DXpedition Funding: Paying for the Rare Ones Page 69

QST

DIGITAL EDITION

ARRL The national association for AMATEUR RADIO®
October 2018 | www.arrl.org
DEVOTED ENTIRELY TO AMATEUR RADIO

DX The Thrill of the Chase

QST Reviews

Icom IC-7610 HF and 6-Meter Transceiver
SteppIR SDA 2000 OptimizIR Controller
IkaScope WS200 Wireless Oscilloscope

DIGITAL FEATURE

52 | See our Video Review of the **Icom** IC-7610 HF and 6-Meter Transceiver

The radio... YAESU

True RF Legend
True Performance

FT DX 5000MP Limited

RF μ-Tuning Unit
(Optional)

■ Provides ultra-high-Q RF preselection selectivity

Congratulations

We congratulate WRTC 2018 Y81N Winning Team from Lithuania

The winners of the World Radio Team Championship 2018
Gedas Lucinskas (LY9A) and Mindis Jukna (LY4L)

Rig used: 2 x FTDX5000MP

YAESU PRIME SPONSOR WRTC 2018

YAESU
The radio

YAESU USA
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CA 90630 (714) 827-7600

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The radio... YAESU

The Legend Continues

The Transceiver that could only be created by Yaesu Offering New Excitement and Surprises

In homage to Sako Hasegawa

FTDX101MP 200W

HF/50MHz TRANSCEIVER

The Ultimate

FTDX101D 100W

HF/50MHz TRANSCEIVER

- Superb and Astonishing Close-in Dynamic Range
- 9MHz IF Roofing Filter Producing Excellent Shape Factor
- 400MHz HRDDS (High Resolution Direct Digital Synthesizer)
- Hybrid SDR: Direct Sampling & NBW (Narrow Bandwidth) SDR
- Completely Independent Dual Receivers
- High-Q VC Tuning Front-End
- Yaesu Renowned Interference Reduction System
- Large Touch-Panel Precision Color Display
- 3DSS (Three Dimension Spectrum Stream) Waterfall Display
- Active Band Indicator with LED illumination of the operating band, enables rapid band changes
- MPVD (Multi-Purpose VFO Outer Dial) provides Sub VFO dial, Clarifier operation, VC-TUNE adjustment, VFO fine tuning or a CS (custom selection) function

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.

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MA-6B 6-Band Beam

Small Footprint – Big Signal

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

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

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

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

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

MA-5B, $499.95. Like MA-6B but five bands: 20/17/15/12/10 Meters. 12 and 17 Meters is a single element trapped dipole.
See cushcraftamateur.com *for gain figures.*

Cushcraft 10, 15 & 20 Meter Tribander Beams

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

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

The 3-element A3S/A3WS and 4-element A4S are world-famous for powerhouse gain and super performance. **A-3WS, $499.95,** 12/17 M. **30/40 Meter** *add-on kits* available.

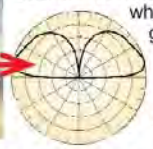
Cushcraft R9...80-6 Meters 80 Meters...No Radials...1500W

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

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

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

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



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

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

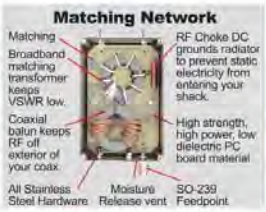
Rugged Construction: Thick fiberglass insulators, all stainless steel hardware and 6063 aircraft-aluminum tubing is double or triple walled at key stress points to handle anything Mother Nature can dish out.

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.



Cushcraft Dual-Band Yagis

One Yagi for Dual-Band FM Radios

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

Cushcraft Famous Ringos Compact FM Verticals

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

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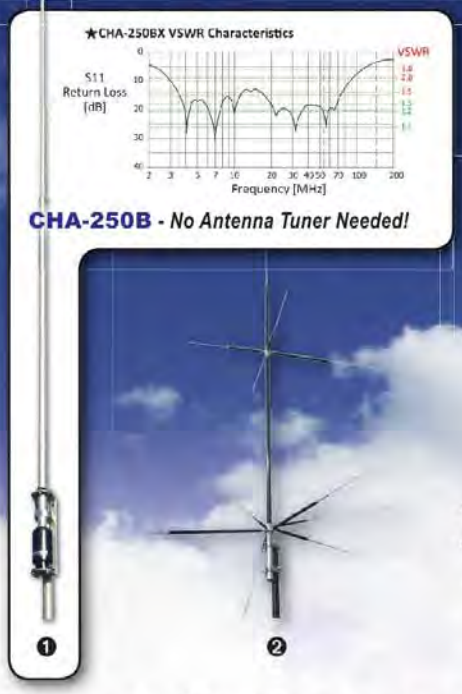

CHA-250B - *No Antenna Tuner Needed!*

❶ ❷ ❸ ❹ ❺ ❻ ❼

Base Antennas

❶ C★MET CHA-250B BROADBAND 80M THROUGH 6M VERTICAL ANTENNA

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

❷ Maldol HVU-8 ULTRA-COMPACT 8 BAND HF/VHF/UHF VERTICAL ANTENNA

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

❸ C★MET GP-3 DUAL-BAND 146/446MHZ BASE REPEATER ANTENNA

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

❹ C★MET GP-6 DUAL-BAND 146/446MHZ BASE REPEATER ANTENNA

Wavelength: 146MHz 5/8 wave x 2 • 446MHz 5/8 wave x 5 • Max Pwr: 200W • Length: 10'2"• Weight: 3lbs. 8ozs. • Conn: Gold-plated SO-239 • Construction: Fiberglass, 2 Sections

❺ C★MET GP-9 / GP-9N DUAL-BAND 146/446MHZ BASE REPEATER ANTENNA

BEST SELLER! • Wavelength: 146MHz 5/8 wave x 3 • 446MHz 5/8 wave x 8 • Max Pwr: 200W• Length: 16' 9"" • Weight: 5lbs. 11ozs. • Conn: GP-9 Gold-plated SO-239 • GP-9N Gold-plated N-type female • Construction: Fiberglass, 3 Sections

❻ C★MET CX-333 TRI-BAND 146/220/446MHZ BASE REPEATER ANTENNA

Wavelength: 146MHz 5/8 wave x 2 • 220MHz 5/8 wave x 3• 446MHz 5/8 wave x 5 • Max Pwr: 120W • Length: 10'2" • Weight: 3lbs. 1oz.• Conn: Gold-plated SO-239 • Construction: Fiberglass, 2 Sections

❼ C★MET GP-15 TRI-BAND 52/146/446MHZ BASE REPEATER ANTENNA

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

NEW CAA-500MarkII

1.8-500MHz Antenna analyzer

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

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

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

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Includes audio
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Our Cover
This issue features a visit with some of the hams of Portugal. Luis Teixeira, CT4NH, is the current president of the Portuguese DX Group. A ham since the 1970s, he lives near Lisbon and uses this multi-element OptiBeam as his main antenna. Learn more about Luis and other Portuguese DXers on page 74. [Henryk Kotowski, SM0JHF, photo]

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VALUE, QUALITY, SERVICE

In the early days of ham radio around the turn of the 20th century all ham equipment was homebrew. If you wanted to get on the air you had to build your own receiver and transmitter; it would be decades before ham equipment became commercially available. By the 40s and 50s, companies like Collins, Hammarlund and Hallicrafters produced receivers and transmitters to the ham market. While the designs were basic, these radios were of high manufacturing quality, offered good value to the amateur buyer, and were backed by dependable factory warranty service. Many of these radios remain classics and highly valued nearly a millennium later.

These commercial values became hallmarks of many American manufactured products. LDG holds these same principles as our core values. In talking to our customers, we find that their priorities are value, quality, service and warranty; we couldn't agree more.

When LDG introduced the desktop microprocessor-controlled switched-L tuner to the amateur market in 1995, most automatic tuners had variable capacitors and inductors equipped with servo motors and an analog control bridge. Our breakthrough designs operated much more quickly, reliably, repeatably and at a lower cost. American hams, and indeed hams world-wide found great value in this approach, and these products formed the foundation of our business.

All LDG tuners come with a comprehensive, industry-leading two-year warranty. Even after the warranty period expires, your tuner will be repaired for a reasonable price. Full technical support is available by phone and e-mail if you have questions or need guidance in installing or using your tuner. Ask around and check online; no one beats LDG on service and support.

The warranty on your LDG product is fully transferable; if you sell or give away your tuner, simply give the new owner a copy of the receipt and the remaining warranty goes with the tuner. No registration paperwork is required; the copy is all that is needed to obtain warranty repairs.

At a time when our markets are flooded with cheaply made goods of questionable quality and little support, LDG is proud to continue the American tradition of building and marketing high-quality products that our customers find of great value, and providing them with comprehensive support and warranty service.

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& WARRANTY...

LDG ELECTRONICS

Z-100Plus

Low cost and Portable, the Z-100Plus operates from any 7 to 18 volt DC source. AA batteries will run it for a year of normal use. Internal frequency counter stores tuning parameters for fast recall. Handles 100 watts SSB or 30 watts Digital.

Z-817

The ultimate QRP autotuner. Seamless integration to the Yaesu FT-817 and FT-818 provide one button tuning. 2000 memories covers 160 through 6 meters, 20 watts SSB, 5 watts digital.

Don't know which tuner is right for you?

See our Tuner Comparison Chart at ldgelectronics.com

AT-200ProII

The AT-200ProII handles the high powered rigs or that small amp. Includes a two position antenna switch with 2000 memories for each antenna. Handles up to 250 watts SSB on 1.8 to 30 MHz, 100 watts on 6M, 75 watts digital. Rugged and easy to read LDG bar-graphs show RF power and SWR.

AT-600ProII

Perfect for mid-sized amps, the AT-600ProII is a great all-around tuner. 2000 memories store your matches for nearly instant recall. Handles up to 600 watts SSB on 1.8 to 30 MHz, 200 watts on 6M, 200 watts digital.

AT-1000ProII

Our Flagship 1000 watt tuner! Large, easy to read bar-graph meter shows forward power and SWR at the same time. Two position antenna switch; RF sensing; Auto and Semi tuning modes; 5 to 1000 watts SSB/CW, 250 watts digital; 1.8 to 54 MHz, 10:1 tuning range (3:1 on 6M).

IT-100

Matched in size for Icom desktop radios including the IC-7300. Enjoy control from the radio's Tuner button or the Tune button on the tuner. For any Icom radio that are AH-3 or AH-4 compatible.

YT-100

For Yaesu' s FT-100, FT-857 and FT-897 transceivers. The operation is to key the radio in AM/FM/CW then press the tune button on the tuner. The tuner will find the match and you are ready to operate. Includes 3' CAT-DIN-8 cable.

YT-1200

Designed for Yaesu' s FT-991A, FTdx-1200, FTdx-3000, FT-450 and FT-950 for seamless tuner integration. Powered by the radio and controlled by the tuner. With CAT-pass through to allow for computer operation. Use any baud rate. Includes 3' YC-1200 interface cable.

RT-100 and RT-600

RT-100 and RT-600: Remote tuners can reduce feedline loss due to SWR. These tuners are DC powered over the coax to allow operation from your shack. Includes mounting brackets and controller for on/off, Auto mode, Lock and Tune. 1.8 to 54 MHz. RT-100: 100 watts SSB. RT-600: 600 watts SSB.

RBA-1:1 and RBA-4:1

RBA-1:1 and RBA-4:1. Designed to allow easy conversion from ladder line, twin lead, and long wires (with a good ground) to coax cable. Covers 1.8 to 30 MHz. 200 watts SSB.

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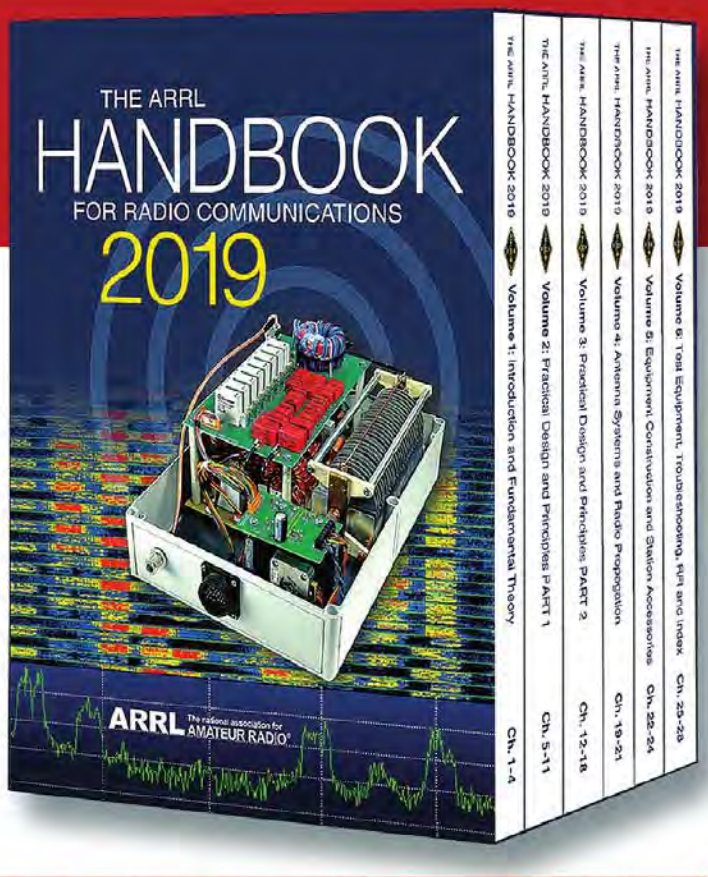

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Key Topics

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- **Digital and analog modulation and protocols**
- **Antennas and transmission lines**
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Barry J. Shelley, N1VXY, ARRL Chief Executive Officer, bshelley@arrl.org

Second Century

Monitoring the Airwaves

"The ARRL Board of Directors met in July, one of their two in-person meetings each year, and at that meeting they approved recommendations from a subcommittee formed over 2 years ago to study the effectiveness of, and recommend changes to, the Official Observer (OO) Program (see page 79). The OO Program is one of the two components of the ARRL Amateur Auxiliary Program, the other being the Local Interference Committees (LICs)."

The principal goal of the OO program is to promote rule compliance. This is done in two ways. First, by notifying amateurs of operating and technical irregularities before they come to the attention of the FCC, and to recognize good operating practices. Second, they serve as the first-line "eyes and ears" for the FCC in identifying repeated, substantive rule violations for referral to ARRL HQ and eventually the FCC.

ARRL has sponsored the OO Program in different forms for more than 90 years. The OO Program's work with the FCC began in 1982. Senator Barry Goldwater, K7UGA, at ARRL's request, sponsored legislation that specifically permitted Amateur Radio organizations to provide volunteer monitoring services to the FCC on Amateur Radio frequencies. ARRL implemented the legislation with a formal contract between the FCC and ARRL. Since 1982, there have been a few changes made in the OO Program, but it was developed at a different time; one in which the FCC umbrella included a number of field offices throughout the country, staffed with tenured, competent engineers that could be called upon to help track down, gather, and confirm evidence on the very few "bad actors" in our community. One role of the OOs was to help identify these individuals and help point the FCC in the right direction. Over time, ARRL's OO Program grew to over 700 volunteers scattered throughout the country, some more active than others, listening, offering advice to individual Amateur Radio operators, and providing information to the FCC.

Times have changed, and so has the FCC. In recent years, budgetary restrictions have forced the Commission to reduce the number of field offices, and with it, much of their cadre of field engineers, limiting the FCC's ability to collect information on even the most egregious violations. As a result of the closures, however, the FCC needed help with enforcement in the Amateur Radio Service. About 2 years ago, the FCC approached ARRL to discuss providing an appropriate level of enforcement in the Amateur Radio Service, given their staff limitations. They noted that the focus of their limited resources had to be on safety of life radio services, but they recognized that repetitive violations of Part 97 rules had to be addressed on a timely basis. Those discussions formed the basis for the new Volunteer Monitoring Program.

Volunteer Monitors (VMs) under the new Program will perform similar tasks to those performed by the former OOs. In case you're interested, the name was selected (a) to differentiate it from the old OO nomenclature and (b) we, and the FCC, believe that it better reflects the actual function of the volunteers. The number of volunteers in the program will be reduced to around 250. They will be individually vetted and selected through a specific process based on interviews, specific skill sets, and geographic location. Each volunteer will be required to complete initial and ongoing training courses to ensure they are up to date on the information required for action by the FCC, who will help in the ongoing educational process. Cases will be processed through ARRL HQ and submitted to the FCC. Repeated and significant violations are expected to be dealt with by the FCC on a timely basis.

Overall, we expect the new VM program to be more focused and responsive in helping FCC to quickly address significant and repeated violations. We expect that faster, more visible FCC enforcement efforts will result. The traditional functions of volunteers in the program, to help individual amateurs to operate efficiently and within the rules, and to encourage compliance will continue. Unfortunately, there are some tradeoffs in the transition to the VM Program. There will be fewer volunteers involved. ARRL is grateful for the contributions of all those who have participated over the years and we encourage all active OOs to apply to be VMs. But it is important to understand that not all who apply for the VM Program will be selected. The FCC, as the "served agency" in this program, has specific needs for volunteers in this program, including a particular geographic distribution, and active, centralized management of the program.

It will take some time to get the new program up and running. Interviewing applicants for Volunteer Monitors will take time, as will the creation and administration of training materials. In the meantime, enforcement efforts have not stopped. There have been several recent announcements by the FCC of actions taken, including some of the more prominent pending cases. We are assured that there are others in the pipeline.

The work of the new Volunteer Monitors, like the Official Observers before them, is critically important to ensuring everyone's enjoyment of Amateur Radio. These volunteers all have performed — and will continue to perform — much-needed tasks, and should be commended for their service.

Barry J. Shelley, N1VXY

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The First Choice of Hams Around the World!

hy-gain® HF Beams

...are stronger, lighter, have less wind surface and last years longer.

Why? hy-gain uses durable tooled components – massive boom-to-mast bracket, heavy gauge element-to-boom clamps, thick-wall swaged tubing – virtually no failures!

TH-11DX, $1199.95. 11-element, 4.0 kW PEP, 10, 12, 15, 17, 20M

The choice of top DXers.

With 11-elements, excellent gain and 5-bands, the super rugged TH-11DX is the "Big Daddy" of all HF beams!

Handles 2000 Watts continuous, 4000 Watts PEP.

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

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

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TH-7DX, $899.95. 7-element, 1.5 kW PEP, 10, 15, 20 Meters

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

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

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

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

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

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

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

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

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

TH-5MK2, $789.95. 5-element, 1.5 kW PEP, 10,15, 20 Meters

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

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

TH-3MK4, $499.95. 3-element, 1.5 kW PEP, 10,15, 20 Meters

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

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

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

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

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

TH-2MK3, $389.95. 2-element, 1.5 kW PEP, 10,15, 20 Meters

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

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

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

EXP-14, $629.95. 4-element, 1.5 kW PEP, 10,15, 20 Meters

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

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

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

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

QK-710, $179.95. 30/40 Meter option kit for EXP-14.

Tooled Manufacturing... Highest Quality Materials

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

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

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

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

Durable precision injection molded parts.

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

Model No.	No. of elements	avg gain dBd	avg F/B dB	MaxPwr watts PEP	Bands Covered	Wind sq. ft. area	Wind (mph) Survival	Boom feet	Longest Elem. (ft)	Turning radius (ft)	Weight (lbs.)	Mast dia O. D. (in.)	Recom. Rotator	Sugg. Retail
TH-11DX	11			4000	10, 12, 15, 17, 20	12.5	100	24	37	22	88	1.9-2.5	T2X	$1199.95
TH-7DX	7	For Gain and F/B ratio–See...		1500	10, 15, 20	9.4	100	24	31	20	75	1.5-2.5	HAM-IV	$899.95
TH-5MK2	5			1500	10, 15, 20	7.4	100	19	31.5	18.42	57	1.5-2.5	HAM-IV	$789.95
TH-3MK4	3	• www.hy-gain.com		1500	10, 15, 20	4.6	95	14	27.42	15.33	35	1.9-2.5	CD-45II	$499.95
TH-3JRS	3	• hy-gain catalog		600	10, 15, 20	3.35	80	12	27.25	14.75	21	1.25-2.0	CD-45II	$379.95
TH-2MK3	2	• Call toll-free 800-973-6572		1500	10, 15, 20	3.25	80	6	27.3	14.25	20	1.9-2.5	CD-45II	$389.95
EXP-14	4			1500	10, 15, 20 opt.30/40	7.5	100	14	31.5	17.25	45	1.9-2.5	HAM-IV	$629.95

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40 ft - $105 / 60 ft - $269 / 72 ft - $469 / 85 ft - $599
QST review: Feb. 2010

SPIDERBEAM ROTATABLE ALUMINUM MASTS - support for 13 to 25 lbs antenna weight. 33 ft - $459 / $485, 41 ft $509, 47 ft $629, 49 ft $575, 60 ft $749. Guy hardware, rotator adapters, other accessories available. QST review: May 2015

Yagi antennas, low band wire antennas, lightweight high band antennas, and more are available from Spiderbeam. See website for detailed information!

www.spiderbeam.us

DX COVERS

DX COVERS are superbly crafted leatherette and felt embroidered logo covers for almost any transceiver or amplifier. Stock covers for popular rigs and custom orders available.

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INRAD DESK MICROPHONES

The INRAD Desk Microphone System is the new standard on HF. Find out what nearly 1000 other hams who have purchased one already know: INRAD means great audio doesn't have to cost hundreds of dollars. Priced at just $138 to $158. ARRL Product Review, January 2018.

1. PICK YOUR MIC – 5 models with microphone, base, and transceiver cable.

2. PLUG IT IN – Works with almost any HF transceiver. Connect detachable coiled cable between base rear and your rig mic jack.

3. TALK – Large Push-To-Talk bar on the front. PTT lock slider for those long QSO's. VOX operation, too!

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USB control of 90 different rotators. Point and click with your mouse. Interfaces with most popular ham software. Kit and assembled versions start at only $99. *QST* review, Nov. 2014.

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2213A RG213/U MIL-SPEC
Non-contaminating Direct-Burial Ultra-Violet Resistant Jacket.
W/SILVER-TEFLON PL259 & WEATHERPROOF HST each end.

Attenuation per 100ft	Power Rating	Efficiency%
0.6dB @ 10MHz	3.43kW	87%
1.0dB @ 30MHz	1.95kW	79%
1.4dB @ 50MHz	1.5kW	73%
2.4dB @ 150MHz	.83kW	57.1%
4.5dB @ 450MHz	.45kW	35.8%

Part #	Length/Ft
2213A-PL-3	3
2213A-PL-25	25
2213A-PL-50	50
2213A-PL-75	75
2213A-PL-100	100
2213A-PL-150	150

1" Tinned Copper Flat Ground Braid. 7ga 85/Amps
w/1/4" Stud Ring Terminals. Quick &
Easy Grounding Terminations.

Part #	Length/Ft
235-5X-20	20
235-5X-10	10
235-5X-5	5
235-5X-3	3

1/2" Tinned Copper Flat Ground Braid. 10ga 53/Amps
w/#10 Stud Ring Terminals. Quick &
Easy Grounding Terminations.

Part #	Length/Ft
233/2-4X-12	12
233/2-4X-10	10
233/2-4X-5	5
233/2-4X-3	3
233/2-4X-1	1

233/2-G4
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 38x48x8/34 10ga 53 amps

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

218XA RG8X (240F) Foil+TC Braid
Non-contaminating Direct-Burial Ultra-Violet Resistant Jacket.
W/SILVER-TEFLON PL259 & WEATHERPROOF HST each end.

Attenuation per 100ft	Power Rating	Efficiency%
0.9dB @ 10MHz	2.16kW	80%
1.6dB @ 30MHz	1.24kW	69%
2.1dB @ 50MHz	0.96kW	62%
3.6dB @ 150MHz	0.55kW	43.5%
6.3dB @ 450MHz	0.31kW	23.2%

Part #	Length/Ft
218XA-PL-1.5	1.5
218XA-PL-3	3
218XA-PL-6	6
218XA-PL-9	9
218XA-PL-12	12
218XA-PL-18	18
218XA-PL-30	30
218XA-PL-40	40
218XA-PL-50	50
218XA-PL-75	75
218XA-PL-100	100
218XA-PL-125	125
218XA-PL-150	150
218XA-PL-200	200

RG316/U Teflon® .100" OD
HT jumpers "antenna attachment for better coverage"

Part#	Description	Length/Ft
23316-NM-3	N Male Both ends	3
23316-NM-6	N Male Both Ends	6
23316-SM-SF-3	SMA Male-SMA Female	3
23316-SM-SF-6	SMA Male-SMA Female	6
23316-SM-SF-9	SMA Male-SMA Female	9
23316-SM-SF-12	SMA Male-SMA Female	12
23316-SM-SF-15	SMA Male-SMA Female	15
23316-SM-3	SMA Male Both Ends	3
23316-SM-6	SMA Male Both Ends	6
23316-SM-PL-3	SMA Male-PL259	3
23316-SM-PL-6	SMA Male-PL259	6
23316-SM-SO-3	SMA Male-SO239	3
23316-SM-SO-6	SMA Male-SO239	6

25400F 400-FLEX (RG8/U TYPE) FLEXIBLE LOW LOSS
Non-contaminating Direct-Burial Ultra-Violet Resistant Jacket.
W/SILVER-TEFLON PL259 & WEATHERPROOF HST each end.

Attenuation per 100ft	Power Rating	Efficiency%
0.8dB @ 30MHz	2.77kW	83.0%
1.1dB @ 50MHz	2.14kW	78.5%
1.8dB @ 150MHz	1.22kW	65.4%
3.3dB @ 450MHz	0.69kW	47.3%

Part #	Length/Ft
25400F-PL-1.5	1.5
25400F-PL-3	3
25400F-PL-6	6
25400F-PL-12	12
25400F-PL-18	18
25400F-PL-35	35
25400F-PL-50	50
25400F-PL-75	75
25400F-PL-100	100
25400F-PL-150	150

25400F 400-FLEX (RG8/U TYPE) FLEXIBLE LOW LOSS
w/N Male plugs each end. Complete
w/Weatherproof Heat Shrink Tubing (WP-HST)

Attenuation per 100ft	Power Rating	Efficiency%
0.8dB @ 30MHz	2.77kW	83.0%
1.1dB @ 50MHz	2.14kW	78.5%
1.8dB @ 150MHz	1.22kW	65.4%
3.3dB @ 450MHz	0.69kW	47.3%

Part #	Length/Ft
25400F-NM-3	3
25400F-NM-6	6
25400F-NM-12	12
25400F-NM-18	18
25400F-NM-25	25
25400F-NM-35	35
25400F-NM-50	50
25400F-NM-75	75
25400F-NM-100	100
25400F-NM-150	150

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Member Spotlight

Fletcher Veitch, K3JYD

A passion for ham radio and electronics led Fletcher Veitch, K3JYD, to many innovative companies throughout his career. He started as a technician at Electromechanical Research Laboratories (EMR), where he was hired by a fellow ham. EMR mainly focused on building spacecraft for NASA's Goddard Space Flight Center and for Dr. James Van Allen (discoverer of the Van Allen radiation belts) at the University of Iowa.

From there, Fletcher went on to work with telemetry data reduction on spacecraft data at Dynalectron. There he met his wife, Patty, who was working on data reduction for one of the first orbital sounders. Next, he started at Sperry, working on environmental simulation for small orbital packages on the NASA Goddard reservation in Greenbelt, Maryland.

Fletcher Veitch, K3JYD. [Fletcher Veitch, K3JYD, photo]

NASA and the Apollo Program

Fletcher moved to NASA's Johnson Space Center in Houston, Texas, in April 1966 — at the height of the Apollo program. He said of the transition, "Goddard was very much a civil service showplace, in addition to being at the leading edge of small instrument package research. Everything was very much by the book. Technicians wore ties. Houston was the Wild West by comparison."

Fletcher worked 12-hour shifts as part of a team testing the spacecraft systems, performed using Chambers A and B, the enormous vacuum thermal simulators that ensured components were safe for spaceflight. The components being tested included the Apollo short stack, the Lunar Module, Apollo Skylab, and some of the Apollo-Soyuz hardware. Patty also worked long shifts for Lockheed's Scientific Computing Center. In the couples' first 6 months working there, their days off overlapped only twice.

By the time Apollo 11 landed on the moon, Fletcher's team was already working on testing for the next flights. He said, "We watched the landing on TV like so many others, and I remember feeling a tremendous sense of pride in being a part of a great engineering accomplishment, but we still needed to get up and go to work." Despite the hard work and long hours, the Apollo program was special. He said, "It was a truly a unique project to work on. All of us knew it could be done, wanted it done, and made it happen."

After 6½ years in Houston, Fletcher went on to work for a digital signal processing company in Virginia, eventually moving on to work as an engineer and project manager for US Navy contractors at Naval Air Station Patuxent River and their other associated facilities. He finished his career contributing to developing some of the first artificial intelligence-driven interactive electronic technical manuals (IETMs), focused on naval communications and aviation maintenance.

Radio's Influence

Fletcher credits ham radio as a guide to his career. He said, "My professional career was strongly driven by my hobby... The experience with real-world design and real problems that Amateur Radio can provide is irreplaceable."

His love of radio and electronics started when his father gave him a Heathkit AR-2 receiver kit for Christmas. The availability of inexpensive surplus military radio equipment also helped make ham radio accessible to Fletcher when he was young. He earned his Novice license in 1959 and quickly upgraded to Technician- and General-class licenses.

Today, he enjoys putting up antennas on his mountaintop residence in West Virginia. When he's not operating, he builds and modifies equipment, attends VHF and microwave conferences, and rediscovers HF through Joe Taylor's, K1JT, FT8 mode.

The Next Generation

Fletcher is a proponent of getting younger people involved in Amateur Radio, and points to the CubeSat project (**www.cubesat.org**) as an example of valuable hands-on learning for students. He said, "We as a community need to encourage youngsters to investigate the diverse world that is Amateur Radio and provide them with some insight into the variety of fascinating areas this great hobby of ours can address."

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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).*

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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.

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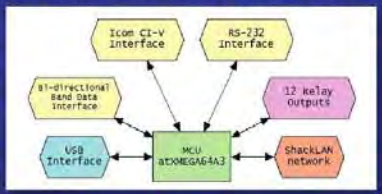

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Array Solutions' products are in use at top DX and Contest stations worldwide as well as commercial and governmental installations. We provide RF solutions to the DoD, FEMA, Emcomm, UN, WFO, FAA and the State Dept. for products and installation of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

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

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

KPA1500 Features

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

Separate remote-controlled power supply

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

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Up Front

Meeting the Future Makers

Wayne Grennier, N2LRE
waynegrennier@comcast.net

Last March, the South Plainfield Amateur Radio Club, in South Plainfield, New Jersey, took advantage of an excellent opportunity to introduce Amateur Radio to a younger audience. They set up tables at a Maker Day event at the John F. Kennedy Memorial Library in Piscataway and offered to help construct Morse code oscillator kits for anyone 12 years of age or younger. The kits were free of charge. The club also set up displays of various Amateur Radio interests.

Members of the South Plainfield Amateur Radio Club assist with building Morse code oscillators at the Maker Day event at John F. Kennedy Memorial Library in Piscataway, New Jersey.

ARRL Northern New Jersey Section Manager Rob Roschewsk, KA2PBT, explains how the kit works.

The South Plainfield Amateur Radio Club provided free Morse code oscillator kits to anyone 12 years of age or younger who wanted to build one.

Harry Chiovarou, KC2PGX, looks on as a young boy assembles his kit.

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"I am very pleased with the CLRspkr here, I also want to praise the West Mountain staff for standing behind their product and wonderful customer support. Thank you."

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DX
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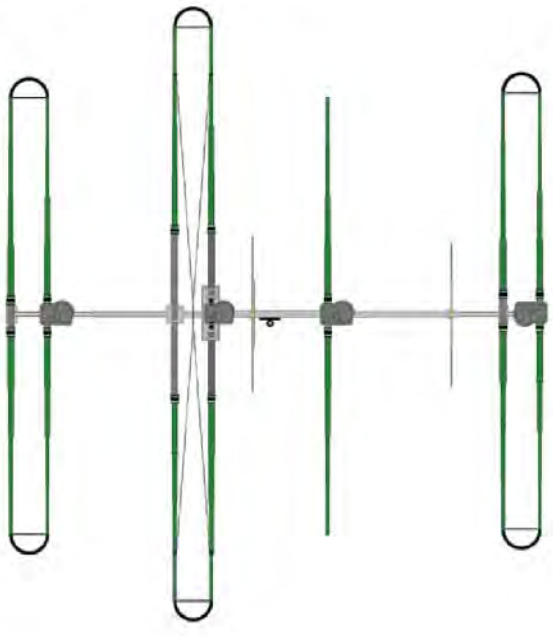
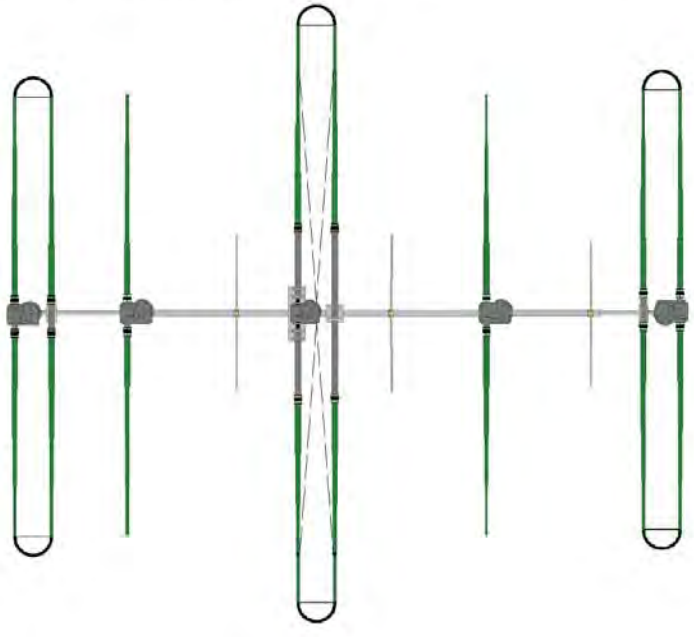
DB36 40-6m 4 Element Yagi

The DB36 Yagi is unique among the Dream Beam series antennas in that it has a single feed line, and no relays inside the EHU's. The DB36 has a 49 ft looped driven element. This patented design allows us to make the end loop elements only 39 feet long, yet the performance is as if all 3 of the loop elements are 49 feet long. The folded dipole loop technology lets the footprint be 40% less than that of the a full sized Yagi. There are 3 active elements on 40/30m and 4 active elements on 20m-6m. The DB36 has a optional 80M dipole that allows for full coverage of the 80M band. The dipole runs parallel to the boom and uses the end elements as capacity hats, creating zero interaction with the rest of the antenna.



DB42 40-6m 5 Element Yagi

The DB42 MonstIR Pro is currently the largest of the DB series of Yagi antennas, with five active elements on 20m-6m and three active elements on 40/30.
For those who aspire to the pinnacle of performance, the DB42 provides coverage from 80m through 6m (with optional 80m dipole kit). The dipole runs parallel to the boom and uses the end elements as capacity hats, creating zero interaction with the rest of the antenna. The DB42 has a 49 ft looped driven element. This patented design allows us to make the end loop elements only 39 feet long, yet the performance is as if all 3 of the loop elements are 49 feet long. The folded dipole loop technology lets the footprint be 40% less than that of a full size Yagi.



Correspondence

Letters from Our Members

Make Time for Slow CW

The "How's DX?" column, "Let Us Know Before You Go," in the August 2018 issue of *QST* was enlightening. I would like to add to it: whether you're operating as part of a DXpedition, a regular contest, or a special event station, please allow a few minutes each hour for CW at about 10 WPM.

I have listened many times when a station calls CQ at 25+ WPM with no answer, especially when the band is so-so. Many of us want to contact you, but even when using a computer, we can't keep up. I would rather work 10 stations in a given period of time at slow CW than contact only one or two in the same time period. Winning is the name of the game in contests and gaining the points. Dedicating a few minutes, say, on the half hour, may give you a surprise.

Al Wasielewski, WA2VJL
San Benito, Texas

QSL Card Caution

While many DX operators have shifted to Logbook of The World (LoTW) and/or eQSL, there are still quite a few who prefer exchanging paper QSLs. Many of these cards move through the IARU/ARRL QSL Bureau system.

I'm the current manager for the Hawaii KH6 Bureau. Recently, within the space of 2 weeks, I received two large packages containing a total of about 2,500 QSL cards. After sorting and cataloging them, I found over 500 of these cards were undeliverable and had to be discarded. Some were for KH6 visitor operations where the operator was not a Hawaii resident and had left instructions on **qrz.com** that cards were to be sent elsewhere, but most were for KH6 calls where the operator had clearly indicated on **qrz.com** that bureau cards were not wanted or accepted. In these cases, I always confirm with the KH6 operator that the cards are to be thrown away before I do so. Many of these stations are high-volume contest operators who get hundreds or thousands of cards per year, and they are understandably not willing to put in the effort and expense to send paper QSLs.

It would save a lot of money and effort on the part of many people if stations wishing to QSL via the bureau system would first look up the DX call sign and follow any QSLing instructions, including acceptance/non-acceptance of paper or bureau cards.

Ned Conklin, KH7JJ
Honolulu, Hawaii
Life Member

Finding Voluntary Interceptors

Thank you for publishing the "Classic Radio" article, "Tales of a World War II Voluntary Interceptor," in the June 2018 issue of *QST*. The author, Ray Fautley, G3ASG, is one of the few remaining Voluntary Interceptors from World War II.

In the buildup to the war, Lord Sandhurst (then involved in the intelligence service) solicited help from Arthur Watts, G6UN, (then the president of the Radio Society of Great Britain, RSGB) in recruiting a corps of radio amateurs who were known to be proficient in Morse telegraphy to monitor for enemy signals that might have been emanating from within the British Isles to handlers in Nazi-controlled Germany. Thus was born the Voluntary Interceptors (VIs).

The VIs arrived already trained in Morse code, had their own receiving equipment, were accustomed to digging weak signals out of the noise, and, therefore, could hit the ground running immediately upon recruitment. Working from their homes, the cost to the government was minimal. Records identifying members of the VIs were destroyed immediately after the war. Only estimates of their total number remain, with the predominant view being that there were between 1,200 and 1,700 during the war.

An effort is currently under way to attempt to gather as much information as possible about those who had served. Pete Windle, G8VG, is compiling a list of VIs, working alongside Bob King, G3ASE, who served as a VI and in the Radio Security Service at Arkley View, London, where the VI logs were processed, and Stan Ames, G4OAV, who worked on assembling spy sets. About 850 VIs have been identified. Their work, and of those who remain unnamed, is commemorated with a new display that has just opened at the RSGB's National Radio Centre located on the grounds of Bletchley Park, an hour's train ride from London. The listing is not yet available online, but anyone having information about someone who had served as a VI can send it, with as much detail as possible, please, to Pete at **pete.g8vg@gmail.com**.

John Swartz, WA9AQN
Petersburg, Illinois
Life Member

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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GEO-4K-COMP Digital World Clock for 4K TV ...$399.00

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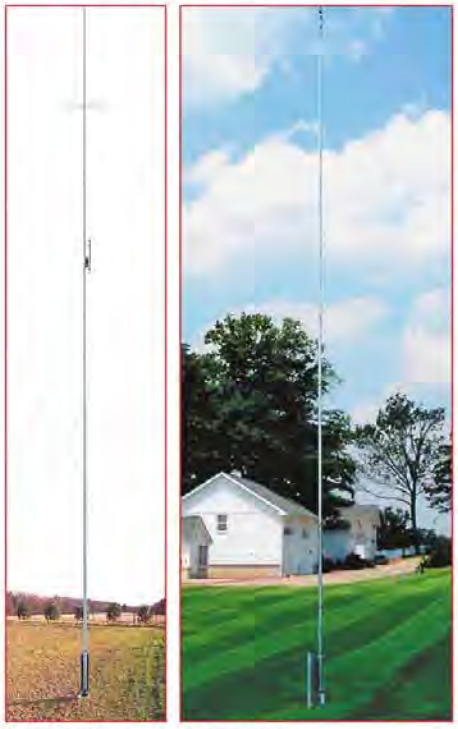
IC-7610 HF/50MHz Transceiver

Ask DXers and contesters who have purchased the IC-7610 and they'll tell you: ICOM hit a grand slam with its latest transceiver. It's packed with features that can take your station to the next level, especially when faced with poor band conditions, large pile-ups and faint signals. The IC-7610 introduces dual RF sampling receivers that achieve 110db RMDR, enabling you to pick out faint signals in the presence of stronger, adjacent signals. The unit comes with ICOM's innovative RF Sampling System, built-in automatic antenna tuner, DIGI-SEL for main and sub bands, a customized VCXO (used by the master clock) that produces ultra-low phase noise, high-quality speaker, 7-inch color display with touch screen, and a long list of CW, receiver, transmitter and operational benefits. Visit DXEngineering.com for full details and customer reviews. **ICO-IC-7610**

DX ENGINEERING



DXE-8040VA-1 **DXE-4030VA-1**

THUNDERBOLT® Vertical Antennas

The compact vertical THUNDERBOLT® DXE-8040VA-1 gives you an impressive presence on the 80 and 40 meter bands, yet stands a mere 55 feet high. It's a great solution if you want dual-band coverage, but can't put up multiple antennas. This self-supporting vertical offers instant bandswitching, easily handles the full legal limit, and delivers impressive bandwidth—300 kHz on 80M and 400 kHz on 40M. High-performance 40/30 meter (DXE-4030VA-1) and 160 meter monoband (DXE-160VA-1) models are also available.

DXE-4030VA-1 ...$284.99 **DXE-8040VA-1 ...$1,045.99**
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ICOM

IC-7300 HF/50 MHz Transceiver

The IC-7300's RF Direct Sampling System borrows SDR tech to replace the conventional superhetrodyne design with an RF Direct system. The result is a versatile and budget-friendly radio that delivers incredible receiver performance, easy filter adjustments and awesome audio clarity. **ICO-IC-7300**

Dust Cover for IC-7300
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HA8DU PRODUCTS

Antenna Tuners

DX Engineering offers a great selection of manual and automatic desktop antenna tuners from HA8DU. Solidly built and featuring exceptional-quality switches, capacitors, inductors and other components, HA8DU L- and T-type tuners deliver 1.8 MHz to 30 MHz coverage and smooth tuning in a rugged, reliable unit that will make a long-lasting addition to your station.

KENWOOD

TS-590SG HF/6 Meter Base Transceiver

Designed for the most demanding DX and contest operators, this 100 watt transceiver boasts highly reliable transmit outputs to deliver an exceptionally clean transmit signal. Expect the best receive dynamic range in its class versus off-frequency interference. Features include a built-in automatic antenna tuner, beat cancel and CW auto tune. **KWD-TS-590SG**

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Noise Cancellation Products

By harnessing cutting-edge digital signal processing technology, bhi Noise Cancellation Products are able to enhance the audio quality of your incoming signals. Removing the interference and noise makes it much easier for you to discern distant and weak audio signals.

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NCC-2 Receive Antenna Variable Phasing System

The NCC-2 combines the NCC-1 Phase Controller and our RTR-2 Receive Antenna Interface technologies into one unit. It features enhanced balance functionality, expanding its ability to phase between two different types of antennas. For those with antenna space constraints, you can easily null out noise by phasing your transmit and receive antennas. Or use two active verticals or loops with built-in bias tee that operates from 13.8 up to 21 Vdc. We've also expanded the NCC-2's versatility with internal slots for the new plug-in versions of our Receiver Guard 5000HD and RPA-2 preamplifier. **DXE-NCC-2...$749.99**

HF Amplifiers

ACOM has built a reputation among serious HF contesters for its high performance Amateur Radio gear. Nowhere is this more evident than with ACOM's stunning line of RF power amplifiers, including the 1200S solid state RF 1,000 watt amplifier with full HF and 6 meter coverage—a solid choice for DXing. See detailed features and specs on the entire ACOM lineup at DXEngineering.com.

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RTR-2 Modular Receive-Transmit Interface

Here is a better solution to add a separate receive antenna when your radio doesn't have a dedicated receive antenna port. It's also ideal for interfacing antennas and multiple radios. The RTR-2 improves upon the previous model by adding bias tee for an active antenna, 12-21 Vdc operation and three internal expansion slots. Add an optional Receiver Guard, RPA-2 preamp or a 75 to 50 ohm transformer.

DXE-RTR-2...$229.99

Footswitches

Go hands-free and speed up your operating. These new rugged PTT footswitches from DX Engineering blend performance and value. You have three options: a budget-friendly plastic model, the stalwart cast iron version, and a new style with an extra-wide pedal—perfect for enthusiastic stomps.

DXE-FS-001...$29.99 **DXE-FS-002...$69.99**
DXE-FS-003...$99.99

RM ITALY

HF and VHF Linear Amplifiers

RM Italy supplies Amateur Radio operators with cutting-edge radio communications equipment. Ham Radio enthusiasts in North America can purchase RM Italy's products through DX Engineering. That means DX Engineering customers can get RM Italy products without lengthy delays or complicated international shipping. DX Engineering carries the latest RM Italy gear, including the BLA600 500W and MLA100 100 watt HF+6M Linear Amplifiers.

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Save your wrist during those marathon contests and work long hours of DX without strain. DX Engineering's washable PaddlePads are a CW operator's best friends. They keep your key from sliding around on your desk and allow your wrist to stay at a comfortable angle. The PaddlePads come in two sizes.

DXE-PADDLEPAD-L 5.75" x 7.50" **$11.99**
DXE-PADDLEPAD-S 3.75" x 5.875" **$8.99**

Key not included.

HA8KF CW Paddles

Equip your shack with a European-made HA8KF iambic dual-lever magnetic tension paddle and feel the comfort and ease that a finely crafted instrument can make for your CW sessions. Offered exclusively in North America by DX Engineering, HA8KF paddles are made with top-grade materials and are built to last, with extra-heavy base, precision bearings and solid brass polished hub. Built for easy tension adjustments on the fly, each plug-and-play model comes pre-wired with a 1/4" phone plug.

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Phonema makes speakers and speaker upgrades that give you audiophile-grade sound reproduction, perfectly matched to Ham Radio's unique audio qualities. Running an SDR? They're an excellent alternative to tinny, harsh computer speakers. Sleek and elegant, Phonema speakers are an aural and aesthetic complement to any base station setup.

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Turn your SDR into a panadapter to see entire bands on frequency/waterfall displays...

New!

An inexpensive wide-band SDR dongle receiver lets you see entire bands on frequency/waterfall computer displays!

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 50 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.

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MFJ-1020C
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Make your SDR receiver come alive with HF signals, .3-40 MHz, while rejecting interference with MFJ-1020C *tuneable* indoor active antenna! Gain control, telescoping whip.

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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.

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Tuneable MFJ-1040C lets you copy weak, noisy SDR signals from 1.8 to 54 MHz. Greatly tunes out and reject out-of-band interference. Up to 20 dB gain. Has gain control. Cascode FET/bipolar transistor gives low noise, high gain without overloading. Switches for 2 antennas and 2 receivers. SO-239s. Has 20 dB attenuator. Automatically bypasses when transmitting or use PTT. 6½W x 2½H x 4D inches.

MFJ LW/MW/SW SDR Preselector/Tuner

MFJ-956
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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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APRS (The Automatic Packet Reporting System) is a registered American trademark of WB4APR (Mr. Bob Bruninga). D-Star is a digital radio protocol developed by JARL (Japan Amateur Radio League).

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An Active Dipole for Long- and Medium-Wave Frequencies

Tune in to the activity below the AM broadcast band with this easy-to-build active dipole.

Bob Dildine, W6SFH

Several local hams and I get together Monday mornings to have breakfast and discuss ham radio topics. One recent topic was the construction of an active antenna with directional characteristics that could be used to null nearby sources of noise and interference. It should cover a range from very low frequency (VLF) through high frequency — approximately 10 kHz to 30 MHz — and be remotely powered through inexpensive transmission line, weatherproof, inexpensive, and easy to reproduce. Multiple identical active antennas could be combined with appropriate phasing to provide additional directivity and beam forming for manmade (QRM) and atmospheric (QRN) noise reduction.

An Electric Field Sensor

A short dipole retains the classic toroidal pattern of a full-size dipole with nulls off the ends, but its impedance is very high. It can be modeled as a voltage source in series with several hundred thousand ohms and several picofarads. When connected to a low-impedance load such as the 50 Ω input of a receiver, most of the received signal is lost. Thus, we need an amplifier with high input resistance and low capacitance. The antenna is a voltage probe that senses the electric field of the incoming signal.

Many active antennas are omnidirectional. Common examples are car radio antennas consisting of a small electric field probe ranging from a few centimeters to about 15 – 20 centimeters in length, mounted on the rear roof of the car (see Figure 1). A small enclosure at the bottom houses an amplifier with high input impedance.

Figure 1 — Small electric field probe mounted on the rear roof of a car.

Today, there are several integrated op-amps with input capacitance as low as or lower than what the JFET used a few years ago. Using an op-amp has the advantage of simplicity and being able to incorporate gain in the same stage. The Analog Devices AD8065 has a specified input impedance of 1,000 GΩ shunted by 2.1 pF, and has a typical bandwidth of 145 MHz, making it a good candidate for the input stage of an active antenna.

Initial Investigation

Glenn Elmore, N6GN, built a breadboard using the AD8065 op-amp that showed the feasibility of the circuit. He used dipole elements of about 50 centimeters on each side, feeding voltage followers with 2 MΩ input impedance. The outputs of the voltage followers were summed with a differential amplifier that drove CAT5 LAN cable. The circuit was battery powered and housed in a ½-inch PVC electrical T. The performance of the device met expectations but had the drawback of being battery powered.

CAT5 LAN cable consists of four twisted pairs. Each pair has a characteristic impedance of 100 Ω and the twist pitch of each pair is different to minimize crosstalk. It is inexpensive and is available shielded and with a direct-burial jacket at a reasonable price.[1] By using CAT5 cable instead of coax, power can be supplied to the active circuit at the antenna on one of the pairs, leaving the other three pairs for RF signals. Shielded CAT5 cable along with good ground management minimizes common-mode ingress of unwanted signals and noise.

[1]See **www.cablewholesale.com/products/network-phone/cat-5-e-stp-cables/product-10x6-722nh.php**.

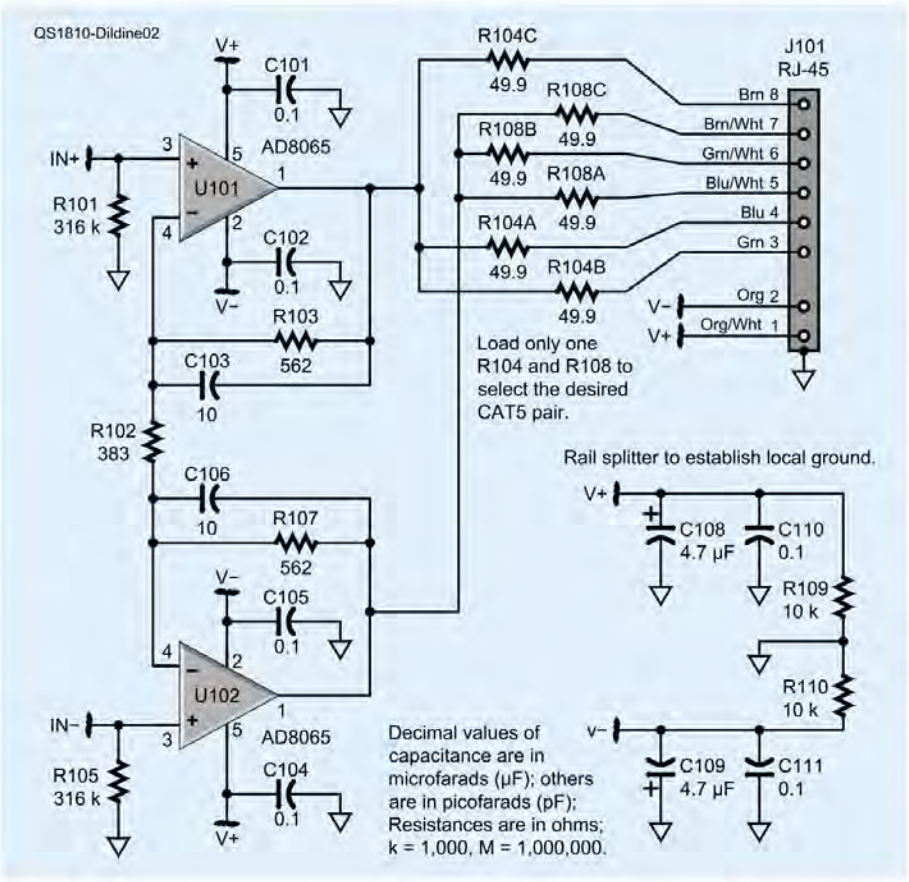
Figure 2 — Active dipole preamp.
C101, C102, C104, C105, C110, C111 — 0.1 µF ceramic
C103, C106 — 10 pF ceramic
C108, C109 — 4.7 µF ceramic
J101 — RJ-45 female connector
R101, R105 — 316 kΩ
R102 — 383 Ω
R103, R107 — 562 Ω
R104, R108 — 49.9 Ω
R109, R110 — 10 kΩ
U101, U102 — AD 8065 op-amp

The differential summing amplifier acts as a broadband active balun to convert the balanced CAT5 twisted pair into 50 Ω coax.

Circuit Details

Glenn's approach closely resembles an instrumentation amplifier so the three AD8065 op-amps were reconfigured as an instrumentation amplifier, as shown in Figures 2 and 3. An instrumentation amplifier means better balance seen by the two dipole elements. The two halves of the instrumentation amplifier are split into a preamp located at the antenna elements and a summing amplifier located in the ham shack next to the receiver. The two circuits are connected with shielded, direct-burial CAT5 LAN cable.

Two separate AD8065s — U101 and U102 — are used for the preamp shown in Figure 2. Preamp gain is set by the ratio of R103 (or R107) and one-half R102. The preamp gain is 9.2 dB. R101 and R105 provide a dc return path for the small bias current of the AD8065, and sets the input resistance seen by the dipole



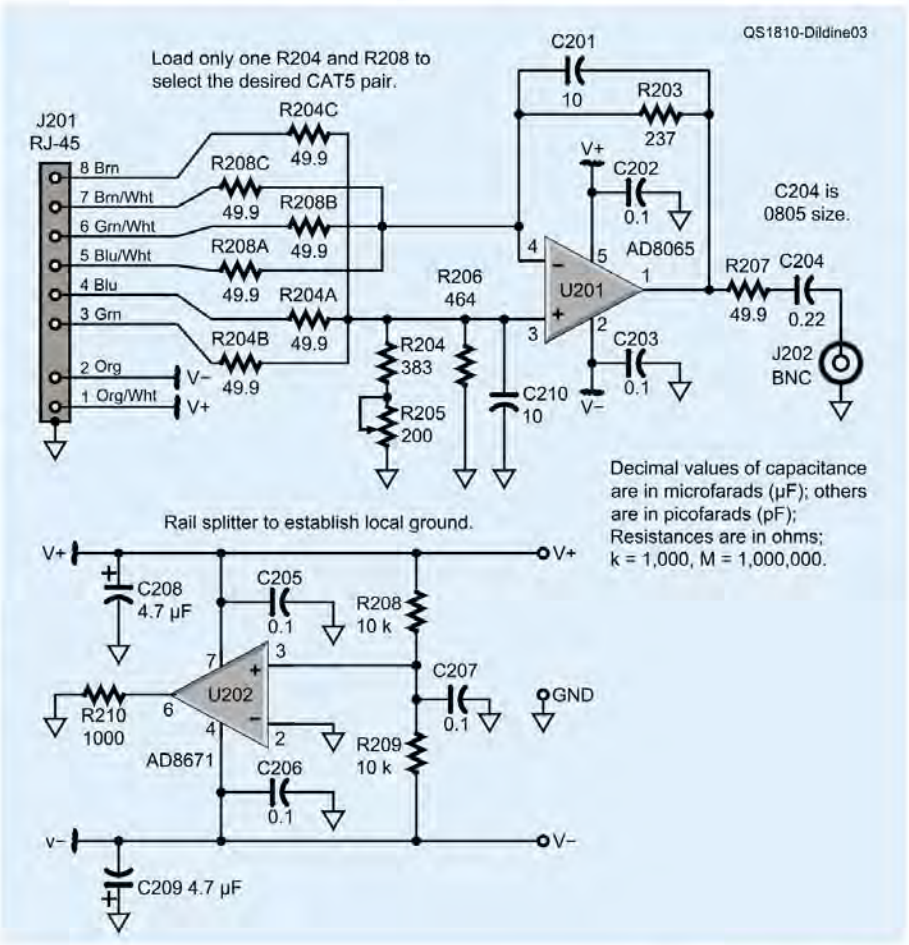


Figure 3 — Active dipole summing amplifier.
C201, C210 — 10 pF ceramic
C202, C203, C205, C206 — 0.1 µF ceramic
C204 — 0.22 µF ceramic
C208, C209 — 4.7 µF
J201 — RJ-45 female connector
J202 — Coax connector, builder's choice
R201, R202, R207 — 49.9 Ω
R203 — 237 Ω
R204 — 383 Ω
R205 — 200 Ω trim potentiometer
R206 — 464 Ω
R208, R209 — 10 kΩ
R210 — 1 kΩ
U201 — AD 8065 op-amp
U202 — AD 8671 op-amp

elements. The value was chosen after extensive evaluation — described later — and is a good compromise between sensitivity, overload on strong local signals, and amplifier stability. R104 and R108 provide terminations for the input of the 100 Ω CAT5 cable. Only one pair of resistors is loaded — R104A, B, or C and R108A, B, or C — to select one of the three available pairs in the CAT5 cable. This allows multiple antennas to be daisy-chained on one cable run for experiments with phased arrays. C103 and C106 provide compensation for the capacitance of the dipole elements on the inputs of the op-amps. The preamp 3 dB bandwidth is about 25 MHz. Smaller capacitors could be used to extend the upper frequency range, but the dipole elements may have to be shortened if there is a problem with stability.

