) of the TEP portion of the path was much higher. For this opening to occur with a solar flux of only 70 is truly remarkable. The mechanism by which this opening takes place is thought to be single- to double-hop sporadic E, extending northeast from Australia and New Zealand; connecting to trans-equatorial afternoon type-1 propagation, going over the geomagnetic equator, then on to North America via double-hop sporadic E. To learn more about these rare openings, see the "World Above 50 MHz" column in the April 2016 issue of *QST* and Carl Luetzelschwab's, K9LA, June and July 2010 columns in *WorldRadio* magazine.[1, 2]

## On the Bands

**50 MHz**. Overall, December was a bust for WA2GFN and many other stations for sporadic E. A few short openings were reported. On December 2, Dave, N9HF (EL99), worked New England and Canada. K5SW (EM25) logged Arizona and KG7OR worked W7QQ in New Mexico on December 5.

One of the highlights of December was the Geminid meteor shower. I (N0JK) made a dozen MSK144 contacts on December 14. My contact with K0TPP (EM48) was a very short distance for meteor scatter. I decoded K0WDO (EM17) on meteor scatter at only 275 kilometers. N0LL also made many meteor scatter contacts.

On December 29, Lance, W7GJ, worked ZL7DX on EME for his 210th 6-meter DXCC contact. December 28 and 29 sporadic-E finally appeared each evening. On December 29, I (N0JK) logged VE3TLO (FN25) on SSB with just 10 W. WA2GFN (FN20) found a nice catch with K9MU/p in rare grid EN46. The next day, I worked KQ4PK (FM15), also on SSB.

**144 MHz**. Gedas, W8BYA, logged KE7NR (DM54) early on during the Geminds on December 12 at 1507Z. This is almost 2,300 kilometers, which is at the extreme range of meteor scatter contacts. Rick, W0RT (EM27), worked VE3 and W8 on MSK144 during the Geminids on December 14. On January 3, K7JA heard the KH6HME/b on tropo across the Pacific.

**Notes**
[1]**http://n5dux.com/ham/pubs/wro-2010/WRO_06_2010.pdf**, p. 24
[2]**http://n5dux.com/ham/pubs/wro-2010/WRO_07_2010.pdf**, p. 26

# Special Event Stations

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

**Feb. 23, 1600Z – 2000Z, K7T**, Green Valley, AZ. Oro Valley Amateur Radio Club. **Titan Missile Museum 35th Anniversary**. CW: 7.040, 14.040; SSB: 7.200, 14.250; FT8: 14.074, 18.100. Certificate. Email request to **qsl@tucsonhamradio.org**. *Spots:* ***DXSummit.fi****. PDF certificates will be emailed. Please, no paper QSLs.* **www.tucsonhamradio.org**

**Mar. 1 – Mar. 14, 0000Z – 0000Z, W5T**, Cleburne, TX. Club KC5NX. **Battleship *Texas* 105th Birthday**. 14.225 14.045 7.225 7.045. QSL. Club KC5NX, 9200 Summit Ct. W., Cleburne, TX 76033. **club.kc5nx@gmail.com** *or* **www.qrz.com/db/kc5nx**

**Mar. 8 – Mar. 10, 1800Z – 2359Z, K9TAL**, Indianapolis, IN. The American Legion Amateur Radio Club. **100th Birthday Celebration**. 14.275 7.225; *CrossRds* EchoLink Conference; IRLP Reflector 9735. Certificate & QSL. The American Legion National Headquarters, P.O. Box 1055, Attn: TALARC, Indianapolis, IN 46206. **k9tal@legion.org** *or* **www.legion.org/hamradio**

**Mar. 9, 1600Z – 2000Z, K7T**, Sonoita, AZ. Oro Valley Amateur Radio Club. **Commemorating the Empire Ranch**. CW: 7.040, 14.040; SSB: 7.200, 14.250; FT8: 14.074, 18.100. Certificate. Email request to **qsl@tucsonhamradio.org**. *Spots:* ***DXSummit.fi****. Please, no paper QSLs.* **www.tucsonhamradio.org**

**Mar. 9, 1700Z – 2359Z, NI6IW**, San Diego, CA. USS *Midway* (CV-41) Museum Ship. **Launching of USS *Midway***. 14.320 7.250; PSK31 on 14.070. QSL. USS *Midway* (CV-41) COMEDTRA, 910 N. Harbor Dr., San Diego, CA 92101.

**Mar. 9 – Mar. 17, 1300Z – 2100Z, W2B**, Clay, NY. Bear Bait Radio Club. **Winter Field Day**. 14.235 14.070 7.070 3.235. QSL. Bear Bait Radio Club, 4483 Route 31, Clay, NY 13090. **www.bearbaitradioclub.com**

**Mar. 23, 1400Z – 2000Z, W4BKM**, Macon, GA. Macon Amateur Radio Club. **Cherry Blossom Special Event Station**. 14.240 7.225. Certificate. Macon Amateur Radio Club, P.O. Box 4862, Macon, GA 31208. **www.w4bkm.org**

**Mar. 30, 1600Z – 2000Z, W7AI**, Marana, AZ. Oro Valley Amateur Radio Club. **Wings of Freedom**. CW: 7.040, 14.040; SSB: 7.200; 14.250; FT8: 14.074, 18.100. Certificate. Send email to **qsl@tucsonhamradio.org.** *Spots on* ***DXSummit.fi****. Email request for PDF certificate to* ***qsl@tucsonhamradio.org****. Please, no paper QSLs.* **www.tucsonhamradio.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* |
|---|---|---|
| **Atlantic** | | |
| Jobst Vandrey, AC0LP | 320 | 23-Jun-08 |
| James McCloskey, NS3K | 303 | 14-Nov-94 |
| Edward Genoino, WA2NDA | 298 | 10-Jul-85 |
| George Brechmann, N3HBT | 268 | 01-Apr-91 |
| Robert Benna, N3LWP | 230 | 21-May-97 |
| **Central** | | |
| Ed Wagner, AB9FN | 312 | 01-Jul-02 |
| Eldon Boehm, NK9U | 300 | 21-Nov-86 |
| Allan Bukowski, N9ZD | 297 | 01-Jun-92 |
| Donald Hlinsky, N9IZU | 288 | 01-Mar-91 |
| Timothy Pechtold, AA9BV | 267 | 01-Nov-92 |
| **Dakota** | | |
| John Schwarz, Jr., AE0AL | 294 | 26-Oct-94 |
| Jeffrey Goodnuff, W0KF | 281 | 17-Jun-03 |
| Daniel Royer, KE0OR | 227 | 01-Jul-91 |
| Shep Shepardson, N0NMZ | 224 | 12-Mar-01 |
| Dennis Ackerman, KB0OQQ | 218 | 15-Jul-96 |
| **Delta** | | |
| Arthur Parry, Jr., WB4BGX | 261 | 01-May-91 |
| Glenn King, N5GK | 227 | 05-Jun-86 |
| Edward Scheufele, AB5RS | 224 | 19-Jan-94 |
| Roger Gray, N5QS | 221 | 01-Mar-93 |
| Joe Lowenthal, WA4OVO | 213 | 25-May-06 |
| **Great Lakes** | | |
| Charles Hall, W8HF | 270 | 01-Jun-92 |
| David Schmidt, KI4QH | 250 | 15-Feb-85 |
| Dale Pritchett, KC8HJL | 223 | 26-Mar-98 |
| Christian Anderson, K8VJ | 216 | 09-Feb-90 |
| Herbert Blasberg, WA8PBW | 216 | 06-Sep-84 |
| Archie Mack, Sr., AF4EB | 212 | 19-Aug-97 |

| *Examiner* | *Sessions* | *Accreditation Date* |
|---|---|---|
| **Hudson** | | |
| Paul Maytan, AC2T | 619 | 06-Sep-84 |
| E. Drew Moore, W2OU | 428 | 01-Aug-90 |
| Stanley Rothman, WA2NRV | 428 | 01-Mar-85 |
| Gerald Miller, Jr., AA2ZJ | 398 | 05-Dec-95 |
| Fritz Boigris, KB2O | 383 | 26-Oct-84 |
| Sid Markowitz, K2GG | 353 | 27-Sep-94 |
| **Midwest** | | |
| David Bartholomew, AB0TO | 693 | 22-Mar-02 |
| Kevin Naumann, N0WDG | 614 | 17-Nov-02 |
| Harry Steger, Jr., W0HMS | 520 | 26-Aug-08 |
| Roland Kramer, W0RL | 513 | 21-Jun-01 |
| Jeanette Nordman, AB0YX | 459 | 21-Aug-03 |
| **New England** | | |
| Robert Beaudet, W1YRC | 362 | 01-Aug-90 |
| Lawrence Polowy, KU1L | 330 | 02-Jan-85 |
| Bruce Anderson, W1LUS | 325 | 11-Feb-88 |
| Stefan Rodowicz, N1SR | 324 | 20-Nov-84 |
| Paul Lux, K1PL | 322 | 25-Jan-85 |
| **Northwestern** | | |
| Richard Morgan, KD7GIE | 450 | 11-Aug-00 |
| Loren Hole, KK7M | 369 | 06-Sep-84 |
| George Ftikas, N7TQZ | 292 | 01-Dec-92 |
| David Brooks, N7HT | 280 | 10-Jun-87 |
| S. Riley McLean, W7RIL | 270 | 02-Sep-99 |
| **Pacific** | | |
| Morris Jones, AD6ZH | 447 | 27-Nov-01 |
| Dieter Stussy, KD6LVW | 380 | 27-Jan-94 |
| Gordon Fuller, WB6OVH | 322 | 06-Sep-84 |
| Bill Nichols, NN7K | 306 | 01-Sep-93 |
| Jim Brunk, N6BHX | 263 | 13-Jul-95 |

| *Examiner* | *Sessions* | *Accreditation Date* |
|---|---|---|
| **Roanoke** | | |
| Judy Friel, AC4RG | 275 | 01-Feb-91 |
| Alan Ronald Moeck, WA2RPX | 253 | 27-Sep-94 |
| David Snyder, W4SAR | 235 | 01-May-93 |
| Sheila Frank, KT4YW | 220 | 30-Oct-96 |
| Thomas Hill, KJ4IV | 201 | 01-Jun-91 |
| **Rocky Mountain** | | |
| Robert Hamilton, N0RN | 367 | 19-May-87 |
| David Avery, N0HEQ | 286 | 13-Jan-88 |
| Jeffrey Weinberg, W0QO | 277 | 01-Apr-93 |
| Philip O'Kunewick, AB0JR | 273 | 24-Feb-00 |
| Frank Goddard, W0AJY | 267 | 01-Feb-92 |
| **Southeastern** | | |
| Victor Madera, KP4PQ | 448 | 01-Mar-92 |
| Pablo Soto, KP4SJ | 369 | 01-May-92 |
| Val Jacyno, AK4MM | 361 | 08-Nov-11 |
| Robert Cumming, Sr., W2BZY | 332 | 29-Jan-97 |
| Joseph Patti, N4UMB | 313 | 01-Sep-90 |
| **Southwestern** | | |
| Bill Martin, AI0D | 962 | 01-Nov-84 |
| Fred Bollinger, AB7JF | 511 | 17-Apr-95 |
| Steve Gurley, KY7W | 408 | 19-Apr-96 |
| Joseph Cutitta, W0SLL | 396 | 09-Nov-99 |
| David Morrill, N7TWT | 387 | 20-Jul-00 |
| **West Gulf** | | |
| Franz Laugermann, K3FL | 1,014 | 01-Dec-91 |
| Wilbert Cannonier, KK5JJ | 449 | 03-Nov-95 |
| Adolph Chris Koehler, K5VCR | 439 | 29-Sep-95 |
| Gerald Grant, WB5R | 437 | 04-Jan-85 |
| David Fanelli, KB5PGY | 421 | 01-Oct-91 |

# Convention and Hamfest Calendar

**Abbreviations**

*Spr* = Sponsor
*Tl* = Talk-in frequency
*Adm* = Admission

### Alabama (Fort Payne) — Mar. 30
D F R T V
8 AM – 1 PM. *Spr:* Dekalb ARC. Dekalb County VFW Fair Grounds, 151 18th St. NE. *Tl:* 147.27 (100 Hz). *Adm:* $5. **w4gbr.org**.

### Arkansas (Fort Smith) — Apr. 6
D H Q R S T V
8 AM – 3 PM. *Spr:* Fort Smith Area ARC. Sebastian County Emergency Communications and Training Facility, 8400 S. Zero St. Hanging Judge Hamfest. *Tl:* 146.64 (88.5 Hz). *Adm:* $5. **hangingjudgehamfest.com**.

### Colorado (Longmont) — Apr. 6
D F H R S V
8 AM – 2 PM. *Spr:* Longmont ARC. Boulder County Fairgrounds Exhibit Building, 9595 Nelson Rd. *Tl:* 147.27 (100 Hz). *Adm:* $5. **www.w0eno.org**.

### Connecticut (Southington) — Mar. 24
D F H R S V
8 AM – noon. *Spr:* Southington ARA. Southington High School, 720 Pleasant St. *Tl:* 444.25 (77 Hz). *Adm:* $5. **www.chetbacon.com**.

### Florida (Fort Walton Beach) — Mar. 15 – 16 D F H Q R S V
Friday 4 – 8 PM; Saturday 8 AM – 2 PM. *Spr:* Playground ARC. C. H. "Bull" Rigdon Fairgrounds, 1958 Lewis Turner Blvd. *Tl:* 146.79 (100 Hz). *Adm:* $7. **www.w4zbb.org**.

### Florida (New Port Richey) — Mar. 16
F H R T V
7 AM. *Spr:* Gulf Coast ARC. Millennium Academy, 10005 Ridge Rd. *Tl:* 146.67 (146.2 Hz). *Adm:* $5. **gulfcoastarc.org**.

### Florida (Odessa) — Apr. 6 D F H R T V
8 AM – 1 PM. *Spr:* Suncoast ARC. Gunn Hwy Flea Market, 2317 Gunn Hwy. *Tl:* 145.35. *Adm:* $5. **www.sarcfl.org**.

### Florida (Stuart) — Mar. 16 D F H R S T V
8 AM. *Spr:* Martin County ARA. Martin County Fairgrounds, 2616 SE Dixie Hwy. *Tl:* 147.06. *Adm:* Free. **www.stuarthamfest.com**.

### Illinois (Godfrey) — Mar. 23 D F H S V
8 AM – 1 PM. *Spr:* Lewis and Clark Radio Club. The Commons at Lewis and Clark Community College, 5800 Godfrey Rd. *Tl:* 145.23 (79.7 Hz). *Adm:* Advance $4 or $10 for 3, door $5. **k9ham.org**.

### Illinois (Noble) — Apr. 6 D F H S T V
8 AM – noon. *Spr:* Clay County Area ARC. IL Emergency Communications Center, 320 E. North Ave. *Tl:* 146.76 (94.8 Hz). *Adm:* $4, children 12 and under free. **www.facebook.com/AprilFoolsFest/**.

### Illinois (Rock Falls) — Mar. 17 D F H R V
7:30 AM – 2 PM. *Spr:* Sterling-Rock Falls Radio Club. Rock Falls Community Center, 601 W. 10th St. *Tl:* 146.85 (114.8 Hz). *Adm:* Advanced $5, door $7. **www.w9mep.org**.

### Illinois (Sullivan) — Apr. 6 D F V
8 AM – 1 PM. *Spr:* Moultrie Amateur Radio Klub. Sullivan American Legion, 8 E. Strain St. *Tl:* 146.655, 146.055 (162.2 Hz). *Adm:* $5. **www.qsl.net/mark/**.

### Indiana (Columbus) — Apr. 6 F H R T V
8 AM – noon. *Spr:* Columbus ARC. Bartholomew County 4-H Fairgrounds, 750 W. 200 S. 36th Annual Hamfest. *Tl:* 146.79 (103.5 Hz). *Adm:* $5. **carcnet.net**.

### Iowa (Glenwood) — Apr. 6 D H R
7:30 AM – 12:30 PM. *Spr:* Heartland Hams ARC. American Legion Hall, 104 N. Vine St. *Tl:* 145.29. *Adm:* $5. **www.heartlandhams.org**.

## MAINE STATE CONVENTION
**March 29 – 30, Lewiston, ME**
D F H Q R S V
Friday 7 – 9 PM, Saturday 8 AM – noon. *Spr:* Androscoggin ARC. Ramada Convention Center, 490 Pleasant St. *Tl:* 146.61 (88.5 Hz). *Adm:* Advance $8, door $9. **w1npp.org**.

### Maryland (Frederick) — Mar. 16
D F H R T V
8 AM – noon. *Spr:* Frederick ARC. Independent Hose Company, 310 Baughmans Ln. FredFest 2019. *Tl:* 146.58. *Adm:* Free. **frederickarc.org**.

