

QST



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amateur radio®

October 2020

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HAM BOOT CAMP

Breaking down
the barriers
new hams face

QST Reviews

**Four Station Power
Supplies**

Low-Power Attenuator Kits

**HybridDX Antenna for
160 - 6 Meters**

**Cushcraft AR-270 Dual-
Band Antenna**

C4FM/FM 144/430MHz Dual Band Mobile

High Visibility and Resolution QVGA Display with Exceptional Operability
Real Dual Band Operation V+V/U+U/V+U/U+V & Simultaneous C4FM Monitoring

FM Friendly Digital : AMS (Automatic Mode Select)

System Fusion II Compatible

WIRES-X Portable Digital Node Function

- **Wide Range RX Coverage : 108 ~ 999.99 MHz**
- **Easy to Operate II (E2O-II) : New User Interface for Easy Operation**
- **New Memory Auto Grouping (MAG) Function**
- **New Multi-Channel Standby (MCS) Function**
- **High-Speed 61 Channel Band Scope**
- **Easy Hands-Free Operation with Built-in Bluetooth® Unit**

C4FM/FM 144/430 MHz DUAL BAND
50 W DIGITAL MOBILE TRANSCEIVER

FTM-300DR



Bluetooth

AMS
Automatic Mode Select

microSD
Card



C4FM
Dual-Band
Clear and Crisp Voice Technology

WIRES-X

YAESU
The radio

YAESU USA
6125 Phyllis Drive, Cypress,
CA 90630 (714) 827-7600

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

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

High Visibility and Operation with a High-Resolution Full Color TFT & Touch Screen Display Superior Performance in a Compact C4FM Digital Transceiver

System Fusion II Compatible

Compact & Reliable 5W RF Power Output

700mW of C4FM Exceptional Quality Audio

Dual band Simultaneous Receive

**High Visibility Full-Color
TFT touch panel Display**

Built-in High Precision GPS Receiver

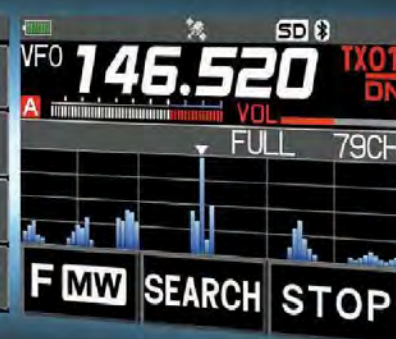
**Easy Hands-Free Operation
with Built-in Bluetooth® unit**

**High-Resolution and High-Speed
79 channel Band scope**

**CAM (Club channel Activity Monitor)
Function**

**FM Friendly Digital by AMS
(Automatic Mode Select)**

WIRES-X Portable Digital Node Function



C4FM/FM 144/430MHz DUAL BAND
DIGITAL TRANSCEIVER

FT3DR



《 Actual Size 》

Cushcraft...Keeping You in Touch Around the Globe



MA-6B
\$759.95

NEW!

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, \$579.95. 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



A-4S
\$759.95



A-3S
\$649.95

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

grow your collection of rare QSLs!

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

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

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



R-9 –
\$699.95

80-6 Meters

R-8 –
\$599.95

40-6 Meters

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!*

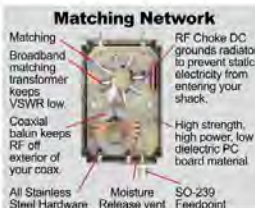
Its omni-directional low angle radiation gives you exciting and easy DX on all 9 bands: 75/80, 40, 30, 20, 17, 15, 12, 10 and 6 Meters with low SWR. QSY instantly – no antenna tuner needed.

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.

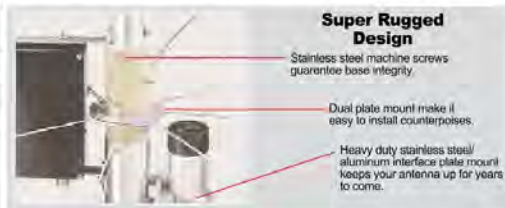
Compact Footprint: Installs in an area about the size of a child's sandbox – no ground radials to bury with all RF-energized surfaces safely out of reach.

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.



Matching Network

Matching Broadband matching transformer keeps VSWR low. Coaxial balun keeps RF off exterior of your coax. All Stainless Steel Hardware. Moisture Release vent. SO-239 Feedpoint. RF Choke DC grounds radiator to prevent static electricity from entering your shack. High strength, high power, low dielectric PC board material.



Super Rugged Design

Stainless steel machine screws guarantee base integrity. Dual plate mount make it easy to install counterpoises. Heavy duty stainless steel/aluminum interface plate mount keeps your antenna up for years to come.

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

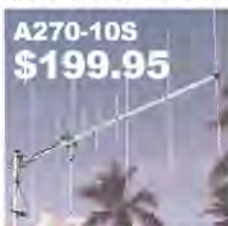
R8, \$569.95. Like R9 antenna but less 75/80 Meters.

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

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

Cushcraft Famous Ringos Compact FM Verticals

Cushcraft Dual-Band Yagis



A270-10S
\$199.95



A270-6S
\$159.95

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.



AR-2
\$79.95



AR-6
\$129.95



AR-10
\$139.95

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

Your New MFJ 2019 Ham Radio Catalog is HERE!
140 Pages of MFJ, Ameritron, Hygain, Cushcraft, Mirage and Vectronics Products! Visit www.cushcraftamateur.com to download your copy!

Cushcraft

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Sales/Tech: (662) 323-9538 • FAX: (662) 323-5803 Open 8-4:30 CST, Mon.-Fri.

Add shipping. Prices and specifications subject to change. 2016 ©Cushcraft.

Cushcraft_MA6B_081110_4C_QST_092019DS



**Life is a JOURNEY.
Enjoy the ride!**



Base Antennas

1 COMET CHA-250B BROADBAND 80M THROUGH 6M VERTICAL ANTENNA

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

2 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.

3 COMET GP-3 DUAL-BAND 146/446MHZ BASE REPEATER ANTENNA

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

4 COMET GP-6 DUAL-BAND 146/446MHZ BASE REPEATER ANTENNA

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

5 COMET 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

6 COMET CX-333 TRI-BAND 146/220/446MHZ BASE REPEATER ANTENNA

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

7 COMET GP-15 TRI-BAND 52/146/446MHZ BASE REPEATER ANTENNA

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



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!

CAA-5SC

Protect your CAA-500MarkII from moisture, shock, dents and dings!

Shoulder strap included.



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ARRL members can access the digital edition via a link at www.arrrl.org/qst, download our iOS app from the iTunes Store, and download our Android app from the Google Play Store.



Our Cover

Getting started in ham radio can be tough without help from a mentor. The Nashua Area Radio Society decided to create a "ham bootcamp" mentoring program to train new and upgraded hams, so they could feel confident getting on the air. Read more about this successful program in Fred Kemmerer's, AB1OC, article, "Ham Bootcamp: Getting Hams On the Air," on page 58 of this issue.



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EMPOWERED BY NATURE

You can't hear the music, without the speakers.



Translated: It's a lot easier to hear the DX, with a SteppIR!

DB18E YAGI

The DB18E Yagi offers incredible performance with a small profile – the boom is only 18 feet in length. The DB18E is optimized at every frequency between 6.8 and 54 MHz – it employs two active elements from 6.8-13.3 MHz and three active elements from 13.3-54 MHz. Each element is 39 feet long and utilizes our patented loop technology, which allows for a 40% reduction in physical length, with minimal sacrifice in performance. The DB18E has inherent SteppIR Yagi features such as 180 degree mode (reverse the direction of the Yagi 180 degrees in just 1.5 seconds), bi-directional mode (enjoy gain in opposite directions, simultaneously) and of course element retract – so you can keep your antenna safe during extreme weather events!

An Optimized, Single-Frequency Antenna on Every Frequency Within its Range

Yagis are single-frequency devices (the signal starts to degrade as the radio is tuned away from that frequency). Fixed length, yagi antennas utilize traps or interlacing to “trick” the radio into thinking it is resonant. With a SteppIR Yagi, the antenna is resonant with nearby 1:1 SWR on all frequencies within its range – no tricks, no compromises. SteppIR Yagis are remotely tuned using an electronic controller and stepper motors – each element tunes to the exact length required for any given frequency.

steppIR
TECH



FOR PRODUCT DETAILS AND ORDERING:
www.steppir.com 425-453-1910

DIAMOND ANTENNA

diamondantenna.net

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

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

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

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

Here is a small sample of our wide variety of antennas

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

X700HNA Special Features:

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

The Standard By Which All Others Are Judged

NR770H Series

SG7900A

X300A / X50A

X700HNA



**RF PARTS
COMPANY**

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Second Century

Change is In the Air

I'm writing this weeks before you're reading it, sitting in COVID isolation, in the sweltering heat during a tropical storm-induced blackout, hoping that life will be very different come October. Despite the circumstances that have many of us feeling stuck and looking forward to a "new normal," amazing changes are taking place at ARRL during this time. From new benefits, to online engagement opportunities, to new technologies and communications, change is in the air, actively reimagining possibilities, developing opportunities, and pushing us to innovate.

Change is nothing new to ARRL, having weathered many world-altering events over the last 106 years and proving time and time again to be adaptable and resilient. In looking at our history, it is clear to see that change, while daunting, can be an opportunity and driver of improvement and growth. Welcoming change is how I see membership, marketing, and communications helping to advance ARRL throughout the next century. Unlike the disruptive changes occurring in our lives today, strategic, incremental changes are planned to help ARRL grow in membership size and member experiences, and get all members more active and involved in ham radio. We're also planning ways to increase our revenues, so we're better equipped to serve members and give back to the community. We look to *advance the art, science, and enjoyment of amateur radio* among those of you who are our most loyal, long-time members as well as those who are new to the ham radio community.

These changes began well before the pandemic, when various departments collaborated on a series of new benefits that help you get more value out of your ARRL membership. Early 2020 brought new offerings such as the *On the Air* magazine, podcast, and blog, which provide resources for those with a beginner-to-intermediate level of experience. Member access to the digital editions of all four ARRL magazines was launched in spring 2020, giving members a look not only at *QST* and *On the Air*, but also the advanced theory and projects available in *QEX*, as well as the radiosport commentary, interviews, and contest results that *NCJ* presents for more seasoned hams.

This summer, we added the benefit of the *ARRL Learning Network*, featuring a series of member-volunteer-led educational webinars, both live and recorded for convenient listening; and *The Current*, a

monthly email communication highlighting articles from all four ARRL magazines, along with news about new and featured ARRL products and benefits, upcoming events, and more. Speaking of events, in response to the changing comfort level with attending in-person events, this summer we began testing virtual platforms and investigating hybrid event options for future opportunities to engage with you, should face-to-face events not be possible.

Coming later this fall, a host of online member service enhancements will take place, including an updated e-commerce system that will allow you to renew your membership, donate to ARRL, and buy a book — all in one transaction. This new system will also connect you to the ARRL Learning Center in the future, providing online learning on a variety of radio communication and technology topics.

The investment in this new technology will also allow us to launch a digital membership option to accommodate those of you who prefer digital delivery of your magazine membership benefit. Other upcoming developments include an onboarding program to better engage new members and re-engage lapsed members, new strategies to assess and revise products and publications, enhancements to ARRL's social media presence, and improvements to the email communications you elect to receive through your online profile.

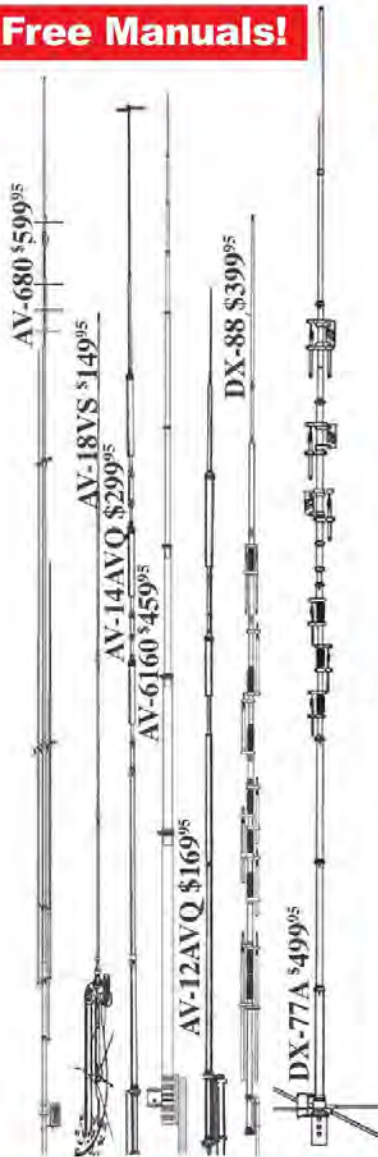
Even with the disruptions of the past few months, many positive changes have sprouted and grown and are working to transition ARRL through these uncertain times. As more of you become active and engaged, your involvement will continue to help ARRL evolve and thrive well past the next century.

*Kathleen Callahan, KC1MBY
Marketing & Communications Manager*

The First Choice of Hams Around the World!

hy-gain® HF Verticals

Free Manuals!



hy-gain® Classics

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

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

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

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

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

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

Two-year limited warranty.

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

AV-680, \$599.95. (80, 40, 30, 20, 17, 15, 12, 10, 6 Meters). 26 ft., 18.5 lbs.

No ground or radials needed.

Low 17 degree radiation angle and omni-directional gives world-wide DX. 2-minute 1500 Watts key down. 1/4 wave stubs on 6/10/12/17 M and efficient end loading coil/ capacity hats on 15/20/30/40/80 M gives automatic band switching. Wide SWR bandwidth. Teflon® wire broadband matching unit. Low 2.9 sq. ft. wind surface. Mounts on decks, roofs, patios. 65 mph wind survival. Aircraft aluminum tubing, stainless steel hardware.

AV-640, \$499.95. (40, 30, 20, 17, 15, 12, 10, 6 Meters). 25.5 feet, 17.5 pounds.

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AV-18VS, \$149.95. (80, 40, 30, 20, 17, 15, 12, 10 Meters). 18 ft., 4 lbs.

Covers 80-10 Meters continuous, 1500 Watts PEP.

Easily change bands by manually moving bandchange wire at base loading coil. Also ideal for shortwave listening. Sleek, low profile. Tiny footprint mounts anywhere on 1.5-1.625" diameter mast driven into ground. Requires at least one radial. Tapered 6063-T6 aircraft aluminum. Stainless steel hardware. 80 MPH wind survival.

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



\$895

PG50PS Pulse Generator

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



SALE
\$775

TDR-Cable Radar®

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

T150 Step Attenuator

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

\$275

SMT Station Monitor

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

\$259



TTG1 Two Tone Generator

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

\$279



DDS-1 Dual Directional Coupler

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

\$175



HFS-1.5 HF Sampler -30dB

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

\$175



RLB-E 500MHz Return Loss Bridge

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

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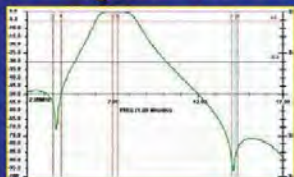


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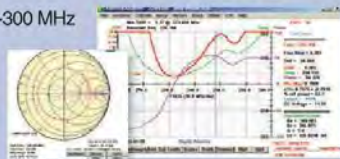


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A more complex system could be a SO2R contest station as shown.



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Member Spotlight

David Godfrey, NY5A

Five years ago, Dave Godfrey, NY5A, started utilizing the knowledge of electronics he'd gained through his amateur radio hobby and a career in microwave maintenance to start a retirement business repairing sewing machines. His business grew as expected, until March of this year. He couldn't have anticipated the effects of a global pandemic. COVID-19 has kept Dave busy since March, repairing sewing machines that contribute to the creation of masks that help lessen the risk of infection.

Electronics and Radio

Dave earned his Novice-class license, WN7DAI, back in 1965, when he was a sophomore in high school. His fascination with electronics has grown ever since. In 1967, he earned his General-class license and focused most of his efforts on DXing.

Dave went on to work in microwave maintenance for Pacific Telephone. "My ham radio experience helped me get the needed commercial license," he said. However, over the years he had fallen in and out of the hobby, until 10 years ago, when he became "hooked" again. For the past 2 years, he has been president of the Walker County Amateur Radio Group in Walker County, Texas. "We have a great group in the club and work well together to teach each other the many aspects of radio," he shared.

A Busy Retirement

Dave's knowledge of electronics came in handy when he decided to start a business repairing sewing



machines during his retirement. His business grew as he expected it to. "I live in a rural area, so most of my customers come from a five-county area," he explained. In March of this year, he noticed a drastic change in business, when the coronavirus pandemic began to spread across the US.

"This whole experience has given me great honor in being able to provide this service to so many people that are just trying to do their part to help in this time of need."

With the pandemic at an all-time high, many people wanted to help make masks for their communities. "People started taking their old sewing machines out of the attic after 10 years, expecting to start making masks," he said. Unfortunately, many of these volunteers discovered their machines needed repairs before they could begin producing masks. Dave explained that some of his customers committed to making 100 masks or more by a certain date, before realizing their machines needed repairs. Needless to say, business has been booming in light of this new demand.

As a result of Dave's thriving business fixing sewing machines, he hasn't had much time for amateur radio, but he's happy to help. "This whole experience has given me great honor in being able to provide this service to so many people that are just trying to do their part to help in this time of need," he said.

Looking Ahead in Radio

When Dave first got into amateur radio, he enjoyed DXing and having long conversations with other operators. However, after his experience helping people give back to their communities during a global time of need, he wants to become more involved in emergency services. The Walker County Amateur Radio Group now has a small group that joined forces with their local Amateur Radio Emergency Service (ARES) group to learn emergency service skills, such as digital and packet communications procedures. "Boy, do I love this hobby and [I'm] so thankful I got into it so long ago," Dave said.

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

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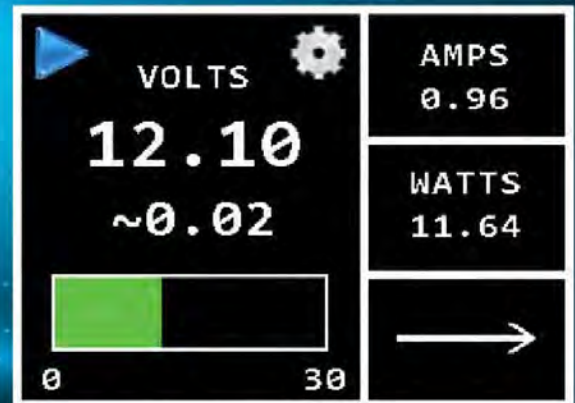
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Up Front

Rare Novice Transmitters



On April 22, 2020, Jon Jesse, WS1K, and Steve Miller, WA3JJT, made their first contacts using their World Radio Labs CW-7 Novice transmitters. Jon's transmitter was a rare original (left), while Steve's (right) was a modern clone. The CW-7 debuted in the early 1950s and used 70L7 and 50L6 tubes. Steve is looking for original manuals and other CW-7 owners. You can contact him at stevemillererie@hotmail.com.



Railroad Telegraphy

While visiting Oakland, Maryland, in the extreme western region of "The Old Line State," Al Rabassa, NW2M, came across the Oakland B&O Railroad Museum. According to Al, it is one of the better train museums he has visited and has the best working telegraphy setup he has ever seen.

3D-Printed Cover

During the coronavirus lockdown, Mark Erbaugh, N8ME, purchased a 3D printer and spent some of his time making new creations for his station. One of his favorites is a cover for the terminals on his Vibroplex® iambic paddles. Mark said, "I never liked the look of the wires coming directly off the posts and wanted some form of strain relief. I also wanted the ability to easily disconnect the paddles. I sketched up the paddle jack cover in *FreeCAD* and printed it, then installed a panel mount 3.5-millimeter TRS jack in the hole on the front and attached short wires with crimp-on ring terminals. I installed the ring terminals on the paddle posts, placed the cover over the terminals, and used the binding nuts to hold the cover in place."



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Correspondence

Letters from Our Members

A Classic Article for an Old-School Operator

In February 1965, at 18 years old, I enlisted in the Army to train in radio communications. I trained on Morse code for 18 weeks at Fort Devens, but never got past 13 WPM, so I was diverted to radio telegraph schools and then shipped out to Japan and Vietnam. Fifty years later, in 2015, I became a new amateur radio licensee. CW had always been my passion, so with a new radio, a J-37 telegraph key from the army, and a wire antenna, I was on the air on 40 meters. I now operate on the same HF bands that I monitored with Collins R-390 receivers while stationed in Japan. I'm now able to send Morse code at up to 15 WPM.

After 5 years in ham radio, as a lifetime ARRL member and a casual but exclusively CW operator, I found an article that got my attention right out of the mailbox. In the August 2020 issue of *QST*, I was drawn to an old article in the "A Look Back" section, about the "Junker" amplifier by Lew McCoy, W1ICP (SK). The use of tubes appealed to me, and I was grateful to read an article that spoke my language. Thank you for republishing it!

Vern Maine, AI1I
Rindge, New Hampshire
Life Member

Upgrading After Coronavirus

In March, I contracted the coronavirus from one of my students. I had received *The ARRL Amateur Extra-Class License Manual* and *ARRL's Extra Q&A* in 2018, but I didn't begin to seriously study for the exam until I was quarantined during the 18 days

that I was sick. Social distancing guidelines and other policies have caused many cancellations of license and upgrade exams here in Michigan. However, once I had recovered from the virus, I was able to find an exam location in another city. When I met with the Volunteer Examiners (VEs), they were very helpful and professional. After I finished the exam and earned my Extra-class license, a newly licensed Technician-class examinee asked if it was worth it to pursue the Extra-class license. My response was, "It was worth the 11 weeks of study!" Becoming a VE is my next challenge, along with possibly introducing the world of amateur radio to my elementary afterschool students.

John Rhodes, Jr., KE8JHB
Flint, Michigan

Transmitting from Californian to Hawaiian Beaches

Larry Paola's, KC2EQA, article, "A Tale of Two Catches," in the August 2020 issue of *QST*, made me recall one of the most satisfying events in my ham radio experience. Around 1980, I brought a Heathkit HW-7 2 W, three-band transceiver to the beach, along with an 8 W solar panel that I had built. I also took a roll of thin wire from a flyback transformer, a kite, and a homemade antenna tuner, which was made from a tapped coil and two open-air variable capacitors.

I set up on the beach just as Larry did in the article; however, I then had to fly a kite and tune it on 40 meters, to the frequency of one of several 40-meter crystals that I had from the early 1960s. I plugged in the solar panel and started listening to the

40-meter CW band. I heard someone calling CQ from Hawaii at my crystal frequency, and I responded. I couldn't believe it when I heard my call sign being broadcast back to me. I was on a beach in Playa del Rey, California, transmitting using an 8 W solar panel and about 1 W of output transmit power, and the other station was 2,550 miles away. That year was near the peak of Solar Cycle 21, so sunspot conditions were at their maximum, which helped.

A small crowd gathered around me when they heard me cheering. One of them even took a photo and mailed it to me a month or two later from Texas. It is incredible to think about the unique opportunities of meeting people, near and far, through radio.

Greg Glenn, WB6MPH
Pacific Palisades, California

International Mail Suspensions Due to COVID-19

I recently received a returned QSL card from Jordan. A note on the envelope stated, "Mail service suspended." The postal service is temporarily suspending international mail acceptance for certain destinations due to the COVID-19 pandemic. Other hams might want to check for suspended service at this time, before mailing a QSL card to a DX station. You can find more info about suspended service on the USPS website, at <https://about.usps.com/newsroom/service-alerts/international>.

Jim Crisco, WA4YIZ
Lincolnton, North Carolina

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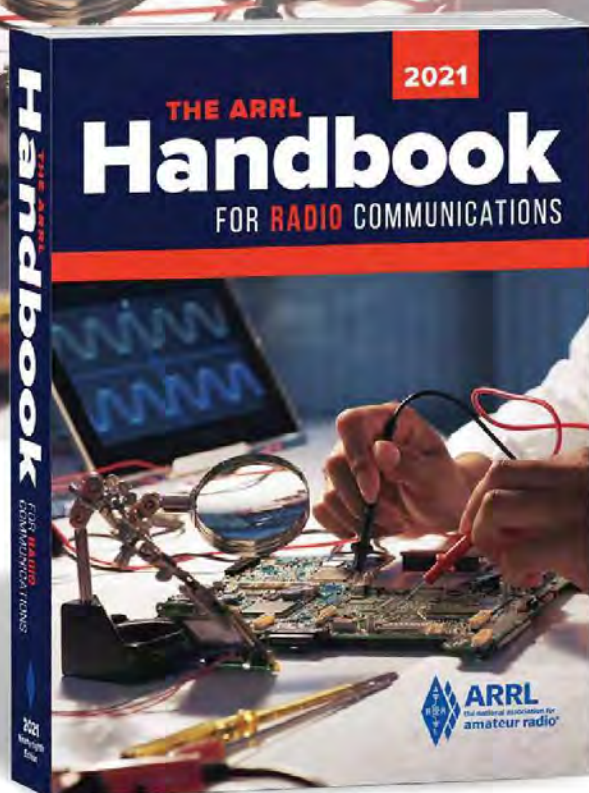
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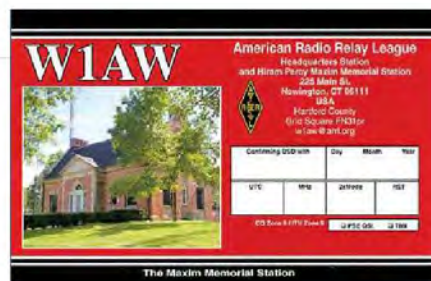
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Spirally Loaded Copper Tape and PVC Dipole

This easy-to-build 2-meter-band vertical dipole is only 40% as tall as a J-pole.

John Portune, W6NBC

Here is a simple starter antenna — especially for a new ham — that offers good performance, and would be a good radio club build-it-yourself project. It's stealthy and low visibility to neighbors and homeowners associations. It's also a good temporary base station antenna for net control at parades and marathons.

Not many hardware store do-it-yourself materials are more attractive to homebrew hams than PVC pipe and copper. The spirally loaded copper tape and PVC dipole is the simplest 2-meter antenna using only these ham favorite materials.

This little gem is an 18-inch tall corkscrew of 1-inch adhesive-backed copper foil tape, wrapped spirally around a 3-foot length of 1¼ inch PVC pipe. The tape is available at many hardware stores. Equally suitable adhesive copper tape, used for RF shielding, is also available from online suppliers. Be sure to purchase it in a 1-inch width.

How It Works

The entire antenna length is just a stretched-out loading coil, a helix of 1-inch by 1.5-mil copper. The wide tape has low resistance, which is important in a small antenna. Aluminum tape can also be used; although, you should select a slightly thicker gauge. The 1-inch-wide turns are separated by a further 1 inch to minimize losses common in loading coils. The result is an antenna with better than 90% efficiency.

Performance

Figure 1 shows the *EZNEC Pro-4* radiation patterns. Our barber pole antenna is vertically polarized and omnidirectional toward the horizon, with a maximum gain of 1.64 dBi. In comparison, the much taller 5-foot copper-pipe J-pole has essentially the same radiation pattern and only a half-decibel more gain.

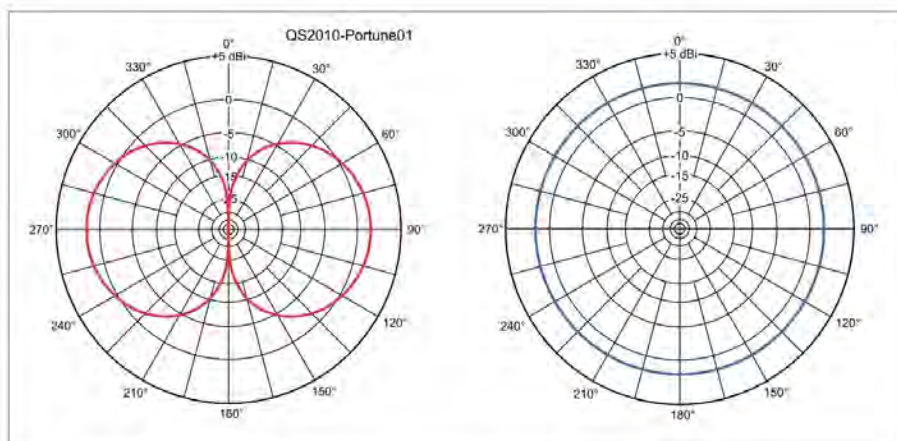


Figure 1 — Elevation (red), azimuth (blue) free-space radiation patterns.

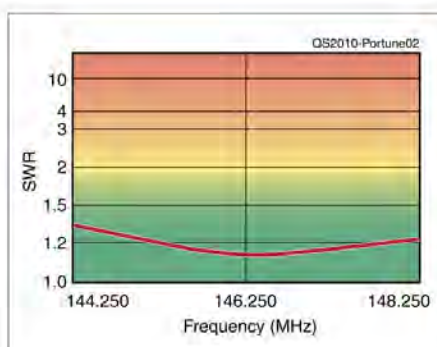


Figure 2 — SWR in the 2-meter band measured with a Rig Expert A-1400.



Figure 3 — Drawing the guideline for accurately applying the copper tape.

sibility is to seamlessly integrate the antenna with its mast for no visible mounting brackets.

Adhesive-backed materials are difficult to position accurately, therefore, you should make up a temporary guide strip for drawing an accurate guideline on the PVC pipe and mast. This can either be a 54 × 2 inch strip of card stock or flexible plastic material. If necessary, align and tape together shorter strips. I cut mine carefully to 2 inches on a paper cutter, from the front covers of heavy 8½ × 11 inch plastic report folders.

Marking the Guideline

Initially, tightly wrap a single turn around the PVC pipe at the lengthwise center of the guide strip, and likewise at the lengthwise center of where the helix will be on the pipe. Butt the strip edges together and temporarily secure this single turn with household tape. Then complete the wrap, being careful to keep the edges butted together. Secure the entire wrap with tape.

Figure 2 shows the SWR and bandwidth at 2 meters plotted with a Rig Expert A-1400 antenna analyzer. The wide copper tape contributes significantly to the bandwidth shown — excellent SWR of less than 1.5:1 across the entire band.

Cost

I purchased a 45-foot roll of 1-inch by 1.5-mil copper RF shielding tape from Amazon for \$10.99. Only 5 feet are needed, but the remaining tape is useful for other radio projects. A 10-foot length of 1¼-inch PVC pipe is roughly \$20. Some stores sell shorter lengths; this antenna requires 3 feet of pipe. Six feet of mini RG8 on the internet costs \$1.20 at \$0.20 a foot. A PL-239 connector is about \$2 to \$4. Considering only the fraction of materials used, this antenna has a modest price tag of about \$10.

Construction

Begin with a 36-inch length of 1¼-inch Schedule 40 PVC pipe. Schedule 80 or ABS DWV pipe is okay too. The top 20 inches are for the helix, and the space at the bottom is for mounting. Alternately, a unique pos-

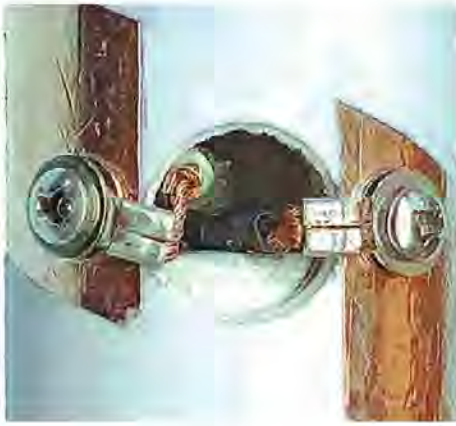
Next, draw the guideline along the edge of the strip with a permanent marker, unwrapping one end a little at a time (see Figure 3). Using the guideline marked on the PVC pipe, carefully adhere 54 inches of copper tape along the guideline. Begin 1 inch from the top, progressively folding back the paper backing that protects the copper tape's adhesive, only in short lengths as you proceed.

Feed-point and Feed-line Pigtail

Next, remove 1 inch of foil at the lengthwise center of the helix and then drill a ¾-inch hole through the PVC pipe in the gap (see Figure 4). The feed coax runs coaxially up through the PVC pipe from the bottom and exits at this hole to connect to the helix.

Next, prepare a 6-foot RG58 or Mini-8 coax feed-line pigtail. Separate the center conductor and shield wires into two individual conductors (see Figure 5). Weatherproof the ends with heat-shrink tubing.

Add #6 ring terminals for the feed-point screws, leaving roughly ½ inch of the conductors exposed to facilitate a sharp bend at the feed point. Drill and tap the



▶ **Figure 4** — Feed point detail.

▶ **Figure 5** — Coax pigtail ends.



PVC pipe, through the helix ends, for 6-32 $\times$ $\frac{3}{8}$ -inch stainless-steel screws and flat washers. Stainless sheet metal screws can also be used.

It is advisable to use heavier coax, such as RG8, RG213, or LMR400, for the downstream run from the pigtail to the shack to minimize losses.

Feed-line Spacer

We also need to keep the coax centered inside the helix and PVC pipe to prevent it from adversely affecting the antenna. Plastic foam is suitable as a spacer. A better choice is 12 inches of $\frac{3}{4}$ -inch PVC pipe with end caps, and centered end holes for the coax. Use end caps that will fit and hold the spacer snugly inside the main pipe. Some caps may require a little filing or a drop of PVC cement. Push the spacer snugly right up to the feed point. It is just visible at the bottom of the hole in Figure 4.

A note of caution: Be sure to connect the coax shield wire to the bottom helix turns, and the center conductor to the top turns. If these connections are reversed, tuning will be difficult.

Balun

The antenna needs a 1:1 current choke balun just below the helix. You can use a stack of VHF-mix ferrite beads on the pigtail inside the PVC mast or an external six-turn 1-inch ring of bundled coax secured with zip ties.

Tune and Match

My antenna tuned up at 146 MHz with a good SWR when trimmed to three and a half helix turns on top and four and a half turns below the feed point. The reason for a non-centered feed point is this. A shortened dipole has a natural center feed-point impedance of

less than 50 Ω . A 1:1 match will be found slightly off-center on either side.

To allow for initial adjustment, the 54-inch length of the copper tape is intentionally too long. The initial frequency will be low. One merely removes small amounts until the desired frequency and SWR are achieved. The number of turns on top compared to the number at the bottom adjusts the SWR. The total length adjusts the fre-

quency. Consequently, remove or add foil only at the top to adjust the SWR. Add or remove similar amounts simultaneously at both ends to change the frequency.

The rule of thumb for trimming antennas is to adjust the SWR first and then the frequency. SWR will change little when you next adjust the frequency.

Begin the tuning of your helix by removing copper tape until there are three and a half turns at the top and four and a half at the bottom. From there, fine-tune for the best SWR. If you remove too much foil, add back a short piece, overlapping the ends by 1 inch, so the capacitive coupling of the overlap prevents the adhesive from interfering with the coupling.

Final Issues

Cut off excess PVC pipe at the top and install a cap to keep out the weather. You can enclose the antenna in a radome of 2-inch PVC. If left exposed, at least the feed point should be weatherproofed with self-curing plastic tape, heat-shrink tubing, or RTV clear silicone sealant.

John Portune, W6NBC, is an ARRL member and frequent contributor to *QST*. He has been licensed for 54 years and has held an Amateur Extra-class license since 1972. John has a BS in physics and also holds an FCC Commercial General Radiotelephone Operator license and an FCC Radiotelegraph license. He retired as a broadcast television engineer and technical instructor at KNBC in Burbank and then from Sony Electronics in San Jose, California. John has published many articles in *QST* and other amateur radio journals, and is a frequent speaker at ham radio clubs. You can reach John at jportune@aol.com or through his website at www.w6nbc.com.

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High-Performance 80 – 40 – 30 Meter Vertical Antenna

This triband vertical antenna can also include 160-meter band operation.

Randy Rhea, N4HI

For the first time in 18 years, I moved to a home where I could put up a tower to support my homebrew log-periodic array. I still needed something for the low bands, so I hung a 72-foot wire vertical in a tree and matched it on 80 and 40 meters using a dual-band network first described by Hayward, W7ZOI, in the June 1977 issue of *QST* and later by Richardson, K6MHE, in the September 2005 issue of *QST*. I laid three 82-foot radials on the ground. The wire vertical antenna was $\frac{5}{8}$ wavelengths on 40 meters and just over $\frac{1}{4}$ wavelength on 80 meters.

Surprised and encouraged by the vertical antenna performance, I began considering an improved vertical.

The Objectives

I had five objectives for the vertical antenna: 1) a more permanent installation than a wire in the trees, 2) addition of 30 meters for 80 – 30 meter coverage, 3) nearly $\frac{5}{8}$ -wavelength height on 40 and 30 meters for reduced ground losses and a lower radiation angle, 4) a single coax feed line to the antenna with no control wires or relays, and 5) provisions for a dc ground to eliminate static buildup on the antenna.

A network to match three frequency bands to an antenna with multiple resonances would be a challenge, but I had access to Genesys RF/microwave synthesis and simulation software (www.keysight.com) to attack the problem.

