Steps for Stabilizing Your Portable Mast Page 38

QST

ARRL the national association for amateur radio®
November 2020 www.arrl.org
DEVOTED ENTIRELY TO AMATEUR RADIO

Dreaming of DX

QST Reviews

RFinder B1 Dual-Band DMR/FM Transceiver with Android Smartphone

Koolertron Dual-Channel DDS Signal Generator

Dr.Duino Pioneer Edition Arduino Project Kit

YAESU
The radio

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
Clear and Crisp Voice Technology
WIRES-X

YAESU
The radio

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

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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.

YAESU
The radio

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

《Actual Size》

C4FM/FM 144/430MHz DUAL BAND DIGITAL TRANSCEIVER

FT3DR

Bluetooth® microSD Card

C4FM Digital Communication Clear and Crisp Voice Technology

AMS Automatic Mode Select

66 ch GPS

YAESU
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Cushcraft Antennas

R9

80-6 Meters! No Radials!

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

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

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

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

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

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

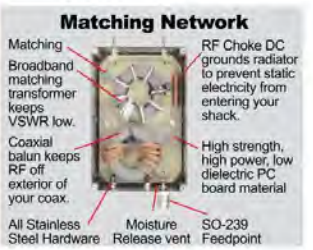
Rugged Construction: Thick fiberglass insulators, all stainless steel hardware and 6063 aircraft-aluminum tubing is double or triple walled at key stress points to handle anything Mother Nature can dish out.

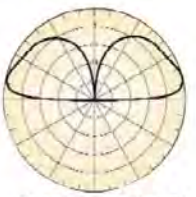
31.5 feet tall, 25 lbs. Mounting mast 1.25 to 2 inches. Wind surface area is 4 square feet.

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

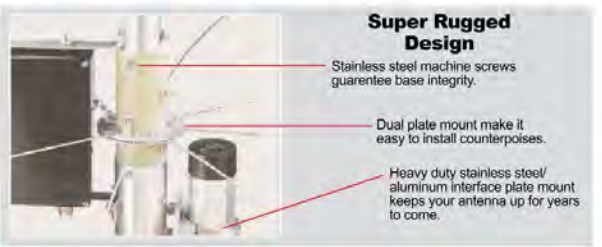
R-8TB, $99.95. Tilt-base lets you tilt your antenna up/down easily by yourself to work on.

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





Omni-Directional
Low angle radiation gives incredible worldwide DX.



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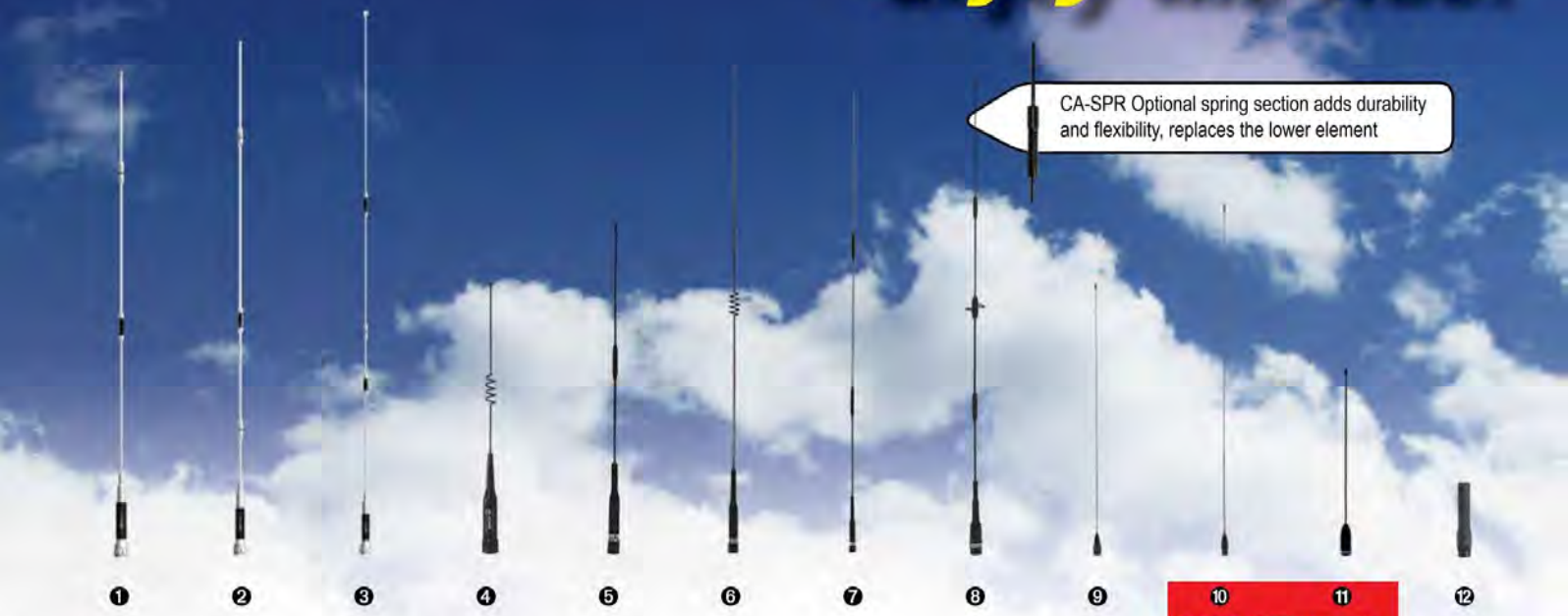
Life is a JOURNEY. Enjoy the ride!