### Massachusetts (Framingham) — Apr. 7
F H R V
9 AM – noon. *Spr:* Framingham ARA. Keefe Regional Technical School, 750 Winter St. *Tl:* 147.15. *Adm:* $5, children under 12 free. **www.w1fy.org**.

### Michigan (Kalamazoo) — Mar. 16
D F H R V
8 AM – noon. *Spr:* Southern Michigan ARS. Wings Event Center, 3600 Vanrick Dr. 2019 Michigan Crossroads Hamfest & Radio Swap. *Tl:* 147.0 (94.8 Hz). *Adm:* $7. **www.w8df.com/hamfest/hamfest2019.pdf**.

### Michigan (Madison Heights) — Apr. 7
D R V
9 AM – 2 PM. *Spr:* General Motors ARC. UFCW 876 Union Hall, 876 Horace Brown Dr. 2nd Annual GMARC Technology Expo. *Tl:* 443.075 (123 Hz). *Adm:* Advanced $5, door $6. **www.gmarc.org**.

### Minnesota (Brainerd) — Apr. 6
D F H R V
9 AM – 1 PM. *Spr:* Brainerd Area ARC. Brainerd National Guard Armory, 1115 Wright St. *Tl:* 147.225. *Adm:* $6. **brainerdham.org**.

### Minnesota (Buffalo) — Mar. 23
D F H Q R V
8 AM – 1 PM. *Spr:* Maple Grove RC. Buffalo Civic Center, 1306 County Rd. 134. *Tl:* 147.0. *Adm:* $10. **www.k0ltc.org**.

## OZARKCON QRP CONFERENCE
**April 5 – 6, Branson, MO**
D F H R S
Friday 4 – 10 PM, Saturday 9 AM – 8 PM. *Spr:* Four States QRP Group. Stone Castle Hotel and Conference Center, 3050 Green Mountain Rd. *Tl:* 146.52. *Adm:* $10. **www.ozarkcon.com/index.php**.

### Missouri (Mt. Vernon) — Mar. 23
D H R S V
8 AM – 1 PM. *Spr:* Ozarks ARS. Mt. Vernon Arts and Recreation Center, 822 W. Mt. Vernon Blvd. *Tl:* 146.97 (162.5 Hz). OARS Springtime Hamfest. *Adm:* Advanced $4, door $5. **w0oar.com**.

### Nebraska (Bellevue) — Apr. 6 D F
9 AM – 1 PM. *Spr:* Bellevue ARC. Masonic Lodge Dinning Hall, 1908 Franklin St. *Tl:* 147.06 (131.8 Hz). *Adm:* $5. **bellevuearc.org**.

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

## 2019 ARRL NATIONAL CONVENTION AT DAYTON HAMVENTION®
**May 17 – 19, Xenia, OH**
D F H Q R S V
Fri. 9 AM – 5 PM, Sat. 9 AM – 5 PM, Sun. 9 AM – 1 PM.
*Spr:* Dayton ARA. Greene County Fairgrounds and Expo Center, 120 Fairgrounds Rd. *Tl:* 146.940 (123 Hz). *Adm:* Advanced $22, door $27. **www.hamvention.org** and **www.arrl.org/expo**.

**New Hampshire (Henniker) — Mar. 17**
D F R S V
8 AM – 2 PM. *Spr:* Contoocook Valley RC. Henniker Middle School, 51 Western Ave. *Tl:* 146.895 (100 Hz). *Adm:* $3. **k1bke.org**.

**New Jersey (Parsippany) — Mar. 16**
D F H R
8 AM – noon. *Spr:* New Jersey Antique RC. Parsippany PAL Building, 33 Baldwin Rd. NJARC Spring Swap Meet. *Tl:* No talk-in. *Adm:* $5. **www.njarc.org**.

**Ohio (Gallipolis) — Mar. 16** D F H R T V
8 AM. *Spr:* Mid-Ohio Valley ARC. Gallia County Senior Citizens Center, 1165 State Rte. 160. *Tl:* 147.06 (74.4 Hz). *Adm:* $5.

**Ohio (Perrysburg) — Mar. 17** D H R S V
8 AM – 2 PM. *Spr:* Toledo Mobile Radio Assn. Owens Community College, 30335 Oregon Rd. Hamfest and Computer Fair. *Tl:* 147.27 (103.5 Hz). *Adm:* $8. **www.tmrahamradio.org**.

**Pennsylvania (Boston) — Apr. 7**
D F H Q R S V
8 AM – 2 PM. *Spr:* Two Rivers ARC. The Boston Spectrum, 6001 Smithfield St. 48th Annual Hamfest. *Tl:* 146.73. *Adm:* Advanced $5, door $7. **www.trarc.net**.

## DELTA DIVISION CONVENTION
**March 30, Sevierville, TN**
D F H Q R S T V
8 AM – 3 PM. *Spr:* Sevier County ARS. Sevier County Fairgrounds, 754 Old Knoxville Hwy. Sevier County Hamfest. *Tl:* 146.940 (118.8 Hz). *Adm:* $5. **seviercountyars.org**.

**Tennessee (Union City) — Mar. 23**
D F H Q R S T V
8 AM – 1 PM. *Spr:* Reelfoot ARC. National Guard Armory, 2017 E. Reelfoot Ave. Ides of March Hamfest. *Tl:* 146.7 (100 Hz). *Adm:* $8. **reelfootarc.com**.

**Texas (Belton) — Apr. 6** D F H R T V
7 AM – noon. *Spr:* Temple ARC. Bell County Expo Center, 301 W. Loop 121. Ham EXPO Spring 2019. *Tl:* 146.820 (123 Hz). *Adm:* $5. **tarc.org/hamexpo/**.

## WEST TEXAS SECTION CONVENTION
**March 16, Midland, TX**
D F H Q R S V
8 AM – 4 PM. *Spr:* Midland ARC. MLK Community Center, 2300 Butternut Ln. St. Patrick's Day Hamfest. *Tl:* 147.3 (88.5 Hz). *Adm:* Advance $10, door $12. **hamfest.w5qgg.org**.

## SOUTH TEXAS SECTION CONVENTION
**March 22 – 23, Rosenberg, TX**
D F H Q R S T V
Friday 3 – 8 PM, Saturday 6 AM – 4 PM. *Spr:* Brazos Valley ARC. Fort Bend County Fairgrounds, 4310 Hwy. 36. Greater Houston Hamfest. *Tl:* 146.94 (167.9 Hz). *Adm:* Advance $8, door $10. **houstonhamfest.org**.

**Virginia (Annandale) — Mar. 24**
D F H Q R T V
8 AM – 1 PM. *Spr:* Vienna Wireless Society. Northern Virginia Community College, Annandale Campus, Richard J. Ernst Community Cultural Center, 8333 Little River Turnpike. 43rd Annual Winterfest. *Tl:* 146.91. *Adm:* $10. **viennawireless.net/wp/events/winterfest**.

## MICROHAMS DIGITAL CONFERENCE
**March 23, Redmond, WA**
H R S
8 AM – 5 PM. *Spr:* MicroHAMS ARC. Microsoft Campus, Building 35, 3940 159th Ave. NE. Demonstration area. *Tl:* 146.58. *Adm:* Advance $30, door $35. **microhams.com/mhdc**.

## WEST VIRGINIA SECTION CONVENTION
**March 23, Charleston, WV**
D H Q R S V
9 AM – 2 PM. *Spr:* Charleston Hamfest Committee. Charleston Civic Center, 200 Civic Center Dr. Charleston WV Hamfest and Computer Show. *Tl:* 145.35 (91.5 Hz). *Adm:* $7. **www.w8gk.org**.

**Wisconsin (Jefferson) — Mar. 17**
D H R V
8 AM – noon. *Spr:* Tri-County ARC. Jefferson County Fairgrounds Activity Center, 503 N. Jackson Ave. *Tl:* 145.49 (123 Hz). *Adm:* $7. **www.w9mqb.com**.

**Wisconsin (Milwaukee) — Mar. 23**
F H R
8 AM – noon. *Sprs:* Milwaukee RAC, Milwaukee Area ARS. Elks Lodge #46, 5555 W. Good Hope Rd. *Tl:* 145.13 (127.3 Hz). *Adm:* Advance $4, door $5. **www.w9rh.org/club-events/swapfest**.

### 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 **March 1** to be listed in the **May** 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**.

## March 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.

March Qualifying Runs will be transmitted by W1AW in Newington, Connecticut at 10 PM EST on Friday, March 1 (0300 UTC on March 2) and at 7 PM EDT on Wednesday, March 13 (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, March 23 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.

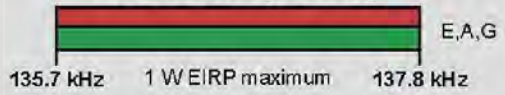
# US Amateur Radio Bands

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

ARRL The national association for AMATEUR RADIO®

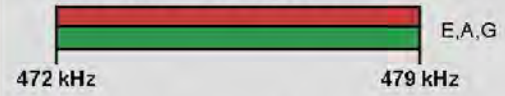
Amateurs wishing to operate on either 2,200 or 630 meters must first register with the Utilities Technology Council online at **https://utc.org/plc-database-amateur-notification-process/.** You need only register once for each band.

## 2,200 Meters (135 kHz)




## 630 Meters (472 kHz)

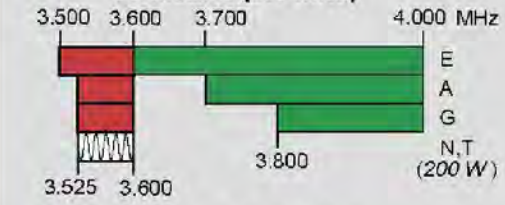
5 W EIRP maximum, except in Alaska within 496 miles of Russia where the power limit is 1 W EIRP.




## 160 Meters (1.8 MHz)

Avoid interference to radiolocation operations from 1.900 to 2.000 MHz

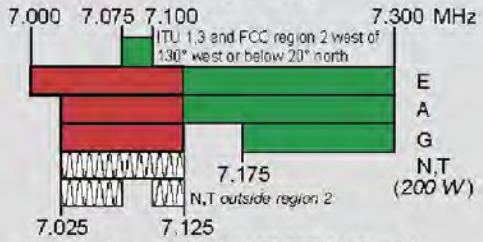
## 80 Meters (3.5 MHz)




## 60 Meters (5.3 MHz)

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

## 40 Meters (7 MHz)

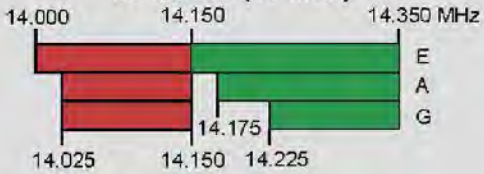



See Sections 97.305(c), 97.307(f)(11) and 97.301(e). These exemptions do not apply to stations in the continental US.

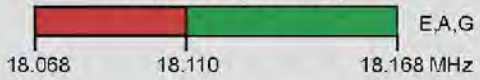
## 30 Meters (10.1 MHz)

Avoid interference to fixed services outside the US.

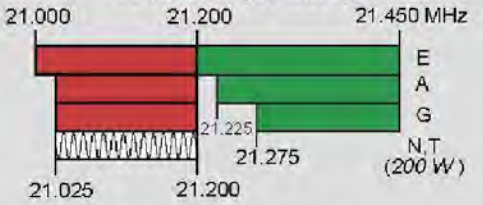
## 20 Meters (14 MHz)



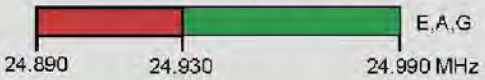

## 17 Meters (18 MHz)



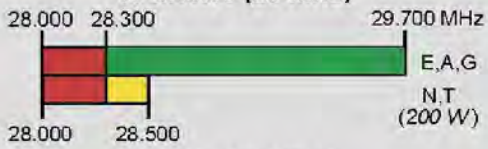

## 15 Meters (21 MHz)




## 12 Meters (24 MHz)

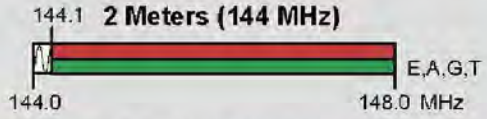



## 10 Meters (28 MHz)

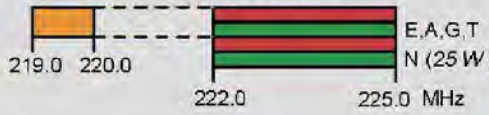



## 6 Meters (50 MHz)

## 2 Meters (144 MHz)

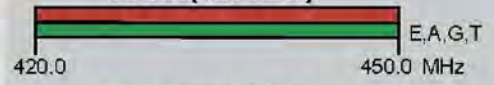



## 1.25 Meters (222 MHz)

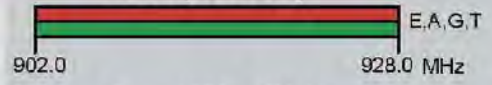



*Geographical and power restrictions may apply to all bands above 420 MHz. See *The ARRL Operating Manual* for information about your area.

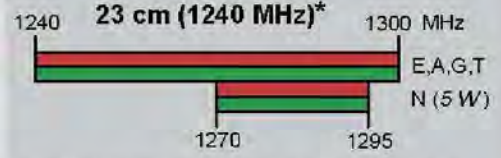
## 70 cm (420 MHz)*




## 33 cm (902 MHz)*




## 23 cm (1240 MHz)*




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

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

‡ No pulse emissions

## KEY

***Note:***

CW operation is permitted throughout all amateur bands.

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

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

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

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

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

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Al Brogdon, W1AB

# 75, 50, and 25 Years Ago

## March 1944

- The cover photo shows W1FWH using his Simple Signal Tracer to check out a piece of equipment.
- The editorial discusses the difference between censorship and prudence in publishing controversial topics during wartime, encouraging constructive discussion among hams.
- In "A Walking WERS Station," Hollis French, W1JLK, describes his chest-pack 112-Mc. transmitter-receiver.
- Clinton B. DeSoto, W1CBD, continues a history of the AACS, in Part 2 of "The Army Airways Communications System," this time elaborating on how AACS developed in 1941 as a preparation for war.
- Walter Bradley, W1FWH, gives us "A Simple Signal Tracer" for receiver testing.
- In "Towers that Never Tire," Robert Donaldson, W8WJF, discusses using old windmill towers as antenna supports.
- Sgt. William Wildenhein of the Army Air Corps announces the discovery of "The New Contrapolar Frequency Spectrum," which may overcome the frequency shortage.

## March 1969

- The cover photo shows the "Airstream Loop" used by W1DBM with his camper.
- The editorial revisits the origins of "The Wouff Hong," a symbol as integral to ham radio as the ARRL diamond.
- George Schleicher, W9NLT, discusses "Phone Patching — Legitimately" following a January 1969 tariff by the Bell System that permitted interconnection with privately owned facilities.
- Wilson Doty, WA4DID, describes "A C.W. Filter for the Collins 75S-1 Receiver," a homebrew solution to a costly mechanical filter.
- "Integrated Circuits in the Keyboard Code Machine," by W. T. Wiederhold, W5OGZ, talks about semiconductor shift registers for the W2QYW keyer.
- "A Band-Spotter and W1AW Marker," by Lewis McCoy, W1ICP, helps us find the band edges accurately.
- The roving Phil Rand, W1DBM, writes about his "Antennas for Travel Trailers and Campers," including his Airstream Loop for use in National Parks.

## March 1994

- The cover photo shows two hand-held transceivers, comparing the influence of cellular radio technology.
- The editorial discusses frequency coordination of repeaters on VHF and UHF.
- Richard Baldwin, W1RU (President, International Amateur Radio Union), reports on "Amateur Radio Direction Finding in China," after the first IARU Region 3 ARDF Championships were held near the Great Wall in October 1993.
- Andy Pfeiffer, K1KLO, discusses "The Pfeiffer Quad Antenna System," a shrunk-down design that wouldn't be blown away by hurricane winds.
- In "On Center-Fed Multiband Dipoles," by John Belrose, VE2CV, and Peter Bouliane, VE3KLO, we learn about radiation patterns for varied horizontal and drooping configurations.
- Norman Stone, WG1C, discusses the benefits of "Cellular Radio and the Modern Amateur," given the lower costs and increased accessibility, encouraging hams to embrace the new technology.