In an effort to keep everything balanced and minimize pickup of unwanted signals and noise, dc power is supplied by one of the pairs in the CAT5 cable with no ground return. A simple rail splitter to establish local dc ground is provided by R109 and R110.

The second half of the instrumentation amplifier is a differential summing amplifier using U201, another AD8065, as shown in Figure 3. Its gain is set by the ratio of R203 and the sum of R104 and R202. The gain is 7.6 dB, giving an overall gain for the antenna of 16.8 dB. R201 and R202 provide load termination for the 100 Ω CAT5 cable. Again, only one pair of resistors is loaded to select the desired pair in the CAT5 cable.

R205 is used to adjust the balance of the differential amplifier to maximize common-mode rejection of signals picked up by the CAT5 cable. The combination of R204, R205, and R206 is selected to give a total resistance of 237 Ω ±10%. This allowed me to use up a supply of some 200 Ω trim pots that were on hand.

Figure 4 — Preamp board (left) and summing amplifier (right) boards are connected with shielded CAT5 cable.

Figure 5 — Preamplifier mounted at the dipole feed point.

C201 and C210 provide compensation for the capacitance of the CAT5 cable on the op-amp input.

U202 is a rail-splitter to establish local dc ground. This rail-splitter must supply the dc component of the output signal from U201. The dc supply voltage can be anything from about 10 to 24 V. Supply current for both the preamp and the summing amp together is about 35 mA. A higher supply voltage will allow the op-amp outputs to swing further without saturating on strong local signals, but in no case should the op-amp maximum rating of 24 V be exceeded. A split supply (±5 V to ±12 V) can also be used, in which case the rail-splitter op-amp can be omitted.

Construction

Small printed circuit boards (PC boards) were fabricated for the circuits as shown in Figure 4. Others should be able to make their own boards using one of the prototyping services such as ExpressPCB. The circuits can also be built "dead bug" style on small pieces of copper-clad board.

The preamp circuit is housed in a ¾-inch PVC electrical T, shown in Figure 5. The dipole elements are 1/16-inch brazing rods approximately 45 centimeters long, held in place by ½-inch PVC plugs threaded into bushings that are glued into the ends of the PVC T. Inside the T, the ends of the brazing rods are connected to the PC board by short lengths of thin wire. The holes through the PVC plugs for the dipole elements are sealed with flowable silicon windshield and glass sealer, available at most auto supply houses. The whole assembly is supported by ¾-inch schedule 80 PVC fastened to the stem of the PVC T with appropriate adapters. This is in turn fastened to a 1-inch electrical metallic tubing (EMT) sweep supported by a 10-foot length of 1-inch EMT, as shown in Figure 5. The dipole is mounted vertically, making it omnidirectional with vertical polarization. If it is mounted horizontally, advantage can be taken of the dipole's directivity to null unwanted noise sources. All threaded connections should be sealed with Teflon tape and all glued connections should be made up as if they are to withstand water pressure. This will ensure the weatherproof integrity of the housing.

Figure 6 — Summing amplifier mounted in an aluminum box. A small linear power supply is on the left. A 550 kHz low-pass filter is visible below the summing amplifier PC board.

Figure 7 — Active dipole with preamp board inside the PVC **T**. Shielded CAT5 cable runs down the conduit.

The summing amplifier was mounted in a small box fabricated from scrap aluminum, shown in Figure 6. A small linear power supply was included in the box as well as a 550 kHz low-pass filter that can be switched out for reception of the AM broadcast band and higher frequencies. The active dipole, seen in Figure 7 mounted on conduit, can also be powered from batteries or an appropriate wall wart, but switching supplies should be avoided to minimize RFI.

Adjustment

The preamp assembly should be placed in its approximate final location and connected to the summing amplifier with shielded CAT5 cable. Connect the CAT5 shield to the summing amplifier ground and the station ground. Do not connect the shield to the preamp ground. The dipole elements should be left off for now and replaced by a couple of 1 kΩ or so resistors. The other ends of the resistors should be connected together. This effectively connects the two inputs of the instrumentation amplifier together with a little isolation between them to maintain stability.

Apply power to the summing amplifier and connect its output to a receiver or spectrum analyzer. Tune in a local broadcast station and adjust R205 for minimum signal. This optimizes common-mode rejection of the summing amplifier to minimize pickup by the CAT5 cable. After adjusting R205, remove the 1 kΩ resistors and connect the dipole elements. Element lengths from 30 centimeters to about 90 centimeters should work. Longer lengths may cause instability in the preamps or overload by strong local AM broadcast stations. Sensitivity starts to fall off significantly with element lengths shorter than about 30 centimeters.

> *"By using CAT5 cable instead of coax, power can be supplied to the active circuit at the antenna on one of the pairs, leaving the other three pairs for RF signals."*

Performance

Extensive testing was done with various dipole element lengths and various values of input resistance on the preamp using 60 kHz signals from WWVB (about 1,500 kilometers from this location), nondirectional beacon FCH at 344 kHz (about 300 kilometers from this location), and several broadcast stations both local and several hundred kilometers away. With long elements and high input resistance, and in the presence of strong AM broadcast signals, the preamp had a tendency to oscillate at several hundred kilohertz, espe-

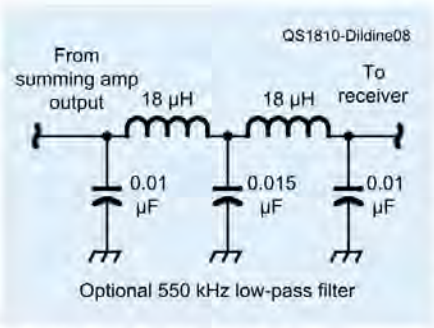


Figure 8 — Optional 550 kHz low-pass filter.

cially when using long lengths of unshielded CAT5 cable between the preamp and the summing amplifier. Switching to shielded CAT5 made the system much more stable. Also, with long element lengths, the system would overload due to strong local AM broadcast stations. The best trade-off between sensitivity, overload, and system stability was found to be with 90-centimeter elements and 316 kΩ input resistors on the preamp. With 80 meters of shielded CAT5 between the preamp and the summing amplifier, no sign of instability was observed.

Strong local broadcast stations can overload the receiver connected to the active dipole. The signal at the summing amplifier output from KSRO here in Santa Rosa (about 5 kW ERP, 4.3 kilometers from my location) is well over 10 mW on modulation peaks. Others living closer to KSRO have seen even higher signal levels. When using the active dipole for VLF or low frequency (LF), such as monitoring 136 kHz or 474 kHz, it may be necessary to place a low-pass filter between the summing amp output and the following receiver to reduce overload from the AM broadcast band. Figure 8 shows a suitable filter with a corner frequency of about 550 kHz. A high-pass filter may be necessary if the active dipole is to be used above 2 MHz in the presence of strong AM broadcast stations. For situations with extremely large broadcast signals, the gain of the preamp may be reduced by increasing R102.

With the dipole elements mounted vertically about 12 feet off the ground and surrounded by trees, WH2XND (1,036 kilometers from here), is regularly spotted on 136 kHz WSPR with signal-to-noise ratios of –25 dB during daylight hours to 0 dB at night. On 474 kHz WSPR, K9FD in Hawaii (3,810 kilometers away) is regularly spotted with a signal-to-noise ratio of –20 dB during the day and better than –5 dB at night. VK4YB (11,395 kilometers away) and ZL2BCG (10,985 kilometers away) have been spotted multiple times.

I don't have a receiver that tunes below 100 kHz, but Navy VLF stations from all over North America as well as Australia are clearly visible on the spectrum analyzer (see Figure 9).

Acknowledgments

The following members of our Monday morning coffee group gave valuable advice and suggestions: Doug Bender, WW6D; Roger Stevens, KK6EEW; Glenn Elmore, N6GN; Allan Beer, K6GSO; Tom Yarish, KJ6MKI; John Watrous, K6PZB; Stephen Sparks, WA6UAT, and Maiko Dildine, W6MLD.

Bob Dildine, W6SFH, was first licensed in 1957 as WN6SFH, and has been interested primarily in the technical aspects of Amateur Radio from audio to microwaves. He received a BSEE from San Diego State College in 1967 and an MSEE from the University of California at Berkeley in 1973. He then joined Hewlett-Packard as an R&D engineer where he has done precision analog design on microwave synthesizers and network analyzers. He retired from Agilent Technologies in 2003 and continues to enjoy designing and building Amateur Radio projects, as well as restoring vintage electronic equipment.

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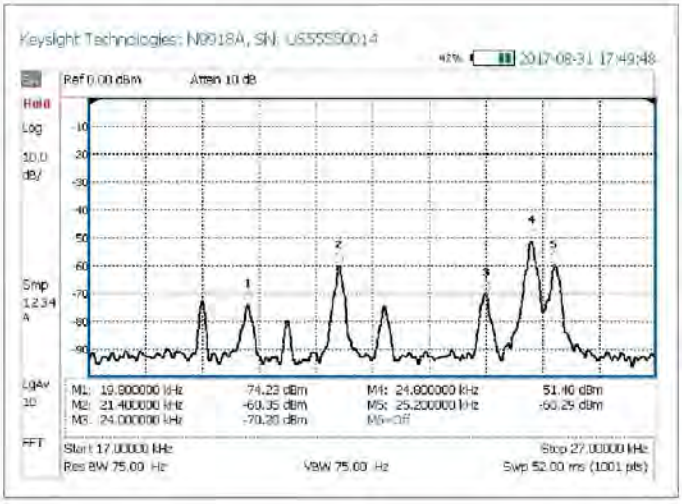


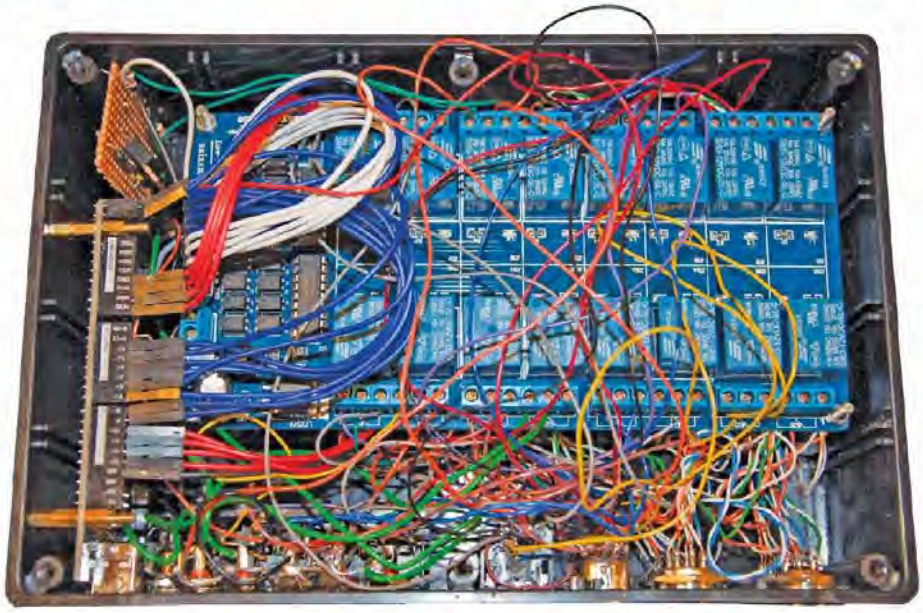
Figure 9 — Spectrum analyzer display of VLF station received with the active dipole. Table 1 identifies the markers.

Table 1
VLF stations observed with active dipole from Santa Rosa, about 80 km north of San Francisco.

Marker	Frequency	Station	Location
1	19.8 kHz	NWC	Victoria, Australia
2	21.4 kHz	NPM	Hawaii
3	24.0 kHz	NAA	Cutler, Maine
4	24.8 kHz	NLK	Jim Creek, Washington
5	25.2 kHz	NMJ	La Moure, North Dakota

A Reconfigurable Station Component Switching Unit

Mark C. Noe, KE1IU



This Arduino-controlled interconnection matrix lets you switch between different station configurations without re-cabling.

Amateur Radio stations generally start out simple — perhaps one antenna, a transceiver, a straight key, and a microphone. Then you bring home an electronic keyer and paddle from a swap meet. It's not a problem to unplug the straight key and plug in the new set. Even the addition of a new antenna is easily handled with a double-throw knife switch, but as the station grows with the accumulation of linear amplifiers, QRP (low-power) kits, a special rig for satellite work, new antennas, etc., changing the station configuration becomes a re-cabling nightmare that is not only time consuming, but prone to error.

My way out of the station reconfiguration conundrum was to design a relay switching matrix controlled by an Arduino microcontroller and the *OpenHAB* application that would be easy to configure and allow for continued station expansion.

System Design

I use *OpenHAB* version 2.0, which is an open-source server application that is capable of integrating hundreds of Internet of Things (IoT) devices into a customizable graphic user interface (GUI) for monitoring and control. *OpenHAB* interfaces to these devices through drivers called bindings. There are unique bindings that can be downloaded into the system for each IoT device that one wishes to enable.

OpenHAB is capable of running on a Windows, Mac, or Unix-based system, such as a Raspberry Pi microcomputer. My home automation system runs on a Raspberry Pi, but I thought it would be more convenient to run a second instance of *OpenHAB* on my radio station's PC, affording direct control of the Arduino through its USB port. The feasibility of this idea was reinforced by the existence of a serial binding for *OpenHAB*, which allows communication to any device connected via an RS232 port (or emulator). The act of customizing the interface could then be done simply through software by modifying the item, rule, and sitemap files that configure the *OpenHAB* GUI.

Hardware

The hardware for the actual switch is quite simple. I used an Arduino Mega 2560 microcomputer for the interface (see Figure 1A). It has the required number of digital I/O interfaces and is available for less than $20 at several vendors.

For the relay boards, I used two SainSmart 16-channel relay modules. These units are comprised of 16 single-pole double-throw (SPDT) relays, plus all of the switching circuitry to convert a 5 V digital high or low signal to the appropriate switching state of the relays. For any one of the 16 input pins, a digital high leaves the relay in its open (relaxed armature) state, whereas a digital low pulls down the relay armature. As an added bonus, the SainSmart boards also contain a 5 V regulator, allowing them to be connected directly to a 12 – 14 V power supply and provide the required 5 V for the Arduino computer.

The peripheral connectors (see Figure 2) include a 13-pin DIN connector for the Icom-9100 accessory cable, eight-pin and seven-pin DIN connectors for the Icom IC-756PROII accessory cables, an eight-pin DIN connector for the Kantronics KAM

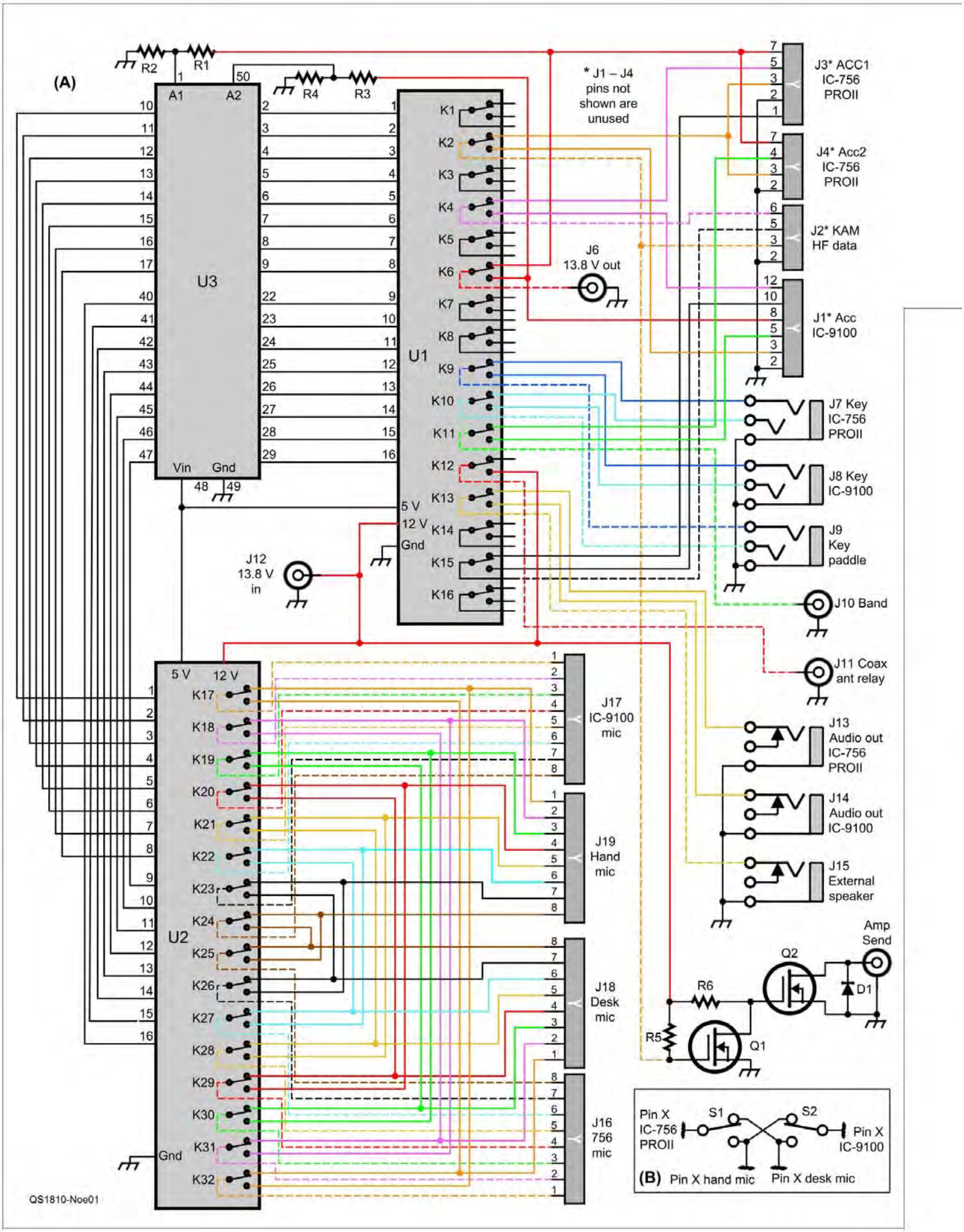

(A)
R2
R1
R4
R3
A1
A2
U3
Vin
Gnd
U1
5 V
12 V
Gnd
K1
K2
K3
K4
K5
K6
K7
K8
K9
K10
K11
K12
K13
K14
K15
K16
* J1 – J4 pins not shown are unused
J3* ACC1 IC-756 PROII
J4* Acc2 IC-756 PROII
J2* KAM HF data
J1* Acc IC-9100
J6 13.8 V out
J7 Key IC-756 PROII
J8 Key IC-9100
J9 Key paddle
J10 Band
J11 Coax ant relay
J12 13.8 V in
U2
K17
K18
K19
K20
K21
K22
K23
K24
K25
K26
K27
K28
K29
K30
K31
K32
J17 IC-9100 mic
J19 Hand mic
J18 Desk mic
J16 756 mic
J13 Audio out IC-756 PROII
J14 Audio out IC-9100
J15 External speaker
Amp Send
Q2
D1
R6
R5
Q1
Pin X IC-756 PROII
S1
S2
Pin X IC-9100
(B) Pin X hand mic
Pin X desk mic
QS1810-Noe01

Figure 1 — Schematic diagram of the component switching unit. Inset (bottom right): Simplified schematic detailing the wiring of one microphone jack pin.
J1 — 13-pin female DIN connector
J2, J3 — Eight-pin female DIN connector
J4 — Seven-pin female DIN connector
J5, J6, J10, J11 — RCA female phone jack
J7, J8, J9 — Eight-pin male circular DIN connector
R1, R3 — 33 kΩ ¼ W resistor
R2, R4, R5, R6 — 10 kΩ ¼ W resistor
Q1 — VN10LP FET Ω
Q2 — IRF730 FET
U1, U2 — SainSmart 16-relay switching module
U3 — Arduino Mega 2560 microcomputer

Figure 2 — Back panel of the switching unit.

interface, ¼-inch phone jacks for the keyer paddle connections, ⅛-inch phone jacks for the external speaker connections, RCA jacks for the amplifier, coaxial antenna relay and automatic antenna switch cables, eight-pin circular DIN connectors for the microphone cables, and a coaxial power connector.

Construction

Construction requires careful attention to the layout of chassis jacks for the various cables (see the lead photo). With 32 relays possessing three connectors each, along with 32 digital lines from the computer to the relay boards (if all relays are connected), there will be quite a bit of wire in the case. I used #20 AWG wire to connect the chassis jacks to the relays. The Arduino pins are connected to the relay board using male to female patch cables.

The two relay boards are stacked on top of each other with 1-inch nylon spacers. The Arduino computer is mounted on the side of the case using brass standoff nuts. Using a plastic case makes hole forming easy for the connectors and the Arduino USB port.

A nice feature of the SainSmart relay board is the presence of LEDs for each relay to indicate its status. This feature assists tremendously with diagnostics. Use an ohmmeter to determine the identity of the contacts so you can wire the connectors appropriately. Each relay triggers when its corresponding input is grounded, so all you need to do is apply power to the board, ground the input pin, and use the ohmmeter to verify connectivity on the relay.

Operation

On startup, the Arduino computer sets all digital outputs to high, thereby leaving each relay in its relaxed state. This is the default configuration for the switching interface, and I have it set to configure my primary radio for use. Upon receiving the appropriate command, the Arduino computer sends several or all digital outputs low, triggering the appropriate relays to switch pins from the connectors to connect various peripherals to the desired radio. In addition, I incorporated an automatic switching feature. Each radio has a low current 13.8 V output on its accessory jack. A simple resistive voltage divider drops that voltage to +3 V, yielding a signal on one of two analog inputs for the Arduino. When set to automatic mode, the Arduino determines which radio is turned on by sensing the voltage on the analog inputs. The Arduino then automatically switches the peripherals to that radio. In the event that both radios are turned on, then both analog inputs will have positive voltage, and the switch will put all peripherals on the default radio.

One exception involves how the unit is configured to handle the microphone inputs. These inputs are managed through relay board 2. Because I have two microphones (a desk mic and a hand mic), I have them set up in a crisscross configuration. In the default instance, where Rig A is selected, the desk microphone is connected to the IC-756PROII and the hand microphone is connected to the IC-9100. When Rig B is selected, the microphones switch. The wiring used to achieve this configuration is quite dense on the full schematic, so a simplified version showing the wiring of one pin is depicted in Figure 1B.

Software and configuration instructions are available on the "*QST* in Depth" web page, **www.arrl.org/qst-in-depth**.

Conclusion

The most complicated part of construction will likely be customizing the software if you are unfamiliar with Arduino programming or the *Open HAB* application. However, you will find learning how to program these devices to be very useful. Best of all, you will never have to swap a cable the next time you want to change radios or devices in the middle of an operating session or contest!

Photos by the author.

Amateur Extra-class license holder Mark Noe, KE1IU, was first licensed at age 10 in 1980 as KA2KPB and has been a member of ARRL for 37 years. Mark received his Bachelor's degree in chemistry from the University of Michigan and his PhD in organic chemistry from Harvard University. When away from his job leading a pharmaceutical industry drug discovery research group, he likes building antennas and station accessories. Mark enjoys HF DXing along with occasionally working low-Earth orbit satellites and operates on SSB, CW, RTTY, and FM. You can reach him at **ke1iu@arrl.net**.

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This sound card interface lets you use new digital modes on your classic transceiver.

Go Digital with Your Classic HF Transceiver

Today, Amateur Radio has some amazingly sophisticated and powerful HF digital modes available to operators using a computer and sound card interface — that is, a device internal or external to the computer that provides a digital-to-analog (DAC) and analog-to-digital (ADC) function.

Paul Newland, AD7I

This article describes a simple, low-cost USB sound-dongle adapter that can be used with classic radios to take advantage of the many digital modes in *fldigi* and *WSJT-X* (including FT8) software. It should work with any other digital communications programs intended for use with a sound card.

Basic Functionality

Figure 1 shows a block diagram of the system. Software on your computer generates the digital signal protocol and feeds it via the USB port to the DAC of the sound card, which generates an analog audio signal that modulates the transmitter, which is in upper SSB mode. The sound card interface also includes circuitry that detects the audio from the computer in transmit mode and generates a "push-to-talk" (PTT) signal to key the transmitter.

In receive mode, the transceiver feeds analog audio to the sound card ADC, which supplies a digital copy of the signal to the computer via the USB connection, that then decodes the digital signal format in software. It's a simple system. All the magic is contained in the computer software that has been created by radio amateurs to implement these digital transmission protocols.

The Radio Audio Interface

Most ham radio stations in the 1950s and '60s did not use audio transformers in the audio path between the sound card — then, a terminal unit — and the radio. However, it's rarely det-

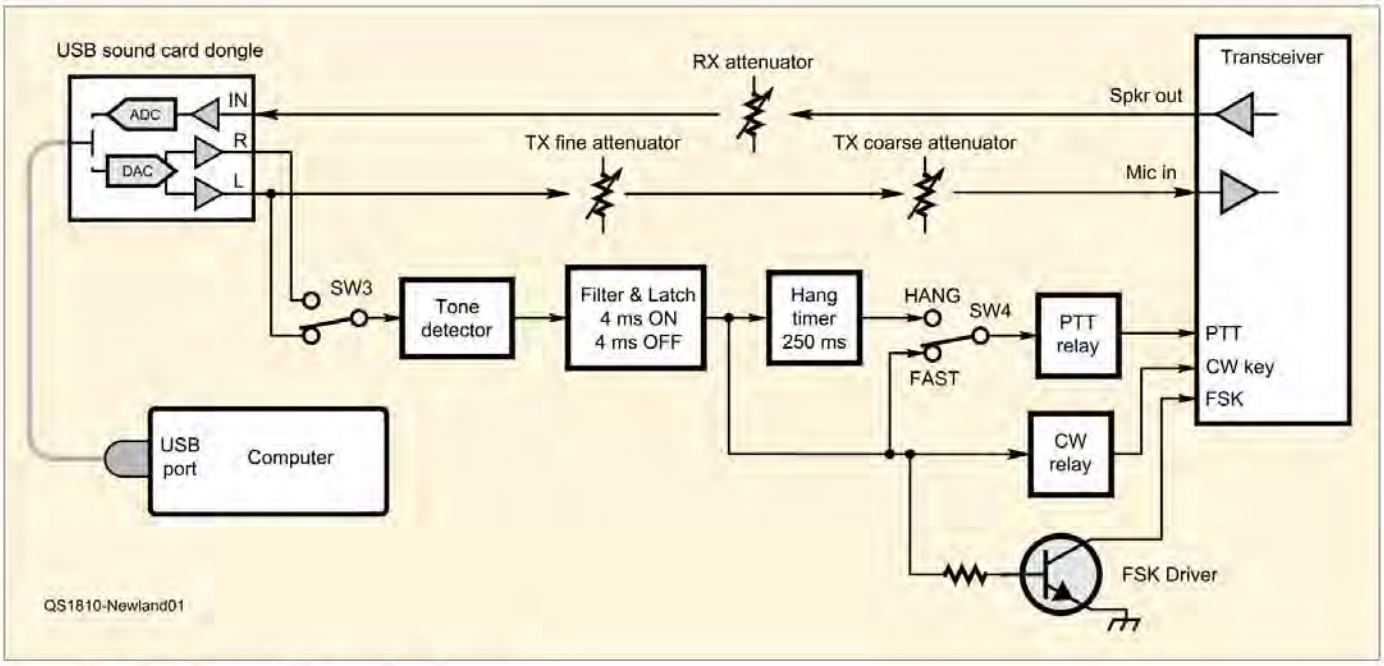

Figure 1 — Block diagram of the sound card system.

rimental to include audio isolation transformers. [The use of ferrite beads on cables, and audio isolation transformers and/or opto-isolators to dc-isolate your transceiver from the sound card and the computer is highly recommended as a measure to mitigate EMI, RFI, and RF common-mode current issues, which may damage the USB port of the computer. — *Ed.*] You can choose to omit the isolation transformers, and simply connect the audio input/output from the internal sound card of the computer directly to the transceiver using dc blocking capacitors and a passive resistive attenuator. I don't recommend omitting the attenuator.

I opted to use an external sound card rather than the internal sound card in my PC and laptop. I make use of a USB sound dongle in this project that I obtained on eBay (**ebay.com**) for less than $4 and connect it to a computer via the USB port. How the dongle is used on my circuit board can be seen in Figure 2.

The Classic Radio Characteristics

Like most classic radios, the audio output amplifier is applied to the internal speaker via the headphone jack — both are controlled by the front panel volume control. Inserting a plug into the headphone jack mutes the speaker. The headphone audio output has a low impedance and can produce an output of at least 10 V ac p-p. The radio's internal volume control determines the amplitude of the audio output. For radio transmit audio, there is a ¼-inch tip-ring-sleeve (TRS) input. Like a standard three-conductor audio stereo headset plug, the microphone jack is used for the transmit audio and for PTT control. The PTT is on the tip contact, and microphone audio is on the ring contact. The radio microphone audio will easily produce an RF power output of 100 W with the transceiver drive control set to about 25% rotation.

The USB Sound Dongle

Your USB sound dongle might look different from mine. Be sure to do some basic electrical testing of your sound dongle before getting deep into the project. A USB connector is on one end and audio I/O are on the other end. The audio I/O passes through two 3.5-millimeter TRS jacks. One of the TRS jacks has **RIGHT** and **LEFT** channel stereo audio output. The **LEFT** is on the tip, **RIGHT** is on the ring, and the **SLEEVE** connects to USB/dongle-board ground.

Each output can drive an impedance as small as 32 Ω when connected through a dc blocking capacitor. A lower value load may result in clipping on the high side of the waveform. Both the **LEFT** and **RIGHT** outputs are singled-ended (unbalanced) with respect to the USB ground. Maximum DAC code values will produce an audio output of about 3 V ac p-p (1 V rms).

The second TRS jack is for the mono microphone input. The tip and ring contacts on this jack are connected together on the dongle circuit board. There is about +5 V dc of bias on the tip and ring connections with a dc

> *"Be sure to do some basic electrical testing of your sound dongle before getting deep into the project."*

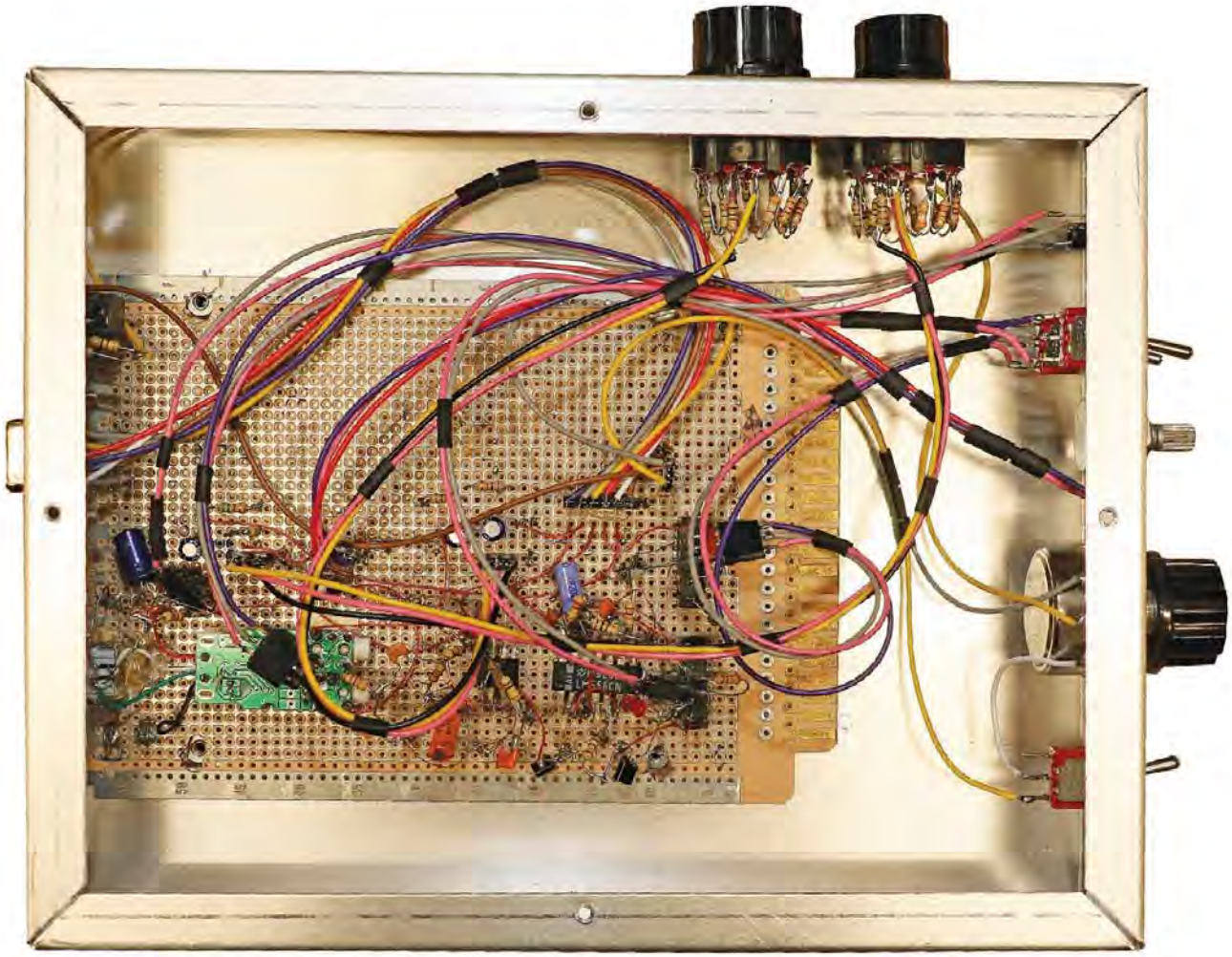

Figure 2 — Circuit board inside the aluminum housing. The sound dongle is visible on the lower left of the perf board.

source resistance of about 3 kΩ. Maximum ADC code values will occur with audio of either 60 mV ac p-p (20 mV ac rms) or 3 V ac (1 V ac rms) applied to the microphone input of the sound dongle, depending on the setting of the AGC option in the "Recording Devices" tab of the computer operating system driver window (if your sound card dongle driver software provides that option).

Please refer to the schematic sheets on the **www.arrl.org/qst-in-depth** web page. Sheet 1 is a block diagram, Sheet 2 shows the USB sound dongle interface, Sheet 3 shows the transmitter keying circuitry, Sheet 4 shows the PTT interface and the optional audio amplifier, and Sheet 5 shows a parts list for the project. Notations such as "3B1" seen on Sheet 2 mean that the matching connection can be found on Sheet 3, page coordinate B1; the reciprocal notation on Sheet 3 is marked "2A5."

The schematic of Sheet 2 shows the connections to the USB cable at USB connector J1 from the sound dongle. Remove any blinking LED from the sound dongle, as the blinking light may introduce noise into the audio paths of the dongle.

Interface Functionality

Because the audio in both directions comes from a high-level, low-impedance source and is sent to a low-level, medium-impedance input, all that is usually needed in each audio path is passive attenuation.

The remaining issue is transmitter control. This interface relies on audio output from the sound card for transmitter control, very much like VOX function (see Sheet 3). *Fldigi*, like other communications software, provides modulation tones on the **LEFT** channel. Additionally, *fldigi* can be configured to produce a control tone output on the **RIGHT** channel output of the sound card. For this interface, the audio source for transmitter keying can be user-selected via SW3 on Sheet 3 from either the **LEFT** or **RIGHT** channel output of the sound.

Interface Circuitry

Sheet 2 shows the interface schematic. My implementation was on a PC board mounted inside an aluminum housing (see Figure 2). The USB side of dongle U1 terminates in a USB Type A connector, designed to plug into a computer. You can use a USB extension cable to connect from the dongle to the computer. The inter-

face +5 V dc is supplied by the computer over the USB cable to the interface and appears on USB connector J1. C1 and C2 provide bypass filtering.

Speaker audio from the radio comes to the interface via Pin 5 of J2 on Sheet 4. Since that audio signal comes from a plug connected into the radio headphone jack, the radio speaker is always muted. I want to be able to control the amplitude of the audible speaker audio as well as mute it without affecting the audio level going to the dongle audio input. To accomplish that, there is a speaker monitor circuit (see Sheet 4) composed of H1, R46 – R49, SW5, and monitor speaker jack J3. Jumper H1 provides a way to electrically isolate the monitor circuit should the need arise. R46 is an ever-present load to the radio in place of a conventional speaker. I show R46 as 33 Ω, but older tube audio amplifiers may need an 8 Ω load. SW5 provides a speaker mute function and R47 provides a speaker volume function. The load presented to the radio audio output will vary as R47 is varied, or when SW5 is open, but it doesn't matter much because the radio's speaker driver output circuit is essentially a very low impedance voltage source. R48 and R49 in series with the J3 contacts allow you to use either mono or stereo cables or devices as your monitor system.

Radio receive audio at Pin 5 of J2 also passes through a dc blocking capacitor C3 on Sheet 2. R2 across C3 ensures that there is a high-resistance dc path in those cases where the receiver output already includes a dc blocking capacitor. SW1 and associated resistors form a 12-step attenuator with approximately 5 dB of attenuation per step. C4 blocks the dc from the sound dongle microphone input from being grounded by the step attenuator. C3 should be a non-polar capacitor.

Audio to modulate the transmitter appears on the **LEFT** audio channel sound card dongle output and is routed through dc blocking capacitor C5, to a potentiometer R15, and then to SW2 and associated resistors, which forms another 5 dB per step attenuator. The step attenuator provides course adjustment while the potentiometer provides fine adjustment.

Ideally, R15 would be an audio taper (logarithmic, type A) potentiometer, but those are hard to find and are expensive. An old designer's trick is to use a linear taper potentiometer with a fixed resistor added between the wiper and ground. That fixed resistor should be about 20% of the potentiometer value. The result is often good enough. For this trick to work, the signal source must come from a low-impedance source, and the audio output at the potentiometer wiper must connect to a medium- to high-impedance circuit. Fortunately, that's the case we have here. The output of the step attenuator passes through a fixed attenuator formed by R29 and R30, which also acts as an impedance stabilizer. The output of the fixed attenuator passes through C6, a dc blocking capacitor, and is presented to the transmitter microphone input via Pin 1 of J2. C6 should be a non-polar capacitor.

Transmitter Keying Circuitry

One of my goals was to provide for moderately high-speed (35 WPM) CW keying of a transmitter via the conventional straight-key input to the radio, rather than an audio CW applied to the microphone jack of the radio. For that reason, I needed an audio signal detector that responds quickly, and with a fairly symmetrical latency. That is, if the keying circuit takes 5 ms to turn on when the CW control audio tone is applied, then the keying circuit should turn off in about 5 ms after the CW control audio tone disappears.

Alternatively, if you don't care about using this interface for transmitting CW, just let the TX audio from the sound dongle control the transmitter via the VOX controls on the radio. Keep in mind that most transmitter VOX circuits require the PTT circuit to be active in order for the transmitter's VOX function to operate. You'll probably want to include a toggle switch on your interface so you can ground the radio PTT lead when needed.

Most digital communication programs output the modulating audio on the **LEFT** channel. *Fldigi* (and perhaps other programs) can also be configured to provide a 1 kHz control signal on the **RIGHT** channel audio output to control the PTT of the transmitter — that is, with the **RIGHT** channel control tone present, the transmitter keys on, and with the **RIGHT** channel control tone absent, the transmitter remains un-keyed. I recommend using this control tone to control the transmitter when the program provides that option. The advantage of using the **RIGHT** channel control tone to control the transmitter is that the amplitude of the control tone is not ramped during on/off transitions. When it's time to turn on the transmitter the first half sinusoidal cycle of the **RIGHT** channel control tone goes to full amplitude.

Fldigi software also provides for FSK output (see Pseudo-FSK in the *fldigi* documentation). When the Pseudo-FSK option is enabled, the presence of the **RIGHT** channel control tone represents the FSK MARK state while absence of the **RIGHT** channel control tone represents the FSK SPACE state. To control the transmitter when the **RIGHT** channel control tone is used for FSK, you must ensure that the *fldigi* RTTY diddle output is active. Then, the **RIGHT** channel control tone will be active for at least one bit of each character, and the diddle feature ensures that characters are constantly generated when in transmit mode. So, if we add a 250-millisecond re-triggerable timer (hang timer) to the output of the control tone detector, we can use hang timer output to derive a PTT signal for FSK. The FSK driver transistor, Q2, can be a 2N3094 for low-voltage applications. If the FSK circuit from the transmitter is high-voltage, then use an MPSA42 for Q2.

For flexibility, the user can select via SW3 either the **LEFT** channel or **RIGHT** channel audio output from the sound dongle to key the transmitter. Comparators U2A and U2B detect positive and negative peaks, respectively, of the audio control tone. Resistors R33 – R36 establish bias voltages on the comparator inputs such that when no audio control tone is present at the input, both comparator outputs are pulled high via R37. The comparator outputs are both open collector, which means that the output is the open collector of an emitter grounded transistor. If the outputs of several open collector output devices are tied together, then any one of those devices can pull that part of the circuit to ground. But the circuit will only go high with the aid of a pull up resistor when all the transistors are inactive. When the control tone amplitude increases to somewhat greater than 500 mV ac p-p, the comparators will begin to detect the positive and negative peaks of the audio signal, with a pulsing low output. However, for consistent operation of the following filter and detector, the control signal should be at least 1.5 V ac p-p.

The output signal from the comparators passes through a filter formed by R38 and C12, and the voltage across filter capacitor C12 is monitored by U3A, one element of a 556 timer chip, which is used as a voltage detector and latch. R39 and D1 in parallel with R38 improve the symmetry of the on/off time of this filter/detector. Without R39 and D1, the activate time is about 6 ms and the deactivate time is about 4 ms. With R39/D1 in parallel with R38, the activate time was reduced to 4 ms and the deactivate time remains at 4 ms.

In this circuit, U3A is used as a voltage detector and latch. When the voltage on C12 goes below ⅓ of the supply voltage (1.67 V dc), the internal latch within U3A is cleared and the output of U3 goes high, and transistors Q1 and Q2 are conducting (on). When the voltage across C12 is greater than ⅔ of the supply voltage (3.33 V dc), the internal latch within U3A is set and the output of U3A goes low, causing Q1 and Q2 to be in cutoff (off). When the voltage on C12 is anywhere between ⅓ and ⅔ of the supply voltage, the output of U3 stays in the same state as it was the last time when the voltage on C12 was either less than ⅓ or more than ⅔ of the supply voltage.

> *"All the magic is contained in the computer software that has been created by radio amateurs to implement these digital transmission protocols."*

In the case of FSK transmissions, it will be necessary to give the PTT driver some hang time. That's the function of the re-triggerable timer U3B and associated components. SW4 allows the user to select whether the PTT follows the control tone with or without PTT hang time.

When operating in AFSK mode, switch SW4 is set to the output of Q1 (U3A), which will cause the transmitter PTT to very closely (4 ms) follow the transmitter control tone. The CW relay is always driven by Q1 with no TX hang time. For FSK operation, the control tone not only represents the MARK tone for the FSK control input to the transmitter, that same tone will be used to control the transmitter PTT. In this case, we need some transmitter hang time to bridge the times when FSK SPACE is being transmitted. So for FSK transmission, SW4 is set to the output of Q3.

You don't necessarily need to use relays because you could use one or two transistors to provide an open collector or open-drain output to control the transmitter PTT and CW circuits. I used a Pan Chang SIP-1A05 reed relay. It takes no more than 300 μs to activate or release, even with the included voltage snubber diode across the coil. The contact bounce time during activation is included in that 300 μs. Caution: snubber circuits, like the reverse biased diode on relay coils, can significantly delay the release time of a relay when the driver connected to the relay interrupts the relay coil current. This is especially true when the relay coil has a large inductance.

I chose to use a DB-9 connector for the radio I/O interface and a 3.5-millimeter TRS jack for the external speaker.

Setup

First, connect the interface to your computer and ensure that your computer recognizes the USB sound dongle. Then, ensure that the audio level settings within your computer for the dongle, both microphone and speaker output, are at or near maximum. How you set up the levels depends on your computer, but some quick internet searching should provide guidance.

On your radio, ensure that your transmit drive control is set to minimum, so if your transmitter is active it will put out minimum power. Next, connect a cable from the output of J2 Pin 1 to the microphone input of your transmitter. Then connect a cable from the output of J2 Pin 3 to the PTT input of your transmitter. Don't forget the grounds on J2 Pin 6. On the interface, adjust SW3 to select **RIGHT** channel and SW4 to select fast PTT operation.

Start your favorite sound card data communication program and select any mode that shows a waterfall display. To adjust the receive side of the interface, set your radio audio volume control to whatever would be a solid listening level if you were using the internal radio speaker while listening to a strong signal. Leave the radio volume control in that position. Connect a cable from the speaker output of

your radio to J2 Pin 5 of the interface. This may mute the radio speaker.

Adjust the receive attenuator, SW1, to fully counterclockwise (minimum amplitude). Tune in a signal on your radio. Rotate SW1 clockwise just until the waterfall display starts to look noisy. Now adjust SW1 counterclockwise one or two positions. You should now have a clean waterfall display, but also a strong signal into the sound dongle. If your software provides an indicator to show when the input audio level is acceptable, then use that indicator to set the position of SW1.

For the transmit side, start by connecting your transmitter to a suitable dummy load. Set R15 to fully clockwise position (maximum amplitude) and set SW1 to fully counterclockwise position (minimum amplitude). Then set the drive control on your transmitter to minimum and ensure that the ALC is off. Set your digital program to RTTY or PSK31 and enable it to transmit audio tones. Advance your drive control to where it would normally be for a CW or SSB transmission. Turn step attenuator SW2 clockwise until you get at least 50 W power, assuming your transmitter rated output is 100 W. The power output from the transmitter should smoothly go up and down as you rotate R15 through its range. An erratic power output when you rotate R15 when transmitting may indicate that you have an RFI problem. Finally, adjust R15 for 20 W output power. Return your data communications program to the receive mode, and then you're ready to get on the air and make contacts.

Modern Radios

The receive attenuators were designed to work with the low-impedance and high audio level output from a speaker driver. If you connect this interface to the speaker output of your modern radio, all should work well.

But consider if you want to connect this interface to the digital (often a six-pin DIN or eight-pin DIN connector) found on HF/VHF/UHF radios. The audio output from the six-pin DIN is often low level (100 mV ac rms) and at a high impedance (5 k to 10 kΩ). One solution is to add a simple speaker driver to the interface using a LM386 IC. That option is shown in the dashed lines of the schematic Sheet 4.

Conclusion

With a personal computer and the interface described here, you can be on the air with lots of digital modes, even with an older tube radio, provided it has good short-term frequency stability. To avoid over-heating and self-generated intermodulation, good Amateur Radio practice calls for limiting digital emissions to about 25 W of output when using a nominal 100 W transmitter.

Special thanks to David Freese, W1HKJ, and Bob Buus, W2OD, for their comments and suggested improvements to the circuitry and text of this article.

Paul Newland, AD7I, was first licensed as a Novice in 1971 at age 15. He soon became fascinated with RTTY when he saw an 80-meter RTTY autostart system in operation. In the mid-1980s, Paul developed his own microcomputer-based AMTOR system and was part of the team that developed the TAPR TNC-2 packet radio controller. Paul is an ARRL Life Member. He earned a BSEL from Cal Poly, San Luis Obispo, and a MSE-ECE from the University of Michigan Ann Arbor. He is a licensed Professional Engineer in the State of New Jersey. Most of Paul's career was spent at Bell Laboratories designing systems and circuits for communications equipment. You can reach Paul at **ad7i@ad7i.net**.

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

Steve Ford, WB8IMY, wb8imy@arrl.org

The *WSJT-X* Appliance

Chuck Kelly, W9MDO/VE1MDO, has put together a device he calls his "*WSJT-X* Appliance." His goal was simple: To build a self-contained, portable station that he could use to operate the WSPR, JT65, and FT8 digital modes. In addition to the transceiver, computer, and *WSJT-X* software, Chuck's appliance includes an automatic antenna tuner for those times when he wouldn't have a resonant HF antenna at the ready.

Within his custom-designed enclosure Chuck installed:

- A µBitx 10 W HF SSB transceiver, which operates on all bands from 3 to 30 MHz (**www.ubitx.net**).
- An Asus Tinker Board, which is similar to a Raspberry Pi microcomputer, but much more powerful (**www.asus.com/us/Single-Board-Computer/Tinker-Board/**).
- A 7-inch LCD color touchscreen.
- The board from an LDG Electronics Z-100Plus automatic antenna tuner.

His appliance is powered by 12 V dc, but Chuck attached a 3-A regulator integrated circuit (IC) to the inside rear panel to create a separate 5 V dc line for the Tinker Board and touchscreen display. The Tinker Board is mounted so that its USB and Ethernet connectors are accessible at the rear panel. This allows easy attachment of a keyboard and mouse.

The *WSJT-X* software controls the frequency of the µBitx transceiver, thanks to an inexpensive RadI2Cino board, which is available from Jim Sheldon, W0EB. The board allows an I2C connection to the front panel display and a host of other improvements. It is available at **www.ubitx.net/tag/radi2cino/**.

Chuck says that his LCD color display works well, but he recommends a display sizing program (such as *GDevilsPie*) to help make *WSJT-X* fit on the screen.

Linux Based

Chuck's Tinker Board runs a Linux-derived operating system called Linaro, which is similar to Raspbian, but with some significant differences. According to Chuck, it takes some finagling to get it working with *WSJT-X*. Fortunately, Mike Coffey, KJ4Z, has an excellent website devoted to the task at **www.kj4z.wordpress.com/2017/09/17/ft8-on-the-tinker-board/**.

Of course, a Linux operating system requires a Linux version of the *WSJT-X* software. Like all the other *WSJT-X* versions, this is available for free download at Joe Taylor's, K1JT, website: **www.physics.princeton.edu/pulsar/k1jt/wsjtx.html**.

The Bottom Line

Chuck believes he has invested about $400 in his *WSJT-X* appliance. Skipping the automatic antenna tuner would reduce the cost to well under $300, but that would also reduce the station's flexibility in the field.

Some amateurs might prefer building a similar appliance around a Raspberry Pi 3 rather than the Tinker Board, because a Raspberry Pi 3 will easily run more familiar operating systems, such as one of the Raspbian Linux packages. However, if you plan to copy Chuck's ideas and use the appliance with FT8, I caution against choosing a Raspberry Pi 3. I've found that the Pi 3 works well with WSPR and JT65, but the fast decoding required by FT8 is a little more than a Raspberry Pi 3 can handle. When I've attempted it, I've found the software lagged by several critical seconds, and that spells doom in the FT8 world.

Product Review

Icom IC-7610 HF and 6-Meter Transceiver

Reviewed by Joel R. Hallas, W1ZR
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The IC-7610 is a nominal 100 W SSB, CW, AM, FM, and digital-mode transceiver for 160 through 6 meters. While its ancestry is clearly based on the popular direct-sampling IC-7300, its performance and features may be more closely tied to Icom's top-of-the line IC-7851.[1, 2] The key step up from the '7300 is the addition of a completely independent second receiver, with performance equal to the primary receiver and separate audio channels for speakers or headphones. In addition, the dual-frequency readouts and virtual analog multimeters are reminiscent of the larger, heavier, and more expensive IC-7800 and '7851 front panels.

The Display

We were smitten by the display of the IC-7800, first reviewed in 2004 — particularly its digital emulation of traditional analog meters. The IC-7610's display is equally impressive (see Figure 1), with a nice upgrade — display and operational features can be selected by a touch of the screen.

In some cases, such as frequency and band selection, there are other ways to change the settings, but some — notably mode and meter selection, as well as the mode-specific side and bottom buttons — seem to be accessible only via the touchscreen. Unlike the ubiquitous smartphone, the display is not change-able by pinching or spreading of the fingers. This was fine for me, because I always seem to get in trouble when attempting those maneuvers.

The display offers multiple configurations. The spectrum display can provide a single view of the received spectrum, as in Figure 1. You can change frequency by touching the spectrum display screen, although you can have more precise control by plugging a USB mouse into one of the front panel USB sockets and clicking on a frequency on the spectrum display with that.

I often find it easier to spot weak signals on a waterfall display, and one can be added, as shown in Figure 2. If frequencies are too far apart for signals from both receivers to be shown on a single display, they can be separated, as shown in Figure 3.

While the virtual meters are fun to look at, they do take up a big chunk of the display, and a more compact bar graph meter allows more room for the spectrum display. All meter choices can be viewed simultaneously, as shown in Figure 4 — handy during setup. An external monitor with a DVI connector can be used for a larger display.

Bottom Line

The IC-7610 direct-sampling transceiver is a full-featured, two-receiver, competition-ready, HF and 6-meter radio that can be an asset to almost any amateur station. It brings together the look and feel of their top-of-the-line transceivers with the benefits of digital sampling at signal frequency, all at a price in the middle of their range.

How It Works

As with the IC-7300, this transceiver is based on a direct-digital sampling architecture. That is, there are no conversion steps in front of the analog-to-digital (ADC) conversion — it all happens at signal frequency. This arrangement has multiple advantages. There are no nonlinear mixer or converter stages between input and output, eliminating images and many sources of birdies, as well as places for intermodulation products to hide.

The downside is that if the ADC is overloaded, other problems can arise. The IC-7610 takes pains to reduce the likelihood of this happening by switching in filters, including a

Figure 1 — A close-up of the IC-7610 display showing the virtual analog meters and a single spectrum display.

Figure 2 — A waterfall display can be added below the panadapter spectrum display. The waterfall often makes it easier to spot weak signals.

Figure 3 — If the two receiver frequencies are on different bands, or are too far apart to be shown on a single display, the spectrum displays can be separated, as shown here.

Figure 4 — A more compact bar graph of a selected meter at the top of the display allows more room for the spectrum display, or all meter choices can be viewed simultaneously, as shown here.

switchable tracking filter (**DIGI-SEL**) that follows the tuned frequency, as well as attenuators (and amplifiers if needed) ahead of the ADC for gain management.

To help avoid receiver overdrive problems, the display includes an overload indicator (**OVF**) that illuminates if the ADC overflows due to excessively strong signals. The operator can eliminate the problem by turning back the preamp a notch, or adding attenuation. I saw this while participating in a 75-meter net — lots of booming signals, and I had inadvertently left **PREAMP 2** on (rarely is any preamp helpful on 80/75 meters). It was an easy fix, once I recognized my self-inflicted problem.

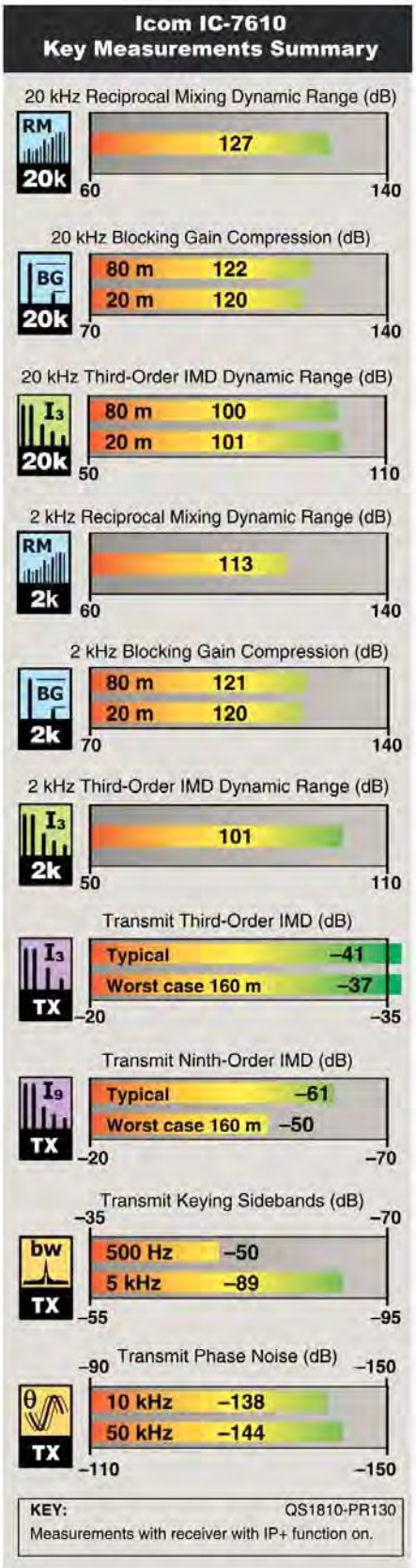
Computer Connectivity

The IC-7610 includes two USB type-B computer connections on the rear panel. These can make use of typical USB printer cables. The manual indicates that one is dedicated to remote operation and data exchange (such as frequency and mode data for logging software), while the other is for digital data input and output. I found that I could get two data channels as well as RTTY audio in both directions on a single connection to **USB 1**.

Another jack supports Icom's CI-V remote-control protocol, which is used by many logging and station management programs. There is also an RJ-45 ethernet jack for remote control using Icom's optional RS-BA1 remote-control software. This can work over your in-house LAN or from a distant internet-connected computer. No computer is needed at the radio end.

On the front panel are two USB type-A connectors and an SD card slot. These can be used to back up configuration data to a memory card or flash drive or to upgrade software. A USB mouse and/or keyboard can also be connected to one or both of the USB jacks.

I was successful in getting both the CAT (computer-aided transceiver) data and audio signals routed between the radio and most of my PC logging and digital-mode applications, but it took some fussing with computer settings to route signals through the appropriate ports. The key is to download the drivers and



Lab Notes: Icom IC-7610

Bob Allison, WB1GCM, Assistant Laboratory Manager

I found no issues during ARRL Lab testing of the IC-7610. The receiver is considered higher performance because its lowest dynamic range (third-order IMD dynamic range, 3IMD DR) at 2 kHz spacing is 101 dB with the IP+ feature on. The IP+ feature enables a dither signal, which decreases the sensitivity by 3 dB or so, but increases the 3IMD DR by at least 14 dB. If you are not experiencing the effects of intermodulation distortion and desire slightly more sensitivity, turn the IP+ feature off. Note that the sensitivity and dynamic range measurements shown in Table 1 were made with this feature on.