Mobile Antennas

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

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

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

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

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

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

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

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

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

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

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

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

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QST

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November 2020 ♦ Volume 104 ♦ Number 11

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Write for *QST*

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

Our Cover
As the weather grows colder and hams prepare for winter, many find themselves dreaming of the perfect DX experience — whether that means taking their gear and some friends on a DXpedition to a far-off place or finally managing to log that rare entity from home. Spark your DX dreams by reading about "Mini DXpeditions on a Cruise with MARCO," by Jay Garlitz, AA4FL, on page 57 of this issue. [Jay Garlitz, AA4FL, photo]

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Engineers of LDG Mini-Notebook

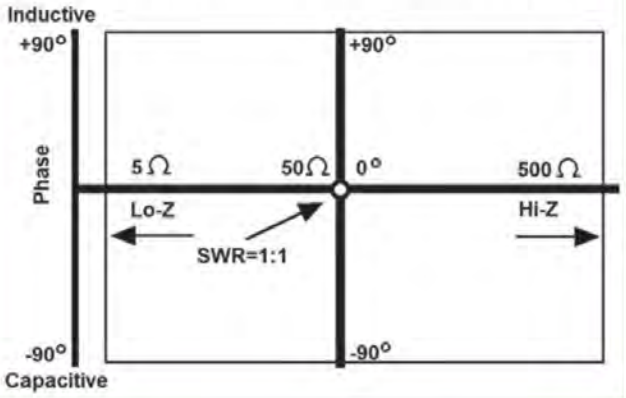
Tuning Range

Any way you look at an LDG tuner, it functions as a variable impedance transformer. No matter where you place it in the feedline, it's just like a balun, unun or any other matching transformer device. Way back in 1944, Phillip H. Smith (of Smith-Chart fame) wrote about the eight ways to configure an L-type matching circuit for transmitters using one inductor and one capacitor. Smith wrote in *Electronics for Engineers*: One of the simplest and most effective impedance transforming networks for RF applications is the half-section L-type circuit. Those circuits, with the aid of microprocessors and software control, have been whittled down over the years to the standard LDG "Switched-L Network".

The tuning range of the typical LDG tuner is about 15 to 1 to favor high impedance (Hi-Z) loads such as dipoles, vertical, end-fed, ect and about 8 to 1 for less popular low impedance loads (Lo-Z) like loops, folded dipoles, ect. Choosing the components for the range are critical, as going too far beyond a 10:1 range will cause excess losses to accumulate in the tuner. Using decades of feedback from our users, LDG has tailored the range in our models to best fit the needs of today's Ham.