# Field Organization Reports

**December 2018**

## 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**.

771
WA7PTM

420
W0KCF

415
KD8TTE

406
WB7OSC

334
W7PAT

309
WM2C

295
WA3EZN

290
N8SY
KB2RTZ

280
KW9EMG

265
KK4PUX

250
KI6LNB

245
AL0Y

233
KK7TN

223
WA2CCN

220
KT2D
W0DSF

215
W0PZD

213
KV4LY

210
K7WXW

207
KD2LPM

205
WS6P

200
K2RMF
WC9CW

190
K9NYS

185
N2LJM

181
W3GWM

180
K0IBS
KC1CIC

160
WB9QPM
WM3G

159
WB8RCR

155
WD8MWD

150
K8LPC
K3LJ
K8RDN

147
WA2BSS

145
W2PH

141
W8IM

142
W3CB

140
AG9G
K9LGU
N2WGF
W5DY
W0LAW
WB3FTQ
KK3F
WB6OTS
WO2H
W4DNA

138
KB3KYH

135
WB9WKO
AD3J
W3YVQ

130
NA7G
N2JBA
K4IWW
WD8USA
KW1U

128
KB1TCE

126
KE5HYW

125
KE5YTA
K2TV
KC8WH
WB4ZIQ

122
KE8CYC

121
KE8BYC

120
WA4VGZ
W4CMH
KI0JO
AC0KQ
KD8UUB
WB8YYS
KY2D
AA7BM
WK4WC

115
N8CJS
K0PTK
K8ED
N1TF

114
N7IE

110
WC4FSU
WA3QLW
KA5AZK
KF5IOU
KC5OZT
WB8YLO
KB8LKH
W1KX
KA2ZNZ
KD2IWN
K6HTN
KO4OL
K3IN
K1HEJ
WB8TQZ
N1IQI
W1RVY
KD2JKV

108
KD2MEN
N3KRX

106
AC8NP
KI4UDZ

104
KE4AHC

103
NI2W

102
W2CTG
KC4BQK
N3SW

100
ND0CW
W4NWT
NN7H
KN9P
N9VC
NX9K
WB4RJW
KZ8Q
KD2MDV
KB8MAF
K3RC
AC8RV
WB8QLT
KB2YAA
AA3SB
W4TTO
KB1NAL
K0VTT
N1LAH

99
K6JGL

97
W8CPG

95
N2PQJ
AA3N
N5MKY

94
W7PHX

92
KA1G
W4NHO
KW4GU

91
N2DW

90
KM4VTK
KM4WHO
KD4EAQ
K8KRA
WD8Q
KA2GQQ
N2TSO
WD0BFO
WB8WKQ
WB0B

89
KC5ZGG
KB1NMO

88
AD5CQ

87
N3RB
WA1LPM

86
KA8ZGY
KG5NNA
K3YAK

85
K1XFC
WS4P

84
KF4DVF
K6JT

82
KB3YRU
KA5DON

81
KB3IN
W5XX

80
W9NXM
AA4XZ
KB2QO
KF7GC
AF4NC
KC1HHO
KT4WX

78
N3JUY
K8AMH

77
KA2HZP

76
KL7RF
KB5PGY
KD8ZCM

75
W2PAX
KN4AAG
KC8YVF

74
N3JET
KC7ASA

73
KA0DBK

71
K6RAU
WD8DHC
K3MIY
KT5SR

70
WK2RP
WA0UIG

The following stations qualified for PSHR in previous months but were not reported in this column: (Nov.) KB2RTZ 330, N1LL 140, KA9QWC 120, K9DUR 104, W9EEU 104, W9BGJ 98, AB9ZA 94. (Oct.) W2PAX 74.

## Section Traffic Manager Reports

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

## Section Emergency Coordinator Reports

The following Section Emergency Coordinators reported: AL, AR, AZ, CT, DE, ENY, EWA, GA, IA, ID, IL, IN, KY, LA, MDC, ME, MI, MN, MO, MS, ND, NFL, NM, NLI, NNJ, NNY, OH, OR, PAC, PR, SFL, SNJ, SJV, STX, SV, TN, VA, 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.

KK3F 2908, WS6P 1070, WB9WKO 989, N1IQI 882, K6HTN 815, NX9K 803, KI0JO 583.

The following station qualified for BPL in November 2018, but was not reported in this column: NX9K 866.

# Silent Keys

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

| | | |
|---|---|---|
| • KA1AN | **Davis**, Richard H., Wethersfield, CT |
| ♦KA1BLL | **Painter**, Stanley "Mickey," Winthrop, ME |
| N1IFE | **Thornton**, Ronald M., Spearfish, SD |
| ♦K1FK | **Bowker**, David W., Fort Kent, ME |
| WA1GCT | **Perry**, Roger L., Telephone, TX |
| N1MWJ | **Rud**, Ellis A., New Ashford, MA |
| KB1NGQ | **Long**, Thomas R., Waterbury Center, VT |
| W1NRZ | **Le Blanc**, Paul A., Gainesville, FL |
| • KB1OAW | **Noyes**, Gregory, Stoughton, MA |
| ♦WA1QJB | **Glassbrook**, Robert C., Jr., Bowdoin, ME |
| WN1OTV | **Benson**, Donald A., Millinocket, ME |
| ♦K1RQZ | **Simpson**, Richard D., Glendale, CA |
| W1SEP | **Lefebvre**, Joseph G., Tewksbury, MA |
| N1SWE | **Lisby**, Alfred L., Ramona, CA |
| W1VSX | **Turney**, Malcomb E. "Bud," Bradenton, FL |
| ♦W1VVX | **Blanchard**, Richard O., II, Concord, NH |
| KA1YDN | **Staines**, Kevin L., Jefferson, NH |
| N1ZZO | **Kelly**, George L., Scituate, MA |
| KA2ACV | **Schleiff**, Thomas L., Fort Smith, AR |
| N2JD | **D'Onofrio**, Joseph V., Wayne, NJ |
| W2JNW | **Katz**, Arthur J., Peoria, IL |
| N2NS | **Hervatine**, Bob, Prather, CA |
| W2NYX | **Katonah**, John H., Walden, NY |
| ♦AF2S | **Lipsky**, William M., Baldwin, NY |
| ♦WB2SLQ | **Supliski**, Otto J., Yonkers, NY |
| KA2SZV | **Webber**, Philip A., Medford, NJ |
| • KC2UJJ | **Bridge**, Thomas R., Buffalo, NY |
| • WB2UVU | **Kaltenbach**, Kenneth F., Paramus, NJ |
| WA2YYX | **Gartenberg**, Marty, Staten Island, NY |
| ♦N3ATV | **Brown**, William "Tenney," Catonsville, MD |
| K3BCV | **Royer**, Charles E., Allentown, PA |
| W3CAU | **Higgins**, Charles A., West Chester, PA |
| WB3EKO | **Bowden**, John "Brad," Aliquippa, PA |
| N3ESY | **Hackman**, Elmer E., "Bus," III, Hockessin, DE |
| KB3GCQ | **Arbeider**, Adriaan A., Germania, PA |
| AA3GZ | **Seitner**, Jack E., Doylestown, PA |
| • AA3HG | **French**, Anne A., Bethlehem, PA |
| • K3JLG | **Francis**, Bruce, Waynesboro, PA |
| K3KCN | **Oldroyd**, Rexford H., Millerton, PA |
| KC3LZ | **Fisher**, Donald M., Leeper, PA |
| K3OTV | **Shooster**, David H., Media, PA |
| WA3UYJ | **Pione**, Albert R., Wilmington, DE |
| KA3VFW | **Stimmel**, William S., III, Stahlstown, PA |
| N3YKF | **McSweyn**, Norman J., Binghamton, NY |
| W3ZMC | **Makarauskas**, Robert V. "Mack," Jr., McKinney, TX |
| KI4BTX | **Johnson**, Henry A., Maylene, AL |
| KF4OGH | **Daniel**, David T., Tallula, IL |
| KJ4CIA | **Armstrong**, Neil A., Port Orange, FL |
| AA4CX | **Milledge**, Robert D., Stone Mountain, GA |
| KG4DKY | **Helton**, Lawrence "Steve," Jacksonville, FL |
| WA4IMR | **Herring**, Bernard G., Sr., Dothan, AL |
| KG4IUO | **Adams**, John G., Stevenson, AL |
| ♦• W4JAN | **Bridge**, Jan Edward, Alexandria, VA |
| W4JDI | **Sorkin**, Robert D., Saint Augustine, FL |
| AC4KA | **Wonson**, Richard E., Milton, FL |
| • W4KUZ | **Booth**, Wendell, Beattyville, KY |
| W4LHR | **Gibson**, Marion, Huntsville, AL |
| WB4OGP | **Nichols**, Harold L., Jr., Arnold, MD |
| W4PRF | **Black**, David DeLisle, Jr., Montgomery, AL |
| ♦W4RFZ | **Barnett**, Lloyd K., Decatur, AL |
| KG4RNA | **Crosby**, Kevin J., Gainesville, FL |
| ♦W4RPI | **Potter**, David W., Roanoke, VA |
| • KC4SZE | **Helton**, Kenneth A., Cullman, AL |
| ♦N4TM | **Siler**, Timothy A., Florala, AL |
| KE4UGF | **Clemens**, Donald F., Floyd, VA |
| KJ4WJ | **Keck**, Bert M., Greenwood, SC |
| W4WCC | **Hopson**, Jeffery K., Greeneville, TN |
| ♦W4WXZ | **Brydges**, Charles H., Advance, NC |
| • AG4XY | **Crabtree**, Ralph A., Monticello, KY |
| KT4Z | **Blevins**, Richard D., Pulaski, VA |
| K4ZH | **Goetz**, Nathan L., Naples, FL |
| KJ4ZM | **Bridges**, Sam, Chester, SC |
| W4ZPQ | **Wurfel**, Walter W., Falls Church, VA |
| • N5AGD | **Bresson**, Clarence "Dick," Bartlesville, OK |
| ♦WB5CMN | **Burke**, Jack J., Colleyville, TX |
| W5DEA | **Manena**, Joseph L., Lake Charles, LA |
| WA5DKD | **Shrewsbury**, John W., Amarillo, TX |
| ♦• WD5GBL | **Jenkins**, James "Bob," Westwego, LA |
| • WD5GZU | **Boehly**, Frank X., San Antonio, TX |
| • KA5HUF | **Raborn**, Robert L., Baton Rouge, LA |
| KE5HWW | **Hull**, Mitchell A., Tulsa, OK |
| W5IAA | **Raymond**, Michael L., Jr., Patterson, LA |
| W5JGC | **Buchanan**, James S., Oklahoma City, OK |
| KF5JTB | **Belk**, James Wesley, Baytown, TX |
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| • W5PYU | **Hughes**, William E., Grapevine, TX |
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| K5UOR | **Crain**, Hubert "Stan," China Spring, TX |
| KE5UWD | **Rector**, Jeffrey M., Altus, OK |
| WB5YKR | **Marr**, Robert J., Vicksburg, MS |
| W5YKU | **Welch**, Herbert, Richardson, TX |
| K5ZSA | **Perry**, Bob R., Austin, TX |
| KG6AEB | **Mergogey**, William "Tom," Pittsburg, CA |
| • K6AEZ | **Doctorman**, Bill L., Camarillo, CA |
| KI6GPP | **Mickelberry**, Michael E., Rio Vista, CA |
| KD6IBM | **Meyer**, James A., Redlands, CA |
| WA6INY | **Misenhimer**, John R., Glendora, CA |
| KW6JIM | **Armstrong**, Jim, Eureka, CA |
| N6MTS | **Hunt**, Ronald W., Clovis, CA |
| K6NE | **Krigbaum**, Joe A., Ventura, CA |
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| AA7H | **Frese**, George M., Wenatchee, WA |
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| ♦G3YRQ | **Parkinson**, Ian Joseph, Fearnhead, Warrington, Great Britain |

The February 2019 column listed an incorrect address for Donald V. Evans, KA4IMX. It should have been Newport News, VA.

♦ Life Member, ARRL

• Former call sign

For information on how to list a Silent Key in *QST*, please visit **www.arrl.org/silent-key-submission-guidelines**.

Note: Silent Key reports must confirm the death by one of the following means: a copy of a newspaper obituary notice, a copy of the death certificate, or a letter from the family lawyer or the executor. Please be sure to include the amateur's name, address, and call sign. Allow several months for the listing to appear in this column.

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

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### FTDX5000MP Limited | *200W HF + 6M Xcvr*

• Internal Power Supply • Two Totally Independent Receivers • 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 • Snap-shot 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

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

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

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### IC-9100 | *The All-Round Transceiver*

• HF/50MHz 144/43vvv0 (440) MHz and 1200MHz*[1] coverage • 100W on HF/50/144MHz, 75W on 430 (440) MHz, 10W on 1200MHz*[1] • Double superheterodyne with image rejection mixer

### IC-7851 | *HF/50MHz Transceiver*

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

### IC-7700 | *HF/50MHz Transceiver*

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

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

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

### IC-7300 | *HF/50MHz Transceiver*

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

### IC-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-7100 | *All Mode Transceiver*

• HF/50/144/430/440 MHz Multi-band, Multi-mode, IF DSP • D-STAR DV Mode (Digital Voice + Data) • Intuitive Touch Screen Interface • Built-in RTTY Functions

### IC-718 | *HF Transceiver*

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

### IC-2300H | *VHF FM Transceiver*

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

### IC-2730A | *VHF/UHF Dual Band Transceiver*

• VHF/VHF, UHF/UHF simultaneous receive • 50 watts of output on VHF and UHF • Optional VS-3 Bluetooth® headset • Easy-to-See large white backlight LCD • Controller attachment to the main Unit

### IC-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

### ID-5100A Deluxe

*VHF/UHF Dual Band Digital Transceiver*

• Analog FM/D-Star DV Mode • SD Card Slot for Voice & Data Storage • 50W Output on VHF/UHF Bands • Integrated GPS Receiver • AM Airband Dualwatch

### ID-4100A | *VHF/UHF Dual Band Digital Xcvr*

• Compact, Detachable Controller for Flexible Installation • DV/FM Near Repeater Search Function • Apps for iOS™ and Android™ devices • Wireless Operation with VS-3 & UT-137 Bluetooth® Headset & Module • MicroSD Card Slot

### IC-R30 | *Digital/Analog Wideband Xcvr*

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

### ID-51A PLUS2

*VHF/UHF D-STAR Portable*

• RS-MS1A, free download Android™ application • New modes for extended D-STAR coverage • Terminal Mode & Access Point Mode allow D-STAR operation through Internet • DV & FM repeater search function • Dplus reflector link commands

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### TS-990S | *200W HF + 6M Transceiver*

• World's first dual TFT display • 200W output on all bands • ±0.1ppm TCXO ensures both high stability and reduced power consumption • Triple 32-bit DSP's dedicated to main/sub receivers and band scope • Main receiver employs full down conversion, new mixer & narrow band roofing filters • Third order intercept point (IP3) +40dBm for highest level of RX performance ( main receiver)

**Call For Special Price!**

### TS-890S | *HF/50MHz Transceiver*

• Receive performance on a whole other level from narrow bandwidth roofing filters that only full down conversion can provide • CW Morse code decode/encode possible with stand-alone unit • 150dB Blocking dynamic range (BDR) • Expanded touch operation scope • Kenwood Sky Command® II Support • Remote operation achieved without host PC Direct remote-control function (KNS)

### TS-590SG | *HF/50MHz Transceiver*

• Equipped with 500 Hz/2.7 kHz roofing filter as standard • ALC derived from TS-990S eliminating spike issues • Antenna output function (shared with DRV connector) • CW - morse code decoder function • Improved 1st mixer • New PFB key with multi-function knob • New split function enabling quick setting • LED backlight with selectable color tone

### TM-D710G | *2M/440 Dualband*

• V+V/V+U/U+U operation • Built-in GPS • Built-in TNC for APRS & DX-Cluster operation • 50W 2M & UHF • 1,000 memories • Dual receive • Green or amber backlight colors • Latest APRS firmware w/new features • Sky Command II remote functions

**Call For Special Price!**

### TM-V71A | *2M/440 DualBand*

• High RF output (50W) • Multiple Scan • Dual receive on same band (VxV, UxU) • Echolink® memory (auto dialer) • Echolink® Sysop mode for node terminal ops • Invertible front panel • Choice of green/amber for LCD panel • 104 code digital code squelch • "Five in One" programmable memory • 1000 multifunction memory

**Call Now For Your Low Price!**

### TM-281A | *2 Mtr Mobile*

• 65 Watt • 200 Memories • CTCSS/DCS • Mil-Std specs • Hi-quality audio

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### TS-480SAT/HX | *HF + 6M Transceiver*

• 480HX 200W HF & 100W 6M (no tuner) • 480SAT 100W HF & 6M w/AT • Remotable w/front panel/speaker • DSP built-in

**Call Now For Low Price!**

### TH-D72A

*2M/440 HT w/extended RX*

• 5W TX, RX 118-524 MHz, VxU, VxV, UxU • APRS w/built-in 1200/9600 TNC • Built-in GPS, Built-in USB, digipeater • Echolink® compatible, • Mil-Spec STD810

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### TH-D74A

*2M/220/440 HT w/D-STAR!*

• D-STAR compatible • APRS ready w/built in GPS • Color weather station information • Built-in KISS mode TNC • High-performance DSP voice processing • Standard compatibility for Bluetooth

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### TH-K20A | *2M Handheld*

• 2M 5.5W • VOX • CTCSS/DCS/1750 Burst built-in • Weather alert

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**218XATC-PL-(length) RG8x (240UF) w/PL259 Connectors Each End. Weather-Proof Heat Shrink Tubing.**

- Stranded Center Conductor.
- 95% TC Braid + bonded 100% Foil Shield.
- Very Flexible, Light Weight, and Smaller than RG8 sizes.
- Non-Contaminating-UV Resistant-Direct Burial-Black Jacket.