Our dynamic range tests use strong signals that are no more than 40 kHz away from the desired frequency. What about strong out-of-band signals? Receivers with an ADC at the front end can overload from very strong signals outside the current operating band, especially in an environment where the RF spectrum density is high. The IC-7610 has an automatically tuned digital preselector (**DIGI-SEL**) that attenuates the cumulative effects of strong out-of-band signals (about 20 dB for a signal 1 MHz away, for example), while not attenuating the signal that you're listening to. The addition of the digital preselector makes the transceiver a good performer in a multi-transmitter Field Day environment, where stations are operating on multiple bands in close proximity. It's also important to keep receiver gain management in mind, and turn off preamps or use attenuation when unwanted effects are observed or the overload indicator lights.

The best receiver cannot overcome the effects of wide or spurious signals generated by a transceiver with poor transmit performance, and transmitter cleanliness is facing increasing scrutiny these days. The transmit quality of the IC-7610 is quite good overall, with low transmit phase noise and relatively low transmit intermodulation distortion (IMD) on SSB. On CW, the keying waveform, with resulting narrow CW sidebands, makes the IC-7610 a good neighbor to those on adjacent frequencies. The keying sidebands can be made even narrower with no degradation of signal quality by selecting 6 ms rise time (the 4 ms default was used for Lab testing).

High-speed CW ops will appreciate the fact that the receive processing delay time (the time it takes from when a signal arrives at the antenna jack to when it comes out the speaker) is only 12 ms. What comes out of the speaker is clear audio, with total harmonic distortion of only 0.5% at normal listening levels. The S-meter scale is 3 dB per S-unit. With the preamp off, S-9 is at –73 dBm, and the + scale is very accurate — S-9+10 dB is –63 dBm, S-9+20 dB is –53 dBm, and so on. As seen in Table 1, the S-meter reads higher with the preamps on. Power-off current consumption is 25 mA, a consideration for those using battery power only.

the *USB Driver Installation Guide* from Icom's support website.

The *Installation Guide* provides step-by-step instructions for installing the drivers for Windows 7, 8.1, and 10 systems. No other operating systems are mentioned. After the drivers are installed and the radio is connected, two USB-to-UART bridges appear in the **PORTS** section of *Windows Device Manager,* which identify the virtual com port numbers and allow setting of parameters to match those of the software.

As with most current transceivers, firmware is updated regularly to add features and fix bugs. Our radio arrived with firmware version 1.04, which we used for initial evaluation. Updates to V1.05 and V1.06 add subtle improvements in many areas, including SSB sideband suppression, AM receiver filtering, transmitting and receiving signal quality, various interface improvements, and bug fixes.

To update the firmware, download the appropriate ZIP file from Icom's support website and extract the

compressed files to a folder named **IC-7610** on an SD card or USB thumb drive. The uncompressed V1.06 upgrade files took less than 14 MB of space on my USB drive.

After the firmware file was on my USB drive, it took about 2 minutes for the upgrade of four areas (**MAIN CPU**, **SUB CPU**, **FRONT CPU**, and **FPGA CPU**). The manuals strongly warn that if power is interrupted, or anything else stops the process, the radio may need to go back to an Icom distributor for firmware reinstallation. An uninterruptible power supply (UPS) or battery could be used to prevent power loss during the firmware update. After the firmware upgrade, the radio came right back up and all is well.

ARRL Lab test results are shown in Table 1, Figures 5, 6, and 7, and the "Lab Notes" sidebar.

On the Air with the IC-7610

I enjoyed using the IC-7610 as my main station rig and had an opportunity to test it in most modes. While getting started was simple, as with most full-featured radios, expect to spend some time with the manuals to be able to fully appreciate and learn to operate all the advanced features. You can almost assume that any feature or function you've encountered is supported on this radio.

Some basic features stand out on the IC-7610. Tuning with the weighted knob is smooth and easily adjustable for drag. The tuning rate speeds up whenever you tune quickly and can be adjusted to different speeds by touching the kilohertz portion of the frequency display. By touching the display for a second, you can set the fast rate on a mode-by-mode basis.

The **DUAL WATCH** feature on the '7610 is not the same as with many other Icom transceivers, in which the radio receives on two frequencies in the same band and combines the audio into a single channel. On the '7610, it is really two completely independent,

Table 1
Icom IC-7610, serial number 1201580, Main CPU V1.06 FPGA V1.05

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Receive, 0.03 – 60 MHz; transmit, not specified.	Receive, 0.03 – 60 MHz. Transmit, 160 – 6 meter amateur bands, including 5.255 – 5.405 MHz.
Power requirement: Transmit, 23 A (maximum). Receive, 3.5 A (maximum audio) at 13.8 V dc (±15%).	At 13.8 V dc: Transmit, 20 A (maximum), 18.5 A (typical) at maximum RF power output; 6.0 A at minimum RF output. Receive, 2.43 A (maximum audio and backlight), 2.24 A (minimum backlight). Power off, 25 mA.
Modes of operation: SSB, CW, AM, FM, PSK, RTTY.	As specified.

Receiver	Receiver Dynamic Testing
SSB/CW sensitivity: At 10 dB S/N, 0.16 µV typical at 1.8 – 30 MHz (preamp 1 on); 0.13 µV typical at 50 MHz (preamp 2 on), filter soft.	Noise floor (MDS), 500 Hz bandwidth, IP+ on: *Preamp* *Off* *1* *2* 0.137 MHz –116 –127 –133 dBm 0.475 MHz –130 –137 –141 dBm 1.0 MHz –131 –140 –142 dBm 3.5 MHz –132 –140 –142 dBm 14 MHz –130 –138 –142 dBm 50 MHz –130 –138 –141 dBm
Noise figure: Not specified.	Preamp off/1/2, 14 MHz: 17/9/5 dB; 50 MHz, 17/9/6 dB.
AM sensitivity: At 10 dB S/N, 6.3 µV typical at 0.1 – 1.8 MHz and 2.0 µV typical at 1.8 – 30 MHz (preamp 1 on); 1.0 µV typical at 50 MHz (preamp 2 on), filter soft.	10 dB (S+N)/N, 1 kHz tone, 30% modulation, 6 kHz BW: *Preamp* *Off* *1* *2* 1.0 MHz 2.28 1.20 0.90 µV 3.88 MHz 2.21 1.07 0.98 µV 29.0 MHz 2.34 1.05 0.78 µV 50.4 MHz 3.46 1.40 1.0 µV
FM sensitivity: At 12 dB SINAD, 0.5 µV typical at 28 – 29.7 MHz (preamp 1 on); 0.32 µV typical at 50 MHz (preamp 2 on), filter soft.	For 12 dB SINAD, 3 kHz deviation, 15 kHz BW: *Preamp* *Off* *1* *2* 29 MHz 0.81 0.30 0.23 µV 52 MHz 0.59 0.26 0.20 µV
Spectral sensitivity: Not specified.	Panadapter display, preamp off/1/2: 14 MHz, –109/–120/–128 dBm 50 MHz, –107/–118/–126 dBm Waterfall display, preamp off/1/2: 14 MHz, –106/–117/–125 dBm 50 MHz, –104/–115/–123 dBm
ADC overload level: Not specified.	With single in-passband signal, >+10 dBm.
Blocking gain compression dynamic range: Not specified.	Blocking gain compression dynamic range, 500 Hz BW: *20 kHz offset Preamp off/1/2* *5/2 kHz offset Preamp off* 3.5 MHz 122/119/113 121/121 dB 14 MHz 120/117/113 120/120 dB 50 MHz 122/119/113 122/122 dB
Reciprocal mixing dynamic range: Not specified.	14 MHz, 20/5/2 kHz offset: 127/116/113 dB.

ARRL Lab Two-Tone IMD Testing (500 Hz bandwidth, IP+ on):

Band/Preamp	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR*
3.5 MHz/off	20 kHz	–132 dBm –97 dBm	–32 dBm –16 dBm	100 dB
14 MHz/off	20 kHz	–130 dBm –97 dBm	–29 dBm –16 dBm	101 dB
14 MHz/1	20 kHz	–138 dBm –97 dBm	–38 dBm –26 dBm*	100 dB
14 MHz/2	20 kHz	–142 dBm –97 dBm	–44 dBm –34 dBm*	98 dB
14 MHz/off	5 kHz	–130 dBm –97 dBm	–29 dBm –17 dBm	101 dB
14 MHz/off	2 kHz	–130 dBm –97 dBm	–29 dBm –17 dBm	101 dB

Manufacturer's Specifications	Measured in the ARRL Lab

ARRL Lab Two-Tone IMD Testing (500 Hz bandwidth, IP+ on) continued:

Band/Preamp	Spacing	Measured IMD Level	Measured Input Level	IMD DR
50 MHz/off	20 kHz	–130 dBm –97 dBm	–31 dBm –15 dBm	99 dB
50 MHz/2	20 kHz	–141 dBm –97 dBm	–43 dBm –32 dBm	98 dB

Second-order intercept point: Not specified.	Preamp off/1/2: 14 MHz, +73/+69/+63 dBm 21 MHz, +77/+55/+39 dBm 50 MHz, +71/+71/+71 dBm.
DSP noise reduction: Not specified.	15 dB.
FM adjacent channel rejection: Not specified.	Preamp 2 on: 29 MHz, 82 dB; 52 MHz, 86 dB.
FM two-tone third-order IMD dynamic range: Not specified.	20 kHz offset, preamp 2 on: 29 MHz, 82 dB**; 52 MHz, 86 dB.** 10 MHz spacing, preamp 2 on: 29 MHz, 88 dB; 52 MHz, 92 dB.
Squelch sensitivity: SSB, <3.2 µV; FM, <0.32 µV.	FM, preamp 2 on: 29 MHz, 0.1 µV to 112 mV; 52 MHz, 0.13 µV to 112 mV. SSB, preamp off: 14 MHz, 4.31 µV to 91.1 mV.
S-meter sensitivity: Not specified.	S-9 signal, preamp off/1/2: 14 MHz, 51.8/23.7/23.2 µV 50 MHz, 72.4/34.6/35.4 µV. Scaling: 3 dB per S-unit.
Notch filter depth: Not specified.	Auto-notch, 52 dB; attack time, 200 ms (single tone).†
IF/audio response: Not specified.	Range at –6 dB points:‡ CW (500 Hz BW): 344 – 859 Hz; Equivalent Rectangular BW: 516 Hz; USB (2.4 kHz BW): 234 – 2,750 Hz; LSB (2.4 kHz BW): 234 – 2,750 Hz; AM (6 kHz BW): 30 – 3,188 Hz.
Receive processing delay time: Not specified	12 ms.
Audio output power: >2 W (8 Ω load, 1 kHz tone, 10% THD).	2.17 W at 10% THD. THD at 1 V_{RMS}, 0.5%

Transmitter	Transmitter Dynamic Testing
Power output: 1 – 100 W (SSB, CW, RTTY, PSK, FM), 1 – 25 W (AM).	SSB, CW, RTTY, PSK, FM: 1.8 – 30 MHz, 0.4 – 100 W; 50 MHz, 0.4 – 93 W. AM: 1.8 – 30 MHz, 0.4 – 26 W; 50.4 MHz, 0.15 – 23 W.
RF power output at minimum specified operating voltage: Not specified.	At 11.7 V dc: 14 MHz, 83 W; 50 MHz, 75 W.
Spurious-signal and harmonic suppression: >50 dB (HF); >60 dB (50 MHz).	HF, 69 dB typical; 60 dB worst case (5.330 MHz); 50 MHz, 78 dB. Complies with FCC emission standards.
Third-order intermodulation distortion (IMD) products: Not specified.	3rd/5th/7th/9th order, 100 W PEP: –41/–37/–46/–61 dB (HF typical) –37/–41/–44/–50 dB (worst case, 160 m) –32/–35/–45/–58 dB (50 MHz) At 50 W RF output: –30/–41/–62/–70 dB (14 MHz) –33/–44/–58/–63 dB (50 MHz)
CW keyer speed range: Not specified.	6 to 47 WPM, iambic mode B.
CW keying characteristics: Not specified.	See Figures 5 and 6.
Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.	S-9 signal, AGC fast, SSB, 50 ms; CW (full break-in), 45 ms.
Receive-transmit turnaround time (TX delay): Not specified.	SSB, 60 ms; FM, 11 ms (29 MHz and 52 MHz).
Transmit phase noise: Not specified.	See Figure 7.
Amplifier key line closure RF output: Selectable, 0 to 30 ms.	As specified. RF off to key line open, 5.5 ms.

Size (height, width, depth, incl. protrusions): 4.8 x 13.7 x 12.7 inches; weight, 18.7 pounds.

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

*At threshold of ADC overload.
**Measurement is phase noise limited to the value indicated.
†Auto notch reduces two tones ≥38 dB, if two offending tones are 500 Hz or more apart.
‡Default values; bandwidth is adjustable via DSP.

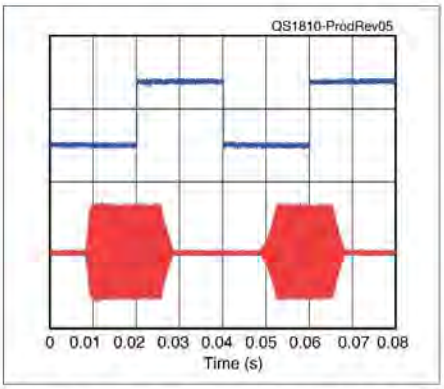


Figure 5 — CW keying waveform for the Icom IC-7610 showing the first two dits in full break-in (QSK) mode using external keying and the default 4 ms rise time setting. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 ms. The transceiver was being operated at 100 W output on the 14 MHz band.

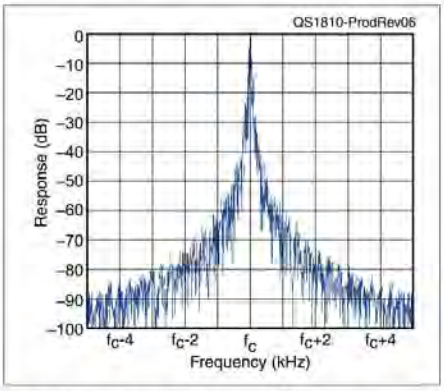


Figure 6 — Spectral display of the Icom IC-7610 transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying and the default 4 ms rise time setting. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 100 W PEP output on the 14 MHz band, and this plot shows the transmitter output ±5 kHz from the carrier. The reference level is 0 dBc, and the vertical scale is in decibels.

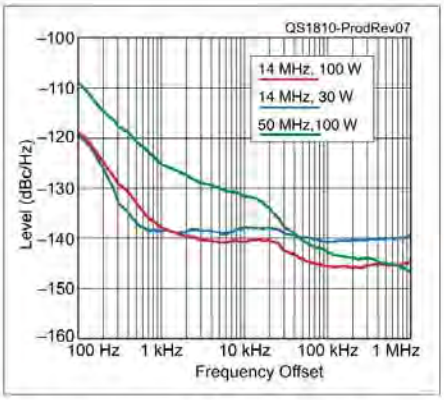


Figure 7 — Spectral display of the Icom IC-7610 transmitter output during phase noise testing. Power output is 100 W on the 14 MHz band (red trace), 30 W on the 14 MHz band (blue trace), and 100 W on the 50 MHz band (green trace). The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 100 Hz to 1 MHz from the carrier. The reference level is –100 dBc/Hz, and the vertical scale is 10 dB per division.

identical receivers that can operate on different bands and modes if you wish. Each receiver drives its own speaker or one side of stereo headphones, so you can keep track of what's happening on each frequency. Push the **SPLIT** button and the transceiver transmits on the sub-receiver frequency, just as I like.

Unlike some radios with dual receivers, the IC-7610 is equipped with a single tuning knob that can be switched between receivers. After a bit, I realized that this was not a limitation for me. My use of **SPLIT** is generally for working DX stations that are listening on an offset frequency. You first tune them in on the main receiver, then leave that alone while you switch to tuning the sub-receiver to find a good frequency to transmit on. If this arrangement doesn't work for you, Icom offers an optional RC-28 encoder that connects to the front panel through a USB cable. It provides a tuning knob that can be used to tune either receiver and also offers other control functions.

The IC-7610's digital noise reduction (NR) and noise blanker (NB) were impressive in both their functionality and lack of digital artifacts. The DSP selectivity system also works well. The **FILTER** button cycles through

A Contester's Impressions of the IC-7610

Scott Wright, K0MD
National Contest Journal *Editor*

My first impressions of the IC-7610 were amazement at the quietness and sensitivity of its receiver, and the beauty of its panadapter. It is significantly quieter than my Icom IC-7800 and nearly identical to my IC-7851. It is able to pull out weak signals, even amid interference on a crowded band.

I evaluated the IC-7610 in the CQ World Wide WPX CW and IARU HF Championship contests. It has two independent receivers, which can function on separate bands if two antennas are attached. I operated mainly in the SO2V (single-operator, two-VFO) mode, where I used **ANTENNA 1** for both receivers. That said, I have a stack of Force 12 C49XR tribanders, so I was able to operate on any two of the 10-, 15-, and 20-meter bands simultaneously.

Most often, I used the IC-7610's second receiver to work SSB stations when I was running on CW, or to pick up multipliers within the same band segment while running either CW or SSB. When running full break-in (QSK) CW, you can almost believe the rig is running SO2R (single-operator, two-radio) mode, as the second receiver is minimally inhibited during transmissions on the main VFO. When operating on separate bands, it is essentially like SO2R operation. My automatic amplifier could change bands without missing a beat.

Panadapter

The panadapter and waterfall displays on the IC-7610 are simply beautiful. They are colorful, sensitive, and adjustable. Contesters will find the situational awareness they create to be invaluable. I found several empty frequencies to establish a run by simply looking at the panadapter during the busy contests. I could also find adjacent interference more easily and filter it out.

APF

The audio-peak filter (APF) is one of the IC-7610's secret weapons. It is adjustable in gain, center, and peak frequency. It peaks CW signals amid noise without distorting the desired signal. I found it incredibly useful during the weak band conditions of the IARU contest.

Filtering and Noise Management

One of the great strengths of the IC-7610 is noise management. The summertime IARU contest had a lot of static from storms in North America. I found myself using 20 – 24 dB of attenuation on 40 through 160 meters, and the signals seemed to pop out of the noise as I added more attenuation. The AGC with the IC-7610 is a CW operator's dream. It handles weak and powerful signals equally, and does not require riding the RF gain control to avoid hearing damage.

RC-28

I recognized an apparent weakness in the IC-7610's small footprint — lack of a second VFO knob for control of the second, independent receiver. Icom answered with the RC-28, a remote control that plugs into the IC-7610's USB port and allows dual-VFO control of the radio. I set it up on my rig to control **RECEIVER B** only, giving each of the IC-7610's receivers a separate VFO knob.

The RC-28 is a peripheral option that I deem essential for contesting or DXing. It is extremely helpful with using **RECEIVER B** to search the bands for multipliers and other SO2V operation tasks when running stations on **RECEIVER A** with the main VFO. It is a smooth dial, similar to but smaller than the main VFO knob. It is a plug-and-play accessory and requires no setup, except to download the latest firmware to the RC-28.

USB Computer Interface

I was surprised at how easy it was to use the USB computer interface with *N1MM+ Logger* contest software. No external interface, such as a WinKeyer for CW, is required. The transceiver keys smoothly, even above 40 WPM, without any delay. Icom has designed this radio to work perfectly with PC control. From start to finish, setup with *N1MM+ Logger* was under 5 minutes.

I found the IC-7610 to be easy to use, with performance, functionality, and features like my IC-7851. I bought the IC-7610 for contesting overseas, but if I were limited to one radio in my current station, it would be the one I choose to keep.

three mode-specific bandwidths, each of which can be changed easily. For example, on CW the defaults are 250, 500, and 1,200 Hz. Each filter can be adjusted in 50 Hz steps to customize your choices, and each filter can have either sharp or soft corners. I set the review radio for 150, 350, and 1,000 Hz, for example.

The receiver features a **TWIN-PBT** (passband tuning) function that allows either edge of the passband to be moved in or out to eliminate close-in interference.

There are 99 frequency memories available, each also storing the mode and selectivity choice. Each press of a band-select button cycles through the last three frequencies and modes used on the band. There is also quick-access memo pad (**MPAD**) memory that stores five frequencies, along with modes and filter settings — handy for going back to a station that was busy when you last listened.

The spectrum scope is quite useful. It can be set to cover a particular portion of a band, or to be centered on your receive frequency. The spectrum of your transmit signal is also shown. By switching to **AUDIO** on the main menu, the receive audio signal is shown, both in the frequency and time domain on separate screens, and it also switches to show your transmit signal on each display.

The internal antenna tuner quickly tunes an antenna system with up to a 3:1 SWR to near 1:1, and it remembers the tuner settings and antenna selection for that frequency. By selecting **EMERGENCY** operation, the tuner will do the best it can with a system with an SWR of greater than 3:1, but power output is limited to 50 W.

Voice Operation

Voice modes all worked well with good audio reports received on SSB and AM. For 10- or 6-meter FM operation, the transceiver provides easy split-frequency offsets, as well as CTCSS tone encoding for repeater access, and decoding to avoid unwanted reception.

The transceiver is supplied with a handheld HM-219 electret microphone that plugs into the round eight-pin front-panel jack. The jack can supply electret bias voltage in the **MIC** line, or it can be set to **OFF** by a menu item to use dynamic microphones or electrets that require bias on a separate pin — also provided on the connector. In addition to the HM-219 and a professional quality dynamic, I tried an amateur desktop electret mic and received good reports on all.

On SSB, the transmit voice bandwidth can be set to **WIDE** (100 – 2,900 Hz), **MID** (300 – 2,700 Hz), or **NAR** (500 – 2,500 Hz). This option is not available for AM or FM voice, presumably set on **MID** range. Each voice mode has its own tone control settings, allowing a boost or cut in the **BASS** or **TREBLE** ranges of up to ±5 dB in 1 dB steps. While this is likely fine for most microphone and voice characteristics, the folks on the Antique Wireless Association 75-meter AM net, who tend to appreciate booming broadcast-quality sounding modulation, thought it "sounded a bit thin, but of good communications quality."[3] Voice-operated transmit control (VOX) worked flawlessly, as did the anti-VOX function. The VOX didn't trigger from loud received stations, even with the mic pointed at the speaker.

The receiver was excellent and easy to use. The receiver default SSB selectivity choices are 1.8, 2.3, and 2.9 kHz, just about right, in my opinion, but each setting is easily adjusted in 50 Hz steps. The twin-passband filter allows sliding either edge in to remove interference on either side of the passband and the automatic or manual notch can be used to eliminate a tuner-upper or heterodyne. The audio sounded good through the internal speakers, and even better on a larger external pair, pointed at the operator. If desired, a high-pass and low-pass audio filter can be engaged, or the bass and treble can be boosted or cut by up to 5 dB, with separate settings for each voice mode to compensate for speaker limitations, room acoustics, or personal preference.

CW Operation

The designers of the IC-7610 did a good job of including many useful features for the CW operator. Full break-in (QSK) or adjustable-delay semi-break-in operation is supported, and the transmit-receive switchover is silent even with my ear on the cabinet top. A ¼-inch stereo jack on the front panel accepts connections from a keyer paddle, while a ¼-inch mono jack in the rear can be used for a straight key or connections to an external keyer. The built-in iambic electronic keyer can be adjusted from 6 to 48 words per minute. Multiple CW transmit memories are provided, including the capability to

Figure 8 — The IC-7610 decoding the W1AW RTTY propagation bulletin. Note the two-tone tuning indicator and the open panel for use as a type-ahead buffer.

automatically increment contest serial numbers.

Also provided is a very sharp audio-peaking filter (**APF**). The manual notch filter (**NOTCH**) is also very sharp and can completely eliminate a strong signal in the passband. Unlike some other radios we have recently tested, the IC-7610 won't allow engaging the automatic notch on CW (or RTTY), which would automatically notch out the signal you are trying to hear.

Data Modes

The IC-7610 has many options for data-mode operation. Of particular note is that the '7610 can operate on RTTY or PSK modes without a computer. The radio can decode received data and display six lines of text on the bottom part of the display, in place of the spectrum plots. Tuning indicators appropriate for RTTY (see Figure 8) and PSK are both provided. Due to poor band conditions, I was having trouble finding signals to display, but the W1AW bulletins came to my rescue. There's nothing like having a 1 kW transmitter on 80 meters less than 60 miles away. For transmit in either mode, a USB-connected keyboard can be plugged into one of the front-panel USB jacks, and you're good to go.

There are multiple other ways to do any of the popular computer-based digital modes. For RTTY, an accessory jack (**ACC1**) provides connectivity to support traditional FSK RTTY operation, as well as AFSK RTTY or the many "sound card" digital modes, such as FT8. As noted previously, the rear USB connectors can support audio and control signals, saving some wiring in the process. The front-panel **MIC** connector can also be used with any of the popular input switching and interface devices. It is handy because the receive audio is also available on that connector.

As with other modes, all the selectivity and audio-filtering options are available in data modes, as well as a RTTY-specific twin band-pass filter that can provide optimum selectivity for two-tone frequency-shift signals.

Documentation

Our IC-7610 came with a comprehensive 80-page *Basic Manual* that includes a description of every control, along with a set of connection diagrams. That is only the beginning. A supplied CD/ROM includes a PDF copy of the *Basic Manual*, along with a multi-language version of the same, a 91-page *Advanced Manual*, and a 31-page book of schematic diagrams.

Unfortunately, the indices of the two manuals do not list some key functions, and you must go from manual to manual to find out how to perform some key tasks. I think the manuals could use a bit more structure to help users find their way through this radio. The searchable PDF versions are a help. The '7610 can do a lot, and do it very well, but more complete indices would help owners take full advantage of all its capabilities.

Wrapping Up

The IC-7610 is a very effective, full-featured transceiver that would work well in most stations. While compact enough to fit into most spaces, its front panel is large enough to include plenty of useful controls and a fantastic touchscreen display. It performs well enough to hold its head high among the best of transceivers, yet is priced near the middle of the range. It is packed with many more features than we can cover here. While it takes some time to become familiar with all it can do, the effort is more than worthwhile.

Manufacturer: Icom America, 12421 Willows Rd. NE, Kirkland, WA 98034; **www.icomamerica.com**. Price: IC-7610, $3,400; RC-28 remote USB encoder with tuning knob, $259; RS-BA1 remote-control software, $95.

[1]S. Ford, WB8IMY, "Icom IC-7300 HF and 6-Meter Transceiver," Product Review, *QST*, Aug. 2016, pp. 41 – 47.
[2]J. Hallas, W1ZR, "Icom IC-7851 HF and 6-Meter Transceiver," Product Review, *QST*, Jul. 2016, pp. 43 – 46.
[3]The Antique Wireless Association AM net meets on 3837 kHz on Sundays at 7 PM Eastern during Daylight Saving Time and at 4 PM Eastern during standard time. Coverage is usually very good throughout the Great Lakes, New England, and mid-Atlantic regions. AWA membership is not required for participation, and while many classic radios are heard, those with modern gear are more than welcome.

Visit https://youtu.be/8mgl3VxkYSg to see our review of the Icom IC-7610 HF and 6-Meter Transceiver on YouTube.

SteppIR SDA 2000 OptimizIR Controller

Reviewed by Martin Ewing, AA6E
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SteppIR Communications Systems offers a unique line of HF antennas, based on beryllium-copper tapes that are extended and retracted by stepping motors to assure a perfectly tuned antenna at every operating frequency.[4] Beginning in 2001 with the original three-element Yagi, which tuned from 14 to 54 MHz, many other models have been introduced, all based on the same adjustable-tape technology.

Nearly all these products have been operated through a basic control box that you install at your station desk. It uses buttons to set the operating band and frequency, and to choose normal, reverse, or bidirectional antenna patterns. Through menu selections, you can adjust your antenna element lengths, but they are normally set automatically according to frequency and desired beam pattern. You can connect your transceiver or computer through the serial I/O port for automatic frequency tracking. While the basic controller serves well for normal operation, some functions are awkward to access through the menu system, and the text display is minimal. Customizing and troubleshooting your antenna is possible, but not very convenient.

The new SDA 2000 "OptimizIR" is a decidedly more modern and user-friendly controller. It offers an attractive, informative display that shows the current operating frequency and the nominal antenna performance. Buttons allow you to select the desired pattern and operating band. Two selector knobs give you ready access to all menu options. The menu system is well designed, making some of the more advanced options, such as **CREATE /MODIFY**, much easier to use for special antenna adjustments. Antenna parameters can be saved internally, or exported or imported through a micro-SD card.

SDA 2000 Operation

It is important to note that the SDA 2000 is a controller that works from a pre-stored matrix of antenna parameters. It does not actually compute or optimize your antenna pattern on the fly. Rather, it lets you change your antenna configurations (element lengths) with new antenna models. The default screen (see Figure 9) shows front-to-back ratio, gain, and beamwidth data, including a bidirectional "thermometer" that indicates the relative forward and reverse antenna response.

There are three basic patterns (normal, 180 degrees, and bidirectional) selected by push buttons (**NORM**, **180**, **BI**). The 180-degree pattern reverses the antenna to fire backward, while the bidirectional pattern produces both a forward and reverse beam. Within the normal pattern, you can select a wide or a maximum front-to-back variant using the **K1** knob. In the bidirectional pattern, you can choose variants that weigh one direction over the other in several steps.

Note that the gain, F/B, and beamwidth on the display are values that apply to a standard installation, but they may not represent your actual situation. For example, your antenna might be interacting with the ground or nearby objects, or you might even have an element failure; neither would be visible on the display. The controller can, however, detect some electrical problems, such as open motor connections.

The factory-installed data will let you operate any current or older model SteppIR antenna, but if you have

Bottom Line

The SteppIR SDA 2000 offers a flexible and attractive user interface for SteppIR antennas that integrates a number of previously optional features, such as lightning protection or tuning relay features. It works with a wide variety of SteppIR antennas, new or old.

[4]H. W. Silver, N0AX, "SteppIR 3-element Yagi Antenna," Product Review, *QST*, May 2003, pp. 67 – 69.

Figure 9 — Default screen.

Figure 10 — CREATE/MODIFY screen for a three-element antenna.

special needs, you may want to calculate new parameters and upload them to the SDA 2000. The data is stored on the SD card in a CSV spreadsheet format. There is third-party support, such as *AutoEZ*, to help you generate antenna models for the SDA 2000 (see **www.ac6la.com**).

The **CREATE/MODIFY** menu option (see Figure 10) shows you the antenna settings currently in effect for your operating frequency and pattern, along with default and saved element lengths. You can edit your antenna data in real time, adjusting element lengths any way you like. If you have high SWR due to an interaction with a local obstacle, you can try to tune it out by adjusting the driven element. You can also apply a percentage change to all elements in common, letting you easily adjust for effects such as wet or ice-covered elements.

The SDA 2000 has several standard features that are add-ons for the earlier SDA 100, including lightning protection (relays that protect motor driver chips) and a tuning relay that will disable your amplifier when the elements are in motion.

The unit will support an optional remote motor controller board that can be placed near your tower, in case your cables exceed the allowed 500-foot length. The remote driver can be up to 2,000 feet from the SDA 2000.

Alas, there is no block diagram, schematic, or other design information provided, which may disappoint the techies among us. But it appears that the SD 2000 is built around an ATxmega128A1 processor. A USB port is provided to allow software updates from your PC. You can't operate the SDA 2000 through the USB with current firmware, however. Basic control (frequency, pattern, and other functions) is provided through the serial I/O ports.

Operating Experience

I put the new controller to good use by connecting to my 2004-vintage three-element SteppIR beam. It proved to be very compatible without any wiring changes, including the serial I/O connection to my FlexRadio FLEX-6500 transceiver. Choosing the right configuration for this particular beam was straightforward.

Sadly, after carefully checking operation on different bands, I found an unusually high SWR on 6 meters, while the lower bands showed a normal match. Using the **CREATE/MODIFY** display, I quickly found a problem with my reflector element, following the checks suggested in the SteppIR troubleshooting guides.

The pattern variants for maximum gain or F/B ratio are nice options, but the differences are subtle. I could not test this, but we ought to be able to use higher F/B to reject strong interference by carefully aiming away from the offending station. (On 20 meters, with my three-element antenna, the controller claims 22.0 dB F/B for the normal pattern, and 35.0 dB for the maximum F/B pattern. Take these numbers with a grain of salt.) One variant I would like to have is a super wide beamwidth option — basically allowing a multi-element beam to work as a dipole. That would be helpful for nets or other operations where directivity is not desired.

As a software-oriented device, the SDA 2000 can be kept up to date with downloads from the SteppIR website. During the review period, we received two new bug fix updates. That provided the opportunity to try out the firmware update process. First, you load the *Avr-Osp II* program on your PC. That's a general-purpose programmer. It has many options that you should ignore, but SteppIR's instructions aren't clear about this. Computer-savvy folks can figure it out, as I did, after some head scratching. A **VERIFY** feature gives you confidence that things worked properly.

Suggestions

The SDA 2000 is a major improvement over the earlier controllers for its usability and appearance. It is highly compatible with the older models. The supplied user manual is good for normal operation, but I found a few things lacking. There is no description of the connector pinouts, which will be necessary for anyone setting up new connections for the antenna motors or the transceiver interface. There is some information about diagnostic tests, but there could be more about normal waveforms, voltages, resistances, and so on. Much of this can be found in other SteppIR documents, but it would be handy to have it in the controller manual.

If you want to create your own antenna designs and software, you will need the details of antenna configurations and formats, but you will need to consult the factory, because there is no programmers guide. Support from the online forum (**groups.io/g/steppir**) has been very responsive.

Conclusion

The SDA 2000 gives you a friendly and attractive user interface for SteppIR antennas, integrating a number of previously optional features. For many new SteppIR installations, it will be a natural choice. Users of older controllers may wish to upgrade, especially if they need to add the lightning protection or tuning relay features. As an updateable device, we can expect improved functions and bug fixes to be provided over time.

Manufacturer: SteppIR Communication Systems, 13406 SE 32nd St., Bellevue, WA 98005; **www.steppir.com**. Price: $899.99. Unit tested: serial no. 10727; firmware version 1.13.

IkaScope WS200 Wireless Oscilloscope

Reviewed by Paul Danzer, N1II
n1ii@arrl.net

The object in Figure 11 is not an oscilloscope probe. It is an entire single-channel oscilloscope that relies on a computer, tablet, smartphone, or other device for control and display functions, and it communicates with the control device via a Wi-Fi connection. The IkaScope application software is available online for Windows, Linux, macOS, Android, and iOS operating systems.

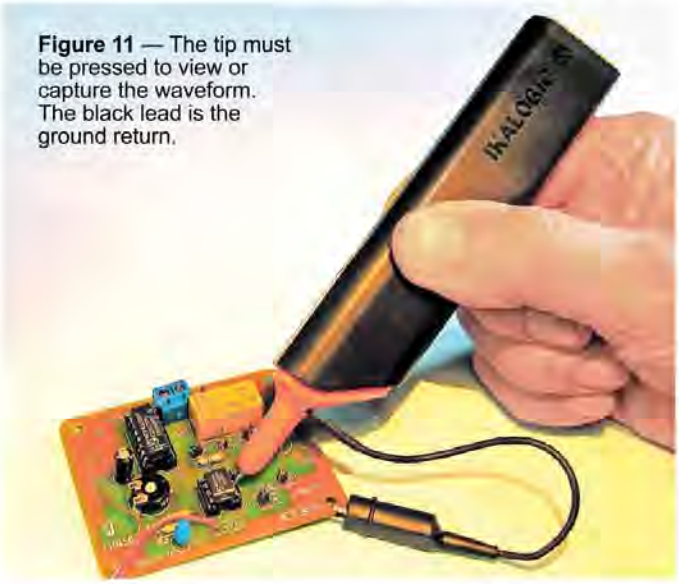


Figure 11 — The tip must be pressed to view or capture the waveform. The black lead is the ground return.

Table 2 lists the IkaScope specifications. In summary, the unit is rated at 200 MSPS (mega samples per second) for a 30 MHz bandwidth. It has 4 Kpts (4,000 points) of memory. The input range is 80 V_{p-p}, ac or dc. The manufacturer claims that for 20 measurements per day, the internal rechargeable 420 mAh battery will last for a week.

The IkaScope resembles any modern digital oscilloscope. It has an analog front end, followed by a digital processing stage, and a Wi-Fi module. Measured signal values are scaled, then followed by analog-to-digital conversion in an eight-bit converter. The result is sent to your host computer/device over the Wi-Fi link.

Table 2
IkaScope WS200 Specifications

Sampling rate: 200 MSPS.
Rise time: 12 ns.
Sampling memory: 4 Kpoints.
Bandwidth (–3 dB): 10 V/div, 30 MHz to 100 mV/div, 50 MHz.
Timebase accuracy: ±2.5%.
Input impedance: 1 MΩ, 14 pF.
Vertical resolution: 8 bits.
Max. input voltage: 80 V_{p-p}.
DC vertical gain accuracy: ±3% full scale.

There are two capabilities that especially interested me. First, it's wireless, so there is no connecting cable that can tangle on the work bench. Second is the flexibility and size of the display. With a smartphone or tablet, it's extremely portable and can be used anywhere. At home, it looks great on a 15-inch laptop or 24-inch desktop PC monitor. You can also use it in a presentation to an audience by sending laptop video to a projector.

Setup

When you open the package, the unit has a protective cover for the front end, a micro-USB cable, and a small instruction card. While the enclosed instruction card gives basic information, additional information is available on the IkaScope website. Although this instrument is imported from France, all of the paperwork and online information is in well-written English.

To charge the IkaScope's internal battery, plug in the micro-USB cable, and connect the other end to a

Bottom Line

The IkaScope is a flexible and useful 30 MHz oscilloscope that is not much bigger than a typical probe. Coupled via Wi-Fi to its application software running on a desktop PC or mobile device, it can be used in a variety of settings.

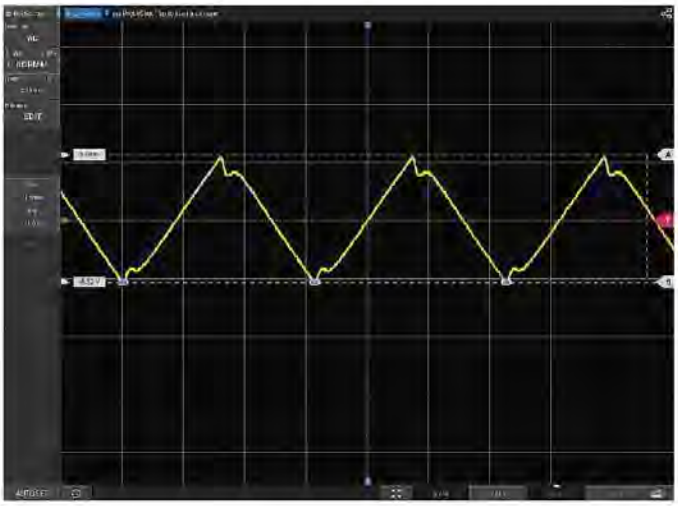


Figure 12 — For these symmetrical triangular waves, the **AUTOSET** function was not used. The cursor was set so you can see the peak-to-peak voltage, shown on the left.

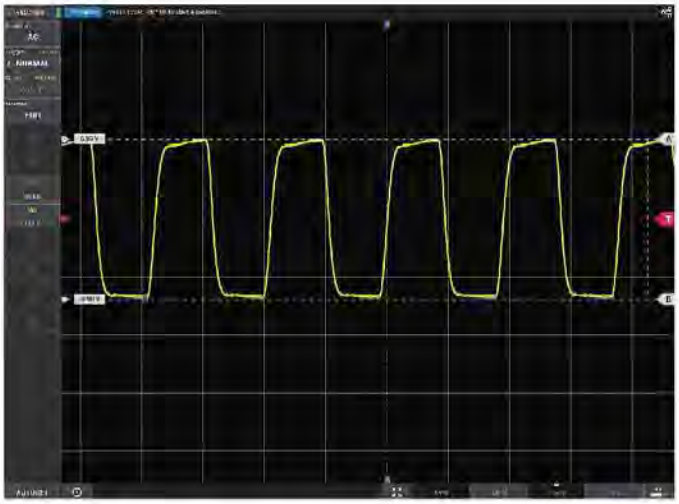


Figure 13 — The **AUTO** trigger was set at 0 V, so this nonsymmetrical square wave shows different positive and negative levels.

computer USB port or a USB charger (not included). An orange LED on the rear of the unit will light and then turn green when the battery is fully charged.

I decided to use the IkaScope with a Windows PC that had a wireless card, but was not connected to my home network. From the IkaScope website, I downloaded the **IKASCOPE_SETUP.EXE** file for Windows. Note that once you have downloaded the setup file, you no longer need internet access. Just follow the instructions to connect your computer to a new local network set up by the oscilloscope.

After charging the IkaScope battery and running the software installation program on my Windows 10 PC, I followed these steps to connect the software and IkaScope:

1) Press the IkaScope probe tip against a solid surface (pressing in the tip turns on the device). A white LED on the back of the unit will start blinking.

2) On the PC, go to the listing of available Wi-Fi networks. A new one called **IKASCOPE-XXXXXXX** (the device serial number) will appear. Select this network.

3) The blinking white LED on the IkaScope will stay on steadily.

4) Launch the IkaScope application, and you are ready to run.

Before you start the process, be sure you know how to find the screen on your PC or device that lets you select Wi-Fi networks. If you take too long, the blinking white LED will go off, and you will probably have to start over.

Using the IkaScope

This scope operates differently from most that I have used. The probe end does not have any sort of hook because you must press in the tip to see a waveform. As long as the tip is pressed, the current waveform is shown. When you release it, the scope software stores the last frame.

The small symbol in the upper right corner of the display screen gives the choices for storage. You can copy an image to the host device clipboard or save the image to a file. (That's how I created Figures 12 and 13.) There is a third alternative — save to a CSV file. This option saves the data to a numerical text file that can be examined using *Excel* or a similar spreadsheet program. The CSV file is semicolon delimited (not the usual comma-delimited format) and can be imported into a spreadsheet for further processing. A segment of one such file is shown in Figure 14.

Figure 12 shows a horizontal symmetrical triangle waveform from a signal generator. This signal generator has a dc offset capability, so the image shows the waveform going from +5.68 V to –5.32 V — a small offset.

The menu on the left side of the screen changes parameters by clicking your mouse. If you are trying to observe a changing waveform, you need one hand to hold the probe tip down and the other to move the mouse. Sometimes I felt that I needed three hands. However, because you can change parameters with the mouse after you release the probe and store the last-viewed waveform, it is manageable.

In Figure 12, I set **MEASURE** in the left column to **EDIT** and moved the top cursor to just miss the top of the waveform. I set the bottom to just touch the bottom of the waveform (the little blue circles say that I have just missed the bottom). In the left column, you can see a set of gray + signs under the **EDIT** button. Select one of these, and a menu of choices is brought up on the screen, slightly covering the waveform. In this case, I selected **FREQUENCY** and **Vpp** (voltage peak-to-peak), and the values of 31.9 kHz and 11.0 V are displayed.

The red line is the **TRIGGER** value shown at the left, and it's in the **AUTO** position. In using the IkaScope, I found the automatic trigger function to be very useful and very dependable. The **AUTOSET** function (automatic scaling in both voltage amplitude and horizontal frequency) was also very dependable. I tested it from audio frequencies to slightly less than 30 MHz (for the amateur 10-meter band).

The selections along the bottom of the screen are dropdown menus, giving you a choice of manually set values. Here, it is set at 5 V per division vertically and 10 µs per division horizontally.

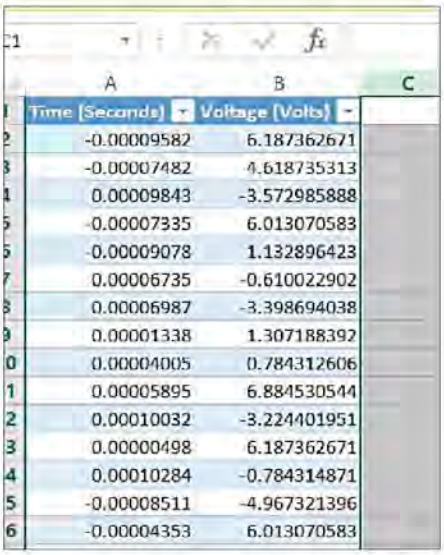
Figure 13 shows a square wave. The cursors are set to measure the peak-to-peak voltage, but the automatic measurement tells us that the manually positioned cursors are off by a bit. The automatic frequency reads 106 kHz.

There is also an automatic storage feature where several previous pictures can be saved and recalled for comparison. While many scopes have a storage capability, they are usually controlled by a **RUN/STOP** button. With the IkaScope, pressing on the probe tip is the equivalent of **RUN**, and releasing the tip is the equivalent of **STOP**. When you release the tip, the picture is saved automatically for editing and processing.

Advantages

As previously mentioned, there is no lead from the probe to the scope body. And you can view the waveform on a desktop computer monitor, thus letting you see details that might not be obvious on a typical 5-inch oscilloscope screen.

After using the scope for a few hours, including troubleshooting an audio amplifier, I found storage features to be quite useful. The ability to reexamine a stored picture and rescale it, both in time and amplitude, let me look for things I did not see on the original screen capture. Then, after I made a small change in the audio amplifier input load resistance, I could see the difference by comparing two stored images on my PC monitor. I could see immediately if I had made a significant change.



	A	B	C
1	Time (Seconds)	Voltage (Volts)	
2	-0.00009582	6.187362671	
3	-0.00007482	4.618735313	
4	0.00009843	-3.572985888	
5	-0.00007335	6.013070583	
6	-0.00009078	1.132896423	
7	0.00006735	-0.610022902	
8	0.00006987	-3.398694038	
9	0.00001338	1.307188392	
10	0.00004005	0.784312606	
11	0.00005895	6.884530544	
12	0.00010032	-3.224401951	
13	0.00000498	6.187362671	
14	0.00010284	-0.784314871	
15	-0.00008511	-4.967321396	
16	-0.00004353	6.013070583	

Figure 14 — A segment of a waveform saved using the CSV file option. If the CSV file is just copied into your spreadsheet, all these values will be in the single selected cell. If you follow the procedure to import the information, you get stored values like this, so you can apply any calculations you want to the measurement data.

As with most modern digital scopes, the IkaScope does a lot and has a learning period. If you're used to conventional knob-and-button scopes, it will probably take you a while to get used to the major controls and capabilities. After the initial familiarization, I found that the logical order of the on-screen controls makes the scope use quite straightforward.

Manufacturer: IkaLogic, 19 Rue Columbia, 87000 Limoges, France; **ikalogic.com**. Available in the US from Saelig Company, **www.saelig.com**. Price: $300.

New Products

Mastrant's Universal Stainless-Steel Mast Clamp

Mastrant introduces a universal stainless-steel guying mast clamp for a wide range of mast diameters. It is strong, with a 4-millimeter (5/32-inch) thickness and a 40-millimeter (1½-inch) height, and it uses 5/16-inch M8 screws with 60-millimeter (2¼-inch) or 100-millimeter (3⅞-inch) length. The clamps are also very durable, using AISI 316 screws, nuts, and washers and AISI 304 steel-plate brackets, which are universal for both three- or four-directional configurations. In the bracket, there is a hole for a security bolt. The holes for 16-millimeter-diameter (⅝-inch-diameter) guys can adopt shackles, chain couplers, or carabiners of 4-millimeter (5/32-inch) sizes and thimbles of 3 to 10 millimeters (⅛ to ⅜ inches).

Pricing

Three-directional, ⅝ – 2 inches (15 – 53 millimeters)	$19
Three-directional, ⅝ – 4 inches (15 – 102 millimeters)	$20
Four-directional, 1¼ – 3¼ inches (32 – 85 millimeters)	$25
Four-directional, 1¼ – 5 inches (32 – 127 millimeters)	$27

www.mastrant.com

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

The Doctor is In

Switches Aren't Perfect

Q Grant, W5XJ, asks: I want to switch several radios in my shack via a coax switch to a single coax antenna feed. The rigs include a pair of discontinued 100 W solid-state HF transceivers and various old vacuum-tube transmitters, one of which runs a legal-limit carrier. Do you think an Alpha Delta commercial coax switch will have enough port-to-port isolation to avoid damage to the solid-state gear? How does one measure port isolation of a switch? What else do you recommend?

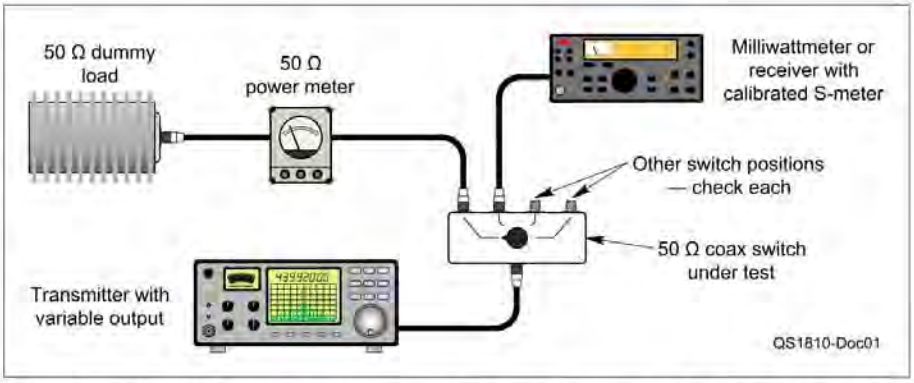


Figure 1 — Method of measuring port-to-port isolation of a coax switch. It is important that the receiver has a calibrated S-meter in order to have valid data.

Table 1
S-Meter Readings Indicating Port-to-Port Isolation at 10 W

S-Meter	dBm	Isolation (dB)
S-9 +70 dB	–3	43
S-9 +63 dB	–10	50
S-9 +60 dB	–13	53
S-9 +50 dB	–23	63
S-9 +40 dB	–33	73
S-9 +30 dB	–43	83
S-9 +20 dB	–53	93
S-9 +10 dB	–63	103
S-9	–73	113

A Unfortunately, transceiver manufacturers do not generally specify the maximum safe input level of their receivers, and while many coax switch makers specify their port-to-port isolation, not all do. Alpha Delta provides a link on their website to "Tech Data for Government and Military Users" that indicates that the nominal isolation of their 2B and 4B switches is >60 dB at 30 MHz (>50 dB at 150 MHz). Daiwa, Diamond, DX Engineering, MFJ, and others also provide isolation specifications for some of their coax switches — check manufacturers' websites before you select a switch to make sure it will provide the isolation that you need. Note that port-to-port isolation is not as important if switching one radio to multiple antennas.

Measuring port-to-port isolation is not difficult, but it requires care, especially if the switch has poor isolation. The technique is shown in Figure 1.

To make an accurate reading, you need to have a receiver with a calibrated S-meter. The transmitter supplies a known power output — start with the lowest possible output (most transceivers can be turned down to 10 W or less). The difference between the transmit power and power coupled to a non-switched port represents the isolation. If you have an accurate milliwattmeter, the calculation will be even more straightforward.

Table 1 shows the readings for various isolation levels based on a 10 W carrier on the driven port. Note that a fairly wide S-meter dynamic range is required if the isolation is very good. Unless your transceiver's attenuator modifies the S-meter calibration, switching it on may get you within an easier to read range. In any case, you should be able to get an idea of what's happening — but only if your S-meter is calibrated.

If your transmitter puts out 1,000 W carrier (probably not quite), that is 30 dB above 1 W (or 30 dBW), or also 60 dB above a milliwatt (or 60 dBm). During product reviews, the ARRL Lab tests receiver intermodulation response with an input level of up to +10 dBm and has never lost one, so we consider that a safe level, although it's not a guarantee. That is a difference of 50 dB from 1,000 W, so that gives you a 10 dB safety margin if the isolation is actually 60 dB. This assumes that coupling between switch ports is the only source, which requires that everything else is solid, such as coax connectors snugged tight, shields well connected to connectors, and no other paths around the switch.

Because neither of your solid-state radios are currently well supported by their manufacturers, a 10 dB margin may be cutting it a bit close, but it certainly is not unreasonable. Solid-state equipment is more vulnerable if powered on than turned off, so to improve your chances, keep unused gear powered down while not in use.

Figure 2 — View of a portion of the W1AW patch panel used to interconnect transmitters and antennas using coax jumper cables. Yours probably doesn't need to be quite as extensive [Joe Carcia, NJ1Q, photo].

Various sales outlets may offer surplus military or commercial switches with even higher isolation ratings, but make sure they can also handle your maximum transmit power.

Another very good solution to consider is to make a patch panel and manually use a jumper cable to switch your antenna to different rigs. A large coax patch panel is used to interconnect the antennas with both bulletin transmitters and guest console transceivers at W1AW, the ARRL Headquarters station (see Figure 2). Your panel does not need to be as extensive, and could even be built in a project box. If you build a panel with BNC-type connectors on the radio side, it will be almost as quick to operate as a switch. If you then use UHF connectors on the antenna side of the jumpers, it won't be possible to accidentally connect two radios together.

Q Tony, N4RCK, asks: My antenna system started out with an SWR at the radio of 1.5:1. I was able to trim it to achieve an SWR of 1:1 at my favorite spot on the band. I have, however, read Walt Maxwell's series, "Reflections," in *QST* and wonder if there was any benefit to making that adjustment?[1] Maxwell seems to say that an SWR of less than 2:1 is not significant.

A Walt Maxwell's "Reflections" series in *QST* is a classic and highly recommended reading for any who wish to understand what is happening on their transmission lines. I agree with Walt on the 2:1 conclusion, with just a few reservations, which are likely detailed within his writing.

Most transceivers start to reduce output power with increasing SWR (called folding back) to make sure that the transmitter circuitry isn't damaged by high current or voltage that might result from an excessive SWR. Most don't do that at an SWR of less than 2:1, but some do. The antenna will still radiate all the power that gets to it, but the transmitter will put out less. This does not often happen with an SWR below 1.5:1, so it's not an issue in your case.

When you change the length of your antenna to tune it, and in the process reduce the SWR from 1.5 to 1:1 (which is not always possible), you will reduce the transmission line loss a bit. The amount depends on the line type, frequency, length, and SWR. For example, at 3.5 MHz with 100 feet of RG-213, the loss at an SWR of 1.5:1 will be 0.403 dB. At an SWR of 1:1, it will be 0.364 dB — not worth a thought. On the other hand, at 50 MHz with 100 feet of RG-58, it will be 4.091 dB at 1.5:1; at 1:1, 3.931 dB. The difference is less than 0.2 dB — still not much, but not nothing.

Keep in mind that if measuring the SWR at the transceiver, the measured SWR will be lower than that at the antenna because any transmission line loss reduces both the power that reaches the antenna, as well as the reflected signal that comes back. Because the SWR is a function of the relationship between reflected power and forward power at the measurement point, the SWR seen at the radio will be less than that on the rest of the line. Again, the difference depends on the same factors as noted above. A measured 1.5:1 SWR at the bottom of 100 feet of RG-213 will occur with an antenna SWR of 1.56:1. With 100 feet of RG-58 at 50 MHz, 1.5:1 at the bottom will correspond to 3:1 at the antenna — quite a difference.

[1]W. Maxwell, W2DU, "Another Look at Reflections — Part 1," *QST*, Apr. 1973, pp. 35 – 41. See also Part 2, *QST*, Apr. 1973, pp. 20 – 27; Part 3, *QST*, Aug. 1973, pp. 36 – 43; Part 4, *QST*, Oct. 1973, pp. 22 – 29; Part 5, *QST*, Apr. 1974, pp. 26 – 29, 160 – 165; Part 6, *QST*, Dec. 1974, pp. 11 – 14, 158 – 166; Part 7, *QST*, Aug. 1976, pp. 15 – 20, and W. Maxwell, W2DU, "Technical Correspondence — Corrections to Another Look at Reflections," *QST*, Aug. 1991, p. 42.

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

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

Paul Wade, W1GHZ, w1ghz@arrl.org

Microwavelengths

From a Parabolic Dish to an Antenna

Setting up a classic prime-focus dish (a dish with the feed in the center) seems pretty intuitive — the feed is placed at the focal point above the center of the dish and pointed at the vertex (the center of the dish). The resulting narrow antenna beam is on the axial line through the vertex and the focus, so aiming is obvious. For best performance, the feed horn should be chosen for proper illumination of the reflector F/D — see **www.w1ghz.org** for suggestions.

Prime-focus dishes place the feed horn in the center of the beam, blocking part of the energy, reducing gain and efficiency. If the electronics are placed near the feed, they present an additional obstruction. The alternative of placing the electronics behind the dish adds the loss of the feed line, which is significant at microwave frequencies.

There is also a mechanical problem. Small dishes like the one shown in Figure 1 may be balanced by the weight of the electronics on the back. Larger dishes may require a counterweight.

Figure 1 — Fred Stefanik's, N1DPM, prime-focus 10 GHz dish. Note the long feed line from the electronics behind the dish.

Offset Parabolic Dishes

The major advantage of an offset-fed dish is that the feed horn is not in the beam of the antenna, so that the whole reflector is utilized and efficiency is higher. Equipment may also be placed out of the beam but close to the feed horn for minimum feed-line loss. But setting up an offset-fed dish is much less obvious: where is the focus, where should we point the feed horn, and how do we aim the antenna?