I had recently acquired about 47 feet of Rohn 25G tower that had been sawed from a concrete ground foundation. I buried the remaining base in concrete, which left 43½ feet of the tower above ground. The rest of the vertical antenna would be telescoping aluminum tubing.

The Concept

The elevation pattern for an antenna that is $\frac{5}{8}$ wavelengths on 40 meters is lobed and undesirable on 30 meters, so I added a trap at 60 feet, in the form of a shorted 10.1 MHz coaxial stub trap, which easily hangs in the tubing and tower. The final concept was a 43½-foot tower, a 16½-foot tubing section, a coaxial-stub trap, and a 12-foot top tubing section.



I had recently acquired about 47 feet of Rohn 25G tower that had been sawed from a concrete ground foundation.

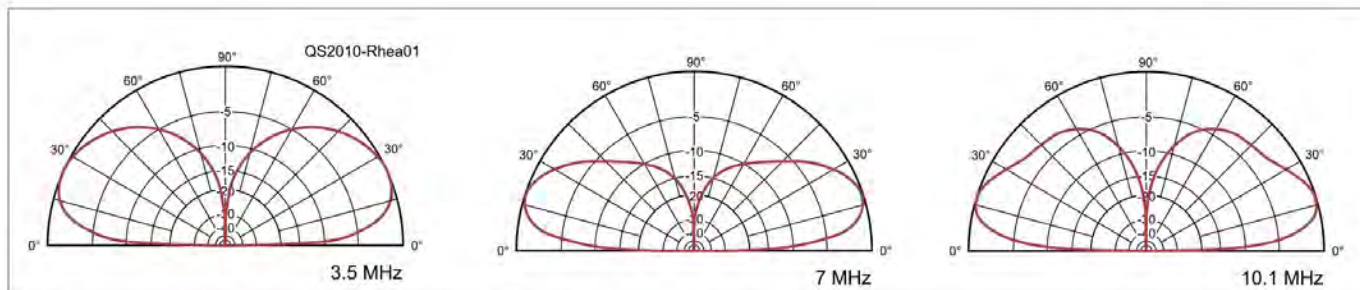


Figure 1 — EZNEC-simulated elevation patterns for the vertical over a medium ground.



Figure 2 — PVC section terminating the 10.1 MHz coaxial-stub trap at 60 feet, before (left) and after (right) applying heat-shrink tubing.

I ran a simulation using *EZNEC* (www.eznec.com) to verify the patterns (see Figure 1) and estimate the base impedance. The antenna is near resonance on 3.5 MHz, but the 7 and 10.1 MHz impedances are reactive. I planned to finish the network design using measured data.

Construction of the Antenna

The 16½-foot section was 1½-, 1⅜-, 1¼-, and 1⅝-inch ID telescoping aluminum tubing. With a table saw, I ripped a slot along the length of an 18-inch section of 2-inch Schedule 40 PVC pipe. When compressed, it fit

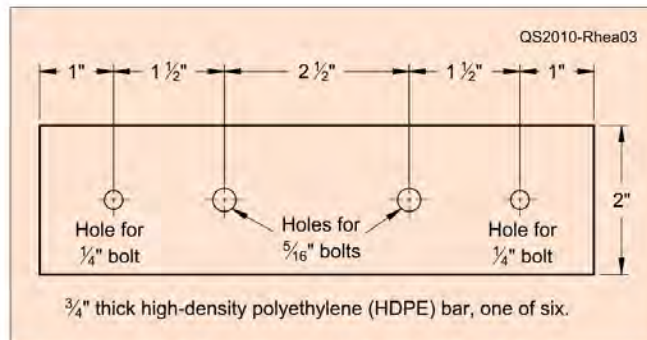


Figure 3 — Drill-hole pattern for a ¾ × 2 × 7½ inch high-density polyethylene (HDPE) hinge. Six hinges are needed.

tightly within the top tube of the tower. I slipped the bottom 1½-inch aluminum tube inside the PVC and secured it with two bolts through the tower and aluminum tubing at right angles to each other.

The 10.1 MHz stub is 20½ feet of LM400 coaxial cable that has a velocity factor of 0.84. It hangs within the 16½-foot middle tubing section and it protrudes a few feet down into the Rohn 25G tower section.

Figure 2 shows the PVC pipe and stub termination assembly that connects the bottom aluminum section to the top aluminum section. A 12-inch piece of ¾-inch Schedule 40 PVC pipe was also ripped. I drilled two holes in the PVC pipe for the coaxial stub at the slot while the pipe was compressed in a vise. The top copper wire is the center conductor of the coaxial line, and the bottom copper wire is soldered to the outer shield of the coax. The PVC pipe was then compressed and slipped into the top 1-inch ID tube of the lower aluminum tube section.

The upper section of the vertical is 12 feet of ¾-, ⅝-, and ½-inch telescoping aluminum tube. The bottom of this section slips inside the PVC terminating section. The total height of the antenna is 72 feet.

My ground system comprises two 8-foot ground rods and 24 82-foot-long evenly spaced radials of insulated



Figure 4 — The base of the high-performance vertical shows the insulating base hinges, the matching network enclosure mounted on one of the ground rods, and a portion of the radial system.

solid #16 AWG wire (dog fence wire) laying on the ground and held down with landscaping pins.

The Insulating and Hinge Base

I opted to insulate the base of the tower. This offered the opportunity to use a hinge system at the base to erect the antenna. I cut six hinge bars, 7½ inches long, from 4-foot stock of ¾ × 2 inch high-density polyethylene (HDPE) bar. Figure 3 shows the dimensions and drill-hole pattern for a typical hinge bar.

For strength, I cut out 6½-inch sections of each tower leg so that the end of each leg was short and close to a cross bar (see Figure 4). The holes in the tower legs must be placed so the cross bars do not interfere with the hinging tower. Also, careful alignment is required in the holes drilled in the tower leg for easier insertion of the bolts when the tower is erected. Galvanized ¼-inch and ⅝-inch bolts secure the tower to the hinge bars. The insulating hinge bars, matching network enclosure, and ground system are seen in Figure 4. Once erected (see the lead photo), the tower is guyed at 35 feet with non-conducting cable. The guys are

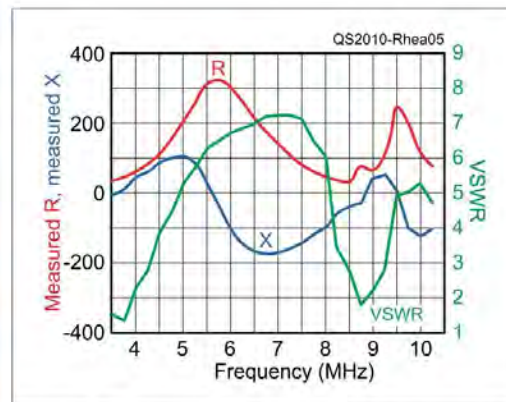


Figure 5 — Measured impedance at the base of the high-performance vertical antenna. Resistance is shown in red, reactance is shown in blue, and SWR is shown in green.

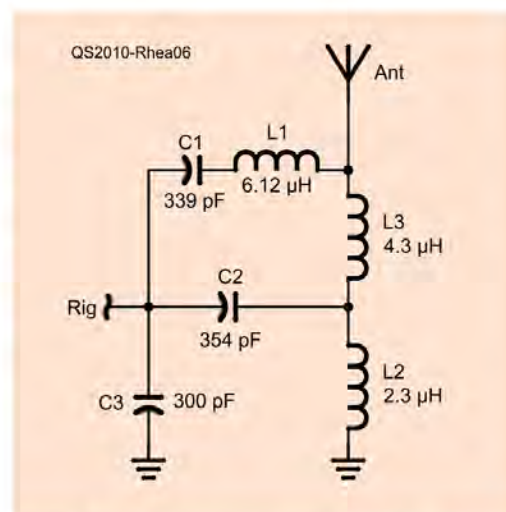


Figure 6 — Antenna-matching network for the 80-, 40-, and 30-meter bands.

attached to the tower before erection to avoid climbing the tower.

The Matching Network

After the antenna was completed, I measured the base impedance using an AA-35 Zoom Antenna and Cable Analyzer by RigExpert (www.rigexpert.com). The base impedance from 3.5 to 10.25 MHz is shown plotted in Figure 5. I designed the network by trial and error using the *Genesys* circuit theory simulator. The schematic of the final network is shown in Figure 6. Because the measured base impedance was capacitive and higher than 50 Ω on both 40 and 30 meters, I began with an inductive stepdown transformer consisting of L2 and L3. This also provides a dc ground.

Capacitor C2 improves the SWR on 40 and 30 meters, while C1 and L1 are near resonance on

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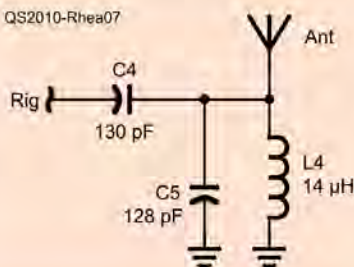


Figure 7 — Antenna-matching network for the 160-meter band.

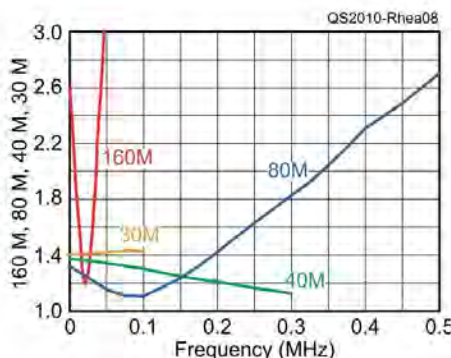


Figure 8 — SWR of the matched antenna measured in the shack through 120 feet of LM400 coax cable. Frequency shown is from the bottom of each band.

80 meters and bridge the antenna directly to the input. The value of C3 is not a critical, but it improved the match on all bands. I used *Genesys* to optimize all the component values, resulting in a good match on 80 through 30 meters.

The 160-Meter Bonus Band

With a 72-foot radiator and an extensive radial system in place, I tested the vertical on 160 meters. The base impedance measured with the AA35 was (13.5 – j237) Ω.

I constructed the matching network for 160 meters, shown in Figure 7. The final values of the matching network were empirically adjusted. C4 is not sensitive and may be fixed. Tune capacitor C5 to place the SWR minimum at the desired frequency.

I elected to use two inputs on top of the matching network box and two SO-239 bulkhead connectors on the sides, and then select networks manually.

Construction of the Matching Network

The matching network is enclosed in a 12 × 12 × 6 inch weatherproof plastic electrical junction box. Mount the box on one of the 8-foot copper ground rods using

two small U bolts, as seen in Figure 4. The U bolts serve as the ground reference inside the box. The antenna has a 12-inch jumper to a ¼-inch brass bolt on top of the box. Inductors L1, L2, and L3 are #14 AWG enamel magnet wire closely spaced and tightly wound on ½-inch thin wall PVC, with 26, 12, and 19 turns respectively. L4 is 27 turns on 1-inch Schedule 40 PVC. The magnet wire may be straightened before winding by slightly stretching the wire. The windings are stabilized by wrapping with electrical tape.

The matching network is tuned after installation. I accomplished this using variable capacitors for C1 and C2. The value of capacitor C3 is not critical, and it may be a fixed capacitor. C1 and C2 may also be used to obtain the lowest SWR to the phone portions of the bands if desired. Centering the lowest SWR for each band should result in a reasonable match on 80 through 30 meters. The bandwidth on 30 meters is wide, and once C1 and C2 are tuned, the SWR on 30 meters should be low. However, the bandwidth of the 160-meter network is small, so C5 must be tuned for the desired segment. I operate without a linear amplifier, so closely spaced variable capacitors are suitable. Fixed capacitors, and parallel capacitors to reduce required variable capacitance, can be doorknob variety or 1,000 V silver-mica capacitors.

Performance

Figure 8 shows SWR under 1.5:1 is achieved across the entire 40- and 30-meter bands, as well as the CW and digital portion of 80 meters. The bandwidth of the 160-meter network is narrow. The antenna is more of a compromise on 160 meters.

Randy Rhea, N4HI, was first licensed in 1962. He worked as an electrical engineer at Boeing, Goodyear Aerospace, and Scientific Atlanta. In 1985, Randy founded Circuit Busters, later renamed Eagleware, which was acquired by Keysight Technologies in 2005. The Eagleware RF/microwave software design suite *Genesys* is still supported by Keysight and used by thousands of engineers worldwide. Randy is the author of several engineering reference books covering oscillators and filters. He operates exclusively HF CW. He is married and has two children and five grandchildren. You can reach Randy at oscillatordesign@gmail.com.

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

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Feedback

In the July 2020 issue of *QST*, the list of Legacy Circle Members should have included Ron Pollack, K2RP. *QST* regrets the omission.

Mapping Your Contacts with QSOmap.org

If you grow tired of exporting ADIF files and then importing them into QSOMAP, the website has an additional feature that receives forwarded contacts from several logbooks, including *Ham Radio Deluxe*, *N1MM Logger*, *N3FJP*, and *Log4OM*. Each time you add a contact to one of those logbooks, it can be automatically forwarded to QSOMAP and added to its database.

A popular map with the Parks on the Air (POTA) group is the Polyline map. For this map, hams generally delete all of their contacts from the QSOMAP database and only upload those contacts made during a POTA operation.



For more information, visit www.QSOmap.org.

Product Review

Four Station Power Supplies

Reviewed by Mark Wilson, K1RO
k1ro@arrl.org

A typical 100 W HF transceiver needs a power supply that can provide 13.8 V dc at about 20 A. The four power supplies reviewed here will easily power a transceiver plus a few station accessories. You can find previous reviews of other suitable station power supplies in the online Product Review archive (www.arrl.org/product-review).

Lab Testing

The accompanying tables show the results of testing in the ARRL Lab. All of the supplies measured close to 13.8 V output with no load. To simulate typical use dur-

ing SSB or CW operation, the Lab tested dynamic regulation by switching rapidly between 1 A and 20 A loads. The test results appear as *Dc variation during dynamic testing* in the tables. The *Low line dropout voltage* is the line voltage at which a power supply's output drops to 11.4 V dc, the minimum specified operating voltage of most transceivers. This test was done with a 20 A load.

Bottom Line

The power supplies in this group provide more than enough current to power transceivers and station accessories.

Conducted Emissions Testing

Some electronic devices, including switchmode power supplies, intentionally generate RF as part of their normal operation. This RF is not intended to be radiated as it would be by a transmitter. Under Part 15 of the FCC rules, such devices are defined as *unintentional emitters*.

Radio amateurs are concerned about RF noise generated by the switching regulators, and the power supplies reviewed here are designed and built with shielding and other techniques to suppress noise that could be heard in a station receiver.

Part 15 rules establish absolute limits for two types of emissions from unintentional emitters:

- *Conducted emissions* are conducted onto the house wiring and power lines via the device power cord. Part 15 provides absolute limits for conducted emissions from 150 kHz to 30 MHz. Conducted emissions are the primary problem below 30 MHz because ac power wiring provides a physically large "antenna" at HF and lower frequencies.

- *Radiated emissions* are radiated by the device itself. The absolute limits in this case are specified at 30 MHz and higher. Power lines are relatively inefficient transmission lines at VHF and higher frequencies, so radiated emissions are the primary problem at those frequencies.

FCC Part 15, Section 15.107, sets the limits for conducted emissions based on frequency:

- 0.15 – 0.5 MHz, 66 to 56 dB μ V (decreases with the logarithm of the frequency);
- 0.5 – 5.0 MHz, 56 dB μ V;
- 5.0 – 30.0 MHz, 60 dB μ V;
- Above 30.0 MHz, no limits.

Limits are expressed in dB μ V, or dB relative to a microvolt. In this case, 1,000 μ V of signal equals +60 dB μ V.

Power Supply Tests

The ARRL Lab uses a line impedance stabilization network (LISN), a Tektronix RSA306B spectrum analyzer, and Tektronix *EMCVu* software to measure conducted emissions. The device under test is plugged into the LISN, which separates the unwanted RF from the desired 60 Hz ac power. The conducted emissions are then measured using CISPR quasi-peak detection as specified in FCC Part 15. (This technique uses AM and a 9 kHz bandwidth and is designed to assess the effect of interference of a received signal to the human ear.)

Figures 2, 4, 6, and 8 in the review show conducted emissions from 150 kHz to 30 MHz for each power supply operating with a 1 A load, typical of a transceiver during receive. The red lines at the top of each plot represent the FCC limit of conducted emissions based on frequency. Larger versions of the plots are available from www.arrl.org/qst-in-depth.

It is important to note that Part 15 limits are not low enough to eliminate the possibility of interference. Interference from a supply that is near the limits may show up as a buzzing noise or as discrete signals, particularly at the lower end of the spectrum. The severity of the interference can also depend upon other factors, such as the placement of power cords and distance from the antenna. Using a properly grounded ac outlet may help. See the *ARRL RFI Book* for information on techniques to help with interference problems. — Bob Allison, WB1GCM, and Paul Cianciolo, W1VLF, ARRL Lab

Next, the Lab tested each supply under a 20 A load and used an oscilloscope to observe ripple on the dc output, as well as the presence of high frequency switching spikes while under load. All of the supplies exhibit low ripple and low amplitude switching spikes.

Finally, each supply was tested for conducted emissions (noise that the device conducts into the ac house wiring and power lines via the device power cord). See the sidebar, "Conducted Emissions Testing," for details.

Alinco DM-430T

Alinco's compact DM-430T switchmode power supply is about the same size as a typical VHF mobile transceiver, yet it's rated for 25 A continuous and 30 A maximum. The supply has a front-panel switch to select 13.8 V fixed output or 4 to 15 V variable output using the **VOLTAGE ADJUST** knob. The supply is protected against short circuits at the output, as well as current overload and excessive temperature.

The front-panel LCD shows output voltage and current simultaneously with large, easy-to-read characters. The front panel includes a set of 30 A Anderson Powerpole

connectors, and the rear panel has a pair of binding posts. The rear-panel line cord is detachable, and there is no external fuse holder. A cooling fan on the rear panel turns on automatically if the supply's internal temperature reaches about 110 °F, although I never saw it come on during indoor operation with a 100 W transceiver. Test results for the Alinco DM-430T are shown in Table 1 and Figures 1 and 2. The supply operated well down to about 90 V ac, dynamic regulation was in line with other switchmode supplies we have tested, and spikes due to switching are low. The DM-430T tested well below the Part 15 levels on the amateur bands, but was just above the FCC conducted emission limit around 160 kHz.

The brief instruction sheet includes illustrations of the front and back panels with a short description of each feature, a table of specifications, and a lot of safety information.

Manufacturer: Alinco, Osaka, Japan; www.alinco.com. Distributed in the US by REMTronix Inc., Lathrop, California; remtronix.com and available from amateur radio dealers. Price: \$145.

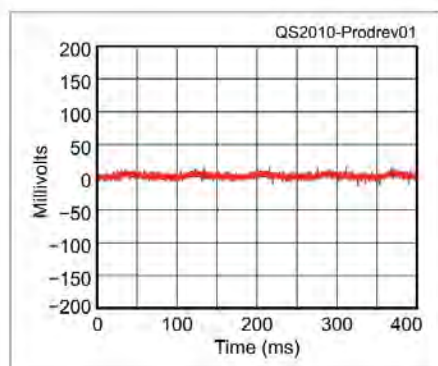


Figure 1 — An oscilloscope trace of the dc output of the Alinco DM-430T with a 20 A load. The vertical scale is 50 mV/div, and the horizontal scale is 5 ms/div.

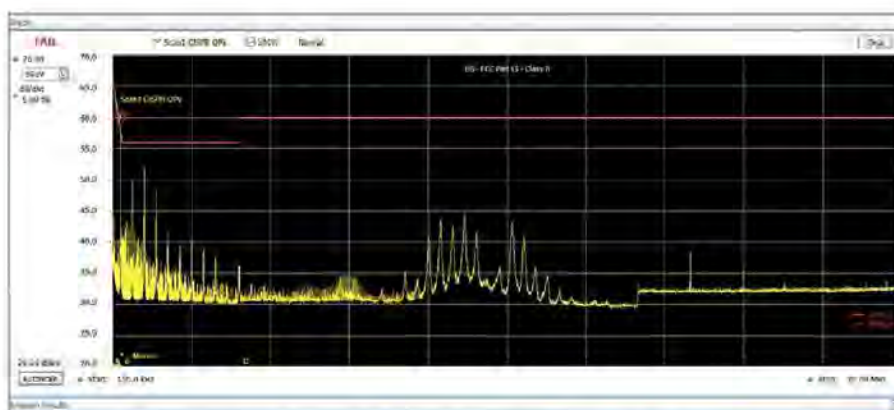


Figure 2 — Alinco DM-430T conducted emissions from 150 kHz to 30 MHz with a 1 A load. The red lines at the top of each plot represent the FCC limit of conducted emissions based on frequency.

Table 1 — Alinco DM-430T

Manufacturer's Specifications

Power supply type:	Switchmode.
Power requirements:	120 V ac.
Output voltage:	5 to 15 V dc.
Output current:	25 A continuous (30 A max).
Size (HWD, with protrusions):	2.5 × 5.1 × 7.7 inches. Weight: 3.5 lbs.

ARRL Lab Measurements

Output voltage, no load:	3.76 to 15.59 V dc (13.85 V dc with switch set to 13.8 V).
Output voltage, 20 A load:	3.70 to 15.40 V dc (13.66 V dc with switch set to 13.8 V).
Low line dropout voltage:	93 V ac.
Dc variation during dynamic testing:	180 mV.
Efficiency:	82% at 20 A.



Kenwood PS-60

The Kenwood PS-60 switchmode power supply is styled to match Kenwood's TS-590S/SG HF transceiver. The sturdy package is the same height as the radio, and it has the same size bale on the bottom to match the transceiver when the front panel is tilted up. The PS-60 can operate with a wide range of ac line voltages. Output is a fixed 13.8 V dc at 22.5 A continuous current. There is no output metering, and the only control on the front panel is a **POWER** switch with a red LED indicator.

The rear panel has a set of screw terminals for the transceiver power cable and a removable ac power cord. No adjustment is needed to switch between 120 V and 240 V ac line voltage. The temperature-controlled internal cooling fan on the rear panel draws air through vents in the front left side panel, so it's best placed to the left of the transceiver for best airflow. I never heard the fan start during normal operation with a 100 W transceiver.

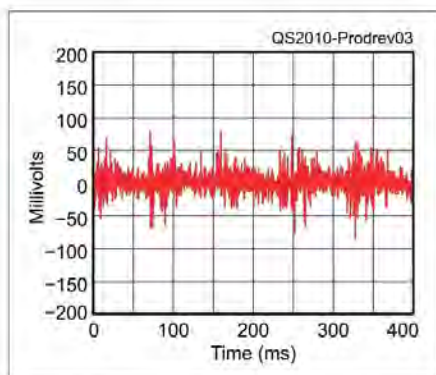


Figure 3 — An oscilloscope trace of the dc output of the Kenwood PS-60 with a 20 A load. The vertical scale is 50 mV/div, and the horizontal scale is 5 ms/div.

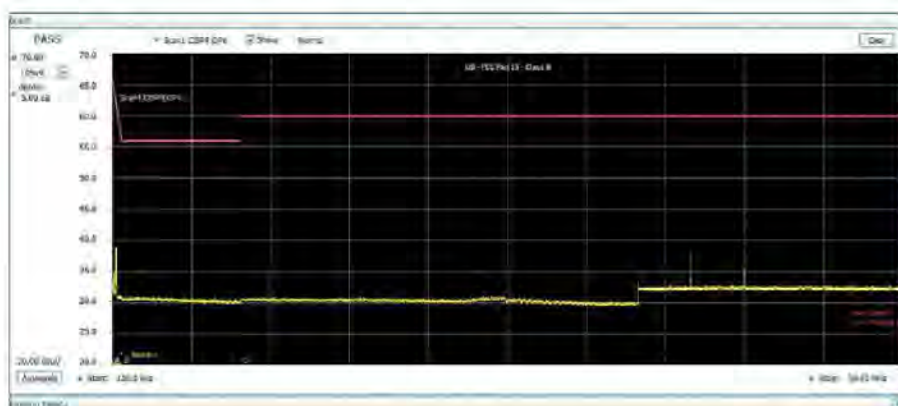


Figure 4 — Kenwood PS-60 conducted emissions from 150 kHz to 30 MHz with a 1 A load. The red lines at the top of each plot represent the FCC limit of conducted emissions based on frequency.

Table 2 — Kenwood PS-60

Manufacturer's Specifications

Power supply type:	Switchmode.
Power requirements:	100 to 240 V ac.
Output voltage:	13.8 V dc (fixed).
Output current:	22.5 A continuous.
Size (HWD, with protrusions):	4.2 × 6.9 × 9.0 inches. Weight: 5.5 lbs.

ARRL Lab Measurements

Output voltage, no load:	13.80 V dc.
Output voltage, 20 A load:	13.72 V dc.
Low line dropout voltage:	90 V ac.
Dc variation during dynamic testing:	80 mV.
Efficiency:	92% at 20 A.

Test results for the Kenwood PS-60 are shown in Table 2 and Figures 3 and 4. The supply operated well down to about 90 V ac, and dynamic regulation was excellent with just 80 mV variation between no load and 20 A. At about 150 mV peak-to-peak, spikes due to switching were higher than the other supplies reviewed here, but they were in line with switchmode supplies we have tested previously. Conducted emissions (see Figure 4) were exceptionally low for a switchmode supply.

Documentation is on a single sheet with features, specifications, installation, operation, and troubleshooting information. It also includes a list of certifications, including FCC Part 15 compliance.

Manufacturer: JVCKENWOOD USA, Communications Sector, 1440 Corporate Dr., Irving, TX 75038; www.kenwood.com/usa. Price: \$440.



MFJ-4230MV

The MFJ-4230MV switchmode power supply is the smallest and lightest in this group, slightly smaller than the Alinco DM-430T. Output voltage is adjustable from about 3.5 to 16.5 V dc using a front-panel **ADJUST** knob. There is no 13.8 V dc fixed output switch, but the knob has a center detent for 13.8 V output (this setting measured about 13.5 V in the Lab). Be sure the supply is adjusted correctly before connecting your equipment. Current rating is 25 A continuous or 30 A maximum. Input voltage is specified at 85 to 135 V ac, and a version for 170 to 260 V ac is available as well.

The supply features overvoltage and overcurrent protection, and a front-panel **FAULT** indicator illuminates if there is a problem. Turn the supply off for 20 seconds to reset. The illuminated analog front-panel meter is switchable between output voltage (0 – 16 V) and

current (0 – 32 A). The temperature-controlled cooling fan draws air through holes in the side panels. The output connectors are red and black binding posts on the rear panel.

Test results for the MFJ-4230MV are shown in Table 3 and Figures 5 and 6. The supply operated well down to about 90 V ac, dynamic regulation was in line with other switchmode supplies we have tested, and spikes due to switching were very low. Conducted emissions tested well below the Part 15 levels throughout the spectrum.

Documentation is a single sheet with operating instructions, specifications and warranty terms.

Manufacturer: MFJ Enterprises, P.O. Box 494, Mississippi State, MS 39762; www.mfjenterprises.com. Price: \$100.

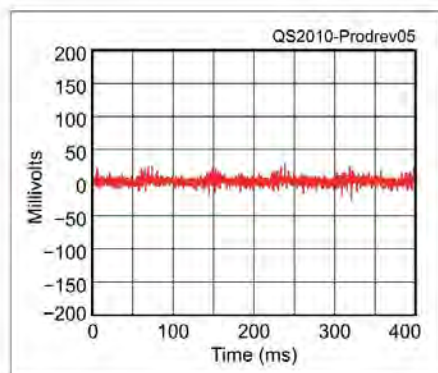


Figure 5 — An oscilloscope trace of the dc output of the MFJ-4230MV with a 20 A load. The vertical scale is 50 mV/div, and the horizontal scale is 5 ms/div.

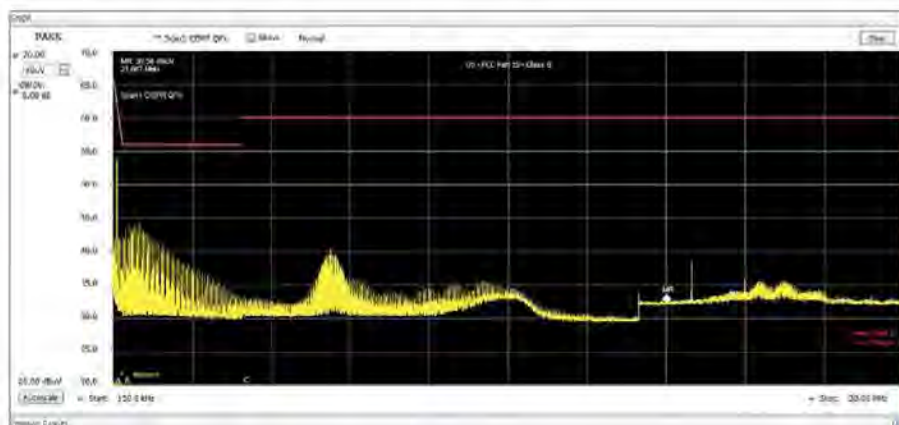


Figure 6 — MFJ-4230MV conducted emissions from 150 kHz to 30 MHz with a 1 A load. The red lines at the top of each plot represent the FCC limit of conducted emissions based on frequency.

Table 3 — MFJ-4230MV

Manufacturer's Specifications

Power supply type:	Switchmode.
Power requirements:	85 to 135 V ac.
Output voltage:	4 to 16 V dc.
Output current:	25 A continuous (30 A max).
Size (HWD, with protrusions):	2.5 × 5.1 × 7.4 inches. Weight: 3.0 lbs.

ARRL Lab Measurements

Output voltage, no load:	3.37 to 16.55 V dc (13.46 V dc with knob at detent).
Output voltage, 20 A load:	3.34 to 16.37 V dc (13.27 V dc with knob at detent).
Low line dropout voltage:	90 V ac.
Dc variation during dynamic testing:	190 mV.
Efficiency:	86% at 20 A.



Yaesu FP-1030A

Yaesu's FP-1030A is the only supply in this group that uses a conventional transformer, filter, and linear regulator. That means it is larger and heavier than the switchmode supplies. Output voltage is fixed at 13.8 V dc at 25 A continuous. The supply operates from 120 V ac.

Two large analog meters on the front panel display output voltage and current simultaneously. They are not backlit, and may be difficult to read under some lighting conditions.

There are three power connections. Red and black binding posts handle up to 25 A. There are two sets of spring terminals for up to 6 A total, and a cigarette-lighter type socket for up to 10 A. The total available current is 25 A, and the various connections are handy for powering accessories.

The internal fan runs continuously at low speed, increasing in speed as the supply heats up. There are plenty of ventilation slots on the side, rear, and bottom panels. A current foldback circuit protects the power supply from excessive current draw, and a red LED on the front panel lights if the protection circuit activates.

Test results for the Yaesu FP-1030A are shown in Table 4 and Figures 7 and 8. The supply operated well down to about 100 V ac, dynamic regulation was outstanding, with just 10 mV variation between no load and 20 A. As expected with an analog power supply, there are no visible spikes due to switching, and conducted emissions are extremely low.

Instructions are on a single 8.5 × 11 sheet and include a general description, installation and use instructions, safety precautions, and specifications.

Manufacturer: Yaesu USA, 6125 Phyllis Dr., Cypress, CA 90630; www.yaesu.com. Price: \$270.

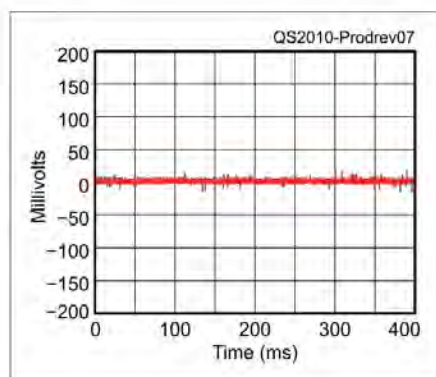


Figure 7 — An oscilloscope trace of the dc output of the Yaesu FP-1030A with a 20 A load. The vertical scale is 50 mV/div, and the horizontal scale is 5 ms/div.

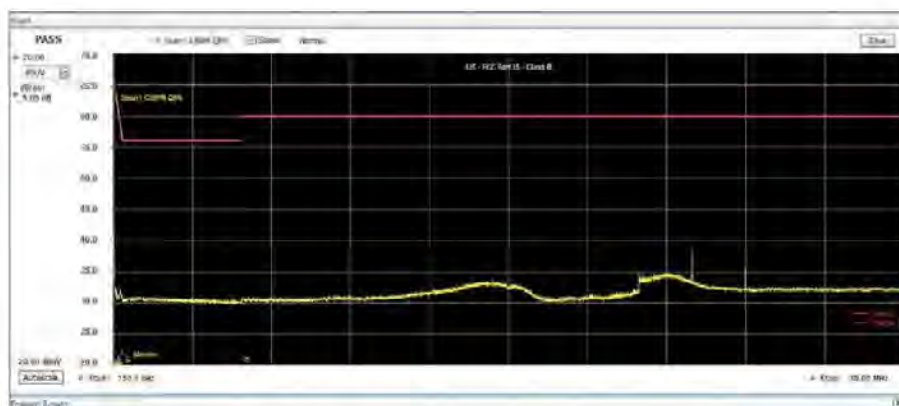


Figure 8 — Yaesu FP-1030A conducted emissions from 150 kHz to 30 MHz with a 1 A load. The red lines at the top of each plot represent the FCC limit of conducted emissions based on frequency.

Table 4 — Yaesu FP-1030A

Manufacturer's Specifications

Power supply type:	Linear regulator.
Power requirements:	120 V ac.
Output voltage:	13.8 V dc (fixed).
Output current:	25 A continuous.
Size (HWD, with protrusions):	6.0 × 9.9 × 9.5 inches. Weight: 21 lbs.

ARRL Lab Measurements

Output voltage, no load:	13.89 V dc.
Output voltage, 20 A load:	13.88 V dc.
Low line dropout voltage:	101 V ac.
Dc variation during dynamic testing:	10 mV.
Efficiency:	60.2% at 20 A.



Low-Power Attenuator Kits

Reviewed by Paul Danzer, N1II
n1ii@arrl.net

A few years ago, I decided to test a new 2-meter antenna design by comparing a signal with my old standby, a simple ground plane. The test signal was the local repeater, but my 2-meter transceiver had no S-meter — just five bars showing relative signal strength. I made a switchable attenuator and carefully compared the attenuation needed to bring the repeater signal down to the squelch threshold with each antenna.

This simple test showed me a few things about attenuators. First, 1 dB steps may not be always needed, but they are very handy. Also, a design that is mostly immune to changes in attenuation caused by the proximity of your hand while making adjustments is helpful. Finally, bilateral connections — the ability to use either end as input or output — can simplify the test setup.

HeckKits 62 dB Step Attenuator Kit

The HeckKits step attenuator shown in Figure 9 allows selection of attenuation values up to a maximum of 62 dB. From left to right, the seven toggle switches con-

trol attenuation values of 1, 2, 3, 6, 10, 20, and 20 dB. These values allow you to select attenuation from 1 to 62 dB in 1 dB steps. The gold-plated BNC connectors can be used for either input or output in a 50 Ω system.

The attenuator uses $\frac{1}{4}$ W, 2% metal-film resistors. No power rating is specified for the attenuator, but the use of $\frac{1}{4}$ W resistors would seem to limit it to receiving applications or low-level oscillator or amplifier stage testing. No frequency range is specified. The included aluminum case is predrilled for the seven miniature double-pole, double-throw (DPDT) toggle switches and BNC connectors.

In common with most small kits, the assembly manual is supplied as a PDF. The manual is emailed upon purchase (and not available on the HeckKits website). I usually print the manual, so I can physically check off each step as I complete it. Using a color printer for a few of the illustrations for this kit will make parts placement a bit easier. Although not explicitly stated, the resistors mount on the side of the board seen in a photo in the instructions. This side of the board has



Figure 9 — The HeckKits attenuator is packaged in a small die-cast aluminum case. Although the PC board is labeled, no decal or label for the front panel is provided.

Bottom Line

These inexpensive attenuator kits operate into the VHF region and could be useful for receiver testing, S-meter calibration, hidden transmitter hunting, and other applications.