**233/2-G4-(length).**

- Unique design **(Nickel Grommets 4" Spacing)** allows for easy attachment to a vehicle's body or truck bed to create a "ground-plane".
- Good option as a "buss-bar" in the shack.
- ½" wide tinned copper 38x48x8/384 10ga 53 Amps.
- Stocked in 1.5', 3', 5', and 10' foot lengths.

### The SDRplay RSP FAMILY

**THE WORLD'S FAVORITE SDR RECEIVERS**

- Continuous SDR coverage from 1kHz to 2GHz (NO GAPS!)
- Now includes the new RSPduo 14-bit Dual-Tuner SDR
- RSPduo can simultaneously receive on 2 totally independent 2MHz spectrum windows, anywhere between 1kHz & 2GHz
- All RSPs can receive, monitor and record up to 10MHz spectrum at a time
- Visualise all the signals in multiple bands simultaneously
- S/W pre-sets for all the bands from the new LF2200m to 23cm
- Excellent dynamic range for challenging reception conditions
- Built-in High performance Front-end Filters
- Use as a stand-alone general coverage receiver, or as a high resolution Panadapter
- SDRuno Windows SDR software provided free-of-charge
- Also works with other platforms and popular SDR Software
- The perfect gift for newcomers & returners to the radio hobby
- Calibrated S meter/RF power & SNR measurement with SDRuno
- Only needs a computer and an antenna
- Backed by the biggest and best SDR support community

US TOWER

### MA-40

• 40' Tubular Tower

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### MA-550

• 55' Tubular Tower • Handles 10 sq. ft. at 50 mph • Pleases neighbors with tubular streamlined look

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**Big Sale on all Towers!**

### TX-455

• 55' freestanding crank-up • Handles 18 sq. ft. @ 50 mph • No guying required • Extra-strength construction • Can add raising and motor drive accessory • Towers rated to EIA specifications • Other models available at great prices!

ZUMspot-kit

ZUMRadio

**ZUMspot is an advanced radio module kit. When paired with a Raspberry Pi and the MMDVM software it becomes a small and efficient multi-mode digital hotspot.**

- Supports D-STAR, DMR, System Fusion, P-25 and NXDN
- Open source software (MMDVM) and hardware design
- Onboard LEDs to show status (Tx, Rx, Mode)
- 1.3 inch OLED screen
- Mounts cleanly on all current Raspberry Pi's including Pi Zero

**The ZUMspot Kit Package Includes:**

- ZUMspot RPi UHF board and antenna fully assembled and tested
- Pi Zero WH (Wireless With Header Installed)
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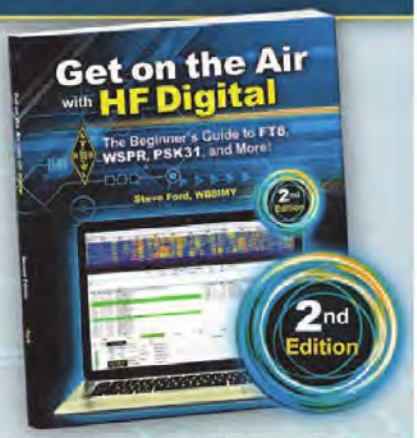


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**by Steve Ford, WB8IMY**

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As of Jan. 2019 this device has not been approved by the Federal Communications Commission.
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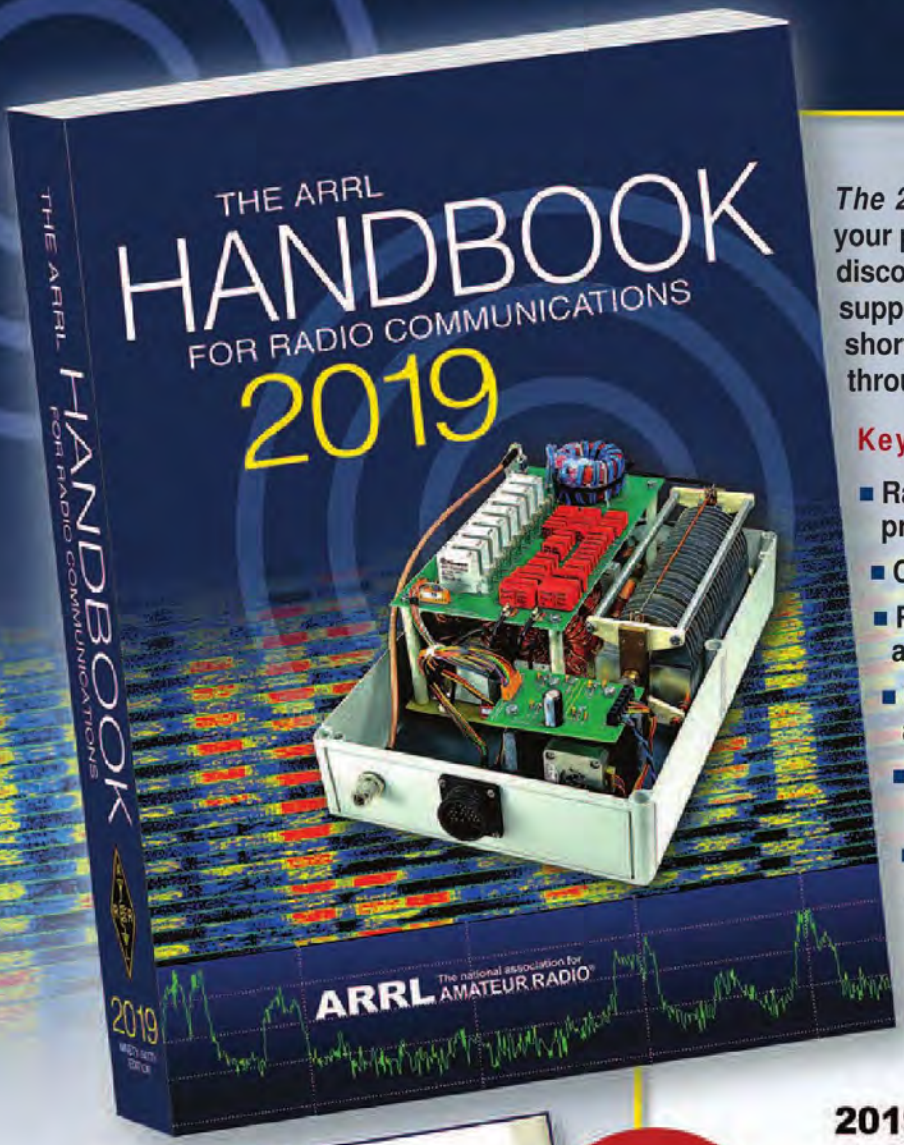


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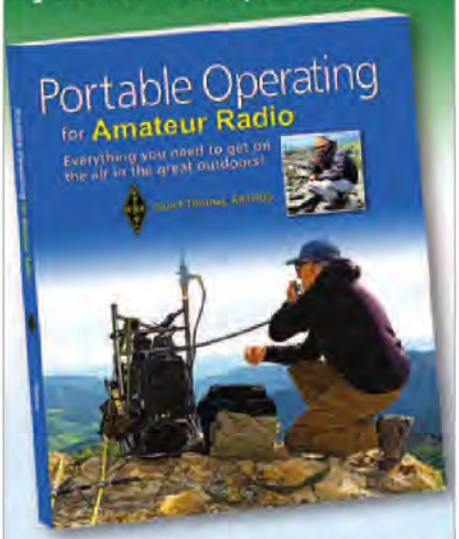


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- **Model DELTA-4B/N**; ..... $120.00 ea. 4 position, N connectors, 1.3 GHz
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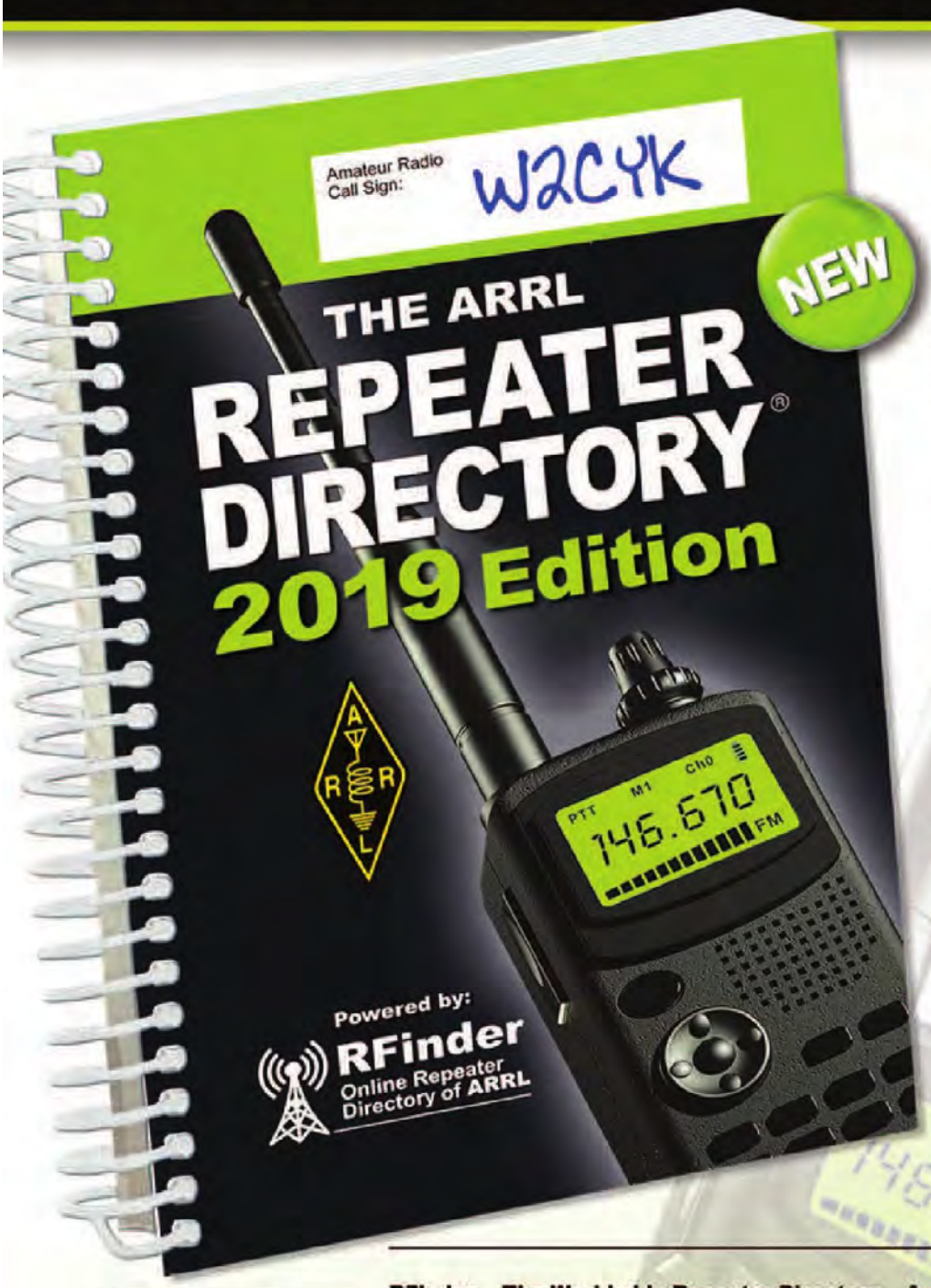


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**HAM-VI – $749.95** with DCU-2

**HAM-VII – $799.95** with DCU-3

| HAM V Rotator Specifications | |
|---|---|
| Wind Load Capacity (inside tower) | 15 square feet |
| **Wind Load (w/mast adapter)** | **7.5 square feet** |
| Turning Power | 800 in.-lbs. |
| **Brake Power** | **5000 in.-lbs.** |
| Brake Construction | Electric Wedge |
| **Bearing Assembly** | **Dual race/96 ball bearings** |
| Mounting Hardware | Clamp plate/steel U-bolts |
| **Control Cable Conductors** | **8** |
| Shipping Weight | 26 lbs. |
| **Effective Moment (in tower)** | **2800 ft.-lbs** |

## TAILTWISTER SERIES II – $799.95

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**T-2XD2 – $899.95** with DCU-2

**T-2XD3 – $949.95** with DCU-3

| TAILTWISTER Rotator Specifications | |
|---|---|
| Wind Load Capacity (inside tower) | 20 square feet |
| **Wind Load (w/mast adapter)** | **10 square feet** |
| Turning Power | 1000 in.-lbs. |
| **Brake Power** | **9000 in.-lbs.** |
| Brake Construction | Electric Wedge |
| **Bearing Assembly** | **Triple race/138 ball bearings** |
| Mounting Hardware | Clamp plate/steel U-bolts |
| **Control Cable Conductors** | **8** |
| Shipping Weight | 31 lbs. |
| **Effective Moment (in tower)** | **3400 ft.-lbs** |

## CD-45II – $449.95

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**CD-45D2 – $549.95** with DCU-2

**CD-45D3 – $599.95** with DCU-3

| CD-45II Rotator Specifications | |
|---|---|
| Wind Load Capacity (inside tower) | 8.5 square feet |
| **Wind Load (w/mast adapter)** | **5.0 square feet** |
| Turning Power | 600 in.-lbs. |
| **Brake Power** | **800 in.-lbs.** |
| Brake Construction | Disc Brake |
| **Bearing Assembly** | **Dual race/48 ball bearings** |
| Mounting Hardware | Clamp plate/steel U-bolts |
| **Control Cable Conductors** | **8** |
| Shipping Weight | 22 lbs. |
| **Effective Moment (in tower)** | **1200 ft.-lbs** |

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### DCU-3 – $449.95

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

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| AR-40 Rotator Specifications | |
|---|---|
| Wind Load Capacity (inside tower) | 3.0 square feet |
| **Wind Load (w/mast adapter)** | **1.5 square feet** |
| Turning Power | 350 in.-lbs. |
| **Brake Power** | **450 in.-lbs.** |
| Brake Construction | Disc Brake |
| **Bearing Assembly** | **Dual race/12 ball bearings** |
| Mounting Hardware | Clamp plate/steel U-bolts |
| **Control Cable Conductors** | **5** |
| Shipping Weight | 14 lbs. |
| **Effective Moment (in tower)** | **300 ft.-lbs** |

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**MFJ-1708B-SDR**
**$99.95**

**If** you want to know where the activity is, who's generating splatter, what's in the DX window, how wide your audio is or what frequencies are clear, it's all right there! While receiving on your transceiver, MFJ-1708B-SDR switches your SDR to your antenna showing the entire band. On transmit your SDR is switched out and grounded to protect your SDR. PTT and a failsafe RF sense switches MFJ-1708B-SDR. For HF/VHF/UHF. Monitor multiple bands with multiple SDRs and a multi-coupler.

**MFJ-1708B-SDR-S, $104.95.** SMA connector for your SDR.

**MFJ-1708SDR, $79.95.** 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.

## MFJ Low Noise VLF/HF Receiving Loop

***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.

**MFJ-1866, $49.95.** Like MFJ-1868 but transmits 144-1290 MHz. Coax and mounting hardware not included.

## Tuned Indoor SDR Active Antenna

**MFJ-1020C**
**$99.95**

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.

## Untuned Indoor SDR Active Antenna

**MFJ-1022, $69.95.** Hear weak, noisy VLF to UHF signals. Noise-less feedback gives excellent low noise reception. Handles strong signals.

## Active Outdoor Antenna

**MFJ-1024**
**$159.95**

*World Radio TV Handbook* says "MFJ-1024 is a *first rate, easy-to-operate active antenna, quiet, excellent dynamic range, good gain, very low noise factor, broad frequency coverage, excellent choice...*" **Outdoor** mounted 54-inch whip/pre-amp gives maximum signal and minimum noise. Covers .05-30 MHz. **Indoor** unit: 20 dB attenuator, gain control, 2 receiver and 2 antenna switches.