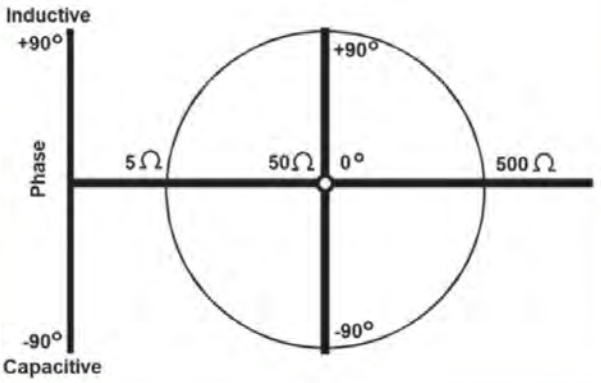
Perfect Tuner

Tunes all Impedances "and" all Phase angles.



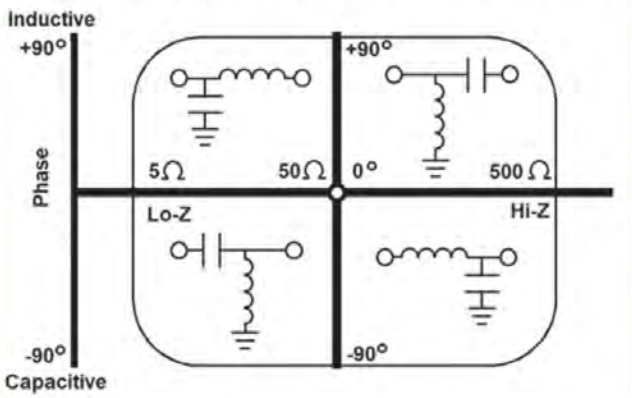
Ideal Real-World 10:1 Tuner

Fixed impedance range at all phase angles.



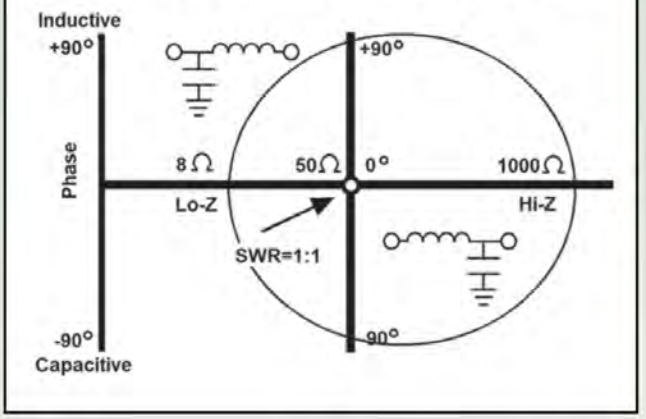
Ideal Smith L-Type Circuits

Half-section impedance transforming networks.



LDG Switched-L Tuner

Range selected for average US Ham.



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Urban Beam & OptimizIR

ROCK the 13 Colonies Special Event!

A note of praise from Brian (KB3WFV):

"Over the course of the 7 day long 13 Colonies Special Event, The UrbanBeam made over 4,333 contacts. The log stats show that all 50 states, most of Canada, 34 Countries, and 5 Continents were worked. Contacts were made on the 10m, 12m, 15m, 17m, 20m and 40m bands.

The Urban Beam and the OptimizIR never missed a beat. The ability to operate 20m and up in the bi-directional played a huge role in adding to the log numbers. Being able to listen and transmit in two directions at the same time, allowed coverage of both USA stations and Europe stations at the same time. A simple push of a button and the antenna switches to Normal (pointed towards EU), or 180 (pointed towards USA), then back to bi-directional, which made picking up contacts very very easy. Even the ability to adjust the forward gain and the front to back ratio on the fly made the difference between a contact making it in the log or being lost in the noise.