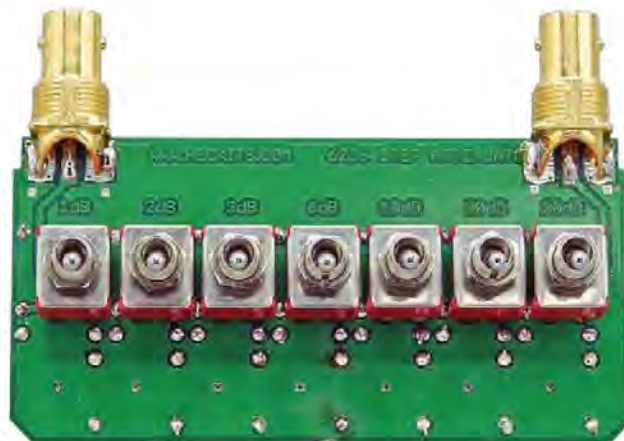
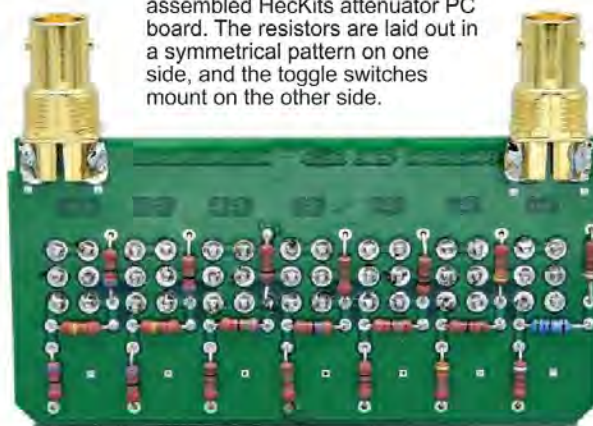


Figure 10 — Both sides of the assembled HeckKits attenuator PC board. The resistors are laid out in a symmetrical pattern on one side, and the toggle switches mount on the other side.



two solder pads on the two top corners; the reverse side, where the resistor leads are soldered, has three pads near each corner. Figure 10 shows the assembled board.

There are almost two dozen resistors. As I was preparing to sort out the resistors, I found this kit had something very helpful — paper tags with the resistor values written on them. No measuring or reading color codes were needed. After placing and soldering the resistors on the board, the manual gives very clear instructions for mounting the two BNC connectors and the seven switches.

Both the top cover and the bottom section of the enclosure have black arrows inside. The assembly is correct when the BNC connectors and the two arrowheads all are on the same side. First, do a test fit by installing the two end switches and make sure the board and switches line up with the holes in the case. If all is okay, you may find it easier to remove one of test switches and then install and tighten the inside nut on each remaining switch in series with a very thin $\frac{5}{16}$ open-end wrench, finishing up with the end switch you removed.

Manufacturer: HeckKits, 1302 Highland Dr., Cedar Park, TX 78613; www.heckkits.com. Price: \$65 plus shipping.

Pacific Antenna 41 dB Step RF Attenuator

The Pacific Antenna attenuator kit shown in Figure 11 provides up to 41 dB of attenuation, selectable in 1 dB steps. It's not supplied with a case, but a base fixture design for 3D printing is available from www.thingiverse.com/thing:3728178.

This compact 2.8×3.9 inch board has all components mounted on one side. BNC connectors are used for input and output, and it's bidirectional, so either end can be the input or output. Six pushbutton switches, mounted along the bottom of the board, select attenuation values of 1, 2, 3, 5, 10, and 20 dB. One switch at the top of the board controls a bypass function.

The attenuator sections use 2 W resistors, with three per section for a total of 18. Maximum continuous dissipation is specified as 5 W, and up to 10 W for intermittent use, so it can be used for low-power transmitting, as well as receiving applications. The manual specifies operation from dc to more than 200 MHz.

In order to speed up the assembly process, I copied the parts list for the resistors at a 2x enlargement and mounted the copy on a piece of foam backing board. Then I measured the resistors and stuck them into the parts list on the foam board. When I built the unit, I did

not have to hunt for the proper value resistor at each step. They were already sorted and sticking out of the foam (see Figure 12).

Some identical resistors come taped together, which simplified the sorting. Instead of pulling the tape off the resistor leads, it's better to cut the lead below the tape, so you won't have to clean glue residue from the leads. The final assembly step is placing a top cap on each switch. I suggest doing this in an area where you can



Figure 11 — All components mount on one side of the Pacific Antenna attenuator PC board. The top switch bypasses the attenuator. Either BNC connector can be used as input or output.

Part	Value and T
R1	6.2 ohm, 2W
R4	12 ohm, 2W
R7	18 ohm, 2W
R10	33 ohm, 2W
R13	75 ohm, 2W
R16	270 ohm, 2W
R17 & R18	68 ohm, 2W
R14 & R15	100 ohm, 2W
R11 & R12	200 ohm, 2W
R8 & R9	300 ohm, 2W
R5 & R6	470 ohm, 2W
R2 & R3	910 ohm, 2W

Figure 12 — Presorting the resistors will speed up the assembly.

easily find a cap if it pops off (which happened to me several times).

A set of four soft plastic feet completes this one-evening project. The assembly manual, downloaded from the manufacturer's website, includes a resistive checkout procedure. The resistance of each attenuator section selected by the switches is given, so you can check your wiring with an ohmmeter connected to either of the BNC connectors.

Manufacturer: Pacific Antenna, P.O. Box 10301, Fayetteville, AR 72703; www.qrpkits.com. Price: \$25 plus shipping.

Testing the Attenuators

Phil Salas, AD5X

These inexpensive attenuators are useful for amateur applications. The Pacific Antennas 41 dB attenuator is specified up to 200 MHz. The HeckKits 62 dB attenuator has no specified frequency range, but it is mounted in a die-cast metal case and would seem to be suited for use at higher frequencies.

I measured the SWR and insertion loss of each attenuator by sweeping them up to 500 MHz with an Array Solutions VNAuhf vector network analyzer. Measurements were made with 0 dB (bypass), and then the sequential addition of each attenuator section. Just the 6 dB attenuation step for each attenuator is shown here (equivalent to one S-unit). Larger versions of the plots for additional attenuation steps are available online from www.arrl.org/qst-in-depth.

In each plot, the vertical dark blue line is in the 2-meter band, the dashed horizontal light blue line is 1.5:1 SWR, the green trace is attenuator insertion loss, and the red trace is SWR.

HeckKits 62 dB Attenuator

This attenuator consists of seven sections of attenuation: 1, 2, 3, 6, 10, 20, and 20 dB giving a maximum of 62 dB attenuation in 1 dB steps. The sections are selected with toggle switches, and it can be bypassed (0 dB attenuation) with all switches off. Measurements were made by cascading each stage sequentially, providing data at 0, 1, 3, 6, 12, 22, 42, and 62 dB attenuation levels. As shown in Figure A, with 6 dB selected, SWR is very close to 1:1 through the 2-meter band. Attenuation is flat through the HF range, rising to about 6.4 dB in the 2-meter band, and is still within 1 dB at 400 MHz.

Pacific Antennas 41 dB Attenuator

This attenuator consists of six sections of attenuation: 1, 2, 3, 5, 10, and 20 dB. This gives a maximum of 41 dB attenuation in 1 dB steps. The sections are selected with pushbutton switches. There is also a full bypass position. Measurements were made by cascading each stage sequentially, providing data at 0, 1, 3, 6, 11, 21, and 41 dB attenuation levels. As shown in Figure B, with 6 dB selected, SWR is 1:1 and attenuation is within a few tenths throughout the HF range. SWR rises to 1.5:1 and attenuation rises to 7 dB in the 2-meter band.

Both attenuators provide quite usable performance through 2 meters. In all cases, as the attenuation level is increased, the SWR improves at higher frequencies. The HeckKits attenuator does provide lower SWR, higher attenuation accuracy, and better performance, especially at VHF.

In Summary

The accompanying sidebar, "Testing the Attenuators," presents swept-frequency measurements of each unit with 6 dB attenuation selected. These measurements were made using a vector network analyzer, but if you have a suitable signal source and an accurate micro-wattmeter, you can calculate power loss from:

$$\text{Attenuation in dB} = 10 \log (P_1/P_2),$$

where P_1 is the power input, and P_2 is the power output.

Many workshops are not equipped with accurate low-level power measuring capability, but most do have

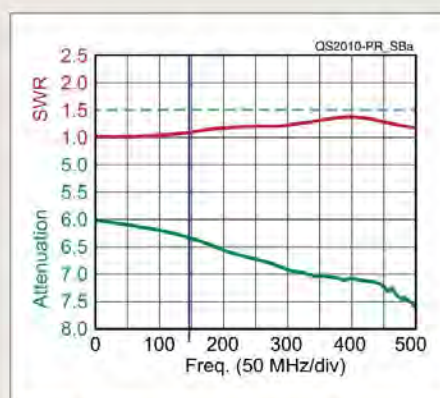


Figure A — SWR and insertion loss sweep of the HeckKits attenuator with 6 dB attenuation selected.

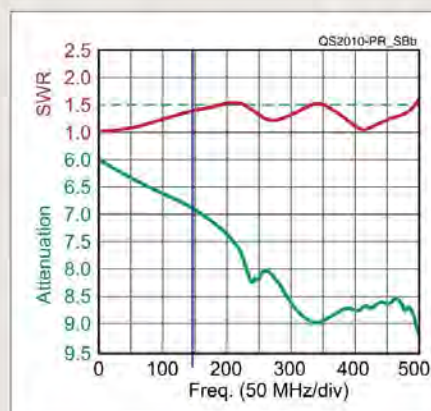


Figure B — SWR and insertion loss sweep of the Pacific Antenna attenuator with 6 dB attenuation selected.

reasonably accurate voltmeters. You can calculate the power loss at dc from:

$$\text{Attenuation in dB} = 20 \log (V_1/V_2),$$

where V_1 is the voltage input, and V_2 is the voltage output.

I measured the attenuators at dc, and the results are available online from www.arrl.org/qst-in-depth. A good explanation of decibels can be found in "Untangling the Decibel Dilemma," by Ward Silver, NØAX, in the January 2020 issue of *QST*.

HybridDX Antenna for 160 – 6 Meters

Reviewed by Norm Fusaro, W3IZ
w3iz@arrrl.org

The HybridDX is a 135-foot doublet configured to fit into a smaller space. I wouldn't say it is a revolutionary design, but it does take a different approach to the idea of compressing a full-sized dipole into a tight space. The assembled HybridDX is 79 feet long and designed to work on 160 through 6 meters with an antenna tuner.

The manufacturer designed the bare copper radiating wire to be suspended from a supplied catenary line of heavy-duty dacron/polyester rope. The kit includes large and small spreaders that you attach to the support rope using cable ties (see Figure 13). After attaching the spreaders to the catenary line, you then thread the light-gauge solid antenna wire through the lower portion of the spreaders. In this configuration, the manufacturer claims to have an advantage over a typical doublet antenna.

Assembly

The HybridDX antenna is a kit. Assembly was rather easy. The main rope is clearly marked with colored tape at the intervals where you attach the spreaders. The red and white markers show the location of where large or small spreaders get attached to the rope. The instructions say to remove the tape before tightening the cable ties. I believe paint markings would have eliminated the tedious process of removing the tape, but there is no doubt that the premeasured markers made assembly a breeze. I had the entire antenna together in about an hour and a half.

Bottom Line

The HybridDX antenna is a 79-foot alternative to the typical 135-foot center-fed multiband dipole for operation on 160 through 6 meters.

The instructions suggest laying the antenna on the ground at the place where the antenna is going to be installed, or suspending it at shoulder height between two supports. I chose the latter because it put the work in front of me and eliminated the need for bending down. The instructions are very detailed and easy to follow. They suggest visiting the website for a diagram of the assembled antenna. It would have been nice if they had included a diagram on the back of the instruction sheet, so I would not have had to refer to the small picture on my phone. As this review wrapped up, Quicksilver Radio told us that an illustration is now included with antennas that are currently shipping.

The instructions offer a standard configuration and a configuration for maximum performance. Minimum suggested antenna height is 35 feet. The standard configuration lets the ends of the radiating wires dangle. These ends are almost 28 feet long, and you will have to use weights or some rope to keep the stiff wire straight and vertical.



Figure 13 — Sturdy $\frac{3}{8}$ -inch UV-resistant dacron/polyester rope supports the #18 AWG solid antenna wire. The wire is quite stiff, and it takes some experimentation to get it to look like the photo at www.hybridddx.com.



Figure 14 — The center insulator and 75-foot, 450 Ω feed line are preassembled.

The maximum performance configuration uses plastic clips and nylon fishing line to bring the end back under the element to form “precisely calculated loops created by the wire and fishing line.” I configured the antenna for maximum performance not so much for the performance, but to get the ends off the ground. Again, it may take a little work to get the loops to stay in the shape shown in the drawing online.

The design of the antenna is for those with limited space, and many hams in that situation also lack supports of any great height. I was able to get the antenna up just over 40 feet above the ground, which prevented the loops from catching anyone by the neck.

The HybridDX antenna includes a 75-foot piece of 450 Ω window line preassembled to a center insulator (see Figure 14). Unlike some doublet designs, such as G5RV, the length of the parallel feed line is not important with the HybridDX antenna design, so you may

trim or add to the feed line as needed to fit your installation. I was able to use the feed line as supplied.

Tuner Required

Antenna systems of this design require an antenna tuning unit (ATU). Most ATUs built inside transceivers do not have enough range to match the broad range of impedances presented by this antenna system, so an external unit is required. In addition to being able to match impedance over a wide range, the antenna tuning unit used must also have a balanced output connection, otherwise an external balun will be needed so that the unbalanced-to-balanced transition is present. If your tuner is not designed for use with balanced feed lines, the instructions recommend connecting the supplied 450 Ω feed line to a 1:1 current balun, and then connecting to the antenna tuner with less than 20 feet of high-quality coaxial cable.

For this review, I used an SGC-239 automatic antenna coupler located outside on a table in the garden as far as the twin-lead from the antenna would reach, and then I used RG-8X coax to connect the tuner to the radio inside the house. After clearing the memories in the auto tuner, I was able to achieve SWR readings of less than 1.5:1 on all amateur bands from 160 through 10 meters. (The tuner does not cover 6 meters.)

Making Contacts

On-air performance was what I expected from the doublet antenna when used with my 100 W transceiver. I was able to make contacts on 40- and 80-meter SSB, and I even contacted some European stations on 20-meter CW. Having an automatic antenna coupler made band changes quick and easy.

I changed tuners to the ubiquitous MFJ-941 manual antenna tuner. Changing bands was easy by tuning for maximum receiver noise before making final adjustments while transmitting.

Bottom Line

Time will tell if the HybridDX antenna materials will withstand wind, snow, and ice, but for this test, everything stayed up. I can't say if the HybridDX worked any better or worse than the doublet that I normally use at my site, but if you have a tight space and two tall-enough supports, the HybridDX could be a solution to your antenna needs. Support is available online <https://www.hybriddx.com>.

Available from Quicksilver Radio, www.qsradio.com. More information is available from www.hybriddx.com. Price: \$119.73.



Cushcraft AR-270 Dual-Band Antenna

Reviewed by Steve Ford, WB8IMY
wb8imy@arrl.net

The Cushcraft AR-270 is essentially a ground-plane vertical antenna for both 2 meters and 70 centimeters. At just slightly more than 4 feet in length, the AR-270 functions as a $\frac{5}{8}$ -wavelength radiator on 2 meters. A coil assembly creates an electrical $\frac{5}{8}$ -wavelength for 70 centimeters as well. At the base of the antenna you find a small loading coil and three $6\frac{3}{4}$ -inch radials (see Figure 15). The antenna weighs just two pounds and is rated for 250 W on both bands.

Assembly and Tuning

The AR-270 assembles quickly. I needed only 15 minutes to attach the radial rods and join the upper and lower sections. The rods simply screw into the base, but the instructions caution against over tightening. They aren't kidding; I've seen rods like these instantly snap off with the overzealous application of a wrench.

The vertical radiator pieces slide into each other and are held in place by a small hose clamp. Any tuning that may be necessary is accomplished by loosening the clamp and adjusting the overall length. Following the guidance in the instructions, I adjusted for a total length of 20 inches between the base and the bottom of the upper coil. When I swept the AR-270 with an antenna analyzer, I was pleased to see no more than a 1.4:1 SWR across the entire 2-meter band, and a maximum of 1.5:1 between 438 and 450 MHz.

Up and On the Air

The AR-270 replaced a $\frac{1}{4}$ -wavelength dual-band ground plane that I have been using for many years. I removed the battered antenna from its 10-foot PVC mast and attached the AR-270 using the two large hose clamps supplied. Ten feet isn't much altitude for a VHF/UHF antenna and to make matters worse, the location was surrounded by trees in full bloom. (Dense vegetation can be deadly to signals on these frequencies.)

Bottom Line

The Cushcraft AR-270 is a rugged dual-band VHF/UHF home station antenna that is easy to assemble and install.





Figure 15 — A close-up view of the base of the AR-270.

With low expectations, I attached the feed line and returned to my transceiver. To my surprise, I heard local signals that were significantly stronger than before. The big test would be with the W1AW repeater on 2 meters. My home is 30 miles from the repeater, and I had never been able to reach it with the old antenna, regardless of the transceiver I was using. When the repeater was in use, I could barely hear it and, as you'd expect, it was steadfastly deaf to my transmissions.

I squeezed the push-to-talk button on the microphone, announced my call sign, and the machine instantly responded with an S-4 signal. According to reports, my signal was full quieting. I was impressed.

The AR-270 is not designed for use with amateur satellites, but I couldn't resist trying. During an OSCAR 91 pass, I heard signals from the bird when it was at maximum elevation, and I even managed to make a contact. I'll be interested to see how the AR-270's performance changes in late fall when the trees have finally shed their leaves.

Manufacturer: Cushcraft, 300 Industrial Park Rd., Starkville, MS 39759; www.cushcraftamateur.com.
Price: \$150.

Workshop Tip: Soldering Iron Tip Cleaner

I recently ran across an inexpensive addition to my workbench. The Hakko 599B soldering iron tip cleaner replaces the wet sponge that many amateurs use to keep a soldering iron tip shiny while working on a project. Inside the two-part container there are coils of brass similar to steel wool. To clean the soldering iron tip, you stab the tip into the brass coils. The coils slide oxidation or excess molten solder off the tip. The removed material falls through the brass to the bottom of the container, and very occasionally you can open the container and empty out the fallen material. The entire assembly is very light, so you will have to hold the unit in one hand while stabbing the iron tip with your other, or else use double-sided tape or another means of securing the tip cleaner to your workbench. Various similar units are available online, as are brass coil replacements. The Hakko 599B is readily available online for about \$12. — *Paul Danzer, N11I*



The Doctor is In

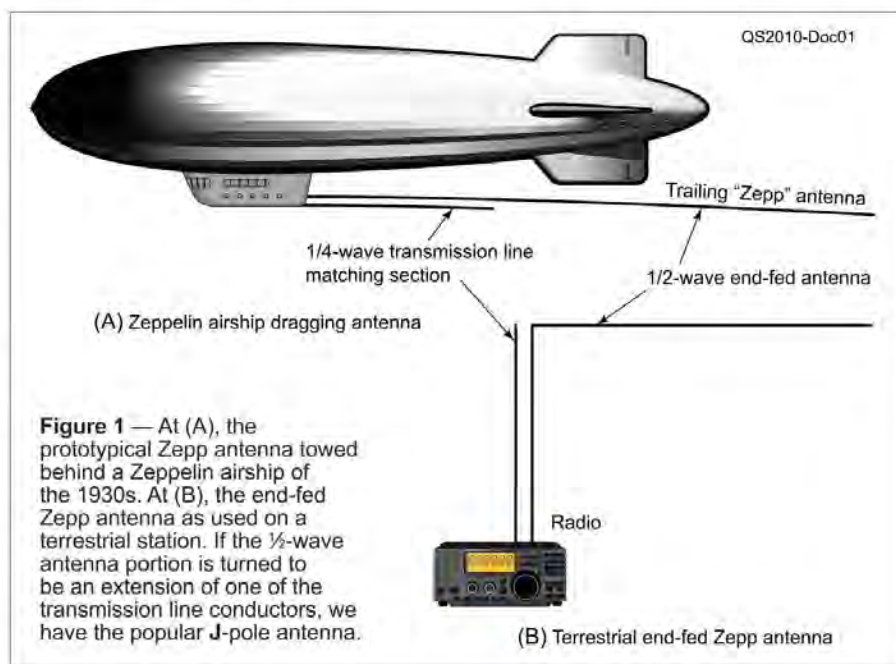
End-Feeding Antennas Can Make Installations, But Not Connections, Easier

Q David, WA4DSP, asks: What is meant by “end-feeding” an antenna? Are the standard SO-239 UHF coax antenna connectors on my transceiver amenable to end feeding? Is there a practical difference between a 4:1 voltage balun and a 4:1 current balun?

A Amateur radio operators are perhaps most used to center-fed antennas, such as dipoles, but there are many other possibilities. A local AM broadcast station, for example, likely has one (or more) monopole elements fed from the bottom against a radial ground field. This is one type of “end-fed” antenna and is the most commonly used, often with a horizontal wire on top as an end load.

In the early days of radio, when frequencies below the AM broadcast band were most commonly used, most amateurs used a top-loaded antenna, often with multiple horizontal wires serving as the load. The ubiquitous VHF $\frac{1}{4}$ -wave mobile whip is another application of the end-fed $\frac{1}{4}$ -wave monopole, so they are not just low-frequency structures.

It is important to note that the monopole is only part of the antenna. The ground, against which it is fed, is another important part. Every antenna connected to the radio needs connections to both the inner conductor and the shield of the SO-239 connector. Still, some will just stick the end of a piece of wire into the center pin and think they have an end-fed wire without a ground — but ground is always somewhere. In this case, the coax shield connection is tied to the transceiver chassis, which should be tied to



your power ground system, either directly or through your power supply.

A popular elevated end-fed antenna is the end-fed Zepp. This is a traditional antenna that goes back to its use as a trailing-wire antenna from a Zeppelin air ship (see Figure 1). It is a $\frac{1}{2}$ -wave dipole fed from one end through a $\frac{1}{4}$ -wave matching section of open-wire line. The matching section was used to transform the high impedance at the end of the $\frac{1}{2}$ -wave antenna to the low-Z that the transmitter wanted to see. This looks strange, because one side of the open-wire line at the antenna end appears not to be connected to anything. This also happens if a wire is stuck into the center conductor of an antenna tuner's coax socket. Note that a banana plug is a good fit for a single wire and provides a better connection.

The old argument was that the impedance at the end of the antenna was so high that no current flowed, so there was no need for a return path. In reality, the other side becomes a common-mode current that flows back toward the radio. Perhaps because the cabinets were often wooden, no one noticed on their airship — but this is not the case for most amateurs, so be careful. This is the same configuration as the popular 2-meter J-pole antenna, which is notorious for common-mode current problems, unless the current is choked off below the matching section.

Regarding the difference between a current and voltage-type balun, if we are matching to a balanced load (impedance of each side to ground equal), as intended with a balun, both

the current and the voltage on each side will be equal for either type of balun. On the other hand, if the load is not balanced, perhaps because an antenna is lower on one side than the other, the current and voltage on each side will be unequal. The balun can be designed to force either the current or the voltage to be equal, but not both if the impedances are not the same. If the antenna or load is truly balanced, the type of balun doesn't matter. If not, it is almost always better to force the currents to be equal with a current balun to eliminate common-mode current on the transmission line. Note that for the 1:1 case, a common-mode choke does the same thing — usually for less money and weight.

Q Ed, K6SDW, asks: Due to severe antenna restrictions, I use an end-fed antenna. My antenna uses the commonly available 9:1 transforming ratio balun and seems to work pretty well, given it's only 20 feet in the air with about 48 feet of wire. I've heard that some hams use a 49:1 balun for matching an end-fed antenna to 50 Ω coax, instead of the more common 9:1 balun. Is there an advantage to the 49:1 balun over the 9:1 unit?

A The impedance of a resonant end-fed $\frac{1}{2}$ -wave antenna, fed against ground, is in the thousands of Ohms resistive, so a 49:1 transformer can provide a close match to 50 Ω coax. Your antenna, by itself, isn't $\frac{1}{2}$ wave long on any band, except perhaps 30 meters, and isn't particularly resonant, so it's a different situation.

You don't say what bands you are using it on, or how it is fed — against ground with a 20-foot ground wire? Then it is not really end-fed, but the 20-foot ground wire is part of the antenna and you are feeding a grounded wire 30% above ground. That is fine, but the impedance will be very different.

If you don't have a ground wire at the

balun, the coax shield will act like one and also act like part of the antenna. It's best if it's well grounded as it enters the house to avoid radiating into household systems, as well as picking up noise from systems within the house.

The impedance that the balun sees will be very different on each band and will result in a fairly high SWR on the coax with either ratio balun on most bands. If the coax is good quality, low loss, and especially if short, the loss won't be too high. If your tuner can deal with it, it should work. But note that the impedance will be all over the place and, ideally, you would likely want a different ratio balun for each band (nobody that I know does that) — probably 1:1 for 80 and 40 meters, where the impedance is quite low, and higher on each of the other bands. So, 9:1 may be a good compromise. Providing more details on your configuration and your planned usage could make it possible for me to provide a more detailed answer.

Q Joseph, N3TTE, asks: I want to check the receive functionality of my solid-state HF transceiver. I'm wondering if, with a suitably large 50 Ω attenuator, I can use my antenna analyzer to verify that the receiver part of the radio is working correctly. I'm thinking that I can use the antenna analyzer to generate a frequency to inject into the radio. I don't want to overdrive it, hence using an attenuator, or perhaps rig up a transformer. Any suggestions?

A Unfortunately, you didn't identify the model of your analyzer, but the units I discussed in my ARRL book, *Understanding Your Antenna Analyzer*, ranged in output power from 0.5 mW (−3 dBm) to 20 mW (+13 dBm), most within the 10 dBm known safe range, based on ARRL Lab Product Review testing at that level. Most analyzers should be safe, even if connected directly to the

receiver input. Even the strongest output units won't require much attenuation. If you look up the QST Product Review of your analyzer, or perhaps the specification page of your analyzer's manual, you can likely find the actual power output of your analyzer (see the Product Review archive at www.arrl.org/qst-product-review-and-short-takes-columns).

Of more concern to me would be the safety of the analyzer, if directly connected. If your transceiver's key, PTT, or VOX is accidentally activated, you could easily put 100 W into the analyzer, and that would be a problem. Please either turn the power output down to zero, or switch the TRANSMIT off, if your transceiver can do that, before you connect the analyzer.

Some analyzers have a frequency counter, which may be accurate enough to give you a good indication of your transceiver's frequency calibration. Other analyzers may not be as good for that, but you can get an idea by checking the frequency of a broadcast station, W1AW or WWV, and seeing how the analyzer frequency read-out compares.

If you don't have an attenuator on hand and want a lower level signal than the analyzer provides (while +10 dBm should be safe, it will be quite strong at about an S-9 +83 dB on a calibrated S-meter), just put a small loop on the analyzer output and another on the transceiver antenna connection and then couple them with a variable distance, starting a few feet apart. I would suggest keeping the input level close to S-9 (50 μ V, −73 dBm) to minimize overloading.

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Hints & Hacks

Soda-Can Straight Key; Decoding DX Postal Addresses, and Upgrading Vintage Equipment

The Soda Can Key

To create this key, you need to cut the top of the beverage container free, just below the lip, exposing sharp edges. The best way I found to deal with this hazard was to carefully cut all around the can and about $\frac{1}{2}$ inch below the rim with a sharp utility knife (see Figure 1). Metal cutting shears or scissors may work as well. Once the top has separated, make a single cut through the metal to the rim at the top. Then, using long-nose pliers, grip the metal at this cut and roll the pliers around the circumference of the lid, removing all the metal (see Figure 2). The goal is to have a can top with none of the can sides remaining, so it can be handled safely and fit properly into the wooden base.

To fashion the wooden base, you'll need a piece of pine at least $\frac{3}{4}$ inch thick, $2\frac{3}{4}$ inches wide, and a foot or so long (the length is just to give you an area to apply pressure with your hand while drilling). Draw a circle on the wood using a compass with its diameter just less than the width of the board (in this case, about $2\frac{3}{4}$ inches) and mark its center. At the center point, drill a hole all the way through using a $\frac{3}{32}$ -inch-diameter bit. This hole will accurately spot the center of both circles onto the opposite side. With a 2-inch-diameter Forstner drill bit (which you can find at any home improvement store), drill the side that will be the top of the base to a depth of $\frac{3}{16}$ inches. Test fit the can top to this drilled hole to make sure it seats properly. Turn the board over and, using the same 2-inch-diameter bit centered in the $\frac{3}{32}$ -inch hole you



Figure 1 — Cut away the top of the can with scissors or any other suitable tool. [Karl Schwab, KO8S, photo]



Figure 2 — With pliers, grip the remaining metal at the top of the can and roll the pliers around the circumference of the lid, removing all the metal. [Karl Schwab, KO8S, photo]

drilled previously, drill to a depth of about $\frac{7}{16}$ inches. What should be left is about $\frac{1}{8}$ -inch thickness of wood. Choose the point where you want the wire cable to be brought into the side of the lower part of the base and drill a hole for it to pass through.

The can top is retained in the base with two 6-32 $\times$ $\frac{1}{2}$ inch long machine



Figure 3 — The can top is secured to the base with two 6-32 $\times$ $\frac{1}{2}$ inch long machine bolts. [Karl Schwab, KO8S, photo]

bolts. In addition to securing the top, they also function as electrical contacts (see Figure 3). One bolt must be insulated from the metal and located under the movable arm so that when the arm is depressed it touches the head of the bolt. The other bolt is not insulated.

Place the top in the base and, using an ice pick or equivalent, punch through the aluminum under the arm just enough to mark a drill location in the wood. Do the same 180 degrees on the opposite side.

The hole under the arm (in the top only) needs to be $\frac{3}{16}$ inches in diameter to electrically clear the bolt. The opposite bolt is at the junction of the can opening and the rest of the top. This hole is made by filing a $\frac{1}{8}$ -inch-diameter notch, or just large enough for the 6-32 bolt to pass through.

Drill two $\frac{1}{8}$ -inch-diameter holes through the base, at the two previously marked positions for the two 6-32 bolts. Now you can cut off the



Figure 4 — The finished key. [Karl Schwab, KO8S, photo]



Figure 5 — You can enhance the electrical safety of older gear by replacing the two-wire ac cord with a socket to accommodate a three-wire cord. Both filtered and unfiltered sockets are shown here. [Patrick Hamel, W5THT, photo]

surplus wood and leave it in a square shape or round off the edges into a circular shape, as I did. Once the sanding was complete, I stained the wood with varnish (see Figure 4).

As you install the bolts in the can top to attach it to the base, be sure to insulate the bolt underneath the arm. You don't want it making electrical contact with the top or bottom. I used clear plastic washers and placed a tiny length of heat-shrink tubing on the threads of the bolt itself.

With the cable attached to the bolts on the underside of the base, use a digital voltmeter to make sure there is no continuity between the two bolts until the arm is pressed down (touching the bolt head). — 73, *Karl Schwab, KO8S, ko8s@arri.net*

Getting DX Addresses Right

I've had times when I tried to send a QSL card to a DX station, but I found myself confused by the address I'd been given. It can be hard to decipher the town name, or which line shows the name of the street, or why there are no numbers in the address.

The Universal Postal Union (UPU) is the worldwide organization that coordinates international mail. Each of their 192 member countries have their own standards for mail items and address formats, and the UPU has posted them online.

To find a DX station's address format, go to www.upu.int/en/Postal-Solutions/Programmes-Services/Addressing-Solutions. Scroll down the page until you see "Postal Addressing Systems (PAS)." Select the country using the dropdown menu, then click the **DOWNLOAD** button to the right. You will be presented with a standards sheet, usually one or two pages long. It will not give you the correct address, but it will tell you how to format it correctly. Fewer QSLs lost in the mail means more countries confirmed. — 73, *Bill Principe, K1NS, k1ns@comcast.net*

Making Vintage Gear Safer

To bring vintage equipment up to modern electrical standards, you can replace the dangling two-conductor ac cord with a three-conductor socket with the third conductor grounded to the chassis (see Figure 5). You can install either a standard socket or a filtered model to help reduce RFI.

Once you remove the old cord, you'll need to widen and reshape the opening to accommodate the new socket. Steel will resist nibbling tools, so you may need to use a power tool. With the socket installed, you can now power the equipment with a modern, three-wire cord. This simple change will ensure a safety ground on gear that may otherwise present a potential hazard. Before you perform this modification, however, check the equipment to make sure that one side of the ac line is not grounded to the chassis. Some older types of gear used this approach and, if so, this modification should not be attempted. — 73, *Patrick Hamel, W5THT, w5tht@arri.net*

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

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

Microwavelengths

The Rise of Rain-Scatter Contacts

There has been a surge in 10 GHz rain-scat activity in the northeast and Midwest over the past year, with contacts spanning impressive distances (more than 500 kilometers). A number of stations were able to make long rain-scat contacts last August during the 2019 ARRL 10 GHz and Up Contest. After the contest, many operators realized that rain-scat contacts don't need mountaintops, and we could have fun from home or more easily accessible locations, or even just from the driveway (see Figure 1).

Enjoying Rain-Scatter Contacts

Peter Prabucki, VA3ELE, is one of the instigators behind this activity. From his home station in Mississauga, Ontario, at the western end of Lake Ontario, Peter is ideally situated to reach stations to the east, in western New York, Quebec, and New Eng-

land, as well as into the Midwest and Ontario. There isn't much elevation at the lakefront, but rain scatter from large thunderheads helped him work 35 grids on 10 GHz, including my station in FN34 at 603 kilometers, a new grid for both of us. Peter also does a lot of roving, generating more activity and helping others work new grids.

Rain-scat prospects have been improved by software written by Andy Flowers, K0SM, making it possible to quickly locate and utilize promising storms for rain- and snow-scat propagation. The latest version is an interactive website, www.rainscatter.com, which amalgamates weather radar data from multiple locations to show storms over the continental US and Canada. Storm intensity is displayed in various colors, and promising storm cells are highlighted with small circles. Available stations are also displayed — some are home stations, while others are ready to set up at a nearby site.

A contact I made in June for a new grid using the website is shown in Figure 2. Active stations and storms are shown on the map. Contacts are started by clicking on the chosen station. In this example, I clicked on W1FKF, Don Twombly. Once a station is clicked on, a direct path line is displayed, with heading and distance. This direct path had serious obstructions making propagation unlikely, so I looked for a storm in a favorable direction for both stations. Clicking on the storm adds the scatter path to the display, with headings for both stations to aim their antennas (remember that 10 GHz antennas are quite sharp, so accurate headings are important).

Showing the heading for both stations is useful because the heading can be

related to rovers that may not have internet access to view the website. These contacts usually take some liaison to set up, either on 2 meters or by internet or text message.

Rain Scatter Explained

Many of us have made contacts using reflection: bouncing the signals off a hill or large structure. Scattering is a different phenomenon — the energy is absorbed by a material, in this case water, and re-radiated (see www.wa1mba.org/papers/WA1MBA%20Scattering%20Super%20202019%20Paper.pdf for a more detailed explanation). The falling raindrops, often just the right size for 10 GHz, re-radiate like a dipole in the same polarization as they are illuminated. For horizontal polarization, the radiation pattern is like a dipole facing the



Figure 1 — Gedas Vysniauskas, W8BYA, celebrated his first 10 GHz contact, made by snow scatter, with Russ Dwarshuis, KB8U. [Nancy Vysniauskas, KC9MOM, photo]

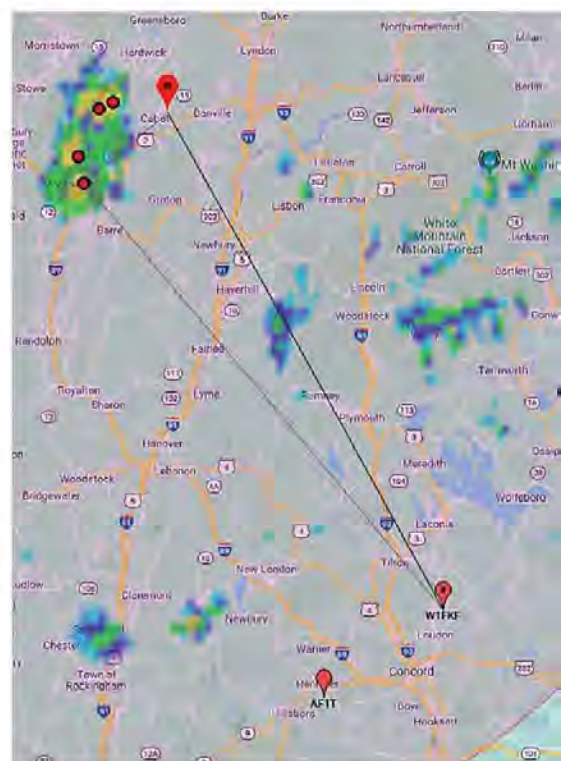


Figure 2 — An example of a rain-scat contact between Paul Wade, W1GHZ, and Don Twombly, W1FKF, using www.rainscatter.com. [Paul Wade, W1GHZ, photo]



Figure 3 — A 10 GHz dish with a cordless screwdriver and threaded rod for elevation adjustment. [Bill Davis, K0AWU, photo]



Figure 4 — Gary Danelius, WB0LJC, and Jim Hermanek, K0KFC, worked rain scatter across Lake Superior from the Minnesota shoreline during the 2007 ARRL 10 GHz and Up Contest. [Donn Baker, WA2VOI, photo]

incoming energy, with the strongest radiation on the front and back, but very little off to the sides. Because we all use horizontal polarization, the best scattering path is closer to the direct path between stations. It's possible to work stations off to the side, but signals are typically much weaker as the angle approaches 90°. The path shown in Figure 2 is close to 90°, but I tried anyway, and the signals were still strong. Vertical polarization might work better, but I don't know of anyone who has tried it.