## HF SDR Preselector

**MFJ-1040C**
**$119.95**

**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 by-passes when transmitting or use PTT. 6½W x 2½H x 4D inches.

## MFJ LW/MW/SW SDR Preselector/Tuner

**MFJ-956**
**$69.95**

**Highly** rated series-tuned MFJ-956 boosts your desired signals while greatly rejecting interference and preventing serious overload. **Greatly** improves reception 0.15 to 30 MHz. Incredibly effective below 2 MHz. **Super** easy to operate, select band and tune! **Bypass** tuner and ground receiver switch positions. **Compact** 2 x 3 x 4 inches. SO-239 connectors.

**MFJ-1708B, $99.95.**

## 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-1707B, $99.95.**

## 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*!

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# MFJ Dummy Loads & SWR/Wattmeters

## Dummy Loads

### World's most popular Dry 300 Watt HF/VHF Dummy Load

**Air-cooled,** non-inductive resistor in a perforated metal housing; Has SO-239 connector. Full 300W for 30 seconds. Derating curve to 5 minutes. SWR below 1.1:1 to 30 MHz, 1.5:1 30 to 650 MHz. Compact 2¼ x 2¼ x 7 inches. **MFJ-260CN, $49.95.** With type "N" connector.

**MFJ-260C**
**$39.95**

### Dry 1.5 kW HF/VHF/UHF Dummy Load

***Ham radio's most versatile*** 1.5 kW 50 ohm *dry* dummy load covers DC through 650 MHz. SWR 1.1:1 to 30 MHz and 1.3:1 to 650 MHz. Handles 1500 Watts for ten seconds, 100 Watts for 10 minutes. 3W x 3H x 9D in. SO-239 connector. **MFJ-264N, $84.95.** With type "N" connector.

**MFJ-264**
**$74.95**

### Oil-Cooled 1 kW CW, 2 kW SSB 50-Ohm VersaLoad™

**Run** 1kW CW or 2 kW PEP for 10 minutes. Run *continuous duty* with 200 Watts CW or 400W PEP. Transformer oil included. SWR 1.2:1 to 30 MHz. Low SWR to 400 MHz. SO-239 connector. Safety vent with cap, carrying handle. 7½H x 6⅝D in. **MFJ-250X, $49.95.** No transformer oil.

**MFJ-250**
**$69.95**

### 500 MHz, 100 Watt Dummy Load

**Connects** directly with built-in PL-259. Finned aluminum air-cooled heatsink. 15 Watts continuous, 100W peak. SWR <1.5:1, DC-500 MHz. 15/8 inch round by 3 inches long. **MFJ-262B, $59.95.** PL-259. 35 Watts continuous, 200W for 5-seconds. SWR< 1.2;1 DC-1 GHz.

**MFJ-261**
**$27.95**
*with PL-259*
DC to 500 MHz

### MFJ 2500W *fan-cooled* Dry Load

**MFJ's** 2500 Watt *fan cooled* load handles legal limit amps, 2500W average one minute on, ten minutes off, 300W continuous. DC- 6 Meters. SWR <1.25, 30 MHz; <1.4, 30-60 MHz. Detailed power curve. 12 VDC or 110 VAC. 8¼W x 4H x 9½D in. SO-239s. 5 pounds.

**MFJ-265**
**$219.95**

### Switchable RF Dummy Load

**Select** 16.6, 25, 50, 100, 150 Ohm dummy loads. Test/calibrate your wattmeters, SWR accuracy. At 50 Ohms it handles 300 Watts for 30 seconds with SWR < 1.1, 60 MHz. SO-239. 4½W x 2¼H x 6½D in. Optional 12 VDC/110 VAC adaptor, MFJ-1312D, $15.95.

**MFJ-251**
**$149.95**

### 3 GHz, 300 Watts Dry Dummy Load

***New high-tech metal film resistor*** on large heavy-duty air-cooled heatsink. 300 Watts for ten seconds and 125W continuously. SWR < 1.1, 1 GHz; <1.2, 1.5 GHz; <1.5, 3 GHz. N-connector. 10¾W x 2¼H x 5¼D inches.

**MFJ-263**
**$99.95**

### 1.5kW Dry DummyLoad/SWR/Wattmeter

**Tune** up your transceiver, linear amplifier or antenna tuner into a safe 50 Ohm dummy load at *full power.* Then instantly switch to your antenna and monitor SWR, forward and reflected power on lighted cross-needle meter. 300/3000 Watt ranges. DC-60 MHz.Test/tune Xceivers, amps, tuners, baluns, filters, coax, stubs.

**MFJ-267**
**$159.95**

## SWR/Wattmeters

### Compact Cross-Needle SWR/Wattmeters

**Large** 3-inch lighted Cross-Needle meter covers 1.8-200 MHz in 30/300W power ranges. Read forward, reflected power, SWR *simultaneously.* 3¼W x 3¼H x 3¼D in. SO-239 connectors. **MFJ-842, $59.95.** 140-525 MHz, 15/150W.

**MFJ-822**
**$59.95**

### High-accuracy 1.8-60 MHz Digital SWR/Wattmeter

**Highly accurate!** Auto-ranging select 25W, 250W, 1500W ranges with *full 10-bit* resolution. Frequency compensated data insures highest accuracy. *True peak*/average forward/reflected power, SWR and frequency are *simultaneously* displayed on backlit LCD and large 3-inch lighted cross needle meter. Peak hold. LED, buzzer, amplifier-by-pass alerts and protects your amplifier when SWR is high and toggles extra relay. 6½W x 2⅝H x 6D". **MFJ-826B, $179.95.** No meter, ampr bypass, control relay.

**MFJ-828**
**$229.95**

### MFJ GrandMaster™ SWR/Wattmeters

***GrandMaster***™ SWR/Power Meters are the *Cadillacs of ham radio!* Large 3¼ x 1¼ inch precision illuminated meter gives easy wide-angle viewing of SWR, forward or reflected power. 7½W x 3⅛H x 4¼D in. SO-239s. **MFJ-870, $79.95.** 1.6-60 MHz. 30/300/3000 Watt ranges. **MFJ-874, $109.95.** 1.8-525 MHz. 5/20/200 Watt ranges.

**MFJ-870**
**$79.95**

### MFJ *giant* 6.5 inch SWR/Wattmeter

**World's *largest*** HF+6M SWR/Wattmeter has giant 6½ inch meter! Extra-long scales gives highly accurate SWR/power 1.8-54 MHz. Huge numbers make reading easy. *True* peak or average forward and reflected power. 20/200/2000 Watt ranges. 9 Volt battery, 12 VDC or 110 VAC with **MFJ-1312D, $15.95.** 7W x 5½H x 5D in. SO-239s.

**MFJ-868B**
**$149.95**

### VHF SWR/Wattmeter plus Field Strength

**World's most popular** – and most affordable – VHF SWR/Wattmeter. Read SWR, forward and reflected power over 144-220 MHz in two ranges, 30/300W. Built-in field strength meter for 1-220 MHz. 4½W x 2¼H x 3D".

**MFJ-812B**
**$39.95**

### Compact Digital SWR/Wattmeters

**Displays** forward, refelected power, SWR (1.6-60 MHz) and battery *all in a single glance!* Large ½" forward power digits and 5/8" reflected/SWR digits! 0-200W. Power/backlight on/off. SO-239s. **MFJ-847, $99.95.** 125-525 MHz, 0-120W. **MFJ-849, $169.95. Large** 3.5" bright orange LCD displays SWR, forward/reflected power. 1.5-525 MHz, 200W, HF/VHF-UHF switch.

**MFJ-845**
**$99.95**

**MFJ-849**
**$169.95**

### MFJ HF *QRP* SWR/Wattmeter

**Read** forward, reflected power 1.8- 50 MHz, 0-5W. Also reads SWR, relative power 100 mW to 50W. SO-239s. 4½W x 2¼ H x 3D in.

**MFJ-813**
**$39.95**

### VHF/UHF SWR/Wattmeter

**Lighted** Cross-Needle,SWR/Watts,144/220/440 MHz, 30/300W Forward power, 6/60W Reflected power.

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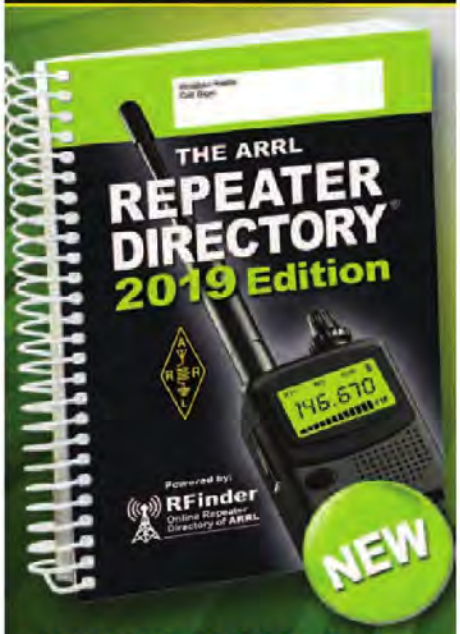


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# MFJ-4416C Super Battery Booster

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

MFJ-4416C **$179.95**

**Keeps** your transceiver at full power output, provides full performance, high efficiency, prevents output signal distortion and transceiver shutdown. Compensates for run-down battery, wiring voltage drop or when car is off. Provides up to 25 Amps peak with 90% efficiency. Selectable 9/10/11 Volts minimum input voltage prevents battery damage from over-discharging. RF sense turns MFJ-4416C off during receive to save power, increases efficiency and reduces noise. Adjustable 12 to 13.8 VDC output pass-through improves efficiency and lets transceiver run cooler. Has output over-voltage crowbar protection. *Anderson PowerPoles®* and high-current 5-way binding posts for DC input, regulated output. 7 3/4W x 4H x 2 1/8D inches. **MFJ-4416BRC, $79.95.** Booster Remote Control.

### PowerReady™ EmComm

**Emergency** on-the-go power! Use any 24-30 size battery.

MFJ-4452 **$89.95** 2-sets Power-Poles™, binding posts, cigarette lighter socket, 2.1A USB port, digital voltmeter. Carrying strap.

### RFI Filter for DC power

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

MFJ-1142 **$59.95**

### Digital Volt/Amp Meter

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

MFJ-4442 **$34.95**

### RFI Ferrite Chokes

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

MFJ-700A4 **$10.95**

### PowerPole™ DC Outlet Box

**One** fused 30 Amp input and 25, 10, 5 Amp fused outputs with *Anderson PowerPoles®*. Has open fuse indicator. Sturdy metal construction, 2 3/4W x 3 1/4H x 1 1/2D inches.

MFJ-1104 **$44.95**

### MFJ Low Pass Filter

**High** attenuation above 40 MHz. 1.5kW, 1.8-30 MHz. SWR<1.3. Nine Chebyshev poles, *Teflon®* dielectric capacitors, high-Q inductors, ground plane shielding, RF tight.

MFJ-704 **$89.95**

### Lightning Surge Protector

**Protect** your expensive equipment from lightning induced surges on 50 Ohm coax. Use for transceivers up to 400 Watts, 1000 MHz. **MFJ-272, $29.95.** 1.5 kW.

MFJ-270 **$19.95**

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**World's** most compact 30 Amp switching power supply. Switchable Volt/Amp meter. Adjustable 4 to 16 VDC output. Select 120/240 VAC input. 5W x 2 1/2H x 6D in., 3 lbs.

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**Instantly** turn any wire into a small, high-efficiency multi-band transmitting loop antenna. Full 150W, 5.3-30 MHz.

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**300** Hz - 2.8 GHz. 1 Hz resolution, 10-digit backlit LCD, signal strength bargraph, lithium battery.

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**Relative** field-strength readings .1-500 MHz. Sensitivity control, 1 3/4 inch meter. 20-inch telescoping whip. Finger contact increases sensitivity.

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**17-foot** stainless steel whip collapses to 27". Full 1/4 Wave on 20/17 Meters, 30-160 Meter operation with loading coil. Fits any standard 3/8-24 threaded mount.

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**Giant** 2 1/2 inch super bright LEDs – see from across the street day or night. 12/24 switch, 110VAC, 9V battery backup.

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**MFJ** 2-position *remote* antenna switch uses a *single* coaxial feedline to feed two antennas, DC power and control signals. Remotely switch HF and/or VHF antennas. Covers 1.8 MHz to 150 MHz and handles 1500 Watts. Impedance is 50-75 Ohms. Compact 4W x 2 5/8H x 1 1/2D". *Outside Switch Box* is fully enclosed and weather protected. Three quality *Teflon®* SO-239 connectors for transmitter, antenna one and antenna two. Stainless steel 1 1/2" tall bracket with a U-bolt for masts up to 1 1/2 in. O.D. *Inside biastee* control is 2 1/4W x 2 1/2H x 1 1/4 in. Use 12 VDC or 110 VAC with **MFJ-1312D, $15.95.**

MFJ-4712 **$79.95**

### MFJ Artificial RF Ground

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**MFJ-4230MV**
**$89.95**

**Ham Radio's Best Seller!**

**MFJ-4230MV** is ham radio's best selling and most compact switching power supply – just 5W x 2 1/2H x 6 D" and 3 lbs. Takes up little room at your operating position and perfect for home station, Field Day, DXpeditions, camping, hiking, or for your next business trip or vacation.

**MFJ-4230MV** gives 25 Amps continuously or 30 Amps surge at 13.8 VDC. Voltage is front-panel adjustable from 4 to 16 VDC.

**Selectable** input voltage of 120 or 240 VAC at 47-63 Hz lets you carry it with you and use it worldwide.

**Front-panel** rocker switch lets you choose Amp or Volt meter for continuous monitoring. Cool operation with excellent 75% efficiency. Extra low ripple and noise is less than 100 mV.

**It's quiet!** Continuous air-flow gently cools the power supply and a heat sensor increases the fan speed if the temperature rises above 70 degrees celsius.

**Over-voltage** and over-current protection fully protects your transceiver and has ALARM LED. DC output is 5-way binding posts on the back so you can power your HF, VHF, UHF transceiver and accessories with ease.

**Add a pair of PowerPoles®**
**MFJ-4230MVP**
**Adds** a pair of Anderson PowerPoles® on back of unit.
**$99.95**

## 75-Amps, $259.95

**MFJ-4275MV** high-current switching power supply gives 75A max/70A continuous. Great for ALS-500M amplifier. Adjustable output 4-16 VDC. 110/220 VAC. Binding posts, quick connects, PowerPoles®, cigarette lighter socket on front. Battery charger gives charging current of 20A max, 5A continuous. 9 3/4W x 5 1/2H x 9 1/2D". Only 10.5 lbs.

## 45-Amps, $149.95

**MFJ-4245MV** Switching power supply gives 45A surge/40A continuous. 9-15 VDC out. 85-260 VAC in. Low ripple, highly regulated. 5-way posts, cig lighter, quick connects. 5 lbs., 7 1/2W x 4 3/4H x 9D".

## 35-Amps, $134.95

**MFJ-4235MV** switching power supply gives 35A surge and 30A continuous. 4-16 VDC with 1% voltage regulation. < 9 mV peak-to-peak ripple. AC input 90-125 or 200-240V. 7W x 4 1/4H x 8 3/4D", 4 lbs.

## 35-Amps, $149.95

**MFJ-4035MV** 19.2 lb. transformer delivers 35A max, 30A continuous. 1-14 VDC out, 110 VAC in. Highly regulated, 1% load regulation. 1 mV ripple. 5-way binding posts, quick connects. 9 1/2W x 6H x 9 3/4".

## 28-Amps, $84.95

**MFJ-4128** switching power supply delivers 28A surge, 25A continuously at 13.8 VDC. Selectable AC input voltage 85-135 and 170-260 VAC. 5-way binding posts, cigarette lighter socket, fan "on" LED, 7W x 2 1/4H x 7 1/2D", 4 lbs.

## 25-Amps, $99.95

**MFJ-4225MV** Switching power supply gives 25A surge, 22A continuous. Adjustable 9-15 VDC output, 85-260 AC input. Large 3" dual Amp/Volt meters, Binding posts, Cigarette lighter socket. 3.7 lbs. 5 1/4W x 4 1/2H x 6D inches.

## 25-Amps, $84.95

**MFJ-4125** gives 25A surge, 22A continuous. 13.8 VDC switching power supply has 5-way binding posts on front panel and quick connects on back. 3.5 lbs. Super compact 5 1/2W x 2 1/2H x 5 3/4D inches fits anywhere.

## 25-Amps, $94.95

**MFJ-4125P** gives 25A surge, 22A continuous. 13.8 VDC switching power supply front has 2 pair of Anderson PowerPoles® and 5-way binding posts on front. Quick connects on back. 3.5 lbs. Super compact 5 1/2W x 2 1/2H x 5 3/4D".