Almost all offset dishes, and especially the ubiquitous small satellite TV dishes, use a simple geometry, where the oval reflector projects as a circle

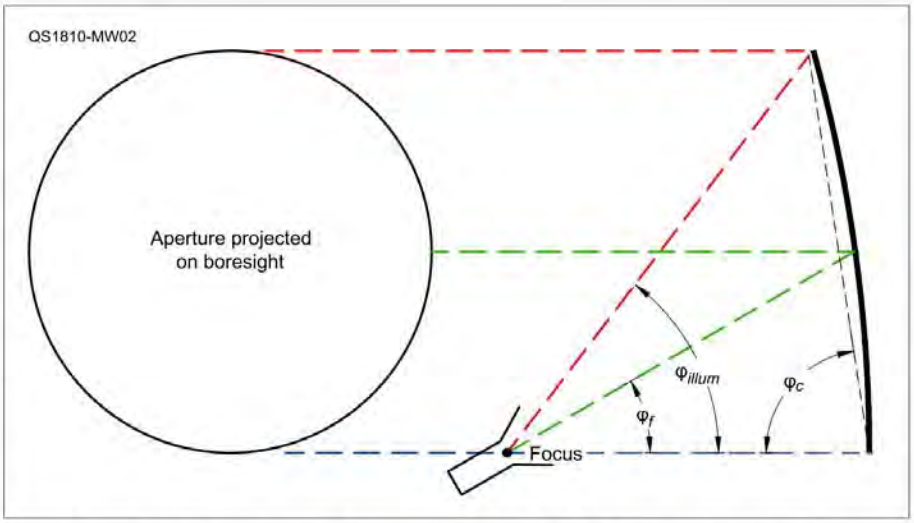


Figure 2 — Geometry and angles for common offset-fed dishes like small satellite TV dishes.

looking along the beam from the front, so the effective diameter D equals the width of the oval. The bottom of the offset dish is the vertex of a full parabola, so that the vertex, focus, and beam are still in line. This simplifies the required calculations.

The geometry is shown in Figure 2. The focal length f is calculated from the width and height of the oval reflector using Legon's equation:

$$f = focal\ length = \frac{width^3}{16 * depth * height}$$

The resulting F/D is about 0.6 for most common offset dishes.

The feed horn is placed with its phase center at the focus, and aimed so that the reflector is evenly illuminated. The feed horn must illuminate the whole reflector, a subtended angle of

$$\varphi_{illum} = 2\tan^{-1}\left(\frac{1}{2\,f/D}\right),$$

about 80° for common offset dishes.

The angle of the center of the dish is half of φ_{illum}, or about 40°. Note in Figure 2 that the focus is closer to the bottom of the dish than to the top — the feed must be aimed slightly higher than the center of the dish to compensate and balance the illumination. So, the feed is aimed up toward the dish by the feed angle:

$$\varphi_f = 2\tan^{-1}\left(\frac{1}{4\,f/D}\right),$$

about 45° for common offset dishes.

The offset reflector is then tilted forward by the tilt angle φ_c to aim the beam on the horizon

$$\varphi_c = \tan^{-1}\left(\frac{4f}{D}\right),$$

about 67° for common offset dishes.

Figure 3 — An offset-fed dish with the transverter mounted under the feed horn. The feed line is short but the weight is not balanced. Note the bubble level at the base of the dish to indicate nominal elevation.

Practical Considerations for Offset Dish

The focal point of an offset dish is the most important dimension, but the location is not obvious. If you find one with the original feed assembly, your calculations should be close to the placement of the original feed. Otherwise, the focal point is separated from the bottom edge of the dish by the focal length, and from the top edge by a distance of

$D / \sin\varphi_{illum}$.

The feed horn should be chosen to properly illuminate the F/D of the reflector, about 0.6 for common offset dishes. The aiming angle for the feed is less critical — aiming a little above the center will work fine.

Fortunately, small errors in an offset-fed dish result in a beam which is tilted slightly up or down, easily compensated for by tilting the antenna elevation. The final elevation angle should be found by peaking on a distant signal. I put a bubble level on my dishes at the approximate angle to aim at the horizon.

Offset dishes also have mechanical problems. Ideally, the electronics are placed under the feed horn, with a short feed line and out of the beam. However, this puts all the weight at the end of the feed support, as shown in Figure 3. If the reflector is mounted from the rear, as most are, a sturdy tripod is required even for a small dish. Another choice is to mount the offset dish on top of the electronics, like Figure 4.

Figure 4 — An offset-fed dish with the dish mounted on top of the transverter for better weight balance. The tilt angle is set by a wooden wedge.

With any dish, it is desirable to have some elevation adjustment, since microwave signals can bend due to atmospheric effects. I often find that distant (beyond line-of-sight) signals peak at a few degrees of elevation, and occasionally below the horizon.

For portable operation, always calibrate azimuth and elevation on a signal at each setup — a beacon is best. Bouncing around in a vehicle tends to shift adjustments and even distort parabolic reflectors slightly.

Photos by the author.

Microwave Update

Microwave Update, the premier microwave conference and get together, will be held October 11 – 14 in Dayton, Ohio. Visit **www.microwaveupdate.org** for more information. See you there!

Hints & Hacks

No More Sliding Keys, Easy Remote Tuning, and More

Stop Keys from Sliding

The surface of my newly built radio desk has a smooth finish. Unfortunately, my Kent key kept sliding around, which meant that my sending was awful. My solution was to use tape designed to stop rugs from slipping. This tape is adhesive on one side and has gridded raised rubber on the other side. The tape comes in a roll and can be found in the flooring section of home improvement stores. I just fastened the tape firmly in place, and now there's no more sliding (see Figure 1). — *73, Lionel Booth, N5LB,* **n5lb@outlook.com**

Easy Alpha Loop Remote Tuning

When we began planning to relocate to an apartment or condominium, I started exploring my antenna options. I purchased an Alpha Loop package, installed it on the porch, and attached it to an Elecraft KX2 running 10 W. The results were good on digital modes, including JT65, JT9, FT8, and even PSK modes.

However, to change bands, the loop requires tuning a capacitor to maximize receiver noise. (The KX2's ATU takes care of the rest, always achieving 1:1 matching.) This means disconnecting the sound card, turning up the volume, opening the window so receiver noise can be heard at the antenna, and going outside to do the tuning. This makes frequent band changes painful.

Figure 1 — A CW key placed on non-slip tape designed for rugs stops sliding during sending. [Lionel Booth, N5LB, photo]

I needed a solution to make band changes easy. I designed a pushbutton system to power an electric motor (see Figure 2). A DPDT (double pole, double throw) switch to change dc polarity would enable forward and reverse motion and the pushbutton would deliver power to the motor, which turns the capacitor shaft. The capacitor does not have hard stops at full-open and full-meshed positions, so high current motor stalls will not be an issue.

I built this project mainly from items in my junk box, including a small, geared 12 V motor; the motor's 5-millimeter shaft (hollowed, and threaded inside the hollowing); a ¼-inch collar; a ¼-inch shaft coupler; a small pushbutton switch designed for circuit board mounting; 5-centimeter-long bolts and nuts; an old pill bottle, and 4-centimeter-long spacers. I used four-wire telephone station cable to connect the remote motor to a controller in my station (only two wires were needed).

Box Modification

The capacitor's housing is a plastic box, so I removed the cover. Two holes are needed to secure the spacers supporting the motor to the box. I used the motor to locate these holes (mine were offset from the axis of the capacitor shaft).

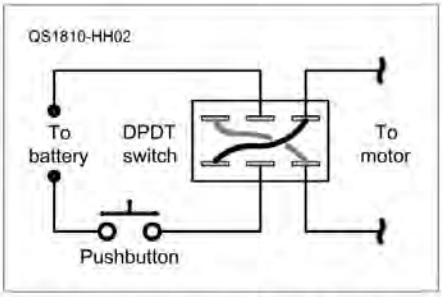


Figure 2 — A schematic of the author's design.

Caution: I tried unmounting the box from the support pole. One of the clamps is secured with a nut beneath the board holding the capacitor, and I had to disassemble the works to reattach that bolt. A better plan is to remove the support tripod and loop from the pole, leaving the metal connecting piece attached to the box.

Motor Modification

The motor shaft must be enlarged to fit the ¼-inch coupler. The collar may be force-fit to the shaft if its inner diameter is machined to match the shaft, or the collar may be secured with a bolt.

Motor Assembly

I attached the coupler to the motor and secured it with the set screw. I then attached the motor to the box using the 4-centimeter spacers and the 5-centimeter bolts and nuts. I next slid the coupler over the capacitor shaft and secured it with the set screw. I tested the installation with a 9 V battery, making sure to try both directions. The motor has good torque, so minor misalignments should be no problem.

Figure 3 — The control "box," with DPDT switch on top. [Monty Shultes, K2DLJ, photo]

Controller Assembly

I removed any cardboard from the lid of the pill bottle, then mounted the DPDT switch to the plastic lid after attaching wires per the diagram. The pole (center terminal) wires go to the battery and pushbutton, and the throw wires (end terminals cross-wired) go to the motor via the station cable (see Figure 3).

My pushbutton is designed for PCB mounting, so I drilled four small holes in the lid for its mounting feet then mounted the switch, bending the feet over to hold it. Solder blobs on the underside secure the switch. I attached one contact to a pole of the DPDT switch, and attached a 9 V battery to the other pushbutton contact and the other pole of the DPDT switch.

Using the remote is easy. I just flip the DPDT switch, hold the pushbutton, and wait for the received noise to peak. Overshooting the sweet spot is inevitable, but all I need to do is reverse directions and poke the button as often as needed. Success comes quickly after a few trials. Be sure to mark the DPDT positions as **UP** and **DOWN** once you learn which way the motor turns (see the final product in Figure 4).

Tuning now is almost fun. It's so easy that I find myself trying new bands.
— 73, A LaMont "Monty" Shultes, K2DLJ, **montys@mindspring.com**

Figure 4 — The completed motor attached to the capacitor box. [Monty Shultes, K2DLJ, photo]

Prevent QSL Card Fading

I've noticed that the writing on some QSL cards tends to fade over time. To combat this, I recommend using an archival-quality pen to fill out your handwritten QSL cards. Archival pens are specifically designed to resist fading and many use pigments instead of dyes. Archival pens are available for purchase at online retailers and office and art supply stores.
— 73, Zach Manganello, K1ZK, **zmangane@comcast.net**

Meter Magnet Magic

There is no set screw on the Drake 4-line meters to zero the meter if the needle is somehow below or above the point it should rest while powered off. On the plate current meter, the point should read 0, and on the S-meter it should read 1. The out-of-place needle affects the accuracy of its readings. Here are some options for fixing this issue.

Production of these meters stopped years ago, but if you can find another on eBay, you can use the scale from a working S-meter in the plate current meter with the broken needle, or vice versa. In that case, carefully remove the plastic front, which is glued to the frame of the meter's metal case.

There is a simpler way, however. By moving a small magnet on the meter's case, you can pull the needle below or above where it should rest while powered off. When you've found the right spot, put a bit of glue on the magnet and attach it to the meter (see Figure 5). Few will notice the modification if they open the cabinet for visual inspection.

Don't worry that the magnet will affect the linearity and accuracy of the

Figure 5 — A small magnet can correct a meter needle that rests above or below zero. [Peter Ravn, OZ8CTH, photo]

meter. I connected a repaired plate current meter with an original plate current meter in parallel and gradually increased voltages from zero. Both meters showed 1.4 V at full deflection and moved at 50 mA intervals at the same pace. — *73, Peter Ravn, OZ8CTH,* **fasan5@privat.dk**

A 12 to 9 V DC Adapter for the MFJ-299 Desk Mic

The MFJ-299 desk microphone is my usual choice for HF use with my Kenwood TS-570S. I especially like the mic's volume unit (VU) meter, which allows me to easily monitor the level of outgoing audio. Of course, the other features such as the built-in PTT transmit indicator LED, selectable compression, and graphic equalizer make it a powerful unit indeed. The only negative aspect is that it's designed to be powered only from a 9 V battery, with no other option.

The problem is if you forget to switch the microphone off after use, then approximately 11 mA is continuously taken from the battery, which will necessitate its replacement several times per year.

I decided to build a simple 9 V dc source and install it in the MFJ-299 in place of the battery. Ideally, it would be no larger than a conventional 9 V battery and would take its power from the same 13.8 V dc bus I use to power my rigs, meter illumination, shack lighting, and so on.

Figure 8 — A comparison of the stripboard power supply to the 9 V battery it's replacing. The stripboard circuit is enclosed in a piece of clear heat-shrink tubing for protection. [Don Dorward, VA3DDN, photo]

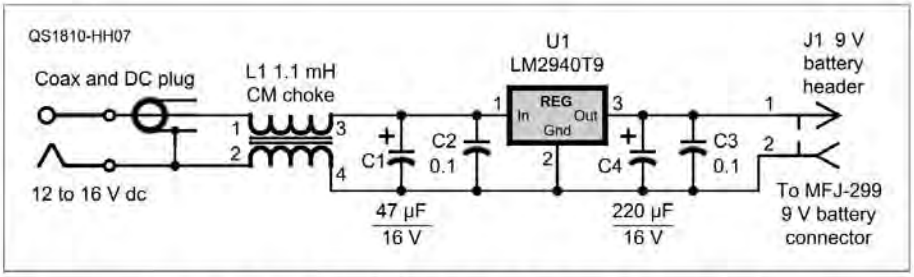


Figure 6 — A schematic of the author's 9 V dc source for the MFJ-299. [Don Dorward, VA3DDN, photo]

L1 — 1.1 mH common-mode choke
C1 — 47 µF, 25 V electrolytic capacitor
C2, C3 — 0.1 µF, 50 V ceramic capacitor
C4 — 220 µF, 25 V electrolytic capacitor
U1 — LM2940-T9 LDO voltage regulator
J1 — snap terminals taken from the top of a dead 9 V battery

Stripboard: 18 × 5 holes, approximately 1.8 × ½ inches (Veroboard epoxy/fiber or CEM-1 stripboard or equivalent)

Coax and plug: 24 inches of RG174 mini coax, dc power plug of your choice (the author used 5.5 × 2.1-millimeter center)

Grommet: (To protect the RG174 coax where it exits the corner of the battery compartment on the MFJ-299.)

Heat-shrink tubing, clear, ¾-inch diameter, 2¼-inch length (optional)

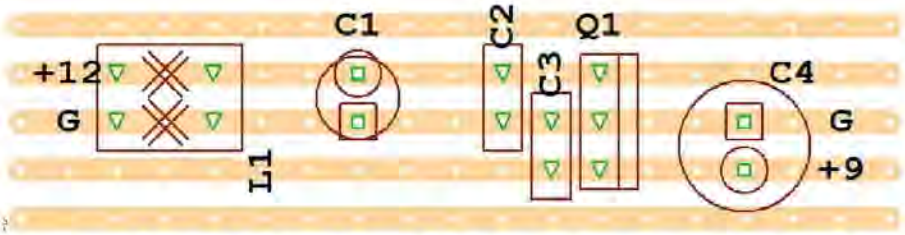


Figure 7 — The circuit on a small piece of perforated stripboard. Note: Cut the copper strips in the locations indicated by the double **X** marks under L1.

Figure 6 shows the simple schematic, using the low-dropout voltage regulator LM2940T9, which will maintain the 9 V output as long as the input is 10 V or higher. I included the common-mode choke L1 as a precaution to prevent RF from coming in on the 12 V dc input. For L1, anything from 1 –10 mH will work fine. In my case, I found some low-cost 1.1 mH common-mode chokes on eBay. However, if you want to make your own, the Laird LFB127079 ferrite (DigiKey 240-2278-ND) with 10 bifilar turns on it will work as well.

I decided to build the circuit on a small piece of perforated stripboard (as shown in Figure 7). This is no larger than the standard 9 V battery it is replacing and easily fits into the battery compartment of the MFJ-299 (see Figure 8). — *73, Don Dorward, VA3DDN,* **va3ddn@arrl.net**

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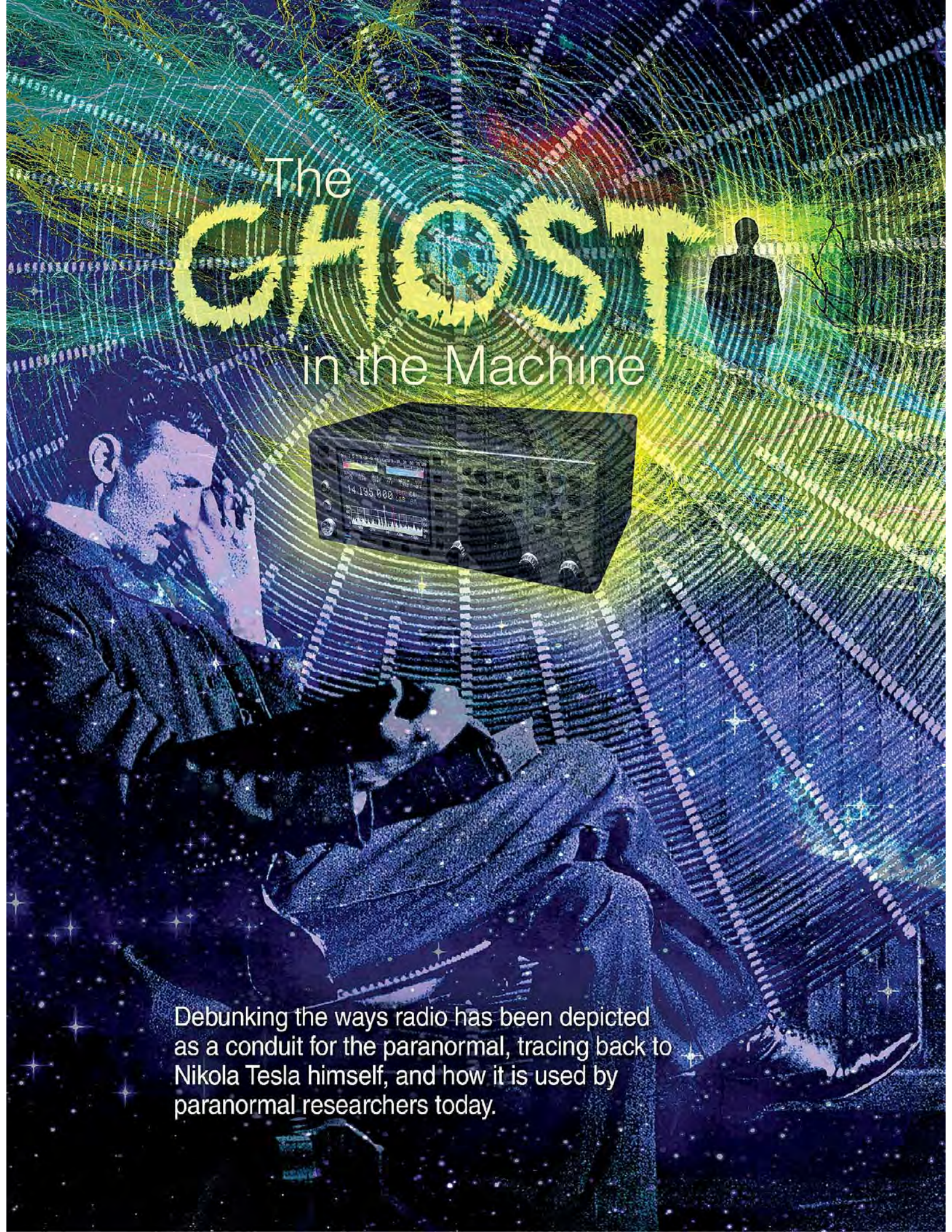

The
GHOST
in the Machine
Debunking the ways radio has been depicted as a conduit for the paranormal, tracing back to Nikola Tesla himself, and how it is used by paranormal researchers today.

Allison McLellan

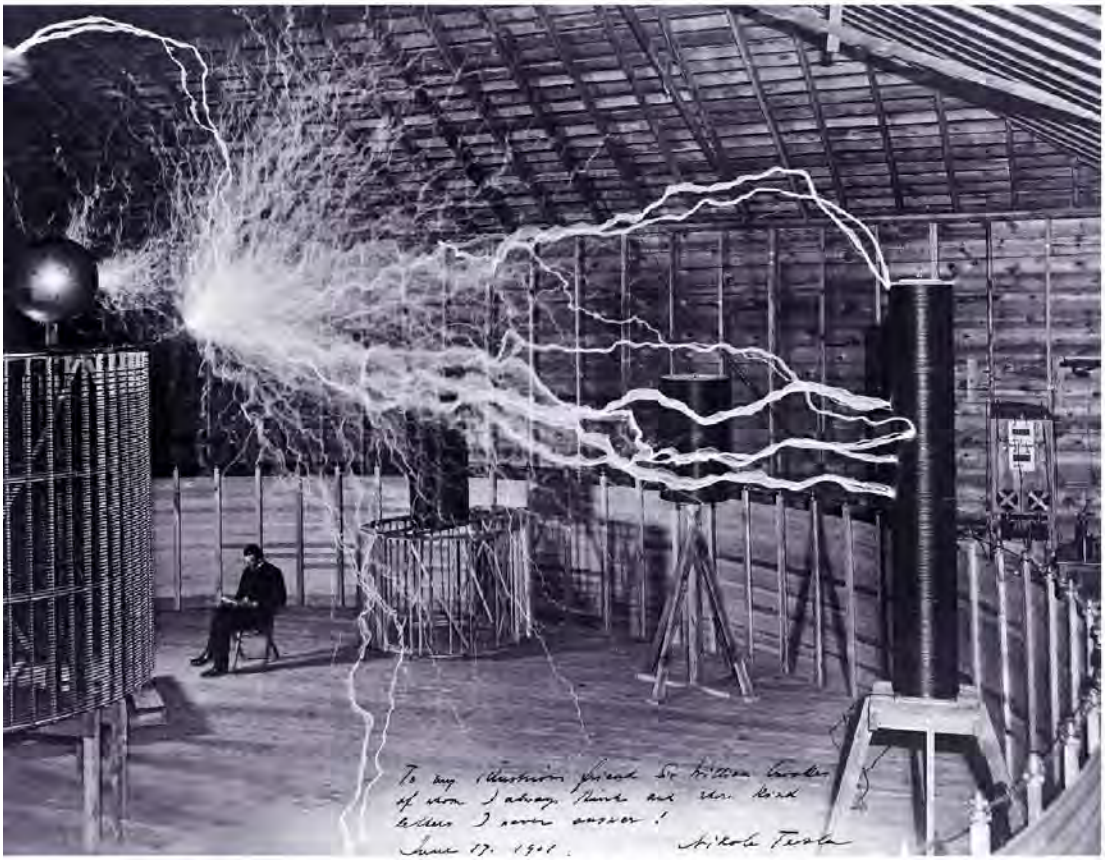
As we approach October, horror movies and paranormal-themed TV shows will start appearing more frequently in the spirit of Halloween, and you shouldn't be surprised if radio makes a cameo. In pop culture, ham radio is often portrayed as a way to contact "the other side" — whether it be ghosts, aliens, or even another dimension. Take the plot of the 2000 sci-fi thriller *Frequency*, and its subsequent 2014 TV adaptation, which relies on the main character, John, using ham radio to contact his father back in time. Or Netflix's sci-fi/horror show *Stranger Things*, in which a group of kids uses a Heathkit radio to communicate with a parallel dimension they call "the Upside Down."

But this mystification with a faceless voice from the radio is nothing new; even Nikola Tesla once thought he was able to achieve intelligent communication with other planets through radio.

The Age of Spiritualism

The United States was amid its Second Industrial Revolution in the late 19th century, spurred in great part by the founding and spread of wireless telegraphy. But this technological revolution intersected a cultural shift with the rise of contemporary Spiritualism. First taking hold around 1850, Spiritualism is based upon a belief in the existence of spirits of the dead and the ability to communicate with them.

Along with Spiritualism came the fad of celebrity mediums — those claiming to be able to mediate communication with the spiritual world. Some mediums' exhibitions were eventually exposed as hoaxes, but a public left grieving after the American Civil War and World War I was willing to latch onto this potential proof of the afterlife as a connection to lost loved ones. In such a groundbreaking era of discovery, communicating with the spirit world didn't seem any less plausible than real-time communication with someone across the country, once just as inconceivable before the telegraph. In fact, some believed achieving contact with another realm would be the greatest possible extension of communication technology.



Sparks emitted from Tesla's high-voltage generator at his Colorado Springs lab around 1899. The voltage was exaggerated through double exposure by photographer Dickenson V. Alley. [Dickenson V. Alley, Wellcome Collection gallery, photo]

Talking with Planets

In the beginning of the 20th century, while the wave of Spiritualism was still largely influential, inventor Nikola Tesla was becoming a household name. The scientist is most revered for his work in designing the modern alternating current (ac) electric supply system, as well as his patented Tesla coil.

In a 1901 article for *Collier's Weekly*, entitled "Talking with the Planets,"[1] Tesla described how he succeeded in creating a machine at his Colorado Springs lab that functioned through "drawing electricity from the earth and driving it back into the same at an enormous rate, thus creating ripples or disturbances which, spreading through the earth as through a wire, could be detected at great distances by carefully attuned receiving circuits."

Lead photo: Nikola Tesla in front of Tesla coil transformer. ["Tesla's Important Advances," *Electrical Review*, May 20, 1896, p. 263., Tonnelé and Co., photo]

> *"In such a groundbreaking era of discovery, communicating with the spirit world didn't seem any less plausible than real-time communication with someone across the country."*

As he continued his experiments, Tesla began to construe an intentional pattern in the sounds being emitted from his devices. He said, "My first observations positively terrified me, as there was present in them something mysterious, not to say supernatural, and I was alone in my laboratory at night.... The feeling is constantly growing on me that I had been the first to hear the greeting of one planet to another."

After so many years, we can't be exactly sure what Tesla was hearing that night in his lab. In the biography *Wizard: The Life and Times of Nikola Tesla*, author Marc Seifer asserts that Tesla may have been picking up signals from his competitor, Guglielmo Marconi, who, at the time Tesla was experimenting in Colorado Springs, was also transmitting messages across Europe and the English Channel. Marconi had been continuously using the three-dot Morse code signal for the letter "S," which aligns with a description Tesla gave of a three-beat signal he intercepted in Colorado. Regardless, as a pioneer of his time, it appears Tesla was genuinely determined to achieve such a feat as intergalactic communication.

Ironically, 20 years later, Marconi also told reporters he had detected radio emissions seemingly coming from space. In 1922, the magazine *Popular Radio* picked up on the possibility, with "Are We getting Radio Signals from Another Planet?" Author E.E. Free, PhD, said, "Everyone knows of [Marconi's] success nine months ago in picking up impulses of very long wavelength, believed not to be of terrestrial origin — impulses which are suggestive, to say the least, of signals sent out from some source and directed by intelligent beings."

However, Free went on to provide a much less sensational source for the signals — sunspots. He wrote, "... there is a direct and important connection between the number and size of sun-spots and the occurrence on earth of what are called 'magnetic storms'.... Wireless operators know to their sorrow the effect of these magnetic storms on ease of communication, on the prevalence of 'static.'"

Amateur operators were only just learning about how radio waves interacted with varying elements like the sun, which, as Free wrote at the time, was "far afield into a part of meteorological science which is still imperfectly understood." Of course, hams today are much more aware of the effects of solar activity on their operation.

In fact, this association between alien communication and radio is still portrayed in modern media, like the 1997 film *Contact.* In the movie, the young version of Jodi Foster's character was mentored by her father in Amateur Radio. After her father's death, she tries to use radio to contact him, similar to Spiritualists who turned to mediums in hopes of connecting to passed loved ones. In the protagonist's adult life, she turns this interest toward monitoring radio emissions from space, searching for the extraterrestrial signals on which the film's plot hinges.

Ghost Hunting

Following their 1922 feature on potential alien signals, *Popular Radio* continued to address just how far radio communication could go in a three-part series, beginning with two articles by Hereward Carrington, PhD, discussing whether radio could be used to contact the spirit world. Carrington neither confirmed nor denied the existence of the spiritual world, but theorized that if the mind can send out "definite vibrations, not unlike radio impulses," then they could be picked up by an instrument designed to detect these impulses, "just as we have already devised a receiving apparatus for...wireless telegraphy."

The third part of the *Popular Radio* series is called "Ghosts that Talk — by Radio," written by famed escape artist — and Spiritualism skeptic — Harry Houdini. He compared mediums to magicians in the way

Famed escape artist Harry Houdini in handcuffs circa 1918. Later in life, he worked to debunk belief in Spiritualists who used radio to trick people into thinking they had communicated with the spirit world. [Bettman/Corbis, *The New York Times* photo archive, Wikimedia Commons, photo]

The Frequency of Fear

Scientists have investigated one unseen force familiar to hams as an explanation for ghost sightings — frequency. *Infrasound* is the term for sound waves below 20 Hz, under the threshold that is audible to the human ear. It is common in nature, formed by earthquakes, lightning, and used by elephants to communicate.

In the 1990s, Vic Tandy, researcher and lecturer at Coventry University in England, published his findings on infrasound in the *Journal of the Society of Psychical Research*. He described working in a supposedly haunted lab at the university when he began to feel uneasy and saw a grey shape out of the corner of his eye. The following day, he had a similar experience, but also noticed that the fencing foil he had been working on was somehow vibrating. After investigating, Tandy discovered a silent fan in the lab creating low-frequency sound waves measured at 18.98 Hz. After turning the fan off, the unsettling feeling disappeared.

Some studies have shown that infrasound can cause headaches, nausea, sleep disorders, and feelings of dread. Tandy theorized that the infrasound created by the fan was responsible for his anxious feelings that night, and that the grey apparition was caused by the low-frequency waves vibrating the eye and creating peripheral hallucinations. NASA says the frequency at which the eyeball vibrates is 18 Hz, right around the same frequency that the fan had been giving off. The foil had been vibrating due to a standing wave formed in the room by the same emissions.

However, infrasound itself may not be to blame for these adverse symptoms. Studies[2] have shown that prolonged exposure to any unwanted sound becomes a source of stress. The inability to locate the source of this discomfort due to infrasound's inaudible frequency could be why blame falls to invisible specters.

they conducted illusions, describing common tricks such as the "Invisible Girl" in which a hidden woman listened to questions from believers and responded in a raspy whisper through a speaking tube concealed within a cabinet. The addition of components like induction coils, circuits, and telephone transmitters then allowed this maneuver to become more efficient. Houdini described, "This was, indeed, the first form of radio telephone. It employed the same principles of induction without wires as the modern complicated radio apparatus, and it worked almost as well over a distance of a hundred feet or more."

Efforts toward creating a device to communicate with the spiritual realm — or similarly, to entertain the public — have continued. Researchers investigating claims of paranormal activity often use tools like "spirit boxes" — a tool that rapidly scans AM and FM frequencies while emitting white noise. The idea is that a spirit can use the energy of the white noise to manipulate snatches of conversation across the bands to form words and communicate. Similar tools may be recognized on paranormal investigation shows like SyFy's *Ghost Hunters*, a series about a team of investigators who work as plumbers by day and researchers by night for The Atlantic Paranormal Society (TAPS), or the Travel Channel's admittedly campy *Ghost Adventures*, which follows a similar premise.

For a quirky afternoon project, an online search will bring up pages of tutorials to DIY your own spirit box. While fun to try, the evidence recorded is often taken with a grain of salt, as any interpretations of communication can be explained away as interference from ongoing broadcasts, or the mind's desire to make sense of white noise by finding words in its chaos.

The B-PSB7 Spirit Box, a common model sold from various online ghost hunting equipment vendors. [GhostStop Ghost Hunting Gear, photo]

The Lasting Magic of Amateur Radio

Just as the kids in *Stranger Things* use their Heathkit to search through that white noise for answers in an upside-down world, hams have used Amateur Radio for ages to find out who — or, as Tesla and Marconi pondered, *what* — is out there. As radio technology and our understanding of it continue to develop, we may not jump to the same outstanding conclusions that first fascinated early inventive minds. However, this curious excitement about the "magic" of Amateur Radio is what has driven over a century of avid hams to discover and evolve the art to this day.

Notes

[1]N. Tesla, "Talking with the Planets," *Collier's Weekly*, Feb. 9, 1901, pp. 4 – 5.

[2]M. D. Seidman, R. T. Standring, "Noise and Quality of Life," *International Journal of Environmental Research and Public Health*, Oct. 2010.

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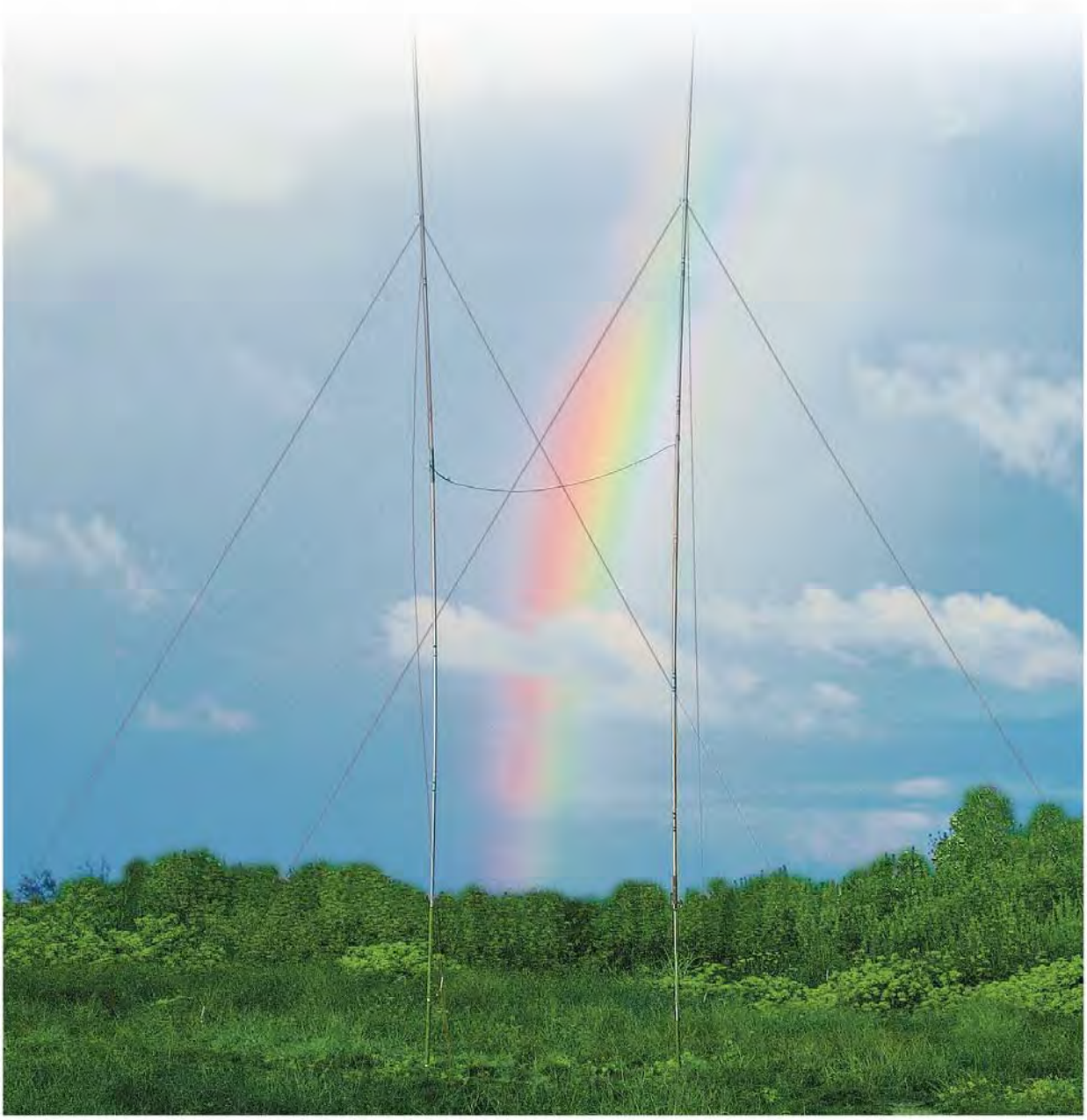
Who Pays for that New One?

Breaking down the financing behind DXpeditions to the remote locations that so many hams hope to put in their logs.



The T31A DXpedition to Kanton Island in April 2011 had six stations on the air. Kanton Island is part of Central Kiribati, which is currently the 28th most-wanted DXCC entity. [Phil Florig, W9IXX, photo]

Don Greenbaum, N1DG

In the past few years, I've been in charge of fundraising for several large DXpeditions. During that time, I became acutely aware that many in the DX community were not only curious about the need for donations, they were unaware of the costs involved in putting a major DXpedition on the air. As treasurer of the Northern California DX Foundation (NCDXF), I have access to years of budgets submitted for grants, and after compiling detailed reports from 30 NCDXF-funded DXpeditions, I was able to analyze the financials associated with the operational results (see Table 1, "Comparing DXpedition Averages").

These DXpeditions occurred over the span of 20 years and included three types: easy fly-in operations, chartered plane or boat expeditions to semi-remote Pacific and Indian Ocean targets, and rare locations in the South Atlantic and Antarctic. All together, these DXpeditions covered 2.5 million contacts at a cost of $5.5 million.

The K1N DXpedition to Navassa Island in January 2015 was made possible through years of discussion with the US Fish & Wildlife Service, and a budget of $350,000, among other factors. Navassa had not been on the air for 22 years, and was the #1 most-wanted DXCC entity at the time of this DXpedition. The 15-person team made more than 140,000 contacts, with 36,000 uniques.

Fly-In DXpeditions

The most common type of DXpedition relies on commercial transportation to a location that usually has some commercial facilities for food and lodging. Of the five DXpeditions analyzed in this category, the largest budget was $90,000, and the smallest was $17,000, resulting in a $46,400 average cost. With an average of 60,000 contacts made, the average cost per contact was $0.86.

The licensing fees are among the larger costs for a fly-in expedition. In one rare country analyzed, licensing charges totaled as much as 50% of the cost of the operation. Secondly, shipping to some of these destinations can be significant due to import duties or unreliable shipping routes.

Offsetting these high costs, travel and planning times are shorter than chartered plane or ship operations.

Because these trips aren't usually rare, they rely on a high percentage of operator funding (66%). The rest of the budget was provided by foundations and clubs (21%), and individuals via donations and QSL requests (13%).

Table 1
Comparing DXpedition Averages

	Fly-In	Semi-Remote	Rare
Budget	$46,000	$145,000	$374,000
Team Contribution	65%	53%	48%
Club/Foundation Contribution	18%	19%	23%
Plane/Ship	-	$86,000	$296,000
Individual Donations	17%	28%	29%
Cost per Contact	$0.86	$1.59	$4.06
Cost per Unique Contact	$2.34	$5.94	$14.74
Donation per Unique Contact	$0.40	$1.64	$3.85
European Contacts	52%	33%	43%
North American Contacts	19%	41%	37%
Asian Contacts	25%	21%	15%
Direct QSL	15%	25%	33%
Operation Days	18	13	13
Travel Days	5	8	20

Semi-Remote DXpeditions

Trips to semi-remote locations often require teams' extensive planning, gaining government approval, and scheduling noncommercial transportation. The 13 semi-remote DXpeditions analyzed had an average chartered transportation cost of $86,000, with the largest budget being $327,000 and the smallest being $54,000. The average budget was $145,000, and with these expeditions making an average of 96,600 contacts, the resulting average cost per contact was $1.59, which is almost double the cost per contact of fly-in DXpeditions. (The cost per unique contact was $6, almost triple that of fly-in DXpeditions).

Because of the licensing, transportation charter requirements, and the need for fundraising, it takes an average of 1 year to plan a 13-day on-air trip, with an average of 8 days for travelling.

The average DXpedition member spent over $6,500 to bring you a new one, representing 53% of the budget. Foundations and clubs provided 19% of the funding, and the remaining 28% came from individuals via donations and QSL requests. Funding from North America in this category was over 80%, twice the level of North American contacts made (41%).

Rare DXpeditions

Many challenges make these entities rare, including access restrictions for wildlife preservation or by general international treaties, specific environmental obstacles, or special shelter or operating equipment necessities. For instance, helicopters, specialized crew ships, wind-resistant shelters, and generators able to withstand harsh environments are just a few of the considerations, as well as the team's ability to plan a month or more away from jobs and families. The scheduling and planning process can, therefore, take up to 2 or more years, especially with fundraising concerns.

Of the nine rare DXpeditions analyzed, the largest budget was $493,000, with an average of $375,000, taking into consideration expenses such as the $300,000 average ship charter, $20,000 for supplies, and shipping and port charges of $25,000. These expeditions made an average of 99,000 contacts, at $4.06 per contact ($14.74 for unique calls). In terms of time on the air, the cost per minute of the rare DXpedition is $19.69.

Over a 20-year span, the average DXpedition member has spent over $12,000 to bring you a rare new one, but more recent expeditions can reach $15,000. Team members typically provided half the total funding, with 29% coming from individuals via donations and QSL requests. For rare DXpeditions, foundations and clubs cover a larger portion of the funding compared to the other types of DXpe-ditions. This financial trend can be associated with the fact that the rarer the target, the higher the cost, and the more willing outside groups are to provide financial aid. Amazingly, a total of $800,000 was provided by clubs and foundations for the nine DXpeditions altogether, for a cumulative 23% of all funding. Of that total, NCDXF contributed $388,000 — roughly half of the total funding from outside organizations worldwide. An analysis of all sources of funding in this category shows that although North America made 37% of the contacts, North American funding amounted to over 85% of the funding provided.

"The bulk of the contributions occur after the start of operations. That is the paradox of DXpedition financing. In effect, 90% of the budget is spent before the first contact ever takes place."

Cash Flow Considerations

Historically, most individuals waited until they made a contact before contributing to the team's efforts. Even a few clubs and foundations will not fund a trip until after the stations are on the air or meet other operational benchmarks. With the advent of websites and PayPal, more individuals do contribute earlier, but the bulk of the contributions still occur after the start of operations. That is the paradox of DXpedition financing. Transportation must be booked and paid for in advance. The purchase and shipping of equipment must occur months before a DXpedition arrives and the first contact is ever made. In effect, 90% of the budget is spent before the

In January and February 2016, a 14-person team traveled to South Sandwich as VP8STI and South Georgia as VP8SGI, which were the third and eighth most-wanted DXCC entities, respectively, at the time. The DXpedition lasted more than a month (including travel) and had a budget of $425,000, nearly half of which was contributed by the team members. Severe weather at the South Georgia location, pictured here, led to the operation being cut short, but not before the team logged more than 82,000 contacts as VP8SGI.

Raphael Island, pictured here, is the largest island in the Saint Brandon archipelago. The eight-person 3B7A DXpedition in April 2018 had five HF stations on the air and made more than 71,000 contacts.

first contact ever takes place. Most of this funding is met by the team, clubs, and foundations. In many cases, a few team members loaned funds to the teams above the planned contributions until after the QSLs arrived and they could be paid back.

In the case of the Microlite Penguins DXpedition team's, VP8ORK, 2011 trip to the South Orkney Islands, the timing of individual contributions was distributed as follows: prior to the DXpedition, the team had gathered 43%; by the time they were on the air, they had gathered an additional 20%, and within 6 months after the end of operations, they'd received the last 36%. By the time Logbook of The World (LoTW) was uploaded 6 months after the expedition, 99% of the individual contributions were made. In fact, after uploading the full logs to LoTW, except for the trickle of late QSL requests, all contributions ceased. This is especially true of European contributions. European stations who donate after the expedition include roughly the same donation rate with their QSL request as their North American counterparts. The difference in support is largely due to fewer contributions made before a DXpedition arrives on site. And, while only 4% of North American stations request a QSL via the bureau, Europe and Asia bureau requests average 14%, and those stations do not contribute to the funding flow.

The K5P DXpedition to Palmyra Atoll in January 2016 required obtaining permission from the US Fish & Wildlife Service as well as The Nature Conservancy, both of whom have jurisdiction on the island. Here, members of the 12-person team are contributing volunteer maintenance work while not on the air. K5P had a budget of nearly $200,000, and made 75,000 contacts, with 24% of those being uniques.

Growing Use of OQRS and LoTW

In the past few years, many DXpeditions have adopted the online QSL request system (OQRS) and full log uploads to LoTW after around 6 months. OQRS has increased the amount of funding DXpeditions

Unique Contacts

Often you hear DXers talk of the number of *unique contacts* worked as a benchmark of the DXpedition's success. From a financial viewpoint, the more stations a team works, the more individual donations one would expect to receive.

The problem is that a chaser probably won't donate nine times more if they work a DXer on nine bands, and low-band contacts don't bring in more money than 20-meter contacts. Additionally, in the 1990s, the average DXpedition made 25,000 unique contacts, and in 2016, it was not much higher, despite associated costs having raised significantly in that time.

Looking at the cost per unique and the donation per unique, there is still a long way hams can go to fund DXpeditions. Fly-ins cost $2.34 per unique; semi-remote trips are $5.94, and rare ones cost $14.74. Compare that to the average individual donations of $.40, $1.64, and $3.85, respectively.

The 14-person VK0EK DXpedition to Heard Island in 2016 took several years of planning, and a budget of nearly half a million dollars. The island, known for having a fragile and rapidly changing environment, is on the World Heritage List. The operation made more than 75,000 contacts.

Permits for the Malpelo Island HK0NA DXpedition in January and February 2012 took 5 years to obtain. Visitors to this UNESCO World Heritage Site require written permission from the Colombian Ministry of Ecology, as well as the Colombian Navy. Malpelo was the 12th most-wanted DXCC entity at the time of the DXpedition, which lasted 16 days. The 20-person team had six stations on the air and made more than 195,000 contacts. Both of the operating locations on Malpelo required a climb. Here, Manu Siebert, LU9ESD, makes his way to the topmost operating location. [Gustavo Amórtegui, HK3ORE, photo]

receive from those QSLing direct, due to a minimum fee requested and the ease with which one can add a donation. A significant amount of those having LoTW matches also request direct and bureau cards, so the desire for a card isn't necessarily replaced by LoTW. The adoption of rapid LoTW uploads to those who pay for a card via OQRS also adds to the rapid cash flow for DXpeditions and postage savings for the people using OQRS.

Final Thoughts

Looking over the data of DXpeditions during the last 2 decades, a few trends stand out. Ship chartering costs to South Atlantic destinations have doubled in the past 10 years due to higher fuel, insurance, and port costs around the world. And although technology enabled each DXpedition to make more contacts, technology also brought added cost for computers, networks, and internet access (sometimes costly satellite internet). Furthermore, those contacts are increasingly being made for competition on Club Log leaderboards, yearly DX marathons, and challenge band points, thus not necessarily resulting in proportional increased income for the teams.

The sad fact remains that more funding from the ham community is needed if we are to see DXers continue to activate those rare ones for our benefit. Generous foundations and clubs remain the most important source of funding (after the team members) for enabling DXpeditions to rare places, but these groups need contributions from equally generous members. Another glaring fact is that funding continues to be overwhelmingly concentrated in North America. Many Europeans and Asians still rely on the bureau system — which costs DXpeditions money — to provide cards, without actually providing support for the expeditions.

The next time you work that new one, check out the website and look up the list of individuals and foundations/clubs supporting the team, and think about adding your name to that list to help make the next one happen.

Don Greenbaum, N1DG, was first licensed at age 11 in 1962. He has been on several major DXpeditions, including KH1/KH7Z, VP8ORK, K4M, and A52A. He has also operated as A61AD, A51DG, C92DG, A73A, as well as /KH9, /VP9, /VS6, /BV2, /4X, and /9V. In 2005, *CQ* Magazine honored Don at Hamvention by inducting him into the CQ DX Hall of Fame. He is treasurer and a director of the Northern California DX Foundation. His professional background includes banking and financial management in the computer industry. He can be reached at **don@aurumtel.com**.

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

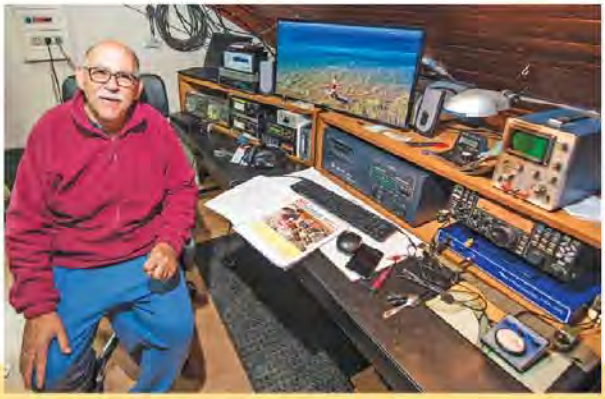
Portuguese DXers

Half a century ago, Portugal was rarely heard on the air, but a December 2017 visit proved that Amateur Radio is now popular and thriving.

Henryk Kotowski, SM0JHF

Located on the western edge of Europe, Portugal is 35,000 square miles and has a population of 10.5 million. Portugal is known to be very attractive, and has a reputation as one of the safest countries, with little engagement in European conflicts. Some 500 years ago, Portuguese sailors and merchants explored the coasts of Africa, Asia, and South America. The list of Portuguese explorers from the 15th and 16th centuries is long, including Vasco da Gama, Henry the Navigator, Magellan, and Juan Rodriguez Cabrillo, who explored the West Coast (and was Trey Garlough's, N5KO, inspiration for naming the Cabrillo universal contest log format that he developed). Today, many Portuguese hams continue this traditional search for exotic places on the HF bands.

Official figures regarding Amateur Radio are lower than in industrial European countries. There are about 6,200 valid licenses issued in mainland Portugal and the islands, and about 90 percent of them are active on the air. The IARU national organization, Rede dos Emissores Portugueses (REP), has about 1,000 members, including Madeira and the Azores archipelagos. There are local societies on the islands, not affiliated with REP and the IARU. The Portuguese DX Club (GPDX) has over 100 members, but only a quarter of them are currently active and engaged in chasing DX.



Antonio, CT1DVV, lives in central Portugal, near Coimbra, in a wooded hilly area, which was scorched during wildfires in October 2017. His huge antennas survived the fire. Antonio is 60 years old and started with Amateur Radio in the 1990s. He had lived in Africa, where he discovered the benefits of two-way radio while flying small aircraft.

Antonio's, CT1DVV, son — Antonio, CT1ESV — lives a quarter mile away on a hill. His antennas were not affected by the wildfires.

Jose, CT1EEB, is 50 years old and received his license in 1987. His grandfather was also a radio amateur. Jose was noted in the DX community for his activation of East Timor in 2000 as 4W6EB, when it became a new entity. He is the DXCC card checker for Portugal and very keen on chasing DX. Jose lives in a small town in central Portugal near the Aveiro Lagoon. His station is in an old farmhouse, a few miles away from town.

Antonio, CT1ESV, has mainly monoband antennas, as he is primarily interested in contesting on the HF bands.

Luis, CT4NH, is 70 years old and became involved with Amateur Radio in 1977. He lives near the capital city of Lisbon, and his station is well equipped and modern, with a multielement OptiBeam. Luis is known among local radio amateurs for being helpful and considerate. He is also the current president of the Portuguese DX Group, is #1 on the DXCC Honor Roll, and he is involved in Islands on the Air (IOTA).

Photos by the author.

Henryk, SM0JHF, is 73 years old and 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**.

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

Road Trip of a Lifetime Through Eastern Europe

Paul Schreier, HB9DST/AA1MI

The Summits on the Air (SOTA) program has 138 active Associations, which are defined by a country or regions within larger countries and outline the recognized SOTA summits within that area. I set my sights on collecting as many as I could in Eastern Europe and the Baltic states. To achieve this, I undertook a month-long SOTA road trip with my partner Juerg, HB9BIN, who is the top activator in the world for summit-to-summit contacts and the second for unique contacts.

Over 26 days, two Swiss SOTA activators drove more than 5,000 miles to activate summits in 14 countries.

Juerg used a KX3, a 20-meter J-pole, an end-fed antenna for 20, 30, and 40 meters (designed by Heinz, HB9BCB), and a conventional 40-meter dipole. I used a KX2 and an EndFedz for 20, 30, and 40 meters. For logging, we both used *VK port-a-log*, an Android app.

We departed on September 19, 2017 and returned on October 15, 2017. The first leg of our trip was leaving Switzerland and going east through Austria (OE), touching on the Czech Republic (OK), briefly crossing over into Poland (SP) and through Slovakia (OM) to the Ukraine (UT) border. The second leg was south through Hungary (HA), Romania (YO), Bulgaria (LZ), Serbia (YU), Macedonia (Z3), and Greece (SV). The third leg backtracked through Macedonia and Serbia but then turned west-northwest through Bosnia and Herzegovina (E7), then Croatia (9A) and Slovenia (S5) before

Figure 1 — Our route, which started and ended in Switzerland, covered roughly 5,000 miles over 26 days and included activations in 14 SOTA Associations. [Image courtesy of Paul Schreier, HB9DST]

Figure 2 — Paul, HB9DST, is sitting to the side of "no man's land" at the Slovak-Ukraine Schengen border for summit UT/CA-357, which is also a double summit with the designation OM/PO-078. Note in the background the camera tower, which is one of many placed every 100 meters along the border. [Paul Schreier, HB9DST, photo]

again entering Austria and Switzerland (see Figure 1).

Passing through a national border almost every day, we focused on easy-to-access summits, many of them drive-ups. Juerg was focusing on activating one or more summits every day of the trip, so he ended up with 33 activations. I, on the other hand, sometimes took a day off to visit the cities, such as Budapest, Skopje, or Ljubljana, so I activated 24 summits during the trip.

Tension on the Ukraine Border

During the planning stages, we came to see that Ukraine would not be an easy part of the journey. We were told the border crossing could take as long as 6 hours, and the poor road conditions could prevent us from driving to a reasonable position for hiking to the summits. Luckily, with Daniel, OM6AN, who was familiar with the area, we were able to activate Kosmatets (UT/CA-357) with minimal difficulty, though it was stressful.

Taking advantage of a SOTA rule that defines a summit's activation zone as being within 25 vertical meters of the actual summit, we decided to activate Kosmatets' Ukraine summit point from within Slovak territory, which is just a few meters away.

We drove into the woods as far as we could with a standard car and then hiked less than an hour to the summit through bear-inhabited areas. We soon got close to the border, which we were very careful not to cross. Because Slovakia is a member of the Schengen free-movement agreement, and Ukraine is not, this is essentially the border of the European Union. Given the recent refugee crisis, such borders are tightly guarded with regular armed foot patrols and guard dogs. Many camera towers are placed along the border at 100-meter intervals (see Figure 2), and while we did not see any soldiers or guards, we did trigger motion detectors and were observed on video surveillance.

When we were driving out of the woods and back onto a main road, we were pulled over by a police patrol for a passport check and inspection of the contents of the trunk.

Luckily, we'd driven Daniel's car, which has Slovak plates, and he was able to explain to the police officers what we were doing. His assistance saved us from issues we'd have faced if we were in Juerg's car, with Swiss plates, and were unable to communicate in the local language. If you ever intend to activate this summit, be assured you will be in contact with the authorities at one point or another.

A 500-Mile Day Trip

Continuing south to Timisoara, the second-largest city in Romania, I reunited with Sorin, YO2MSB, and Zoli, YO2BP, both of whom I met on my first Romanian SOTA Marathon in 2015 (see the May 2016 issue of *QST*, pp. 72 – 73), and made a new friend, Marian, YO2MBU. Sorin drove us in his 4 × 4 vehicle up a logging road, so we could get our first Serbian activation from the Gudurica Peak (Gudu ricki vrh, YU/VO-001), and on the way home, we drove up to the Piatra Goznei (YO/WC-207) summit, checking Romania off the list. The next day, Sorin again drove us 400 kilometers (250 miles) to our Bulgarian activation of Karneva Livada (LZ/WB-061), and then he drove us back home on the same day, which shaved 3 days off our trip and considerably eased our driving logistics, especially with the difficult road conditions that he was able to handle masterfully.

Following a Presidential Visit

Although we had already activated a Serbian summit, Belgrade was a natural stop on our way south. Aca, YU1CA, who was a welcoming local ham, provided us with local information, gave tips on a great hotel near the summit, met us at our hotel, and

Figure 3 — Aca, YU1CA, on Avala summit (YU/CS-043) in Serbia, standing in front of the "Monument to the Unknown Hero", dedicated to an unknown Serbian soldier from World War I. [Paul Schreier, HB9DST, photo]

even drove us to the Avala (YU/CS-043) summit (see Figure 3). This is a national park with a massive monument, and on the day of our activation, we had to first wait for the country's president to finish his visit, where he laid a wreath to commemorate an unknown soldier. While we were touring the park grounds, we were also joined by Serbia's SOTA Association manager, Fric, YU1WC, and then by Dusko, YU1RK.

The Southernmost Point: Greece

In Thessaloniki, Greece, we met up with Christos, SV2OXS, and Stavros, SY2BIK, in Lakkia before driving up to Thermo's summit (SV/MC-031). We were very glad to have Christos' guidance, as the summit was crisscrossed with dirt roads, and Christos knew to

Figure 4 — Stavros, SY2BIK; Paul, HB9DST; Juerg, HB9BIN, and Christos, SV2OXS, on the Thermo summit (SV/MC-031) in Greece after a successful activation. [Stavros Triadafyllou, SY2BIK, photo]

make a GPS track of our drive up, so we would have a safe and easy return after twilight. It was a thrill to look in one direction and watch the sun reflected off the waters of the Thermaic Gulf on the Aegean Sea, and look in another direction to see Mount Olympus in the distance (see Figure 4).

Figure 5 — We activated the Kozara-Mrakovica summit (E7/BO-067), which is home to the "Monument to the Revolution" in Bosnia and Herzegovina. [Paul Schreier, HB9DST, photo]

Staying Safe on Bosnian Summits

At this point, we turned west and entered the northern area of Bosnia and Herzegovina (E7). We made sure to follow local ham advice, paying particular attention to Ferid's, E73SF, list of safe summits, which included Kozara-Mrakovica (E7/BO-067), near Banja Luka. We were thankful he'd warned, "All other summits near the east are very risky because of landmine fields." Boban, E77O, also advised we take an alternative route than that provided by the GPS, which allowed us to avoid poor country roads.

The Kozara-Mrakovica summit is dominated by the "Monument to the Revolution," a World War II memorial sculpture dedicated to 2,500 Yugoslav fighters and the 70,000 civilians (predominantly Serb), who were killed or deported to concentration camps (see Figure 5).