The best rain for DX is an intense rainstorm near the middle of the path. Severe thunderstorms can reach high altitudes (50,000 feet or more), providing RF visibility to stations over a large area. On the other hand, heavy rain near a station can absorb too much of the energy, making contacts more difficult. A relatively clear path to a distant storm is best. The website helps to locate these storms and potential stations to work.

A signal is scattered from falling raindrops being blown by wind. There's likely to be a predominant storm velocity giving an overall Doppler shift in frequency. But there can be turbu-

lence, causing the Doppler effect to slightly shift the frequency on each scattered signal. The result is a rough sound, easily spread over several hundred hertz in frequency during moderately turbulent rainfall. This makes SSB extremely difficult to copy, and most digital modes nearly impossible. Most contacts use CW, though FM works well for strong signals. But the interesting DX contacts are usually the weak ones, and the CW doesn't have to be fast. Beginner speeds are fine — microwave operators are happy to make the contact.

A curious effect is that signals sound stronger than the actual peak signal strength. On my panadapter, I can find and copy weak signals with peak levels that would be extremely difficult to copy for a pure CW tone. One reason for this is the rain-scatter signal has less short-term fading than a typical 10 GHz signal. Another reason might be that the power that's spread in frequency is integrated by the ear.

Operating During Rain Scatter

When someone observes a potential storm on www.rainscatter.com, they

notify a potential contact on a lower band or by internet, text message, phone, or chat page. The operators coordinate headings and decide who will initiate transmission to get started, usually sending dashes to differentiate the signal from noise. If a signal is not found, operators might take turns adjusting the antenna heading slightly, or even adjusting elevation to find higher rain or to clear local obstructions or trees.

Rain scatter is a good way to overcome obstructions or lack of altitude (see Figure 3). Slightly adjusting the dish elevation can sometimes increase signal strength enough to make a contact. Our rain scatter attempts aren't always successful, but we have fun trying. Sometimes we even get wet, as shown in Figure 4.

Summary

If you have a 10 GHz station, give rain scatter a try — you might work some new contacts. Rain scatter is also possible on lower microwave bands, though 10 GHz seems best. There have even been reports of 24 GHz contacts, and we hope to try 47 GHz rain scatter soon.

Technical Correspondence

DX Performance of 43-Foot Verticals; Wind Noise and Mobile Antennas

Takeoff Angles of 43-Foot Vertical Antennas

Many stations include ground-mounted 43-foot verticals as their primary low-elevation takeoff angle (TOA) antennas for DX work. Modeling the antenna for TOA on several commonly used bands allows a simple comparison. As it turns out, a 43-foot vertical is approximately $\frac{5}{8}$ wavelength on 20 meters. On higher bands, however, it offers less than ideal TOAs.

The 20-meter plot (see Figure 1) shows maximum gain occurring at 15 degrees elevation. The other elevation plots (as shown in Figures 2 – 6) are not meant to be absolute in terms of gain; they only depict rela-

tive TOA between bands. The primary lines in the comparison plots represent the 20-meter plot for the sake of comparison. The green shaded area below 45 degrees represents where the antenna is most effective in reaching out to DX stations. The lower the TOA, the fewer Earth bounces the signal must suffer on the long DX journey. Each bounce touches land and reduces the signal strength. Note that on the 160-meter band, the plot indicates significant power below 45 degrees elevation. The maximum gain on 160 meters is about 8 dB lower than on 20 meters. The approximately 1.5 S-unit reduction still qualifies as a DX antenna. Of course, for best performance, any

vertical antenna requires a low-loss RF ground return path. — 73, Joe Ostrowski, K15FJ, ki5fj@arrl.net

Wind Noises Generated by Mobile Antennas

The electrical performance of a through-chassis roof-mounted antenna is fantastic. On the VHF and UHF bands, there is no better ground plane available.

I drilled a hole in the metal roof of my car for an NMO (New Motorola Mount) to achieve this ultimate performance. I then installed a traditional 19-inch $\frac{1}{4}$ -wavelength antenna for 2 meters. The antenna had very low wind resistance and exhibited a broad standing-wave ratio (SWR) curve across the band. Everything

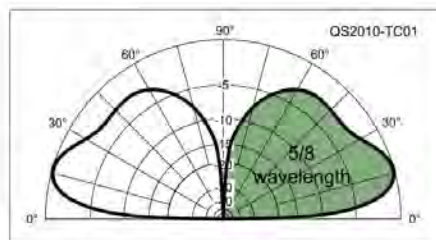


Figure 1 — On 20 meters, the elevation plot of the 43-foot vertical antenna is labeled with its fraction of a wavelength: $\frac{5}{8}$. In my estimation, this is the gold standard for takeoff angles (TOA).

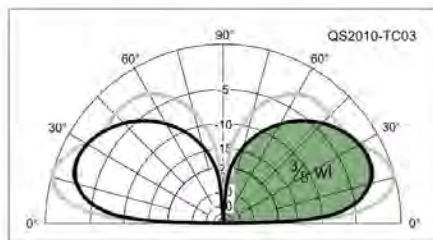


Figure 3 — The 43-foot vertical antenna is $\frac{3}{8}$ wavelength on 40 meters for a 3 dB gain reduction.

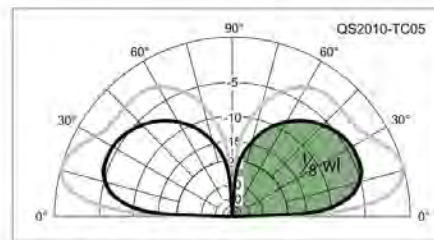


Figure 5 — The 43-foot vertical antenna is $\frac{1}{8}$ wavelength on 80 meters.

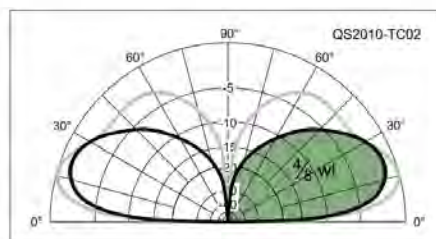


Figure 2 — The 43-foot vertical antenna is $\frac{3}{4}$ wavelength on 30 meters. This results in about a 2 dB reduction in maximum gain.

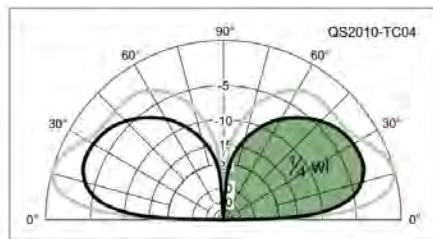


Figure 4 — The 43-foot vertical antenna is $\frac{1}{4}$ wavelength on 60 meters, with gain comparable to 40 meters.

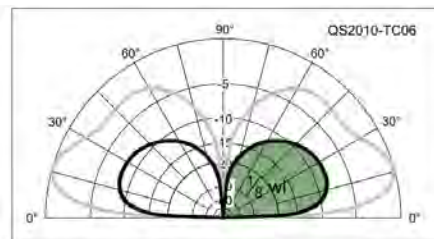


Figure 6 — On 160 meters, the plot indicates the 43-foot vertical has the lowest DX gain.

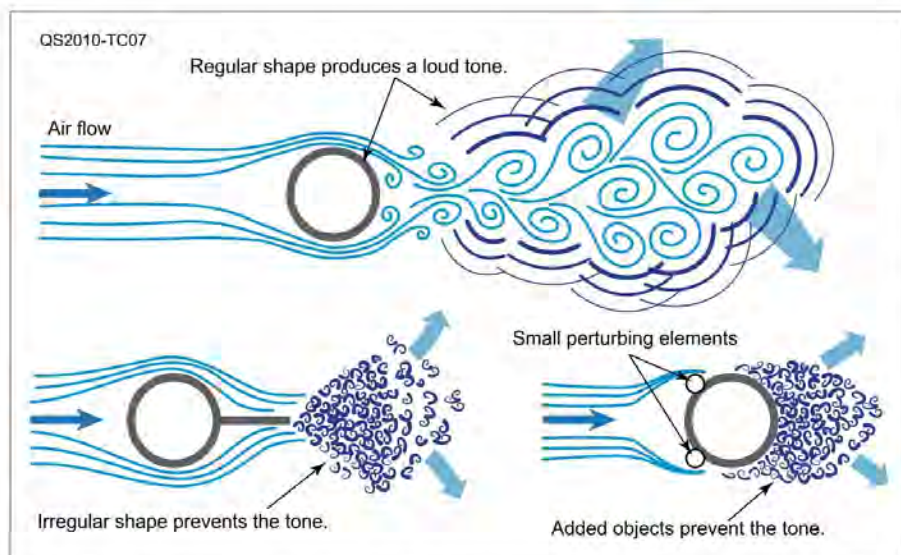


Figure 7 — Acoustic tones can occur as air flows around a smooth, regular shape, such as a mobile antenna. By adding irregularly shaped elements to the antenna, it is possible to disrupt the downstream air flow and prevent the production of tones.

seemed fine — until my car reached 70 MPH.

At highway speeds, the wind produced a strong, 1,000 Hz tone heard inside the vehicle. At lower speeds, the tone would randomly toggle between 1,000 and 2,000 Hz. The entire roof became a sound box for this cacophony of musical tones.

Hearing the harmonic relationship between the tones, my first response was to change the mechanical resonance of the antenna at the $\frac{1}{3}$ mark by attaching a lead fishing weight to add mechanical mass at one of the nodal maximums. It didn't work, so clearly something else was going on.

In fluid dynamics, a Kármán Vortex Street is a repeating pattern of swirling vortices caused by a process known as vortex shedding across a blunt object, and it is responsible for such phenomena as the “singing” of suspended telephone or power lines, guy wires, and the vibration of a car antenna at certain speeds (see Figure 7). For more information about Kármán Vortex Streets, visit https://en.wikipedia.org/wiki/Karman_vortex_street.

Based upon my findings, I needed a quick trip to the hobby shop for a 19-inch piece of square plastic tubing. I intended to disrupt the airflow across the antenna by using sharp edges. I simply slid the hollow plastic square tubing (from the bottom up) over the length of the antenna while keeping the top ball as a physical

stop. There was no change to the SWR, and it worked perfectly. I no longer heard the acoustic effects of trailing vortices carried inside the car.

This is a widely known problem, with many articles published and solutions discussed. So the next time you see spiral windings around a smoke-stack (with a linear or non-linear taper/pitch), or the spirals around your AM/FM antenna on your car, you'll know that the engineers are purposefully addressing the negative effects of this fluid dynamics phenomenon. — 73, Al Rabassa, NW2M, nw2m@arrrl.net

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

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

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

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

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

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

Ham Bootcamp



A beginner-friendly program to mentor new and upgraded hams, developed by the Nashua Area Radio Society.

Getting Hams On the Air

Fred Kemmerer, AB1OC

For the last 5 years, the Nashua Area Radio Society (NARS) in Nashua, New Hampshire, has been actively providing licensing classes and training to help new amateur radio operators develop their skills. Our club has helped over 420 people earn or upgrade their licenses.

The Nashua Area Radio Society has spent quite a bit of time trying to understand why so many of the people who earn a license or an upgrade don't get on the air. The number one reason we discovered is that the amateur radio community isn't providing the mentoring that many hams need to get active. Some examples of the necessary mentoring include:

- Help getting a handheld transceiver or base radio programmed for repeater use
- Guided practice making contacts on the air
- Help to overcome "mic fright"
- Help choosing equipment for their first VHF/UHF or HF station
- Help setting up an effective first HF station

Beyond these basic items, the club has also found that mentoring in the following areas helps boost interest in getting on the air among new and upgraded hams:

- An introduction to foxhunting
- An introduction to low-Earth orbit (LEO) satellite operations
- An introduction to operating on the 6-meter band
- Getting set up and learning how to use *WSJT-X* and FT8/FT4 modes
- A basic introduction to contest participation
- A guide to working DX and confirming receipt of transmissions
- Help with basic physical station-building issues such as grounding, getting cables into a building, and putting up simple antennas and feed lines

Above: Mackenzie Pooler, KE1NZY, and her father, Dan Pooler, AC1EN, mentor hams by explaining how to get started with satellites at Ham Bootcamp.

Creating Ham Bootcamp

Our solution was a new program created by our club, called Ham Bootcamp. This program was designed to address the barriers preventing newly licensed and upgraded hams from getting on the air. The addressed barriers were shared by the club's license students via surveys.

Creating this type of program is not difficult. Before agreeing to launch Ham Bootcamp, the concept was discussed among license-class instructors. The initial program was taught by three volunteers from our instructor pool.

We took the most noted feedback items and scheduled a three-session inaugural Ham Bootcamp. It was taught at our station (AB1OC-AB1QB) in New Hampshire. Ham Bootcamp is free to anyone who wants to participate. The club learns more about what topics best meet the needs of attendees each time the program is offered, and the items covered are continuously improved upon.

Effective mentoring needs to be hands-on and personal. This requires spending time with hams to understand what they want to do with amateur radio, and each Ham Bootcamp begins with this discussion.

Program Structure

Ham Bootcamp includes hands-on demonstrations of the on-air activities that new licensees seem to enjoy most. This is done so that attendees can figure

Effective mentoring needs to be hands-on and personal. This requires spending time with hams to understand what they want to do with amateur radio, and each Ham Bootcamp begins with this discussion.

out what interests them. We also spend time talking about and demonstrating the basics of building VHF/UHF and HF stations.

New and recently upgraded hams are interested in a broad range of topics. With this in mind, NARS created specific activities for each level of ham radio licensees. The topics are taught via demonstrations and hands-on activities. For example, instructors conduct a practice repeater chat net on a UHF simplex channel, where all program attendees can check in and practice participating in a net. During the program, hams assemble and work with demonstration HF stations and the associated computer and software applications for logging and digital operation. This approach gives them a chance to work with similar gear that they'll be using to build and operate their own stations.

Most young and new hams come to Ham Bootcamp with a great deal of concern about making mistakes while operating on the air. To help with these problems, a focus is placed on practicing basic operating techniques to get attendees comfortable with being on the air.

Program Locations

NARS has been scheduling a Ham Bootcamp series after each set of our spring and fall license classes. This gives the Technician-, General- and Amateur Extra-class licensees (as well as other hams) a chance to participate in the program shortly after they earn their licenses or upgrades. Each Ham Bootcamp series consists of two Saturday meetings to cover the Technician-, General-, and Amateur Extra-class license items, and an evening visit to the local Ham Radio Outlet store. This



James Finchum, AC1DC, explains how to assemble an HF station at Ham Bootcamp.



The start of Ham Bootcamp at the 2019 New England HamXposition in Boxborough, Massachusetts.

format is offered to small groups of 10 – 20 attendees and is taught at our station, where they have access to a complete set of equipment for hands-on demonstrations and use.

Ham Bootcamp is also offered at the Northeast HamXposition in a group format. The program occurs on a Saturday morning with about 80 people, and the format consists of two tracks — one for Technicians and unlicensed hams and one for Generals and Amateur Extras. After the main sessions, attendees receive a guided tour of NARS's ham radio display and vendor area at the show.

The hamfest format is delivered in a large conference room with groups of about eight hams at each table. The instructors rotate from table to table delivering their elements of the hands-on presentation and demonstration of their topics. This format requires 8 – 10 instructors, which the club staffs from our license-class instructor pool.

Ham Bootcamp and Social Distancing

Ham Bootcamp has continued safely during the COVID-19 pandemic. The program is offered as an online activity via three Zoom sessions, structured the same way as the in-person program. The Ham Radio Outlet trip is replaced with an online shopping trip where attendees look at various equipment choices online using vendor websites. The topics for the online shopping trip are chosen through Zoom polls completed by program participants.

Getting On the Air After Ham Bootcamp

The Ham Bootcamp program is only 2 years old, so it's still relatively new. Program results have been encouraging, however. More than half of the program attendees are building stations and getting on the air. Ham Bootcamp has been an effective motivator for both newly licensed and upgrading hams, as well as those who had their license for a while and weren't active before attending the program.

Conclusion

Ham Bootcamp is continuously evolving as time goes on. NARS will be opening online license classes and online Ham Bootcamp to all licensed and prospective hams in North America. Contact classes@n1fd.org to sign up for the next set of license classes and the next online Ham Bootcamp. For more information on Ham Bootcamp, visit www.n1fd.org/ham-bootcamp.

All photos provided by the author.

Fred Kemmerer, AB1OC, earned his Amateur Extra-class license in 2010. He's an electrical engineer and has held positions as a technology and business executive in the telecommunications industry. He enjoys building stations and space communications, and he has a blog dedicated to these interests, which can be found at <https://stationproject.blog>. Fred also serves as president of the Nashua Area Radio Society. He can be reached at ab1oc@arri.net.

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

VOTE

If you enjoyed this article, cast your vote at www.arri.org/cover-plaque-poll

ARRL Board Meets in Virtual Session

Due to travel and gathering restrictions in place because of the coronavirus pandemic, the ARRL Board of Directors met on Friday, July 17, in a remote session, using the Zoom videoconferencing platform.

At this meeting, the Board took these actions:

- ◆ Accepted the final recommendations of the Band Planning Committee. Committee chair and ARRL First Vice President Mike Raisbeck, K1TWF, introduced the motion to adopt the plan. An earlier draft of the plan was introduced at the Board's in-person January meeting. After the January Board meeting, the Committee received and considered hundreds of comments from interested amateurs. The final band plan can be viewed on the ARRL website.
- ◆ Voted, in anticipation of hiring a new Director of Emergency Management, to modify the charter of the search committee to study and, if appropriate, prepare a report on the implementation of a new Standing Committee of the Board to emphasize emergency communications and provide advice to the CEO in these matters. The report is expected to be delivered to the Board by November 24.
- ◆ Created a Standing Order that gives the Programs and Services Committee authority to approve, by vote, proposed rule changes for contests and awards.
- ◆ Accepted the financial reports from the Chief Financial Officer and Treasurer on the finances and investment portfolio of the organization.
- ◆ Modified the composition of the ARRL Legal Defense and Assistance Committee and the guidelines for what activities will be funded by ARRL.
- ◆ Amended ARRL By-Law #18 to conform with changes made at the January Board meeting regarding the election period for Division elections.

- ◆ Clarified the rules for attendance at standing committee meetings and the reimbursement of expenses incurred thereto.
- ◆ Approved the recipients of several awards, including the Hiram Percy Maxim Memorial Award.
- ◆ Acknowledged the efforts of ARRL Headquarters staff in dealing with and maintaining operations during the pandemic.
- ◆ Discussed personnel matters in a Committee of the Whole.

The meeting was unusual in that, at the end of the day on July 17, the Board recessed until August 16, when it reconvened, concluded its business, and adjourned. Meeting minutes are forthcoming.

The ARRL Board also conferred several awards and recognitions.

The Hiram Percy Maxim Award

The ARRL Board conferred the 2020 ARRL Hiram Percy Maxim Award on Jacob M. Nagel, ADØJA, of Wright City, Missouri. Licensed since 2012, the Board cited Nagel for exemplifying the spirit of amateur radio by learning new technologies, providing community service, and helping with emergency communication. ARRL's top youth honor, the Hiram Percy Maxim Memorial Award is given annually to a radio amateur and ARRL member under the age of 21. The award consists of a \$1,500 stipend and an engraved plaque, to be presented at an ARRL convention or event.



Jacob M. Nagel, ADØJA

The Board cited Nagel's involvement in providing technical assistance to the Okaw Valley Amateur Radio Club and the Egyptian Radio Club of Illinois for the installation and upgrading of their club repeaters; advising the Germantown, Illinois, Fire Department on upgrading its communication systems; speaking at the 2016 Dayton Hamvention® Youth Forum; sharing his expertise in online forums, and active involve-

ment in projects that allow him to integrate his amateur radio knowledge with other technical ventures in electronics.

Knight Distinguished Service Award

The Board named veteran ARRL Rhode Island Section Manager Robert G. "Bob" Beaudet, W1YRC, of Cumberland, Rhode Island, as the recipient of the Knight Distinguished Service Award, given to an ARRL Section Manager. Beaudet has been Rhode Island SM since 2002.



Robert G. "Bob" Beaudet, W1YRC

The Board cited Beaudet's active promotion of ARRL activities in his Section, including visiting hundreds of Field Day operations; participating in many Volunteer Examiner test sessions; attending countless club meetings; staying active as a contester, DXer, and mentor, and serving as a model to other Section Managers. The Board said "Beaudet's leadership of the ARRL Rhode Island Section Field Organization has led to a strong working cadre of volunteers within the Section."

Doug DeMaw, W1FB, Technical Excellence Award

The Board named Al Rabassa, NW2M, of Rockville, Maryland, as the recipient of the Doug DeMaw, W1FB, Technical Excellence Award. The Board cited Rabassa's frequent contributions to the *QST* "Hints & Hacks" column, and his *QST* technical articles,



Al Rabassa, NW2M

including "The Basics of Fan Cooling." The Board also noted that Rabassa has served as a subject-matter expert of the Yaesu FT-101 transceiver, maintaining a website devoted to the technical aspects of the vintage transceiver series.

ARRL Technical Service Award

The Board named James W. Brown, K9YC, of Santa Cruz, California as the recipient of the 2020 ARRL Tech-

nical Service Award. The Board cited Brown's frequent contributions to, and presentations at, amateur radio forums at conventions including Dayton Hamvention, Pacificon, and the International DX and Contesting Convention in Visalia, California; his collaborations with the ARRL Lab; his work on various ARRL publications, including *The ARRL Handbook*, *The ARRL Antenna Book*, and others; and his sharing of his technical and educational expertise in the fields of audio engineering, RFI, and other aspects of electronics and engineering with the amateur radio community at large, particularly in terms of the informational website he maintains, which is available at no charge. The Board said, "Brown continues to provide his expertise as a means of 'giving back' to the amateur community, in the spirit of the amateurs that worked with him when he was first licensed at the age of 13."



James W. Brown, K9YC

Recognitions

The Board recognized:

- ◆ the Fort Wayne Radio Club on its centennial and 90 years of ARRL affiliation.
- ◆ the Radio Club of Tacoma for 100 years as an ARRL-affiliated club.
- ◆ the Marietta Amateur Radio Club of Ohio for 100 years as an ARRL-affiliated club.

Happenings

ARRL Welcomes Paul Z. Gilbert, KE5ZW, as Director of Emergency Management

ARRL has named Paul Z. Gilbert, KE5ZW, of Cedar Park, Texas, as its first Director of Emergency Management. The appointment marks another step in ARRL's increased focus on strengthening its emergency communications capabilities and long-standing working relationships with federal and state agencies and private emergency response organizations.

Gilbert brings more than 30 years of professional and amateur radio experience in public service to the table. Following his appointment as an



Paul Gilbert, KE5ZW

Emergency Coordinator in 1987, he has held multiple positions within the ARRL Field Organization, and served for more than a decade as West Gulf Division Assistant Director for Public Service. At the time of his appointment, Gilbert was in his second term as South Texas Section Manager.

Professionally, Gilbert most recently served as Radio Officer, HQ Staff, for the Texas State Guard, where he was responsible for planning and implementation of the organization's communications capabilities for the past 6 years.

An Amateur Extra-class licensee, Gilbert is a member of Army MARS and holds numerous Department of Homeland Security certifications. He is a member of the FEMA Regional Emergency Communications Coordination Working Group, a graduate of the FEMA Emergency Management Institute's Exercise Design Course, and a founding member of the Texas Division of Emergency Management Communications Coordination Group.

Gilbert will manage a team responsible for supporting ARRL Emergency Communications programs and services, including the Amateur Radio Emergency Service® (ARES®) and National Traffic System (NTS), as well as lead the continued modernization of those programs.

QSO Today Virtual Ham Expo to Become Twice-Yearly Event

The QSO Today Virtual Ham Expo (www.qsotodayhamexpo.com) in early August appears to have been an unmitigated success, so much so that another virtual event will be held next March. The show was an ARRL-sanctioned event.

"It was far better than we expected," Virtual Ham Expo Chair Eric Guth, 4Z1UG/WA6IGR, told ARRL. "We had over 26,000 registered and over 14,000 on the platform both days."

Guth said event sponsors and exhibitors were "thrilled with the turnout, engagement, and response" and enthusiastic about the second QSO Today Virtual Ham Expo, set for March 13 – 14, 2021. "Our plan is to offer this twice a year," Guth added.

The show, developed on the vFairs virtual conference platform, cleverly recreated the atmosphere of a typical large hamfest, with several tracks of forum sessions on a wide array of topics.



The QSO Today Virtual Ham Expo simulated a convention center atmosphere with virtual exhibits and auditoriums.

Icom, a principal sponsor of the event, had team members from around the globe staff its exhibits. "We really enjoyed the virtual event," said Icom America Senior Sales Manager Ray Novak, N9JA. "It is our goal to see this grow and to have hams from the various countries attend in anticipation of

this becoming a multilingual event, as we all are starving for ham radio events during this pandemic."

Product Development Manager Bob Inderbitzen, NQ1R, was among the ARRL representatives engaging with event attendees using text and video chat. "Our team answered questions

about ARRL membership programs and services, amateur radio licensing, and even had some fun challenging visitors to our booth with ham radio trivia," he said. Working from W1AW at ARRL Headquarters, Inderbitzen treated more than 500 visitors to live, online tours.

Chris Brault, KD8YVJ, is 2020 Amateur Radio Newsline Young Ham of the Year

Christopher "Chris" Brault, KD8YVJ, of Liberty Township, Ohio, is the 2020 Bill Pasternak WA6ITF Memorial Amateur Radio Newsline Young Ham of the Year (YHOTY). The son of Jocelyn, KD8VRX, and



Chris Brault, KD8YVJ

Kimberly Brault, Chris, 18, was the recipient of the 2015 ARRL Hiram Percy Maxim Award. A ham since 2014, he credits his father for being his guide into amateur radio.

A senior and honor student at Saint Xavier High School in Cincinnati, Chris helped restart the school's amateur radio club, W8GYH. He has also been recognized as the 2017 ARRL Great Lakes Division Young Amateur of the Year, and he took part in the 2017 Dave Kalter Youth DX Adventure to Costa Rica with other up-and-coming young radio amateurs. He has been a Youth Forum presenter at Dayton Hamvention® and HamCation in Orlando.

Among other activities, Chris serves as social media director for the Youth on the Air organization and is a contesting mentor for young hams involved in its programs. See www.youthontheair.org for more information. — Thanks to CQ Communications

FCC News



US Department of Defense to Share 3450 – 3550 MHz with 5G Commercial Operations

The FCC will auction sharing rights to the upper 50 MHz of the 3300 – 3500 MHz secondary amateur radio allocation to commercial 5G interests in the wake of the Department of Defense (DoD) agreement to share spectrum at 3450 – 3550 MHz. The entire band currently supports a variety of military operations; amateur radio has a long history of peaceful coexistence with the Department of Defense as a secondary user of this spectrum.

Late last year, the FCC proposed to delete the amateur 3300 – 3500 MHz secondary allocation, as well as the amateur-satellite allocation at 3400 – 3410 MHz. ARRL strongly opposed the move in its comments on the rulemaking proposal. This latest move makes a contiguous band of spectrum from 3450 – 3980 MHz available for commercial 5G networks. The FCC could auction the 100 MHz of spectrum in early 2022.



"For a number of years, the National Telecommunications and Information Administration (NTIA) and FCC have focused on the 3450 – 3550 MHz band as the spectrum most conducive to sharing with commercial users," said ARRL Washington Counsel David Siddall, K3ZJ, adding that the August 10 action indicated that a sharing framework had been worked out.

HobbyKing Fined Nearly \$3 Million for Marketing Unauthorized Drone Transmitters

The FCC has issued a *Forfeiture Order* calling for HobbyKing to pay a fine of \$2,861,128 for marketing drone transmitters that do not comply with FCC rules. An FCC Enforcement Bureau investigation stemmed in part from a 2017 ARRL complaint that HobbyKing was selling drone transmitters that operated on amateur and non-amateur frequencies, in some instances marketing them as amateur radio equipment. The fine affirms the monetary penalty sought in a June 2018 FCC *Notice of Apparent Liability*.

The FCC said its investigation found that dozens of devices marketed by the company transmitted in unauthorized radio frequency bands and, in some cases, operated at excessive power levels. "Such unlawful transmissions could interfere with key government and public safety services, like aviation systems," the FCC said. The ARRL EMC Committee and Lab also determined that potential interference to the secondary (transponder) air traffic control radar system on 1030 – 1090 MHz could occur. HobbyKing did not contest any facts in the matter.

AMSAT-DL Submits Lunar Lander Proposal to European Space Agency

Germany's amateur satellite organization AMSAT-DL (www.amsat-dl.org) has submitted a comprehensive proposal to the European Space Agency (ESA) for its Lunar Amateur Radio Transponder (LunART) lunar lander — a communications platform for the European Large Logistic Lander (EL3). LunART would support communication and payload experiments. AMSAT-DL's Peter Guelzow, DB2OS, and Matthias Bopp, DD1US, say that a LunART would support direct communication with Earth via amateur radio, support university and student payloads and offer direct access to their experiments, and expand the reach of radio science. It could also provide backup communication capability and capacity during an emergency, or when the ESA network is busy.

The comprehensive radio platform would use the European frequency protocol of 2.4 GHz up and 10.45 GHz down (approximately 100 W), pioneered in the QO-100 satellite, the first geosynchronous amateur radio payload. The platform would also include a VHF/UHF transponder. AMSAT-DL would develop and build the necessary hardware and software and provide ground station support via the 20-meter dish at AMSAT-DL headquarters in Bochum, Germany. It envisions developing a smaller ground station with an approximately 1-meter dish to support groups, including schools and universities. Low-power beacons would transmit on various frequencies from VHF (145 MHz) through SHF (up to 24 GHz or even 47 GHz), AMSAT-DL's proposal says. In addition, LunART could include the capability to transmit still or slow-scan television images and video.



The European Space Agency plans to launch European Large Logistic Lander (EL3) probes on the lunar surface every 3 years from 2027 and invited proposals for interesting experiments and payloads. [European Space Agency, image]

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. It is acceptable to submit signatures that have been sent via email or mail under the following guidelines: The petition copies must be made from the original form supplied by ARRL or downloaded from the ARRL website. The form must be exactly the same on both sides, (i.e., autobiographical information should appear exactly the same on all copies). All forms/copies must be submitted at the same time.

Candidates may use any available electronic signature platforms, such as DocuSign, HelloSign, or signed PDF. Candidates who use an electronic signature platform to be nominated, as described above, do not need to send in original paper copies of the nominating documents. The packet that is sent to ARRL Headquarters must be complete. Multiple files or emails for a single petition will not be accepted.

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 4, 2020. If more than one member is nominated in a single Section, ballots will be mailed from Headquarters no later than January 4, 2021 to full members of record as of December 4, 2020, which is the closing date for nominations. Returns will be counted February 23, 2021. Section Managers elected as a result of the above procedure will take office April 1, 2021.

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, 2021. If no petitions are received from a Section by the specified closing date, such Section will be resolicited in the April 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. — *Bart Jahnke, W9JJ, Field Services & Radiosport Department Manager*

Public Service

The Great ShakeOut Drill and Earthquake Communications

Participate in the 2020 Great ShakeOut earthquake drill on October 15, at 10:15 AM, and exercise your family, neighborhood, and community earthquake disaster radio communications plans. “Drop, Cover, and Hold On” is the first response to an earthquake. Drop where you are, onto your hands and knees. Cover your head and neck with one arm and hand, and crawl underneath a table or desk or to an interior wall, away from windows. Hold on until the shaking stops. This drill is supported by the National Earthquake Hazards Reduction Program (NEHRP), US Geological Survey (USGS), Federal Emergency Management Agency (FEMA), and others. Register and get more information at www.shakeout.org. Although October 15 is the official drill date, your drill can be conducted at any time.

The Radio Amateur’s Role

Amateur radio provides emergency communications during earthquake disaster situations and has a role in local and state emergency management drills, as well as major FEMA exercises, such as 2016’s Cascadia Rising. Based on a scenario of an M9.0 earthquake off the coast of central Oregon triggering a tsunami along the entire Pacific Northwest coastline, Cascadia Rising started with a failure of all regular communication systems. ARRL leadership in the Oregon, Western Washington, and Idaho Sections (as well as ARRL Headquarters) were involved in this national exercise.

Disaster response organizations are currently evaluating how to respond to emergencies and disasters related to the COVID-19 pandemic, and earthquakes are no exception. Sheltering, emergency operations centers (EOCs) and overloaded hospital operations,

feeding, damage assessment, and urban search and rescues for earthquakes will all have to be done differently. Amateur radio is unique in that operators don’t have to physically be there — it’s a network with built-in social distancing. The ShakeOut earthquake exercise presents amateur radio operators with an opportunity to assess how to respond during the pandemic.

The Role of CERTs and ARES®

When aftershocks occur during the unstable aftermath of an earthquake, trained and registered radio amateurs in groups such as the Amateur Radio Emergency Service (ARES) can support Community Emergency Response Teams (CERTs) on their missions in neighborhoods and the broader community. The CERT program educates the public about disaster preparedness for hazards that may impact their area and trains them in

basic disaster response skills, such as fire safety, light search and rescue, team organization, and disaster medical operations. Radio communications is an essential emergency support function for CERT members’ activity and should be well-exercised and planned for.

After an earthquake, before deploying and supporting a CERT mission to the neighborhood for assessing and communicating damage, the radio amateur must ensure the structural integrity of their family residence and the safety and well-being of their own family members first.

CERT basic training was updated this year, featuring a revised Disaster Medical Operations section, and new hazard-specific annexes. The FEMA Independent Study (IS) course, IS-317A: An Introduction to the Community Emergency Response Team (CERT), was updated in May. CERT is sponsored by the US





Department of Homeland Security, FEMA, and the Ready program. For more information, visit www.ready.gov/cert.

SKYWARN for Earthquakes

Like the SKYWARN program, the US Geological Survey's Did You Feel It (DYFI) system receives basic reports from residents who are experiencing

an earthquake. With this crowdsourcing, the USGS gets a complete picture of the earthquake area, magnitude, damage, and extent. Affected residents send their reports over the internet (see the sidebar, "Did You Feel It Report Sample").

By providing a DYFI report when you can do so safely after an earthquake, you help ensure that your area has been represented in the compilation of the maps of shaking. In the process, you will learn more about how other communities fared and gain a greater understanding of the effects of earthquakes. For more information on the USGS Did You Feel It program, visit <https://earthquake.usgs.gov/data/dyfi>.

For radio amateurs, the reporting system can be complemented by the hybrid internet-amateur radio email system Winlink, especially when the internet is down in affected areas.

The Winlink Connection

In the ARRL Headquarters comprehensive after-action report of the Cascadia Rising exercise, the following was noted on what worked: "Winlink was found to be extremely useful during the exercise. This allowed radio amateurs in the disaster area to send radio email to ARRL HQ, which could be received normally. When the internet and phone outage at ARRL HQ was injected to the exercise, the transition to RF-only radio email between ARRL HQ and the disaster area occurred quickly and seamlessly." Winlink continues its development path with evolving digital mode algorithms that give more throughput, robust efficiency, and effectiveness in transmission of messages and form handling.

Did You Feel It Report Sample

- Did you feel the earthquake?
- What time did it occur?
- Where were you when it occurred?
- What was your situation during the earthquake?
- How would you describe the shaking?
- Was it difficult to stand and/or walk?
- Did you notice any swinging of doors or other free-hanging objects?
- Did objects rattle, topple over, or fall off shelves?

Reports can be made at <https://earthquake.usgs.gov/earthquakes/eventpage/tellus>.

One year after the M7.1 Ridgecrest earthquake in Southern California, the Winlink team rolled out its Did You Feel It utility for its popular *Winlink Express* software. Through cooperative efforts with the USGS, amateur radio operators worldwide can now report the effects of an earthquake at their location directly to the USGS with no internet or phone service required.

In the *Winlink Express* program (make sure you have the most up-to-date version), you can find the HTML DYFI form by accessing **MESSAGE TAB > HTML FORMS > STANDARD FORMS > USGS FOLDER**.

Get ready to drop, cover, and hold on this October, when you exercise your earthquake disaster plans.