## 18-Amps, $99.95

**MFJ-4218MV** ham radio's only adjustable 0-24 VDC output switching power supply! 18A at 13.8 VDC, 9A at 24 VDC. Backlighted Volt/Amp meters, 5-way binding posts outputs, LED load fault indicator. 6W x 2 1/4H x 6 3/4D", 2.2 lbs. 110/220 VAC input.

## 15-Amps, $69.95

**MFJ-4215MV** switching power supply gives 15A surge and 13A continuously. Variable 4-16 VDC with 1% voltage regulation. Less than 9 mV peak-to-peak ripple. Select AC input 90-125 or 200-240 VAC. Backlighted Volt/Amp Meters. 5-way binding posts for output. 5W x 3 3/4H x 7D", 2.9 pounds.

## 15-Amps, $69.95

**MFJ-4115** Super-compact 3 3/4W x 2 1/4H x 7 3/4D", 1.5 lb. switcher. 17A surge, 15A cont. 13.8 VDC. 110/220 VAC. Fault LED, 5-way posts.

## MFJ High Current DC Multi-Outlet Strips

**Power multiple transceivers/accessories from a single DC power supply**

**MFJ-1118, $84.95. Power** two HF and/or VHF rigs and six accessories from rig's 12VDC supply. 35A high-current and 15A accessory binding posts, Voltmeter, on/off switch. Master fuse, RF bypass.

**MFJ-1116, $59.95. Like** MFJ-1118 but 15A total, 8 pairs 5-way posts. "On" LED, 0-25 VDC voltmeter.

**MFJ-1112, $44.95. Like** MFJ-1116 but 6 pairs 5-way binding posts, no meter or switch. 12 1/2W x 2 3/4H x 2 1/2D".

**MFJ-1117, $64.95. High-current**. Powers four HF/VHF radios simultaneously – two at 35A each and two at 35A combined. 8W x 2H x 3D".

**MFJ-1129, $114.95. 10 outlets.** Installed fuses: two 1A, three 5A, three 10A, two 25A, one 40A. Outlets 1, 2, 4-8 are PowerPoles®. Outlet 3 is a 35A high current binding post, outlet 9, 10 are 15A binding posts. On/off switch, 0-25 VDC voltmeter. 12 1/2W x 1 1/4H".

**MFJ-1128, $104.95. 12 fused** Power Poles®: three 1A, four 5A, four 10A, one 25A, one 40A. Switch. Meter.

**MFJ-1126, $84.95. 8 fused** PowerPoles®: One 1A, three 5A, two 10A, one 25A, one 40A. Switch. Voltmeter. 9W x 1 1/4H x 2 3/4D".

**MFJ-1124, $64.95. Four** pairs 35A PowerPoles®, two pairs 35A high current binding posts.

**www.mfjenterprises.com**
**800-647-1800**

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# bhi

## Boost your receive audio.. ..with a bhi noise cancelling product

### NES10-2 MK3
- 8 DSP filter levels 9 to 35dB
- 2.7W Amplified DSP speaker
- 3.5mm Headphone/aux socket
- On/off audio bypass switch
- 12 to 24V DC (500mA)
- Fused DC power lead supplied

### DESKTOP

- 10W Amplified DSP base station speaker
- Separate volume and filter level controls - 8 filter levels 9 to 35dB - Speaker level and line level audio input sockets
- Headphone socket
- Size 200(h)x150(d)x160(w)mm
- Supplied with manual plus audio & fused DC power lead
- Suitable for SDR radio

### DSPKR

10W amplified DSP speaker - Pushbutton control of DSP filter - Sleep mode - Filter select & store - Volume control - Input overload LED - Headphone socket - Supplied with manual & fused DC power lead - Mobile or base station

### ParaPro EQ20 Audio Range

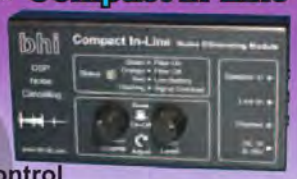
- 20W modular audio power amplifier with Parametric Equaliser - Four versions available with bhi DSP noise cancelling and Bluetooth connectivity optional

*Boost the sound of your receive audio to suit your ears!*

### Dual In-Line
- Versatile Dual Channel DSP noise cancelling module
- Use on all types of radio incl' SDR - Mono/stereo inputs
- 7W mono audio output
- Separate line level I/P & O/P
- Stereo headphone socket
- Improved noise cancelling!

*Upgrade your radio or extension speaker with a bhi audio DSP install modules!*

### Compact In-Line



- Use in-line with your radio and phones
- Latest bhi DSP noise cancelling
- Use with mono or stereo signals
- 8 filter levels
- Separate volume control & input overload - Use base station or mobile
- Use a12V DC supply or 2 x AA batteries

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**MFJ...the World Leader in Ham Radio Accessories!**

# MFJ Antennas

## MFJ Super High-Q Loop™ Antennas

### MFJ 36-inch diameter loop antenna lets you operate 10 through 30 MHz continuously – including the WARC bands!

**Ideal** for limited space -- apartments, small lots, motor homes, attics, or mobile homes.

Work exciting DX with low angle radiation and local close-in contacts with high angle radiation when mounted vertically. 150 watts.

**Super** easy-to-use! MFJ remote control auto tunes to your desired band. Fast/slow tune buttons, Cross-Needle SWR/Wattmeter lets you quickly tune to your exact frequency. No control cable needed.

**World's** most efficient small loop antenna has all welded construction, welded butterfly capacitor with no rotating contacts, large 1.050 inch diameter aluminum radiator – gives you highest possible efficiency.

**Every** capacitor plate is welded for extremely low loss and polished to prevent high voltage arcing.

Nylon bearing, antibacklash mechanism, limit switches, continuous no-step DC motor gives smooth precision tuning. Heavy-duty ABS plastic housing has ultraviolet inhibitor protection.

**Cover 40-15 Meters. MFJ-1788, $499.95.** Like MFJ-1786 but covers 40-15 Meters continuous. Includes remote control.

**MFJ-1780, $329.95. Portable** 24 x 24 x 5 3/4" box fan loop with carrying handle. 20-10 Meters continuous Fast/slow tune remote control. Highly efficient all-welded contstruction.

## MFJ *no radial* Multiband Antennas...

### ...highly efficient end-loading gives full size performance

### 40/20/15/10/6/2M Vertical

**MFJ-1796**
**$299.95**

**Only 12 feet high with a tiny 24 inch footprint!**

**Covers** 40/20/15/10/6/2 Meters. Mount anywhere – ground level, tower top, roofs, patios, apartments and small lots.

**Small** and lightweight – perfect for DXpeditions, field day, camping, vacations.

**Efficient** end-loading, no lossy traps. Entire length radiates. Full halfwave on 2/6 Meters.

**High** power air-wound choke balun eliminates feedline radiation. Adjusting one band has minimum effect on others.

**Automatic** bandswitching, low radiation angle, omni-directional, handles 1500 watts PEP. Goes together in an afternoon.

**MFJ-1796W, $299.95.** WARC band version for 12, 17, 30, 60 Meters.

### 40/30/20/17/15/12/10M Vertical

**MFJ-1797**
**$329.95**

**SkyMaster**™ covers 40, 30, 20, 17, 15, 12, 10 Meters. Extra-long 40 Meter radiator gives super 40M performance!

**Super** low profile makes it perfect for roof mounting, ground mounting, on patio, tower top or to blend into the trees.

**23.5** feet tall including extra-long 40 Meter radiator. Weighs just 7.5 lbs.

**No** ground or radials needed. 1000 Watts PEP. High strength 6063 aircraft aluminum. Use mast up to 1 3/4 inches.

**MFJ-1797LP, $299.95.** Like MFJ-1797 but without extra-long 40 Meter radiator. Less efficient with narrower bandwidth on 40M. 9 feet tall, weighs just 6 lbs.

### 80/40/30/20/17/15/12/10/6/2M Vertical

**MFJ-1799**
**$399.95**

**All Bands HF through VHF!**

**Highly** efficient endloaded 1/2 Wave vertical requires no radials, no lossy traps.

**Only** 20 feet high with a seven foot footprint so it mounts easily in a small area or patio.

**High** power air-wound choke balun eliminates feedline radiation. Automatic band-switching, low radiation angle, omnidirectional, 1500W PEP.

**Built-to-last.** Incredibly strong solid fiberglass rod and aircraft strength aluminum tubing are in the main structure.

**MFJ-1799X, $349.95. Like** MFJ-1799, but covers 40-2 Meters.

### 40/30/20/17/15/12/10 Meter ground mounted Vertical

**MFJ-1794**
**$249.95**

**High** performance, low cost, low profile, ground mounted. 7 bands: 40, 30, 20, 17, 15, 12, 10 Meters, full 1500 Watts PEP.

**Permanent** or temporary in antenna restricted spaces.

**Full** 11 feet collapses to 7 feet to hide behind fences, etc.

**Automatic** bandswitching, low radiation angle for DX, omni-directional. Highly efficient end-loading. Entire length radiates. Low SWR.

**Ground** or roof mount with radials, ground rod.

**Portable** or permanent operation with **MFJ-1901**, $109.95 (left) 2 x 2 foot *ground-coupled* stainless antenna base. Hard-ware, U-bolts included.

**MFJ-1795, $199.95**, **Like** MFJ-1794 but covers 40/20/15/10M.

**MFJ-1795W, $199.95**, **Like** MFJ-1795 but for 12, 17, 30, 60 Meters.

**MFJ-1901**
**$109.95**

### 9-Band *Rotatable* Mini-Dipole covers 40-2M

***Low profile 14 feet...7 ft. turning radius...40, 30, 20, 17, 15, 12, 10, 6, 2 Meters... 1500 W***

**New!** **MFJ-1789**
**$379.95**

**Directivity** reduces QRM/noise and focus your signal to work real DX. Operate 40, 30, 20, 17, 15, 12, 10 plus 6 and 2 Meters. Run full 1500 Watts SSB/CW on HF!

**End-loading** inductors and capacitive hats insures highest efficiency. Entire length radiates. 6 and 2 meters are fulllength halfwave dipoles.

**Low profile** at fourteen feet – size of TV antenna – easily rotated by inexpensive rotators like Hy-Gain's ***AR-500, $129.95.***

**Built-to-last** – incredibly strong solid rod fiberglass center insulator and 6063 T6 aircraft strength aluminum tubing radiator. Assembles in an afternoon.

**MFJ-1775, $319.95.** Like MFJ-1789 but covers 40, 20, 15, 10, 6 and 2 Meters.

**MFJ-1775W, $319.95.** WARC band version for 12, 17, 30, 60 Meters only.

**MFJ-1785, $399.95. 80/40/20M**. Endloaded *rotatable* dipole 33 feet. 1500W PEP. 6063 T6 al. tubing, solid center fiberglass.

**MFJ-4603 Universal Window Feedthrough**
**$89.95.** 4 SO-239, 1 N, 1 F, 3 ceramic feedthru for random/balanced lines, binding posts, more!

### MFJ *G5RV Antenna*

**MFJ-1778**
**$49.95**

Covers all bands, 160-10 Meters with antenna tuner. 102 feet long. Can use as inverted vee or sloper. Use on 160 Meters as Marconi. 1500 Watts. Super-strong fiberglass center/feedpoint insulators. Glazed ceramic end insulators. All hand-soldered connections. Add coax, some rope and you're on the air!

**MFJ-1778M, $44.95.** G5RV Junior. Half-size, 52 ft. 40-10M with tuner, 1500 Watts.


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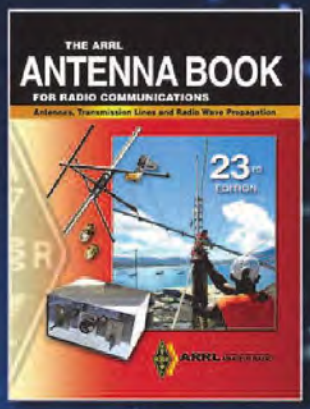


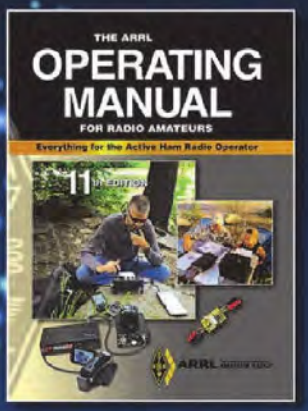


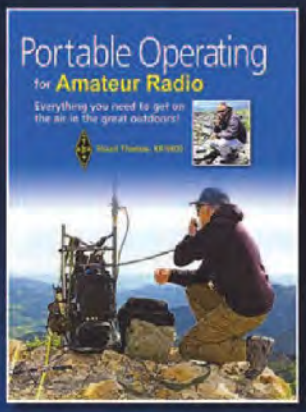


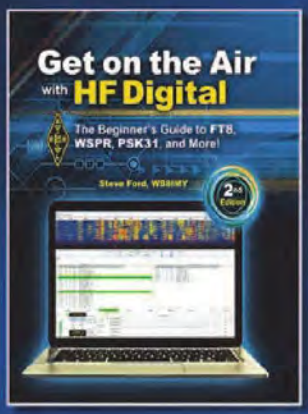


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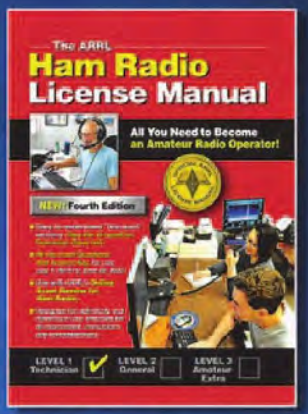


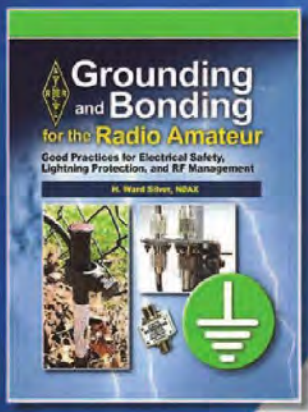


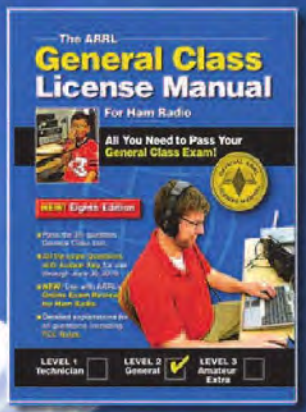

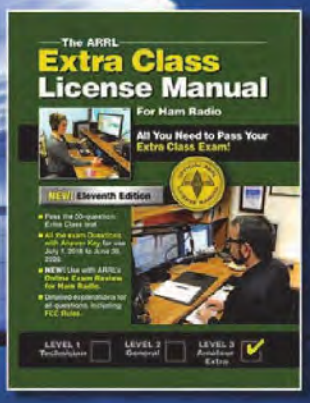

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# MFJ Analyzers

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

**MFJ-259C**
**$299.95**

***Super easy-to-use!***

***Dual analog meters, LCD – New and improved, now covers 530 KHz-230 MHz!***

***World famous*** MFJ-259C gives you a complete picture of your antenna's SWR and Complex Impedance.

**MFJ-259C** is a complete ham radio test station including – frequency counter, RF signal generator, *SWR Analyzer*™, RF Resistance/Reactance Analyzer, Coax Analyzer, Capacitance/Inductance Meter and more!

**You** can read Complex Impedance as series resistance and reactance (R+jX) or as magnitude (Z) and phase (degrees).

**Determine** velocity factor, coax cable loss in dB, length of coax and distance to short/open.

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

**MFJ No Matter What™ Warranty**

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

**Read** inductance (uH) and capacitance (pF) at RF frequencies.

**Large** easy-to-read two line LCD screen and side-by-side meters clearly display your information.

**Built-in** frequency counter, Ni-MH/Ni-CD charger circuit, battery saver, low battery warning, smooth reduction drive tuning.

**Super** easy to use! Just set the bandswitch and tune the dial – just like your transceiver. SWR and Complex Impedance are displayed instantly!

**Fully** portable, take it anywhere – remote sites, up towers, on DX-peditions. Use 10 AA or Ni-Cad or Ni-MH batteries (not included) or 110 VAC with MFJ-1312D, $15.95. Rugged metal cabinet only 4 x 2 x 6¾ inches.

**MFJ-249C, $279.95.**

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

## *More hams use MFJ analyzers than all others in the world!*

### MFJ-269C

**530 KHz - 230 MHz *plus* 415-470 MHz, 12-bit A/D**

**MFJ-269C**
**$399.95**

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

### MFJ-223

**1-60 MHz Color Graphic VNA Analyzer**

**MFJ-223**
**$299.95**

**This** *pocket-sized* wonder breaks the mold for analyzer design with user-friendly convenience, top notch accuracy, and a vivid TFT multi-color display. Don't let the size fool you, MFJ-223 is packed with all the VNA features and performance you need!