I'm truly amazed at the performance for the UrbanBeam and the OptimizIR. They never gave me a moments trouble. I thoroughly enjoyed using them. Please share my experience with everyone at SteppIR and be sure to pass along my thanks for making a great product! **THANK YOU!"**

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

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

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

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

X700HNA Special Features:

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

Here is a small sample of our wide variety of antennas

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

The Standard By Which All Others Are Judged

RF PARTS™ COMPANY

Diamond Antenna is a division of RF Parts Company

Becky R. Schoenfeld, W1BXY, w1bxy@arrl.org

Second Century

Ham Radio Lives in You

In my 9 years at ARRL thus far, I've learned many things about ham radio, and foremost among them is that ARRL, the organization, is not not ham radio. ARRL doesn't make ham radio happen. You — the individual ham, the club, the Section, the community — you make ham radio happen. Ham radio doesn't live at 225 Main Street, Newington, Connecticut. It lives wherever you live.

QST, the membership journal of ARRL, is a perfect example of this. Any magazine is a reflection of the audience it serves, and *QST* is perhaps even more so, because its readers *write* what goes into the magazine. Though the *QST* staff does a fair amount of soliciting material on specific topics, most of what you see in the magazine is what hams have been moved to write up and send in. In that sense, *QST* is very much a reflection of its audience, and of the ham radio community.

Occasionally, *QST* receives emails and letters from hams who feel that *QST* ignores a part of the hobby that they and their friends enjoy. Characteristically, these missives claim that the writer's favorite aspect of ham radio should be held up as something to learn more about and to aspire to, and that *QST*'s lack of focus on it is disappointing — perhaps even calculated — and this should be rectified.

These messages, when they appear, are nearly identical in their spirit and concerns, and the only thing that sets them apart from each other is the ham's favorite aspect of the hobby. Name any part of ham radio you can think of — microwaves, contesting, AM, high-end DXing, vacation-style DXing, giant towers, simple wire antennas — and someone has written to lament the lack of it in *QST*, and decry what they see as a glut of material on some other, less-worthy aspect of ham radio.

Behind each of these messages is a fear that something beloved will be overlooked, forgotten, lost, and a belief that *QST* can and should do something to prevent that from happening. While I certainly sympathize with wanting to guard against the loss of something cherished, I also feel that these concerned hams could use some reassurance as to who's truly in charge of which parts of ham radio fall by the wayside, and which parts survive.

Who's in charge? Hams are. You are. Ham radio lives and breathes on the air, and in the ham community. It's true that ARRL's mission is to advance the art, science, and enjoyment of amateur radio, but we at ARRL HQ — including those of us at *QST* — take our cues from the community. We see what's being written on internet message boards and other social media platforms. We attend forums and talk to hams at conventions. And, in terms of *QST*, we read the manuscripts that hams submit, which are an indicator of what the community is moved to share with others. *QST* has always been written by hams, for hams.

So if you want to see something specific in *QST*, by all means, write it up and send it in for consideration. The main exchange of ham radio knowledge occurs in the community of folks out there on the air — that's been the case for more than 100 years — and *QST* reflects that community. If you want the community to know about something you value, *QST* can help amplify your voice, to help shape the community.

Anybody can send in a manuscript at any time. We have an author guide at **http://www.arrl.org/qst-author-guide** that offers a great deal of information about what we're looking for. Take a look at it and consider writing that article you've been thinking about for months or years. Don't let your favorite niche of ham radio be lost to time; write a how-to, let other hams know what they might be missing out on. Having an article accepted in *QST* can be part of your ham radio legacy. Speak up; write it down. Let the community know how and where ham radio lives in you.

Becky R. Schoenfeld, W1BXY
Editorial Director, QST

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The First Choice of Hams Around the World!

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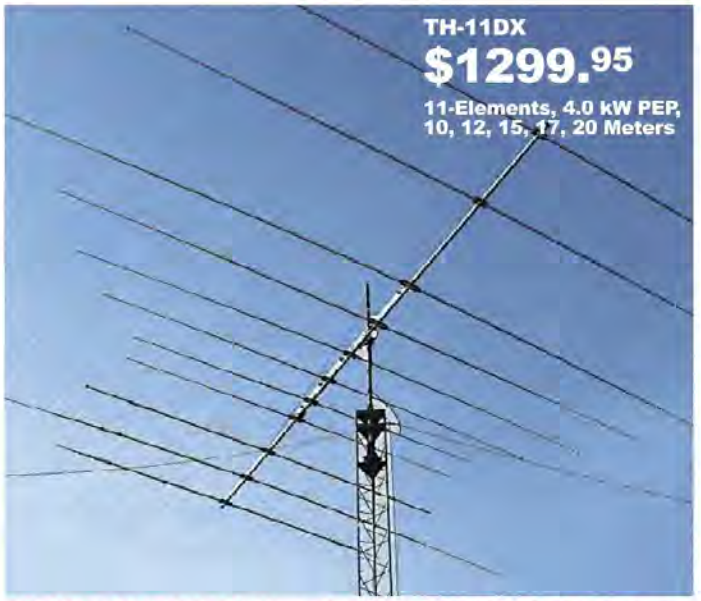
...are stronger, lighter, have less wind surface and last years longer.