Field Organization Reports

July 2020

Public Service Honor Roll

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

635 KD8TTE	175 W3GWM	KA9QWC AG9G K9LJU	100 WB4RJW AD4DO	WA1LPM
526 W7PAT	170 N1PZP	K3JL W0LAW KY2D	89 K28Q KN9P NX9K AC8RV WB8SIQ	89 KB1NMO
463 WA7PTM	160 K0RCJ KK3F	119 AC8NP KA8ZGY	88 KB2QO KE5YTA KF5OMH KG5NNA	88 N6IET
455 WA3EZN	159 W9RY	118 A9F	86 W7PHX AA3SB K8ED	86 KF7GC
440 N9VC	155 W8DJG	115 AF4NC WBIM KD8ZCM N1TF	85 WA1MXT N1LAH	85 KL7RF
331 KE8BYC	151 WA2BSS	98 K8MDA WV5Q	83 W5XX	83 W5XX
304 W9GRG	145 N1LL WM2C	112 N2DW	82 W9BGJ K8RDN	82 W9BGJ K8RDN
296 KD2LPM	140 KC8WH W02H KB8RCR K1REZ	110 K04OL WA3QLW K6HTN K2TV N3SW WB8YLO KA9MZJ KA5AZK KF5IOU KI7TIG K3IN WB8TQZ AB1AV N1QI KD2JKV W1RVY	80 WB6NCT W4INK KC1HHO	80 KD8UUB N8MRS KG7QWR KJ7BHO
275 K15GRH	138 N3KRX	96 N8CJS	79 N3JET AB3WG	79 N3JET AB3WG
248 WA2CCN	135 KC9FXE W3YVQ	95 W9EEU K0IBS K1XFC	78 KA0DBK WB8R	78 KA0DBK WB8R
247 KB3YRU	130 WA4VGZ AC0KO WB9QPM N2JBA K3FAZ K8AMH WB8USA N5MKY KW1U NA7G	94 KE1ML	77 N3RB KC7ASA	77 N3RB KC7ASA
235 WB9WKO	128 KY2MMM	91 K1STM	75 NV1N	75 NV1N
232 N2WGF	126 W7EES	90 KM4WHO AA4XZ AB9ZA KB4CAU K8KRA KB8HJJ KA1G N2TSO K3MIY K2MJF KA2GQQ KA2HZP W2AH W3CJD K6JT WD0BFO WB8WKQ KC1KYV	74 KC1MSN KB0DTI	74 KC1MSN KB0DTI
210 KT2D	125 N8SY	105 WB7QSC AD3J N1ZW	73 WB2VUF	73 WB2VUF
205 AD8CM W0PZD ND8W	120 W4NWT WC4FSU	104 KV8Z	72 K6RAU K0FBS KJ6CNO	72 K6RAU K0FBS KJ6CNO
195 KE8KOC		102 K1HEJ	70 K9GDF W3ZR	70 K9GDF W3ZR
186 WS6P		101 WB8YY5		
184 KD2NMG				

The following stations qualified for PSHR in previous months but were not reported in this column: (June) WB6ZIQ 120, WF2Y 110, WS4P 106.

Section Traffic Manager Reports

The following Section Traffic Managers reported: AL, AR, AZ, CO, CT, DE, EMA, ENY, EPA, IL, IN, KS, KY, LAX, MDC, MI, MN, MS, NC, NE, NFL, NH, NLI, NM, NNJ, NTX, OH, OR, SD, SFL, SJV, TN, UT, VA, WCF, WMA, WI, WPA, WV, WY.

Section Emergency Coordinator Reports

The following Section Emergency Coordinators reported: AR, CT, DE, ENY, EWA, GA, IA, ID, IL, IN, KS, KY, LA, MDC, MI, MN, MO, MS, MT, ND, NFL, NLI, NNJ, NNY, NM, NV, OH, OR, PAC, SFL, SJV, SNJ, STX, SV, TN, VA, VI, WCF, WPA, WI, WPA, WTX, 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.

KK3F 2,309, NX9K 1,287, K6HTN 1,025, WB9WKO 885, KW1U 552.



IARU Announces HF Digital Mode Band Plan Review

An International Amateur Radio Union (IARU) working group was formed in August to develop solutions to reduce congestion within very popular mode segments, while preventing mutual interference between “incompatible modes” as much as possible. The working group includes representatives of the three regional band-planning committees, marking the first time the three IARU regions have joined together to coordinate band-planning efforts.

“Because frequency allocations and amateur radio operating interests vary in different parts of the world, the development of band plans — voluntary guidelines on the use of the spectrum that is available to radio amateurs — is a responsibility of the three IARU regional organizations,” the IARU explained in announcing the working group. “Each of the three regions has a band-planning committee to focus on this work.”

The IARU says this approach to band planning has generally kept pace with the evolution of amateur radio operating, but the explosive growth in HF digital modes, particularly FT8, has led to perceived overcrowding of HF digital mode band segments.

In August, the new working group reported having had “fruitful discussions” with the WSJT Development Group led by Joe Taylor, K1JT. Additional discussions, including with other HF stakeholders, will be held as part of a fundamental review of

the different HF digital modes, and how they can best be categorized and arranged to share the limited spectrum available.

In recent years, moves have been made to bring the regional band plans into alignment wherever possible. Final approval of any band plan revisions typically occurs during regional conferences of IARU member-societies, held every 3 years on a rotating basis.

IARU Appoints New Electromagnetic Compatibility (EMC) Coordinator

The International Amateur Radio Union (IARU) Administrative Council has appointed Martin Sach, G8KDF, as global Electromagnetic Compatibility (EMC) Coordinator, succeeding Tore Worren, LA9QL.

“EMC is a major challenge for all radiocommunication services,” the IARU noted. “Radio amateurs are experiencing increased interference caused by unwanted radio frequency emissions from a wide variety, and rapidly growing number, of electronic devices.”

The EMC Coordinator’s mission is to ensure that the concerns and needs of radio amateurs are effectively addressed in international standards bodies — particularly the International Special Committee on Radio Interference (CISPR) and the International Telecommunication Union (ITU) — as well as in regional telecommunication organizations and at national levels through IARU member-societies. Assisting in the

effort is a network of volunteers with expertise in the field of EMC.

“We are fortunate that someone as qualified as Martin is willing to take the reins,” IARU President Tim Ellam, VE6SH, said. “He has already represented the IARU effectively at important international meetings and we look forward to working even more closely with him.”

New IARU Video

The video “What is IARU?” is now available on the International Amateur Radio Union (IARU) Region 2 website, at www.iaru-r2.org.

“This video explains the mission and roles of IARU to represent, develop, and defend frequencies for amateur radio around the world,” IARU Region 2 explains. “It also describes the regional organizations and the critical roles of its more than 160 member-societies.” The English-language presentation was developed by the IARU Administrative Committee and approved at its meeting last October in Lima, Peru.

The short video, available in English and Spanish, was produced by IARU Region 2 Director Carlos Beviglia, LU1BCE, and Fernando Gomez Rojas, LU1ARG. It is available in MP4 format.

IARU Region 2 encourages member-societies and radio clubs to use the video to explain the role and mission of IARU to amateurs, regulators, and others.

Contest Corral

October 2020

Check for updates and a downloadable PDF version online at www.arrl.org/contest-calendar.

Refer to the contest websites for full rules, scoring information, operating periods or time limits, and log submission information.

Start - Finish		Bands	Contest Name	Mode	Exchange	Sponsor's Website
Date-Time	Date-Time					
1 1700	1 2000	3.5	SARL 80-Meter QSO Party	Ph	RS, serial, grid or QTH	www.sarl.org.za
1 1700	1 2100	28	NRAU 10-Meter Activity Contest	CW Ph Dig	RS(T), 6-char grid square	nrau.net/activity-contests
1 1900	1 2100	1.8-50	SKCC Sprint Europe	CW	RST, SPC, name, mbr or power	www.skccgroup.com
3 0600	4 0600	1.8-28	Oceania DX Contest, Phone	Ph	RS, serial	oceaniadxcontest.com
3 0600	4 1800	3.5-28	TRC DX Contest	CW Ph	RST, serial, "TRC" (if member)	trcdx.org/rules-trc-dx
3 0700	3 1000	3.5, 7	German Telegraphy Contest	CW	RST, LDK (if DL)	agcw.org/index.php/en
3 1200	4 1159	3.5-28	RTTYops WW RTTY	Dig	RST, 4-digit year first licensed	rttyops.wordpress.com
3 1200	4 1159	1.8-28	Russian WW Digital Contest	Dig	RST(Q), 2-char oblast code (if UA)	rdclub.ru/ustav-rtsrk
3 1400	4 0200	All	YLRL DX/NA YL Anniversary Contest	CW Ph Dig	Serial, RS(T), SPC	ylrl.org/wp/dx-na-yl-contest
3 1600	4 1100	3.5, 7	International HELL-Contest	Dig	RST, serial	www.darc.de
3 1600	4 2200	1.8-28	California QSO Party	CW Ph	Serial, county or SPC	www.cqp.org/Rules.html
3 1700	3 2100	3.5-28	FISTS Fall Slow Speed Sprint	CW	RST, SPC, name, mbr or power	fistsna.org
3 1800	4 1800	All	SKCC QSO Party	CW	RST, SPC, name, 4-char grid	www.skccgroup.com
4 0500	4 2300	3.5-28	RSGB DX Contest	CW Ph	RS(T), serial	www.rsgbcc.org/hf
4 0600	4 0900	3.5	UBA ON Contest, SSB	Ph	RS, serial, ON section (if ON)	www.uba.be/en
4 2200	4 2359	7, 14, 21	Peanut Power QRP Sprint	CW Ph	RS(T), SPC, peanut nr or power	www.nogaqrp.org
5 1900	5 2030	3.5	RSGB 80-Meter Autumn Series, CW	CW	RST, serial	www.rsgbcc.org/hf
6 0100	6 0300	3.5-28	ARS Spartan Sprint	CW	RST, SPC, power	arsqrp.blogspot.com
7 1700	7 2000	144	VHF-UHF FT8 Activity Contest	Dig	4-char grid square	ft8activity.eu/index.php/en
7 1900	7 2300	432	432 MHz Fall Sprint	CW Ph Dig	4-char grid square	svhfs.org
7 2000	7 2100	3.5	UKEICC 80-Meter Contest	Ph	6-char grid square	www.ukicc.com
10 0000	10 2359	1.8-28	QRP ARCI Fall QSO Party	CW	RST, SPC, mbr or power	qrparki.org/contests
10 0000	11 1559	3.5-28	Makrothen RTTY Contest	Dig	4-char grid square	pl259.org/makrothen
10 0000	11 2359	50-1296	ARRL EME Contest	CW Ph Dig	Signal report	arrl.org/eme-contest
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 0300	11 2100	1.8-UHF	Nevada QSO Party	CW Ph	RS(T), county or SPC	nvqso.com/contest-rules
10 0600	11 0600	1.8-28	Oceania DX Contest, CW	CW	RST, serial	oceaniadxcontest.com
10 0800	10 1400	902 and up	Microwave Fall Sprint	CW Ph Dig	6-char grid square	svhfs.org
10 1200	11 1200	3.5-28	Scandinavian Activity Contest, SSB	Ph	RST, serial	www.sactest.net
10 1200	11 2359	1.8-50	SKCC Weekend Sprintathon	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
10 1500	11 0459	1.8-144	Arizona QSO Party	CW Ph Dig	RS(T), county or SPC	www.azqsoparty.org
10 1600	11 2200	1.8-UHF	Pennsylvania QSO Party	CW Ph	Serial, county or SPC	paqso.org
10 1700	10 2100	3.5-28	FISTS Fall Unlimited Sprint	CW	RST, SPC, name, mbr or power	www.fistsna.org
10 1800	11 1800	1.8-144	South Dakota QSO Party	CW Ph Dig	RS(T), county or SPC	www.sdqsoparty.com
10 2000	11 2000	1.8	PODXS 070 Club Great Pumpkin Sprint	Dig	RST, SPC	www.podxs070.com
11 0530	11 0800	3.5	UBA ON Contest, CW	CW	RST, serial, ON section (if ON)	www.uba.be/en
11 0800	11 1000	50	UBA ON Contest, 6 Meters	CW Ph	RS(T), serial, ON section (if ON)	www.uba.be/en
12 0000	12 0200	1.8-28	4 States QRP Second Sunday Sprint	CW Ph	RS(T), SPC, mbr or power	www.4sqrp.com
14 0030	14 0230	3.5-14	NAQCC CW Sprint	CW	RST, SPC, mbr or power	naqcc.info
14 1700	14 2000	432	VHF-UHF FT8 Activity Contest	Dig	4-char grid square	www.ft8activity.eu
14 1900	14 2030	3.5	AGCW Semi-Automatic Key Evening	CW	RST, serial, year first used a bug	agcw.org/index.php/en
14 1900	14 2030	3.5	RSGB 80-Meter Autumn Series, Data	Dig	RST, serial	www.rsgbcc.org/hf
17 0000	18 1600	50, 144	Araucaria World Wide VHF Contest	CW Ph	RS(T), 6-char grid square	avhfc.com/rules/en.pdf
17 0000	18 2359	3.5-28	JARTS WW RTTY Contest	Dig	RST, age of operator	jarts.jp/rules2020.html
17 0001	18 2359	28	10-10 International Fall Contest, CW	CW	Name, mbr or "0", SPC	www.ten-ten.org
17 1400	18 0200	All	New York QSO Party	CW Ph Dig	RS(T), county or SPC	www.nyqp.org
17 1500	18 1459	3.5-28	Worked All Germany Contest	CW Ph	RS(T), DOK code or "NM" or serial	www.darc.de
17 1500	18 1500	1.8	Stew Perry Topband Challenge	CW	4-char grid square	www.kkn.net/stew
17 2000	17 2359	1.8-7, 21-50	Feld Hell Sprint	Dig	RST, mbr, SPC, grid	sites.google.com/site/feldhellclub
17 2130	17 2230	7	Argentina National 7 MHz Contest	Ph	RS, year first licensed	lu4aa.org/wp/concurso-nacional-40m
18 0000	18 0200	14-21	Asia-Pacific Fall Sprint, CW	CW	RST, serial	jsfc.org/apsprint/aprule.txt
18 1400	21 0800	1.8-144	Classic Exchange, Phone	Ph	Name, RS, SPC, rig	classicexchange.org
18 1700	19 0100	1.8-144	Illinois QSO Party	CW Ph Dig	RS(T), county or SPC	http://www.w9awe.org/ILQP%202020%20Rules.pdf
18 1900	18 2030	3.5	RSGB RoLo CW	CW	RST, 6-char grid of previous QSO	www.rsgbcc.org/hf
18 2300	19 0100	1.8-28	Run for the Bacon QRP Contest	CW	RST, SPC, mbr or power	qrptest.com/pigrun
19 1300	23 2359	All	ARRL School Club Roundup	CW Ph	RS(T), class (I/C/S), SPC	arrl.org/school-club-roundup
19 1800	20 0300	1.8-UHF	Telephone Pioneers QSO Party	CW Ph Dig	RS(T), chapter (if member), name	www.tpqsos.com
19 1900	19 2030	3.5	RSGB FT4 Contest Series	Dig	4-char grid square	www.rsgbcc.org/hf
24 0000	25 2359	1.8-28	CQ Worldwide DX Contest, SSB	Ph	RS, CQ zone	www.cqww.com/rules.htm
28 0000	28 0200	1.8-28	SKCC Sprint	CW	RST, SPC, name, mbr or power	www.skccgroup.com
28 2000	28 2100	3.5	UKEICC 80-Meter Contest	CW	6-char grid square	www.ukicc.com
29 2000	29 2130	3.5	RSGB 80-Meter Autumn Series, SSB	Ph	RS, serial	www.rsgbcc.org/hf
30 1600	30 2359	3.5-14	Zombie Shuffle	CW	RST, SPC, Zombie nr/area code, name	www.zianet.com/grp
31 1200	1 1159	1.8-28	Russian WW MultiMode Contest	CW Ph Dig	RST(Q), oblast or serial	rdclub.ru/ustav-rtsrk
31 1200	1 1200	3.5-28	UK/EI DX Contest, SSB	Ph	RS, serial, district (if UK/EI)	www.ukicc.com

There are a number of weekly contests not included in the table above. For more info, visit: www.qrpfoxhunt.org, www.ncccsprint.com, and www.cwops.org.

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

2019 – 2020 School Club Roundup Results

The next School Club Roundup will take place October 19 – 23, 2020.

The main purpose of the School Club Roundup (SCR) is to acquaint school-age students with the fun of amateur radio. Each of the most recent sessions had more than 400 operators reported. These included both licensed and unlicensed participants acting as operators and loggers. The average number of participants per school was between nine and 10 students taking part. Only two schools reported 40 or more operators each (W0BHS and W0LHS).

Traditionally, some clubs use various strategies to attract students, such as having food available during the event. It always helps to have support from school principals or department heads. The emphasis is on having fun getting on the air.



Jeremiah Thompson, KO4AST, operated during the February 2020 School Club Roundup at the Augusta University Amateur Radio Club's station. [Darby Wills, KK4PEQ, photo]

The Results

Although overall we've seen a significant increase in entries, there was a decrease in February 2020. SCR is an operating event, not a contest, so you should make of it what you like and enjoy yourselves.

The full results for this and many past SCRs can be found at contests.arrl.org/scrresults.php?cn=scrspring. Click on the event month for the scores you want to view. The full details of all entries, along with any comments, can be viewed by clicking on the call sign of the entrant. Results 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.

COVID-19 Impact

The next SCR session will be unlike any before. There's no telling what the impact of COVID-19 will have on the upcoming school year. Many clubs will have to look at

alternative ways to operate during the SCR. We're looking at our most recent Field Day experience as a model.

Many special event operations use their special call sign and pass it around to different participating stations. If a school club can't operate from the school, licensed members (with permission from the club's trustee) might be able to operate from their home stations.

Many schools have been using video conferencing software. You could try operating a home station with students using platforms such as Zoom or Google Meet. Phone operation might work using VOX or coordinating push-to-talk (PTT) with the control operator, like the old-style phone patch.

In light of the poor propagation conditions in recent

years, many stations are anxious to use some of the popular digital modes. FT8 doesn't readily support the full exchange of an SCR contact. A more convenient alternative is *JS8Call*. It has many of the characteristics of FT8 but supports keyboard-to-keyboard contacts and more flexible macros.

Conclusion

Encourage your local school or university club to get on the air and make some contacts! Individual hams are also encouraged to make contacts with the students. A student might enjoy making an SCR contact from a home station, as well. If you're interested or have questions about SCR, you can join [@groups.io](https://groups.io/join/SCR) or email scr@limarc.org. The full rules are available at www.arrl.org/school-club-roundup.

We look forward to seeing the creative solutions you employ. Feel free to discuss them on [@groups.io](https://groups.io/join/SCR) and mention them on the Soapbox page with your submission. Get on the air, experiment, and have fun!

The 2020 ARRL November Sweepstakes

CW: 2100 UTC Saturday, November 7 – 0259 UTC Monday, November 9
Phone: 2100 UTC Saturday, November 21 – 0259 UTC Monday, November 23

The ARRL November Sweepstakes is the premier domestic contest in the US and Canada. Join thousands of operators of all skill levels as they attempt to beat personal records, win categories, and achieve the coveted Clean Sweep by working all 84 ARRL/RAC Sections in a single weekend.

Entrants may operate for a maximum of 24 of the 30 hours



Stephen Wojton, NN2NN, searched for contacts on 80 meters during the 2019 ARRL November Sweepstakes. [Stephen Wojton, NN2NN, photo]

during the contest period. Off-times must be a minimum of 30 consecutive minutes without listening or transmitting. Exchange is serial number, precedence, your call sign, check, and ARRL/RAC Section.

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Logs are due 7 days after the conclusion of the event. Electronic logs must be uploaded to our web app at <https://contest-log-submission.arrl.org>. Send paper logs to ARRL November Sweepstakes, 225 Main St., Newington, CT 06111. Sweepstakes CW logs must be submitted or postmarked by 0300 UTC Monday, November 16, and Phone logs must be submitted or postmarked by 0300 UTC Monday, November 30.

If you want to convert your paper log into a Cabrillo-formatted log for electronic submission, go to <http://www.b4h.net/cabforms> and select the event. You can input your log data, which will be converted to a Cabrillo-formatted log for you (be sure to save the generated file on your computer). Then upload your formatted log to the web app at <https://contest-log-submission.arrl.org>.

For more information, visit

www.arrl.org/sweepstakes or email contests@arrl.org

New Products

bhi NES10-2MK4 Amplified DSP Noise-Canceling Speaker

The bhi NES10-2MK4 removes noise and interference from speech signals, enabling you to have a more enjoyable listening experience. The speaker is compact and easy to use and incorporates the latest bhi high-performance DSP noise-canceling technology. The three-position switch on the top of the speaker controls the main functions, "Off" (audio bypass), "On" (amplified audio), and "DSP" (noise canceling on). The speaker has a quality 5 W audio amplifier with DSP noise canceling from 8 to 40 dB over eight user-selectable levels, and tone reduction up to 65 dB. The NES10-2MK4 requires 10 to 18 V dc (500 mA) and has an integral 2-meter audio lead terminated with a 3.5-millimeter monaural jack plug. There is a 3.5-millimeter monaural headphone socket on the side, and this can also drive an external loudspeaker. The NES10-2MK4 speaker is supplied with a rotary filter select knob, two fixing screws, four self-adhesive rubber feet, 1 × 1030 FPL fused dc power lead, and a user manual. Distributed in the US by DX Engineering; tel. 800-777-0703; www.dxengineering.com. \$165.99.



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How's DX?

The First DXpedition to Albania, 50 Years Later

For this month's column, Martti Laine, OH2BH, reflected on his DXpedition to Albania in 1970.

In 1970, Albania was the most difficult country to reach via radio. Although it is located in the center of Europe and surrounded by other countries, it had remained totally closed off and only in correspondence with distant China. In July 1970, Albania welcomed its first ever group of tourists, travelling in from Denmark (OZ), to the isolated beaches of Durres, a 1-hour ride down winding dirt roads from the capital, Tirana.

On that very first plane, there were three adventurous amateur radio operators: Erkki, OH2BW (SK); Ville, OH2MM, and myself, OH2BH. On July 10, 1970, we hit the airwaves.

In July 2020, 50 years later, Ville and I enjoyed an exclusive dinner in Helsinki, Finland, with the Albanian Honorary Consul General, Ms. Liliana Verdha, remembering those early days in her homeland. Liliana (Lili) is the person who allowed that first ZA activation to proceed after Albanian officials tried to halt the operation, because they had no laws in place regarding amateur radio. Years later, during the mysterious ZA blockage from the rest of the world, Lili had moved to Finland, where she became well known.

During our dinner party, Lili admitted that it was in fact her father, Vice Minister Sali Verdha, who had graciously allowed the first Albania radio operation, paving the way to make Albania a household DX country.



The original ZA/OH2BH QSL card from 1970. From left to right: Erkki, OH2BW (SK); Ville, OH2MM, and Martti, OH2BH, in front of the Ministry of Communication.

Albania's First Amateur Training Course

It took a series of visits from 1970 through 1989, and even one failed DXpedition, to discuss amateur radio with the regime's frequency management officials, headed by Dajlan Omeri. Those decisions were consistently negative, even though Omeri was nodding during the meetings, as if in agreement. As it turns out, vertical nodding in Albania means no, and time and again I left those meetings

with no success. Omeri's young engineer, Fredrick Kote, presented some positive signs that encouraged me to come back time after time.

In 1989, the head of the Albanian Telecom Administration visited Finland. Even though he was carrying a card with the name Toli Halili, he was later identified as Sokol Hoxha, the son of Enver Hoxha, the dictatorial Prime Minister of Albania. Sokol was a very warm and intelligent person, who quickly agreed to



The first IARU training course yielded a group of new operators.

allow the first-ever amateur radio training course and operating event, ZA1A, in September 1989.

This training course and the local students not only changed my direction in amateur radio, but did the same for many others, such as Wayne, N7NG/ZA1NG, and Chip, K7JA/ZA1JA, who both participated in this historic project.

Amateur radio regulations for Albania were written as part of this event and the license forms were produced. As the project director, I was able to allocate the call sign ZA1A for the event and the students, and for the IARU member-society (AARA) that was established at the time. Dajlan Omeri was among the graduates and decided to override all other call sign structures, wanting Albania to start with ZA1KAA for the students. He assigned the first call sign, ZA1KAA,

to himself (today he's ZA1Z) and became the president of AARA.

Licensing at the University of Tirana

In 2003, we agreed to have amateur radio included in the course offerings at the Technical University of Tirana. We had invited a slate of amateur radio educators to lead that historic undertaking, led by John, G3OKA, and his co-educators, including Uli, DJ2YA, and Carl, K9LA. The result of the class was 38 new amateur radio licensees. Even the university chairperson, Sonila Agako, ZA1YL, took the exam.

Along with the university course in Tirana, a large multinational team activated Albania again, along the same beaches in Durres where this story had begun with my team's DXpedition in 1970. The follow-up event to further boost amateur radio

awareness was organized under the title, "First DX Convention of Albania, ZA1DX," in 2004.

Looking Back on 50 Years

Albania has truly opened up for tourism now and is reachable through direct flights from many cities in Europe. We have not forgotten Albania, those great students, and the beautiful Durres beaches. In fact, those of us on the original DXpedition team became residents of Albania and established our radio station on the very same Durres beach with two fellow hams, Pertti, OG2M, and Pekka, OH2TA.

A recent earthquake did some damage to the Durres area, but all our fond memories are still there — standing proudly alongside the tower with the Stepper beam at 170 feet. Once we are clear from earthquake repairs and the COVID-19 pandemic, we plan to return.

All photos provided by the author.

From left to right: Honorary Consul General Liliana "Lili" Verdha, President of Albania Ilir Meta, and former President of Finland Martti Ahtisaari.



The Durres beach is miles long and has been the site of amateur radio activities over the past 50 years.

The World Above 50 MHz

Rare 6-Meter Propagation Across the Geomagnetic Equator in July

July was an amazing month for propagation. Many stations in North America reported strong and frequent openings to Europe and the Far East. On July 10, at 2244Z, Skip, WS9V (EM59), worked Joel, KG6DX (QK23), in Guam. Terrestrial contacts on 50 MHz from Guam to North America have not taken place during July until this contact was reported, possibly making this the first non-F-layer terrestrial 50 MHz contact of this distance reported.

During solar cycle peaks, F2 contacts between Guam and North America occur regularly on 6 meters. Rich, K1HTV, and I recall working Joel in November 1989 of Solar Cycle 22 via F2 on 6 meters. I was running only 10 W with a Kenwood TS-680, and the SSN was about 170.

On July 18, John, WA1EAZ (FN42), worked Alain, TR8CA, in Gabon. On July 25, a strong opening took place from North America to South America (see Figure 1). Contacts were made much deeper into South America than usual, with stations such as CP6UA working into Colorado. Then CE1PTT and CE3SX in Chile were received by stations in Colorado, Kansas, and the Gulf Coast states. The contacts made by Joel, Alain, and the Chilean stations share a commonality: the DX stations are either on or south of the geomagnetic equator. Mid-latitude sporadic-E contacts do not normally cross the geomagnetic equator, which makes us wonder how the 6-meter signals got over it.

During the equinoxes, the mechanism is straightforward. Sporadic-E from North American stations lands in the northern terminal of the TEP (trans-equatorial propagation) zone. Radio signals propagate by TEP by refract-

ing off of two bulges of ionization, located 20 degrees north and south of the geomagnetic equator. The signals cross the geomagnetic equator and come down on the other side. TEP works best when the sun is directly over the geomagnetic equator (equinoxes) in the afternoon. The E_s-TEP contacts are often made during solar cycle peaks, when the F-layer ionization is higher.

Stations in CE, LU, and PY were worked by North American stations around the equinoxes. But these TEP contacts have occurred, though are rare, during solar cycle minimums,

such as the E_s-TEP contacts on April 15, 2020. But in July, the sun is far north of the TEP zone, and conventional wisdom is that TEP ionization is very weak, and at the solar cycle minimum, too feeble to propagate signals at 50 MHz. Perhaps there was some help.

For the WS9V – KG6DX contact, multi-hop sporadic-E put the signals out into the eastern Pacific. For the last hop to KG6DX, equatorial sporadic-E may have helped and played a role in WA1EAZ's contact with TR8CA. The sun was shining on the stations in Bolivia and Chile on July 25. A slow-moving coronal mass ejection left the sun on July 19 and hit Earth on July 24. It arrived embedded in a solar wind stream and had a strong magnetic field. This caused a geomagnetic storm with the Kp peaking at 4, with visual aurora seen in Minnesota. The geomagnetic activity boosted the MUF of the northern and southern bulges of the TEP zone to above 50 MHz, allowing E_s-TEP contacts.

Hamspeak: Geomagnetic Equator

The theoretic line around the earth where the magnetic field is horizontal. As the magnetic north and south poles change slowly over time, the magnetic equator is not fixed, and changes according to the movement of the magnetic poles.



Figure 1 — PSK Reporter showing the opening from North America to South America on July 25, 2020. [pskreporter.info/pskmap]



▲ **Figure 2** — Barry Hansen's, K7BWH, portable setup from CN98. [Barry Hansen, K7BWH, photo]

► **Figure 3** — Gene Shea's, KB7Q, portable operation from DN58. [Gene Shea, KB7Q, photo]



On the Bands

50 MHz. Six meters took a few days off as July started, then came roaring back on July 4. On the afternoon of July 4, from central Texas, Jerry, K5JC (EM00), with just 90 W and a four-element Yagi up 20 feet, logged JW7QIA.

That evening, Mike, K7ULS (DN41), worked a number of stations in Japan and BH4SCF (PM01) in Shanghai, China. K5JC found KL7HBK (BO49) for his 50th state on 6 meters. July 10 was good for N0LL (EM09) with 10 Japanese stations and HL3GOB for a new one.

July 11 was one of the best days, particularly for the central US states, which had openings to Europe all day. Nelson, KD2CYU (FN20), said it was "game on" with western Europe at 1230Z. Then I, S5, Ukraine, and eastern Europe boomed in. Nelson ended up putting 200 European stations in 20 countries in his log. From eastern Kansas, Dragan, K0AP (EM28), worked stations in Germany. N2CG (FN20) had European openings for 10 hours. Mario, K2ZD, said the band was open to Europe for him for 5½ hours starting at 1148Z. Starting at 2146Z, Mario had a 2-hour opening to Japan, working "19 different stations in all call areas." W3ATV worked JR1AIB with only a 40-meter dipole. Joe Taylor, K1JT, worked 27 Japanese

stations and HL3GOB (marking Joe's 117th DXCC contact). JA7QVI worked VO2AC (in CQ zone 2) to complete the challenging 40-zone Worked All Zones award on 50 MHz, with all terrestrial contacts.

On July 12, N1AV (DM43) worked 35 stations in Japan and Korea. From Alaska, John, KL7HBK, worked "over the North Pole" into Europe with 11 contacts to YU, SP, Z3, and HA around 1200Z. KB7Q covered DN48/58/68 along the Canadian Border from Montana on several bands. On July 16, Al, K6AVP, worked EA8DBM with 70 W to a Moxon antenna. Barry, K7BWH, operated from rare CN98 and completed 254 contacts (see Figure 2).

On July 19, Lance, W7GJ (DN27), reported "the best Japanese opening ever." He worked 65 JA, two KH6, and three HL stations. On July 20, Randy, N0LD (EM15), worked DL8GP with only a loop up 30 feet. N0LL was portable in grid EN02, and he made 14 contacts on E_s with FT8. Lance, W7GJ, operated portable in DN25 and DN35 and made 119 contacts on FT8.

144 MHz. The E_s MUF rose briefly above 144 MHz on July 5. The paths intersect for an intense E_s cloud located over southern Indiana. Jim,

K5ND, wondered if an outbreak of Noctilucent clouds may have sparked the E_s. On July 12, K7ULS worked KB7Q/p in DN56 on MSK144 (see Figure 3). Two-meter E_s made a brief appearance again in the CQ VHF Contest on July 18 at the start. Another short sporadic-E opening took place on July 25.

Here and There

According to the report, "Overlapping Magnetic Activity Cycles and the Sunspot Number: Forecasting Sunspot Cycle 25 Amplitude," scientists from the National Center for Atmospheric Research, Centre for Fusion, Space and Astrophysics, University of Maryland Department of Astronomy, NASA Goddard Space Flight Center, Centre for the Analysis of Time Series, London School of Economics and Political Science, School of Engineering and Innovation have made an optimistic prediction about Solar Cycle 25. The report said Solar Cycle 25 "will have a magnitude that rivals the top few since records began...Our best estimate for the SSN amplitude of Solar Cycle 25 is 233 spots, with a 68% confidence that the amplitude will fall between 204 and 254 spots. We predict with 95% confidence that the Cycle 25 amplitude will fall between 153 and 305 spots."

Special Event Stations

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

Because of the COVID-19 pandemic, many organizations are canceling or rescheduling events. This is the information we had at the time we went to press. We suggest you contact the event organizer to confirm. — Ed.

Sep. 4 – Oct. 1, 1800Z – 2000Z, GB200FN, Romsey, United Kingdom. RSGB. **Florence Nightingale Bicentenary 2020**. 14.200 3.665. QSL. John Wakefield, Oakhurst, Lower Common Rd., Romsey SO51 6BT, United Kingdom. www.qrz.com/db/gb200fn

Sep. 10 – Sep. 14, 0000Z – 0300Z, WA2NYC, Staten Island, NY. Wireless Association of New York City. **19th Anniversary of the Attack on the World Trade Center**. 28.450 14.390 7.238 D-STAR XRF 020B. QSL. Wireless Association of New York City, 233 Wolverine St., Staten Island, NY 10406. We remember the more than 2,900 lives lost that day. www.qrz.com/db/wa2nyc

Sep. 18 – Sep. 20, 0101Z – 0101Z, NV7V, Las Vegas, NV. Clark County NV ARES. **Silver State Classic Challenge**. 446.60 147.18 145.24 145.22. Certificate. Tim Duerson, 3719 Robin Knot Ct., North Las Vegas, NV 89084. www.sccc.us or www.ccnvares.org

Sep. 19 – Sep. 20, 0800Z – 0800Z, KF5DFD, Henrietta, TX. Clay County Amateur Radio Club. **Clay County Pioneer Day**. 14.255 7.255. Certificate. Michael B. Boydston, 103 N. Crockett, Henrietta, TX 76365. mbrentusa@gmail.com

Sep. 26 – Sep. 27, 1500Z – 2100Z, N0N, Johnson, NE. Southeast Nebraska Amateur Radio Club. **84th Anniversary, SENARC Emergency Communication Exercise**. 14.230 7.180. Certificate & QSL. Charles Bennett, P.O. Box 67181, Lincoln, NE 68506. *From Coryell Park*. senebrradioclub@gmail.com or www.facebook.com/SENARC

Oct. 2 – Oct. 3, 1500Z – 2300Z, W0D, Macon, MO. Macon County Amateur Radio Club. **Lester Dent — Doc Savage Mystery Special Event**. 14.270 7.200 3.950. Certificate. Macon County ARC, P.O. Box 13, Macon, MO 63552. dbagley@cvalley.net or www.maconcountymissouriarc.org

Oct. 2 – Oct. 12, 0000Z – 2359Z, N6D, Healdsburg, CA. Will Pattullo, AE6YB. **Anniversary of the Dedication of Mission Dolores, San Francisco, 1776**. 14.265 7.265. QSL. Will Pattullo, 161 Presidential Cir., Healdsburg, CA 95448. www.qrz.com/db/ae6yb

Oct. 3, 1300Z – 2000Z, N1EPJ, East Greenwich, RI. Massie Wireless Club. **New England Wireless & Steam Museum Yankee Steam-Up**. 3.558 14.058 7.25 14.258. QSL. Massie Wireless Club, N1EPJ, P.O. Box 883, East Greenwich, RI 02818. www.newsm.org or www.qrz.com/db/n1epj

Oct. 8 – Oct. 16, 0400Z – 2359Z, W3T, Harleysville, PA. WV2M. **Anniversary of Towamencin Encampment**. 14.074 14.030 7.074 7.030; SSB, CW and FT8. Primary mode will be FT8. QSL. Frank Gallo, 106 Tweed Way, Harleysville, PA 19438. www.w3t.info

Oct. 10, 1600Z – 2300Z, N16IW, San Diego, CA. USS Midway (CV-41) Museum Ship. **Celebrating the Birthday of the US Navy, October 1775**. 14.320 7.250 14.070 (PSK31) D-STAR on various reflectors. QSL. USS Midway Museum Ship (COMEDTRA), 910 N. Harbor Dr., San Diego, CA 92101.

Oct. 10 – Oct. 11, 1500Z – 0500Z, W7A, Tucson, AZ. Radio Society of Tucson. **Arizona QSO Party**. 14.248 14.048 7.189 3.848. Certificate. Bill, Clark, 222 N. Suntan Dr., Vail, AZ 85641. www.azqsoparty.org

Oct. 10 – Oct. 18, 0000Z – 2359Z, W5I/W5K/W5E, Sherman, TX. Grayson County Amateur Radio Club. **Eisenhower Birthday Special Event**. 14.250 14.040 7.250 7.040. QSL. Grayson County ARC, P.O. Box 642, Sherman, TX 75091. qrz.com/db/w5i or <https://graysoncountyarcl.org>

Oct. 10 – Oct. 18, 0000Z – 2359Z, various call signs, various cities. World Wide Flora and Fauna. **Third Annual Get Your Parks ON! Earth Science Week 2020**. 14.244 14.044 10.124 7.044. Certificate. N9MM, 4245 Holstein Dr., Cleveland, TX 77328. Operators from around the world are encouraged to participate in this year's international event. See website for details. www.wvff.us

Oct. 11 – Oct. 12, 1800Z – 0300Z, N3APS, Orinda, CA. Expatriate Marylanders Radio Club. **140th Anniversary of the Current Maryland Flag**. 14.320 7.275 28.425 146.550. QSL. M.G. Vurek, P.O. Box 617, Orinda, CA 94563. www.qrz.com/db/n3aps

Oct. 17, 1300Z – 1900Z, W1M, Russell, MA. Western Mass. Council — BSA. **Woronoco Heights Outdoor Adventure/SCOTA/JOTA/JOTI**. 14.290 14.060 10.115 7.190. QSL. Tom Barker, 329 Faraway Rd., Whitefield, NH 03598. W1M will also operate on BrandMeister TG 907 and its affiliated TAC talk groups. All logging is done on paper. QSL card available on eQSL or for a 4 x 6 SASE.