- **Single-frequency** and *swept-frequency* operating modes
- **Truly accurate** SWR, R, X, and Z measurements
- **Seamless DDS** coverage with 100-Hz resolution from 1-60 MHz
- **Smooth "skip-free"** encoder tunes fast or slow without missing a step
- **Powerful +5-dBm** stimulus generator overrides local interference
- **Field-strength meter** measures local signals, detects potential interference
- **DDS generator** precision signal source
- **Vivid 1600-pixel/inch** color graphics on a 2x2 inch non-glare TFT screen

### MFJ-225

**1.5-180 MHz *continuous* Two-Port Graphic Analyzer**

**Out** in the field, MFJ-225 is a compact completely *self-contained handheld graphing analyzer*. On the bench it becomes a full-fledged two-port (S21) desktop machine when teamed up with your PC. Using powerful IG-miniVNA freeware, you'll run detailed data analysis and print out stunning color-graphic plots to document your work!

**MFJ-225**
**$299.95**

Built-in back-lighted *3-inch LCD graphic* display. Make fine adjustments using fullscreen easy-to-view SWR bargraph, capture vivid swept displays for SWR, impedance, return loss, phase angle, more. DDS generator.

### MFJ-269CPRO™ Analyzer

**MFJ-269CPro, $429.95**

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

### *MFJ VNA Antenna Analyzer*

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

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

**MFJ-226**
**$339.95**

### MFJ SWR Analyzer Accessories

- **A. MFJ-29D/MFJ-39D, $24.95.** Carrying Pouch for MFJ-259C/269C.
- **B. MFJ-92AA10, $29.95.** 10-Pack 2500 mAh Ni-MH Supercells.
- **C. MFJ-66, $24.95.** Dip coils, set of two covers 1.8-230 MHz.
- **D. MFJ-731, $99.95.** Tunable Analyzer Filter, 1.8-30 MHz, for strong RF fields.
- **E. MFJ-917, $29.95.** 1:1 Current balun for SWR Analyzers to test balanced line antennas, other loads.
- **F. MFJ-5510, $9.95.** 12VDC cigarette lighter adapter.
- **G. MFJ-7737, $5.95.** PL-259 to BNC Female.
- **H. MFJ-7727, $5.95.** PL-259 to SMA Female.
- **I. MFJ-633, $29.95.** Ultra-fast intelligent charger.


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# Quicksilver Radio

## HAMMO-CAN™ Go Box

Ready to go, a complete VHF-UHF station in a box. New! Get them with or without radios installed. Fits most FM mobiles & several HF radios, too. Powerpoles, USB, lighter socket & Voltmeter included!

**Happy New Year!**
**Best wishes for 2019**
**from your friends at**
**Quicksilver Radio**

## Connectors & Adapters

Excellent quality, no bargain basement stuff here. Adapters & connectors for most types of connections.

## Powerpole Mounts

EZ install, just drill a 1-1/8" hole. Great for go-kits, power supplies, and other projects in the shack or on the bench.

## Ultimate Crimp Kit™

Ultimate Anderson Powerpole & Coax prep, strip & crimp kit. Crimp 15, 30, 45, 50 & 75A Powerpoles. Works with all popular coax types like RG-213, LMR-400 & 240, RG-8X, etc.

## USB Microscopes

Up to 1000X magnification. Capture still images and record live video. Built in LED Lighting. New models available!

## Powerpole Connectors

The standard for DC power connections. Power distribution, pre-built cables, mounts & more.

## Play-Series™ System

Check out our new Play-Series™ USB modules. New body & LED colors & styles. Aluminum body available. Spruce up your Ham shack, car, etc.

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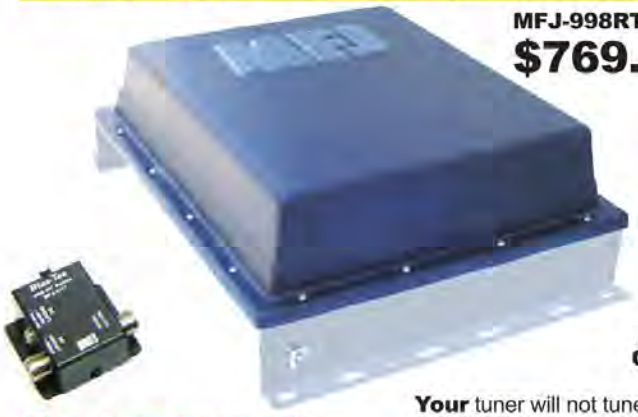
# MFJ 1500 Watt Remote Auto Tuner

## Place this MFJ-998RT remote tuner at your antenna to match high SWR antennas/long coaxes -- greatly reduce losses for high efficiency

**. . . Match 12-1600 Ohms, 1.5 kW, SSB/CW, 1.8-30 MHz . . . Match coax/wire antennas . . . Weather-sealed . . . Remotely powered thru coax . . . Amplifier, radio, tuner protection . . . Output static/lightning protection . . . StickyTune™ always tunes when power folds back . . . DC power jack . . .**



**MFJ-998RT**
**$769.95**

**Bottom Chassis**

**Inside View**

### Tune your antenna at your antenna

**Get greatly reduced losses and high efficiencies with long coax runs and high SWR antennas with this new MFJ-998RT 1.5 kW Remote Antenna Tuner.**

### Weather-Sealed

**A tough**, durable weather-sealed ABS cabinet with over-lapping lips, sealing gasket and stainless steel chassis protects the MFJ-998RT from all kinds of weather.

### No Power Cable Needed!

**No** power cable needed -- remotely powered through coax. Includes MFJ-4117 Bias-Tee with on/off switch for station end of coax. Has 12 VDC jack for power cable, if desired.

### Fully Protected

**MFJ** exclusive algorithms protect your tuner, radio and RF power amplifier from damage.

**Automatic** inductor and capacitor limiting prevents tuning extreme loads which can destroy your tuner.

**Your** tuner will not tune if more than 75 Watts with SWR greater than 3:1 is applied or if more than 125 Watts is applied.

**Tuner** output is static electricity and lightning induced surge protected.

### MFJ exclusive StickyTune™

**Very** high SWR can fold back transmitter power and prevent tuning caused by extreme differences in loads (example: changing bands and other conditions).

**But** MFJ exclusive StickyTune™ always tunes with a simple on/off power cycle and re-transmit.

### Tunes Coax fed and Wire Antennas

**Tunes** both coax fed and wire antennas. Has ceramic feed-through insulator for wire antennas. 2 kV Teflon® insulated SO-239 – prevents arcing from high SWR.

### High Power, Highly Efficient

**A** highly efficient L-network matches 6-1600 Ohms at full 1500 Watts legal limit SSB/CW 1.8 to 30 MHz with Hi-Q Ls, Cs.

### MFJ-998RT Learns as you Operate

**As** you operate, the MFJ-998RT automatically tunes for minimum SWR and remembers your frequency and tuner settings. The next time you operate on that frequency and antenna, its tuner solution is restored in milliseconds and you're ready to operate!

### Highly Intelligent, Ultra-fast Tuning

**MFJ** InstantRecall™ recalls stored tuning solutions from 10,000 memories. For new frequencies, MFJ Intelli-Tune™ measures your antenna impedance and instantly determines the correct matching components. If antenna impedances cannot be measured, MFJ AdaptiveSearch™ searches only the relevant components that can match your antenna giving you ultra-fast tuning.

**Field** upgradeable firmware. Requires 12-15 VDC at 1.4 Amps maximum or 110 VAC with optional MFJ-1316, $21.95. Weighs 9.5 lbs. 13 1/4W x 6 3/4H x 17 1/2D inches.

## 600W Remote IntelliTuner™

**MFJ-994BRT** – perfect for 600 Watt SSB/CW amplifiers like Ameritron's AL-811/ ALS-600/ALS-500M. Matches 12-800 Ohms. Coax/wire antennas, 1.8-30 MHz. Fully weather-sealed for outdoor use. Remotely powered through coax. Tough, durable, built-to-last cabinet, 9 1/4W x 3H x 14 1/4D inches, 4 lbs. Includes MFJ-4117 BiasTee Power Injector.

**MFJ-994BRT**
**$399.95**

## 300W Remote IntelliTuner™

**MFJ-993BRT** handles 300 Watts SSB/CW and matches an extra-wide 6-1600 Ohm impedances. Coax/ wire antennas, 1.8-30 MHz. Fully weather-sealed for remote outdoor or marine use. Remotely powered through coax. Tough, durable, built-to-last cabinet measures 9 1/4W x 3H x 14 1/4D inches. Weighs just 4 pounds. Includes MFJ-4117 BiasTee Power Injector.

**MFJ-993BRT**
**$299.95**

## 200W Remote IntelliTuner™

**MFJ-926B**, 200 Watts SSB/CW, matches 6-1600 Ohms, Coax/wire antennas, 1.8-30 MHz. Includes BiasTee.

**MFJ-926B $279.95**

### MFJ No Matter What™ Warranty

One year **No Matter What**™ Warranty
30 Day Money Back Guarentee
(less s/h) on orders direct from MFJ.

## 160-6 Meters 43 foot Vertical Antenna

**Operate** all bands 160-6 Meters at full 1500 Watts with this self-supporting, 43 foot high performance vertical! Assembles in less than an hour. Low profile blends in with sky and trees -- barely see it. Entire length radiates. Exceptional low angle DX performance on 160-20 Meters and very good performance on 17-6 Meters. Telescope it shorter for more effective low angle radiation on 17-6 M if desired. One of these wide range MFJ automatic tuners at the antenna easily matches all bands 160-6 Meters. There's no physical tuning adjustments on the antenna -- you simply put it up! Requires ground system, at least one radial, more the better. Includes balun and base mount. **MFJ-1932, $34.95**. All band ground radial system.

**MFJ-2990**
**$359.95**

**MFJ Enterprises, Inc.** 300 Industrial Pk Rd, Starkville, MS 39759
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# QST QuickStats

**Online QuickStats Poll Results for December 1 through January 1, 2019.**
Get on the web and vote today at **www.arrl.org/quickstats**!

## Do you listen to audio podcasts?

- Yes, often. **20%**
- Yes, occasionally. **40%**
- No. **38%**
- I don't know what a podcast is. **2%**

## When you listen to podcasts, do you choose Amateur Radio podcasts?

- Yes, exclusively. **16%**
- I listen to Amateur Radio podcasts, but I enjoy others as well. **40%**
- I never listen to Amateur Radio podcasts. **6%**
- I don't listen to podcasts. **38%**

## What do you think is the best length for an audio podcast?

- About 10 minutes. **11%**
- 10 to 20 minutes. **23%**
- 20 to 30 minutes. **20%**
- More than 30 minutes. **8%**
- I don't listen to podcasts. **38%**

## What is your chief complaint about Amateur Radio podcasts?

- Poor audio quality. **2%**
- Announcer voices are irritating. **2%**
- Announcers trying too hard to be funny (and failing). **8%**
- Too many boring topics. **7%**
- Conversations that drift off the topics. **13%**
- I don't have any complaints. **26%**
- I don't listen to Amateur Radio podcasts. **4%**
- I don't listen to podcasts. **38%**

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# MFJ Tuners

## Ham Radio's Most Popular 300 Watt Antenna Tuner

**More hams use MFJ-949s than any other antenna tuner in the world!**

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

### Full 1.8-30 MHz Operation

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

### Custom inductor switch

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

MFJ-949E **$189.95**

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

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

### 8-Position Antenna switch

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

### Lighted Cross-Needle Meter

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

### QRM-Free PreTune™

**MFJ's** QRM-Free PreTune™ lets you pre-tune your MFJ-949E off-the-air into its built-in dummy load! Makes tuning your actual antenna faster and easier.

### Plus Much More!

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

**MFJ-948, $169.95.** Econo version MFJ-949E. Has all features except for dummy load.

### No Matter What™ Warranty

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

## More hams use MFJ tuners than all other tuners in the world!

### MFJ-989D Legal Limit Tuner

MFJ-989D **$409.95**

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

### MFJ-986 Two knob Differential-T™

MFJ-986 **$369.95**

**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. $10^3/_4$W x $4^1/_2$H x 15 in.

### MFJ-962D Compact kW Tuner

MFJ-962D **$319.95**

**A few** more dollars steps you up to a KW tuner for an amp later. Handles 1.5 KW PEP SSB amplifier input power (800W output). Ideal for Ameritron's AL-811H! AirCore™ roller inductor, gear-driven turns counter, pk/avg lighted Cross-Needle SWR/Wattmeter, antenna switch, balun, Lexan front, 1.8-30MHz. $10^3/_4$ x $4^1/_2$ x $10^7/_8$ in.

### MFJ-969 300W Roller Inductor Tuner

**Superb**, AirCore™ Roller Inductor tuning. Covers 6 Meters thru 160 Meters! 300 Watts PEP SSB. Active true peak reading lighted Cross-Needle SWR Wattmeter, QRM-Free PreTune™, antenna switch, dummy load, 4:1 balun, Lexan front panel. $10^1/_2$W x $3^1/_2$H x $9^1/_2$D inches.

MFJ-969 **$229.95**

### MFJ-941E Super Value Tuner

**Most** for your money! 300 Watts PEP, 1.8-30 MHZ, lighted Cross-Needle SWR/Wattmeter, 8 position antenna switch, 4:1 balun, 1000 volt capacitors, Lexan front panel. $10^1/_2$W x $2^1/_2$H x 7D in. **MFJ-941EK, $129.95.** Tuner Kit -- Build your own!

MFJ-941E **$149.95**

### 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 8 x 2 x 6 in. Lighted Cross-Needle SWR/Wattmeter. Lamp and bypass switches. Covers 1.8-30 MHz and 6 Meters. 300 Watts PEP. MFJ-20, $6.95, mobile mount.

MFJ-945E **$129.95**

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

MFJ-971 **$129.95**

### MFJ-901B Smallest Versa Tuner

**MFJ's** smallest (5 x 2 x 6 in.) and most affordable wide range 200 Watt PEP Versa tuner. Covers 1.8 to 30 MHz. Great for matching solid state rigs to linear amps.

MFJ-901B **$99.95**

### MFJ-902B Tiny Travel Tuner

**Tiny** $4^1/_2$ x $2^1/_4$ x 3 inches, full 150 Watts, 80-6 Meters, has tuner bypass switch, for coax/random wire. **MFJ-904H, $149.95**. Same but adds Cross-needle SWR/Wattmeter and 4:1 balun for balanced lines. $7^1/_4$ x $2^1/_4$ x $2^3/_4$ inches.

MFJ-902B **$99.95**

### MFJ-16010 Random Wire Tuner

**Operate** all bands anywhere with MFJ's reversible L-network. Turns random wire into powerful transmitting antenna. 1.8-30 MHz. 200 Watts PEP. Tiny 2 x 3 x 4 in.

MFJ-16010 **$69.95**

### MFJ-9201 QRPocket™ Tuner

80-10 Meters, 25 Watts. 12 position inductor, tune/bypass switch, wide-range T-network, BNCs. 4W x $2^5/_8$H x $1^1/_2$D inches. **MFJ-9201, $49.95**

MFJ-9201 **$49.95**

### MFJ-921/924 VHF/UHF Tuners

**MFJ-921** covers 2 Meters/220 MHz. **MFJ-924** covers 440 MHz. SWR/Wattmeter. 8 x $2^1/_2$ x 3 in.

MFJ-921/924 **$89.95**

### MFJ-931 Artificial RF Ground

**Eliminates** RF hot spots, RF feedback, TVI/RFI, weak signals caused by poor RF grounding. Creates artificial RF ground or electrically places far away RF ground directly at rig. **MFJ-934, $209.95**, Artificial ground/300 Watt Tuner/Cross-Needle SWR/Wattmeter.

MFJ-931 **$109.95**


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# MFJ G5RV Antennas

## Operate all bands 10 through 160 Meters with a single wire antenna!

***The famous** G5RV antenna is the most popular ham radio antenna in the world!*

**It's an efficient**, *all* band 102 foot long antenna – shorter than an 80 Meter dipole. Has 32.5 foot ladder line matching section ending in SO-239 connector for your coax feedline.

**MFJ-1778**
**$49.95**

**Use** horizontally or as Inverted Vee or Sloper with just one support. 1500 Watts.

**Operate** all bands 80-10 Meters with an antenna tuner and even 160M with ground.

**Fully** assembled with *ceramic* end and fiberglass center insulators. *Hang and Play*™ – add coax, rope to hang and you're on air!

**MFJ-1778M, $44.95.** *Half-size,* 52 foot *G5RV JUNIOR for limited space.* 40-10 Meters with tuner. Full 1500 Watts.

### MFJ All Band Classic Doublet

**MFJ 102 foot** *all band* doublet covers 160-6 Meters with balanced line tuner. Super strong custom fiberglass center insulator relieves stress on 100 foot ladder line.