I spent an hour on the air, and then I returned with Boban and his daughter, who educated me on the complex history of their country. Even Boban's previous call signs reflect this history, starting with YU4WSO when, following World War II, the region was still part of the Socialist Federal Republic of Yugoslavia.

Continuing through what was once Yugoslavia, we turned northwest and went to Zagreb, the capital of Croatia. Our specific goal was Sljeme (9A/ZH-002), a nature park just north of the city, where we operated well into the night.

Acknowledgments

In the process of this experience, we were thankful for everything we learned. We saw remnants of the history of these regions and got a glimpse of some of the geopolitical issues facing this area of the world. I would like to extend a grateful thank you to all the local SOTA activators and chasers for their part in our experience, generously assisting in planning and executing this road trip. They provided us with invaluable information in advance of this trip, including extensive summit details and even hotel and additional summit recommendations, and also met with us and often led us up to summits for joint activations. It was also a great comfort to us and our loved ones to know that we would have local support in case of any problems or irregularities. Now, when I make a SOTA contact as a chaser or an activator, I will often hear a familiar call sign and remember a smiling face. It's great to travel when you know you always have a friend nearby!

Paul Schreier, AA1MI/HB9DST, who was first licenced in 1968, is an American who has lived in Switzerland since 2001. In that time, he became a Swiss citizen. He is a retired freelance translator and technical writer. Paul is on the Board of Directors of Helvetia Telegraphy Club, HB9HTC, and the Swiss SOTA Group, HB9SOTA. He is frequently either aboard his sailboat on Lake Zurich or activating SOTA summits (he has achieved Mountain Goat status). He can be reached at **aa1mi@arrl.net**.

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

ARRL Board Adopts Volunteer Monitoring Program; Official Observer Program to be Retired

The ARRL Board of Directors has adopted the recommendations of the Official Observer Program Study Committee, which would retire the venerable Official Observer (OO) Program and institute the Volunteer Monitoring (VM) Program. The action came at the Board's July 20 – 21 meeting in Windsor, Connecticut, with the Board instructing that the transition "be implemented as soon as practicable." Under the terms of the new program, current Official Observers will be invited to apply for appointment as Volunteer Monitors. The Board expressed its appreciation for the OOs and their dedicated volunteer service over the years.

ARRL President Rick Roderick, K5UR (left), who moderated the Board meeting, and ARRL CEO Barry Shelley, N1VXY. [Steve Ford, WB8IMY, photo]

Rationale and Logistics

The action is expected to re-energize enforcement efforts in the Amateur Radio bands and was undertaken at the request of the FCC in the wake of several FCC regional office closures and a reduction in field staff, the Board said. Under the new system, coordination of cases and evidence gathering would become the responsibility of ARRL Headquarters staff, while the FCC will retain the responsibility for final decisions regarding action in specific cases.

The study committee's report spelled out the additional steps necessary to launch the Volunteer Monitoring Program. Among them would be the appointment of a dedicated Headquarters staff member or an independent contractor working under the direction of ARRL Headquarters to administer the new program and interface with its participants. The Volunteer Monitoring Program administrator would, among other duties, create a vetting and accreditation process for prospective Volunteer Monitors. The authority to accredit, appoint, and dismiss VMs would be assigned to ARRL Headquarters staff. Section Managers will continue to be a part of the vetting process for VMs, although they will not have appointment or dismissal authority.

Volunteer Monitor accreditation would serve a 3-year term, renewable by satisfying requirements necessary to ensure competency. A new training manual is being developed.

The administrator will create a target for the number of geographically distributed Volunteer Monitors. Preliminary plans would include up to five Volunteer Monitors per ARRL Section and up to 250 Volunteer Monitors overall.

The administrator would also "develop a rubric or other aid for program participants to highlight offenses and other criteria that the FCC considers a priority," the motion said. The administrator further would be charged with organizing periodic webinars, highlighting technologies, techniques, and other continuing education topics that would assist, motivate, and better enable Volunteer Monitors. The FCC is to be actively involved in the development and presentation of these training opportunities.

The new Volunteer Monitor Program would continue to send notices recognizing good on-the-air operating practice. Under the new program, positive or negative operator notices would be sent from ARRL Headquarters, not by individual Volunteer Monitors, in part to maintain their anonymity.

The action further authorized ARRL President Rick Roderick, K5UR, to terminate the standing *Amended Agreement* between ARRL and the FCC Field Bureau regarding the use of amateur volunteers and execute a new *Memorandum of Understanding* (*MOU*) between ARRL and the FCC Enforcement Bureau. The *MOU* is under final review.

Other Board Actions

In other action, the Board:

- unanimously adopted recommendations of the ARRL Executive Committee to update ARRL's *Articles of Association* and *Bylaws* (see the July 2018 issue of *QST*, p. 74, or refer to Minutes 22 – 25 of the Board's July 20 – 21, 2018 meeting).
- approved a motion to have President Roderick appoint an ad hoc committee of four that would include the ARRL General Counsel, one Director, one Vice Director, and one Officer, charged with developing rules and time frames for ethics matters. The committee will submit its findings and recommendations in advance of the Board's January 2019 meeting.
- established a 3-month general comment period for the *ARES Strategic Plan*, with comments due no later than October 31, after which the Public Service Enhancement Working Group (PSEWG) will present the final plan to the ARRL Annual Board of Directors meeting in January 2019 for consideration for adoption.
- received the preliminary final report of the PSEWG regarding the rollout of the ARES Connect program. The Board agreed to obtain additional field input this fall.
- received an update from the CEO Search Committee.
- heard the report of Chief Financial Officer Diane Middleton, W2DLM, who said ARRL continues to have a financially strong balance sheet and has generated a larger-than-expected gain from operations due to several one-time, non-recurring items. Total revenues were generally on forecast, and cash flow for the first 6 months of 2018 was good, she told the Board.
- accepted and discussed reports from standing committees as well as ad hoc and advisory committees of the Board.
- was informed, as part of the CEO's report, of current work under way in preparation for World Radiocommunication Conference 2019 (WRC 19). The issue of wireless power transmission (WPT) continues to be a concern leading up to the international conference.
- heard greetings from International Amateur Radio Union (IARU) President Tim Ellam, VE6SH/G4HUA, and from Radio Amateurs of Canada (RAC) President Glenn MacDonell, VE3XRA. Both attended as guests.
- heard the report of the ARRL Foundation from its president, New England Division Director Tom Frenaye, K1KI, who told the Board that the Foundation approved the awarding of approximately 80 scholarships totaling some $130,000.

From left to right: Radio Amateurs of Canada President Glenn MacDonell, VE3XRA; ARRL President Rick Roderick, K5UR; ARRL International Affairs Vice President Jay Bellows, K0QB, and IARU President Tim Ellam, VE6SH/G4HUA. [Photo courtesy of Radio Amateurs of Canada]

ARRL Chief Financial Officer Diane Middleton, W2DLM (top), and General Counsel Chris Imlay, W3KD, at the July ARRL Board Meeting. [Steve Ford, WB8IMY, photo]

Award Recipients Named

At its July meeting, the ARRL Board of Directors named the recipients of several awards and honors:

- Ruth Willet, KM4LAO, of Cana, Virginia, was named the recipient of the 2018 ARRL Hiram Percy Maxim Memorial Award (see the sidebar, "Ruth Willet, KM4LAO, is 2018 Hiram Percy Maxim Memorial Award Recipient").
- Producers and staff of *The Takeaway* — a daily radio news magazine produced jointly by Public Radio International, WGBH, and WNYC, and produced at WNYC in New York — were named to receive the 2017 Bill Leonard, W2SKE, Professional Media Award for Audio Reporting. The program, aired by more than 280 outlets, included an in-depth interview with ARRL Emergency Preparedness Manager Mike Corey, KI1U, about the role of Amateur Radio volunteers deployed in Puerto Rico following Hurricane Maria.
- The Weather Channel's Jim Cantore, Jen Carfagno, and TWC's *AMHQ* program staff were the joint

Ruth Willet, KM4LAO, is 2018 Hiram Percy Maxim Memorial Award Recipient

Nineteen-year-old Ruth Willet, KM4LAO, of Cana, Virginia, was named the recipient of the 2018 ARRL Hiram Percy Maxim Memorial Award by the ARRL Board of Directors at its July meeting. ARRL's top youth honor, the Hiram Percy Maxim Memorial Award is given annually by the Board to a radio amateur under the age of 21 whose accomplishments and contributions to both Amateur Radio and the local community are of an exemplary nature.

Willet, who earned her Technician license in June 2015 and upgraded to Amateur Extra in May 2016, was instrumental in re-establishing the Amateur Radio and Electronics Club (K8HPS) at Kettering University in Michigan, where she is a junior pursuing a double major in engineering physics and mechanical engineering. She alternates 11-week academic terms with 11-week co-op jobs at Textron Specialized Vehicles in Augusta, Georgia.

Willet is actively involved in recruiting and mentoring new licensees and in community awareness programs. She is on the air daily on HF, using SSB or CW and satellites. In addition to her membership in ARRL, Willet belongs to AMSAT and CWOps, as well as several other clubs. She enjoys HF contesting, participating in local club events, and chasing and roving to grids on Amateur Radio satellites. Willet and her mom Sharon, KM4TVU, participated in ARRL's highly successful National Parks on the Air (NPOTA) event in 2016.

Willet won the 2017 ARRL August *QST* Cover Plaque for her article "The 2016 Youth DX Adventure to the Caribbean Island of Saba," based on her experience as a participant.

In May, Willet was presented with the Radio Club of America's Young Achiever Award. Last spring, she was the keynote speaker at the 32nd annual SWODXA DX Dinner, held in conjunction with Hamvention®, where her topic was "Experiencing the Hobby of a Lifetime." She also spoke at the 30th Hamvention Youth Forum in 2017 on "Plugging into Your Valuable Club Resources."

The Hiram Percy Maxim Memorial Award, which includes a cash award of $1,500 and an engraved plaque, is intended to provide a tangible reward to those deserving young amateurs who contribute time, skills, and energies daily to their commitment to Amateur Radio. — *Thanks to ARRL Communications Manager Dave Isgur, N1RSN*

recipients of the 2017 Bill Leonard, W2SKE, Professional Media Award for Video Reporting. *AMHQ* also conducted an extensive interview with Corey about Amateur Radio's role in Puerto Rico in the aftermath of Hurricane Maria.

♦ ABC affiliate WCIV-TV in Charleston, South Carolina, was recognized for "its outstanding coverage" of the August 2017 solar eclipse. The station aired a live remote broadcast with members of the Charleston Amateur Radio Society (CARS) regarding their on-the-air efforts to record the eclipse's propagation effects during the Solar Eclipse QSO Party. The station was credited with explaining "the application of physics, radio theory, and other sciences" and their importance and relevance "in a comprehensive, yet understandable manner."

♦ E. Gordon Mooneyhan, W4EGM, was named the winner of the 2018 Philip J. McGan Silver Antenna Award for his outstanding public relations success on behalf of Amateur Radio as an ARRL Public Information Officer in the South Carolina Section. Mooneyhan was credited with adapting and applying "innovative strategies to emerging social media" in promoting Amateur Radio and events.

♦ The Amateur Radio Emergency Data Network (AREDN) project team was named as recipient of the 2018 ARRL Microwave Development Award for its initiatives to utilize Amateur Radio's microwave bands. These included extending the network's high-speed multimedia capabilities from solely 2.4 GHz to 900 MHz, 3 GHz, and 5.8 GHz, and adding 802.11n protocol to improve data throughput. The Board also acknowledged the efforts of the many AREDN implementation groups around the country who are building networks based on this technology and who stand ready to utilize them to serve the needs of their communities in times of disaster.

Honors and Recognitions

In addition, the ARRL Board of Directors:

♦ conferred the title of ARRL Director Emeritus on Coy Day, N5OK, in recognition of "superior and distinguished service to the Board. Day served for 9 years as ARRL West Gulf Division Director and has continued to be active in supporting ARRL, including serving on the ARRL DX Advisory Committee."

♦ recognized and congratulated the Walla Walla Valley Amateur Radio Club of Washington for 90 years of "exemplary service."

♦ recognized and congratulated the Apple City Amateur Radio Club of Wenatchee, Washington, for more than 50 years of service to its community and to Amateur Radio.

♦ congratulated the Oregon Tualatin Valley Amateur Radio Club, W7OTV, for 40 years of "excellent service to the hobby."

Rick Lindquist, WW1ME, ww1me@arrl.org

Happenings

FCC Proposes $18,000 Fine in Louisiana Amateur Radio Interference Case

The FCC has issued a *Notice of Apparent Liability* (*NAL*) proposing to fine Jerry W. Materne, KC5CSG, of Lake Charles, Louisiana, $18,000 "for apparently causing intentional interference and for apparently failing to provide station identification on amateur radio frequencies," the FCC said.

"Mr. Materne was previously warned regarding this behavior in writing by the Enforcement Bureau and, given his history as a repeat offender, these apparent violations warrant a significant penalty," the FCC said in the *NAL*, released on July 25.

In 2017, the FCC received numerous complaints alleging that Materne, a General-class licensee, was causing interference to the South West Louisiana Amateur Repeater Club W5BII repeater, preventing other amateur licensees from using it. In March 2017, the repeater trustee banned Materne from using the repeater.

Responding to some of the complaints, the Enforcement Bureau issued a *Letter of Inquiry* (*LOI*), directing Materne to address them. He denied causing interference, but admitted to operating simplex on the repeater's output frequency. In June 2017, the FCC received an additional complaint alleging that Materne had repeatedly interfered with an attempted emergency net called up as Tropical Storm Cindy was about to make landfall. According to the complaint, Materne "repeatedly transmitted on the repeater's input frequency, hindering the local emergency net's ability to coordinate weather warnings and alerts on behalf of the National Weather Service," the FCC said in the *NAL*.

Local amateurs were able to track the interfering signal to Materne's residence and confirmed their findings to the FCC, prompting a *Warning Letter* advising Materne of the complaint and pointing out that his behavior "as described in the complaint would be a violation of Section 97.101(d) of the Commission's rules." Materne responded to the *Warning Letter* to argue that it was legal to transmit on the repeater's output frequency, further stating that he was "tired of this trash harassing me," the FCC said.

In the wake of further complaints, FCC agents visited Lake Charles, tracked transmissions on 146.130 MHz to Materne's residence, and monitored them for up to 7 hours. The agent reported hearing Materne "playing music on 146.130 MHz and warning other amateur operators that the local Amateur Radio club would not be able to conduct their net later that day."

That evening, the agent watched as Materne drove to a location near the W5BII repeater, where, the agent said, Materne "began transmitting an amateur digital radio signal from a handheld radio in his vehicle," disrupting the net and failing to identify. The agent, accompanied by a deputy from the Calcasieu Parish Sheriff's Office, approached Materne's vehicle and confirmed that he possessed a radio capable of operating on 146.130 MHz. "Audio recordings captured by the agent demonstrate that the intentional interference ceased as the agent and the Sheriff's deputy approached Mr. Materne's vehicle," the FCC said in the *NAL*.

Parity Act Options Open Despite Removal from Defense Bill

The July removal of Amateur Radio Parity Act (HR 555) language from the National Defense Authorization Act (NDAA) Conference Report does not kill the initiative. The Parity Act would ask the FCC to grant radio amateurs living in deed-restricted communities the right to install effective outdoor antennas.

Although the language was removed from the final report, other viable options remain to see the Parity Act succeed.

The House-passed version of the NDAA included the Parity Act language, but the Senate bill did not. The Parity language did not survive the House-Senate conference committee final report. While ARRL is disappointed, there are other House-passed legislative vehicles that contain the language, including the Financial Services & General Government Appropriations bill, which funds the FCC. We will continue to keep pushing for this legislation and keep members informed as things happen.

ARRL Comments in "Strong Opposition" to Part 15 Modification Petition Affecting 5 GHz

ARRL has commented in "strong opposition" to a *Petition for Rulemaking* by RADWIN Ltd. that seeks to amend certain Part 15 rules to permit point-to-multipoint (P2MP) communication services in portions of the 5 GHz band at power levels now permitted only for point-to-point unlicensed systems. ARRL has focused its concern on proposed high-power P2MP operation in the band from 5.725 – 5.850 MHz, but points out that the entire 5.650 – 5.925 GHz allocation has been "subjected to a continuing series of overlays domestically" for more than 2 decades. Amateur Radio is secondary to military radars on the band.

ARRL said the Amateur Radio national "weak-signal" calling frequency of 5,760.1 GHz already has experienced a "very substantial" rise in ambient noise in many areas that has significantly affected Amateur Radio operation in the 200 kHz centered on that frequency, where extremely weak received signal levels are typical. Only low-density usage and the low-power levels permitted for unlicensed national information infrastructure (U-NII) devices have sustained "a good deal of compatibility" between Amateur Radio and U-NII devices at 5 GHz, ARRL said.

"It is quite obvious that RADWIN's proposal for simultaneous point-to-multipoint transmission, with higher input power and [effective isotropic radiated power (EIRP)], using an electronic steerable antenna system, presents an exceptionally high interference potential to ongoing, weak-signal Amateur Radio Service communications," ARRL said in its comments filed on July 30. Greater yet, ARRL noted, is the potential of interference to users of RADWIN's system.

ARRL said the FCC "has no idea at all" about aggregate noise levels in the 5 GHz band in general. "Both the *Petition* and the technical statement accompanying the *Petition* are silent on potential interaction between P2MP simultaneous transmission systems operating at high power, and any Amateur Radio facility," ARRL said. "As a result, the petition is fatally flawed and should be dismissed, relative to the 5.725 – 5.850 GHz band."

Texas Volunteer Examiner Setting Sights on Next 1,000 Exam Sessions

In July, Franz Laugermann, K3FL, of Houston, achieved a milestone that no other VEC has before by taking part in his 1,000th exam session as a Volunteer Examiner. But, he told ARRL, he's far from finished.

"As long as I can be here, I'm going to go on doing this. It's so rewarding to help other people," he said, adding that he's set his sights on 2,000 sessions. He estimated that he's helped about 5,000 people get their Amateur Radio licenses. At one recent session, a 10-year-old boy who passed the exam became the fourth generation in his family to get licensed through Laugermann, who had also conducted the testing sessions at which the boy's father, grandfather, and great-grandfather earned their ham licenses.

Laugermann became an ARRL-accredited Volunteer Examiner (VE) in 1991. His wife Barbara, KA5QES, has been a VE nearly as long as her husband. Both are ARRL members.

Retired from the US Army in 1975, Laugermann, 78, has been licensed since 1978 and has served as an Official Observer for 27 years. As a member of ARES®, he supported the ARES effort for Hurricane Harvey at the Harris County Office of Homeland Security and Emergency Management's Emergency Operation Center at Houston TranStar.

He has been running VEC sessions at Houston TranStar for more than 16 years. "I like meeting new people," Laugermann says, adding that when he talks to people young or old, he always encourages them to give Amateur Radio a try. "I tell them, 'I don't know everything, but I'll tell you everything I do know,'" he said with a laugh.

He's taken to telling his recent exam graduates to text him with their new call signs so he can keep an ear out for them when he's on the air. "I'm retired, so I'm on the radio all day long," he said.

Harris County Judge Ed Emmett (right) presents Laugermann with a framed proclamation from the County in recognition of Laugermann's accomplishments as a Volunteer Examiner.

ARRL Board of Directors' Committee Seeks Input for Proposed ARES Strategic Plan

Following up on an ARRL Board of Directors directive at its July meeting, the Public Service Enhancement Working Group (PSEWG) has contacted all ARRL Section Managers (SMs) and Section Emergency Coordinators (SECs) seeking comments and suggestions regarding the proposed *ARES Strategic Plan* via an online form. The deadline is October 31.

Created in 1935, ARES® has undergone very few changes over the years, while the agencies ARES serves have undergone many. The PSEWG evaluated the ARES program for 2 years and drafted several proposed enhancements aimed at updating the program.

The *ARES Strategic Plan* introduces changes and a platform for future growth. For many, this will represent a major paradigm shift; for others, it will formalize many of the requirements they have routinely employed for several years.

An independent team of individuals experienced in ARES and emergency work from across the US has reviewed the proposed plan. Their suggestions and recommendations were carefully considered, and many were included in the plan during its development.

The PSEWG asks that comments be respectful, concise, and on point. Also, SMs and SECs were reminded that specific agency agreements and needs must be honored. Those having concerns about a proposed new policy are requested to offer alternatives.

Broadcast-Quality Audio Processor Donated to W1AW

Orban Labs, Inc. of Pennsauken, New Jersey, has donated a state-of-the-art audio processor — the all-digital 9300 OPTIMOD-AM — to ARRL. Orban Labs Vice President of Business Development Mike Pappas, W9CN, arranged for the donation with the intention of improving the audio quality transmitted by W1AW during its evening phone bulletins. The 9300 OPTIMOD-AM is used worldwide at broadcast stations that want the best possible sound.

W1AW Station Manager Joe Carcia, NJ1Q, installed the 9300 OPTIMOD-AM into W1AW's audio chain. After making necessary setup adjustments and working with instructions that Pappas provided, he determined that overall average modulation had increased and audio clarity was improved.

At that point, though, it became apparent that some low-level hum in the station's audio chain was sneaking in prior to the new processor. The hum was traced to the station's audio distribution amplifier. ARRL Lab volunteer Tim Smith, WA1HLR, offered up a homebrew method of using a passive (non-amplified) distribution method. After construction and installation of the new audio distribution system and some level adjustments, W1AW's audio chain was passing world-class audio with no trace of hum on its transmitted signals.

"We greatly appreciate the donation of the Orban 9300 OPTIMOD-AM," ARRL Assistant Laboratory Manager Bob Allison, WB1GCM, said. "W1AW audio quality is improved, with increased average power output, while still occupying the same transmitted bandwidth. ARRL thanks Mike Pappas for arranging this significant donation and Tim Smith for his technical assistance."

Amateur Radio Satellite Pioneer, Past AMSAT President Bill Tynan, W3XO, SK

A giant of the Amateur Radio satellite world has fallen. William A. "Bill" Tynan, W3XO, of Kerrville, Texas, died on August 7, following a lengthy illness. An AMSAT Charter Life Member and past President, and the editor of the *QST* column "The World Above 50 MHz" from 1975 until 1992, Tynan was 91. Licensed in 1946, he became an early enthusiast of FM, which helped to set him on his path to broadcasting, VHF, and ham radio satellites. Through his *QST* column, Tynan was an early champion of using grid squares as VHF/UHF contest multipliers.

In 1969, his eager curiosity for VHF led him to attend the first meeting of what would become AMSAT. He became AMSAT President in 1991, serving for 7 years. In his later years, Tynan served as AMSAT's OSCAR Number Administrator, the individual who confers alphanumeric designators on qualifying Amateur Radio satellites.

Tynan played a key role as AMSAT's Vice President for Human Spaceflight (earlier "Manned Space") in convincing NASA to permit Amateur Radio operation from the space shuttles. The early SAREX (Shuttle Amateur Radio EXperiment) program led to the current Amateur Radio on the International Space Station (ARISS) program that offers students a chance to speak directly to International Space Station (ISS) crew members via ham radio.

An ARRL Life Member, Tynan was the Hamvention® Amateur of the Year in 1996.

Astro-Ham Alexander Gerst, KF5ONO, Jams with Kraftwerk for Festival Audience

European Space Agency (ESA) Astronaut Alexander Gerst, KF5ONO, had the opportunity on July 20 to sit in from space with German pioneers of electronic music, Kraftwerk, as part of the Jazz Open Festival, held on Schlossplatz, the largest square in Stuttgart, Germany. During the performance, Gerst appeared on a huge screen behind Kraftwerk and accompanied the four band members, each on synthesizers, using a tablet device equipped to serve as a mini-synthesizer.

"Never thought that the first concert I [would] ever play in [would be] with the legendary Kraftwerk, let alone jamming live from space with them, from the 'Spacelab 2.0' *Columbus* directly to Stuttgart," Gerst tweeted afterward. He was in the ESA *Columbus* module for the event, which was attended by about 7,500, and began his part of the concert by "sneaking in" the well-known five-note melody from the film, *Close Encounters of the Third Kind*. As Gerst explained, "It just fit too perfectly."

Before joining Kraftwerk for the musical portion of the occasion, Gerst, speaking in his native German, said, "I want you to come along with me...with us...on this fantastic journey." Gerst will be aboard the ISS until December.

Alexander Gerst, KF5ONO, performing on screen from the *Columbus* with Kraftwerk in the foreground. [Kraftwerk/ESA/JazzOpen – Sitara Schmitz, photo]

Section Manager Nomination Notice

To all ARRL members in Arizona, Arkansas, Iowa, Kentucky, Mississippi, Montana, North Texas, Orange, and Wyoming: You are hereby solicited for nominating petitions pursuant to an election for Section Manager (SM). Incumbents are listed on page 16 of this issue.

To be valid, a petition must contain the signatures of five or more full ARRL members residing in the Sections concerned. It is advisable to have a few more than five signatures on each petition. A sample nomination form is available on the ARRL website at **www.arrl.org/section-terms-nomination-information**. Nominating petitions may be made by facsimile or electronic transmission of images, provided that upon request by the Field Services Manager, the original documents are received by the Manager within 7 days of the request.

We suggest the following format:

(Place and Date)

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

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

(Signature___ Call Sign___ City___ ZIP____)

Any candidate for the office of Section Manager must be a resident of the Section, an Amateur Radio licensee of Technician class or higher, and a full member of ARRL for a continuous term of at least 2 years immediately preceding receipt of a nominating petition. Petitions must be received at Headquarters by 4 PM Eastern Time on December 7, 2018. If more than one member is nominated in a single Section, ballots will be mailed from Headquarters no later than January 2, 2019, to full members of record as of December 7, 2018, which is the closing date for nominations. Returns will be counted February 19, 2019. Section Managers elected as a result of the above procedure will take office April 1, 2019.

If only one valid petition is received from a Section, that nominee shall be declared elected without opposition for a 2-year term beginning April 1, 2019. If no petitions are received from a Section by the specified closing date, such Section will be resolicited in the April 2019 issue of *QST*. A Section Manager elected through the resolicitation will serve a term of 18 months. A Section Manager vacancy occurring between elections is filled through appointment by the Field Services Manager. — *Norm Fusaro, W3IZ, Radiosport Department Manager*

Rick Lindquist, WW1ME, ww1me@arrl.org

WRTC 2018: Amazing Contact Totals and Scores Despite Poor Conditions

A team of contesters from Lithuania won the gold medal in World Radiosport Team Championship 2018 (WRTC 2018), held in Germany on July 12 – 16. Operating as Y81N, Gedas Lucinskas, LY9A, and Mindis Jukna, LY4L, topped the real-time scoreboard for much of the event, which is held as a competition within a contest, in conjunction with the IARU HF Championship. Lucinskas and Jukna had ended up in sixth place during WRTC 2014, held in New England. In WRTC 2018, they posted a final score of 5,690,685 points, logging 5,139 contacts, with a heavy emphasis on CW. Final results for all competing teams have been posted on the WRTC 2018 website at **www.wrtc2018.de**.

We are the champions! The second-place team of Stefan von Baltz, DL1IAO, and Manfred Wolf, DJ5MW (left), and the third-place team of Dan Craig, N6MJ, and Chris Hurlbut, KL9A, flank gold medalists Gedas Lucinskas, LY9A, and Mindis Jukna, LY4L. [WRTC 2018 photo]

Despite mediocre conditions, the 63 competing teams logged a total of 262,746 contacts during the 24-hour competition.

Taking second place to the pleasure of the German sponsors was the Y81A team of Manfred Wolf, DJ5MW, and Stefan von Baltz, DL1IAO, with 5,273,488 points and 4,936 contacts, the majority on CW. They placed third in a nail-biting finale for the bronze at WRTC 2014.

In the third spot this time around was the WRTC 2014 defending champion team of Dan Craig, N6MJ, and Chris Hurlbut, KL9A, who operated as Y82V, and racked up a final tally of 4,891,710 points, heavily weighted toward CW.

The WRTC 2014 second-place team of Rastislav Hrnko, OM3BH, and Jozef Lang, OM3GI, from the Slovak Republic, landed in 10th place at WRTC 2018.

This year's first-place team scored nearly 1.5 million fewer points but 567 more contacts than the WRTC 2014 first-place team of N6MJ and KL9A.

The WRTC 2018 Live Scoreboard transformed the event from an isolated radio competition into a sporting event that could be followed online around the world. Although Live Scoreboard viewers knew where things stood among the 63 teams, the competitors had no clue until the event concluded.

Determining the final results of WRTC 2018 involved an extensive log-checking process. Randy Thompson, K5ZD, reported at the July 16 closing ceremony that the evaluation committee received 3,500 logs within 16 hours of the event's end for auditing competitors' logs.

The father-son Y87B team of Jeff Briggs, K1ZM, and Patrick Briggs, KK6ZM, won the SSB Leader Award. The CW leaders, operating as Y83O, were Tonno Vahk, ES5TV, and Toivo Hallikivi, ES2RR, of Estonia. Vahk and Hallikivi were also the WRTC 2018 multiplier leaders.

Claiming the award for the most accurate log — which was very close — was the Y86V team of Leo Slavov, OR2F, and Pascal Lierman, ON5RA, of Belgium. They made 39 logging errors out of 3,052 contacts (1.28%).

Youth Team Award winners were Alexandru Mancas, YO8TTT, and Leo Kharchenko, UT5GW, who landed in 14th place overall. There were three youth teams for competitors age 25 or younger. The youngest WRTC 2018 competitor was 14-year-old Bryant Rascoll, KG5HVO, who paired with 22-year-old Y83Z team leader Mathias Acevedo, CE2LR.

Christian Janssen, DL1MGB, president of the WRTC 2018 Organizing Committee, said he's looking forward to WRTC 2022, which will take place in Bologna, Italy, as announced at the closing ceremony. Additional coverage on WRTC 2018 will appear in the November issue of *QST*.

Rick Palm, K1CE, k1ce@arrl.org

Global Reach: IARU Emergency Communications Programs

A June 2018 meeting of emergency communicators at the Ham Radio international exhibition in Friedrichshafen, Germany, highlights the global interest in the utility of Amateur Service telecommunications for public service/safety in emergency, disaster response, and planned event applications. A report on the Emergency Communications meeting was drafted and posted by the International Amateur Radio Union's (IARU) Region 1 Emergency Coordinator Greg Mossop, G0DUB, which cited an excellent turnout. The meeting was sponsored by the IARU.

As the worldwide voice of Amateur Radio, the representative democracy that is the IARU follows the lead of the International Telecommunication Union (ITU) — the specialized UN agency for information and communication technologies and frequency allocation — in dividing the world into three regions for administrative purposes. Region 2 comprises the Americas; Region 1 comprises Europe, Africa, the Middle East, and Northern Asia, while Region 3 comprises Asia and the Pacific.

Region 1 Emergency Communications

Mossop discussed activity in his region that lends perspective on the breadth and depth of emergency communications initiatives in that part of the world: outreach to schools in Turkey, special exercises in Malta, training programs in Slovenia, and support of public events in South Africa, for examples. In May, radio amateurs provided response/relief radio communications in the Cyclone Mekunu disaster, described as the most intense storm to strike the Arabian Peninsula in recorded history. Younis Al Balushi, A41MA, reported that he and other amateurs in Oman were able to connect cut-off areas with the command center in Salalah, when no other means of communications existed.

Michal Wilczynski, SP9XWM, and Krzysztof Gaudnik, SP7WME, spoke on the activities of the SP Emergency Communications Club (SPEC), a member of the Polish Radio Amateur Union (PZK). Between 2016 and 2018 SPEC conducted six national weather catastrophe readiness exercises, and in May 2017, they worked with the Deutscher Amateur Radio Club for an international exercise, dubbed "Lightning 2017." Strikingly similar to ARRL and the US ARES® program, SPEC has partnership agreements with governmental agencies and has responded to many incidents and events. Herbert Koblmiller, OE3KJN, discussed May's "Exercise Solar Flare" that tested communication systems with good cooperation among Austrian radio amateurs, the military, and telecom service providers. Large solar flares can take out regular communication systems with sometimes devastating disruption of infrastructure.

Alberto Barbera, IK1YLO, and Marco, IU1GJE, of the Raggruppamento Nazionale Radiocomunicazioni Emergenza discussed the benefits of, and plans for, Motorola's digital mobile radio (DMR) hybrid network as an emergency communications asset in Italy.

Region 3 Emergency Communications

In Asia and the Pacific, typical of training and preparedness for the emergency communication role is the Amateur Radio emergency service in Hong Kong. The organization's radio amateurs are trained and then enrolled on the duty roster, ready if needed. Hong Kong ARES holds a memorandum of understanding with the Security Bureau of Hong Kong for supplemental/alternative communications services when primary systems are down. The group maintains a UHF repeater that incorporates an APRS weather station.

In the Philippines, Super Typhoon Nock-Ten (locally "Nina") had many radio amateurs responding to provide communications for the disaster. Six lives were lost, and 380,000 residents were evacuated. The Philippines Amateur Radio Association's Ham Emergency Radio Operations (HERO) Network activated in advance of the storm. Both HF and VHF systems were employed, and Network members compiled damage reports, relaying them to authorities listening on the HERO net.

Occasionally, figures emerge that serve as inspirations for the rest of the region and, indeed, the world.

Region 3's Jim Linton, VK3PC (SK), chair of the Region's Disaster Communications Committee, was considered a "tireless worker for the common good," as IARU Secretary David Sumner, K1ZZ, said. Linton was a leading source of reports on Amateur Radio disaster response activities for years.

At Home in Region 2

A recent, profound example of international cooperation and coordination in Region 2 is the response to the historic, catastrophic spate of hurricane disasters that occurred in 2017 affecting the Caribbean nations, Puerto Rico, and the continental US. Well documented in *QST* and other outlets, the disasters and the efficient responses of the international amateur community were on a scale seldom seen before.

Region 2's Amateur Service disaster communications apparatus has a long history of excellence in organization, administration, and responsiveness. The Region is divided into areas, representing all parts of the Americas for administration, with Area Emergency Coordinators appointed and led by the Region 2 Emergency Coordinator (EMCOR) Dr. Cesar Pio Santos, HR2P. The position of Area B (the United States) Emergency Coordinator is currently held by ARRL Emergency Preparedness Manager Mike Corey, KI1U, who traveled to Puerto Rico and worked with the Red Cross and numerous other entities and amateurs to provide for radio communications in the relief effort following the colossal devastation.

IARU Region 2 Emergency Coordinator Dr. Cesar Pio Santos, HR2P, co-chaired the second IARU Region 2 Emergency Communications Workshop, held in Viña del Mar, Chile, in October 2016. [Mike Corey, KI1U, photo]

Regional meetings and workshops around the world on disaster/emergency communications topics foster the international environment of cooperation and coordination. For example, the second IARU Region 2 Emergency Communications Workshop, held in 2016 in Viña del Mar, Chile, addressed regional challenges, with ARRL and IARU Region 2 sponsoring the meeting. Corey and Pio Santos co-chaired. The goal was to "share ideas, to network, and to improve response capability," they said. Attendees came from countries within and outside of Region 2, including Chile, Argentina, Ecuador, Peru, Brazil, Venezuela, Honduras, India, Trinidad and Tobago, the US, Canada, and Mexico. There is another workshop being held in Lima, Peru, in October 2019.

GAREC

In 2005, the first Global Amateur Radio Emergency Communications (GAREC) Conference was organized in Tampere, Finland. Tampere is where, in 1998, the First Intergovernmental Conference on Emergency Telecommunications (ICET-98) adopted the groundbreaking *Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations*, which, among other things, waived regulatory barriers to the use of telecommunication resources, including amateurs, for efficient and effective disaster response.

The IARU recommended that GAREC conferences should continue "as an informal meeting among representatives of IARU member societies and of Amateur Radio Emergency Communications Groups within or outside of the respective National IARU Member Society, serving as a forum for the exchange of experience and as an advisory body for the work on emergency communications of the IARU." The last GAREC was held in 2015 in Alabama, with representatives from all three regions presenting.

WGET

In the past, ARRL Headquarters has sent a staff representative to meetings of the UN Working Group on Emergency Telecommunications (WGET), which was established in 1996 as a technical forum to increase the effectiveness of its participants in humanitarian work and disaster relief. The forum brought together national governments, UN entities, non-governmental organizations (NGOs), inter-governmental organizations, the private sector, and academia with these shared interests.

IARU Emergency Telecommunications Guide Available

Highly recommended reading and reference is the latest version of the *IARU Emergency Telecommunications Guide*, available for download at **www.iaru.org/uploads/1/3/0/7/13073366/emcommguide_1sept2016.pdf**.

Conclusion

As well organized and effective as our Amateur Service programs are in this country, they are matched in scope and proficiency by many similar programs across the globe. And these numerous global mechanisms are striving to imbue amateur emergency services with even more professionalism, technical capability, and operating skill, all for humanitarian purposes.

George J. Misic, KE8RN, ke8rn@comcast.net

Classic Radio

The Heathkit AT-1 CW Transmitter

The Heathkit AT-1 CW transmitter for 80, 40, 20, 15, 11, and 10 meters was the beginning of Heathkit's introduction to the ham radio market (see the lead photo). The AT-1 was for sale in time for Christmas of 1952 and was sold until 1956, when it was replaced by the model DX-20 and the DX-35. The AT-1 only cost $29.50 in kit form (complete with tubes) and was basically the most affordable transmitter available on the Amateur Radio market. All anyone needed to get on the air as a Novice on 80, 40, and 15 meters was a crystal, a key, and a means to switch between transmit and receive.

The Heathkit AT-1 CW transmitter, sold as a kit in the late 1950s.

Design

The minimalist AT-1 transmitter used only three tubes; it doubled in the final stage on 15, 11, and 10 meters. The earliest versions of the AT-1 were sold before 15 meters became a ham band. All AT-1 units included 11 meters, which used the 10-meter band position (11 meters was a ham band while AT-1s were sold).

The three tubes used in the Heathkit AT-1 were a 5U4 rectifier tube to make high voltage, a 6AG7 crystal oscillator and amplifier or multiplier, and a 6L6 final amplifier stage to run about 25 – 30 W of input power. The final stage doubled the drive frequency on 15, 11, and 10 meters.

The transmitter had no internal circuitry for AM phone operation, though it did have a rear panel octal socket connector for the addition of an external modulator (see Figure 1). The line from the internal power supply to the final amplifier stage went through Pins 3 and 4 of the octal socket. If a modulator was added, it would go between the internal power supply at Pin 3 of the octal socket and Pin 4 of the socket that went to the 6L6 final amplifier stage.

The Heathkit AT-1 did not include 15 meters as a band switch position because it only became a ham band in the early 1950s. The transmitter worked as designed on 15 meters with the band switch in the 10-meter position. The 11-meter band was close enough to the 10-meter band that nothing changed in the transmitter between 11 and 10 meters. Eleven meters remained a ham band until 1958, when the FCC reassigned it to the Class D Citizen's Radio Service, forming the CB (citizens band) radio band.

Tubes and Circuitry

In the Heathkit AT-1, the 6AG7 was configured as a crystal oscillator with either an untuned output or a tuned output to double, triple, or quadruple the crystal frequency. The crystal was multiplied by four if a crystal in the 80-meter band was used on 20 meters. Because the AT-1 doubled in the final, a 40-meter crystal could not be used, as was often done in other rigs on 15 meters.

The oscillator stage had an output in the 3.5 – 4.0 MHz range for 80 meters, and 7.0 – 7.3 MHz on 40 meters. On 20 meters, the plate circuit output was in the 14.0 – 14.35 MHz range, doubling a 40-meter crystal or quadrupling an 80-meter crystal. On 15 meters, the manual recommended crystals in the range of 5250 – 5362.5 kHz, or a quarter the output frequency. The common practice of using a 40-meter crystal for 15 meters did not work, because the AT-1 doubled in the final amplifier. Ten meters called for a crystal from 3500 – 3712.5 kHz or 7000 – 7425 kHz. The stage either quadrupled or doubled the frequency of the crystal and the

Figure 1 — The back of the AT-1.

final amplifier doubled the frequency. The AT-1 circuit had a 1.1 mH choke and a 100 Ω resistor in series with the cathode of the tube to ground.

Heathkit recommended jumping out the choke and resistor if an external VFO was used. They did not run the cathode circuit to the VFO power octal socket on the rear panel, although they could have, to facilitate shorting out these two components for VFO operation. The plate circuit of the 6AG7 stage was fed through a 90 μH choke on all bands except 80 meters, a tuned circuit tuned by the 50 pF driver tuning variable capacitor with the inductance of the plate coil in parallel with the RF choke; the correct inductance was selected by taps on the plate circuit coil.

Final Amplifier Stage and Power Supply

The final amplifier stage was a doubler on 15, 11, and 10 meters using a type 6L6 tube. It was operated in Class C with grid bias developed across the grid 47 kΩ, 2 W resistor. Grid current was used as a tuning indication of the driver tuning. The panel meter had a full-scale indication of 10 mA when in the **GRID** position. In the **PLATE** position, the meter had a full-scale indication of 100 mA. The AT-1 had a separate plate coil with a suitable coupling link inside each coil; separate switch-selected coils were provided for 80, 40, 20, and 15 – 10 meters. A common coil was used for both 15 and 10 meters. The coils were tuned by a 50 pF air variable capacitor. The capacitor had enough range at 15 and 10 meters to tune from below 21 MHz to above 29.7 MHz with a single coil switched in.

The internal dc power supply made about 450 V dc from the full-wave 5U4 rectifier. The filter was a capacitor input filter using a series choke. The capacitors were made from two 8 mFD, 350 V capacitors in series to give an equivalent 4 mFD, 700 V dc capacitor at the input and output of the filter pi section. The full 450 V plate potential was used on the 6AG7 crystal oscillator — not the best idea for great stability, but good for powerful oscillator output. A **STANDBY** switch opened the connection of the center tap of the power transformer to the filter network and the common circuitry ground.

The AT-1's Successors

The DX-20 that replaced the AT-1 sold for $35.95 and was offered from 1957 – 1960. The DX-20 had no provisions for AM and no socket to allow the connection of a separate modulator, which Heathkit never made. The DX-20 also did not have a socket to provide power to an external VFO. The DX-35 came out before the DX-20 and had provisions for an external VFO, like a Heathkit VF-1. It also had an internal screen modulator for AM phone operation. The DX-35 had three RF stages ending in a 6146 tube and did not double in the final stage on any band, significantly increasing the output power on 15 and 10 meters.

Despite its somewhat minimalist design, the Heathkit AT-1 was a sales success. It was low-cost, fairly easy to assemble, and worked well enough as a starter rig to launch Heathkit in the ham radio kit business. It led to the development of the DX-100 and the DX-35 and DX-20, plus the many Heathkit models to follow. It was a very humble beginning, but made Heathkit a major player in ham radio from the late 1950s through the 1980s.

Photos by the author.

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

Contest Corral

October 2018

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					
1	0800	7	2000	All	IQRP Quarterly Marathon	CW Ph Dig	RS(T)	www.arimontebelluna.it
2	0100	2	0300	3.5-28	ARS Spartan Sprint	CW	RST, SPC, power	arsqrp.blogspot.com
3	0700	3	1000	3.5-7	German Telegraphy Contest	CW	RST, LDK (if DL)	www.agcw.org
3	1900	3	2300	432	432 MHz Fall Sprint	any	6-char grid square	svhfs.org
3	2000	3	2100	3.5	UKEICC 80-Meter Contest	Ph	4-char grid square	www.ukeicc.com
4	1700	4	2000	3.5	SARL 80-Meter QSO Party	Ph	RS, serial, grid or QTH	www.sarl.org.za
4	1700	4	2100	28	NRAU 10-Meter Activity Contest	CW Ph Dig	RS(T), 6-char grid	www.nrau.net
5	1400	7	0200	All	YLRL DX/NA YL Anniversary Contest	CW Ph Dig	Serial, RS(T), SPC	ylrl.org
6	0600	7	1800	3.5-28	TRC DX Contest	CW Ph	RST, serial, "TRC" (if member)	www.trcdx.org/trcdxc
6	0800	6	1400	902 and up	Microwave Fall Sprint	Any	6-char grid square	svhfs.org
6	0800	7	0800	1.8-28	Oceania DX Contest, Phone	Ph	RS, serial	www.oceaniadxcontest.com
6	1200	7	1159	1.8-28	Russian WW Digital Contest	Dig	RST(Q), oblast code or serial	www.rdrclub.ru
6	1600	7	1100	3.5-7	International HELL Contest	Dig	RST, serial	www.darc.de
6	1600	7	2200	1.8-28	California QSO Party	CW Ph	Serial, county or SPC	www.cqp.org
6	1700	6	2100	3.5-28	FISTS Fall Slow Speed Sprint	CW	RST, SPC, name, mbr or power	fistsna.org
7	0500	7	2300	3.5-28	RSGB DX Contest	CW Ph	RS(T), serial	www.rsgbcc.org/hf
7	0600	7	0900	3.5	UBA ON Contest, SSB	Ph	RS, serial, section (if ON)	www.uba.be/en
7	2200	7	2359	7-21	Peanut Power QRP Sprint	CW Ph	RS(T), SPC, peanut nr or power	nogaqrp.org/PeanutPower
8	1900	8	2030	3.5	RSGB 80-Meter Autumn Series, CW	CW	Other's call, your call, serial, name	www.rsgbcc.org/hf
10	0001	10	2359	28	10-10 International 10-10 Day Sprint	CW Ph Dig	Name, mbr or "0," SPC	www.ten-ten.org
10	0030	10	0230	3.5-14	NAQCC CW Sprint	CW	RST, SPC, mbr or power	naqcc.info
13	0000	14	1559	3.5-28	Makrothen RTTY Contest	Dig	4-char grid square	www.pi259.org/makrothen
13	0300	14	2100	1.8-UHF	Nevada QSO Party	CW Ph Dig	Serial, county or SPC	nvqso.com
13	0800	14	0800	1.8-28	Oceania DX Contest, CW	CW	RST, serial	www.oceaniadxcontest.com
13	1200	14	1200	3.5-28	Scandinavian Activity Contest, SSB	Ph	RST, serial	www.sactest.net
13	1200	14	2359	1.8-50	SKCC Weekend Sprintathon	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
13	1200	14	2359	1.8-28	QRP ARCI Fall QSO Party	CW	RST, SPC, mbr or power	www.qrparci.org
13	1600	14	2200	1.8-144	Pennsylvania QSO Party	CW Ph Dig	Serial, county or SPC	paqso.org
13	1700	13	2100	3.5-28	FISTS Fall Unlimited Sprint	CW	RST, SPC, name, mbr or power	www.fistsna.org
13	1700	14	0500	1.8-144	Arizona QSO Party	CW Ph Dig	Serial, county or SPC	www.azqsoparty.org
13	1800	14	1800	1.8-144	South Dakota QSO Party	CW Ph Dig	RS(T), county or SPC	www.sdqsoparty.com
13	2000	14	2000	1.8	PODXS 070 Club 160-Meter Great Pumpkin Sprint	Dig	RST, SPC	www.podxs070.com
14	0530	14	0800	3.5	UBA ON Contest, CW	CW	RST, serial, ON section (if ON)	www.uba.be/en
14	0800	14	1000	50	UBA ON Contest, 6 Meter	CW Ph	RST, serial, ON section (if ON)	www.uba.be/en
15	0000	15	0200	1.8-28	4 States QRP Group Second Sunday Sprint	CW Ph	RS(T), SPC, mbr or power	www.4sqrp.com
15	1300	19	2359	All	ARRL School Club Roundup	CW Ph	RS(T), Class (I/C/S), SPC	arrl.org/school-club-roundup
15	1800	16	0300	1.8-UHF	Telephone Pioneers QSO Party	CW Ph Dig	RS(T), chapter nr (if any), name	www.tpqso.com
17	1900	17	2030	3.5	RSGB 80-Meter Autumn Series, Data	Dig	Other's call, your call, serial, name	www.rsgbcc.org/hf
20	0000	21	1600	50-144	Araucaria World Wide VHF Contest	CW Ph	RS(T), 6-char grid square	www.avhfc.com
20	0000	21	2359	3.5-28	JARTS WW RTTY Contest	Dig	RST, operator's age	jarts.jp/rules2018.html
20	0001	21	2359	28	10-10 International Fall Contest, CW	CW	Name, mbr or "0," SPC	www.ten-ten.org
20	1400	21	0200	All	New York QSO Party	CW Ph Dig	RS(T), county or SPC	www.nyqp.org
20	1500	21	1459	3.5-28	Worked All Germany Contest	CW Ph	RST, DOK or "NM" or serial	www.darc.de
20	1500	21	1500	1.8	Stew Perry Topband Challenge	CW	4-char grid square	www.kkn.net/stew
20	2000	20	2359	1.8-7, 21-50	Feld Hell Sprint	Dig	RST, mbr, SPC, grid	sites.google.com/site/feldhellclub
21	0000	21	0200	14-21	Asia-Pacific Fall Sprint, CW	CW	RST, serial	jsfc.org/apsprint
21	0700	21	1000	144	UBA ON Contest, 2 Meter	CW Ph	RS(T), serial, ON section (if ON)	www.uba.be/en
21	1700	22	0100	1.8-144	Illinois QSO Party	Ph	RS(T), county or SPC	www.w9awe.org/ILQP.html
21	1900	21	2030	3.5	RSGB RoLo CW	CW	RST, previous 6-char grid square received	www.rsgbcc.org/hf
22	0100	22	0300	1.8-28	Run for the Bacon QRP Contest	CW	RST, SPC, mbr or power	qrpcontest.com/pigrun
24	0000	24	0200	1.8-28	SKCC Sprint	CW	RST, SPC, name, mbr or power	www.skccgroup.com
25	1900	25	2030	3.5	RSGB 80-Meter Autumn Series, SSB	Ph	Other's call, your call, serial, name	www.rsgbcc.org/hf
27	0000	28	2359	50-1296	ARRL EME Contest	CW Ph Dig	Signal report	www.arrl.org/eme-contest
27	0000	28	2359	1.8-28	CQ Worldwide DX Contest, SSB	Ph	RS, CQ zone	www.cqww.com
31	2000	31	2100	3.5	UKEICC 80-Meter Contest	CW	4-char grid square	www.ukeicc.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.

Although October brings cooler weather, the 2018 ARRL International Grid Chase (IGC) is still heating up. With fall HF and VHF+ operating events, weekend "grid-peditions," QSO parties, contests, and plenty of casual home operations, now is a great time to make a push to work a few more unique grid squares on HF or VHF (and with FFMA and VUCC awards at VHF, you get twice the benefit).

Upcoming Events

Check out upcoming DXpeditions for possible new grids in the next few months. See **https://www.ng3k.com/Misc/adxo.html**, courtesy of Bill Feidt, NG3K, for more info.

If you want to give state QSO parties a try, see **www.contestcalendar.com/stateparties.html**, courtesy of Bruce Horn, WA7BNM.

Be sure to keep an eye on ham radio news outlets, like ARRL News (**www.arrl.org/news**), and the IGC Facebook and Twitter for updates on rare grids that will be on the air.

July Activity

Per the leader board at **https://igc.arrl.org/leader-board.php**, the month of July saw 22,711 Logbook of The World (LoTW) submissions, while June saw 21,881.

July activity saw modest increases at HF, with a slight decline at VHF+. HF band activity drove the July IGC overall stats up (as compared with June) by over 7%, with over 8,000 more QSOs. As compared to June stats, the highest band increases seen were 80 meters, up by 3,000 QSOs; 40 meters, with over 3,500 more QSOs; 30 meters, with a 1,000-QSO increase; 20 meters, up by over 3,000 QSOs, and 15 meters, with a 2,000-QSO increase. July VHF+ activity decreased about 30% compared to June. August and September numbers are expected to stay flat as we see a decline in summer sporadic E, however, in fall we do begin to see increases of tropospheric propagation, as well as our usual VHF+ events.

You can always find complete Grid Chase information online at **www.arrl.org/international-grid-chase-2018**. See you next month, and on the air!

Val, KN7D, activated the grid boundary of DN30/DN31, within Great Salt Lake, Utah. In the photo is one of several animal statues at the park. [Val Hanney, KN7D, photo]

July 2018 ARRL International Grid Chase (IGC) 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	0	708	2,477	5,299	2,786	6,398	1,844	3,198	773	2,128	1,281	125	0	39	7	5	0	27,068
Phone	0	210	1,772	5,223	2	7,383	1,702	2,112	476	1,883	1,366	867	3	557	23	2	2	23,583
Digital	11	958	4,782	10,438	7,483	14,555	8,122	7,577	4,537	6,804	7,027	356	0	16	7	2	0	72,675
Band Totals	11	1,876	9,031	20,960	10,271	28,336	11,668	12,887	5,786	10,815	9,674	1,348	3	612	37	9	2	123,326

—July submissions: 22,711
—This report represents all IGC-eligible* QSOs matched in LoTW during July 2018 as uploaded to LoTW by 2359 UTC August 10, 2018.
*IGC-eligible LoTW matches occur only when both stations upload their QSOs to LoTW, and both stations include their grid square in their LoTW TQSL station location(s).
—No contacts were reported to LoTW in July 2018 on 2200 meters, 33 centimeters, or on most microwave bands above 13 centimeters.
—30-meter stats may be a log entry typo (30-meter phone is not permitted in the US).

2017–2018 School Club Roundup Results

The upcoming School Club Roundup will take place October 15 – 19, 2018.

Anita Brouse, KC1IPS, principal of All Saints STEAM Academy, enjoying PSK31 activity during the Winter 2018 School Club Roundup. Thirty students from grades 2 – 8 participated and learned about "communications resiliency." [Michael Cullen, K1NPT, photo]

Lew Malchick, N2RQ
n2rq@arrl.net

The School Club Roundup (SCR) takes place twice during each school year, in October and February. The SCR is not primarily intended to be a contest. Its main purpose is to acquaint students with the fun of Amateur Radio. Participation in the October 2017 SCR included about 600 operators, and in February 2018 around 650 operators took part. Of the 123 school or club entries, 32 of them listed 10 or more operators each. The following eight stations reported 30 or more operators each: W1SYE (45); K5LMS (40); N1SAS (30); W0BHS (77); K38FWT (35 in October, 40 in February); W8EDU (40 in October, 50 in February); KD8NOM (34), and K4WBM (56).

To get so many students interested in participating, clubs do things like coordinating with Parents' Night at the school, bringing in food, and getting support from school principals or department heads. In all cases, the emphasis is on having fun by getting on the radio. We also see clubs appearing repeatedly, building a tradition of SCR participation that encourages students to get on the air.

We really appreciate college entries, regardless of size. Their prestige can be used to motivate students, especially high schoolers. Non-club hams and DXers are also welcome!

Full Results and Submitting Scores

The full results for this school year's SCR can be found at **www.b4h.net/arrlscr**. They are sorted by category and score, including information on where the club is located, how many contacts and multipliers they logged, and a breakdown of how they got their score. If your club enters SCR, this is also the web page to access for getting on the scoreboard (click the "Submit Score" link).

After the Long Island Mobile Amateur Radio Club (LIMARC; the SCR sponsor) checks your QSO and score calculations, the preliminary scores are changed to final. The full details of the entry, along with any comments from the club, can be viewed by clicking on the call sign of the club. More comments are available in the full version of this writeup, available online at **www.arrl.org/contest-results-articles**.

The next SCR session is coming up on weekdays from October 15 – 19, 2018. Encourage your local school or university club to join the more than 600 participants who were active in both the October and February events. Get on the air and make some contacts! Individual hams are also encouraged to get on the air and make contacts with the students. For questions and more information, join **SCR-L-subscribe@yahoogroups.com** or email **scr@limarc.org**. The full rules for the contest are available at **arrl.org/school-club-roundup**.

Soapbox Comments

At Caldwell High School, AG7HP, in Caldwell, Idaho, approximately 15 students from the engineering and robotics classes spent their afternoons and evenings making contacts with other stations from across the continent. Junior Kelsey Ferro said, "I really enjoyed the opportunity to use the knowledge of radios I learned. This was one of the coolest and nerdiest things I can gladly say I've done. From stringing the antenna from the roof to using the radio and talking to new people, these kind of opportunities are why I love engineering."

Lampasas Middle School Youth Amateur Radio Club, K5LMS, in Lampasas, Texas, said, "Two of our student operators, Amelia and Isabel, made probably 80% or more of our contacts, working pileups every day — mostly without prompting from any of our three licensed operators!"

The 2018 ARRL November Sweepstakes

Since 1930, the ARRL November Sweepstakes (SS) has been the premier domestic contest in the US and Canada. Steeped in tradition, this event draws amateurs of all levels, from hardcore competitors to casual participants. Join thousands of other operators as they attempt to beat personal records, win categories, and achieve the coveted Clean Sweep by working all 83 ARRL/RAC sections in a single weekend.

Entrants may operate for a maximum of 24 of the 36 hours during the contest period. Off-times must be a minimum of 30 consecutive minutes without listening or transmitting. The exchange is serial number, precedence, your call sign, check, and ARRL/RAC section.

New 5-Day Log Submission Deadlines

Things to keep in mind now that logs are due 5 days after the contest:

- SS CW logs must be uploaded to our web app (**http://contest-log-submission.arrl.org**) by 0259 UTC November 10, 2018.

CW: 2100 UTC Saturday, November 3 – 0259 UTC Monday, November 5

Phone: 2100 UTC Saturday, November 17 – 0259 UTC Monday, November 19

- SS phone logs must be uploaded to our web app (**http://contest-log-submission.arrl.org**) by 0259 UTC November 24, 2018.

By the respective deadlines, paper logs must be mailed to ARRL November Sweepstakes, 225 Main St., Newington, CT 06111.

See the ARRL website for more details. Clubs entering Sweepstakes must be sure to comply with the Club Competition rules at **www.arrl.org/sweepstakes** (also visit **www.arrl.org/contest-club-tools** for more details). Contact **contests@arrl.org** if you have questions about the rules or what information is required.

After the event results are published, certificates and sponsored plaques will be awarded. Join in the fun!