Oct. 17, 1400Z – 2000Z, K4RC, Yorktown, VA. Williamsburg Area Amateur Radio Club. **Yorktown Surrender Day Event**. 14.265 7.265. QSL. QSL Manager, K4RC, P.O. Box 1470, Williamsburg, VA 23187. www.k4rc.net

Oct. 31, 1500Z – 2300Z, WW1USA, Kansas City, MO. National World War I Museum and Memorial. **102nd Anniversary of the Armistice**. 14.225 14.060 7.250 7.060. Certificate. WW1USA Amateur Radio Station, World War I Museum and Memorial, 2 Memorial Dr., Kansas City, MO 64108. ww1isa@theworldwar.org or www.qrz.com/db/ww1isa

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 x 12 inch self-addressed, stamped envelope (three units of postage) to the address listed in the announcement. To receive a special event QSL card (when offered), be sure to include a self-addressed, stamped business envelope along with your QSL card and QSO information.

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.

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 **January QST** would have to be received by **November 1**. In addition to being listed in *QST*, your event will be listed on the ARRL Web Special Events page.

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

W1AW Schedule

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

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

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

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

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

Code bulletins are sent at 18 WPM.

For more information, visit us at

www.arrl.org/w1aw

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

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

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

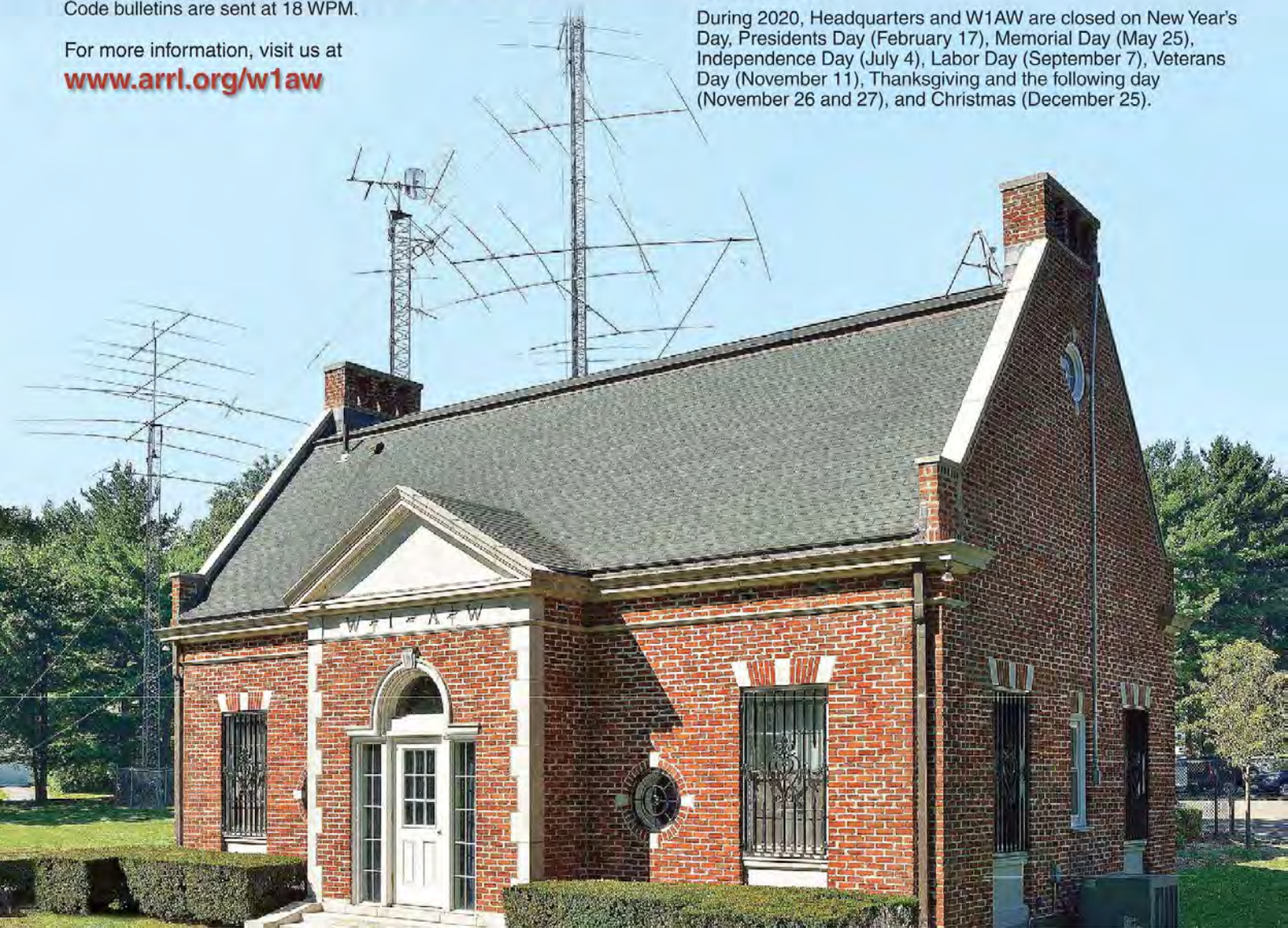
Keplerian elements for many amateur satellites will be sent on the regular digital frequencies on Tuesdays and Fridays at 6:30 PM Eastern time using Baudot and PSK31.

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

♦ Notes: On Fridays, UTC, a DX bulletin replaces the regular bulletins. W1AW is open to visitors 10 AM to noon and 1 PM to 3:45 PM Monday through Friday. FCC-licensed amateurs may operate the station during that time. Be sure to bring 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 2020, Headquarters and W1AW are closed on New Year's Day, Presidents Day (February 17), Memorial Day (May 25), Independence Day (July 4), Labor Day (September 7), Veterans Day (November 11), Thanksgiving and the following day (November 26 and 27), and Christmas (December 25).



Certificate of Code Proficiency

Recipients

Sponsored by **VIBROPLEX**
www.vibroplex.com



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

May 2020

Kirk S. Goddard, AG7YM	10
James Joseph Goudy, NØJG	10
Randy E. Prescher, AC9WR	10
William A. Riches, WA2DVU	10
Gregory S. Weiler, K3MGQ	10
Benjamin M. Cahill, III, AC2YD	15
Benjamin M. Cahill, III, AC2YD	20
Richard E. DuBroff, W9XW	20
Ralph L. Irons, N4RLI	25
William J. Wrbcian, K3QP	30
Philippe Givet, F5IYJ	35
Jay P. Jenkins, WE2KEY	35

June 2020

Michael P. Essi, K8WZY	10
Richard J. Gibilisco, NEØJ	10

Kenneth A. Knox, KD2KEH	10
Mark A. Rollings, N5JJC	10
Byron L. Smith, W9ELM	10
Gary G. Swenson, KA2HAN	10
Christopher H. Tenev, K2QFA	10
Richard W. Candelent, KE1RC	15
John M. Carlson, KØHD	15
Maynard L. Denny, K4WMT	15
Steven K. Jenkins, W4MGT	15
Colin K. Phoon, AE3A	15
Maynard L. Denny, K4WMT	20
Ronald J. Hollas, K8RJH	20
Steven K. Jenkins, W4MGT	20
Garth R. Kennedy, W9KJ	20
Juan P. Munoz, KC2FKM	20
Robin L. Zinsmaster, N6PHP	20
Leland R. Bond, N7KC	25

Ronald J. Hollas, K8RJH	25
Lynn R. Landin, WBØU	25
Murray A. Scott, KE8UM	25
Jay P. Jenkins, WE2KEY	40

July 2020

Andrew M. Majot, K5QO	10
John P. Scruggs, N4JRC	10
Sean Walberg, KN4ZMA	10
William J. Wilkes, Jr., K4EMU	10
Paul A. Gierow, KN4NVU	15
Robert S. Boles, W4SB	25
Garth R. Kennedy, W9KJ	25
Arnold M. Podolsky, W8DU	25
Frank P. Arciulo, W1ZAH	30

Congratulations to all the recipients.

October 2020 W1AW Qualifying Runs

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

October Qualifying Runs will be transmitted by W1AW in Newington, Connecticut at the times shown at 1.802.5, 3.581.5, 7.047.5, 14.047.5, 18.097.5, 21.067.5, 28.067.5, 50.350, and 147.555 MHz. The West Coast Qualifying Runs will be transmitted by KH6TU on Wednesday, October 28 at 6 PM HST (0400 UTC on October 29) on 7047.5 and 14047.5 kHz. Unless indicated otherwise, sending speeds are from 10 to 40 WPM.

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

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

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

checked against the actual transmissions to determine if you have qualified.

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

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



W1AW Code Proficiency Schedule — October 2020 (All times in Eastern Daylight Time)

Monday	Tuesday	Wednesday	Thursday	Friday
10/5 4 PM – 2000Z 10 – 35 WPM	10/6 7 PM – 2300Z 35 – 10 WPM		10/8 10 PM – 0200Z (10/9 – UTC) 10 – 40 WPM	10/9 9 AM – 1300Z 10 – 35 WPM
Columbus Day	10/13 4 PM – 2000Z 10 – 35 WPM	10/14 7 PM – 2300Z 10 – 40 WPM	10/15 9 AM – 1300Z 35 – 10 WPM	10/16 10 PM – 0200Z (10/17 – UTC) 10 – 35 WPM
	10/20 9 AM – 1300Z 10 – 35 WPM	10/21 10 PM – 0200Z (10/22 – UTC) 35 – 10 WPM	10/22 7 PM – 2300Z 10 – 35 WPM	10/23 4 PM – 2000Z 10 – 40 WPM
10/26 10 PM – 0200Z (10/27 – UTC) 10 – 40 WPM		10/28 9 AM – 1300Z 35 – 10 WPM	10/29 4 PM – 2000Z 35 – 10 WPM	10/30 7 PM – 2300Z 10 – 35 WPM

Convention and Hamfest Calendar

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

Abbreviations

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

Because of the COVID-19 pandemic, many organizations are canceling or rescheduling events. This is the information we had at the time we went to press. We suggest you contact the event organizer to confirm. — *Ed.*

Arizona (Congress) — Nov. 7 **DQRTV**
8 AM. *Spr*: Hassayampa ARK. Escapees North Ranch, 30625 AZ Hwy. 89. *Ti*: 146.58. *Adm*: Free. www.harkaz.org

Arizona (Sierra Vista) — Nov. 7 **DFRTV**
7 AM – 2 PM. *Spr*: Cochise ARA. Cara Green Acres, 2756 Moson Rd. *Ti*: 146.76 (162.2 Hz). *Adm*: Free. www.k7rdg.org

285 TECH CONNECT TECH FEST

November 7, Lakewood, CO

R
9 AM – 3 PM. *Spr*: 285 Tech Connect RC. Bridge Church at Bear Creek, 3101 S. Kipling St. *Ti*: 145.145 (107.2 Hz). *Adm*: Door \$10 (cash only). www.na0tc.org

FLORIDA STATE CONVENTION

October 9 – 10, Melbourne, FL

DFHQRSTV
Friday 1 PM – 7 PM, Saturday 9 AM – 3 PM. *Spr*: Platinum Coast ARS. Melbourne Auditorium, 625 E. Hibiscus Blvd. *Ti*: 146.85 -600. *Adm*: \$10. www.pcars.org

Georgia (Savannah) — Oct. 24 **FRT**
8 AM – 1:30 PM. *Spr*: Coastal ARS. Savannah Hilton Head Regional Airport Recreation Building, 250 Crossroads Pkwy. *Ti*: 144.72. *Adm*: Free. www.coastalamateurradiosociety.net/wpW4LHSblog/?page_id=871

Indiana (Mitchell) — Nov. 7 **DFHIRSTV**
8 AM – 1 PM. *Spr*: Hoosier Hills Ham Club, W9QYQ. Lawrence County 4H Fairgrounds, 11265 US Hwy 50 W. *Ti*: 146.73 (107.2 Hz). *Adm*: \$5. www.w9qyq.org

Iowa (Davenport) — Nov. 1 **DFHRS**
6 AM – 2 PM. *Spr*: W0BXR. Iowa National Guard Armory, 5300 W. Kimberly Rd. *Ti*: 146.25/88 (77 Hz). *Adm*: Advance \$7, door \$8.

Kentucky (Hazard) — Oct. 24 **DFHRTV**
8 – 11 AM. *Spr*: Kentucky Mountains ARC. Avawam Volunteer Fire Dept., 3680 W. Kentucky Hwy. 80. *Ti*: 146.67 (103.5 Hz). *Adm*: \$5. www.facebook.com/kymarc

Michigan (Madison Heights) — Oct. 25 **DFHQRV**
8 AM – 1 PM. *Spr*: Utica-Shelby Emergency Communication Assn. United Food and Commercial Workers Local 876 Hall, 876 Horace Brown Dr. *Ti*: 147.18 (100 Hz). *Adm*: \$5. www.usecaarc.com

NEBRASKA STATE CONVENTION

October 31, Lincoln, NE

DFHRSV
8 AM – 3 PM. *Spr*: Lincoln ARC. Lancaster Event Center, 4100 N. 84th St. *Ti*: 146.76. *Adm*: 16 years or older \$8, LARC Members \$5. www.lincolnhamfest.org

New Jersey (Wayne) — Oct. 17 **DFH**
8 AM – 1 PM. *Spr*: WRAET ARC. United Methodist Church, 99 Parish Dr. *Ti*: 145.21 -0.6 (79.7 Hz). *Adm*: \$5. dfreeswick@optonline.net

New York (Hicksville) — Oct. 25 **DFHQRSTV**
9 AM – 1:30 PM. *Spr*: Long Island Mobile ARC. Levittown Hall, 201 Levittown Pkwy. *Ti*: 146.85 (136.5 Hz). *Adm*: \$6. www.limarc.org

Ohio (Westminster) — Oct. 10 **FHRT**
8 AM – 1 PM. *Spr*: Northwest Ohio ARC. Westminster UMC (Warm Building), 6650 Faulkner Rd. *Ti*: 16.67. *Adm*: \$5. www.nwoarc.com

South Carolina (Conway) — Oct. 24 **DFHQRSTV**
8 AM – 2 PM. *Spr*: Grand Strand ARC. Academy of Hope School, 3521 Juniper Bay Rd. *Ti*: 145.11 (85.4 Hz). *Adm*: Advance \$6, door \$7. www.w4gs.org

South Carolina (Gaffney) — Oct. 24 **FHIRST**
8 AM. *Spr*: Carolina ARES. Southside Baptist Church, 204 W. Oneal St. *Ti*: 145.15. *Adm*: \$5.

Tennessee (East Ridge) — Oct. 16 – 17 **DFHQRSTV**
Friday 1 – 7 PM, Saturday 8 AM – 3 PM. *Spr*: Chattanooga ARC. Camp Jordan Arena, 323 Camp Jordan Pkwy. *Ti*: 146.79. *Adm*: \$10. www.hamfestchattanooga.net

Texas (Sinton) — Oct. 17 **DFHIRSTV**
8 AM – 3 PM. *Spr*: South Texas Hamfest Assn. San Patricio County Fairgrounds Event Center, 219 W. 5th St. *Ti*: 147.08 (107.2 Hz). *Adm*: Advance \$5, door \$7. www.southtexashamfest.org

WISCONSIN STATE CONVENTION

October 24, Wisconsin Rapids, WI

HS
9 AM – 4:30 PM. *Spr*: WeComm, LTD. McMillan Memorial Library, 490 E. Grand Ave. *Ti*: 146.79 (114.8 Hz). *Adm*: Free. www.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.

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.



ARRL Foundation Presents the 2020 Scholarship Recipients

The ARRL Foundation is pleased to present the students selected to receive scholarship awards for 2020. Scholarships are made possible through the generosity of individuals and clubs. This year, 103 scholarships totaling over \$145,000 were awarded. Additionally, the non-profit Amateur Radio Digital Communications (ARDC) has generously awarded The Amateur Radio Digital Communications' Brian H. Kantor, WB6CYT, Memorial Scholarship grant to the ARRL Foundation to match each scholarship on a dollar-for-dollar basis, making the grand total of scholarships awarded \$287,300. The ARRL Foundation Board of Directors offers these hams their best wishes for continued success as they pursue their college degrees. The 2021 application period is expected to open on October 1, 2020. For more information, please visit www.arrl.org/scholarship-program.



**Eric T. Albitz,
N9ETA**
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The Charles Clarke Cordle Memorial Scholarship



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The Homer V. Thompson, W4CWV, and Annette P. Thompson, W4LKM, Memorial Scholarship



Levi J. Zima, KN4YHS
The ARRL Foundation General Fund Scholarship

Congratulations

July 2020
QST Cover Plaque Award Winner

Jacek Pawlowski
SP3L

Jacek's article, "A Vertical End-Fed Dipole with a Folded Stub," describes a unique antenna that fits well in limited spaces. Although it's designed for 20 meters, it can be scaled for other bands as well.

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

www.arrl.org/cover-plaque-poll

Log in now and pick your favorite article in this issue!



A Vertical End-Fed Dipole with a Folded Stub

Jacek Pawlowski, SP3L

If you don't have a system of radials buried in the ground, or if you want to place a vertical dipole on a balcony (see the lead photo) or roof where an RF ground is not available, the solution could be an end-fed Zepp antenna — a century-old design. The Zepp is an end-fed half-wavelength ($\lambda/2$) dipole in which a quarter-wave stub made of a ladder line is connected to the dipole end in order to transform the very high antenna impedance to a low impedance. A classic half-wavelength Zepp with a horizontal quarter-wave stub is shown in Figure 1. The stub does not radiate.

Despite its advantages, the classic end-fed Zepp is not often used on HF bands. This is probably because of the length of its $\lambda/4$ stub. So, let's revisit and modify the venerable Zepp to make it more attractive.

Folded-Stub Concept

My modification of the end-fed Zepp reduces the space needed for the antenna installation while improving its performance. To start, I folded the stub in half and rotated it to the vertical position (see Figure 2). This brought the feed point close to the bottom end of the $\lambda/2$ radiator.

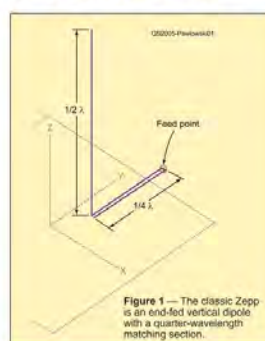
The overall antenna height is $\lambda/2$ and the folded rotated stub itself is now $\lambda/8$ high. The antenna has a very small footprint because the stub is located close to the radiator.

Total radiation from the stub is still almost zero. The antenna radiates the same as a center-fed dipole.

Hamspeak Stub

A length of transmission line connected at just one end. Stubs can function as capacitors, inductors, or resonant circuits, depending on their electrical length and whether they are open or short circuits at the free end of the stub.

Free-space simulations reveal a gain of 2.13 dBi, feed point impedance Z_0 of 71 Ω , and a bandwidth 66% that of the center-fed dipole.



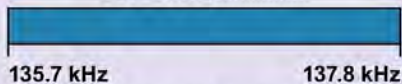
US Amateur Radio Bands

Operator license classes: **E** = Amateur Extra **A** = Advanced **G** = General **T** = Technician **N** = Novice
CW operation is permitted throughout all amateur bands. Except as noted, all frequencies are in megahertz (MHz).

 = RTTY, data, phone, image  = USB phone, RTTY, data and CW  = RTTY and data  = phone and image
 = SSB phone  = CW only

LF – Low Frequency band

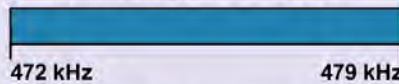
2200 Meters (135 kHz) E,A,G 1 W EIRP maximum



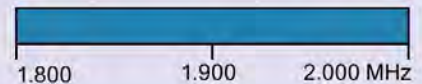
MF – Medium Frequency bands

630 Meters (472 kHz) E,A,G

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



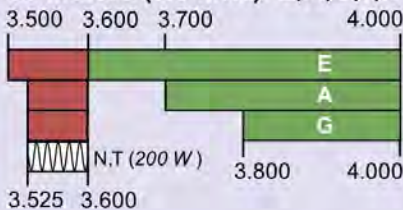
160 Meters (1.8 MHz) E,A,G



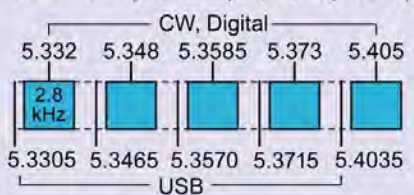
Amateurs wishing to operate on 2200 or 630 meters must first register with the Utilities Technology Council online at <https://utc.org/plc-database-amateur-notification-process/>. You need only register once for each band.

HF – High Frequency bands

80 Meters (3.5 MHz) E,A,G,T,N

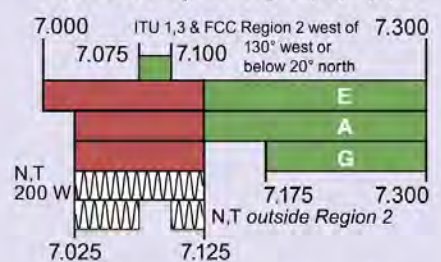


60 Meters (5.3 MHz) E, A, G (100 W)

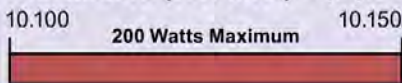


Gen, Adv, and Extra licensees may operate on a secondary basis with a maximum ERP of 100 W maximum.

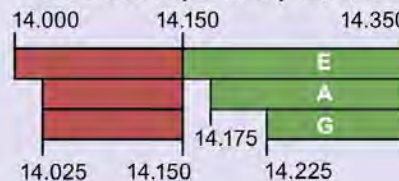
40 Meters (7 MHz) E,A,G,T,N



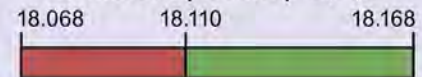
30 Meters (10.1 MHz) E,A,G



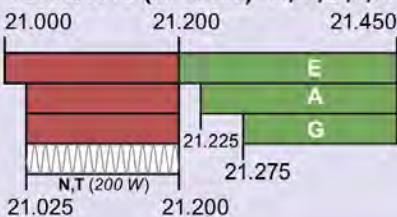
20 Meters (14 MHz) E,A,G



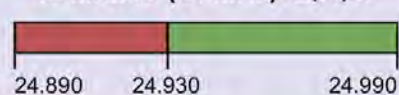
17 Meters (18 MHz) E,A,G



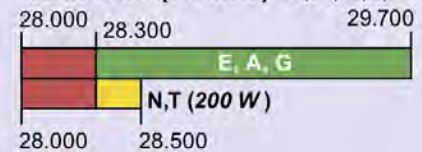
15 Meters (21 MHz) E,A,G,T,N



12 Meters (24 MHz) E,A,G

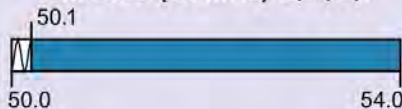


10 Meters (28 MHz) E,A,G,T,N

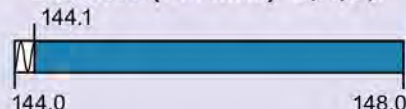


VHF – Very High Frequency bands

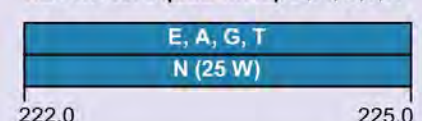
6 Meters (50 MHz) E,A,G,T



2 Meters (144 MHz) E,A,G,T

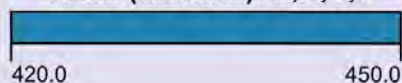


1.25 Meters (222 MHz) E,A,G,T,N

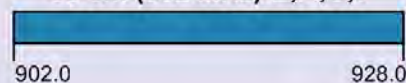


UHF – Ultra High Frequency bands

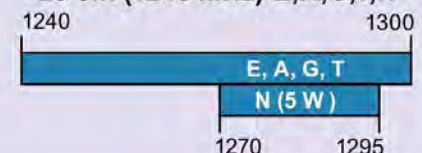
70 cm (420 MHz) E,A,G,T



33 cm (902 MHz) E,A,G,T



23 cm (1240 MHz) E,A,G,T,N



SHF&EHF – Super and Extremely High Frequency bands

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

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

See www.arrl.org/band-plan for detailed band plans.

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OTAbands rev. 1-22-20

A Look Back



• *Beginner and Novice*

A High-Output VFO for a Beginner's Transmitter

BY PETER ZILLIOX, WA3EQK*

WHEN A Novice graduates to a higher-class license, he wants to take advantage of his new privileges as soon as possible, including the use of a variable-frequency oscillator. A VFO will permit the operator to control his transmitter operating frequency without investing in a bank of crystals. Most of the beginners' transmitters use tubes, and the first stage of such a rig requires 15 volts or more drive from a VFO. The solid-state variable-frequency oscillators described in ham publications have a number of outstanding features, but have only one or two volts output — not nearly enough to drive a tube-type transmitter.

The unit shown in the photographs is based on a collection of proven circuits from past *QST* articles.¹ It is possible to use the VFO as an 80/40-meter QRP transmitter. As such, it will deliver up to 2 watts into a 50-ohm load by omitting the output impedance-matching transformers. In a trial, the VFO was keyed by breaking the 13-volt lead from the power supply. Surprisingly, no chirp resulted. The daring may wish to try this approach, but a keying filter should be added to prevent clicks. Those interested in a QRP VFO-controlled rig, however, should add a second buffer stage such as shown in "Once More with QRP" (*QST*, August, 1970).

Circuit Data

The circuit is given in Fig. 1. The VFO and buffer stages are identical to those previously described in *QST* for June, 1970. In the oscillator stage, the base bias resistor, R1, was changed to 15,000 ohms. This modification reduces the sensitivity of the oscillator to variations in supply voltage. Also, the buffer stage is coupled to the power amplifier through a .001- μ F disk ceramic capacitor, instead of the 47-pF unit specified originally.

The power amplifier stage is identical to a design that appeared in *QST* (June 1969), and in the 1970 edition of *The Radio Amateur's Handbook*. The output half-wave filter is designed

*Room 410, Beaver Terrace Apartments, State College, PA 16801

¹DeMaw, "The 'QRP 80-40' C.W. Transmitter," *QST*, June, 1969; DeMaw, "Building a Simple Two Band VFO," *QST*, June, 1970.



Front view of WA3EQK's VFO. The unit operates on 3.5 to 4 and 7 to 7.3 MHz. Included are a 2-watt amplifier and broadband rf transformers so that the VFO can drive tube-type transmitters directly.

to match 50-ohms at each end. The input impedance of a tube operated in Class C is high, usually in the range of 5000 to 50,000 ohms. An impedance transformer consisting of L9-L10 for 7 MHz and L11-L12 for 3.5 MHz matches the low-impedance output of the VFO to the first stage of a transmitter. The capacitance of the output cable (36 inches of RG-58/U) tunes the output transformers, producing a broadly-peaked response centered at 3.7 and 7.15 MHz. If a different length of connecting cable is used, the builder will have to add or subtract turns on L10 and L12 to set the resonant frequency of the transformers at the center of the 40- and 80-meter bands, respectively.

A regulated power supply provides the positive voltage required for the transistors. A 24-volt transformer, a full-wave rectifier, and a Darlington-connected pass transistor are employed. The supply has excellent regulation and filtering, which is a necessity for any VFO.

Going General? Here is a VFO with sufficient output to drive most of the popular two- and three-tube cw transmitters.

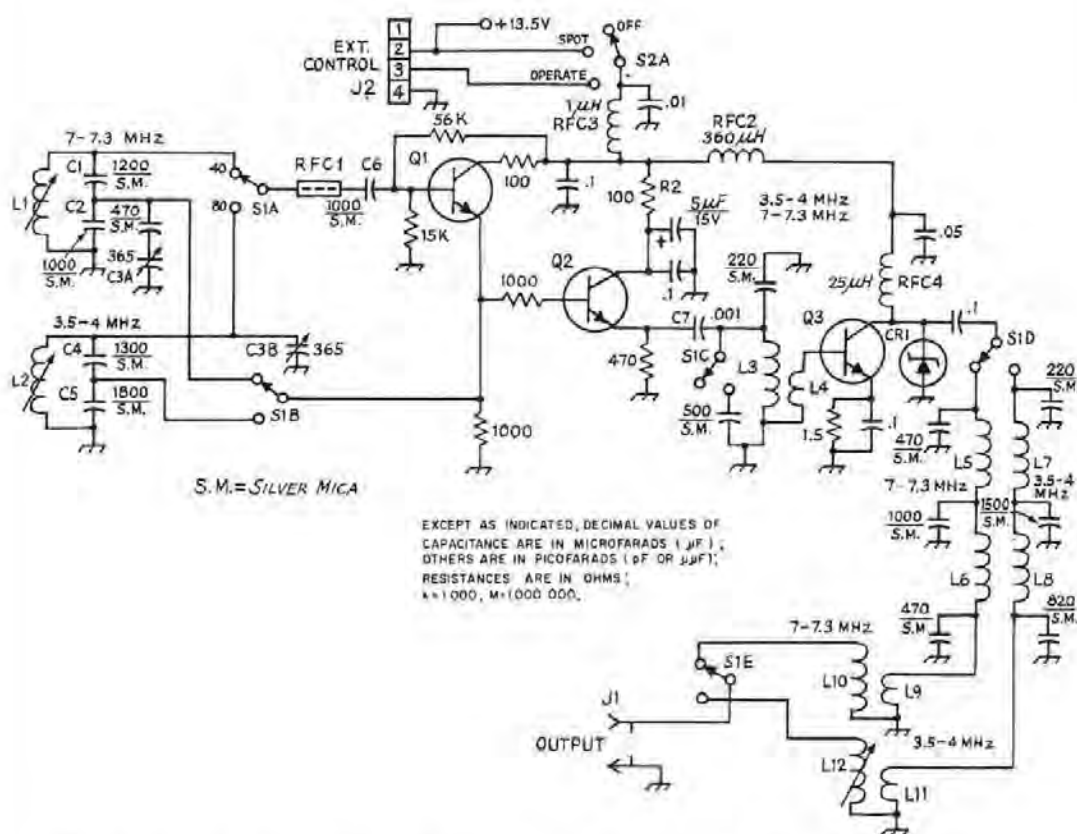


Fig. 1 — Schematic diagram of the VFO. Resistors are 1/2-watt composition; capacitors, except those marked as silver mica, are disk ceramic. Parts not listed below are marked for text reference.

C3 — Dual-section air variable, 365 pF per section (Miller 2112).

CR1 — Zener, 36 V, 1W.

J1 — Phono connector, panel mount.

J2 — 4-terminal ceramic strip (Millen E-304).

L1 — 0.68-1.25 μH , slug tuned (Miller 42A106CB1).

L2 — 2.2-4.1 μH , slug tuned (Miller 42A336CB1).

L3 — 2 μH , 25 turns of No. 24 enam. wire on Amidon T-50-2 toroid core (Amidon Associates, 12033 Otsego Street, North Hollywood, CA 91607).

L4 — 12 turns No. 22 hook-up wire over L3.

L5, L6 — 13 turns of No. 20 enam. wire on Amidon T-68-2 core.

L7, L8 — 18 turns of No. 20 enam. wire on Amidon T-68-2 core.

L9 — 7 turns of No. 26 enam. wire over L10.

L10 — Approx. 3 μH , Miller 4405 with the slug and 4 turns removed.

L11 — 7 turns No. 26 enam. wire over L12.

L12 — 23 μH (Miller 4407).

Q1 — HEP-55.

Q2 — HEP-758.

Q3 — 2N2102.

RFC1 — Three Amidon ferrite beads on a 1/2-inch length of No. 22 wire. A 15-ohm resistor may serve as a substitute.

RFC2 — Miniature choke (Millen J300-360).

RFC3 — Miniature choke (Millen 34300).

RFC4 — 2.5 μH rf choke (Millen J300-25).

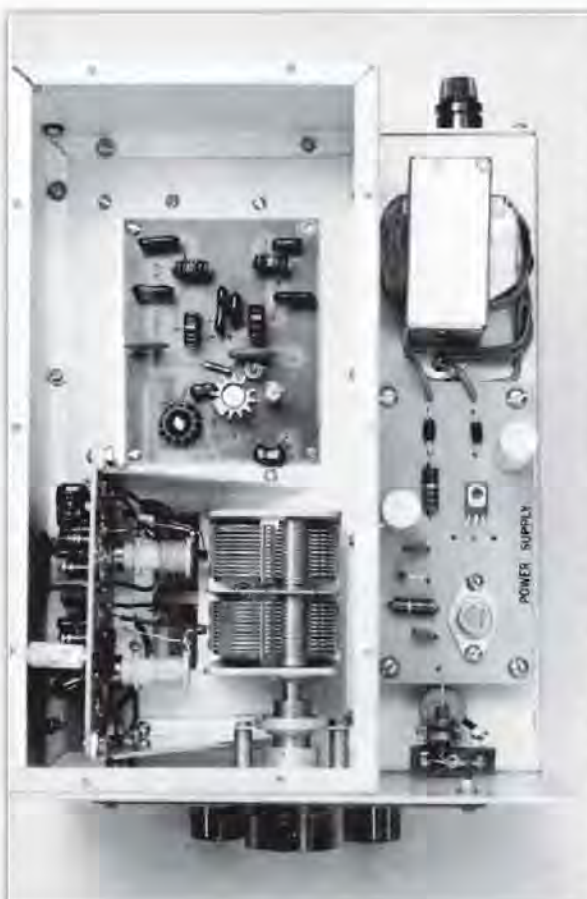
S1 — Home-assembled switch made from a Centralab PA-272 kit and 3 Centralab RRD sections.

S2 — Ceramic rotary switch, 2 pole, 3 position, one section, non-shorting contacts (Mallory 3223J).

Construction

The VFO is built on a 7 X 9 X 2-inch homemade chassis, but a Bud AC-409 can be used. The oscillator and buffer stages are constructed on an etched circuit board. A template for the oscillator board appeared in the original *QST* article. Positioning of the circuit board is important, as short leads are necessary to the variable capacitor and band switch. Two holes are

cut in the shielding box that surrounds the oscillator compartment, allowing access to the VFO tank coils for alignment purposes. The shield is cut from sheet aluminum and is bent to fit over most of the chassis, allowing a space along one side for the power-supply components. A shield is necessary to protect the low-level circuits from rf fields and to improve the mechanical rigidity of the chassis.



Top view, with the cover removed, of the rf compartment. The VFO board is mounted on two aluminum brackets. All leads from this circuit board should be made with heavy wire to minimize mechanical instability from vibration. The amplifier board is flush-mounted on the chassis. The dual-section broadcast-variable capacitor is driven by a Miller MD-4 dial. L1 and L2 are adjusted through holes cut in the left side of the shielded compartment.

A template for the power-amplifier etched board is shown in Fig. 2. This component mounts over a 2 1/2 X 3 1/2-inch hole cut in the chassis. The hole is smaller than the board to provide enough lip overhang to pass the mounting bolts. Lock washers must be employed between the board and the chassis to insure a good electrical connection.

The band switch, S1, is a custom-built assembly made up of Centralab RRD wafer sections and a PA-272 kit. One end of the switch is supported by the front panel, while the center and end sections are held rigidly in place by homemade aluminum brackets (see Fig. 5). The power supply components, with the exception of the transformer, are mounted on a third circuit board. Point-to-point wiring can be used, if desired. A template for the power-supply circuit is illustrated in Fig. 3.

Be careful when mounting the TR-23C pass transistor to insure that the bolts used do not short to ground on the circuit board. The case of the TR-23C is internally connected to its collector. One mounting screw is used as the collector connection to the foil lead on the board, while the other is left "floating." The completed supply should deliver about 13 volts, and a 20-percent variation in line voltage should not affect the 13-volt output level.

A Miller MD-4 vernier dial provides a dual rate for the TUNING capacitor. A ratio of 6-to-1 is used for quick excursions across a band, while a 36-to-1 tuning rate is available for smooth "zeroing in."

Alignment and Operation

L1 and L2 are used to set the 40- and 80-meter dial calibration, respectively. A well-calibrated receiver can be used to spot the VFO output while marking the dial face. The 20-, 15- and 10-meter bands are reached by frequency multiplication of the 40-meter VFO output in the succeeding transmitter stages, and can be marked on the dial below the 7- to 7.3-MHz hash marks. L12 and L10 are adjusted at 3.7 and 7.15 MHz, respectively, for maximum drive to the transmitter.