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



TH-11DX, $1299.95. 11-element, 4.0 kW PEP, 10, 12, 15, 17, 20M

The choice of top DXers.

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

Handles 2000 Watts continuous, 4000 Watts PEP.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Tooled Manufacturing... Highest Quality Materials

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

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

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

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

Durable precision injection molded parts.

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

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

hy-gain® Antennas, Rotators & Towers 308 Industrial Pk Rd, Starkville, MS 39759 USA

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Step up to Top Performance with the HG3 Stepper Mag Loop!

NEW!

The new HG3 stepper tuned Mag Loop Antenna (MLA) sets a new standard delivering unprecedented capability in remote tuning, performance and convenience for an MLA. It employs a proven, accurate and repeatable stepper motor design. Band selection, remote tuning, including optional loop rotation, is controlled via a microcontroller driving a high resolution stepper motor.

A built-in digital SWR bridge provides auto-tuning based on an SWR scan. This ensures compatibility with most radios. Manual tuning uses a convenient rotary encoder knob - no more finicky push buttons. The four-line LCD displays band selected, SWR, ERP, Cap value and more. The bottom line - count on top-notch RX and TX performance!

KEY FEATURES

- STEPPER MOTOR ACCURACY
- CONVENIENT REMOTE TUNING
- DISPLAYS BAND, SWR, ERP & MORE
- QUICK BAND SELECTION
- AUTO-TUNING BASED ON SWR
- 80m - 10m COVERAGE AVAILABLE
- NO COMPROMISE SPOT-ON TUNING
- MAX POWER: 100 W PEP*

A precise LC match at the desired frequency ensures spot-on tuning (red SWR, blue RL, green Z) and minimizes mismatch losses within the MLA's specified frequency range.

* For EXPRESS & PRO models, see specifications for limittions

preciseRf
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Patent pending

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Professional Grade Equipment from Array Solutions

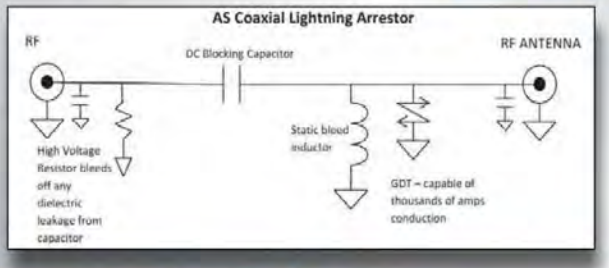
Array Solutions Lightning Arrestors

Coaxial , Ladder Line, Single wire, Control Line protection for Rotators, Switches, and Antenna Motors

AS-300 Series arrestors are known for their reliability and performance. They feature easy mounting to plates, ground rods with our stacking bracket and also a convenient screw lug. The stacking bracket can be used on plates as well to save precious room in arrestor enclosures.

- Available in SO-239, Type-N, and 7/16 DIN connectors
- DC blocked, DC pass is available as a custom option
- Unique static bleed system with a UL approved Gas Discharge Tube, also ITU K 12 tested. This system usually prevents the GDT from ever firing unless a direct hit is taken. Saves your radio from static build up on large antennas.
- Models available for 3 kW, 5 kW, 10 kW and higher, details on website. Lower power available.
- FM low power broadcast model AS-303D FM
- Model AS-309H high-power single wire or ladder line arrestor, also DC block with static bleed
- Control line Arrestors for 8, 12, and 16 wires – 65V sparkover.
- Models for HF, VHF to UHF – Extremely low loss and Low VSWR

AS-303U



Hamation Station Automation

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

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

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

The Shared Apex Loop Array™!