For more information (including a guide for first-time operators), visit **www.arrl.org/sweepstakes**

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 2018, Headquarters and W1AW are closed on New Year's Day, Presidents Day (February 19), Good Friday (March 30), Memorial Day (May 28), Independence Day (July 4), Labor Day (September 3), Thanksgiving and the following day (November 22 and 23), and Christmas (December 25). For more information, visit us at **www.arrl.org/w1aw**.

Steve Jones, N6SJ, n6sj@earthlink.net

How's DX?

Honoring a Legendary DXer in Bhutan

When I first started chasing DX in the 1960s, the "Big Three" of DXpeditioners were Don Miller, W9WNV; Lloyd and Iris Colvin, W6KG and W6DOD, and Gus Browning, W4BPD, who would become the first DXer ever elected to The CQ DX Hall of Fame in 1967. At the time, my call was WA6SVY, and I was operating out of my parents' house in Sacramento, California. My CW-only station was a Heathkit DX-60, a homebrew amp, and a 20-meter ZL Special antenna, aimed due north.

Paro's rooftops, covered in red peppers laid out to dry. Across the valley is the north-facing slope with the A52SJ 160-meter antennas.

My QSO with a Legend

One morning in April 1965, I was tuning 20 meters when I heard Gus on SSB from Bhutan, working the west coast. His call was AC2H, the "H" standing for the radio manufacturing company Hammarlund, who sponsored him as their "DXpedition of the Month." I joined the pileup, and, to my delight, after a few calls, I heard Gus say in his distinct drawl, "Okay fellers, there's a corn whiskey station in there callin' me. The corn whiskey station, go ahead." I tapped out a 5 by 7 and he gave me a 579. I was thrilled to have made contact with him and immediately checked my globe to figure out where Bhutan was. That was the start of my lifelong wish to visit Bhutan.

The Dragon Kingdom

The Bhutanese call their country Druk Yul, which translates to "Land of the Thunder Dragon." Bhutan has a population of about 800,000 in an area the size of Maryland. It is made up of a series of valleys surrounded by high mountains, similar to Switzerland, and has never been conquered by an invading army. Over half of Bhutan is protected in parks or preserves. No mountain climbing is permitted, even though two of the highest unclimbed Himalayan peaks lie within Bhutan. The country's main source of revenue is selling hydroelectric power to India, their southern neighbor.

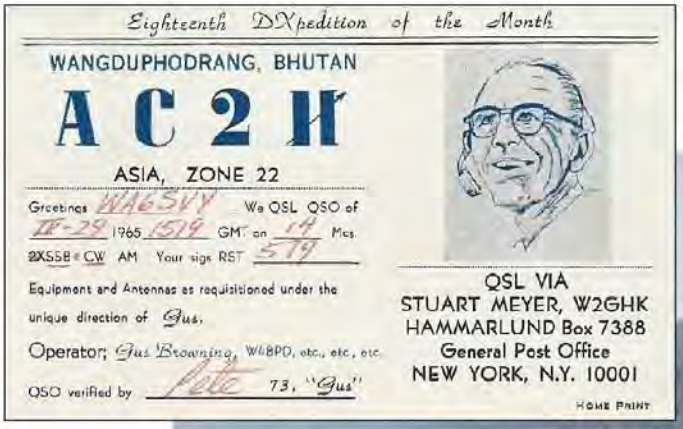
Bhutan's government operates under the guidance of "Gross National Happiness" (GNH), a holistic philosophy first coined by King Jigme Singye Wangchuck in 1972. GNH requires that Western technology be used where appropriate and useful, but cautions that it is never to supplant the country's Tibetan Buddhist cultural heritage.

The Beverage Crew, from left to right: Tharchu, Dophu, Dophu, and Passang. Later that day, Passang climbed a Himalayan blue pine tree to put up my inverted L antenna.

Planning the 2017 A52SJ DXpedition

My trip to Bhutan got under way a few years ago when I met Dr. Glenn Johnson, W0GJ, a serious DXpeditioner himself. He had been to Bhutan several times and put me in touch with Yeshey Dorji, A51AA, a ham living in Bhutan's capital city of Thimphu, who offers guidance to hams visiting the area. Yeshey and I worked out the details of our DXpedition and trek via email, and soon I was issued the call A52SJ.

I asked my local DX club how many of them had worked Bhutan on 160 meters and no one had! So, I designed all wire antennas for 160 meters and subtitled my operation "California or Bust," hoping to


Eighteenth DXpedition of the Month

WANGDUPHODRANG, BHUTAN

AC2H

ASIA, ZONE 22

Greetings WA6SVY We QSL QSO of
IV-29 1965 1519 GMT on 14 Mcs.
2XSSB CW AM Your sigs RST 579

Equipment and Antennas as requisitioned under the unique direction of Gus.

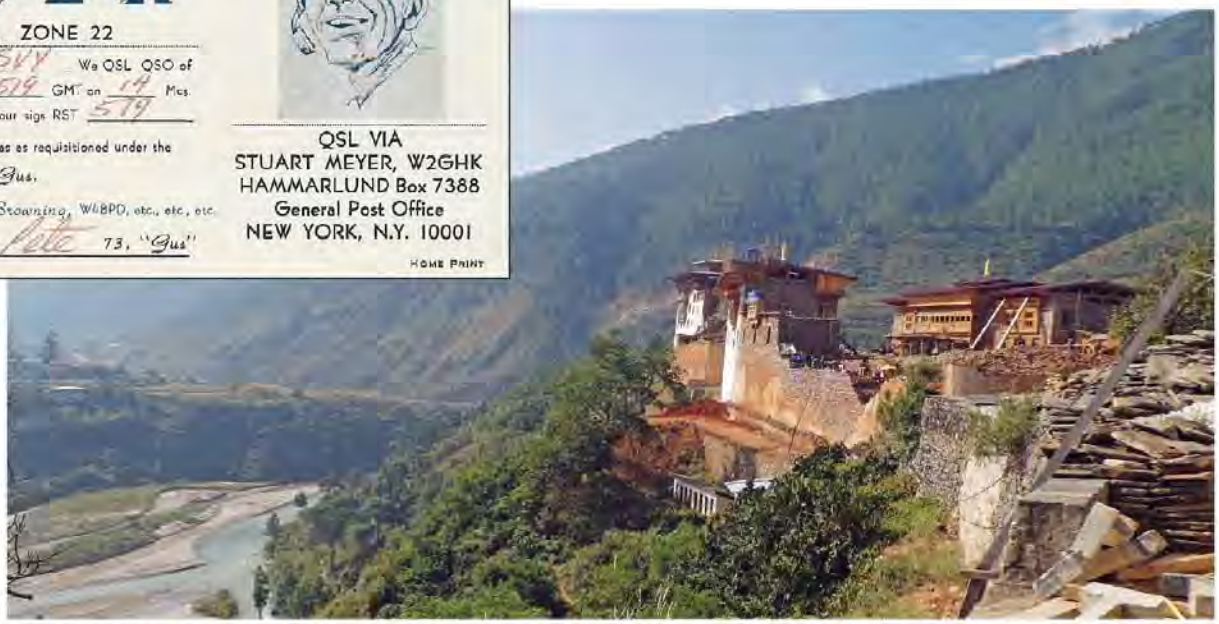
Operator; Gus Browning, W6BPD, etc., etc., etc.

QSO verified by Pete 73, "Gus"

QSL VIA
STUART MEYER, W2GHK
HAMMARLUND Box 7388
General Post Office
NEW YORK, N.Y. 10001

HOME PRINT

My 1965 QSL card from Gus in Bhutan. This is my one and only cross-mode (CW × SSB) contact and confirmation.


The Wangdue Phodrang dzong (fortress/monastery), currently under reconstruction. Gus' 1965 station was located on this ridge just west of here.

contact a club member. I installed Beverage and inverted L antennas at home and tested them by working JA (Japan) grid squares and Steve, VK6VZ, in Perth. Satisfied with how the antennas were working, I coiled up my copper wire and packed it.

The DXpedition Begins

We flew first to Bangkok and reached Paro, Bhutan, on October 12, 2017. Our Tourism Council of Bhutan (TCB) guide, Tharchu, and our driver, Dophu, met us at the airport. Along with two helpers, Passang and another Dophu, they had my Beverage and inverted L wires installed on the north-facing hillside below our hotel by late afternoon.

I started calling CQ on 1,826.5 kHz that first evening and Chak, JT5DX, in Ulaanbaatar, the capital of Mongolia, answered right away. But I did not contact any other stations on CW that week. However, the new FT8 mode had just been released that summer, and several club members had helped me set it up on my laptop. The extra 20 dB of system gain helped me work across Eurasia as far west as Amsterdam, but there seemed to be no signals at all from the east of Bhutan — none from JA, ZL, VK, or KL7, and none from the US west coast. My "California or Bust" mission was certainly a bust!

Journey Through Bhutan

Thankfully, the rest of the trip was certainly not a bust. For the next week, my wife, Valerie, and I went on a memorable trek high in the Himalayan foothills, and hiking up to 16,000 feet at Bongteyla Pass. When we returned to our hotel in Paro, I tried 160 meters one more night and morning, but, as the locals would say, the propagation gods were wrathful. Even on FT8, the band was closed.

The next week of our trip was my pilgrimage to where Gus had operated AC2H in 1965. With our trekking guide, Nado Chhogyal, we drove east to visit Thimphu, Punakha, and, finally, Wangdue Phodrang, the original operating location of Gus, AC2H.

We were able to observe the Gross National Happiness philosophy in action as we passed through the countryside, watching rice being harvested with hand tools, and talking with yak herders who heated their stone houses with yak dung in winter. We saw the monumental statue of Buddha, on the scale of a medieval cathedral, built over the course of 10 years on the hilltop above Thimphu. I felt privileged to have witnessed such a proud and ancient culture.

Pilgrimage Complete

Finally reaching Wangdue Phodrang, I saw the ridge above the Punakha River where Gus had set up his station. Nado told us the paved road we had arrived on was just a dirt track in 1965, so Gus would have arrived on foot, with his radio baggage on horses. Just north of town, I looked south down the valley through which our signals must have passed on that magic contact so many years ago. I felt very lucky to have lived to see my lifelong wish come true.

Jon Jones, N0JK, n0jk@arrl.org

The World Above 50 MHz

Unusually Great Sporadic-E Conditions in 2018

A number of readers have commented about the great conditions on 50 MHz this summer. Some wondered if it was due to unusually good sporadic-E conditions or if FT8 has been able to decode weak signals and find band openings present below the noise.

FT8 certainly played a role. It can decode down about 18 – 21 dB below the noise level, allowing weaker multi-hop sporadic-E openings to be exploited for contacts. Some great openings did take place — June 21, July 10, and July 21 come to mind. It is more difficult now to compare E_s seasons year to year, now that FT8 adds another variable to the mix.

Figure 1 — Mike's, K7ULS, portable setup in Utah (DN41) for the CQ VHF Contest. [Mike's, K7ULS, photo]

July 21 was an outstanding late-season E_s opening from North America to both Japan and Europe during the CQ VHF Contest (see Figure 1). John, KF0M (EM17), who has a modest station with an old four-element Yagi, made contacts with both Europe (G4RRA) and Japan on 6 meters around 2200Z on FT8. Stations east of the Mississippi River ran Europe, while to the west, Japan was everywhere. Later, KH6/K6MIO worked across the midwest to the east coast. 10 meters also opened for sporadic E, and Jeff, N8II, found July 21 good on 10 meters, as well as on SSB and CW. He found the next 2 days incredible, working many stations in Europe and Africa, even hearing HZ1TT in Saudi Arabia on July 23. Jeff said, "I can't remember such consistent European openings on E_s in any past years, and the odds are even more against it, being a month after the summer solstice." Jeff also felt conditions were better than past years on 6 meters.

I tend to think 2018 was a better-than-average year for sporadic E on both 6 and 10 meters. Though, the FT8 mode did play a major role helping to find and utilize weaker openings on 50 MHz for contacts. The 6-meter band is open more often than many thought.

Reasons for a Better 2018 Summer E_s Season

Sporadic-E seasons vary from year to year. The mechanism underlying sporadic-E formation is still not well understood, but seasonal variation of sporadic E is well known. Pat Dyer, WA5IYX (SK), documented this in his meticulous records of FM commercial broadcast station reception over many years. A possible reason for the great sporadic-E conditions this year may be due to upper air wind circulation and jet streams. This can be seen in noctilucent cloud formation, which happens at very high altitudes — around 85 kilometers above the Earth's surface in polar regions. This is just below the E-layer, where sporadic E forms. They are composed of meteor-seeded ice crystals.

This year, the summer season has been outstanding for noctilucent clouds. Normally, noctilucent clouds stop forming in the Northern Hemisphere by August 1. But this year, they have been going strong into the first week of August. Previous studies[1] have shown noctilucent clouds can increase during solar

minimums, due to a decrease in extreme ultraviolet (UV) rays. Extreme UV splits water molecules. Decreased extreme UV means there is more water vapor present in the mesosphere. Thus, noctilucent clouds are thriving, and although mesospheric noctilucent clouds do not propagate radio signals, the sporadic-E clouds just above them do. Perhaps the increased water vapor and associated change in the wind circulation at the top of the Earth's atmosphere may be intensifying sporadic E as well. Some of the best openings in mid- to late July were across the polar region, from North America to Japan, and North America to Europe.

On the Bands

50 MHz. On July 3, AA5AM put JW7QIA in his log at –19 dB. On July 6, K2ZD worked 9K2GS at 1206Z for his 200th 6-meter DXCC. On July 8, W9FF (EN40) logged GU8FBO. He used a FLEX-6500, Harris amplifiers running 1,300 W, and a seven-element Yagi. Dan, KF6A, said July 9 was "insane," and with so many openings to Japan, "it was hard to work them." July 10 was good for openings from North America to Europe. Ken, AC4TO (EM70), worked Z68M at 1331Z for a "6-meter first" from North America to Kosovo.

N4CC worked Z68M after Ken. Arliss, W7XU (EN13), worked 25 Japanese stations, and was called by BV3UF. Later, he worked KH6/K6MIO for his 48th state on FT8. He also worked HA3FOK/mm in CM54. Dan, KF6A (EN73), said he copied KH6/K6MIO at local midnight. On July 10, Larry, N0LL (EM09), also logged 45 Japanese stations, almost worked TF1A, and put BA4SI in his log.

On July 12, a huge sporadic-E opening between North America and Europe took place. It was so strong that Ken, AC4TO (EM70), was able to work F4VPC in France on FM at 2312Z. Steve, NN4X, noted US5WE worked FG8OJ on July 16, and K1TOL heard Chinese TV stations "over the North Pole" on July 17. Fred, K6IJ, worked DU7/PA0HIP on July 17 as well. On July 18, KX4R (EM73) made a contact with BU2BV (PL05) at 2252Z (see Figure 2).

There were great conditions during the CQ VHF Contest. Rich, K1HTV (FM18), logged R6KA (Crimea) at 1350Z for his 160th 6-meter DXCC. He then worked 4O6BLM for #161 an hour later. He decoded 51 different countries on July 21. KF6A worked three new DXCC entities. K5EJ worked LY1G. I (N0JK) decoded JH4UYB (PM64). Later, KH6/K6MIO had E_s across North America as far east as K2LNS (FN21). I appreciate reports from K0GU, W7GJ, K2WH, N6ZE, KO1DX, WD3D, WQ0P, W5VY, WA2GFN, K6QXY, and KV7K.

144 MHz. There was a lot of tropo and sporadic E in July. During the Field Day weekend, Angel, WP3GW, worked NP2RC and NP2OW on FM via tropo.

On July 7 – 9, a high-pressure system stagnated over the midwest. Strong tropo occurred. Some of the best contacts reported were by W7XU (EN13), who worked KA1ZE/3 (FN01), N8WAC (EN81), and KC8YJB (EN91) on FT8. His best contact was with W1VD (FN31) at 0258Z on July 9 on SSB. Larry, N0LL (EM09), also worked KA1ZE/3 on July 9 on SSB.

More tropo occurred during the CQ VHF Contest. KF0M (EM17), N0LL (EM09), W7CNK (EM15), K5SW (EM25), and others noted a remote-operated station by AA0F (EN04) was heard very loud Saturday and Sunday morning of the contest.

On Monday, July 23, E_s occurred from the midwest to Idaho, Montana, Nevada, and Utah. W5AFY (EM04), K5SW, W0RT (EM27), KA0JGH (EN10), and AF5CC (EM04) worked several stations, including K7ULS (DN41), WA7GSK (DN13), W7ID, and KF7UV (DM26).

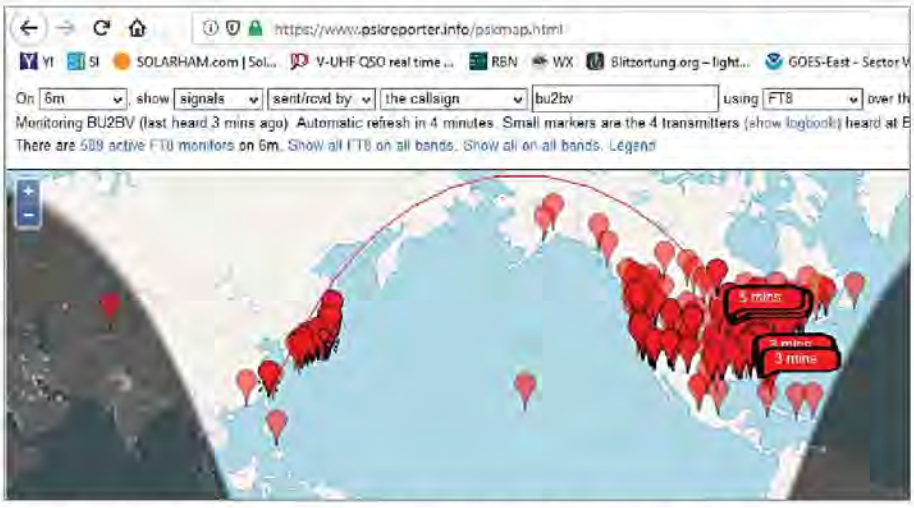


Figure 2 — The PSK reported on July 18 at 2300Z. [**https://pskreporter.info**]

[1]G. E. Thomas, R. D. McPeters, E. J. Jensen, "Satellite observations of polar mesospheric clouds by the solar back-scattered ultraviolet spectral radiometer: Evidence of a solar cycle dependence," *Journal of Geophysical Research*, Jan. 20, 1991.

Special Event Stations

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

Sep. 8 – Sep. 16, 0000Z – 2359Z, W6Q, Brookfield, IL. Six Meter Club of Chicago. **Route 66 On The Air**. 28.366 14.266 7.166 3.866. QSL. Michael Huedepohl, WD9GJK, 3532 Raymond Ave., Brookfield, IL 60513. *Part of California to Illinois commemoration of Historic Route 66 coordinated by the Citrus Belt ARC, W6JBT.* **www.k9ona.com**

Sep. 14 – Sep. 23, 0000Z – 2359Z, K4MIA, Loxahatchee, FL. PBSE Radio Society. **POW MIA Recognition Day**. 28.466 18.150 14.265 7.185. QSL. Michael Bald, 6758 Hall Blvd., Loxahatchee, FL 33470. *Sister stations K4MIA/5, K4MIA/7, and K4MIA/8 will be in operation on some days. Possible satellite operation. Please take time to remember our POWs and MIAs, as well as their families.* **www.qrz.com/db/k4mia**

Sep. 22, 1400Z – 2000Z, NE1PL, Middleboro, MA. USTNR NE1PL. **Happy Birthday Big Mamie — USS *Massachusetts* 77 Years Young**. 7.259 14.259. QSL. USTNR c/o Rick Emord, 135 Wareham St., Middleboro, MA 02346. **ne1pl.org**

Sep. 22, 1400Z – 2100Z, N2R, Manalapan, NJ. NJ Royal Rangers District. **Pow-Wow Amateur Radio Event**. DMR Talkgroup 91 and DMR Talkgroup 3100; 14.250 14.078. QSL. Lawrence Stewart, O'Hensyn Village, Apt. 4A, Budd Lake, NJ 07828.

Sep. 22 – Sep. 23, 1400Z – 2359Z, W0CXX, Cedar Rapids, IA. Rockwell Collins Amateur Radio Club. **85th Anniversary of the Collins Radio Company**. 14.245 14.045 7.195 7.045. QSL. W0CXX, 1157 Hwy. 965 NW, Cedar Rapids, IA 52404. *Several stations participating from various Rockwell Collins facilities. Primary operating hours 0900 to 1900 local time for each station as operators are available. Check other bands across HF and 6 meters for CW, SSB, AM, and digital modes.* **www.w0cxx.us**

Sep. 29, 1300Z – 1800Z, NC4AR, Thomasville, NC. Tri-County Amateur Radio Club. **Everybody's Day**. 7.210. Certificate. NC4AR, P.O. Box 747, Trinity, NC 27370. **www.qrz.com/db/nc4ar**

Sep. 29 – Sep. 30, 1000Z – 1500Z, W9S, Shelbyville, IN. Blue River Valley Amateur Radio Society. **50 Years of Pioneer Fair**. 7.135 7.030. QSL. John Walker, 302 W. Hendricks St., Shelbyville, IN 46176. **www.brvars.com**

Sep. 29 – Sep. 30, 1400Z – 0200Z, KY4LAW, Lawrenceburg, KY. Anderson Radio Club. Anderson County Burgoo Festival. 28.400 14.250 7.250 3.800. QSL. Anderson Radio Club, c/o Brian Carter, 159 Hickory Rd., Lawrenceburg, KY 40342. *We will rotate bands as conditions change throughout the day and evening.* **www.ky4law.com**

Oct. 4 – Oct. 7, 1700Z – 1700Z, W2V/W2VL/WV2KI, Levittown, NY. Long Island Mobile Amateur Radio Club. **110th Anniversary of the Vanderbilt Motor Parkway — New York State Historic Plaque Dedication**. 21.340 14.240 7.240. Certificate. LIMARC, P.O. Box 392, Levittown, NY 11756. *On Oct. 7, we will have mobile operations as part of the parade of antique cars. The mobile call sign will be WV2LI, and will be mobile for about 4 hours, 0800 – 1200 UTC. Special recognition if you are able to work the mobile and one of the other call signs.* **www.limarc.org**

Oct. 5 – Oct. 6, 1200Z – 2300Z, W4O, Harlem, GA. Amateur Radio Club of Columbia County. **30th Annual Oliver Hardy Festival**. 28.330 14.330 7.230 3.830. QSL. ARCCC, Attn.: QSL Manager, P.O. Box 285, Evans, GA 30809. **https://www.arccc.org**

Oct. 5 – Oct. 6, 2200Z – 2100Z, KN4BBD, Pinson, AL. Pinson Valley High School Amateur Radio Club. **Alabama Butterbean Festival**. 18.160 14.260 7.2460 3.850; FT8: 21.074 18.100 14.074 7.074 3.573. QSL. PVHS Amateur Radio Club, 6895 AL Hwy. 75 N., Pinson, AL 35126. *The world's largest pot of baked beans; confirmed record by Guinness World Records.* **www.qrz.com/db/kn4bbd**

Oct. 5 – Oct. 7, 1300Z – 2300Z, W5DDL, Lafayette, LA. Acadiana Amateur Radio Association, Inc. **Tour du Teche 2018 Canoe Race**. 24.960 14.265 7.265 7.260. QSL. Roland Guidry, NA5Q, 701 S. Arenas St., Rayne, LA 70578. **www.w5ddl.org/clubsite**

Oct. 5 – Oct. 8, 0001Z – 2359Z, N4OLT, West Palm Beach, FL. The Benjamin Franklin Institute of Global Education. **Global Learn Day on the Air**. 21.387 14.287 7.187 3.803. Certificate. OLT Amateur Radio Club, 2669 Forest Hill Blvd., Ste. 207, West Palm Beach, FL 33406. **bfranklin.edu/gldota**

Oct. 6, 1200Z – 1700Z, W0CWP, Anamosa, IA. Jones County Amateur Radio Club. **Ryan Norlin Weigh-Off Anamosa Pumpkinfest**. 14.260 7.240. Certificate. KB0OCH, 428 W. 8th St., Monticello, IA 52310.

Oct. 6 – Oct. 7, 1300Z – 2100Z, W1W, Cornwall Bridge, CT. Northville Amateur Radio Association. **Warren Fall Festival**. 14.225. Certificate. NA1RA, P.O. Box 354, New Milford, CT 06776. **www.na1ra.org**

Oct. 6 – Oct. 14, 0000Z – 2359Z, W5B, Albuquerque, NM. High Desert Amateur Radio Club. **Albuquerque International Balloon Festival**. 14.235 7.180. QSL. Jerry Aceto, K6LIE, 1023 Purple Aster, Bernalillo, NM 87004. **www.nm5hd.com**

Oct. 8 – Oct. 14, 0000Z – 2359Z, W4V, Vienna, VA. Vienna Wireless Society. **55th Anniversary**. 448.375 146.685 14.225 7.225. QSL. W4V – Vienna Wireless Society, P.O. Box 418, Vienna, VA 22183. **viennawireless.net**

Oct. 8 – Oct. 16, 0000Z – 2359Z, W3T, Harleysville, PA. WV2M. **Towamencin Encampment**. 14.240 14.030 7.240 7.030. QSL. Frank Gallo, 106 Tweed Way, Harleysville, PA 19438. **www.w3t.info**

Oct. 8 – Oct. 16, 0000Z – 2359Z, W5I, Sherman, TX. Grayson County Amateur Radio Club. **Eisenhower Special Event**. 14.250 7.200 14.040 7.040. QSL. Grayson County ARC, P.O. Box 642, Sherman, TX 75091. **www.graysoncountyarc.com**

Oct. 13, 1300Z – 1600Z, KK1PMA, Providence, RI. Providence Emergency Management Agency RACES. **Roger Williams Special Event Amateur Radio Station**. 147.42 53.02 14.275 7.275. Certificate. Barry Noel, P.O. Box 28091, Providence, RI 02908. **w1bsnpema@gmail.com** *or* **www.qrz.com/db/kk1pma**

Oct. 13, 1400Z – 2000Z, K3SMD, La Plata, MD. Charles County Amateur Radio Club. **Mallows Bay Ghost Fleet**. 14.240 7.270. QSL. Bob Curran, 120 Sherman Rd., Waldorf, MD 20602. **www.k3smd.net**

Oct. 13, 1600Z – 2300Z, NI6IW, San Diego, CA. USS *Midway* (CV-41) Museum Ship. **Establishment of the United States Navy Oct. 13, 1775**. 14.320 7.250 14.070; D-STAR on REF001C. QSL. USS *Midway* (CV-41) COMEDTRA, 901 N. Harbor Dr., San Diego, CA 92101.

Oct. 13 – Oct. 14, 1400Z – 2359Z, W0D, Macon, MO. Macon County Amateur Radio Club. **Lester Dent — Doc Savage Special Event**. 14.250 7.200. Certificate. W0D, c/o Macon County Amateur Radio Club, P.O. Box 13, Macon, MO 63552. **www.facebook.com/pg/maconcountyarc/events**

Oct. 14 – Oct. 20, 0000Z – 2359Z, KA2LHO, Global. World Wide Flora and Fauna — North America. **Get Your Park ON!** All bands, all modes. Certificate. Kraig D. Pritts, 6637 NE 5th Ln., Ocala, FL 34470. *Goal is to activate as many World Wide Flora and Fauna (WWFF) parks as possible throughout North America and have callers to these parks from throughout the world. We are cooperating with Earth Science Week to promote the protected nature areas of the world.* **getyourparkon.com**

Oct. 15 – Oct. 21, 0500Z – 2359Z, W9C, Orland Park, IL. Metro DX Club. **Illinois Bicentennial Celebration**. 14.280 14.050 7.280 7.050. Certificate & QSL.* Jim Mornar, 8607 W. Kendall Ln., Orland Park, IL 60462. Certificate also available by email to **n9tk@comcast.net**. **www.metrodxclub.com**

Oct. 17 – Oct. 22, 2300Z – 0200Z, W5W, Springdale, AR. Razorback Contest Club. **Washington County, Arkansas, 190th Anniversary**. 14.250 14.040 7.200 7.040. Certificate & QSL. Razorback Contest Club, 3407 Diana St., Springdale, AR 72764. **arske5xx@gmail.com** *or* **www.qrz.com/db/ke5xx**

Oct. 18 – Oct. 20, 1400Z – 2300Z, W5Y, Gilmer, TX. Longview East Texas Amateur Radio Club ARES. **W5Y East Texas Yamboree**. HF 7290 kHz; 147.34 Pos 136.5 tone. QSL. Jim Liberacki N5TQI, 2539 FM 555, Gilmer, TX 75645. **n5tqi@aol.com** *or* **www.letarc.org**

Oct. 19 – Oct. 21, 1402Z – 1402Z, W8E, Loveland, OH. United States Coast Guard Auxiliary District 8ER. **Commemorating the 79th Anniversary of the United States Coast Guard Auxiliary**. 21.336 7.234. QSL. David Stroup, 6138 Misty Creek Dr., Loveland, OH 45140. **cgaux8@yahoo.com**

Oct. 20, 1400Z – 2030Z, K4RC, Yorktown, VA. Williamsburg Area Amateur Radio Club. **Surrender Day Special Event**. 14.265 7.265. QSL. K4RC, P.O. Box 1470, Williamsburg, VA 23187. *237th Anniversary of the British surrender at the Battle of Yorktown, ending the American Revolution.* **www.k4rc.net**

Oct. 21, 1400Z – 2000Z, W4PCF, Milledgeville, GA. Milledgeville Amateur Radio Club. **Deep Roots Festival Special Event Station**. 14.310 7.210; SSB, 20 and 40 meters, digital possible. Certificate. Daniel R. Simpson, K4DRS, P.O. Box 1882, Milledgeville, GA 31059. **www.milledgevillearc.org**

Oct. 22 – Oct. 31, 0000Z – 2359Z, OE100ES, Tulln, Austria. Club Station ADL 305 Tulln-Stockerau. **100th Anniversary of Egon Schiele's Death**. All bands, all modes. QSL. Via Bureau or direct to Special Event Centenary of Egon Schiele's Death, Rudolf-Buchinger Str. 11, 3430 Tulln an der Donau, Austria, Europe. **www.qrz.com/db/oe100es**

Oct. 27, 1700Z – 2300Z, K7T, Tombstone, AZ. Oro Valley Amateur Radio Club. **Shootout at the OK Corral**. CW: 7.040, 14.040; PSK: 7.070, 14.070; FT8: 7.074, 14.074; SSB: 7.200, 14.250. Certificate. Via email to **qsl@tucsonhamradio.org**. *Email requests only. No paper QSLs, please.* **www.tucsonhamradio.org**

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

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

Submissions must be received by ARRL HQ no later than the 1st of the second month preceding the publication date; a special event listing for **December** *QST* would have to be received by **October 1**. In addition to being listed in *QST*, your event will be listed on the ARRL Web Special Event page. Note: All received events are acknowledged. If you do not receive an acknowledgment within a few days, please contact us. ARRL reserves the right to exclude events of a commercial or political nature.

Special Events listed in this issue include current events received through August 10. You can view all received Special Events at **www.arrl.org/special-event-stations**.

October 2018 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.

October Qualifying Runs will be transmitted by W1AW in Newington, Connecticut at 10 PM EDT on Monday, October 1 (0200 UTC on October 2) and at 4 PM EDT on Wednesday, October 17 (2000 UTC) at 1.802.5, 3.581.5, 7.047.5, 14.047.5, 18.097.5, 21.067.5, 28.067.5, 50.350, and 147.555 MHz. The West Coast Qualifying Runs will be transmitted by K6RB on Wednesday, October 24 at 9 PM PDT (0400 UTC on October 25) at 3590 kHz. Unless indicated otherwise, sending speeds are from 40 to 10 WPM.

Strays

QST Congratulates...

The Center for Amateur Radio Learning (CARL) of Phoenix, Arizona for winning the 2018 Museum Association of Arizona Community Support Award. Club president Jack Landon, KD7ROB, is shown holding the award. CARL's club call is W7ASC. They staff the station 363 days each year at the Arizona Science Center during regular Center hours, plus evenings when special events are scheduled.

Convention and Hamfest Calendar

Abbreviations

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

ALABAMA SECTION CONVENTION

November 10, Montgomery, AL
D F H Q R S T V
8:30 AM – 4 PM. *Spr:* Montgomery ARC. Alcazar Shrine Temple, 555 Eastern Blvd. *Tl:* 146.84. *Adm:* $8. **www.w4ap.org/Events/Hamfest.htm**.

Arizona (Congress) — Nov. 10 D H R T
8 AM. *Spr:* Hassayampa ARK. Escapees North Ranch, 30625 Hwy. 89. *Tl:* 146.58. *Adm:* Free. **harkaz.org**.

Arizona (Marana) — Nov. 10
D F H Q R S T V
7 AM – 1 PM. *Spr:* Oro Valley ARC. Marana Middle School, 11285 W. Grier Rd. *Tl:* 146.62, 444.1, 147.32, 447.525 (all 156.7 Hz). *Adm:* $5. **tucsonhamradio.org**.

Arizona (Maricopa) — Oct. 27
F H Q R S T V
7 AM – 1 PM. *Spr:* Maricopa ARA. UltraStar Center, 16000 N. Maricopa Rd. CopaFest 2018. *Tl:* 447.725 (100 Hz). *Adm:* $5. **copahams.org**.

Arkansas (Morrilton) — Oct. 13
A F H Q R T V
8 AM – 3 PM. *Spr:* Randy Griffin Memorial RC. Petit Jean Mountain Lutheran Camp, 110 Montgomery Trace. Cake and pie auction. *Tl:* 146.52. *Adm:* Free. **k5boc.org**.

California (Redding) — Oct. 13 F H T V
10 AM – 2 PM. *Spr:* Shasta/Tehama County ARES. Bentronics, 141 Locust St. *Tl:* 146.64 (88.5 Hz). *Adm:* Free. **www.st-ares.org/swapmeet2018.html**.

PACIFIC DIVISION CONVENTION

October 19 – 21, San Ramon, CA
D F H Q R S T V
Friday 8 AM – Sunday 1 PM. *Spr:* Mount Diablo ARC. San Ramon Marriott, 2600 Bishop Dr. Pacificon 2018, 1-day license class, special event station, QRP events, kit building, youth area, Wouff Hong ceremony, banquet. *Tl:* 147.06 (100 Hz). *Adm:* Advance $25, door $30. **www.pacificon.org**.

Colorado (Lakewood) — Nov. 3 H R S
9 AM – 3 PM. *Spr:* 285 TechConnect RC, Bridge Church at Bear Creek, 3101 S. Kipling St. Fall TechFest. *Tl:* 145.145 (107.2 Hz). *Adm:* $10. **www.na0tc.org/doku.php?id=techfests#section2018**.

Connecticut (Gales Ferry) — Oct. 27
A H R
8 AM – 4 PM. *Spr:* Tri-City ARC. Gales Ferry Firehouse, 1772 Rte. 12. Equipment Auction. *Tl:* 146.73 (156.7 Hz). *Adm:* $2. **www.qsl.net/tricityarc**.

CONNECTICUT STATE CONVENTION

October 21, Meriden, CT
D F H R S T V
8 AM – 1 PM. *Spr:* Nutmeg Hamfest Alliance. Four Points by Sheraton Meriden, 275 Research Pkwy. Nutmeg Hamfest. *Tl:* 147.36. *Adm:* $8. **nutmeghamfest.com**.

Florida (Jacksonville) — Oct. 27
A F H R T
7 AM – noon. *Spr:* North Florida ARS. Terry Parker Baptist Church, 7024 Merrill Rd. *Tl:* 146.7 (127.3 Hz). *Adm:* Free. **nofars.net/home/hamfest**.

Florida (Lakeland) — Nov. 3
F H Q R T V
8 AM – noon. *Spr:* Lakeland ARC. Revolution Church, 7315 Kathleen Rd. *Tl:* 146.685 (127.3 Hz). *Adm:* Free. **lakelandarc.org**.

Florida (Melbourne) — Oct. 12 – 13
D F H Q R S T V
Friday 1 – 7 PM, Saturday 9 AM – 3 PM. *Spr:* Platinum Coast ARS. Melbourne Auditorium, 625 E. Hibiscus Blvd. 53rd Annual Melbourne Hamfest. *Tl:* 146.85. *Adm:* $7. **www.pcars.org**.

Florida (New Port Richey) — Oct. 27
F H R T V
7 AM – noon. *Spr:* Gulf Coast ARC. Millennium Academy, 10005 Ridge Rd. *Tl:* 146.67. *Adm:* $5. **gulfcoastarc.org**.

Florida (Pinellas Park) — Nov. 10
D F H R T V
8 AM – noon. *Spr:* St. Petersburg ARC. Freedom Lake Park, 9990 46th St. N. *Tl:* 147.06. *Adm:* Free. **www.sparc-club.org**.

HAMJAM CONVENTION

November 10, Alpharetta, GA
R S
8:15 AM – 1 PM. *Spr:* North Fulton AR League. Mill Springs Academy, 13660 New Providence Rd. *Tl:* 145.47 (100 Hz). *Adm:* Free. **hamjam.info**.

Georgia (LaGrange) — Oct. 27
D F H R T V
9 AM – 2 PM. *Spr:* LaGrange ARC. Oakside Baptist Church Gym, 1921 Hamilton Rd. *Tl:* 146.7 (141.3 Hz). *Adm:* Free. **www.lagrangeradioclub.org**.

GEORGIA SECTION CONVENTION

November 3 – 4, Lawrenceville, GA
D F H R S T V
Saturday 8 AM – 4 PM, Sunday 8 AM – 2 PM. *Spr:* Alford Memorial RC. Gwinnett County Fairgrounds, 2405 Sugarloaf Pkwy. Stone Mountain Hamfest. *Tl:* 147.075 (82.5 Hz). *Adm:* Advance $8, door $10. **stonemountainhamfest.com**.

Indiana (Lynnville) — Oct. 27 F H R T V
7 AM – 5 PM. *Spr:* Tri-State ARS. Lynnville Community Center, 416 W. State Rd. 68. *Tl:* 146.79 (88.5 Hz). *Adm:* Free. **hamtoberfest.com**.

Indiana (Shelbyville) — Oct. 20 F H R T
8 AM – noon. *Spr:* Blue River Valley ARS. Shelby County Fairgrounds, 500 Frank St. *Tl:* 145.48 (88.5 Hz). *Adm:* Free. **www.brvars.com**.

Kentucky (Hazard) — Oct. 27
D F H R T V
8 AM – 1 PM. *Spr:* Kentucky Mountains ARC. Avawam Volunteer Fire Dept., 3680 W. Kentucky Hwy. 80. *Tl:* 146.67 (103.5 Hz). *Adm:* $5. **www.facebook.com/kymarc**.

Kentucky (Morehead) — Oct. 13
F H R T V
8 AM – 1 PM. *Spr:* Morehead ARS. Kentucky Fire Commission Training Center, 99 Lake Park Dr. Cave Run Hamfest. *Tl:* 146.91 (123 Hz). *Adm:* $5.

Louisiana (Harahan) — Nov. 10
D F H R S T V
8 AM – 1 PM. *Spr:* Crescent City AR Group. Lions Club Building, 1001 Hickory Ave. The Greater New Orleans Hamfest. *Tl:* 146.82 (114.8 Hz). *Adm:* Free. **www.facebook.com/groups/2044282109131267**.

Louisiana (Pineville) — Oct. 13
D F H S V
8 AM – 1 PM. *Spr:* Central Louisiana ARC. Kees Park Community Center, 2450 Highway 28 E. NIMS Training. *Tl:* 147.33 (173.8 Hz). *Adm:* $5. **www.clarc.us**.

Louisiana (Shreveport) — Sept. 29
F H R T
8 AM – 2 PM. *Spr:* ARC of Shreveport. North Shreve Baptist Church, 4930 Old Mooringsport Rd. ARCOS Tailgate Party. *Tl:* 146.67 (186.2 Hz). *Adm:* Free. **n5shv.org**.

Maryland (Hollywood) — Oct. 6 R T
8 AM – noon. *Spr:* St. Mary's County ARA. Hollywood Volunteer Fire Department Bingo Hall, 24801 Three Notch Rd. (MD Rte. 235). 6th Annual TailgateFest. *Tl:* 146.64 (146.2 Hz). *Adm:* Free. **www.k3hki.org**.

Maryland (Upperco) — Oct. 28 F H R T
8 AM – noon. *Spr:* Carroll County ARC. Sportsman's Hall Roller Skating Center, 15500 Hanover Pike. Mason-Dixon Hamfest. *Tl:* 145.41 (114.8 Hz). *Adm:* $5. **k3pzn.net**.

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

Massachusetts (Bourne) — Nov. 3
D F H R V
7 AM – noon. *Spr:* Falmouth ARA. Upper Cape Cod Regional Technical High School, 220 Sandwich Rd. FARAFest. *Tl:* 146.655 (88.5 Hz). *Adm:* $5, under 14 free. **www.falara.org**.

Massachusetts (Cambridge) — Oct. 21
www.swapfest.us.

Michigan (Alpena) — Oct. 6 F
9 AM – 1 PM. *Spr:* Thunder Bay ARC. Alpena Mall, 2380 US 23 S. *Tl:* 146.76 (88.5 Hz). *Adm:* Donation. **thunderbayarc.org**

Michigan (Kalamazoo) — Oct. 21
D F H R S T V
8 AM – noon. *Sprs:* Kalamazoo ARC and Southwest Michigan AR Team. Kalamazoo County Expo Center and Fairgrounds, 2900 Lake St. Active JOTA site, Kalamazoo Makers Guild. *Tl:* 147.04 (94.8 Hz). *Adm:* $6. **kalamazoohamfest.org**.

Michigan (Madison Heights) — Oct. 28
D F H Q R V
8 AM – 1 PM. *Spr:* Utica-Shelby Emergency Communication Assn. United Food and Commercial Workers Local 876 Hall, 876 Horace Brown Dr. *Tl:* 147.18 (100 Hz), 444.775 (Fusion). *Adm:* $5. **usecaarc.com**.

Michigan (Muskegon) — Oct. 20
D F H R S V
8 AM – noon. *Spr:* Muskegon County Emergency Communication Services. Fellowship Reformed Church, 4200 E. Apple Ave. *Tl:* 146.82 (94.8 Hz). *Adm:* Advance $5, door $6. **mcecs.net/Download/HamfestFlyer2018.pdf**.

Mississippi (Ocean Springs) — Nov. 9 – 10 D F H Q R V
Friday 5 – 9 PM, Saturday 8 AM – 3 PM. *Spr:* Jackson County ARA. St. Martin Community Center, 15008 Lemoyne Blvd. *Tl:* 145.11 (123 Hz). *Adm:* $5. **www.jcmsara.com**.

Missouri (Belton) — Oct. 20 D F H V
8 AM – 1 PM. *Spr:* SouthSide ARC. Mill Creek Upper Elementary School, 308 S. Cleveland Ave. *Tl:* 147.12 (151.4 Hz). *Adm:* Advance 3 for $7, door $4 each. **southsidearc.net/hamfests-and-events**.

Missouri (Independence) — Nov. 3
D F H R S T V
8 AM – 1 PM. *Spr:* Raytown ARC. American Legion Post 21, 16701 E. US Hwy. 40. *Tl:* 145.17. *Adm:* Free. **k0gq.com**.

Missouri (Kirkwood) — Oct. 27
D F H R V
7:30 AM – 1 PM. *Spr:* St. Louis ARC. Kirkwood Community Center, 111 S. Geyer Rd. 27th Annual Halloween Hamfest. Breakfast made to order. *Tl:* 147.15 (141.3 Hz). *Adm:* Advance $4 each or 3 for $10, door $7 each or 2 for $12. **halloweenhamfest.org**.

Missouri (Nixa) — Nov. 10 D F H R S V
8 AM – 1 PM. *Spr:* Nixa ARC. The Bridge, 308 W. Mt. Vernon St. *Tl:* 147. 015 (162.2 Hz). *Adm:* $7. **smlrs.info/hamfest-information**.

Nebraska (Norfolk) — Nov. 3
D F H R S V
8:30 AM – 2:30 PM. *Spr:* Elkhorn Valley ARC. CHC Hall, 105 Elm Ave. *Tl:* 146.73 (131.8 Hz). *Adm:* $5. **www.qsl.net/evarc**.

New Hampshire (Deerfield) — Oct. 12 – 13. www.near-fest.com.

New Jersey (Parsippany) — Nov. 3
D F H R
8 AM – noon. *Spr:* New Jersey Antique Radio Club. Parsippany PAL Building, 33 Baldwin Rd. *Tl:* None. *Adm:* $5. **www.njarc.org**.

New Jersey (Township of Washington) — Oct. 13 D F H Q R T V
8 AM – 1 PM. *Spr:* Bergen ARA. Westwood Regional Junior/Senior High School, 701 Ridgewood Rd. BARA Fall Hamfest. *Tl:* 146.79 (141.3 Hz). *Adm:* $5. **bara.org**.

NEW MEXICO STATE CONVENTION

October 19 – 20, Socorro, NM
D F H R S T V
Friday 6 – 8 PM, Saturday 8 AM – 3 PM. *Sprs:* Socorro ARA, Tech ARA, and the City of Socorro. New Mexico Firefighters Training Academy, 600 Aspen Rd. *Tl:* 146.68 (100 Hz). *Adm:* Free. **socorroara.org/hamfest.html**.

New York (Fishkill) — Oct. 28
D F H R T V
8 AM – 1 PM. *Spr:* Mt. Beacon ARC. Downstate Correctional Employee Recreation Center, 83 Red Schoolhouse Rd. *Tl:* 146.97 (100 Hz). *Adm:* $5. **www.wr2abb.org**.

New York (Hicksville) — Oct. 28
D F H Q R V
9 AM. *Spr:* Long Island Mobile ARC. Levittown Hall, 201 Levittown Pkwy. Long Island Hamfest and Electronics Fair. *Tl:* 146.85 (136.5 Hz). *Adm:* $6. **www.limarc.org**.

New York (Horseheads) — Sept. 29
D F H R T V
6 AM – 2 PM. *Sprs:* ARA of the Southern Tier and Chemung County ARES. Chemung County Fairgrounds, Grand Central Ave. 43rd Annual Elmira International Hamfest. *Tl:* 147.36, 146.7. *Adm:* Advance $6, door $8. **www.arast.info**.

New York (Queens) — Oct. 7
D F H Q R V
9 AM – 2 PM. *Spr:* Hall of Science ARC. New York Hall of Science Parking Lot (Flushing Meadows Corona Park), 47-01 111th St. Drop and Shop. *Tl:* 444.2 (136.5 Hz). *Adm:* $5. **www.hosarc.org**.

New York (Rome) — Sept. 22 F H R T
8 AM – noon. *Spr:* Rome Radio Club. Griffiss Institute, 725 Daedalian Dr. *Tl:* 146.88 (71.9 Hz). *Adm:* $5. **romeradioclub.com**.

North Carolina (Maysville) — Oct. 14
D F H R T V
8 AM – 2 PM. *Spr:* Maysville Hamfest Assn. Rotary Park Community Center, 704 8th St. *Tl:* 146.685 (88.5 Hz), 146.52. *Adm:* Free.

MICROWAVE UPDATE CONFERENCE

October 11 – 14, Dayton (Fairborn), OH
D F H R S
Thursday noon – 5 PM (registration), 2 – 5 PM (Tour of Voice of America); Friday 9 AM – 5:30 PM; Saturday 9 AM – 5 PM; Sunday 10 AM – 2 PM (Tour of US Air Force Museum). *Spr:* Midwest VHF/UHF Society. Holiday Inn Dayton/Fairborn I-675, 2800 Presidential Dr. Saturday banquet (6:30 – 9:30 PM). *Tl:* None. *Registration:* Advance $145, door $155 (includes two lunches and banquet). **www.microwaveupdate.org**.

Ohio (Georgetown) — Nov. 3 D F H R
8 AM – 2 PM. *Spr:* Grant ARC. ABCAP Building, 406 W. Plum St. *Tl:* 146.73 (162.2 Hz). *Adm:* $2. **garcohio.net**.

Ohio (Lima) — Oct. 13 F H R T
8 AM – 1 PM. *Spr:* Northwest Ohio ARC. Allen County Fairgrounds Rabbit Building, 2750 Harding Hwy. *Tl:* 146.67. *Adm:* $5. **nwoarc.com**.

Ohio (Massillon) — Oct. 28 D F H R V
8 AM – 2 PM. *Spr:* Massillon ARC. Massillon Boy's and Girl's Club, 730 Duncan St. SW. 58th Annual Hamfest. *Tl:* 147.18 (110.9 Hz). *Adm:* $5. **www.w8np.org**.

Oklahoma (Ardmore) — Oct. 26 – 27
D F H R S V
Friday 5 – 8 PM, Saturday 8 AM – 1 PM. *Spr:* Texoma Hamarama, Inc. Ardmore Convention Center, 2401 N. Rockford Rd. 71st Annual Texoma Hamarama. *Tl:* 146.97 (131.8 Hz). *Adm:* Advance $8, door $10. **www.texomahamarama.org**.

Oklahoma (Enid) — Nov. 3 D F H R S V
8 AM. *Spr:* Enid ARC. Garfield County Fairgrounds Hoover Building, 305 E. Oxford Ave. *Tl:* 444.825, 147.375, 145.29. *Adm:* $3. **www.enidarc.org/enidhamfest**.

Oregon (Rickreall) — Oct. 20 F H R S
9 AM – 3 PM. *Spr:* Mid-Valley ARES. Polk County Fairgrounds, 520 S. Pacific Highway W. Swaptoberfest. *Tl:* 145.33 (186.2 Hz). *Adm:* Advance $8, door $10. **www.swaptoberfest.net**.

PACIFIC NORTHWEST VHF CONFERENCE

October 12 – 13, Seaside, OR
F H Q R S
Friday 1 – 4 PM, Saturday 8 AM – 3 PM. *Spr:* Pacific Northwest VHF Society. Best Western Ocean View Resort, 414 N. Prom. *Tl:* None. *Registration:* Advance $55, door $60. **pnwvhfs.org**.

MID-ATLANTIC STATES VHF CONFERENCE

September 28 – 30, Bensalem, PA
F H R S
Friday 1 – 5 PM, Saturday 8 AM – 5 PM, Sunday 8 – 10 AM (Mini Hamfest). *Spr:* Mt. Airy VHF RC (Packrats). Holiday Inn Bensalem-Philadelphia, 3327 Street Rd. *Adm:* Advance $40, door $50. **packratvhf.com**.

Pennsylvania (Canonsburg) — Nov. 4
D H Q R S V
8 AM – 3 PM. *Spr:* Washington Amateur Communications, Inc. Printscape Arena, 114 Southpointe Blvd. WACOM Hamfest. *Tl:* 147.39 (N), 147.315 (S), 146.79 (E), 145.25 (W) — all 131.8 Hz. *Adm:* $5. **www.wacomarc.org/hamfest.html**.

Pennsylvania (Sellersville) — Oct. 21
D F H R T V
7 AM – 1 PM. *Spr:* RF Hill ARC. Sellersville Firehouse, 50 N. Main St. *Tl:* 145.31 (131.8 Hz). *Adm:* $6, non-hams free. **rfhillarc.org**.

South Carolina (Conway) — Oct. 27
D F H Q R S T V
8 AM – 2 PM. *Spr:* Grand Strand ARC. Old Pee Dee School, 3521 Juniper Bay Rd. 22nd Annual Beachfest & Computer Expo. *Tl:* 145.11 (85.4 Hz). *Adm:* Advance $6, door $7. **www.w4gs.org**.

TENNESSEE STATE CONVENTION

October 20, East Ridge, TN
D F H Q R S T V
8 AM – 2 PM. *Spr:* Chattanooga ARC. Camp Jordan Arena, 323 Camp Jordan Pkwy. *Tl:* 146.79. *Adm:* $10. **www.w4am.net**.

Tennessee (Greeneville) — Oct. 20
greenevillehamfest.com.

Texas (Belton) — Oct. 6 D F H R T V
7 AM – noon. *Spr:* Temple ARC. Bell County Expo Center, 301 W. Loop 121. HamEXPO. *Tl:* 146.82 (123 Hz). *Adm:* $5. **tarc.org/hamexpo**.

Texas (Sinton) — Oct. 20 D F H R S T V
8 AM – 3 PM. *Spr:* South Texas Hamfest Assn. San Patricio County Fairgrounds Event Center, 219 W. 5th St. South Texas Hamfest & Electronics Expo, Silent Auction. *Tl:* None. *Adm:* Advance $5, door $7. **www.southtexashamfest.org**.

Washington (Bremerton) — Oct. 13
F H R V
9 AM – 1 PM. *Spr:* Kitsap County ARC. West Side Improvement Club, 4109 W. E St. *Tl:* 444.075 (103.5 Hz). *Adm:* $5. **kcarc.org**.

West Virginia (Mineral Wells) — Oct. 13 D F H R T V
8 AM – 2 PM. *Spr:* Wood County Emergency Communications. Wood County 4-H Camp, 2203 Butchers Bend Rd. Parkersburg/Wood County Hamfest. *Tl:* 147.255 (131.5 Hz). *Adm:* $5. **www.wc8ec.org**.

Wisconsin (Appleton) — Nov. 4
D F H R V
8 AM. *Spr:* Fox Cities ARC. Monarch Gardens, 2311 W. Spencer St. *Tl:* 146.76 (100 Hz). *Adm:* Advance $5, door $6. **www.fcarc.club/hamfest.php**.

Wisconsin (Colby) — Oct. 13 D H R T
8 AM – noon. *Spr:* Black River ARA. Colby Lions Pavilion, 103 W. Adams St. 13th Annual Central Wisconsin Swapfest. *Tl:* 147.15 (114.8 Hz). *Adm:* $5.

Wisconsin (Milwaukee) — Nov. 3
D H R S
8 AM – noon. *Spr:* Milwaukee Repeater Club. Elks Club Lodge #46, 5555 W. Good Hope Rd. *Tl:* 146.91 (127.3 Hz). *Adm:* $5. **mrc91.org**.

WISCONSIN ARES/RACES CONFERENCE

October 13, Wisconsin Rapids, WI
H S
9 AM – 4:30 PM. *Spr:* WeComm, LTD. McMillan Memorial Library, 490 E. Grand Ave. *Tl:* 146.79 (114.8 Hz). *Adm:* Free. **wi-aresraces.org**.

To All Event Sponsors

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

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

The deadline for receipt of items for this column is the **1st of the second month preceding publication date**. For example, your information must arrive at HQ by **October 1** to be listed in the **December** 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 the ARRL Advertising Desk at 860-594-0207, or email **ads@arrl.org**.

Strays

QST Congratulates...

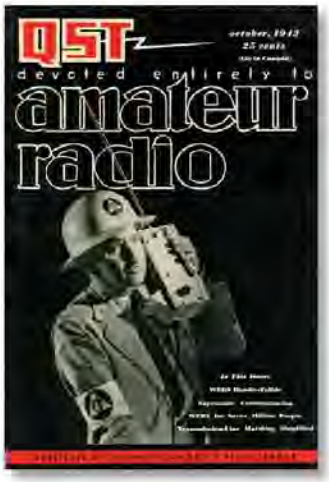
Janusz Wegrzyn, SP9FIH, the winner of the 2017 Single-Operator Cass Award. While operating from Palestine as E44WE during May 2017, Janusz worked 10,087 unique stations during 14 days of his one-person DXpedition, demonstrating an outstanding effort to log as many DXers as possible, and setting a new Single-Operator Cass Award record. Polish Amateur Radio Union President Waldemar Sznajder, 3Z6AEF (right), presented Janusz with his plaque at their convention on May 26, 2018.

The Cass Award sponsors — Club Log, DXLab, and the Northern California DX Club — have also announced the addition of a new "unlimited" award. Presented annually, the Cass Awards encourage DXpeditions to maximize the number of DXers worked with a plaque for the Single-Operator DXpedition that works the most unique call signs during a 2-week interval, and a plaque for the "unlimited" DXpedition that works the most unique call signs. The rules for each award are defined in **www.cassaward.com**.

Al Brogdon, W1AB

75, 50, and 25 Years Ago

October 1943



- The cover photo shows a Civil Defense worker with his homebrew WERS walkie-talkie.
- The editorial compares ham operators' activities during this wartime year with those of a peacetime year.
- In "Supersonics for Communication," Jonathan Weitzer, ex-W2FSB, looks at the practical aspects of using audio frequencies above our hearing range for communication.
- Fred Long, ex-W8BSL, and Vincent Kenney, W2BGO, describe the organization of New York City's successful CD-WERS system, in "WERS for Seven Million People."
- Charles Holden explains in depth "The Japanese Morse Radiotelegraph Code," in response to the popularity of a previously published article on the same subject that became widely used in classrooms to study the Japanese language.
- Paul Palmer, W8UGR, describes "'Handy Andy,'" a 112 Mc. hand set for WERS, built in the same style as the "handie-talkies" used by the armed forces.
- In "The Traffic Cop of the Air," Clinton B. DeSoto, W1CBD, interviews W. D. Terrell, the retired Director of the FCC Field Division and first appointed US wireless inspector.

October 1968

- The cover photo shows transmitting converters for 6 and 2 meters that use stovepipe coaxial tank assemblies.
- The editorial discusses the dispute between well-known DXer Don Miller, W9WNV, and ARRL's DXCC desk. Miller withdrew his legal suit, admitting that he did not always have the required permissions to operate from some countries, and, in other cases, that he was not at the location where he claimed to be.
- Royden Golding, VE3CUS, discusses "Increasing the Accuracy of Frequency Measurement," via improved gate control for the frequency counter.
- Paul Horowitz, W2QYW, tells us how to modify a keyboard Morse machine for RTTY to provide "Perfect Teletype at Your Fingertips."
- Dale Covington, K4GSX, discusses the "Radiation Resistance of Inverted V Antennas," with analysis of the effects of bending a dipole at its center.
- "Matching with Homemade Baluns," by Richard Fenwick, W5KTR, describes his simple adaptation for Hy-Gain beams.