If the transmitter to be VFO controlled doesn't have provisions for an external oscillator input, circuit changes may be necessary in its first stage. The feedback in the tube-type oscillator shown in Fig. 4A is supplied by the plate-to-grid capacitance in the tube. If the drive from the VFO is applied directly to this stage through the crystal socket, spurious oscillation can result. One cure for this problem is to load the grid by shunting a composition resistor, 680 to 1500 ohms, across the

(continued on page 63)

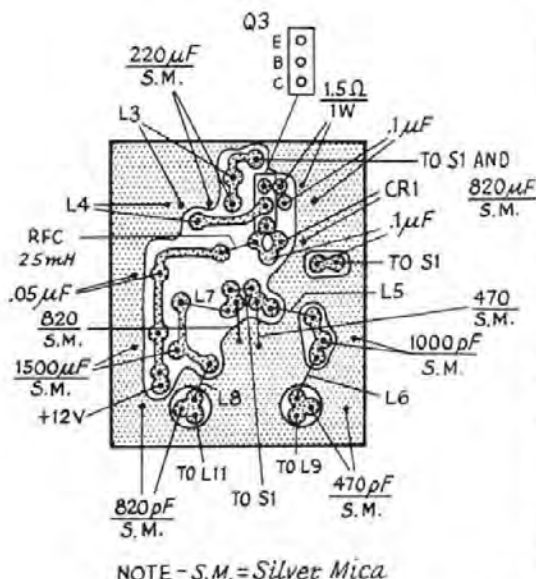


Fig. 2 — Half-scale template for the 2-watt amplifier stage, as seen from the foil side.

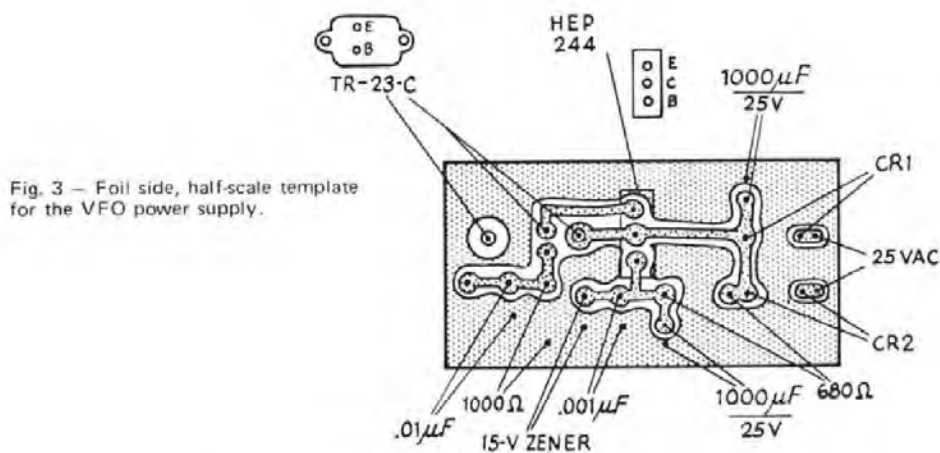


Fig. 3 - Foil side, half-scale template for the VFO power supply.

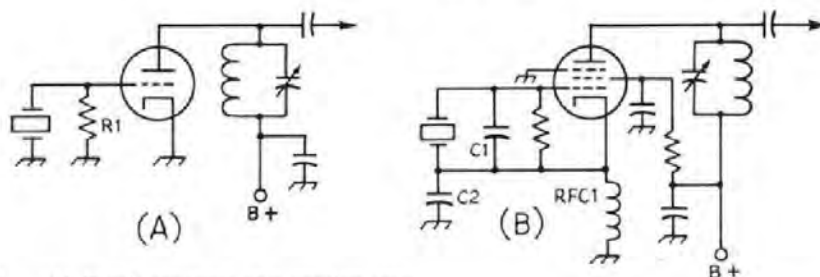


Fig. 4 - (A) Triode oscillator that requires only slight modification for use with an external VFO. (B) The circuit using a pentode tube must be modified by grounding the cathode, shorting out RFC1 and C2. Parts labeled are for text reference.

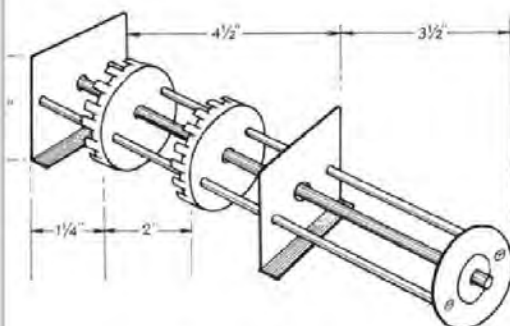
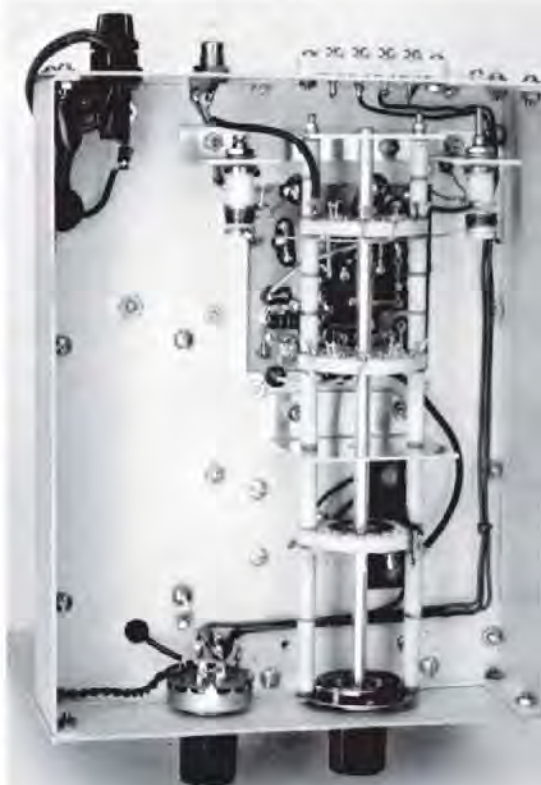


Fig. 5 - Detail of switch assembly - see text.

The bottom view of the VFO shows only the two switches and the output transformers - other components are mounted on the etched-circuit boards "topside."



December 1970

The Drake SPR-4 Receiver

Height: 5 1/2 inches.
Width: 10 3/4 inches.
Depth: 12 1/4 inches.
Weight: 18 pounds.
Power Requirements: 120- or 240-volts ac,
or 12-volts dc.
Price Class: \$450, less accessories.
Manufacturer: R. L. Drake Company, 540
Richard Street, Miamisburg, Ohio
45342.

Test Results

A close examination of the receiver in the ARRL lab indicates that the age dynamic range and the frequency stability of the SPR-4 are superb. A 100-dB change in input signal produced only a 5 dB difference in the audio output level. Frequency drift over a fifteen-minute period was 10 Hz or less after a 20-minute warm-up. On several frequency-drift runs the total variation was only 2 Hz! Dropping the receiver from about five inches above the bench changed the PTO frequency 10 Hz.

The age has a long decay time which is excellent for ssb reception but which makes the

receiver difficult to use for break-in cw. Drake reports, however, that cw buffs can make a simple internal resistor change to alleviate the slow-recovery problem. Lack of dynamic range has long been the major headache in solid-state receiver design. The SPR-4 took 5000 to 7000 μV of input signal before internally-generated spurious signals were observed, better than average for the solid-state receivers that this writer has tested. Skywave signals seldom exceed 2000 μV , so overload should only be a problem for those with neighbors who are active amateurs.

The shoe-box size, lightness of weight, and low power consumption of the Drake "ear piece" are features that should appeal to traveling hams, or to those who operate portable. And, it will double as a DF for boat owners. The initial investment for the unit can be limited by purchasing only the basic receiver and then adding accessories later as financial resources permit. Also, RTTYers who like to listen to the commercial teletype bands, or vhfers who want several megacycles of continuous coverage, might consider the "programmable" feature. As the instruction book contains only operating information, hams who repair their own gear will want to purchase the maintenance manual, which is also an extra-cost item. — *W1KLL*

High-Output VFO

(continued from page 48)

existing grid-return resistor, R1 in Fig. 4A. However, circuits similar to Fig. 4B must be modified by shorting out the cathode rf choke when the VFO signal is injected at the crystal socket. In general, any component that provides feedback for the crystal oscillator should be removed or shorted out, as appropriate, when the VFO is used.

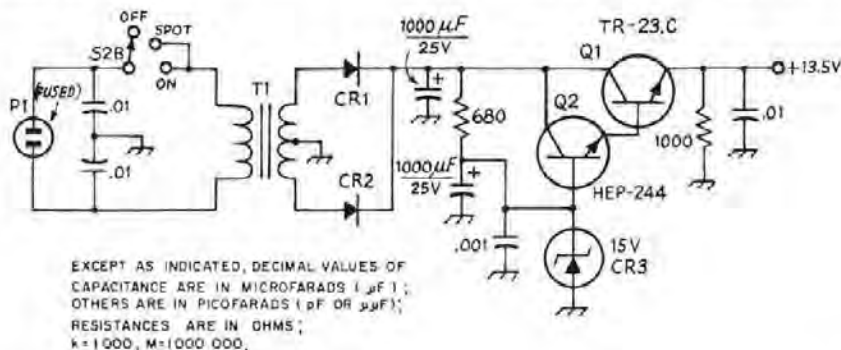
With a 5000-ohm load, the VFO has a measured output in excess of 20 volts rms. This was

sufficient drive for all of the two- and three-tube transmitters tried, even on the 10-meter band. Drift tests indicated a shift of less than 30 Hz over any 15-minute period. The drift is of a random nature which can be attributed to thermal changes caused by air currents around the unit.

The solid-state VFO is somewhat more complicated than a comparable tube unit would be. But, in the near future, transmitters in the 50-watt class will use only solid-state active devices, so now is the time to experiment with the techniques of the transistor age.

Fig. 6 - Power supply for the solid-state VFO. Capacitors with polarity marked are electrolytic, others are disk ceramic. Resistors are 1/2-watt composition.
CR1, CR2 - 100-PRV, 1-A silicon.
CR3 - Zener, 15 V, 1 W.

P1 - Fused plug (use 1-A 3AG fuses).
Q1 - 40-watt npn power transistor (International Rectifier TR-23C).
Q2 - Motorola HEP-24.
S2 - See Fig. 1.
T1 - Filament transformer, 24 V ct at 1 A.



Celebrating Our Legacy

70 Years of Happy Tinkering

I earned my Novice-class license, KN6MUX, when I was 10 years old, and am still licensed at age 79. A ham neighbor convinced me to get my license, as did a friendly TV repairman who taught me resistor color codes. I built a one-tube transmitter and converted a military surplus receiver to ham use. I lived with my grandmother, who wasn't thrilled when I strung a doublet from my window out to the garage.

At 12 years old, I was ready to upgrade to a General-class license. On my first attempt, I passed the code, but flunked the theory. Finally, on my third try, I passed both. By this time, my grandmother decided I was serious about amateur radio and bought me my first ham receiver — a Hallicrafters model. Not long after, I earned my Amateur Extra-class license and built my first voice transmitter (along with some test equipment) using a kit from Heathkit.

After earning a Bachelor's degree in electrical engineering, I went into active duty as a Navy officer. I was lucky to be able to operate from several parts of the world, including Vietnam, Japan, and the Mediterranean. After leaving the Navy, I got married and moved to Arizona, causing me to discard my old K6 call sign and get a "7" area call: W7JSW.

I've taught electronics, been heavily involved in local emergency communications, and was a member of a local ham club. However, I always enjoyed tinkering with radios more than making contacts with other operators. I'm still licensed 70 years later, tinkering and rarely talking, but happy to be part of the hobby.

William J. Hosking, W7JSW
Scottsdale, Arizona
Life Member

Celebrating Over Half a Century in Ham Radio

As I celebrate 55 years in ham radio this year, I find the "100, 50, and 25 Years Ago" column more interesting. I like to reminisce as I look at the *QST* covers I saw when they were first published.

I earned my Novice-class license at age 12 in 1965, and later earned my General- and Advanced-class licenses. In just a few short years, I managed to earn the Worked All States (WAS) and DXCC awards (the sunspot cycle was at about the same point as it is now).

I studied electrical engineering in college and had a 40-year career as an RF systems engineer in wireless and satellite communications. As of my retirement, I had my Amateur Extra-class license for 40 years. For my 50th anniversary as a ham radio operator, I decided to try and

relive my Novice-class days and operate CW only, just like I did back in 1965.

I shared these plans with my friend, ARRL Southwestern Division Vice Director Ned Stearns, AA7A, and he told me about some digital modes to try too. I swapped JT9 and JT65 for CW. When FT8 was added, I soon found myself spending time on that mode as well.

Throughout the past 55 years, I've been limited with the types of antennas I could use because of homeowners association restrictions, so I've learned to be more creative. Today, I use various homebrew antennas and have managed to operate on all bands from 160 meters to 6 meters with reasonable success, just since my retirement.

Even though my radios have changed a lot over the years, amateur radio is still one of my favorite hobbies.

Greg Vatt, NC7B
Mesa, Arizona
Life Member

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



Greg Vatt, NC7B, at his current station (left) and at his 1960s high school station (right).

Classic Radio

The Unveiled Mystery of Emilio Caimi

In between the two World Wars, Emilio Caimi designed and built the Heavy Emilio Caimi Telegraph Key, which was installed in the telegraph stations of all the Royal Italian Air Force. He created another key with an aluminum lid instead of cast iron, installed on Italian Savoia-Marchetti SM.79 anti-ship aircrafts.

The Emilio Caimi Mystery

My interest was sparked because of the heavy key's usage of expensive resources, especially during a severe wartime shortage of raw metallic materials. I also wanted to know why it was so different from other keys built in the same period, such as Ericsson, Pedersen, Amplidan, WT8AMP, JJ38, Junker, and Dyma.

After extensive research in museums, the Central Patent Office in Rome, the Historical Archive of the Italian Air Force, as well as interviews of Morse key collectors, professional telegraphers who served in World War II, prominent scholars and

specialists, I found little information about the key or its inventor.

This only interested me further, so I recruited the help of Pietro Begali, KD2JON/I2RTF, and Claudio Tata, IKØXCB. After several false starts, we tracked down an Industrial Yearbook of the Province of Milan, which informed us that Emilio Caimi was the owner of a company founded in 1905. From there, we had enough information to check the Caimi Company entry at the historical archives of the Chamber of Commerce in Milan. Through further investigative work, we found where Emilio and his wife were buried, which led us to being able to track down and visit his son, Dario (now 85 years old) in Lake Como, Italy.

Thanks to the support and hard work from Pietro and Claudio, as well as the stories from Dario, I was able to put together a good description of Emilio Caimi's personal and professional life.



Emilio Caimi, inventor of the Heavy Caimi Telegraph Key.
[Photo courtesy of Bruna Begali]

Caimi's Early Years

Emilio Caimi was born in Milan in 1878. Emilio was the son of a Milanese goldsmith, from whom he learned to use tools. Emilio attended the High School of Applied Arts of the Castello Sforzesco (founded in 1882) in Milan, where he learned mechanics and technical arts, including technical design.

The Emilio Caimi Enterprise, described as a "precision mechanical workshop," was enrolled in the Chamber of Commerce on June 8, 1911. Emilio set up the company with 10 workers.

In the early 1920s, the Caimi factory was at the forefront of the industrial pioneering period. They were involved in the production of sanitary



The massive Heavy Caimi Telegraph Key. [Bruna Begali, photo]



The Heavy Caimi Key was made to last. [Bruna Begali, photo]

The Heavy Caimi Telegraph Key

The key had a massive, aeronautical blue-colored structure, and weighed 4,397 grams. It consisted of a cast-iron alloy lid (406 grams), with two holes on top. On the sides, in a symmetrical position, there were two grooves (each 6 millimeters wide) that allowed the user to fix it against the two side screw pins. Through the groove, the handling lever was grafted together with the button key, which was made of two separate parts: the button head and the underlying support disc.

The base consisted of a 19 × 3.5 × 10 centimeter box, below which a felt mat was glued. Despite not having a strong non-slip propensity, the mat, along with the considerable weight of the key, stabilized the key on its natural support plane.

Above this base, four bolts fixed a 7.7 × 14.7 × 0.5 centimeter rectangular base in black bakelite in place, on which the lever is actually mounted. The key arm was made of iron for the first part, and in bakelite for the second part.

Another feature of the Heavy Caimi was the rounded-down shape of the second half-arm, which, along with the comfortable lever ratio (0.7:1 centimeters) allowed the operator to transmit in a very relaxed and cadenced way. The key had been equipped with four adjusting pins. The first two upper ones controlled the end of the line and the tension of the spring, respectively. The third one, placed sideways on the fulcrum, allowed for a perfect alignment of the rod and the lever. The last one was placed on the contact pin for the adjustment of the amplitude of the branding.

The key was very indulgent. When operating, you had the feeling of using a very precise key. At each press, the lever transmitted with an elastic movement. The rhythm of the transmission seemed to be helped, sustained, and almost guided.

Ultimately, it was a telegraph key designed to be used in any kind of situation and in any condition, even in the hands of inexperienced operators. It was certainly made to last, as the owners of Caimi keys still in circulation can attest. Today, they seem to have just left that precision factory that ceased production in Milan in the early 1960s.

materials and equipment, armchairs for dentists and barbers, straight keys, as well as a series of bizarre but brilliant inventions, such as the so-called *ponfometro* (as Emilio called it), which was an automatic machine that, after inserting a needle, made injections by simply pressing a button.

Wartime Productions

The reason why Emilio converted his production in favor of telegraph keys is still unknown. He probably felt that the new era of wireless had begun. Around 1912, signs of war were already present (the conflict began on July 7, 1914), and the sector of communications was in great turmoil.

Emilio was aggregated to the 246th Industrial Mobilization Battalion for the duration of the first World War, and when the war was over in November 1918, Emilio was able to go back to running his enterprise at full speed. At 47, Emilio's company won an important contract, beating out the Italian Western Electric and the Allocchio Bacchini of Milan.

In 1930, at the age of 54, Emilio married Ines Baietto, who became his business partner. With orders increasing and Italian industrial production in great expansion, Emilio Caimi became an official supplier of the Royal Italian Air Force in 1932. The production of the Caimi keys should have started after this year.

A new war was on the horizon, however. In 1939, the Armies of the Reich invaded Poland. Though Emilio was discharged from service, he did not escape the impacts of World War II.

In 1943, Wehrmacht officers showed up at Caimi's headquarters and seized telegraph keys from Emilio, as well as all the wheels of the cars available on the company premises, with threats of "severe punishment" if he refused. It was at that time that the factory began to produce fuses for aerial bombs.

The Caimi Legacy

After the war, Emilio continued to supply the Air Force with Morse keys, especially the heavy ones, until the late 1950s. The Caimi Company shut down on April 30, 1955, but on May 2, 1955, Emilio and his wife set up the Electromechanical Construction Caimi Srl., which produced and traded mechanical and electrical materials. This company shut down in 1957, when Emilio was 81. A few years later, he got sick and died in 1963. Ines Baietto died in 1977.

In the meantime, his son Dario founded another company, continuing his father's work, but ceased the production of the telegraph keys and dealt mostly with the construction of electrical material.

Honoring Caimi On the Air This Fall

The special call sign I12EMCA is active to commemorate Emilio Caimi; QSL direct and/or Logbook of The World (LoTW), via IZ2FME. Listen and make contacts with us on CW only (HF/WARC/50 MHz) through the end of 2020.

100, 50, and 25 Years Ago

Due to a printing error, the "100, 50, and 25 Years Ago" column did not appear in the print edition of the September issue of QST. We apologize for any inconvenience.

September 1920

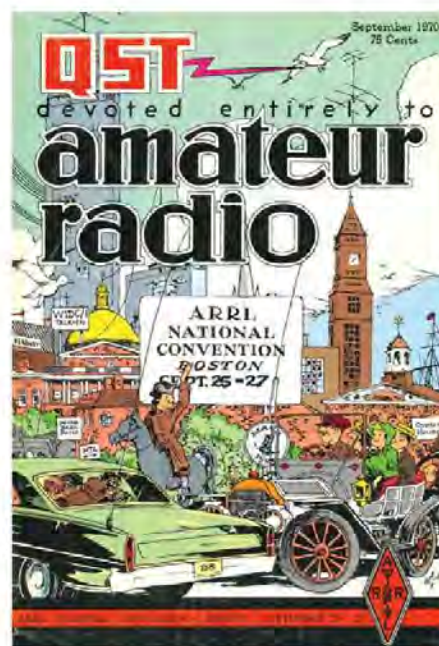
- The cover photo shows the excellent station of 8XK, in Pittsburgh, Pennsylvania. [A few months later, 8XK became the early broadcasting station KDKA. — Ed.]
- The editorial, "In Introspect," takes a look at ham radio of the time, and finds much to be pleased and hopeful about.
- The lead article, "A Few Ideas for Amateur C.W.," begins with the observation that "The number of C.W. sets is rapidly increasing."
- "Station Performance during the Bureau of Standards – A.R.R.L. QSS Tests of June and July, 1920" presents the data collected by participating stations, as we try to learn about fading and its causes.
- McMurdo Silver presents information on the "Construction of a Two-Step Amplifier" for audio signals.
- "Our Less Experienced Brothers," by former League president Hiram Percy Maxim, W1AW, warns against the exclusion of newcomers to our grand adventure by the more experienced operators.
- A. L. Groves tells us "How to Tune the Honeycombs," to get maximum results from honeycomb coils.

September 1970

- The cover art by Gil, W1CJD, reminds us of the League's National Convention, to be held in Boston later that month.
- The editorial, "A Tough Decision," discusses the FCC's expansion of the phone subbands.
- Douglas Blakeslee, W1KLL, shows how to build "A Solid-State VOX."
- Yardley Beers, W0JF, shares Part II of "Short Antennas for the Lower Frequencies," discussing trap construction and adjustment.
- Jerry Arnold, WN6MBP, reports on building "A Two-Band Vertical for the Novice" that covers 40 and 15 meters.
- Doug DeMaw, W1CER, describes how to build "A QRP Console," a mate for the QRP transceiver described in the August 1970 issue of QST.
- Reed Fisher, W2CQH, and Richard Turrin, W2IMU, write about their "UHF Directional Coupler," a handy piece of equipment for UHF hams.
- Frank Walsmith, W8PHR, explains how to build a circuit to provide "Automatic Amplifier Tuning," to maintain tank-circuit resonance when changing frequency.

September 1995

- The cover photo shows the Federal Building in Oklahoma City, and notes that hams served in several roles after it was car-bombed.
- The editorial, "Why Band Plan?," explains why today's bands require observance of the operating segments in our bands.
- "Holocaust in Oklahoma City" recounts the efforts of hams in providing essential communications support following the truck bombing in Oklahoma City.
- "Thrills, Butter Churns, and Honeycombs: A Visit to The Hammond Museum of Radio" describes the wonderful museum operated by Fred Hammond, VE3HC, in Guelph, Ontario.
- Brian Beezley, K6STI, teaches us how to build "A Receiving Antenna that Rejects Local Noise."
- Edwin Andress, W6KUT, joins in with "A K6STI Low-Noise Receiving Antenna for 80 and 160 Meters."
- "Hard-Core QRP," by Richard Arland, K7YHA, shares the tale of his enjoyment of ham radio with transmitter outputs at the milliwatt and microwatt levels.
- The article, "California Mobile Antennas and the Moment of Truth," by Doc Selman, WE6A, includes photos of the antennas used on a day when high-power mobile hams gathered to compare antennas.



100, 50, and 25 Years Ago

October 1920

- The cover art shows a ham adjusting his rig, fashionably attired in suit and tie.
- The editorial, "An Anniversary," notes that it has now been a year since hams got back on the air after World War I and reviews a period of significant accomplishment and progress. The editorial notes that a ham had been heard in the Territory of Hawaii.
- L. A. Hazeltine discusses the usage of "Bulb Oscillators for Radio Transmission."
- In "Concerning Cages," Sumner Young, 1AE, advises on how to construct cage antennas.
- F. S. Huddy, 1II, tells us how to build "A Simple Radiophone Operating on 'B' Batteries."
- "A Paper on QRM," by John Gray, 6MZ, is introduced by the editor as "The best we have ever seen on this important topic."
- The "Amateur Radio Stations" column reports on the excellent stations of 1HAA and 5ZP, complete with photos.

October 1970

- The cover photo shows W1EO's homebrew solid-state counter, which is described in this issue.
- The editorial, "We've Got Problems," discusses recent FCC interpretations of the amateur rules that would prohibit many of ham radio's traditional public service efforts. It explains that ARRL officials are working to clarify and rectify the situation.
- In "The Ham Builder's Nightmare," Doug DeMaw, W1CER, discusses issues in procuring parts, and suggests ways to solve that problem.
- Through a comprehensive, nine-page article, Kenneth MacLeish, W1EO, teaches how to build "A Frequency Counter for the Amateur Station."
- Lew McCoy, W1ICP, describes "The 'Junker' Amplifier," which uses a single 813 tube to provide 500 W on 80 through 10 meters.
- Douglas Blakeslee, W1KLK, and Augustus Wilson, W1NPG, share "A High-Performance HF Converter" that will improve the performance of older receivers.
- "A Frequency Multiplication Technique for VHF and UHF SSB," by Karl Meinzer, DJ4ZC, uses signal processing to eliminate distortion produced by conventional frequency multiplication methods.
- Raphael Soifer, K2QBW, presents a summary of "Australis-Oscar 5 Ionospheric Propagation Results."

October 1995

- The cover photo shows some of the antennas of Montana's Mike Lamb, N7ML, with additional photos of Mike's station shown in "Up Front in QST."
- The editorial, "Thinking Strategically," discusses the Internet and how it can be used with ham radio, noting that survey results show that 48% of ARRL members have access to it.
- Brian Battles, WS1O, reports on ham radio's important support of "The 1995 Special Olympics World Games."
- Jim Cain, K1TN, writes about Fabio Lava, HB9AUS, and his "20 Years of ARRL DX Contesting From the Foot of the Swiss Alps."
- Robert Wilson, AL7KK, tells us how to build a low-cost, compact, multiband antenna that he calls "The Offset Multiband Trapless Antenna (OMTA)."
- Mitchell Lee, KB6FPW, writes about the "Twisted-Pair Controls Switchable Remote Loading Network," which minimizes the number of control wires required.
- In "Propagation Pioneers: The ARRL-Bureau of Standards Experiment," Robert Welsh, N3RW, recalls the early work on determining the causes of radio signal fading problems.
- "Heroes under Siege," by Samir Durakovic, T94ON, describes the role of ham radio in Bosnia-Herzegovina in the midst of war.



Silent Keys

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

Due to a printing error, the "Silent Keys" column did not appear in the print edition of the September issue of QST. We apologize for any inconvenience.

N1AED Roux, Richard M. "Dick," Bedford, NH
K1AMS Schindler, Andrew M. "Mike," Nantic, CT
W1BEP Paiva, Bradford E., East Freetown, MA
•W1DMU Gray, Rodney W., Belchertown, MA
N1D2M Allard, Almon R., Billerica, MA
K1EST Osborne, Paul H., Milford, ME
♦W1GV Gibilisco, Stanley P., Lead, SD
N1HF Blaiklock, Neal E., Merrimack, NH
K1HFR Kratochvil, Jonathan D., Feeding Hills, MA
N1HRM Contois, Stanley L., Essex Junction, VT
K1JG Gawronsky, John A., Athol, MA
•K1KXQ Blaskey, Bernice E., Palm Coast, FL
W1MAP Dupont, Donald S., Farmingdale, ME
♦W1MMN Burnham, David W., Concord, NH
W1QDV Doucette, Conrad R., Cincinnati, OH
W1TAB Pelouquin, Robert H., Jr., Worcester, MA
K1VAD Russ, Raymond, South Chatham, MA
K1X1 MacCord, Donald A., Derry, NH
K2AJH Cicirello, James A., Wellsville, NY
K2ANJ Frazier, James H., Amherst, MA
•W2BSN Hall, Tom, Lyons, NY
W2CPS Super, John P., McNeal, AZ
W2TD Damen, Theodor C., Colts Neck, NJ
K2GZY Paul, Allan T. "Dusty," East Aurora, NY
K2IEC Pickering, Bernard F. "Bernie,"
Susquehanna, PA
K2LP Hall, Marvin D. "Bud," Eastham, MA
W2NHA Messing, Howard, Sparta, NJ
N2PEN Robideau, Paul J., Clifton Park, NY
W2SJO Ofshinsky, Sam J., Dumont, NJ
K2ZW Shontz, Freeman S. "Sam,"
Southampton, NJ
•K2WYZ Malhenzie, Bernard, Athens, AL
K2EZ Hildebrand, Brent W., Loma Linda, CA
W2ZM Raide, Robert J., Penn Yan, NY
K3IP Shaubach, Henry "Kip," Jr.,
Quarryville, PA
♦K3IUY Sanders, Irvin M., Middletown, PA
K3UE Morrison, Edward S., Clearfield, PA
♦W3JTV Vaccaro, Joseph, Hermitage, PA
K3KFD Flink, Stephen, Penn Valley, PA
♦W3LJF Jones, Walter, Duryea, PA
N3MVJ Piper, Robert W., Chambersburg, PA
W3NCN Wetherhold, Edward E., Annapolis, MD
W3NTT Groover, James A., Statington, PA
K3PNW Murphy, Robert G., Annapolis, MD
K3SGX Peach, Robert A., Hookstown, PA
AA3VK Minschwaner, Walter E., Wellsboro, PA
K4AMO Allen, Glenn P., Benton, TN
N4ANV Tyree, Gene, Fayetteville, NC
W4ACN Hardigree, George A. "Allan," Bishop, GA
W4AV Vitolo, Anthony A., Grayson, GA
AK4BE Shipes, Joe F., Yorktown, VA
WE4C Stadlander, David, Cocoa, FL
K4CGN Bateman, Bert D., Topcon, NC
A4DU Bossert, Raymond A., Calabash, NC
K4DXB Turner, Delbert S., Floral City, FL
KE4EC Frazier, Donald E., Punta Gorda, FL
♦AD4F Curle, Charles E. "Charlie," Jr.,
Coltewah, TN
KV4FK Campbell, Donn V., Annapolis, MD
•W4H4V Coleman, James C., Jr.,
Mechanicsville, VA

♦W4HHN Stevens, Russell J., Manassas, VA
N4HK Martin, Haynes K., Fuquay-Varina, NC
K4HSK McCrary, Clifford R., Jr., Elkin, NC
•N4JNL Lindeman, Linda, Coconut Creek, FL
KV4KLT Aspinwall, Thurman R. "T. Ray,"
Mobile, AL
K4MOP Barry, Rebecca F., Decatur, AL
K4ODQ Schmauss, Jo Anne, Lakeland, FL
K4PCN Murphy, Dewey E. "Edward," Odum, GA
W4PJZ Anderson, Bluford J. "Andy,"
Louisville, KY
N4PWP Head, Kenneth L., Elizabethton, TN
K4SBT Hoppe, Robert W., Dacula, GA
AE4SH Hamm, Scott B., Cherryville, NC
W4ASYZ Smith, Brady Q., St. Petersburg, FL
W4TZQ McCaslin, Nick G., Arden, NC
K4UCR Foley, James A., Jr., Birmingham, AL
KN4Y Palagyi, Edward F. "Ed," Crawfordville, FL
K4SAR Shook, Roland S., Silver City, NM
K4BFR Grisham, Farrar, Meridian, MS
•W4TSC Edlin, James I. "Jim," Lubbock, TX
K4COX Crawford, John R., Eads, TN
K4CRJ Warburton, Alan W., Long Beach, MS
•AA4EA Foster, Wallace C., El Paso, TX
AC4F Hughes, Robert L. "Leon," Willis, TX
♦N4GAR Blackwell, Thomas M., Dallas, TX
AB4HA Smith, Paul B., Bossier City, LA
K4SXB Bural, Benjamin T. "Tyler," Edmond, OK
K4HEO Murphy, Clifford L., Fort Worth, TX
K4SK Phelps, Cecil C., Ignacio, CO
K4KBM Strachan, Steve S., Lavaca, AR
K4SOEB Sly, Benjamin C., Sherman, TX
W4SFN Emmons, Albert D., San Antonio, TX
•W4TDH Gilbert, Kenneth L., Plainview, TX
W4TYD Allen, Henry L., Caddo Mills, TX
•K4DPZ Guretzky, Harold "Hal,"
Richmond Hills, NY
W4GCL Hammons, Jerry D., Clovis, CA
•W4IWM Popenoe, Paul, Jr., Portland, ME
K46JJ Pritchard, Grant S., Novato, CA
N4JTA Richards, Russell D., III, Turlock, CA
W4RUF Tsompanas, Emmanuel C.,
Modesto, CA
W4VNQ Towle, Harry D. "Dave," Arbuckle, CA
K46ZTN McLaren, Dorothy J., Santa Barbara, CA
KE7BZD Brassard, Raymond A., Puyallup, WA
W7GXX Powell, Robert B., Taylorsville, UT
K7HEN Gilbert, Mack, Ephraim, UT
W7HTJ Andresen, David C., Lakewood, WA
♦W7JCK Hutton, Merle K., Tucson, AZ
K7JGU Korn, Theresa M., Tucson, AZ
W7PFR Parker, Donald H., Portland, OR
N7UKN Metzler, David E., Glendale, AZ
W7VTW Hawley, James N. "Jim," Newport, OR
W7YFU Bohman, Ronald G. "Gene," Rexburg, ID
•K8BP Cooper, Wyatt C. "Clarke," Muskegon, MI
♦K8DHV Eblin, James B. "Jim," Corvallis, OR
W8END Geerlings, David N., Maristee, MI
N8GCH Warren, Vincent A., Lima, OH
W8HDG Gietzen, William D., Norton Shores, MI
N8IEA Childers, Calvin, Dayton, OH
N8JMK Homer, Bruce A., Cambridge, OH
VD8JUF Ludwig, David L., Swartz Creek, MI
•W8JRW McCloy, Eugene, Vermontville, MI
♦W8LTX Knott, Thomas E., Spring Hill, FL
•W8PJS Thatcher, George R., Asheville, NC
•K8RDO Armstrong, Donald P., Lehigh Acres, FL

W8FEW Weston, Ross E. "Ed," II,
Raynoldsburg, OH
W8MPC Brown, Ralph E., Greenville, OH
•W8WSR Cowley, Robert C., Toledo, OH
♦KD8YR Olson, Harold C. "Charlie," Troy, OH
W8ANT Rudis, Anthony J., Jr., Manhattan, IL
K8BBU Burbey, Lawrence A. "Larry," De Pere, WI
W8BOO Booher, David C., Aurora, IL
K8CJG Michas, Nick W., Princeton, IN
K9CTH Hubbard, William H., Kokomo, IN
W8FFM Wilson, Charles, Robbins, IL
W8HC Brown, Stephen E., Mahomet, IL
N8JSM Wessels, Hye C., Norfolk, AR
K8KMH Cedzo, George S., Shelbygan, WI
K9NEB Beckner, Nancy, Rensselaer, IN
W8ORO Daniels, Ruthann, McGregor, IA
W8ZYO McCarty, Robert R., Racine, WI
W8BDO Huber, Frank J., Montgomery, MN
W8BOB Bartholic, Robert W., Ogden, KS
K8DXX Moody, Michael D., Winfield, MO
AF8F Hisserich, James F. "Jim," Ironton, MO
W8HNB Horn, Bernard H., Nashua, IA
N8ICF Kesselring, Pamela J., Ottumwa, IA
W8OFO Smith, Thomas C., Sun City West, AZ
AC8PJ Gardner, James W., Ogden, IA
•W8QAP Arbogast, Burl T., El Dorado, KS
K8RTF Goetsch, J. Bruce, Decorah, IA
W8OTNA Long, James R., Wentzville, MO
•K8UL Schreiner, Thomas D., Southbury, CT
W8VLY Haumann, David W., Theford, NE
W8QX Biggs, Rodger D., Ellendale, NE
K8XXK Steiner, Harold B., Holstein, NE
K8OYNS Mesenbrink, Corey, Hillsville, MO
VE1OP Nichols, Scott B., North Sydney, NS,
Canada
VE3ENC Mullen, Bernard A., Maberly, ON, Canada
♦VE3JSJ Murphy, Thomas K., Dunnville, ON,
Canada
VE7CFU Leach, Graham Rodney, Oliver, BC,
Canada
VE7ETU Walker, Hugh, Kaslo, BC, Canada
ZL1BKE Beets, Robert F., Queensland, Australia

♦ Life Member, ARRL
• Former call sign

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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.