**MFJ-1777**
**$64.95**

*Glazed ceramic* end insulators. 1500 Watts.

## RF Isolator

**MFJ-915** *RF Isolator* prevents unwanted RF from traveling on the outside of your coax shield into your transceiver. This unwanted RF can cause painful RF "bites" when you touch your microphone or volume control, cause your display or settings to go crazy, lock up your transceiver or turn off your power supply. In mobile installations, stray RF could cause your car to do funny things even blow your car computer. Clear up these problems, plug an MFJ-915 between your antenna and transceiver. 1.8-30 MHz, 1500 Watts. 5 x 2 inches.

**MFJ-915**
**$29.95**

**MFJ-919, $59.95.** 4:1 current balun,1.5 kW.
**MFJ-913, $29.95.** 4:1 balun, 300 Watts.

## True 1:1 Current

### Balun & Center Insulator

**True** 1:1 *Current Balun/Center Insulator* forces equal radiator currents in dipoles for true dipole radiation pattern. Reduces coax radiation and field pattern distortion – your signal goes where *you* want it. Reduces TVI, RFI and RF hot spots. *Don't build a dipole without one!* 50 hi-permeability ferrite beads on high quality RG-303 *Teflon®* coax and *Teflon®* SO-239. 1.5kW 1.8-30 MHz. Stainless steel hardware. 14 gauge stranded copper wire is *directly* connected to your antenna. 5 x 2 inches. Heavy duty weather housing.

**MFJ-918**
**$29.95**

## 2-Position Antenna Switch

**MFJ-1702C, $39.95.** 2-position antenna switch, lightning surge protection, center ground. SO-239s.

### Lightning surge protectors

**MFJ-270, $29.95.** 400W. **MFJ-272, $39.95.** 1500 W. Gas discharge tube shunts 5000 amps peak.< 0.1 dB loss. 1 GHz. SO-239s.

**MFJ-16C06, $4.99.** 6-pack *glazed ceramic* end/center ant. insulators.

**MFJ-16B01, $19.95.** Molded high strength center insulator. SO-239.

**MFJ-16D01, $6.95.** 450 Ohm fiberglass end/center insulator with ladder line stress relief and SO-239 mount.

**MFJ-18H100, $34.95.** 100 feet, 450 Ohm ladder line, 18 gauge copper clad.

# 80-10 Meter End-Fed Half Wave antenna

## Cover all bands with one single wire and no tuner!

**MFJ-1982HP**
**$89.95**

**No tuner needed!**
**All band 80-10M EFHW antenna**

**Get-on-the** air on all bands 80-10 Meters with just one wire and one support (pole or tree) and no tuner or long counterpoise.

**Installs** anywhere in minutes! Rugged *insulated*-wire radiator prevents detuning when contacting limbs/branches. "*No-snag*" end insulator slides over branches, leaves.

**Toss** over a high limb for inverted-V or sloper or go vertical with an inverted-L.

**Dark** jacketed wire is virtually invisible – *don't let antenna restrictions keep you off the air!* Great for emergencies.

**EFHWs** naturally resonate on the 1/2-wave fundamental frequency and odd/even harmonics. Covers 80/40/30/20/17/15/12/10 Meters without traps, stubs or resonators.

**Broad-band matching** transformer at feed point gives SWR so low you may never need a tuner. Compensating inductor optimizes SWR. 800 Watts SSB/CW. 132 feet jacketed antenna wire.

**MFJ-1984HP, $79.95.** Like MFJ-1982HP but 40-10M. 66 feet jacketed wire.

**See www.mfjenterprises.com** for 30 Watt QRP and 300 Watt models.

## Dual Band Dipoles

**MFJ-17758, $89.95.** Operate 80/40 Meters with a short 85 foot dipole. Full-size on 40 Meters with ultra-efficient end-loading on 80 Meters. 1500 Watts. Super-strong custom molded center insulator with SO-239 connector and hang hole. Ceramic end insulators. 7-strand, 14 gauge hard copper wire. No tuner needed!

**MFJ-17758**
**$89.95**
80/40 Meters

**MFJ-17754, $59.95.** Like MFJ-17758 but is only 42 feet. Operate 40/20 Meters. Full-size on 20 Meters, ultra-efficient endloading on 40 Meters. 1500 Watts.

## Single Band Dipoles

**Ultra high** quality center fed dipoles give years of troublefree service. Custom injection-molded UV resistant center insulator has built-in SO-239 and hanging hole. Glazed ceramic end insulators. 7-strand, 14-gauge hard copper antenna wire. 1500 Watts. Use horizontally or as sloper or inverted vee. Simply cut to length with provided cutting chart.

**MFJ-1779A**
**$69.95**
160M, 265 ft.

**MFJ-1779B**
**$49.95**
80-40M, 135 ft

**MFJ-1779C**
**$29.95**
20-6M, 35 ft.

## OCFD Dipoles

***No tuner needed!***
MFJ *Off-Center Fed Dipoles* use MFJ's exclusive *ExactRatio*™ RF broadband transformer to give low SWR and maximum bandwidth on 40/20/10/6 Meters. A Guanella current balun kills feedline radiation, pattern distortion, SWR shifts, RFI and noise pickup. Install anywhere and get the same predictable performance regardless of feedline length. You get ground reinforced gain over verticals. Use horizontally, inverted vee, sloper. 98% efficient, 14 gauge, 7-strand copper wire, ceramic end insulators.

**MFJ-2012**
**$79.95**
1500 Watts

**MFJ-2010**
**$59.95**
300 Watts

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# MFJ Weather-Proof Window Feedthrough Panels

**Weather-proof window feedthrough panels bring coax, balanced lines, HF/VHF/UHF antennas, random wire antennas, ground, rotator/antenna switch cables and DC/AC power into your hamshack without drilling through walls!**

**MFJ** Weather-Proof Window Feedthrough Panels mount in your window sill. Lets you bring all your antenna connections into your hamshack without drilling holes through walls.

**Simply** place in window sill and close window. One cut customizes it for any window up to 48 inches. Use horizontally or vertically. Connectors are mounted on inside/outside stainless steel plates and attached to a 4 foot long, 3 1/2 inch high, 3/4 inch thick pressure-treated wood panel.

**Real** Western Red Cedar wood is naturally resistant to rot, decay and insects -- lasts longer, maintenance-free. Pitch and resin free for a wide range of beautiful finishes or leave it in its naturally beautiful raw finish. Edges sealed by weather-stripping. Seals and insulates against all weather conditions. Includes window locking rod.

**Inside/outside** stainless steel plates ground all coax shields. Stainless steel ground post brings ground in.

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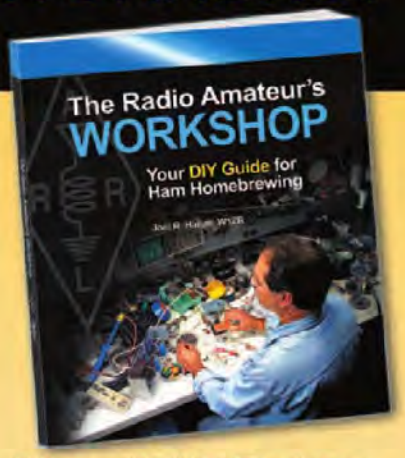


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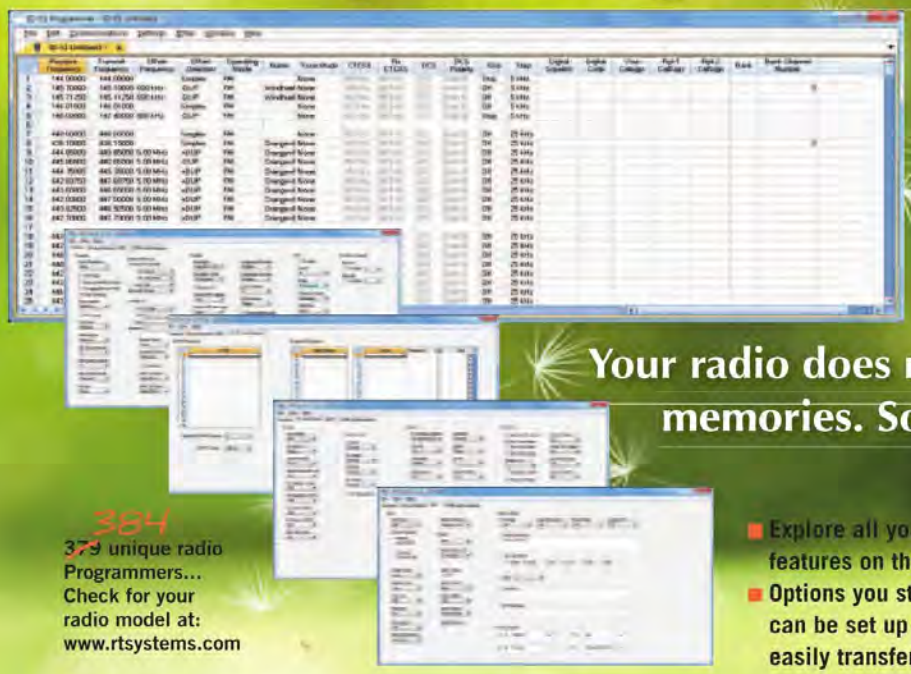

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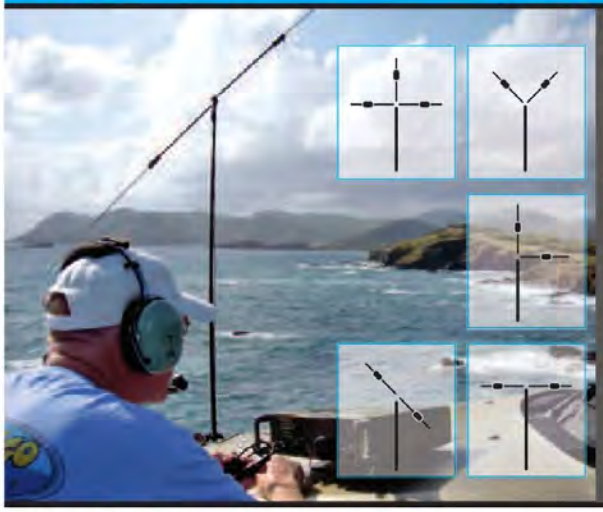

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# QST Index of

**ABR Industries**™ – www.abrind.com ..... 12
**Advanced Specialties** – www.advancedspecialties.net ..... 137
**Air Boss Antenna Launcher** – www.kr4loairboss.com ..... 120
**Alpha Delta Radio Communications, LLC** – www.alphadeltaradio.com ..... 113
**Ameritron** – www.ameritron.com ..... 17
**Arcom Communications** – www.arcomcontrollers.com ..... 142
**Array Solutions** – www.arraysolutions.com ..... 18
**ARRL** – www.arrl.org ..... 28, 108, 110, 111, 113, 114, 116, 118, 120, 126, 132, 134, 136, 137, 138, 139, 144
**bhi Ltd** – www.bhi-ltd.com ..... 124
**BridgeCom Systems** – www.BridgeComSystems.com ..... Cover 3, 23
**Buckmaster Publishing** – hamcall.net ..... 120
**Buddipole Antennas** – www.buddipole.com ..... 141
**CommRadio** – www.commradio.com ..... 136
**Computer International** – www.computer-int.com ..... 120, 137
**Cubex** – www.cubexquads.com ..... 120
**Cushcraft** – www.cushcraftamateur.com ..... 2
**Debco Electronics, Inc.** – www.Debcoelectronics.com ..... 111
**Diamond Antenna** – www.diamondantenna.net ..... 8
**DX Engineering** – www.DXEngineering.com ..... 26, 27
**Elecraft** – www.elecraft.com ..... 19, 21
**Elk Antennas** – www.ElkAntennas.com ..... 111
**Expert Linears America, LLC** – www.ExpertLinears.com ..... 111
**FlexRadio Systems** – www.flex-radio.com ..... 25
**Global TSCM Group, Inc.** – www.kn2c.us ..... 138
**Green Heron** – www.greenheronengineering.com ..... 116
**Ham Ads** – www.arrl.org/ham-ad-listing ..... 140
**Ham Radio Outlet** – www.hamradio.com ..... 104, 105, 106, 107
**Hammond Mfg. Co.** – www.hammondmfg.com ..... 120
**Hamvention®/2019 ARRL National Convention** – www.hamvention.org ..... 139
**Heil Sound** – www.heilsound.com ..... 141
**Hy-Gain** – www.hy-gain.com ..... 10, 115
**ICOM America** – www.icomamerica.com ..... 109

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# Advertisers


**International Radio INRAD** – www.inrad.net ..... 11
**Intuitive Circuits, LLC** – www.icircuits.com ..... 137
**Kenwood Communications** – www.kenwoodusa.com ..... Cover IV, 29, 112, 136
**LDG Electronics** – www.ldgelectronics.com ..... 6
**Mayberry Sales & Service, Inc.** – www.mayberrys.com ..... 142
**MFJ Enterprises** – www.mfjenterprises.com ..... 117, 119, 121, 123, 125, 127, 129, 131, 133, 135,
**Mosley Electronics** – www.mosley-electronics.com ..... 108
**Motosports of Ukiah** – www.hondashop.com ..... 138
**NCG Company** – www.natcommgroup.com ..... 3
**OCI-Olds Communications Inc.** – www.ocicom.com ..... 116
**Pacific Antenna** – www.qrpkits.com ..... 116
**Palomar Engineers** – www.Palomar-Engineers.com ..... 142
**Personal Database Applications** – www.hosenose.com ..... 116
**PreciseRF** – http://preciserf.com ..... 108
**Quicksilver Radio Products** – www.qsradio.com ..... 128
**Radio Club of JHS 22 NYC** – www.wb2jkj.org ..... 124
**RF Parts Company** – www.rfparts.com ..... 143
**RT Systems** – www.rtsystems.com ..... 137
**SEA PAC/NW Division Convention** – www.seapac.org ..... 138
**Skilman** – www.skilman.com ..... 116
**SOTAbeams** – www.sotabeams.co.uk ..... 116
**SteppIR Communications Systems** – www.steppir.com ..... 7
**SwapMyRigs** – www.swapmyrigs.com ..... 138
**Tac-Comm** – www.tac-comm.com ..... 137
**Tennadyne** – www.tennadyne.com ..... 120
**Ten-Ten International Net, Inc.** – www.ten-ten.org ..... 142
**Tigertronics** – www.tigertronics.com ..... 137
**Timewave Technology, Inc.** – www.timewave.com ..... 122
**Vibroplex** – www.vibroplex.com ..... 11
**Warren Gregoire & Associates** – www.superbheadsets.com ..... 120
**West Mountain Radio** – www.westmountainradio.com ..... 22
**Wireman** – www.coaxman.com ..... 120
**Yaesu USA** – www.yaesu.com ..... Cover II, 1


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|---|---|---|
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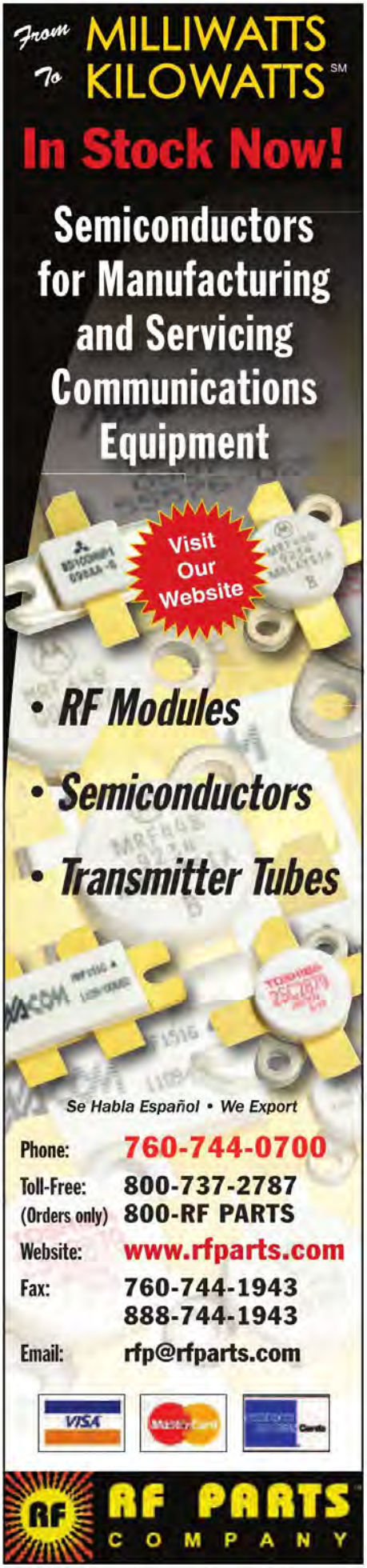

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