October 1993

- The cover shows samples of computer-drawn schematics, which are described in this issue.
- The editorial discusses the many operating interests pursued by radio amateurs, and how ARRL strives to serve us all at a time when the organization has more members than ever.
- Lyle Johnson, WA7GXD, tells us how to build "TAPR's Digital Deviation Meter" and accurately check a rig's frequency deviation, a normally expensive service hams can now do themselves.
- Ken Schofield, W1RIL, explains how to draw diagrams on computers with *Microsoft Windows Paintbrush*, in "Schematics at Your Fingertips."
- George Pataki, WB2AQC, presents an excellent look at "The Radio Clubs of Romania" as amateurs adjust to how radio is controlled after the country's 1989 revolution.
- Kai Siwiak, KE4PT, reports that "Hams Test Antennas Aboard Space Shuttle *Columbia*" to measure patterns and gain from an orbiting shuttle.

Field Organization Reports

July 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**.

578 WA7PTM
449 W7PAT
420 W0KCF
399 W4CAC
385 KD8TTE
351 KE8BYC
335 WA3EZN
325 KI6LNB
310 KI4GWC
282 KB1TCE
290 KW9EMG
270 WS6P
255 KI4GEM
246 K4DND
238 WB7OSC
233 KK7TN
220 N8SY
215 WA2CCN, KF4DVF, AL0Y, NI2W, K7WXW
211 WM2C
205 KI4KWR
200 W0DSF
191 W8IM
190 WC9CW
181 KT2D
175 KC9WWH, WB9WKO, WM3G
174 K5SFM
172 K0IBS
165 W0LAW, W5DY
164 K7BC
161 N5MKY
160 W2PH, WB9QPM, KC1CIC
155 W3GWM, KB3YRU
150 KC8WH, KD2LPM
149 WB8RCR
147 WA2BSS
140 WB2FTX, WB3FTQ, KK3F, K6HTN, N7IE, WD8USA
139 WB8YYS
135 WA4VGZ, K9LGU, WO2H, W3YVQ
130 N3KRX, N2JBA, KA8ZGY, AA3SB, K4IWW, KJ4JPE, W4DNA, NA7G, KW1U, WD8MWD
128 KB0DTI
125 N4LFJ, K8LPC
120 KI0JO, AG9G, AC0KQ, K2RMF, N2WGF, WK4WC
119 K2TV
116 KI4UDZ
115 N4ABM, KO4OL, N1TF, K0PTK
114 K6JGL
113 W3CB, KS6M
111 N2PQJ, KB5PGY
110 W4CMH, K2VX, N9VC, WA3QLW, W1KX, KA2ZNZ, KD2IWN, N2LJM, K3JL, KY2D, K6JT, KA5AZK, KC5OZT, KD8UUB, WB8YLO, K1HEJ, K3IN, K4GK, N1IQI, KE4AHC, WB8TQZ
105 KE4CB, N2DW
104 KT4WX
101 W8CPG
100 W4NWT, WC4FSU, WB4RJW, KZ8Q, KN9P, NX9K, W4NHO, KB2YAA, NN7H, KE5YTA, N8CJS, AC8RV, WB8QLT, K3RC, WB8SIQ, KA1G, KD2MDV, N1LAH, W1RVY, WB6UZX
99 K2KNB
98 K8AMH, KE5HYW
96 KB1NMO
95 K3MIY, K1XFC, KA9IKK
94 W4NHO, W4TTO
93 K3FAZ
91 KC4BQK, K2UNI
90 N3JUY, KM4VTK, AD3J, KA2HZP, WD8DHC, KB8MAF, K8KRA, WD8Q, KC3HWU, AA3N, K8ED, WB8WKQ, ND0CW
89 AD5CQ
88 N9MN, KT5SR
87 K0EK, KG5NNA
86 KD2JKV, KF5TTN
84 KC1HHO
83 N3RB
82 KI4JQB, KD2HYA, N6IET, K7RDB
81 KB3KYH
80 WX4J, KA3NZR, W9NXM, KB2QO, KB3IN, KL7RF, KE8ANW
79 W6GSW
78 K6RAU, KA0GQQ, WB6NCT
76 KI4QAU
74 N3IOD, W5XX, KA0DBK, KD8ZCM
73 AA4XZ, WA1LPM
72 W4TY
71 WB2ZEX
70 AB3WG

The following stations qualified for PSHR in previous months but were not recognized in this column yet: (June) WS6P 550, K6RAU 84, W6SX 80, WS4P 72. (May) WM3G 531.

Section Traffic Manager Reports

The following Section Traffic Managers reported: AL, CO, CT, DE, EB, EMA, ENY, EPA, GA, IL, KS, KY, LA, LAX, MDC, ME, MI, MN, MS, MT, NC, NE, NFL, NLI, NM, NNJ, NTX, OH, OK, OR, SD, SFL, SJV, STX, TN, UT, VA, WCF, WI, WMA, WNY, WPA, WV, WY. The STX STM reported May activity but was not acknowledged in the August *QST* column.

Section Emergency Coordinator Reports

The following Section Emergency Coordinators reported: AR, AZ, CT, DE, EMA, ENY, EPA, EWA, GA, IA, ID, IL, IN, KS, KY, LA, LAX, MDC, MI, MN, MO, MS, NC, NFL, NLI, NM, NNJ, NNY, NV, OH, OR, PAC, PR, RI, SD, SFL, SJV, SNJ, STX, SV, TN, VA, VI, WCF, WI, WNY, WPA, WTX, WV, WWA, WY.

Brass Pounders League

The BPL is open to all amateurs in the US, Canada, and US possessions who report to their SMs a total of 500 or more points or a sum of 100 or more origination and delivery points for any calendar month. Messages must be handled on Amateur Radio frequencies within 48 hours of receipt in standard ARRL radiogram format. Call signs of qualifiers and their monthly BPL total points follow.
NX9K 1482, KK3F 1417, K6HTN 1067, WB9WKO 1022, N1IQI 927, WS6P 901, KI0JO 714, N9CK 620, KW1U 603, WA3EZN 580, K6JT 522, K9LGU 512.

The following station qualified for BPL in June but was not recognized in this column yet: WS6P 1468.

Silent Keys

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

♦K1AM **Bouvier**, Gerard F., Woonsocket, RI
W1BEK **Bekech**, George M., Trumbull, CT
•W1DKY **Bessette**, Robert F., Shelburne Falls, MA
•WB1DVD **Donovan**, Gilbert E., Sr., Littleton, NH
K1FTE **Littlefield**, Kenneth E., Boxford, MA
WB1HAM **Malinoski**, William P., Enfield, CT
•WA1IMU **Straub**, Cloyed T., Jr., Portsmouth, NH
KB1JWM **Williams**, Dolores C., South Portland, ME
W1LIB **Benoit**, Ronald J., Flemington, NJ
W1MLG **Berk**, Laurie "Larry" R., Newton Highlands, MA
♦W1OT **Berg**, Anthony "Tony" C., Williamsburg, VA
AI1R **Bruhin**, A. C., Port Saint Lucie, FL
W1RFA **Hicks**, William "Bill" H., Sevierville, TN
•K1RUS **LaFlam**, Val A., Citrus Heights, CA
KA1TMT **Morales**, John J., Shelton, CT
N1UZN **Jackson**, Lillian E., Lawrence, MA
•KA1XX **Hubley**, Benjamin A., Portland, ME
WA1YBF **Maleska**, Gary E., South Burlington, VT
•WA2ELU **Krane**, Donald J., Pine Brook, NJ
♦•KB2EYX **Scherlacher**, Robert L., Gardiner, ME
KC2IDX **Loucks-Baer**, Sanford "Sandy" M., Cobleskill, NY
KC2IV **Phillips**, Robert M., Middle Grove, NY
K2KAA **Casper**, James, Lumberton, NC
AB2KX **Turner**, Jeffrey M., Poughkeepsie, NY
•K2LBJ **Schimenti**, Salvatore G., Greenwich, CT
KC2LQQ **Sojka**, Daniel J., South Wales, NY
WB2LRR **Castelluccio**, Frank, Jr., Glen Cove, NY
WA2LXE **Barber**, Philip, Westwood, NJ
•WA2MPX **Swarts**, Charles F., Himrod, NY
K2MXF **Frantz**, Milton Xander, Jr., Berlin, NJ
KD2OLN **Podloski**, Peter, Beacon, NY
N2OWN **Holden**, John E., Old Bridge, NJ
KC2THP **Rearick**, Edward W., Marlton, NJ
KA2UAP **Leidahl**, Gary R., Sr., Lindenhurst, NY
KB3AJN **Coleman**, Harold R., Jr., Summerville, PA
K3CAV **Kriston**, Edward R., Westminster, MD
♦•K3DI **Wilder**, Richard L., Bowie, MD
W3GZO **Bainbridge**, Richard C., Erie, PA
N3JPA **Hemler**, Francis "Frank" D., Cleona, PA
W3KLQ **Tarkington**, Frank V., Silver Spring, MD
W3MKE **Kost**, Gilbert, Baltimore, MD
W3NJO **Baer**, Philip "Pete" H., Glenshaw, PA
W3NU **Ring**, Charles E., Jr., Brookfield, OH
♦AE3S **Hornstein**, Leon, Jr., Owings Mills, MD
K3WVC **Stupp**, George B., Jr., Columbia, MD
KB4ABF **Guidas**, Robert "Bob" M., Maynardville, TN
•KA4BEU **McClure**, George M., III, Danville, KY
W4BN **Killian**, Alfred D., Jr., Estero, FL
W4COM **Proctor**, Everett, Augusta, GA
W4CNG **Reynolds**, Stephen T., Milton, GA
W4CNU **Nix**, Erskine S., Arab, AL
WD4COG **Pollard**, Bennie W., Hebron, OH
WB4COL **Wilson**, Kenneth T., Louisville, KY
•KA4DDF **Milner**, Thomas M., Birmingham, AL
•KJ4DHJ **Kline**, Charles R., Palmetto, FL
♦•WA4EJJ **Redman**, Richard G., Rochester, MN
KG4EXE **Lewis**, William O., Brooklet, GA
♦KE4FG **Gonzalez**, Luis, Fort Lauderdale, FL
N4GCW **Clift**, Dewey L., Hixson, TN
•N4HAM **Henderson**, Krieger W., Jr., Alexandria, VA
K4HEM **Friedlander**, Erven S., Pompano Beach, FL
KK4HUA **Anderson**, Carl E., Sutherland, VA
•KM4IS **Cookson**, Robert, Wilmington, NC
N4JFM **Waddell**, Jerry F., Wilkesboro, NC
♦N4KG **Russell**, Thomas A., Harvest, AL
WA4KKW **Hall**, Winn, Ellijay, GA
K4LM **Morell**, La Vant, Palm Beach, FL
KE4OFT **Bowen**, Jimmy W., Pickens, SC
K4QXT **Webb**, Robert B., York, AL
KB4RGC **German**, Robert J., Raleigh, NC
•KK4RQ **Brazeal**, Hank, Hoover, AL
AA4RU **Owens**, Robert W., Zephyrhills, FL
K4SBI **Beasley**, John, Palmer, AK
WB4SHK **Riggins**, James O., Jr., Yorktown, VA
K4SVC **Doyle**, Benjamin E., Murfreesboro, TN
W4TZI **Bolen**, Edwin S., Jr., Lynchburg, VA
W4UTZ **Warr**, Gerald H., Columbia, SC
KI4VC **Higdon**, John, Helena, AL
KC4VGN **Wetmore**, Frank W., Ticonderoga, NY
K4VMH **Hughes**, Chester M., Heflin, AL
W4WUB **Nahser**, Philip J., Burlington, NC
•KC4ZRH **Taylor**, James H., Aylett, VA
•KF4ZZP **Hooper**, William "Bill" C., Charlotte, NC
•N5AF **Neal**, Sammy E., Cleveland, TX
KC5DLF **Hunt**, Thomas E., Midwest City, OK
KZ5K **Morris**, Edmond B., Houma, LA
•N5KHO **Coles**, Linda L., Bryan, TX
WA5UEO **Todd**, Roy A., Avondale, LA
♦K5UTV **Marshall**, Dan H., II, Austin, TX
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KM6AGT **Pausch**, Fredrick D., Magalia, CA
KE6ALP **Ferguson**, Terry J., Westwood, CA
KC6BIU **Ruland**, Le Roy, San Diego, CA
KI6CSO **Knox**, Eleanor M., Yuba City, CA
K6FR **Notaro**, Anthony D., Garden Grove, CA
AC6HZ **Tillery**, George A., Oceanside, CA
KI6LZ **Pietruszenko**, George, Oxnard, CA
AI6MI **Bishop**, Jack H., Jr., Rialto, CA
•KI6NPV **Hackney**, John E., Glendora, CA
•K6OBL **Gooch**, Lou, Eureka, CA
K6OBS **Warren**, Richard C., San Diego, CA
KC6Q **Mallinckrodt**, Albert J., Claremont, CA
•N6QKH **Ekman**, William L., Santa Paula, CA
K6QKL **Hines**, Chuck, Fairview Heights, IL
W6SJ **Johnson**, Randy, Corona del Mar, CA
KK6UGT **Celek**, Nicholas A., Covina, CA
♦•W6UPN **Provenza**, Joseph D., Long Beach, CA
KB6VI **Clark**, John R., Modesto, CA
K6VIP **Metzger**, Royal R., San Jose, CA
•KE6WFK **Beaudette**, Tristan, Irvine, CA
AC6WR **Allain**, Elroy "Bud" E., Buellton, CA
WX6XX **Enockson**, Carl E., Yuma, AZ
•WA7AZN **Stermitz**, James E., Gardiner, MT
♦W7BRU **Crawford**, Gene K., Centralia, WA
KB7DWX **Switzer**, William R., Klamath Falls, OR
KF7EWP **Braatelien**, Edwin H., Jr., Glendale, AZ
WL7GK **Kreiser**, Robert Earle, Fairbanks, AK
W7IAN **Shrader**, Ian M., Ocean Shores, WA
♦W7IWW **Movius**, David L., Billings, MT
♦WA7KMF **Neville**, Bill, Logan, UT
W7LAH **Schwartz**, Alvin D., Portland, OR
AE7LV **Bray**, Brian D., Anacortes, WA
K7LWA **Abel**, L. W., Seattle, WA
•KA7NXV **Sikkens**, John, Reno, NV
•KE7PI **Qualtieri**, Joseph C., Spokane, WA
K7QDK **Hjellen**, Andrew "Bud" O., Seattle, WA
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KE7RT **Blakesley**, Ron G., Lewiston, ID
•N7SFB **Banes**, Gregory L., Klamath Falls, OR
♦K7SN **Maichle**, Robert W., Las Vegas, NV
N7TKA **Radford**, James A., Orlando, FL
N7TLG **Glass**, Tom L., Glendale, AZ
K7TR **Johnsen**, Robert J., Mesa, AZ
K7VCD **Harris**, Richard "Dick" B., Sr., Mountlake Terrace, WA
KE7VRD **Cook**, Jana R., Brigham City, UT
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♦WD8CTL **Stone**, Gary E., Charleston, WV
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♦W9NIO **Stave**, Fred R., Patriot, IN
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WA9QOY **Swenson**, Lloyd D., Chili, WI
W9RDR **Ryan**, Roger D., Barrington, IL
KK9U **Junk**, Mark P., Fort Wayne, IN
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KA9VCQ **Ellingsworth**, Robert D., Peoria, IL
•K0DNI **Newton**, James M., Marion, IA
WDEFD **Boots**, John R., Tampa, FL
KC0FLM **Peterson**, Lawrence L., Brookings, SD
•W0IUQ **Calvert**, Wynne, Iowa City, IA
W0KJ **Kampmeier**, Willard E., Silver Lake, KS
♦W0KWR **Shafer**, John F., Boulder, CO
♦WB0LJW **Chesnut**, Graham H., Sturgis, SD
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•KA0ZHZ **Edhlund**, Arthur J., Sebastian, FL
VE3YRJ **Pattyn**, Robert, London, ON, Canada

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Note: Silent Key reports must confirm the death by one of the following means: a copy of a newspaper obituary notice, a copy of the death certificate, or a letter from the family lawyer or the executor. Please be sure to include the amateur's name, address, and call sign. Allow several months for the listing to appear in this column.

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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• 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

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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-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-7200 | *HF Transceiver*

• 160-10M • 100W • Simple & tough with IF DSP • AGC Loop Management • Digital IF Filter • Digital Twin PBT • Digital Noise Reduction • Digital Noise Blanker • USB Port for PC Control

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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• 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)

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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

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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!

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-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

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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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TS-2000/2000X | *HF/VHF/UHF Transceiver*

• 100W HF, 6M, 2M • 50W 70CM • TS-2000X 10W 1.2GHz • Built-in TNC, DX packet cluster• IF Stage DSP • Backlit front key panel

Call For Special Price!

TM-281A | *2 Mtr Mobile*

• 65 Watt • 200 Memories • CTCSS/DCS • Mil-Std specs • Hi-quality audio

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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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RRC-1258 MkII-S-Set

This set of interfaces allows remote control of your Amateur Radio Station via Internet in a user-friendly and cost effective way! RemoteRig gives you control of the radio coupled with crystal clear TX & RX audio and sending CW with your own Paddle!

New! Now Stereo Version for Dual Receiver radios.

Works with all Computer-controllable radios from: ***Alinco - Elecraft - ICOM - Kenwood - Yaesu***

For radios with detachable front panels no PC is required for: TS-480HX/SAT; TS-2000 (RC-2000 req'd); IC-703/Plus; IC-706 series; DX-SR8T; IC-2820H; IC-R2500

Just simply insert your control box in place of your front panel interconnect cable, place the body of the radio on the remote end and you are on the air as if you are there! Extra Controller and Remote interface units sold individually for multiple sites/users.

Now includes 12V power supply, $12.95 value!

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- Local Oscillator (LO) Design
  –150dBc/HZ @ 10KHz Offset
  –140dBc/Hz @ 1KHz Offset
- 7" Color display with High-speed, real-time spectrum/FFT scope
- Ethernet port with RS-BA1 internal server

Silver: Manfred Wolf, DJ5MW and Stefan Von Baltz DL1IAO

Photo Credit: Carsten Dauer, DM9EE

Bronze: Daniel Craig, N6MJ and Chris Hurlbut, KL9A

Photo Credit: Nodir Tursun-Zade, EY8MM

Congratulations WRTC 2018 teams. Both operating with Icom's IC-7851.

IC-7610

HF / 6M Direct Sampling SDR Transceiver

- 100 Watt Output Power*
- Independent Dual Receiver
- DIGI-SEL Preselector
- 7" Color Touch Screen display with High-speed, real-time spectrum/FFT scope
- Ethernet port with RS-BA1 internal server

IC-7300

HF / 6M Direct Sampling SDR Transceiver

- 100 Watt Output Power*
- 4.3" Color Touch Screen display with High-speed, real-time spectrum/FFT scope

*40W on AM

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HAM-IV – $649.95

The Most Popular Rotator in the World!

For medium communications arrays up to 15 square feet wind load area. Has 5-second brake delay, Test/Calibrate function. Low temperature grease permits normal operation down to -30 degrees F. Alloy ring gear gives extra strength up to 100,000 PSI for maximum reliability. *Precision* indicator potentiometer. Ferrite beads reduce RF susceptibility. Cinch plug plus 8-pin plug at control box. Dual 98 ball bearing race for load bearing strength and electric locking steel wedge brake prevents wind induced movement. North/South center of rotation scale on meter, low voltage control, max mast $2^{1}/_{16}$".

HAM-VI – $749.95 with DCU-2

HAM-VII – $799.95 with DCU-3

HAM IV and HAM V Rotator Specifications	
Wind Load Capacity (inside tower)	15 square feet
Wind Load (w/mast adapter)	**7.5 square feet**
Turning Power	800 in.-lbs.
Brake Power	**5000 in.-lbs.**
Brake Construction	Electric Wedge
Bearing Assembly	**Dual race/96 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	26 lbs.
Effective Moment (in tower)	**2800 ft.-lbs**

TAILTWISTER SERIES II – $799.95

For Large Medium Antenna Arrays up to 20 sq. ft. wind load.

Has 5-second brake delay, Test/Calibrate functions. Low temp grease, tough alloy ring gear, indicator potentiometer, ferrite beads on potentiometer wires, weatherproof AMP connectors plus 8-pin plug at control box, triple bearing race with 138 ball bearings for large load bearing, electric locking steel wedge brake, North/South center of rotation scale meter, low voltage control, $2^{1}/_{16}$" max mast. **MSHD, $109.95**. Above tower heavy duty mast support. T2X, HAM-IV, HAM-V, HAM-VI. Accepts $1^{7}/_{8}$-$2^{5}/_{8}$" OD.

T-2XD2 – $899.95 with DCU-2

T-2XD3 – $949.95 with DCU-3

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

For antenna arrays up to 8.5 sq. feet mounted inside tower or 5 sq. ft. with mast adapter.

Low temperature grease good to -30 F degrees. New Test/Calibrate function. Bell rotator design gives total weather protection, dual 58 ball bearing race gives proven support. Die-cast ring gear, stamped steel gear drive, heavy duty, trouble free gear train, North center scale, lighted directional indicator, 8-pin plug/socket on control unit, snap-action control switches, low voltage control, safe operation, takes maximum mast size to $2^{1}/_{16}$ inches. MSLD light duty lower mast support included.

CD-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**

AR-40 – $349.95

For compact antenna arrays and large FM/TV up to 3.0 square feet wind load area.

Dual 12 ball bearing race. Automatic position sensor never needs resetting. Fully automatic control – just dial and touch for any desired location. Solid state, low voltage control, safe and silent operation. $2^{1}/_{16}$ inch maximum mast size. MSLD light duty lower mast support included.

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**

New!

Hy-Gain Programmable DCU-3 Digital Rotator Controller

DCU-3 – $449.95

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

Press a memory button or dial in your beam heading or let *Ham Radio Deluxe* (or other) take control. Your antenna auto rotates precisely and safely to your DX.

DCU-3 automatically jogs your antenna free and safely unlocks it before rotating begins (*great for older rotators with "sticky" brakes*) then turns off your motor before reaching its final heading. Your antenna gently coasts to a stop before the brake re-locks – greatly reducing damaging overshoots and extending rotator life.

Simply press *Left* and *Right* buttons for full manual control and fine tuning.

Bright blue LCD shows current, dialed in and computer controlled beam headings in one degree increments and your call.

Calibrate lets you accurately match your display to your true beam heading. Has USB/RS-232 ports for computer control. Adjustable LCD sleep time. Field upgradeable firmware. 8.5Wx4.3H x9D".

110 VAC. Order DCU-3X for 220 VAC.

DCU-2 Digital Rotator Controller – $399.95

Like DCU-3, but less programmable memories. 110 VAC. Order **DCU-2X**, for 220 VAC.

Replace your Yaesu Rotator Controller

YRC-1 – $329.95

Hy-gain YRC-1 – more features, more robust, far less prone to lightning damage. Costs less than repairing!

Easy-to-use – dial in your beam heading and tap GOTO button. Exclusive 180 degree *AutoReversal*™ for fast longpath operation. All DCU-2 features. Bright blue LCD shows current, dialed-in, computer controlled beam headings, call. USB port for computer control. Extra heavy-duty AC power supply. Fast variable DC motor minimizes overshoot. Intuitive menu. Field upgradeable. For Yaesu G-800/1000/2800/G450/650. AC or DC motors.

YRC-3, $399.95. Like YRC-1 and adds 6 memories.

AR-500 Rotator/Controller – $129.95

UHF/VHF/6-Meter, MFJ-1886 Rotator/Controller and Remote. For use of small VHF/UHF, 6M, TV, FM, the MFJ-1886 wide band receiving loop and other light-weight ham antennas. Rotator is built in a weather-proof one piece cast aluminum housing with precision all metal gears, steel thrust bearings and automatic braking. Includes rotator, controller, remote, clamps, and all hardware.AR-500 remembers up to 12 directions even after a power outage! Use remote control or direct console. Displays location and relative position.

hy-gain® Antennas, Rotators & Towers 308 Industrial Pk Rd, Starkville, MS 39759 USA
Sales/Tech: (662) 323-9538 ■ **FAX:** (662) 323-5803 Open 8-4:30 CST, Mon.-Fri.

MFJ HexBeam Antenna

6-Bands: 20/17/15/12/10/6 Meters... Full Legal Limit...

New HexBeam from MFJ delivers solid gain and directivity on 20, 17, 15, 12, 10, and 6 Meters in a low-profile package that will have your pocketbook and your neighbors smiling!

The MFJ-1846 uses an updated G3TXQ element configuration for excellent gain, improved bandwidth, superior front-to-back ratio and low SWR – makes snagging rare DX easy!

**That`s just the beginning!** MFJ takes the HexBeam`s unique balanced tension framework to a new level with rugged mounting hardware, exceptionally durable spreaders and sliding antenna-wire guides – all designed to ensure years of reliable service in tough weather conditions.

Some Outstanding MFJ-1846 Features

- **Lightweight** – mounts on a TV mast, tripod, gable mount, or even chimney straps
- **Solid Construction** – gives years of reliable service
- **Proven directivity** and gain from a time-tested design
- **Rotates** with an inexpensive rotor – only 3.5 square-feet of wind loading
- **Handles** maximum legal power, all modes, all six bands
- **Delivers** full-band coverage without a tuner
- **Great for contesting**, QSY instantly among all six bands
- **Just one coax feed**, a real convenience and cost saver
- **Sky-gray spreaders** disappear against most backgrounds
- **Small footprint** – 11-foot turning radius fits cramped spaces
- **Symmetrical footprint** – stays balanced when coated with ice and snow

Gain and directivity makes the difference when DXing or maintaining schedules and the HexBeam delivers!

Great Value: Hexbeams are expensive to manufacture. MFJ`s massive purchasing power and extensive manufacturing capability gives you more HexBeam for less money than others!

MFJ-1846 Specifications:
Gain/front-to-back ratio: see *www.mfjenterprises.com*; **Turning Radius:** 11 ft.; **Max Mast Size:** $2^{1}/_{16}$ inches OD; **Weight:** 25 lbs.; **Wind Load:** 3.5 sq. ft.

Add 40 and 30 Meter coverage!
MFJ-1848, $699.95. 8-Bands: 40, 30, 20, 17, 15, 12, 10, 6 Meters. 40 and 30 Meters are each one element radiators. 14 foot turning radius. 28 lbs.

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Phone: (662) 323-5869 ■ **Tech Help:** (662) 323-0549 ■ **FAX:** (662) 323-6551 8-4:30 CST, Mon.-Fri.

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Auction

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October 19 - October 26, 2018

MFJ Cobweb Antenna

6-Bands: 20/17/15/12/10/6 M...Outstanding Performance!

Restricted space spoiling your operating fun? MFJ Cobweb puts your call back on the map!

This six-band (20, 17, 15, 12, 10, 6 Meters) full half-wave *Cobweb Antenna* is perfect for restricted space or portable operation. Sky-gray fiberglass spreaders and *nearly invisible* wire elements (flat 9 x 9 x 1/2 feet square. 8 pounds), blend in with your surroundings while standing tough against nasty weather.

Outstanding performance! Horizontally polarized for less local noise pickup plus solid gain over verticals will allow you to work DX easily – even on QRP. Omni-directional. No radials needed! Works great at low heights. Low SWR is due to MFJ's exclusive *Spider-Match*™ broadband network. Use lightweight TV hardware to mount on your chimney, balcony, mast.

Low in cost, but big on performance. MFJ *Cobweb Antenna* turns your space problem into a stack of QSL cards from far away places.

MFJ-1836HK34, $119.95. Add-on kit adds 40/30 Meters to MFJ-1835/1835H and MFJ-1836/MFJ-1836H cobweb antennas.

40-6 METER Cobweb Super Heavy-Duty, 1.5 kW

New! Super heavy-duty **40-6 Meter Cobweb Antenna. Built to survive harsh northern winters, heavy snow, ice and strong winds – has super-strong large diameter fiberglass and heavy-duty 14 gauge stranded hard copper wire. 8-bands: 40, 30, 20, 17, 15, 12, 10, 6 Meters, 1500 Watts. Turning radius: 12 feet, 23 lbs.**

MFJ-1838 **$399.95**

BigStick™ Portable Vertical

Strongest, loudest portable signal on the band!

MFJ-2286 **$99.95**

Rugged stainless steel *17 foot* whip telescopes to *full 1/4 wave* from 20 to 6 Meters – gives you *full-size* performance for stronger, louder signals.

17-feet and ultra low loss, high-Q *air-wound* loading coil gives high efficiency on 30/40 Meters. Low SWR. 1 kW.

Includes: 17 foot whip, (27 in. collapsed), loading coil, counterpoise kit, SO-239 mount for mast up to 1 inch dia. Fits backpacks, suitcases! 2 lbs.

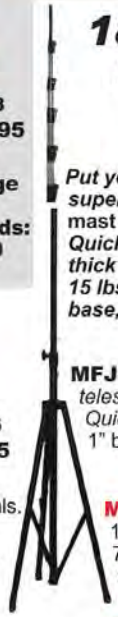
MFJ-2289, $179.95. 40-6M V-Dipole. Full size 20-6M.

18 Foot Telescopic Fiberglass Mast with Tripod

MFJ-1919EX, $159.95.

Put your antennas up high anywhere with this super-strong **18 foot telescoping fiberglass mast and MFJ-1919 heavy duty steel tripod *QuickClamps™ lower mast to 5 feet. Mast has thick 1/8 inch wall, .75" top, 1.5" bottom dia. 15 lbs. Black steel tripod has braced triangle base, non-skid feet, mast lock.***

MFJ-1918EX, $89.95.



MFJ-1918 *tripod with super strong 9.5 foot telescoping fiberglass mast.* 3.8 feet collapsed. *Quick-Clamps™.* Thick 1/8 inch wall, .75" top, 1" bottom diameters. 6.5 lbs.

Tripods Only

MFJ-1919, $89.95, *Large tripod.* Supports 100 pounds. 1.4 inch diameter mast extends 7.8 feet. Collapses to 4.5H x .5D feet. Triangle base spreads to 4.8 feet sides for extra strength. 9.75 lbs.

MFJ-1918, $49.95, *Smaller tripod.* Support 66 lbs. 1" dia. mast. 6 ft. extended, 3.2H x .3D ft. collapsed. Base sides spread to 2.75 ft. weighs 6.75 lbs.

17 Foot Stainless Steel Telescoping Whip

MFJ-1979, $59.95. Super-strong, super long *17 foot stainless steel* telescoping whip. 27 in. collapsed. 10 sections. 3/8-24 threaded base.
MFJ-1977, $44.95/12ft;
MFJ-1976, $39.95/10ft
MFJ-1974, $34.95/8ft;
MFJ-1972, $14.95/4 1/2ft

MFJ Rotatable Mini Dipoles

Lightweight, *isolated* mini-dipoles for imited space, temporary or permanent set-up. Rotate to null QRM, noise, direct your signal. 14 ft. long. Use mast up to 1.25" dia. For 40/30/20/17/15/12/10/6 Meters. Order **MFJ-22XX** (insert band in "XX") **$59.95.** 75/60 Meters, $49.95 each.

MFJ-1704, $89.95 **Heavy** duty *antenna switch.* Select 4 antennas or ground. Unused ant. grounded. Lightning protection. Up to 500 MHz. 60 dB isolation at 30 MHz. 2.5 kW. <.2 dB loss.

MFJ-1700C, $119.95 *Antenna/ Transceiver Switch* selects 1 of 6 antennas and 1 of 6 xcvrs in any combination. Unused terminals grounded. Lightning protection. 1.8-30 MHz. 2 kW SSB. SO-239s.

MFJ-915, $29.95 Stop *RF* traveling down coax line, painful RF "bites" and erratic operation. 1.5 kW 1.8-60 MHz. 2Wx5H". SO-239s.

MFJ-1702C, $39.95 Like MFJ-1704 but 2 antennas.

MFJ-1701, $79.95 Select 1 of 6 antennas.

MFJ-918, $29.95 True 1:1 Current balun & center insulator forces equal antenna currents in dipole elements.

33 ft. Telescoping fiberglass Mast

MFJ-1910 **$79.95**

3.8 feet collapsed, 3.3 lbs. Super strong. Huge 1 3/4 inch bottom section. Flexes to resist breaking. Resists UV. Put up *full size* inverted Vee or vertical in minutes for *full size performance!*

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MFJ Low-Noise Receiving Loop

Work DX and ragchew on the lower bands through horrendous noise!

Pull weak signals out of static crashes, atmospheric, man-made and power line noise!

Hear signals 50 KHz to 30 MHz cleaner and quieter than ever before and even hear stations you never knew existed. Power line noise disappears and static charges are drained to ground.

The MFJ-1886 drastically reduces noise and interference by receiving the magnetic field and rejecting the electric field. Its figure 8 pattern and deep null can be rotated to completely eliminate an interfering signal or greatly peak a desired one.

Excellent antenna and preamplifier balance gives a very deep null. An inexpensive antenna rotator can position this null to eliminate interference.

State-of-the-art Gali MMICs in push-pull give you a preamp with extra wide dynamic range, low IMD and 25 dB of low noise gain. You'll get excellent performance on both strong and weak signals without overload.

Fully protected preamplifier – magnetically coupled voltages up to 40 Volts and capacitively coupled voltages up to 20 Volts will not damage the preamplifier. The output is protected from transmission line surges induced by distant lightning.

Its super low-profile lets you use it anywhere, inside or outside, and it works only a few feet above ground. Your 50 Ohm coax and included Bias-Tee connects to your radio and provides signal and power.

Ruggedly built to withstand extreme weather. 1-inch OD diameter 6061 aircraft quality aluminum tubing gives extreme strength. 36-inch loop diameter. Weighs $2\frac{1}{2}$ pounds. SO-239 connector. Bias-tee power injector and mounting hardware included for masts up to $1\frac{3}{4}$ inches.

Antenna Rotator

AR-500/X
$129.95

Perfect for MFJ-1886 receiving loop!

Rotator is built in a weather-proof one piece cast aluminum housing with precision all metal gears, steel thrust bearings and automatic braking. Includes rotator, controller, remote control, clamps, hardware. Remembers up to 12 directions even after a power outage! Digitally displays position. Order "X" for 220VAC.

Find Power Line Noise

MFJ-852
$119.95

MFJ-856
$159.95

Choose 3 element Yagi or telescoping dipole to quickly pinpoint noise. Handheld, directional noise finders search out leaky insulators, loose hardware, corroded ground lines. Track noise directly to pole, transformer or insulator. Field-strength meter, headphone jack. .3uV, 135 MHz receiver, 70 dB AGC.

Ultrasonic receiver 18" *parabolic dish* pinpoints power line noise!

MFJ-5008
$179.95

Find *power line noise fast!* Extremely narrow beam width pinpoints arcing insulators and corona discharge to less than 12 inches at 50 feet. Listen with headphones. Record proof for power company. Ergonomic handle reduces fatigue.

Wipe out RFI

MFJ-1026
$199.95

Wipe out RFI, noise, interference from any direction at any frequency with a 60 dB notch before it gets into your receiver!

Eliminate severe power line noise from arcing transformers and insulators, fluorescent lamps, light dimmers, touch controlled lamps, computers, TV birdies, lightning crashes from distant thunderstorms, electric drills, motors, industrial processes – *before it gets into your receiver.*

It's *more effective* than a noise blanker! Interference much stronger than your desired signal can be completely removed without affecting your signal. Works on *all modes* – SSB, AM, CW, FM, digital -- and from BCB to lower VHF.

Null out strong QRM on top of weak rare DX and work him! Null out strong local ham or AM broadcast station to prevent receiver overload. Plugs between antenna and transceiver. 12 VDC, 110 VAC with MFJ-1312D, $15.95

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Free Dealer/Catalog/Manuals/Instructions – Visit: www.mfjenterprises.com or call toll-free 800-647-1800

MFJ...the World Leader in Ham Radio Accessories!

MFJ – Wipe Out RFI!

Wipe out RFI, noise, interference from any direction at any frequency with a 60 dB notch before it gets into your receiver!

Eliminate severe power line noise from arcing transformers and insulators, fluorescent lamps, light dimmers, touch controlled lamps, computers, TV birdies, lightning crashes from distant thunderstorms, electric drills, motors, industrial processes -- before it gets into your receiver.

It's more effective than a noise blanker! Interference much stronger than your desired signal can be completely removed without affecting your signal. Works on all modes -- SSB, AM, CW, FM, digital -- and from BCB to lower VHF.

MFJ-281, $12.95. Clearest speech you ever heard! 3" speaker, 8W, 8 Ohms, 6' cord, 3.5 mm plug.

Null out strong QRM on top of weak rare DX and work him! Null out strong local ham or AM broadcast station to prevent receiver overload.

The MFJ-1026 is an adjustable phasing network that combines two antenna signals to give you various directional patterns. Null out a strong interfering signal or peak a weak signal at a push of a button.

Use external or built-in active noise antenna. RF sense T/R switch bypasses your transceiver. Plugs between antenna and transceiver. 12 VDC, 110 VAC with MFJ-1312D, $15.95. 6½ x 1½ x 6¼".

MFJ-1026 $199.95

MFJ-1025, $179.95. Like MFJ-1026 less active antenna, use external noise antenna.

MFJ Morse Code Reader and Keyer Combo

Plug in this MFJ Morse Code Reader with built-in keyer and watch CW turn into solid text messages as they scroll across an easy-to-read LCD

MFJ-464

$199.95

(Keyboard, paddles not included)

Built-in keyer makes working high speed CW a breeze. Type-ahead buffer, message memories and adjustable speed lets you compete with the best high speed CW operators – they won't even know you never passed a code test!

Everything you need for ultimate CW: sends/reads 5-99 WPM, automatic speed tracking, large 2-line LCD shows send/receive messages, use single, iambic paddle or computer keyboard, front panel speed, volume controls, 4 message memories, type ahead buffer, read again buffer, adjustable weight & sidetone, RFI proof, easy menu operation, more!

MFJ-551, $39.95. RFI suppressed keyboard.

MFJ-564/B, $69.95. MFJ Iambic paddles, chrome/black.

MFJ Contest Voice Keyer

Makes contesting easy – Calls CQ, sends your call, does contest exchanges -- in your own natural voice

MFJ-434B

$199.95

MFJ Contest Voice Keyer™ makes contesting easy! Calls CQ, sends your call and does contest exchanges for you in your own natural voice!

Save your voice! Record and play back frequently used phrases like "CQ Contest this is KF5C", "You're 59", "Qth is Mississippi".

Repeat messages continuously. Vary repeat delay 3-500 seconds. Makes a great voice beacon and calling CQ easy.

Record and play back off-the-air signals -- great help if you didn't get it right the first time!

A playing message can be halted by the Stop Button, your microphone's PTT/VOX, remote control or computer.

All audio lines are RF filtered to eliminate RFI, audio feedback and distortion. Audio isolation transformer totally eliminates hum and distortion caused by ground loops.

Five messages, 75 seconds total. Use your mic or built-in mic for recording. Can be remote or computer controlled.

Works with 8 pin round or modular mics. Built-in Speaker amplifier.

External speaker, phone jack. 9V battery, 12 VDC or 110 VAC with MFJ-1312D, $15.95. 6½W x 2½H x 6½D".

MFJ-73, $34.95. MFJ-434B Remote Control with cable.

MFJ SDR T/R Protection Switch

New!

MFJ-1708SDR, $79.95. An inexpensive wide-band SDR dongle receiver lets you see an entire band on a frequency/waterfall computer display! 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-1708SDR 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 circuit switches MFJ-1708SDR. For HF/VHF.

MFJ-1270X TNC for VHF Packet/APRS

MFJ-1270X, $129.95. A universal self-contained KISS mode TNC that works with every Packet software program that supports KISS mode -- just connect your FM transceiver and plug into your computer USB port. Natural for emergency communications. Perfect for APRS. Fully compatible with WinLink 2000. Works with Windows, Mac OS X and Linux. Active audio filter cleans up analog signals. Uses less than 25 mA.

MFJ-1270DG, $29.95. X-digi board converts MFJ-1270X into a remotely configureable digipeater.

MFJ Giant SWR/WattMeter

MFJ-868B, $159.95. World's largest 1.8-54 MHz SWR/Wattmeter has giant 6½ inch meter! True active peak/average forward/reflected power. 20/200/2000 Watt ranges.

MFJ Desk Microphones

MFJ-299, $99.95. Tailored for SSB. Adjustable 11" boom. Silibant sound shield, graphic equalizer, compressor, VU meter, on-air indicator, PTT/lock switch.

MFJ-297, $69.95. SSB Boom Mic, PTT switch.

MFJ Boom-Microphone/Headset

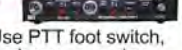
MFJ-393 (K,I,Y), $69.95. Professional Boom-Mic headphones for contesting, DXing, traffic nets. Comfortable padding lets you operate for hours, seals out noise. Frequency-tailored Mic busts thru noise/QRM. Adjustable boom.

MFJ 24/12 Desk Clock

MFJ-108B, $21.95. Read both UTC and local time simultaneously. BIG 5/8 inch digits! Solid brushed aluminum frame. 4¼W x 2H x 1D

Mic Control Center

MFJ-1263, $119.95. Instantly switch ragchewing to DX mic to any two transceivers. Use PTT foot switch, boom mic/headset, phones, speaker, audio-in jack.



MFJ Dry Dummy Load

MFJ-260C, $39.95. 300 Watts. SWR below 1.1:1 to 30 MHz. 1.5:1 from 30-650 MHz. **MFJ-264, $74.95.** 1.5kW load.

MFJ AC Line Filter

MFJ-1164B, $79.95. Filters AC line RFI, surges, noise, transients, hash 30 dB, 60-80 dB with ground. Four 15A/120 VAC outlets.

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Joel R. Hallas, W1ZR
QST Contributing Editor,
"The Doctor"

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Thomas Robinson, WA4OKO

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Tim Lemmon, WK4U

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QS1 2018

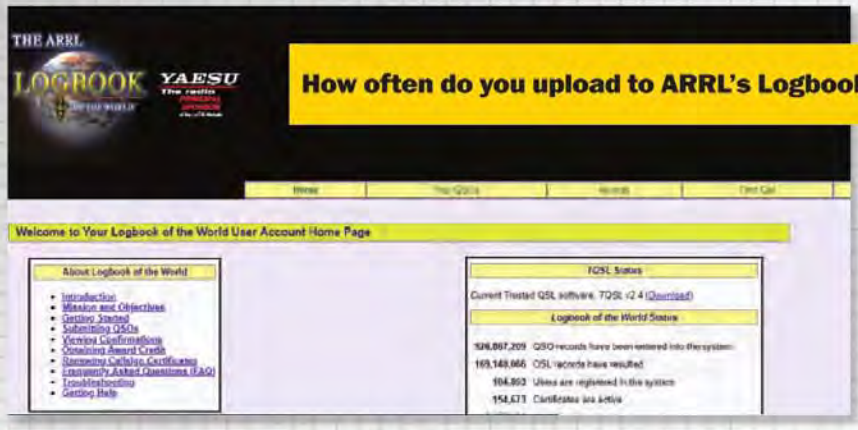
QST QuickStats

sta·tis·tics (stuh-tis-tiks) noun.
1. (used with a singular verb) The mathematics of the collection, organization, and interpretation of numerical data, especially the analysis of population characteristics by inference from sampling.
2. (used with a plural verb) Numerical data.

www.arrl.org/QuickStats

Online QuickStats Poll Results for July 1, 2018 through August 1, 2018.

Get on the web and vote today at **www.arrl.org/quickstats**!



How often do you upload to ARRL's Logbook of The World?

- Daily. **27%**
- Once a week. **17%**
- Once a month. **18%**
- Once a year. **9%**
- I don't use Logbook of The World. **29%**

To exchange paper QSLs for international contacts, do you prefer to mail directly or use the bureau system?

- Direct. **47%**
- Bureau. **37%**
- I don't QSL international contacts. **4%**
- I don't send paper QSLs for any contacts. **12%**

Do you send paper QSLs for contest contacts?

- Yes. **30%**
- No. **43%**
- I don't participate in contests. **18%**
- I don't send paper QSLs for any contact. **9%**

Do you acknowledge QSLs from shortwave listeners?

- Yes. **60%**
- No. **9%**
- I've never received a QSL from a shortwave listener. **31%**

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MFJ IntelliTuner™ Automatic Tuners

More hams use MFJ tuners than all other tuners in the world!

World's most advanced Automatic Antenna Tuners feature world renowned MFJ AdaptiveSearch™ and AutomaticRecall™ algorithms -- world's fastest ultra-wide range tuning. Nine World Class models! Choose your features: Digital/Analog/Audio SWR-Wattmeter, Antenna Switch, Balun, Radio Interface, Digital Frequency Readout, Remoteable, Coax/Balanced Lines/Wire Tuning, Field Upgradeable...

MFJ-998 1500 Watt Legal Limit IntelliTuner™

Only the MFJ-998 gives you fully automatic antenna tuning for your legal limit full 1500 Watts SSB/CW linear amplifier!

Ultra-fast Automatic Tuning
Instantly match impedances from 12-1600 Ohms using MFJ's exclusive IntelliTune™, Adaptive Search™ and InstantRecall™ algorithms with over 20,000 VirtualAntenna™ Memories.

Safe auto tuning protects amp
MFJ's exclusive Amplifier Bypass Control™ makes tuning safe and "stupid-proof"!

Digital/Analog Meters
A backlit LCD meter displays SWR, forward/reflected power, frequency, antenna selected, an auto-ranging bargraph power indication, and much more.

Has quick-glance auto-ranging Cross-Needle SWR/Wattmeter.

MFJ VirtualAntenna™ Memory
MFJ new VirtualAntenna™ Memory system gives you 4 antenna memory banks for each of 2 switchable antenna coax connectors. Select up to 4 antennas on each antenna connector. Each antenna has 2500 memories, 20,000 total. Has binding post for end-fed long wire antennas.

MFJ-998
$699.95

Download & Upgrade Remotely
Download from internet and upgrade your MFJ-998 firmware as new features are introduced.

Plus Much More!
Built-in radio interface controls most transceivers.

Automatically bypasses with excessive tuning power.

Use balanced line antennas with external **MFJ-912, $59.95**, 1.5 kW 4:1 balun.

Small 13W x 4H x 15D inches easily fits into your ham station. 8 pounds. Requires 12-15VDC at 1.4 amps maximum or 110 VAC with **MFJ-1316, $21.95**.

For 600 Watt amps
AL-811/ALS-600/ALS-500

MFJ-994B $359.95

For 600 Watt amps like Ameritron AL-811/ALS-600/ALS-500M. Matches 12-800 Ohms. 10,000 Virtual Antenna™ memories. Cross-Needle SWR/Wattmeter. 10W x 23/4H x 9D inches.

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Every MFJ tuner is protected by MFJ's famous one year **No Matter What™** limited warranty. We will repair or replace your MFJ tuner (at our option) for a full year.

300 Watt Best Seller
Digital Meter, Ant Switch, Balun

MFJ-993B $269.95

The world's best selling automatic antenna tuner is highly acclaimed the world over for its ultra high-speed, wide matching range, reliability, ease-of-use! Matches virtually any antenna.

300 Watt Extra Wide Range
SWR/Wattmeter, 10000 VA Memories

MFJ-991B $229.95

Extra-wide matching range at less cost. Exclusive dual power level: 300 Watts/6-1600 Ohms; 150W/6-3200 Ohms. Cross-Needle SWR/Wattmeter.

200 Watt Compact
Digital Meter, Ant Switch, Wide Range

MFJ-929 $229.95

World's fastest compact auto tuner uses MFJ Adaptive Search™ and InstantRecall™ algorithms. 132,072 tuning solutions instantly match virtually any antenna with near perfect SWR.

200 Watt *MightyMite*™ Matches IC-706, FT-857D, TS-50S

MFJ-939KIY
$159.95

***No** extra space needed!* Just set your IC-706/7000, FT-857D, TS-50S on top of this matching low-profile automatic tuner -- it's all you need for a completely automated station using *any* antenna! Just tune and talk!

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MFJ-1778 $44.95

Covers all bands, 160-10 Meters with antenna tuner. 102 ft. long. Can use as inverted vee or sloper. Use on 160 Meters as Marconi.1500 Watts. Super-strong fiberglass center/feedpoint insulators. Glazed ceramic end insulators. All hand-soldered connections. Add coax, some rope and you're on the air! **MFJ-1778M, $39.95.** G5RV Junior. Halfsize, 52 ft. 40-10M with tuner, 1500 Watts.

200W Weather-sealed
For Remote/Outdoor/Marine

Fully weather-sealed for remote Outdoor/Marine use! Tough, durable, built to last the elements for years.

MFJ-926B $279.95

200 Watt Remote
Coax/Wire Ant, No power cable needed

Weather protected fully automatic remote auto tuner for wire **and** coax antennas – an MFJ exclusive. Powers through coax – No separate power cable needed.

MFJ-927 $259.95

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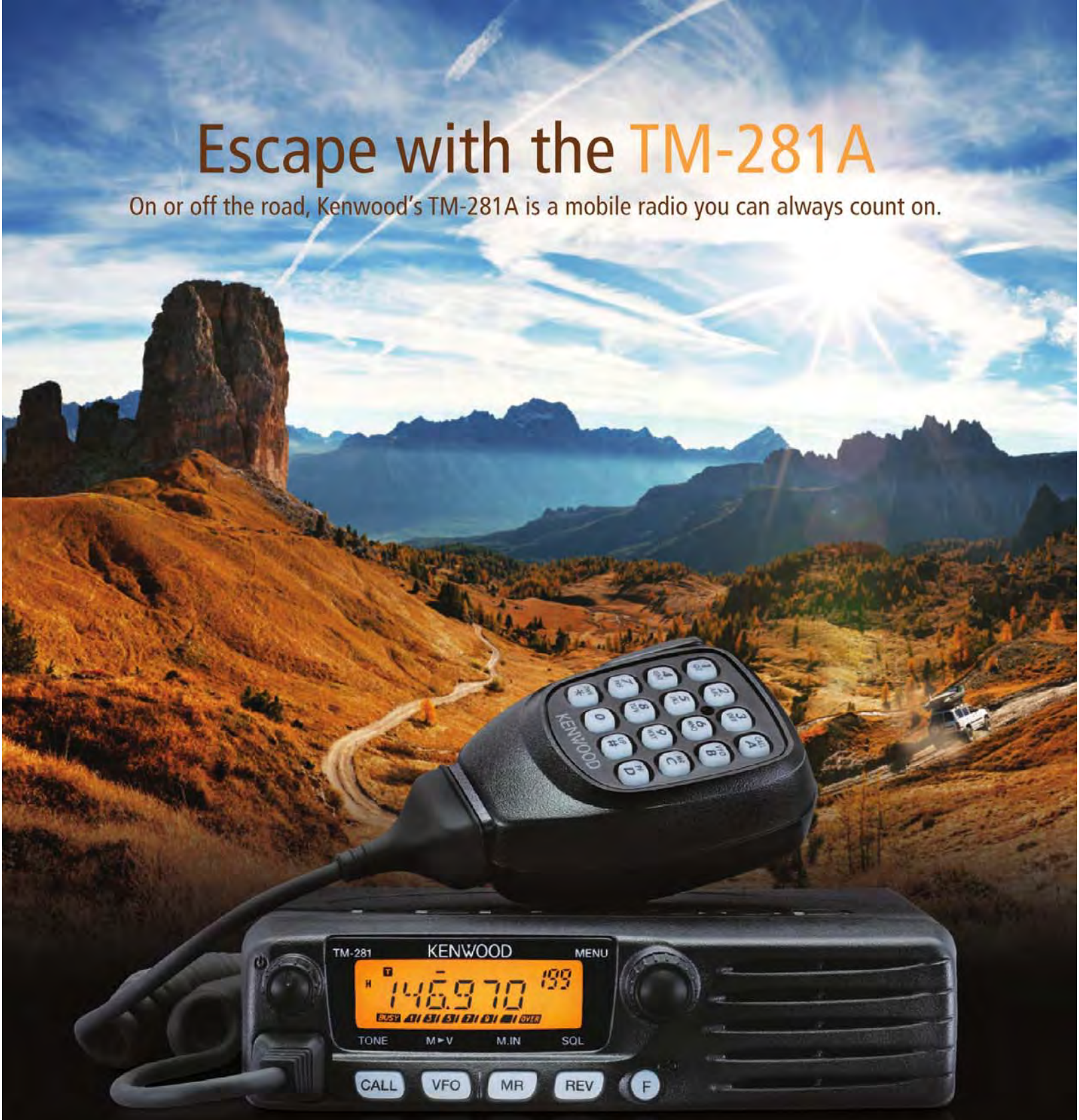

As tough as nails, this MIL-STD-compliant transceiver delivers powerful performance, excellent audio clarity, and a host of advanced features. It offers superb operating ease day or night thanks to the large backlit LCD and illuminated keys. So the next time you take off, take the TM-281A.

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MFJ Tuners

New, Improved MFJ-989D 1500 Watt legal limit Antenna Tuner

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New, improved MFJ-989D legal limit antenna tuner gives you better efficiency, lower losses and a new true peak reading meter. It easily handles full 1500 Watts SSB/CW, 1.8 to 30 MHz, including MARS/WARC bands.

New, dual 500 pF air variable capacitors give you twice the capacitance for more efficient operation on 160 and 80 Meters.

New, improved AirCore™ Roller Inductor gives you lower losses, higher Q and handles more power more efficiently.

New, TrueActive™ peak reading Cross-Needle SWR/Wattmeter lets you read true peak power on all modes.

MFJ-989D $409.95

Includes six position ceramic antenna switch, 50 Ohm dummy load, indestructible multi-color Lexan front panel with detailed logging scales and legends.

The MFJ-989D uses the superb time-tested T-Network. It has the widest matching range and is the easiest to use of all matching networks. Now with MFJ's new 500 pF air variable capacitors and new low loss roller inductor, it easily handles higher power much more efficiently.

New, high voltage current balun lets you tune balanced lines at high power with no worries.

New, crank knob lets you reset your roller inductor quickly, smoothly and accurately.

New, larger 2-inch diameter capacitor knobs with easy-to-see dials make tuning much easier.

New, cabinet maintains components' high-Q. Generous air vents keep components cool. $12^{7}/_{8}$W x 6H x $11^{5}/_{8}$D inches.

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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. 15W x $4^{1}/_{2}$H x $10^{3}/_{4}$D 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. $10^{7}/_{8}$W x $10^{3}/_{4}$H x $4^{1}/_{2}$D in.

MFJ-969 300W Roller Inductor Tuner

MFJ-969 $229.95

Superb, AirCore™ Roller Inductor tuning. Covers 6 Meters thru 160 Meters! 300 Watts PEP SSB. Active true peak reading lighted Cross-Needle SWR Wattmeter, QRM-Free PreTune™, antenna switch, dummy load, 4:1 balun, Lexan front panel. $10^{1}/_{2}$W x $3^{1}/_{2}$H x $9^{1}/_{2}$D inches.

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MFJ-949E $189.95

More hams use MFJ-949s than any other antenna tuner in the world! Handles 300 Watts Full 1.8 to 30 MHz coverage, custom inductor switch, 1000 Volt tuning capacitors, full size peak/average lighted Cross-Needle SWR/Wattmeter, 8 position antenna switch, dummy load, QRM-Free PreTune™, scratch proof Lexan front panel. $10^{5}/_{8}$W x $3^{1}/_{2}$H x 7D inches. MFJ-948, $159.95. Economy version of MFJ-949E, less dummy load, Lexan front panel.

MFJ-941E super value Tuner

MFJ-941E $149.95

The most for your money! Handles 300 Watts PEP, covers 1.8-30 MHz, lighted Cross-Needle SWR/ Wattmeter, 8 position antenna switch, 4:1 balun, 1000 volt capacitors, Lexan front panel. Sleek $10^{1}/_{2}$W x $2^{1}/_{2}$H x 7D in.

MFJ-945E HF/6M mobile Tuner

MFJ-945E $139.95

Extends your mobile antenna bandwidth so you don't have to stop, go outside and adjust your antenna. Tiny 8W x 2H x 6D in. Lighted Cross-Needle SWR/Wattmeter. Lamp and bypass switches. Covers 1.8-30 MHz and 6 Meters. 300 Watts PEP. MFJ-20, $6.95, mobile mount.

MFJ-971 portable/QRP Tuner

MFJ-971 $129.95

Tunes coax, balanced lines, random wire 1.8-30 MHz. Cross-Needle Meter. SWR, 30/300 or 6 Watt QRP ranges. Matches popular MFJ transceivers. Tiny $6^{1}/_{2}$W x $2^{1}/_{2}$H x 6D in.

MFJ-901B smallest Versa Tuner

MFJ-901B $99.95

MFJ's smallest (5W x 2H x 6D in.) and most affordable wide range 200 Watt PEP Versa tuner. Covers 1.8 to 30 MHz. Great for matching solid state rigs to linear amps.

MFJ-902B Tiny Travel Tuner

MFJ-902B $109.95

Tiny $4^{1}/_{2}$W x $2^{1}/_{4}$H x 3D inches, full 150 Watts, 80-6 Meters, has tuner bypass switch, for coax/random wire. **MFJ-904H, $149.95.** Same but adds Cross-needle SWR/ Wattmeter and 4:1 balun for balanced lines. $7^{1}/_{4}$W x $2^{3}/_{4}$H x $2^{3}/_{4}$D inches.

MFJ-16010 random wire Tuner

MFJ-16010 $69.95

Operate all bands anywhere with MFJ's reversible L-network. Turns random wire into powerful transmitting antenna. 1.8-30 MHz. 200 Watts PEP. Tiny 4W x 2H x 3D in.

MFJ-906/903 6 Meter Tuners

MFJ-906 $99.95

MFJ-906 has lighted Cross-Needle SWR/ Wattmeter, bypass switch. Handles 100 W FM, 200W SSB. **MFJ-903, $69.95,** Like MFJ-906, less SWR/Wattmeter, bypass switch.

MFJ-921/924 VHF/UHF Tuners

MFJ-921/924 $89.95

MFJ-921 covers 2 Meters/220 MHz. **MFJ-924** covers 440 MHz. SWR/Wattmeter. 8W x $2^{1}/_{2}$H x 3D in.