Silent Keys

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

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• W1BEG
K1GAX
• KA1GWF
• K1GYA
• K1PGF
KT1Q
K1SVC
W1UMN
K2ASG
W2AXV
N2CSA

WA2EXP
KA2G
AA2HV
WA2JL
KC2MBG
W2QLH
♦ W2P
• W2R0Y
WA2RVL

N2XNR
♦ KB2ZAM
K3EOD
♦ K3JRR
• WA3VH
• K3NN
W3NQN
N3PVP
N3TKW

• KB3UOC
W3VG
AE3X
• W3YRT

N4ASL
N4BG
WB4DLB
KG4EEH
K4EJH
KE4FGC
K4GOR
K4HEU
KF4HPU
• K4IU
WD4IVQ
K4JHD
WA4KH
WD4KNE
KN4NMF
K4OV
K4PGY
KC4TBS
KF4TP
KJ4UE

Buckley, John T. "Jack," Middleboro, MA
Laurent, John A., Lenox, MA
Rumery, Bryce R., Cape Elizabeth, ME
Fitzpatrick, Eugene E., Falmouth, ME
Bradford, Gladys W., Ellenton, FL
Plaisted, Roger C., Vienna, ME
Powloka, Michael A., Shaftsbury, VT
Smith, Arthur J., Jr., Bedford, MA
De Nunzio, John T., Middletown, CT
Spair, Richard A., Sr., Lakewood, NJ
Bell, Robert L., Hinsdale, NY
Cole, Frederick W., III "William,"
North Cape May, NJ
Minott, David, Valley Stream, NY
Glasscott, Eric M., Bluffton, SC
Capucilli, Leonard L., Solway, NY
Murray, Roy R., Howell, NJ
Staeb, John F., Millville, NJ
Ordon, Thomas J. F., Seaneateles, NY
Gealt, Daniel R., Queensbury, NY
Blatchley, Harold E., Painted Post, NY
Newman, Douglas R.,
North Las Vegas, NV
Hoffmann, Roy W., North Bergen, NJ
Fegan, Thomas J., Yorktown Heights, NY
Frank, Lee M., Sr., Rutherford, PA
Harrison, Lawrence T., Jr., Oriders, VA
Finck, Pierre A., Dallas, TX
Tucker, John L., Dayton, MD
Wetherhold, Edward E., Annapolis, MD
Beeman, John L., Clifford, PA
Kinnan, Barbara P.,
Middlebury Center, PA
Skellen, Richard C., Ridgway, PA
Leonard, Theodore M., Bradford, PA
Amatuzio, Thomas R., Sr., Bear, DE
Baer, Carl L., Sr.,
Ruscombman Township, PA
Mann, Louis R. "Pex," Cookeville,
Givaudan, Ben T., Burlington, NC
Baughman, James M., Columbia, SC
McLamb, Cecil R., Wilson, NC
Hopkins, John J., Swansboro, NC
Loyd, William I., Macon, GA
Church, Craig E., Arlington, VA
Ball, Larry E., Abingdon, VA
Harbold, Michael P., Alto, GA
Dye, Kyle E., Jr., Tiger, GA
Golden, Truman, Bremen, GA
Davidson, Joseph H., Ashville, AL
Brignole, Anthony J., III, Memphis, TN
Staton, William A., Sr., Stanton, KY
Demasi, Thomas D., Trenton, SC
Sansbury, Laurie P., Sr., Hartsville, SC
Banister, Marvin B., Albany, GA
Tyree, Patricia H., Fayetteville, NC
Madsen, Olaf J., Shelby, NC
Eldredge, Daniel E., Alexandria, VA

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• WA4YNE
KE4YSW
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N5BT
• K5DCZ
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KG5ION
KC5KNW
• KE5KZA
KE5OG
N5PKL
W5TGO
KE5UFZ
AB5WJ

♦ W5WQW
• W5XYL
N5DKP
W5JLF
• W5JTT
K6LQI
K6LUM
K6MAR
K6POF
♦ K6PTL
N6QIH
W6TEL
W6MM
KT6Y
• N7ERN
AC7EY
W7HTJ
K7JAN
W7LTN
♦ K7NO
K7PG
WA7TZY
KE7VS

• N8AJO
K8BIM
K8ME
K8RFW
K8RGGV
• W8RFB
KE8D
KA9DDN
Von Hagel, Robert E., Clinton, NC
Cason, James H., Tallahassee, FL
Allen, Berry R., Pensacola, FL
Hood, Walton R. "Sonny," Chesapeake, VA
Engelbreton, Edward A., Raleigh, NC
Hodge, Anthony M., Gaffney, SC
Bell, Thomas W., Mount Airy, NC
Shigley, Phyllis K., Asheville, NC
Oswalt, Carol A., Andalusia, AL
Wolff, Helmut O. "Hal," Dallas, TX
Chandler, Craig S., Bartlesville, OK
Goodrich, Donald W., Albuquerque, NM
Ferguson, Walter G. "Grady,"
Houston, TX
Reed, Paul V., Jr., Crosby, TX
Earley, Allan B., Denison, TX
Dawson, Richard E. "Rich,"
Georgetown, TX
Brooks, William L., Alpine, TX
Sosa, Mario, Jr., Laredo, TX
Prechel, Thomas J., Harlingen, TX
Young, Charles Howard, Tupelo, MS
Warren, Franklin A., Sr., "Frank,"
Rio Rancho, NM
Luther, Herbert A. "Mike,"
College Station, TX
Lane, Evonne G., Las Vegas, NV
Harper, Ray L., Granada Hills, CA
Frank, Joseph L., Oakhurst, CA
Kelly, Samuel T., Garden Grove, CA
Grove, Thomas L., Carson, CA
McEwen, John K., Napa, CA
Waterman, Dave J., Bakersfield, CA
Chin, William M. "Bill," Daly City, CA
Lyman, Peter T., Pasadena, CA
Mitchell, Larry J., Draper, UT
Lansing, Theodore E., Camarillo, CA
Mills, Raymond E., Dos Palos, CA
Caldis, Jay D., Walnut Creek, CA
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Wood, Carl E., Great Falls, MT
Andresen, David C., Tacoma, WA
Noland, James A., Boise, ID
Hasman, Frank A., Meridian, ID
Norris, Dean C., Mesa, AZ
Litteer, Glenn G. "Gary," Napavine, WA
Telewski, Frederick, Woodinville, WA
Bloomenrader, Clifford N., Jr., "Neal,"
Casper, WY
Barney, Norman L., Waynesville, OH
Beitel, Robert J., Sr., Whitmore Lake, MI
Meeks, Eugene L. "Roy," Manchester, MI
Newman, Marilyn K., Holland, MI
Denzer, Douglas P., Waldo, OH
Briggs, Rollin P., Spencerville, OH
Moore, Roger W., Tipler, WI
Douglas, James S., Jr., "Skip,"
Grafton, WI

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• N9EHP
N9EWJ
• W9FQC
• N9SG
N9GLO
K9KJT
W9NYS
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N9TA
K9UIF
KA9VCF
KC9WQ
K0BAJ
• N0DIZ
♦ W0FOE
K0HFX
K0JUN
KA0LSM
N0MCT
♦ W0OWY
W0RWW
• W0VAI
W0XOW
♦ W0YVZ
• WB0ZVX
VE3GE
VE3JUK
VE3PRL
HP1AC
Szczubelek, Joseph W., Jr., "Joe,"
Algonquin, IL
Foesch, James C., Sheboygan Falls, WI
Rounds, Gerald L. "Jerry," East Moline, IL
Ellis, Marc F., Evanston, IL
Kujawa, Stanley J., Jr., Fort Smith, AR
Gantt, Norman S., Mundie, IN
Olmstead, Gary L., Rice Lake, WI
Goldstein, Robert L. "Bob," Fox Point, WI
Liebl, Leo V., Stevens Point, WI
Wilson, Randy D., Elkhart, IN
Ley, Roger P., Bossier City, LA
Bennett, John F., Crawfordsville, IN
Cummings, Mark W., Hobart, IN
Sorensen, Thomas C. "Tom," Savannah, IL
Rueger, Walter, Ripon, WI
Drussel, Gary P., Garden City, KS
Disney, Michael K. "Mike," Lincoln, NE
Hendrix, Joseph W. "Bill," Cameron, MO
Maley, Charles E. "Chuck," Clarinda, IA
Nemecsek, Joseph F., Kansas City, MO
Wagoner, Stephen A., Davenport, IA
Duple, Marjorie R., Leeds Spring, MO
Nash, Clarence W. "Bill," Sun City West, AZ
Raymond, Walter B., Fort Payne, AL
Van Erem, Harvey G., Bismark, ND
Janos, Glen P., Greenfield, MN
Glaze, David J., Boulder, CO
Dunham, Delmer F.,
Colorado Springs, CO
Johnston, Walter, Amprior, ON, Canada
Gardiner, Yvonne, Windsor, ON, Canada
Pettitt, Monique, Chatham, ON, Canada
Castillo, Camilo, Panama

♦ Life Member, ARRL
* Former call sign

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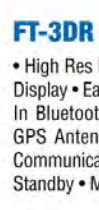
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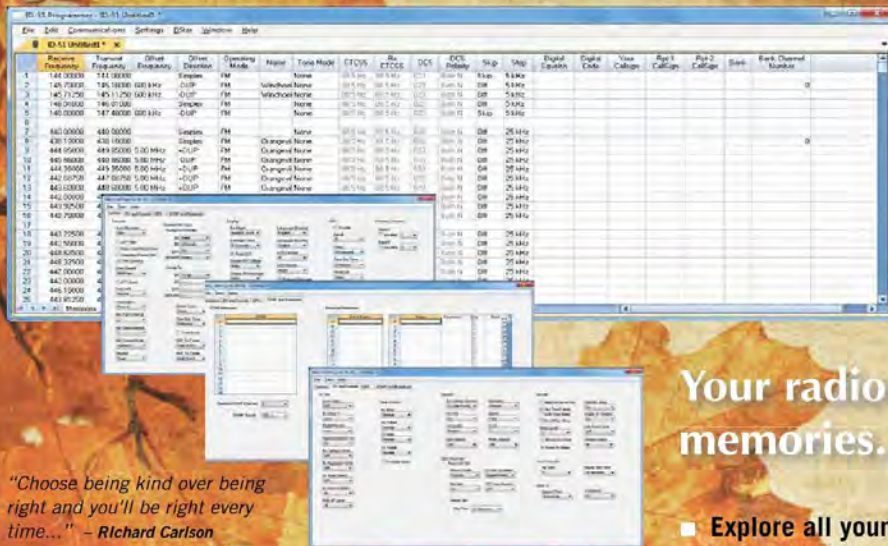
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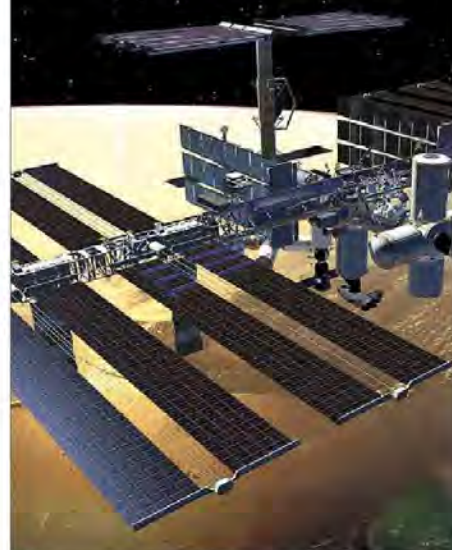
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Wind Load Capacity (inside tower)	15 square feet
Wind Load (w/mast adapter)	7.5 square feet
Turning Power	800 in.-lbs.
Brake Power	5000 in.-lbs.
Brake Construction	Electric Wedge
Bearing Assembly	Dual race/96 ball bearings
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	8
Shipping Weight	26 lbs.
Effective Moment (in tower)	2800 ft.-lbs

TAILTWISTER 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 Rotator Specifications

Wind Load Capacity (inside tower)	8.5 square feet
Wind Load (w/mast adapter)	5.0 square feet
Turning Power	600 in.-lbs.
Brake Power	800 in.-lbs.
Brake Construction	Disc Brake
Bearing Assembly	Dual race/48 ball bearings
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	8
Shipping Weight	22 lbs.
Effective Moment (in tower)	1200 ft.-lbs

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Hy-Gain Programmable DCU-3 Digital Rotator Controller

DCU-3 - \$499.95

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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.

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AR-40 Rotator Specifications

Wind Load Capacity (inside tower)	3.0 square feet
Wind Load (w/mast adapter)	1.5 square feet
Turning Power	350 in.-lbs.
Brake Power	450 in.-lbs.
Brake Construction	Disc Brake
Bearing Assembly	Dual race/12 ball bearings
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	5
Shipping Weight	14 lbs.
Effective Moment (in tower)	300 ft.-lbs

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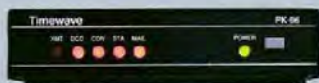
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- The Morse Code Tutor - learn and practice sending and receiving methods, with or without Farnworth encoding.
- The CW Messenger allows you to send up to 50 "canned" CW messages, that are completely changeable in the field without a PC.
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RADIO/ROTOR SOFTWARE

RSS radio/rotor control uses Hamlib, a library of over 200 radios, 30 rotors. **MFJ-1305RP, \$24.95.** 5V, 3A Pwr Supl.

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TECH HELP

- RigPi forum is <https://rigpi.groups.io>
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Instantly gives you a complete picture of your antenna.

Read SWR, return loss, reflection coefficient, match efficiency at any frequency simultaneously.

Read Complex Impedance (280 KHz to 230 MHz plus 2200 Meters) as series equivalent resistance and reactance ($R_s + jX_s$) or as magnitude (Z) and phase (degrees). Also reads parallel equivalent resistance and reactance ($R_p + jX_p$).

Determine velocity factor, coax loss in dB, length of coax and distance to short or open in feet (it's like a built-in TDR).

Coax Calculator™ calculates coax line length in feet given degrees and vice versa for any frequency and velocity factor.

Measure SWR and loss of coax with any characteristic impedance (280 KHz to 230 MHz plus 2200 Meters) from 10 to over 600 Ohms.

Measures inductance in uH and capacitance in pF at RF frequencies, 280 KHz to 230 MHz plus 2200 Meters.

High contrast LCD gives precision readings and two side-by-side analog meters make antenna adjustments smooth and easy.

12-bit A/D converter gives much better accuracy and resolution than common 8-bit A/D converters - **MFJ-269D exclusive!**

Built-in frequency counter, battery saver, low battery warning, Ni-Mh/NiCd charge circuit. 4W x 2D x 6 1/4 inches, 2 lbs. Use ten double A batteries or 110 VAC with **MFJ-1312D**, \$19.95.

New!



MFJ-269D
\$419.95

MFJ-269DPRO™ Analyzer

MFJ-269DPro, \$459.95.

Like MFJ-269D, but UHF range covers **430 to 520 MHz** to include commercial industrial frequencies. Rugged protective shell protects knobs, switches, meters, LCD for industrial/lab work.



MFJ No Matter What™ Warranty

Every MFJ Analyzer is protected by MFJ's famous one year **No Matter What™** limited warranty. We will repair or replace your MFJ analyzer (at our option) for a full year.

More hams use MFJ analyzers than all others in the world!

MFJ-259D

Now Covers 280 KHz-230 MHz plus 2200 Meters, World's most popular and improved analyzers

MFJ-259D
\$319.95

Super easy-to-use - Read antenna SWR, complex impedance, return loss, reflection coefficient. Determine velocity factor, coax cable loss in dB, length of coax and distance to short or open in feet. Read inductance in uH, capacitance in pF at RF frequencies. Large easy-to-see two line LCD screen and side-by-side meters clearly display your information. Built-in frequency counter, signal generator, Ni-Cad charger circuit, battery saver, low battery warning and smooth reduction drive tuning. More!

New!



MFJ-223

1-60 MHz Color Graphic VNA Analyzer

MFJ-223
\$319.95

This pocket-sized wonder breaks the mold for analyzer design with user-friendly convenience, top notch accuracy, and a vivid TFT multi-color display. Don't let the size fool you, MFJ-223 is packed with all the VNA features and performance you need!

- **Single-frequency** and **swept-frequency** operating modes
- **Truly accurate** SWR, R, X, and Z measurements
- **Seamless DDS** coverage with 280-Hz resolution from 1-60 MHz
- **Smooth "skip-free"** encoder tunes fast or slow without missing a step
- **Powerful +5-dBm** stimulus generator overrides local interference
- **Field-strength meter** measures local signals, detects potential interference
- **DDS generator** precision signal source
- **Vivid 1600-pixel/inch** color graphics on a 2x2 inch non-glare TFT screen



MFJ-225

1.5-180MHz continuous Two-Port Graphic Analyzer

Out in the field, MFJ-225 is a compact completely self-contained handheld graphing analyzer. On the bench it becomes a full-fledged two-port (S21) desktop machine when teamed up with your PC. Using powerful IG-miniVNA freeware, you'll run detailed data analysis and print out stunning color-graphic plots to document your work! Built-in back-lighted 3-inch LCD graphic display. Make fine adjustments using full-screen easy-to-view SWR bargraph, capture vivid swept displays for SWR, impedance, return loss, phase angle, more. DDS generator.



MFJ-225
\$339.95

MFJ-249D Analyzer

MFJ-249D, \$279.95

If digital display is all you need MFJ-249D does everything MFJ-259D does without analog meters.



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MFJ VNA Antenna Analyzer

MFJ VNA Antenna Analyzer covers 1 to 230 MHz, 1Hz resolution.

• **Frequency sweep plots:** SWR, Impedance, Resistance, Reactance, Phase Angle, Complex Return Loss, Smith Chart
• **Sign of reactance** positively identifies inductive or capacitive reactance • **Amazing accuracy with OSL (Open-Short-Load) calibration** - calibrate through feedline/test cable at different frequencies and store in memory. Measure directly or through feedline with exceptional accuracy, correcting for line loss/phase angle. **Smith Chart** plots S11 magnitude/phase over any frequency span. **Capture screens** in 32 memories to download to PC via USB.



MFJ-226
\$379.95

MFJ SWR Analyzer Accessories

- MFJ-29D/MFJ-39D, \$39.95.** Carrying Pouch for MFJ-259D/269D.
- MFJ-92AA10, \$39.95.** 10-Pack 2500 mAh Ni-MH Supercells.
- MFJ-66D, \$39.95.** Dip coils, set of two covers 1.8-230 MHz.
- MFJ-731, \$109.95.** Tunable Analyzer Filter, 1.8-30 MHz, for strong RF fields.
- MFJ-917, \$39.95.** 1:1 Current balun for SWR Analyzers to test balanced line antennas, other loads.
- MFJ-5510D, \$15.95.** 12VDC cigarette lighter adapter.
- MFJ-7737, \$9.95.** PL-259 to BNC Female.
- MFJ-7727, \$9.95.** PL-259 to SMA Female.



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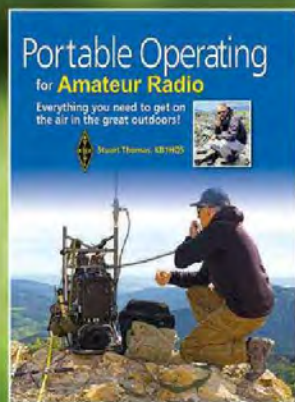
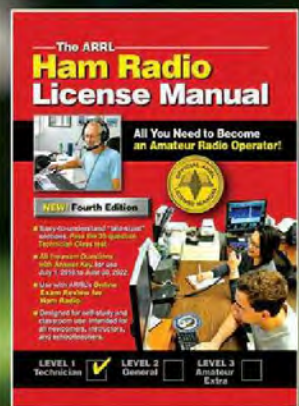
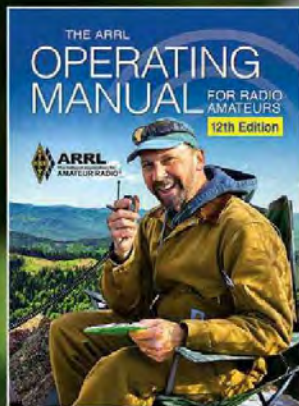
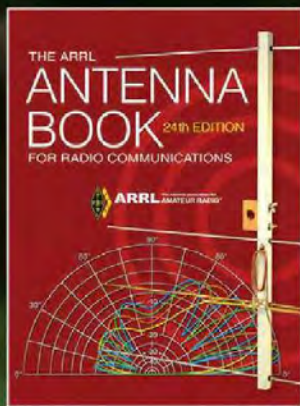
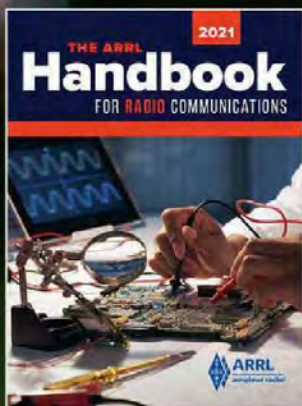
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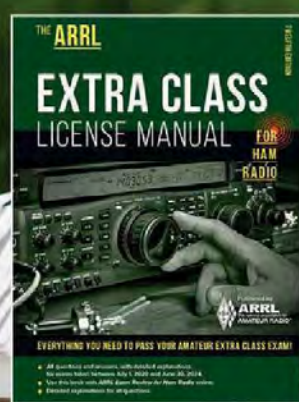
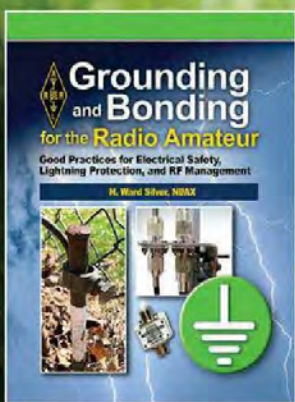
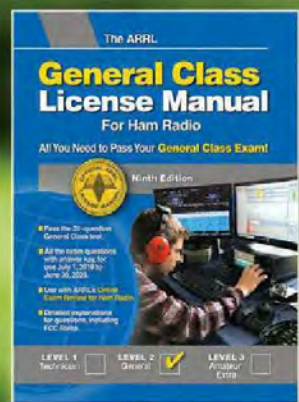
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MFJ 1500 Watt Remote Auto Tuner

Place this MFJ-998RT remote tuner at your antenna to match high SWR antennas/long coaxes – greatly reduce losses for high efficiency

... Match 12-1600 Ohms, 1.5 kW, SSB/CW/Digital, 1.8-30 MHz ... Match coax/wire antennas ... Weather-sealed ... Remotely powered thru coax ... Amplifier, radio, tuner protection ... Output static/lightning protection ... StickyTune™ always tunes when power folds back ... DC power jack ...



MFJ-998RT
\$869.95

Bottom Chassis

Inside View

Tune your antenna at your antenna

Get greatly reduced losses and high efficiencies with long coax runs and high SWR antennas with this new MFJ-998RT 1.5 kW Remote Antenna Tuner.

Weather-Sealed

A tough, durable weather-sealed ABS cabinet with over-lapping lips, sealing gasket and stainless steel chassis protects the MFJ-998RT from all kinds of weather.

No Power Cable Needed!

No power cable needed – remotely powered through coax. Includes MFJ-4117 Bias-Tee with on/off switch for station end of coax. Has 12 VDC jack for power cable, if desired.

Fully Protected

MFJ exclusive algorithms protect your tuner, radio and RF power amplifier from damage.

Automatic inductor and capacitor limiting prevents tuning extreme loads which can destroy your tuner.

Your tuner will not tune if more than 75 Watts with SWR greater than 3:1 is applied or if more than 125 Watts is applied.

Tuner output is static electricity and lightning induced surge protected.

MFJ exclusive StickyTune™

Very high SWR can fold back transmitter power and prevent tuning caused by extreme differences in loads (example: changing bands and other conditions).

But MFJ exclusive StickyTune™ always tunes with a simple on/off power cycle and re-transmit.

Tunes Coax fed and Wire Antennas

Tunes both coax fed and wire antennas. Has ceramic feed-through insulator for wire antennas. 2 kV Teflon® insulated SO-239 – prevents arcing from high SWR.

High Power, Highly Efficient

A highly efficient L-network matches 6-1600 Ohms at full 1500 Watts legal limit SSB/CW and Digital, 1.8 to 30 MHz with Hi-Q Ls, Cs.

MFJ-998RT Learns as you Operate

As you operate, the MFJ-998RT automatically tunes for minimum SWR and remembers your frequency and tuner settings. The next time you operate on that frequency and antenna, its tuner solution is restored in milliseconds and you're ready to operate!

Highly Intelligent, Ultra-fast Tuning

MFJ InstantRecall™ recalls stored tuning solutions from 10,000 memories. For new frequencies, MFJ Intelli-Tune™ measures your antenna impedance and instantly determines the correct matching components. If antenna impedances cannot be measured, MFJ AdaptiveSearch™ searches only the relevant components that can match your antenna giving you ultra-fast tuning.

Field upgradeable firmware. Requires 12-15 VDC at 1.4 Amps maximum or 110 VAC with optional MFJ-1316, \$29.95. Weighs 9.5 lbs. 13 1/4" W x 6 3/4" H x 17 1/2" D inches.

160-6 Meters 43 foot Vertical Antenna

Operate all bands 160-6 Meters at full 1500 Watts with this self-supporting, 43 foot high performance vertical! Assembles in less than an hour. Low profile blends in with sky and trees -- barely see it. Entire length radiates. Exceptional low angle DX performance on 160-20 Meters and very good performance on 17-6 Meters. Telescope it shorter for more effective low angle radiation on 17-6 M if desired. One of these wide range MFJ automatic tuners at the antenna easily matches all bands 160-6 Meters. There's no physical tuning adjustments on the antenna -- you simply put it up! Requires ground system, at least one radial, more the better. Includes balun and base mount. **MFJ-1932, \$44.95. All band ground radial system.**



MFJ-2990
\$399.95

600W Remote IntelliTuner™

MFJ-994BRT – perfect for 600 Watt SSB/CW amplifiers like Ameritron's AL-811/ALS-600/ALS-500M. Matches 12-800 Ohms. Coax/wire antennas, 1.8-30 MHz. Fully weather-sealed for outdoor use. Remotely powered through coax. Tough, durable, built-to-last cabinet, 9 1/4" W x 3 H x 14 1/4" D inches, 4 lbs. Includes MFJ-4117 BiasTee Power Injector.



MFJ-994BRT
\$459.95

300W Remote IntelliTuner™

MFJ-993BRT handles 300 Watts SSB/CW and digital. Has extra-wide 6-1600 Ohm impedances. Coax/wire antennas, 1.8-30 MHz. Fully weather-sealed for remote outdoor or marine use. Remotely powered through coax. Tough, durable, built-to-last cabinet measures 9 1/4" W x 3 H x 14 1/4" D inches. Weighs just 4 pounds. Includes MFJ-4117 BiasTee Power Injector.



MFJ-993BRT
\$339.95

200W Remote IntelliTuner™

MFJ-926B, 200 Watts SSB/CW/Digital, 6-1600 Ohms, Coax/wire antennas, 1.8-30 MHz. Includes BiasTee.



MFJ-926B \$329.95

MFJ No Matter What™ Warranty

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30 Day Money Back Guarantee
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MFJ_998RT_061512_QST_061120DS

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- ✓ Connect all the braid, not just a few strands
- ✓ High reliability
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Crimp-Ons

Excellent quality, no bargain basement stuff here. Adapters & connectors for most types of connections.



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Premium Bury Flex, USA-400 & USA-240 coax jumpers with your choice of UHF, Type N, BNC, SMA, TNC & Mini-UHF Connectors.

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MFJ Tuners

New, Improved MFJ-989D 1500 Watt legal limit Antenna Tuner

World's most popular 1500 Watt Legal Limit Tuner just got better - much better - gives you more for your money!

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 \$469.95

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 1/2" W x 6" H x 11 5/8" D inches.

No Matter What™ Warranty

Every MFJ tuner is protected by MFJ's famous one year **No Matter What™** limited warranty. We will repair or replace your MFJ tuner (at our option) for a full year.

More hams use MFJ tuners than all other tuners in the world!

MFJ-986 Two knob Differential-T™



MFJ-986 \$419.95

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 \$359.95

A few more dollars steps you up to a kW tuner for an amp later. Handles 1.5 kW PEP SSB amplifier input power (800W output). Ideal for Ameritron's AL-811H! AirCore™ roller inductor, gear-driven turns counter, pk/avg lighted Cross-Needle SWR/Wattmeter, antenna switch, balun, Lexan front, 1.8-30MHz. 10 7/8" W x 10 3/4" H x 4 1/2" D in.

MFJ-969 300W Roller Inductor Tuner



MFJ-969 \$259.95

Superb, AirCore™ Roller Inductor tuning. Covers 6 Meters thru 160 Meters! 300 Watts PEP SSB. Active true peak reading lighted Cross-Needle SWR Wattmeter, QRM-Free PreTune™, antenna switch, dummy load, 4:1 balun, Lexan front panel. 10 1/2" W x 3 1/2" H x 9 1/2" D inches.

MFJ-949E deluxe 300 Watt Tuner

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 7 D inches. **MFJ-948, \$179.95**. Economy version of MFJ-949E, less dummy load, Lexan front panel.



MFJ-949E \$219.95

MFJ-941E Super Value Tuner

Most for your money! 300 Watts PEP, 1.8-30 MHz, lighted Cross-Needle SWR/Wattmeter, 8 position antenna switch, 4:1 balun, 1000 volt capacitors, Lexan front panel. 10 1/2" W x 2 1/2" H x 7 D in.



MFJ-941E \$169.95

MFJ-941EK, \$139.95. Tuner Kit -- Build your own!

MFJ-945E HF/6M mobile Tuner

Extends your mobile antenna bandwidth so you don't have to stop, go outside and adjust your antenna. Tiny 8W x 2H x 6D in. Lighted Cross-Needle SWR/Wattmeter. Lamp and bypass switches. Covers 1.8-30 MHz and 6 Meters. 300 Watts PEP. **MFJ-20, \$9.95**, mobile mount.



MFJ-945E \$159.95

MFJ-971 portable/QRP Tuner

Tunes coax, balanced lines, random wire 1.8-30 MHz. Cross-Needle Meter. SWR, 30/300 or 6 Watt QRP ranges. Matches popular MFJ transceivers. Tiny 6 1/2" W x 2 1/2" H x 6 D in.



MFJ-971 \$149.95

MFJ-901B smallest Versa Tuner



MFJ's smallest (5W x 2H x 6D in.) and most affordable wide range 200 Watt PEP Versa tuner. Covers 1.8 to 30 MHz. Great for matching solid state rigs to linear amps.

MFJ-901B \$119.95

MFJ-902B Tiny Travel Tuner

Tiny 4 1/2" W x 2 1/4" H x 3 D inches, full 150 Watts, 80-6 Meters, has tuner bypass switch, for coax/random wire. **MFJ-904H, \$169.95**. Same but adds Cross-needle SWR/Wattmeter and 4:1 balun for balanced lines. 7 1/4" W x 2 3/4" H x 2 3/4" D inches.



MFJ-902B \$129.95

MFJ-16010 random wire Tuner



Operate all bands anywhere with MFJ's reversible L-network. Turns random wire into powerful transmitting antenna. 1.8-30 MHz. 200 Watts PEP. Tiny 4W x 2H x 3D in.

MFJ-16010 \$79.95

MFJ-9201 QRPocket™ Tuner

80-10 Meters, 25 Watts. 12 position inductor, tune/bypass switch, wide-range T-network, BNCs. 4W x 2 5/8" H x 1 1/2" D inches.



MFJ-9201, \$49.95

MFJ-9201 \$54.95

MFJ-921/924 VHF/UHF Tuners

MFJ-921 covers 2 Meters/220 MHz. **MFJ-924** covers 440 MHz. SWR/Wattmeter. 8W x 2 1/2" H x 3 D in.



MFJ-921/924 \$109.95

MFJ-931 Artificial RF Ground

Eliminates RF hot spots, RF feedback, TV/RFI, weak signals caused by poor RF grounding. Creates artificial RF ground or electrically places far away RF ground directly at rig. **MFJ-934, \$249.95**, Artificial ground/300 Watt Tuner/Cross-Needle SWR/Wattmeter.



MFJ-931 \$129.95



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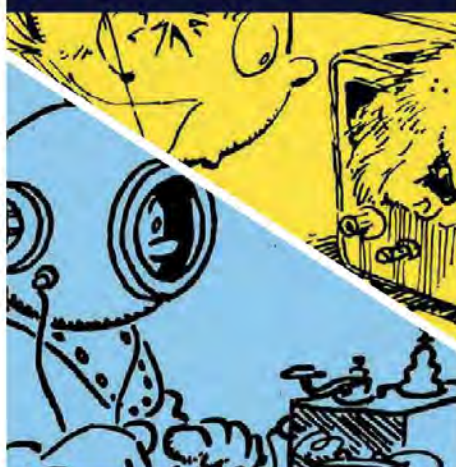
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2021 ARRL CALENDAR

The World of Ham Radio, Through Gil's Eyes



Featuring Gil Cartoons!

When life gets busy, keep track of your important dates, including major Hamfests and Conventions, ARRL contests, and U.S. holidays with our 2021 ARRL Calendar.

This year's calendar features the cheerful artwork of Philip "Gil" Gildersleeve, W1CJD who perfectly captured the lighter side of ham radio life in more than 1500 art pieces for QST.

Display this 12-month wall calendar in your home office or ham radio workshop – and enjoy classic cartoons all year long.

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MFJ Dummy Loads & SWR/Wattmeters

Dummy Loads

World's most popular Dry 300 Watt HF/VHF Dummy Load

Air-cooled, non-inductive resistor in a perforated metal housing; Has SO-239 connector. Full 300W for 30 seconds. Derating curve to 5 minutes. SWR below 1.1:1 to 30 MHz, 1.5:1 30 to 650 MHz. Compact 2 1/4 x 2 1/4 x 7 inches. **MFJ-260CN, \$59.95.** With type "N" connector.



MFJ-260C
\$49.95

Dry 1.5 kW HF/VHF/UHF Dummy Load

Ham radio's most versatile 1.5 kW 50 ohm dry dummy load covers DC through 650 MHz. SWR 1.1:1 to 30 MHz and 1.3:1 to 650 MHz. Handles 1500 Watts for ten seconds, 100 Watts for 10 minutes. 3W x 3H x 9D in. SO-239 connector. **MFJ-264N, \$109.95.** With type "N" connector.

MFJ-264
\$89.95



Oil-Cooled 1 kW CW, 2 kW SSB 50-Ohm VersaLoad™

Run 1kW CW or 2 kW PEP for 10 minutes. Run *continuous duty* with 200 Watts CW or 400W PEP. Transformer oil included. SWR 1.2:1 to 30 MHz. Low SWR to 400 MHz. SO-239 connector. Safety vent with cap, carrying handle. 7 1/2H x 6 5/8D in. **MFJ-250X, \$69.95.** No transformer oil.

MFJ-250
\$79.95



500 MHz, 100 Watt Dummy Load

Connects directly with built-in PL-259. Finned aluminum air-cooled heatsink. 15 Watts continuous, 100W peak. SWR <1.5:1, DC-500 MHz. 15/8 inch round by 3 inches long. **MFJ-262B, \$69.95.** PL-259. 35 Watts continuous, 200W for 5-seconds. SWR< 1.2:1 DC-1 GHz.



MFJ-261
\$34.95
with PL-259
DC to 500 MHz

MFJ 2500W fan-cooled Dry Load

MFJ's 2500 Watt fan cooled load handles legal limit amps, 2500W average one minute on, ten minutes off, 300W continuous. DC- 6 Meters. SWR <1.25, 30 MHz; <1.4, 30-60 MHz. Detailed power curve. 12 VDC or 110 VAC. 8 1/4W x 4H x 9 1/2D in. SO-239s. 5 pounds.



MFJ-265
\$249.95

Switchable RF Dummy Load

Select 16.6, 25, 50, 100, 150 Ohm dummy loads. Test/calibrate your wattmeters, SWR accuracy. At 50 Ohms it handles 300 Watts for 30 seconds with SWR < 1.1, 60 MHz. SO-239. 4 1/2W x 2 1/4H x 6 1/2D in. Optional 12 VDC/110 VAC adaptor, **MFJ-1312D, \$19.95.**



MFJ-251
\$169.95

3 GHz, 300 Watts Dry Dummy Load

New high-tech metal film resistor on large heavy-duty air-cooled heatsink. 300 Watts for ten seconds and 125W continuously. SWR < 1.1, 1 GHz; <1.2, 1.5 GHz; <1.5, 3 GHz. N-connector. 10 3/4W x 2 1/4H x 5 1/4D inches.



MFJ-263
\$139.95

1.5kW Dry Dummy Load/SWR/Wattmeter

Tune up your transceiver, linear amplifier or antenna tuner into a safe 50 Ohm dummy load at full power. Then instantly switch to your antenna and monitor SWR, forward and reflected power on lighted cross-needle meter. 300/3000 Watt ranges. DC-60 MHz. Test/tune Xceivers, amps, tuners, baluns, filters, coax, stubs.



MFJ-267
\$179.95

SWR/Wattmeters

Compact Cross-Needle SWR/Wattmeters

Large 3-inch lighted Cross-Needle meter covers 1.8-200 MHz in 30/300W power ranges. Read forward, reflected power, SWR *simultaneously*. 3 1/4W x 3 1/4H x 3 1/4D in. SO-239 connectors. **MFJ-842, \$69.95.** 140-525 MHz, 15/150W.



MFJ-822
\$69.95

High-accuracy 1.8-60 MHz Digital SWR/Wattmeter

Highly accurate! Auto-ranging select 25W, 250W, 1500W ranges with full 10-bit resolution. Frequency compensated data insures highest accuracy. *True peak/average* forward/reflected power, SWR and frequency are *simultaneously* displayed on backlit LCD and large 3-inch lighted cross needle meter. Peak hold. LED, buzzer, amplifier-bypass alerts and protects your amplifier when SWR is high and toggles extra relay. 6 1/2W x 2 5/8H x 6D". **MFJ-826B, \$199.95.** No meter, ampr bypass, control relay.



MFJ-828
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