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MFJ-931 $109.95

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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.
9¾W x 5½H x 9½D". Only 10.5 lbs.

30 Amp, 4-16 Volts Adjustable, Volt/Amp Meter, 5W x 2½H x 6D"

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 2½H 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

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., 7½W x 4¾H 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 4¼H x 8¾D", 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. 9½W x 6H x 9¾".

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 2¼H x 7½D", 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. 5¼W x 4½H 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 5½W x 2½H x 5¾D 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 5½W x 2½H x 5¾D".

18-Amps, $99.95

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MFJ-1112, $44.95. Like MFJ-1116 but 6 pairs 5-way binding posts, no meter or switch. 12½W x 2¾H x 2½D".

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MFJ-1126, $84.95. 8 fused PowerPoles®. One 1A, three 5A, two 10A, one 25A, one 40A. Switch. Voltmeter. 9W x 1¼H x 2¾D".

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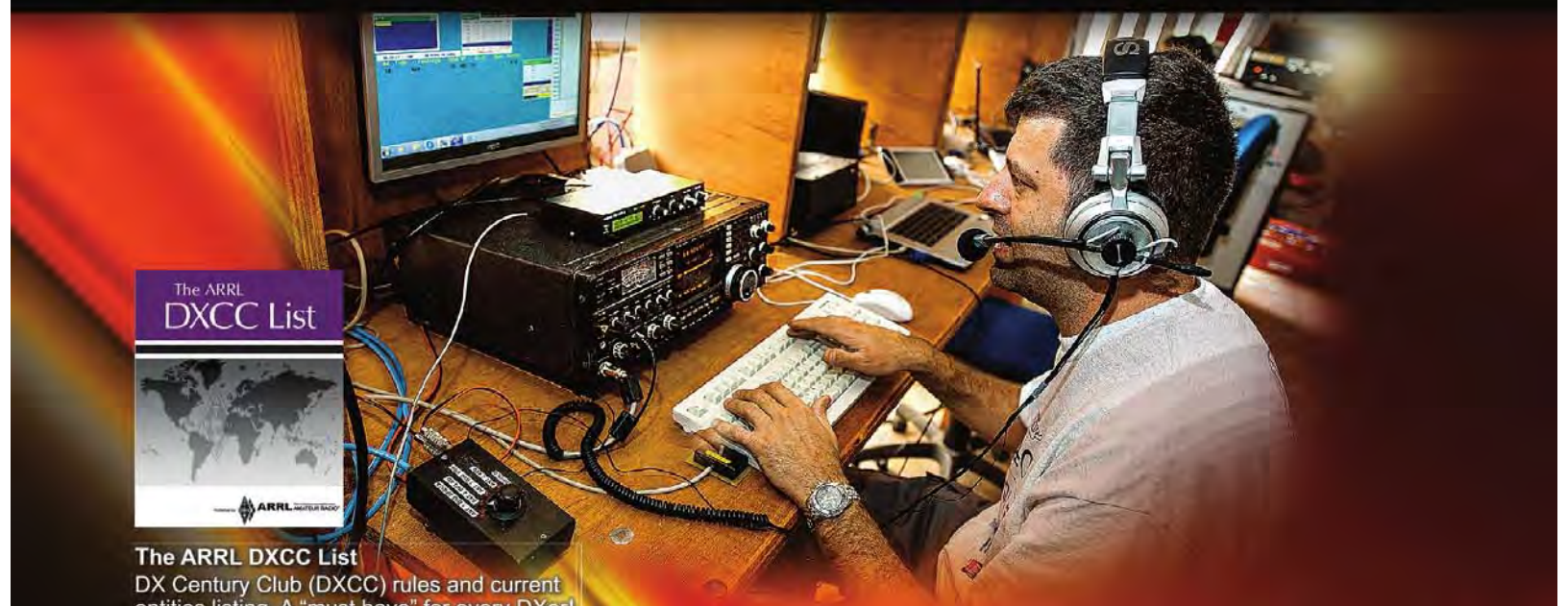

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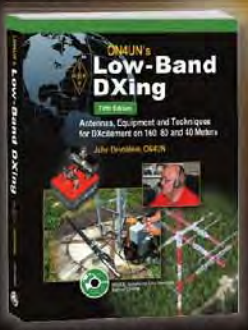

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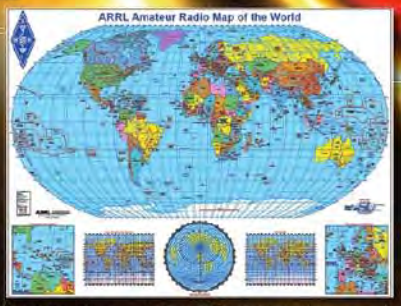

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1. Advertising must pertain to products and services which are related to Amateur Radio.

2. The Ham-Ad rate for commercial firms offering products or services for sale is $2.25 per word. Individuals selling or buying personal equipment: ARRL member 1.00 per word. Non-ARRL member $1.50 per word. **Bolding** is available for $2.50 a word. Prices subject to change without notice. You may pay by check payable to the ARRL and sent to: Ham-Ads, ARRL, 225 Main St., Newington, CT 06111. Or, you may pay by credit card sending the information by fax to 860-594-4285 or via e-mail to hamads@arrl.org. The credit card information we need is: the type of credit card, the exact name that appears on the credit card, the credit card number, the expiration date and the credit card billing address.

3. Remittance in full must accompany copy since Ham-Ads are not carried on our books. Each word, abbreviation, model number and group of numbers counts as one word. Entire telephone numbers count as one word. No charge for postal Zip code. No cash or contract discounts or agency commission will be allowed. Tear sheets or proofs of Ham-Ads cannot be supplied. Ads submitted in writing should be typed or printed clearly on an 8 1/2" X 11" sheet of paper.

4. Closing date for Ham-Ads is the 15th of the second month preceding publication date. No cancellations or changes will be accepted after this closing date. Example: Ads received December 16th through January 15th will appear in March *QST*. If the 15th falls on a weekend or holiday, the Ham-Ad deadline is the previous working day. Please contact the Advertising Department at 860-594-0255 or hamads@arrl.org for further information or to submit your ad.

5. No Ham-Ad may use more than 200 words. No advertiser may use more than three ads in one issue. Mention of lotteries, prize drawings, games of chance etc is not permitted in *QST* advertising.

6. New firms or individuals offering products or services for sale must check with us to determine if a production sample (which will be returned) should be submitted for examination. Dealers are exempted, unless the product is unknown to us. Check with us if you are in doubt. You must stand by and support all claims and specifications mentioned in your advertising.

The publisher of *QST* will vouch for the integrity of advertisers who are obviously commercial in character and for the grade or character of their products and services. Individual advertisers are not subject to scrutiny.

The American Radio Relay League does not discriminate in its advertising on the basis of race, color, religion, age, sex, sexual orientation, marital status or national origin. The League reserves the right to decline or discontinue advertising for any other reason.

7. AN IMPORTANT NOTICE TO ALL HAM AD POSTERS AND RESPONDERS, FROM THE ARRL ADVERTISING DEPARTMENT Greetings from ARRL HQ! Please note that we have received reports from many ARRL members who have placed classified ads in these listings, and have received responses from individuals proposing "creative" payment schemes. These particular instances involved offers of overpayments for goods by bank check, followed by instructions to deduct the cost of your item from the overpayment, and to transfer the overage back or to another individual. This is a well-known scam. Unfortunately, we have no control over this and other scams of this type. Once your email address is posted, you are vulnerable to those individuals seeking to provide you with questionable information.

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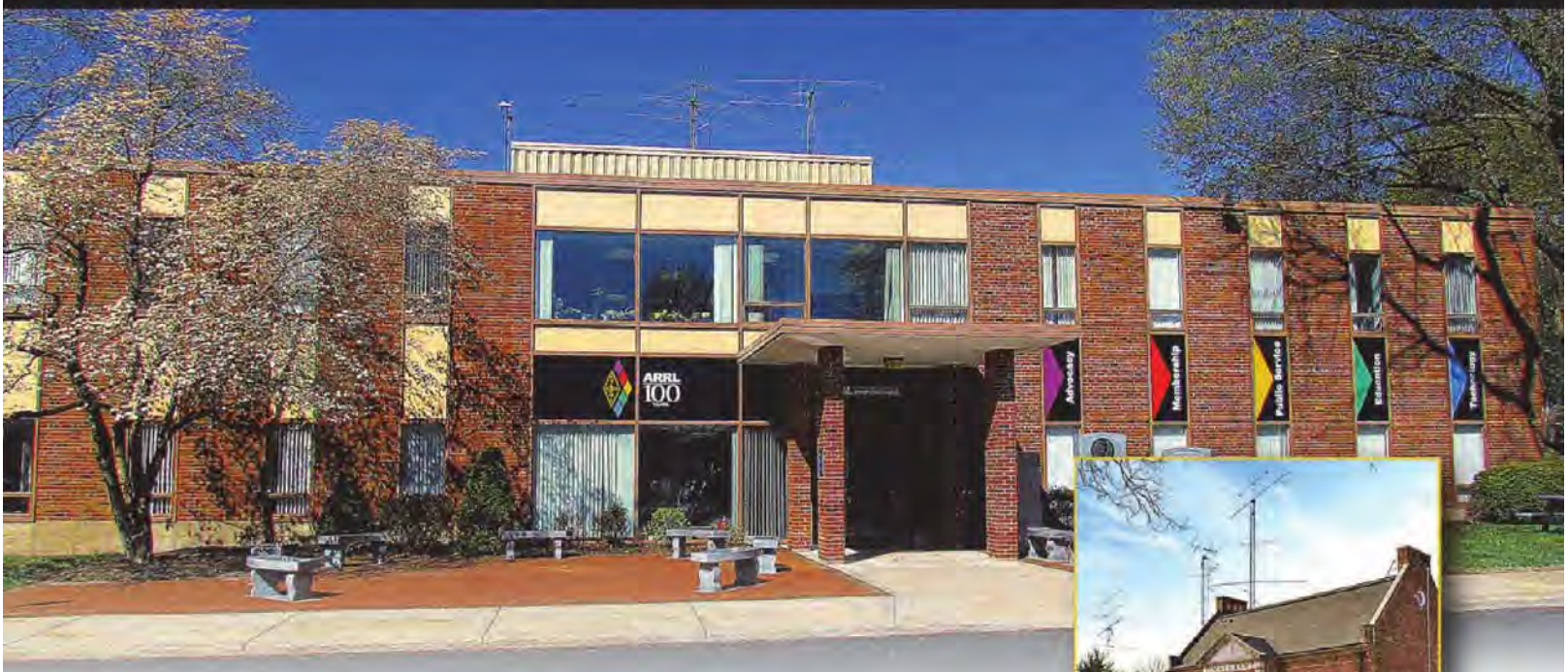

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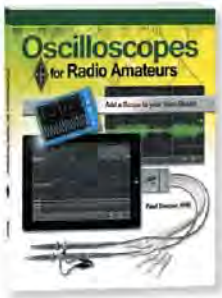

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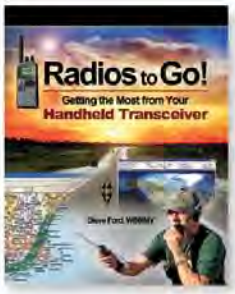

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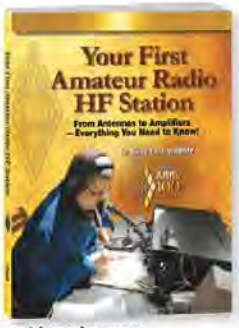

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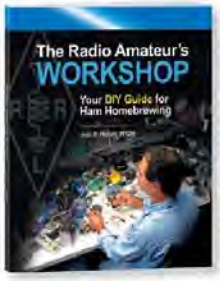

Joel R. Hallas, W1ZR
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ARRL Member Price! $19.95

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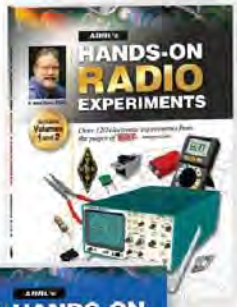
8 years of the best projects and problem-solving techniques from *QST*s **Hints & Kinks** column, one of the most popular sections of the journal. Projects and practical information you can use every day!

ARRL's Hands-On Radio Experiments



Ward Silver, NØAX
Volume 1 and 2
Item No. 0857 – $29.95
Volume 3
Item No. 0796 – $22.95
ARRL Member Price! $19.95

Each volume features short electronics experiments, designed to increase your understanding of basic radio fundamentals, components, circuits and design. The experiments, devised by Ward Silver, NØAX, first appeared in *QST* magazine's "Hands-On Radio" column. The collection covers a wealth of topics designed to educate today's radio experimenters, and inspire others who want to learn what makes their radios work.

More Arduino Projects for Ham Radio

Glen Popiel, KW5GP

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Build a solid foundation through descriptions of Arduino boards and add-on components. Features 15 Arduino projects for your ham radio station. Each project is complete and functional as-is, but room has been left for you to add personal touches and enhancements.

Arduino for Ham Radio

Glen Popiel, KW5GP

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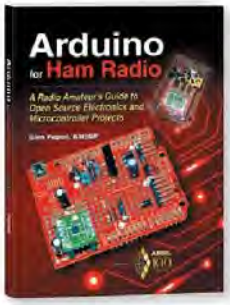
An introduction to Arduino microcontrollers and practical projects for the Amateur Radio station. It starts by building a solid foundation through descriptions of various Arduino boards and add-on components, followed by a collection of ham radio-related practical projects.



Ham Radio for Arduino and PICAXE

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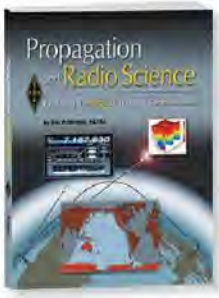
Topics range from theoretical exploration to practical application. It explains the phenomenon we observe on the amateur bands and invites you to embark on the journey through the still-unknown radio propagation universe.



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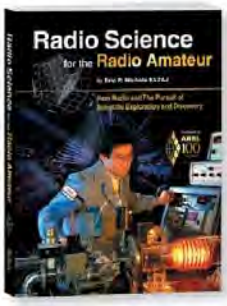

Radio Science for the Radio Amateur

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Explore the science and technology of the radio universe. You'll find solving long-standing mysteries of radio doesn't require expensive hardware, but a scientific mindset and attention to detail.

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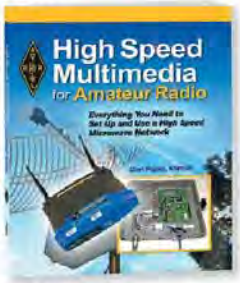
An introduction to HSMM networking, the basics of how it works, and the various technologies in use today. Learn how to deploy your own HSMM network, along with various applications to put it to work.



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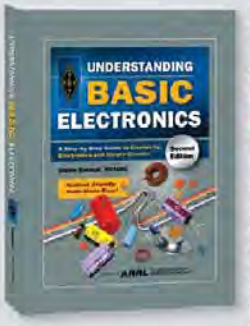
ARRL "Basic" Book Series



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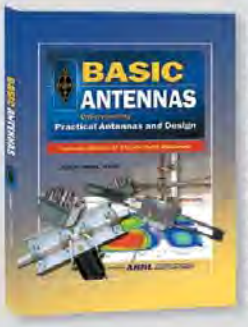
An introduction to radio for everyone. Reveals the key building blocks of radio: **receivers, transmitters, antennas,** and **propagation.** Simple, build-it-yourself projects turn theory into practice.



Basic Antennas

Understanding Practical Antennas and Design
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Rich Arland, K7SZ

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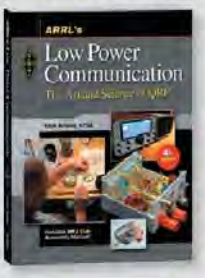

Your guidebook to the fascinating world of low power QRP operating. With only 5 W or less — sometimes much less — you can enjoy conversations over hundreds and even thousands of miles. **Bonus!** Includes the complete assembly manual for the MFJ Cub Transceiver Kit (sold separately).

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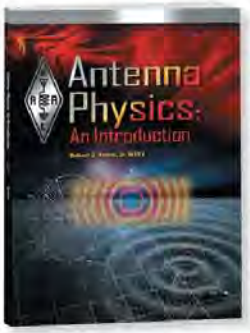

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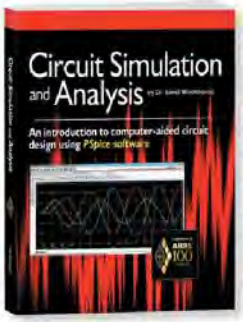

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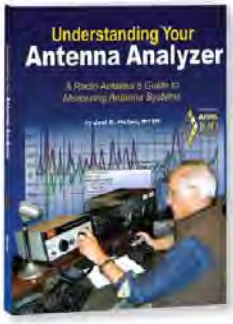

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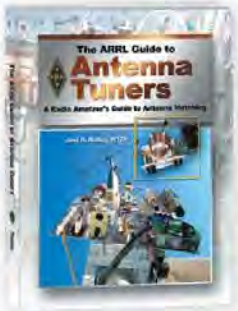

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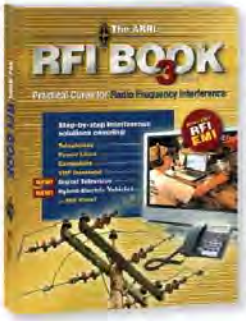
Explore the design, construction and applications of the different types of antenna tuners. You'll gain a better understanding of your antenna system and the way it can be improved through the use of the appropriate antenna tuner.



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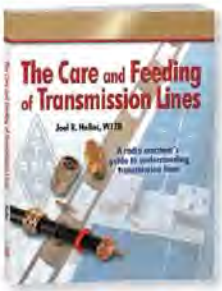

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Includes:

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- The Effects of Ground
- Radio Wave Propagation
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- Multielement Arrays
- Log-Periodic Dipole Arrays
- Antenna Modeling

MF and HF Antennas
- Single-Band MF and HF Antennas
- Multiband HF Antennas
- HF Yagi and Quad Antennas
- Broadside and End-Fire Arrays
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- VHF and UHF Antenna Systems
- VHF and UHF Mobile Antennas
- Antennas for Space Communications
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Special Applications
- Portable Antennas
- Stealth and Limited Space Antennas
- Mobile and Maritime HF Antennas
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- Transmission Lines
- Transmission Line System Techniques

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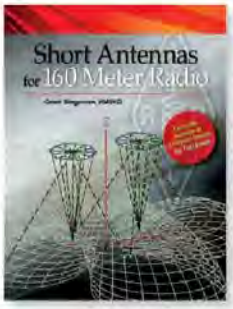
Short Antennas for 160 Meter Radio



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Intended for amateurs with advanced skills in antenna modeling, this book walks through innovative designs for relatively compact antennas. Enhance bandwidth, minimize loss, and employ other techniques to enjoy 160 meters.

Antenna Zoning for the Radio Amateur

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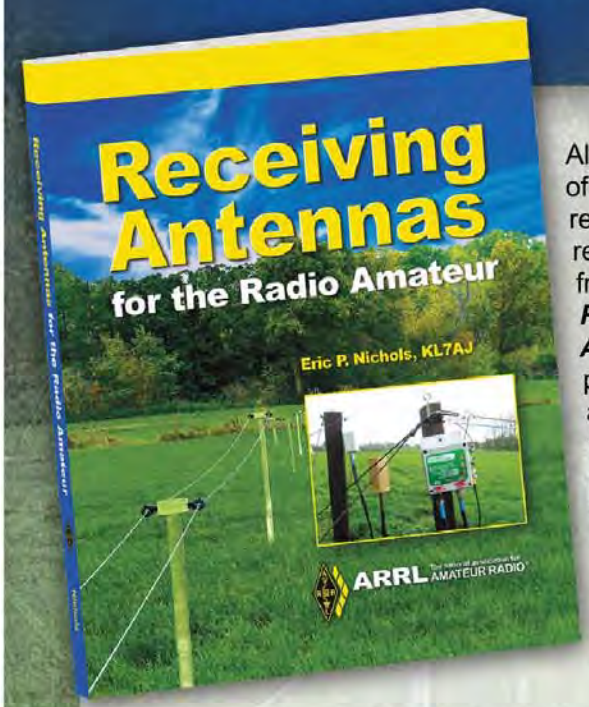
Techniques and strategies that a ham and his or her attorney can use to obtain an antenna-structure permit. Keep peace with the neighbors and enjoy ham radio!

Transmitting and receiving antennas have different jobs to do.



Although the fundamental characteristics of antennas apply to both transmission and reception, the requirements and priorities of receiving antennas can be vastly different from those of transmitting antennas. ***Receiving Antennas for the Radio Amateur*** focuses entirely on active and passive receiving antennas and their associated circuits. There are relatively few cases where a radio amateur cannot benefit from a separate, well-designed receiving antenna or antenna system. On the low bands, including our new allocations at 630 and 2200 meters, heavy emphasis on the receiving end of these radio paths is essential for success.

The *active* antenna holds a prominent position in this book, as it offers good receiving performance while taking up minimal space. Recent developments in radio frequency (RF) semiconductors, especially low-noise RF operational amplifiers, have made a number of previously difficult-to-implement active antenna designs simple to build.

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Receiving Antennas for the Radio Amateur
By Eric P. Nichols, KL7AJ
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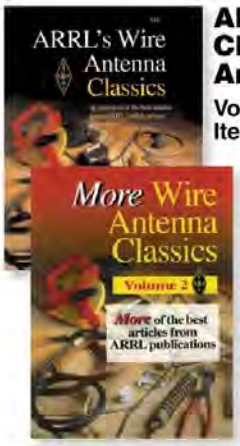

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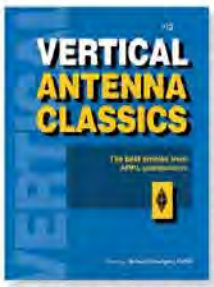
60 articles from ***QST*** featuring practical ideas, tips and some of the best antenna projects. You'll find designs such as the Handy Yagi Antenna, Compact 40 Meter HF Loop, 20 and 40 Meter Verticals on "Autopilot" *and much more.*



Vertical Antenna Classics

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Vertical antennas are everywhere-on cell phones, broadcast towers, portable radios and vehicles. And for good reason! Here are the best articles from ARRL publications in one book. Vertical antenna theory and modeling, VHF and UHF, HF, directional arrays, radials, product suppliers and more.

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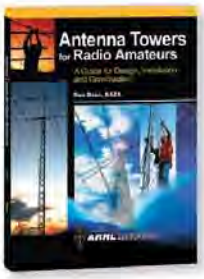
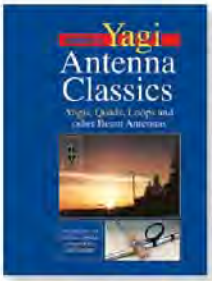


With years of experience as a professional tower climber, Don Daso, K4ZA, leads you through designing and building your own antenna tower. You'll learn the skills, tools, climbing techniques, and safety measures necessary to improve your antenna system.

The digital edition is available in the Kindle format from Amazon.



ARRL's Yagi Antenna Classics

Yagis, Quads, Loops and other Beam Antennas
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Antennas, Equipment and Techniques for DXcitement on 160, 80 and 40 Meters

Level 1 – Technician

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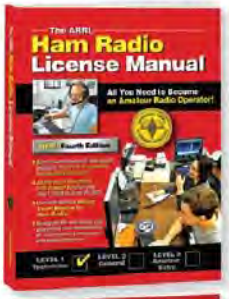

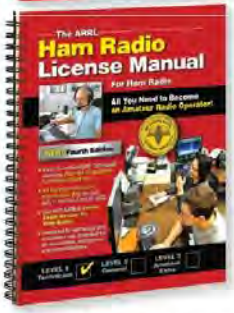

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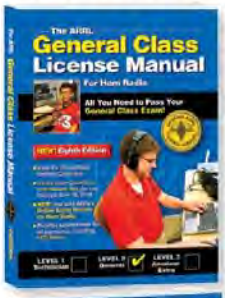

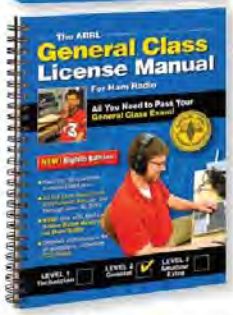

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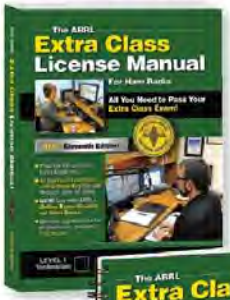

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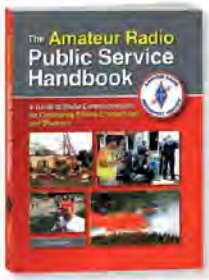

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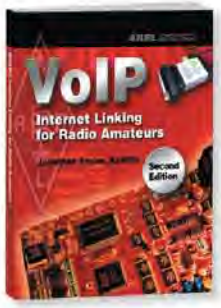

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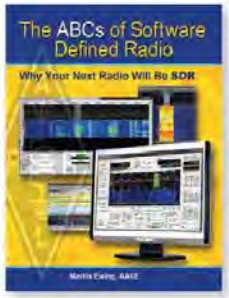

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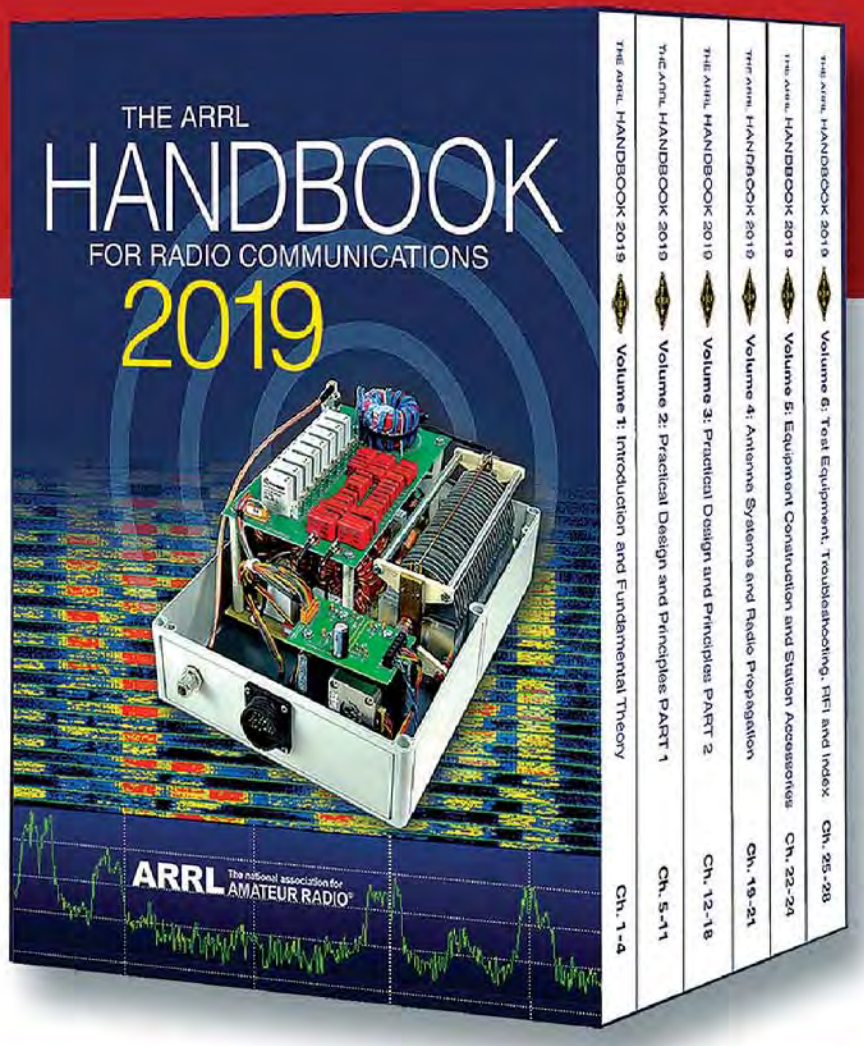

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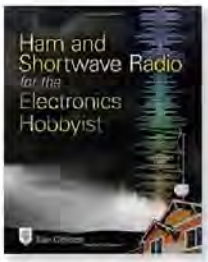

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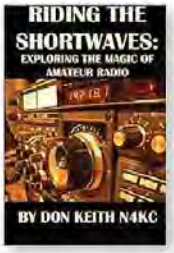

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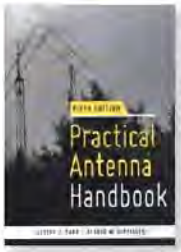

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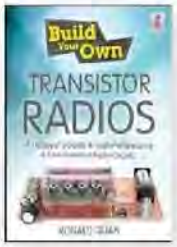

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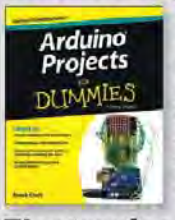

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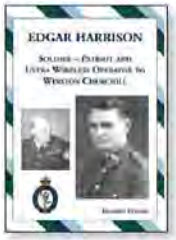

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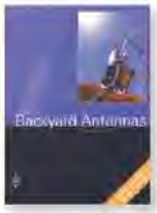

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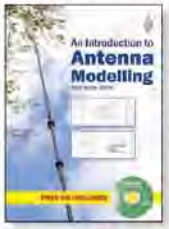

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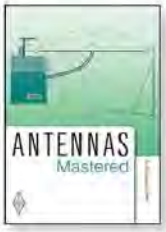

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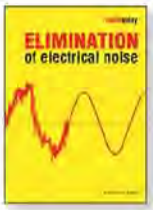

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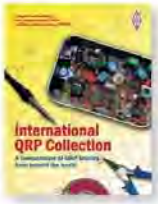
International QRP Collection



Item No. 0020 – $24.95
A compilation of the art and science of QRP. Contains articles from many Amateur Radio magazines including RadCom, *QST*, Sprat, Break In, as well as new material. 176 pages.

IOTA Directory

Item No. 4008 – $19.95
An essential guide to participating in the Islands on the Air (IOTA) award program. Includes details of the award rules, the IOTA contest, the IOTA honor roll, and fascinating reports of IOTA operations. A must-have for every island chaser! 128 pages.

Prefix Guide

12th Edition
Item No. 0209 – $19.95
Complete guide to call sign prefix identification and information. DXCC listings, award details and more. 80 pages.

More RSGB Publications

- **Antenna File.** Item No. 8129 ..... **$29.95**
- **Building a Transceiver.** Item No. 6959 ..... **$24.95**
- **HF Antennas for All Locations.** Item No. 4300 ..... **$34.95**
- **Microwave Know How.** Item No. 0303 ..... **$21.95**
- **Power Supply Handbook.** Item No. 9977 ..... **$29.95**
- **Practical Wire Antennas 2.** Item No. 9563 ..... **$24.95**
- **QRP Basics.** 2nd Edition. Item No. 6401 ..... **$24.95**
- **Radio Auroras.** Item No. 1208 ..... **$12.95**
- **Radio Orienteering.** Item No. 0131 ..... **$19.95**
- **Radio Propagation Explained.** Item No. 0038 ..... **$19.95**
- **SWR Explained.** Item No. 8910 ..... **$15.95**
- **Valve Amplifiers Explained.** Item No. 0045 ..... **$24.95**
- **Weekend Projects for the Radio Amateur.** Item No. 0123 ... **$24.95**

A History of *QST* – Volume 1: Amateur Radio Technology 1915-2013

Edited by Ward Silver, N0AX
Item No. 0003 – $34.95
ARRL Member Price! $29.95

Discover the technical contributions made throughout Amateur Radio's first century. Begin in the era of spark and continue through advances in radio electronics, antenna design, and the dawn of satellites and digital communications.

A History of *QST* – Volume 2: Advertising 1915-2013

Joe Veras, K9OCO
Item No. 0048 – $34.95
ARRL Member Price! $29.95

Trace the history of receivers, transmitters, antennas, and other station gear through this collection of *QST* pages and advertising. It's a nostalgic journey, as told through the creative marketing, advertising and photography or yesteryear.

50 Years of Amateur Radio Innovation

Joe Veras, K9OCO
Item No. 0228 – $39.95

A guided tour of more than 400 legendary radios from 1930 – 1980, the "golden age" of American Radio Technology. This span saw the introduction of receivers, transmitters and transceivers that would become famous throughout the world.

100 Years of *QST* Special Reissue

Item No. 0369 – $9.95

Celebrate 100 years of ARRL's membership journal, with a commemorative reissue of the first *QST*—the December 1915 issue.

The Gil Cartoon Book

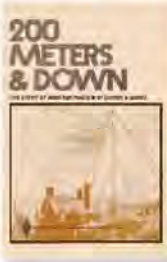
Item No. 0364 – $15.95

The work of Philip "Gil" Gildersleeve, W1CJD, became a tradition. In tribute to this talented, creative and devoted artist and ham, the ARRL presents in this book a reprint of a portion of the best of his work.

The ARRL Film Collection DVD

Dave Bell, W6AQ
Item No. 3725 – $15.95

Take a journey back as ARRL presents a series of videos beginning in the late 1950s. From the original "Hams Wide Word" to "Amateur Radio Today", you will watch the evolution of Amateur Radio unfold before your eyes. 130 minutes.



200 Meters & Down

Item No. 0011 – $15.95

This book chronicles the exciting evolution of Amateur Radio from the pioneers who perfected the wireless art, through the technical advances of the mid-1930s.

The Story of the Queen Mary and W6RO DVD

Item No. 1344 – Only $15.95

A story about W6RO, the Amateur Radio station located aboard the historic Queen Mary. With 35 years of continuous operation, W6RO has presented a positive image to millions of visitors. 28 minutes.

Hiram Percy Maxim

Item No. 7016 – $19.95

This biography explores Maxim's many devotions as inventor, scientist, writer and humanitarian. It's a tribute to his ingenuity and determination.

Where Discover Sparks Imagination

Item No. 1660 - $34.95

Examine the early history of radio and electricity, with a collection of over 600 photographs. Anyone who appreciates the amazing workmanship and artistry of old technology will love this book.

The World of Ham Radio: 1901 – 1950

Item No. 0257 – $29.95

Explore the history of ham radio operators, their social history and their many contributions to the technological development of worldwide communications. This book highlights ham radio in major events of the half century.

Revisit the Ham Radio of Yesteryear!

ARRL Amateur Radio Hat

- **Black Hat – Item No. 5004 – $12.95**
- **Khaki Hat – Item No. 4094 – $12.95**

Medium profile cap with sandwich visor feature contrasting undervisor, mesh lining and adjustable cloth strap closure. Available in black and khaki. One size fits most.

ARRL Mesh Hat

Item No. 1006 – $12.95

Red and white hat embroidered with red ARRL logo on the front. Cotton top. Mesh back with buckle closure. One size fits most.

ARRL Polo Shirt

- **Royal Blue Polo – $24.95**
  Men – Item No. 3108 (S-4XL)
  Ladies – Item No. 3108W (S-3XL)
- **Red Polo – $24.95**
  Men – Item No. 7319 (S-4XL)
  Ladies – Item No. 7319W (S-3XL)

Designed for ARRL Members, this sport polo features the ARRL diamond logo with the words **"ARRL, Amateur Radio"** on the front left chest. Available in royal blue and red.

ARRL T-Shirts

- **Gray – $14.95**
  Item No. 9308 (S-4XL)
- **Turquoise – $14.95**
  Item No. 2003 (S-4XL)

ARRL Sweatshirt

Item No. 0207 – $39.95

Full zip hoodie, embroidered with the words **"ARRL, Amateur Radio"** on the front left chest. Perfect for the fall and winter seasons. Size, S-4XL. Color, Black.

ARRL Jacket

Item No. 0149 – $59.95

Elevate softshell jacket. Thanks to the durability in the fabric, it will last you a long time. Embroidered with the words **"ARRL, Amateur Radio"** on the front left chest. Perfect for cool summer nights. Size, S-4XL. Color, Olympic Blue.

ARRL Fleece Jacket

Item No. 3066 – $39.95

River's End fleece jacket embroidered with the words **"ARRL, Amateur Radio"** on the front left chest. Perfect for cool summer nights. Size, S-3XL. Color, Riverblue.

Pocket Ref

Thomas J. Glover
Item No. 1148 – $12.95
All the information you need in one essential reference book. The cover is embossed with ARRL's logo—making this a particularly special edition of this popular guide.

RFI Pocket Guide

Item No. 5008 – $20.00
Pocket reference offers essential data on radio frequency interference for advanced ham radio operators, wireless engineers and technicians.

Amateur Radio Station Log Book

Item No. 1250 – $7.95
52 log pages with room for 25 contacts per page (1,300 total log entries). Spiral bound (8.5 x 11")

Minilog Book

Item No. 7539 – $4.95
Wire-bound (6.25 x 4")

Log Sheets

Item No. 1265 – $4

L/C/F and Single-Layer Coil Winding Calculator

Item No. 9123 – $12.95
Handy slide rule when tinkering with filters, oscillators, impedance matching circuits or antenna coils. Quick and easy circuit calculations.

Klingenfuss Publications

2018 Shortwave Frequency Guide
22nd Edition
Item No. 0107 – $59.95
The latest schedules of worldwide broadcast and utility radio stations.

2018 Super Frequency List CD-ROM
Item No. 0156 – $44.95
More than 40,000 entries cover both broadcast and utility stations. Hundreds of fascinating new digital data decoder screenshots! Requires *Windows*.

The ARRL DXCC List

2018 Edition
Item No. 0840 – $5.95
The official source of DXCC awards information. Record the DXCC Entities you've worked and QSLed. A "must have" for every DXer!

Radiograms For Traffic Handlers

Item No. 1310 – $2
Message Delivery Cards (package of 20)
Item No. 1320 – $2
Message Pad with 70 sheets

Radio Setup Guides

Consider step-by-step guides that simplify setup and operation. Mini-manuals and pocket reference cards available are available for select Kenwood, Icom, Yaesu, Baofeng and Wouxun models.

Order Nifty! Ham Radio Guides online at **www.arrl.org/shop**.

HT Radio Desk Stand

Item No. 7325 – $34.95
Convenient desk-top holder for all hand-held radios. Holds your radio upright and steady at a comfortable viewing angle. Use to hold your Android phone, iPhone, iPod and more.

ARRL All Weather Pen

Item No. 6108 – Only $13.95
All weather click pen writes on wet paper, upside down and in temperatures from -30F to 250F. Flat black metal barrel, ink black. Size: 5 1/4" long.

ARES All Weather Notebook

Item No. 5580 – Only $6.95
Pocket notebook conveniently sized to take with you–anywhere, anytime, in any weather! Features the ARES logo on a Polydura cover. 100 waterproof writing pages (50 sheets). Size: 3" x 5".

All Weather Minilog

Item No. 1374 – Only $8.95
Waterproof logbook made of synthetic paper. Ideal for harsh field conditions, and mobile use. 50 pages. Size: 3" x 5".

2017 ARRL Periodicals on DVD

Fully-searchable collections of popular ARRL journals, *QST*, *QEX*, and *NCJ*. Every word and photo published throughout the year is included!

SEARCH the full text of every article by entering titles, call signs, names—almost any word.

SEE every word, photo (including color images), drawing and table in technical and general-interest features, columns and product reviews, plus all advertisements.

PRINT what you see, or copy it into other applications.

Item No. 0772 – $24.95

System Requirements: Microsoft Windows™. 1999-2014 editions support Windows and Macintosh systems, using the industry standard Adobe® Acrobat® Reader® software. The Acrobat Reader is a free download at www.adobe.com (included on CD through 2007).

Additional sets available on CD.

- 2016 Edition, **Item No. 0680 – $24.95**
- 2015 Edition, **Item No. 0505 – $24.95**
- 2014 Edition, **Item No. 0325 – $24.95**
- 2013 Edition, **Item No. 0093 – $24.95**
- 2012 Edition, **Item No. 3152 – $24.95**
- 2011 Edition, **Item No. 5651 – $24.95**
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- 2009 Edition, **Item No. 1486 – $24.95**
- 2008 Edition, **Item No. 9406 – $24.95**
- 2007 Edition, **Item No. 1204 – $19.95**
- 2005 Edition, **Item No. 9574 – $19.95**
- 2003 Edition, **Item No. 9124 – $19.95**
- 2002 Edition, **Item No. 8802 – $19.95**
- 2001 Edition, **Item No. 8632 – $19.95**
- 1999 Edition, **Item No. 7881 – $19.95**

The Story of the Enigma: History, Technology and Deciphering

Item No. 1296 – $15.00

The complete story of the Enigma cipher machine, the primary device used by the German Military during WWII. It begins with the history of codes and progresses through the development of code machines, the Enigma, and other cipher machines.

Radio Amateur Callbook CD-ROM

Summer 2018 Edition
Item No. 0043S – $49.95

Feature-packed CD-ROM contains the call sign and address information of the Amateurs Radio stations all over the world. With more than 1,600,000 licensed radio amateurs, it lets you find the data you are looking for in a fast and easy manner. Bonus USB drive included!

The ARRL Handbook 2019 eBook

- **Mac/Linux Version**
  Item No. 0888 MLD – $49.95
- **Windows Version**
  Item No. 0888 WD – $49.95

The fully searchable digital edition of the printed book, as well as expanded supplemental content, software, PC board templates, and other support files.

For more CD's & DVD's visit www.arrl.org/shop

The DIY Magic of Amateur Radio DVD

Item No. 6047 – $10.95

Directed toward the "Do It Yourself" movement, this video features innovative and fun ways hams use radio technology. 8 minutes 32 seconds.

Perera's Telegraph Collectors Reference CD-ROM

Item No. 1282 – $15.00

A complete source of information for those interested in telegraph keys, from beginner to avid collector. It explains the history and technology of telegraph keys and gives their current values. Over 7,000 photographs, and an array of descriptions, prices, books, and more.

ARRL Software Library for Hams 5.0 Download

Item No. 1205D – $19.95

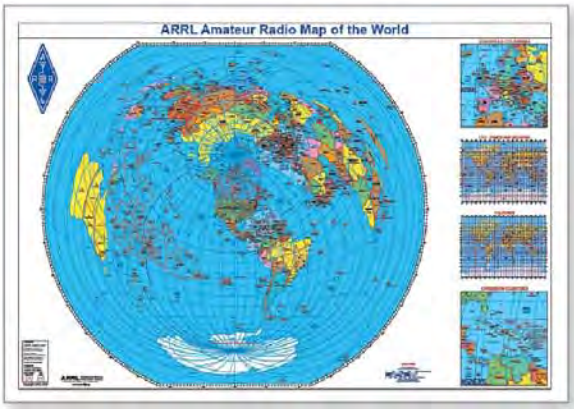
Quick access to utilities, applications and information:

- **Videos**
- **Image Editor**
- **DX Cluster client software** *(CC USER)*
- ***Software Defined Radio***
- **HF digital software** for PSK31, MFSK16, MT63, RTTY and JT65
- ***WSJT*** software for meteor scatter and moonbounce ***and more!***

Buckmaster's HamCall™ CD-ROM

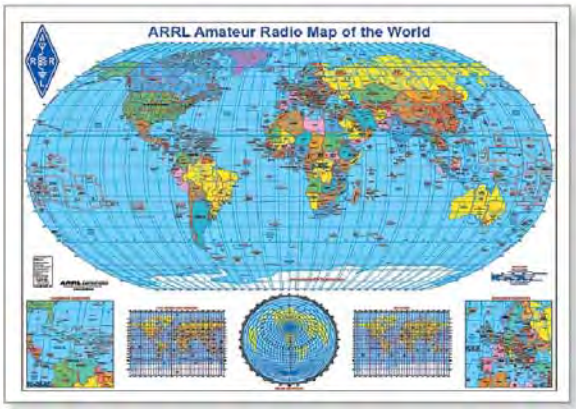
Item No. 8991 – $49.95

Look up hams by call sign, name, street address, city, state, postal code, county, and country. Over 2,300,000 worldwide call sign listings.



ARRL Map of the World Azimuthal

Item No. 7717 – $15
27 x 39 inches.

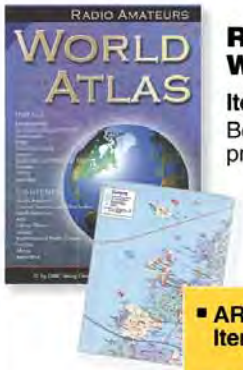


ARRL Map of the World Robinson

Item No. 8804 – $15
26 x 34.5 inches.

ARRL Map of North America 2018 Special IGC Edition

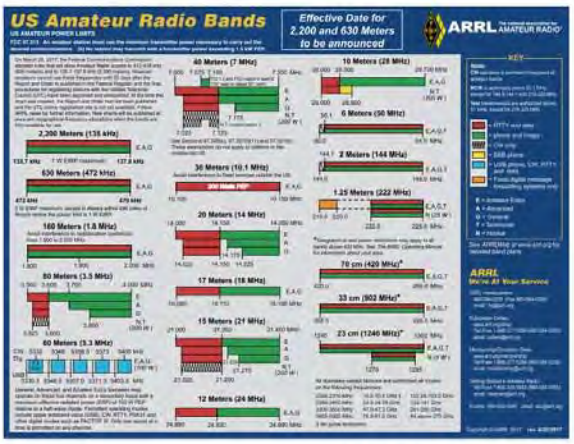
Item No. 8977 – $15
27 x 39 inches.

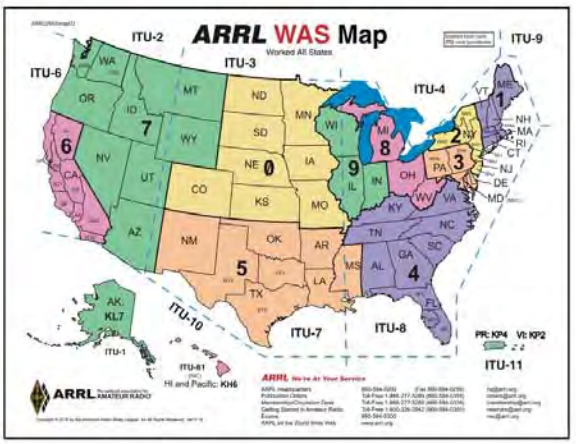


Radio Amateurs World Atlas

Item No. 5226 – $12.95
Booklet of full-color maps, call-sign prefixes and more.

- **ARRL World Grid Locator Atlas**
  Item No. 2944 – $5.95
- **Grid Locator** (US Grid Squares)
  Item No. 1290 – $1
- **Polar Map** (for OSCAR)
  Item No. 1300 – $1





US Amateur Radio Bands Chart

Item No. 1126 – $3
ARRL Worked All States (WAS) map on backside. 11x17 inches.

Ham Oval Stickers
(set of 25)
Item No. 0169 – $30

These stickers are a great way to get the word out! Ideal for the bumper or rear window of your car, van or RV (vinyl with adhesive on the back).

I'm a Member... Stickers
(roll of 100)
Item No. 1037 – $5.00
1 3/8" diameter.

ARRL Magnets (set of 25)
Item No. 0124 – $12
Full colored magnets imprinted with "Advancing the Art, Science and Enjoyment of Amateur Radio" and the ARRL five pillars. The perfect give-away for all ham radio events! Size 3.5" x 2".

Amateur Radio Bookmark and Ruler (set of 25)
Item No. 1063 – $8
A bookmark on one side and ruler on the other. A great recruitment tool for scouts and young hams.

ARRL Ribbons
(set of 25)
- **ARRL Member Ribbons**
  Item No. 1123 – $18
- **ARRL Life Member Ribbons**
  Item No. 0280 – $18

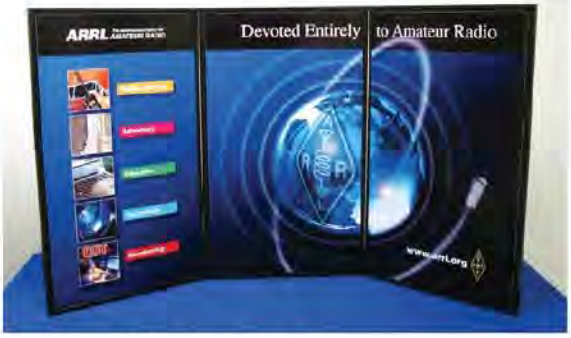
ARRL Members and ARRL Life Members, show off your support with an attractive ARRL ribbon!

Wouff Hong Pins
(set of 25)
Item No. 0060 – $50
Symbolize your participation in the traditional ham ritual with these antique copper plated pins. Perfect for Clubs!

Handouts Available in Packs of 25
- **What is Ham Radio** flyer. Version A. Item No. WIHR-A
- **What is Ham Radio** flyer. Version B. Item No. WIHR-B
- **DIY Magic of Amateur Radio** flyer. Item No. DIYF
- **Serving Your Community** flyer. Item No. SRVE
- **Take the Next Step** flyer. Item No. TINS
- **Ham Radio Youth** flyer. Item No. YTHF
- **ARRL Membership** brochure. Item No. MEMB
- **Scouting and Amateur Radio** leaflet. Item No. SARL
- **Amateur Radio Emergency Service** leaflet. Item No. ARESL
- **Wireless Excitement Amateur Radio** leaflet. Item No. WARL

ARRL Pens (set of 25)
Item No. 0170 – $15
Red push pen imprinted with "ARRL the national association for AMATEUR RADIO". The perfect give-away for all ham radio events!

ARRL Banner
Item No. 1302 – $50
Nylon fabric banner imprinted with "ARRL The national association for AMATEUR RADIO". Size 3' x 8'.



ARRL Tabletop Display
Item No. 0185 – $220
Three panel "Dedicated Entirely to Amateur Radio" display, featuring the ARRL five pillars. A great addition to any trade show or exhibit! 54" x 30" x 3/4".

ARRL Banner Stand Display
Item No. 0310 – $150
Vibrant banner imprinted with "Advancing the Art, Science and Enjoyment of Amateur Radio" and the ARRL five pillars. Includes carrying case. A striking visual for all your ham radio events! Size 29.50" x 69".

Advocacy
Membership
Public Service
Education
Technology

Licensing

Technician Class

Exam: 35-question Technician test (Element 2)

The ARRL Ham Radio License Manual. 4th Edition.
Softcover Book. Item No. 0871 ..... $29.95
Spiral Bound. Item No. 0826 ..... $32.95
ARRL's Tech Q & A. 7th Edition. Item No. 0864 ..... $17.95

General Class (upgrade from Technician)

Exam: 35-question General test (Element 3)

The ARRL General Class License Manual. 8th Edition.
Softcover Book. Item No. 0307 ..... $29.95
Spiral Bound. Item No. 1904 ..... $32.95
ARRL's General Q & A. 5th Edition. Item No. 0338 ..... $17.95

Extra Class (upgrade from General)

Exam: 50-question Extra test (Element 4)

The ARRL Extra Class License Manual. 11th Edition.
Softcover Book. Item No. 0451 ..... $29.95
Spiral Bound. Item No. 0550 ..... $32.95
ARRL's Extra Q & A. 4th Edition. Item No. 4494 ..... $17.95

Operating

The ARRL Operating Manual for Radio Amateurs. 11th Edition.
Item No. 0598 ..... $24.95
The ARRL Repeater Directory®. 2018 Edition.
Item No. 0758 ..... ARRL Member Price $17.95 ..... ~~$19.95~~
Your First Amateur Radio HF Station.
Item No. 0079 ..... ARRL Member Price $19.95 ..... ~~$22.95~~
Portable Operating for Amateur Radio.
Item No. 0802 ..... ARRL Member Price $19.95 ..... ~~$22.95~~
Radios to Go!
Item No. 3077 ..... ARRL Member Price $15.95 ..... ~~$17.95~~
The ARRL DXCC List. 2018 Edition. Item No. 0840 ..... $5.95
Oscilloscopes for Radio Amateurs.
Item No. 0976 ..... ARRL Member Price $19.95 ..... ~~$22.95~~
The Radio Amateur's Workshop.
Item No. 0482 ..... ARRL Member Price $19.95 ..... ~~$22.95~~
Hints & Kinks for the Radio Amateur. 18th Edition.
Item No. 5200 ..... ARRL Member Price $19.95 ..... ~~$22.95~~
FCC Rules and Regulations. 4th Edition. Item No. 1173 ..... $7.95
ARRL Software Library for Hams 5.0 Download.
Item No. 1205D $19.95
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Item No. 0277 ..... ARRL Member Price $24.95 ..... ~~$27.95~~
Radio Science for the Radio Amateur.
Item No. 3381 ..... ARRL Member Price $24.95 ..... ~~$27.95~~
Storm Spotting and Amateur Radio. 2nd Edition.
Item No. 0594 ..... ARRL Member Price $19.95 ..... ~~$24.95~~
Morse Code Operating for Amateur Radio.
Item No. 0004 ..... ARRL Member Price $15.95 ..... ~~$17.95~~
Amateur Radio Station Log Book. Item No. 1250 ..... $7.95
Amateur Radio Station Minilog. Item No. 7539 ..... $4.95
ARRL VEC Volunteer Examiner Manual. Item No. 1328 ..... $10

Maps

ARRL Map of North America. 27" x 39". Item No. 8977 ..... $15
ARRL Map of the World (Azimuthal). 27" x 39". Item No. 7717 ..... $15
ARRL Map of the World (Robinson). 26" x 34.5". Item No. 8804 ..... $15
ARRL Worked All States (WAS) Map. 11" x 17". Item No. 1126 ..... $3
The Radio Amateur's World Atlas. Item No. 5226 ..... $12.95

Antennas

The ARRL Antenna Book. 23rd Edition.
Softcover. Book with CD-ROM. Item No. 0444 ..... $49.95
Basic Antennas. Item No. 9994 ..... $29.95
Receiving Antennas for the Radio Amateur.
Item No. 0789 ..... ARRL Member Price $24.95 ..... ~~$27.95~~
Short Antennas for Small 160 Meter Radio.
Item No. 5798 ..... ARRL Member Price $19.95 ..... ~~$22.95~~
Antenna Physics: An Introduction. Item No. 0499 ..... $29.95
ON4UN's Low-Band DXing. 5th Edition. Item No. 8560 ..... $44.95
ARRL's Small Antennas for Small Spaces. 2nd Edition.
Item No. 0512 ..... ARRL Member Price $19.95 ..... ~~$27.95~~
Antenna Towers for Radio Amateurs. Item No. 0946 ..... $34.95
The ARRL Guide to Antenna Tuners. Item No. 0984 ..... $22.95
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Item No. 2889 ..... ARRL Member Price $22.95 ..... ~~$25.95~~
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Item No. 4784 ..... ARRL Member Price $24.95 ..... ~~$27.95~~
ARRL's Yagi Antenna Classics. Item No. 8187 ..... $17.95
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ARRL's Wire Antenna Classics. Item No. 7075 ..... $14
More Wire Antenna Classics. Volume 2. Item No. 7709 ..... $17.95
Even More Wire Antenna Classics. Volume 3.
Item No. 0239 ..... ARRL Member Price $19.95 ..... ~~$22.95~~
More Vertical Antenna Classics. Item No. 9795 ..... $17.95
Vertical Antenna Classics. Item No. 5218 ..... $12
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ARRL Antenna Compendium. Volume 2. Item No. 2545 ..... $14
ARRL Antenna Compendium. Volume 3. Item No. 4017 ..... $14
ARRL Antenna Compendium. Volume 4. Item No. 4912 ..... $20
ARRL Antenna Compendium. Volume 5. Item No. 5625 ..... $20
ARRL Antenna Compendium. Volume 6. Item No. 7431 ..... $22.95
ARRL Antenna Compendium. Volume 8. Item No. 0991 ..... $24.95

QST on CD-ROM and DVD

2017 ARRL Periodicals on DVD. Item No. 0772 ..... $24.95
2016 ARRL Periodicals on DVD. Item No. 0680 ..... $24.95
2015 ARRL Periodicals on DVD. Item No. 0505 ..... $24.95
2014 ARRL Periodicals on DVD. Item No. 0325 ..... $24.95
2013 Periodicals on DVD. Item No. 0093 ..... $24.95
2012 Periodicals on DVD. Item No. 3152 ..... $24.95
2011 Periodicals on CD-ROM. Item No. 5651 ..... $24.95
2010 Periodicals on CD-ROM. Item No. 2001 ..... $24.95

Technical

The ARRL Handbook 2019. 96th Edition.
Limited Edition Six-Volume Boxed Set.
Item No. 0895 ..... $64.95
Softcover. Item No. 0888 ..... $49.95
Understanding Basic Electronics. 2nd Edition.
Item No. 0823 ..... ARRL Member Price $29.95 ..... ~~$32.95~~
Basic Radio Item No. 9558 ..... $29.95
ARRL's Hands-On Radio Experiments. Volume 1 and 2.
Item No. 0857 ..... $29.95
ARRL's Hands-On Radio Experiments. Volume 3
Item No. 0796 ..... ARRL Member Price $19.95 ..... ~~$22.95~~
The ARRL RFI Book. 3rd Edition. Item No. 0915 ..... $29.95
Arduino for Ham Radio.
Item No. 0161 ..... ARRL Member Price $29.95 ..... ~~$34.95~~
More Arduino Projects for Ham Radio.
Item No. 0703 ..... ARRL Member Price $34.95 ..... ~~$39.95~~
Ham Radio for Arduino and PICAXE.
Item No. 3244 ..... ARRL Member Price $29.95 ..... ~~$34.95~~
ARRL PIC Programming Kit. Item No. 0030 ..... $149.95
L/C/F and Single-Layer Coil Winding Calculator.
Item No. 9123 ..... $12.95
ARRL's Low Power Communication. 4th Edition.
Item No. 5828 ..... ARRL Member Price $24.95 ..... ~~$27.95~~
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Item No. 5828K $105.95
More QRP Power. Item No. 9655 ..... $19.95
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Item No. 0055 ..... ARRL Member Price $24.95 ..... ~~$27.95~~
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Item No. 0086 ..... ARRL Member Price $19.95 ..... ~~$22.95~~
Grounding and Bonding for the Radio Amateur.
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