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

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

Three models to choose from:

- AS-SAL-30 - optimized for VLF, BCB, 1.8-10 MHz
- AS-SAL-20 - optimized for BCB, and 1.8-30 MHz
- AS-SAL-12 - optimized for 3-30 MHz

OM Power Amplifiers Sales and Service

Switches for Six Antennas

5kW - DC to 6m

RATPAK – 1x6

Choice of Multiple Controllers

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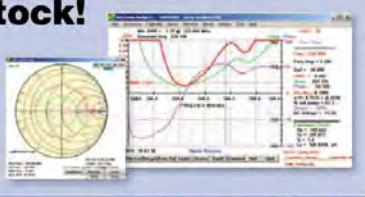
VNAuhf Back in Stock!

Vector Network Analyzer

5 kHz -1.3 GHz **$1295**



StackMatch

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

PowerMaster II

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

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Member Spotlight

Robotics Engineer and YouTuber Bill Strong, WW2HAM

Bill Strong, WW2HAM, divides his time between the past and the future. As a staff research engineer for Northwestern University's Center for Robotics and Biosystems, he works on developing the technology of the future. In his free time, however, Bill likes to tinker with the revolutionary technology of the past. His lifelong interest in electronics led him to restoring vintage military radio gear — especially equipment from World War II. He typically spends his downtime taking apart and repairing old military radios, trying to make them as historically accurate as possible. He showcases this hobby on his YouTube channel, Wartime Workshop (**www.youtube.com/WartimeWorkshop**).

Robotics Career

Bill started working with electronics at a young age. "I've always been obsessed with robots," he said, "and I started early with electronics projects because they were a relatively accessible facet of the robotics world." As a teenager, he built robotics kits and got involved in FIRST Robotics Competition, a competitive robotics program for students at the high school level. He also enrolled in electronics engineering classes at his local community college.

After being homeschooled for most of his life, Bill attended Worcester Polytechnic Institute and earned his bachelor's degree in robotics engineering. Now, at age 26, he works at Northwestern University's Center for Robotics and Biosystems, as a staff research engineer. He explained, "I study robotic swarms and human-robot collaboration, and I help teach robotics design classes."

Radio Restoration

Bill developed an interest in restoring vintage military radios after collecting World War II field gear for a few years. He picked up on the basics quickly, due to his background in electronics. He also noticed that a lot of the vintage gear available had been modified. "My interest is in restoring this equipment to a condition that approximates its appearance and functionality during the war, so that I can recreate as best as possible the user experience of the original operators," he said. This context gave Bill an interest in history, particularly regarding technology's place in the conflicts of the 20th century.

He's had his amateur radio license for a few years, but only recently became immersed in the hobby. "While I've had my license since college, I didn't truly get into ham radio until recently, when I stumbled back into it as a result of my interest in historical military equipment," he said. "Most of my equipment is gear I've acquired for restoration." He explained that he spends more time restoring old rigs than getting on the air, where he enjoys checking in on local nets.

As a history buff, Bill especially appreciates "the way amateur radio history is tied into modern technological development," he said. "Many of the earliest radio experimenters were amateurs, and I find that extremely compelling in the context of modern Maker culture."

Finding an Audience

This year, Bill decided to showcase his restoration efforts on YouTube. Through his channel, Wartime Workshop, he hopes to "provide accurate historical context for each project." Bill's channel is still growing, thanks in part to interest from other hams. "I especially appreciate subscribers from within the ham radio community," he said.

Getting the hang of making videos — and restoring military gear — is a work in progress. "My first few videos represent a learning curve in both radio/restoration knowledge and video production and editing," he explained. "I'm still a total beginner, but I'm learning every day."

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

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

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

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

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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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Up Front

"Junk-Box" Keys

As many people have some free time now, due to being at home more often, it may be a good opportunity to try a new hobby. When he found himself with some extra time on his hands, Jay Buscemi, NY2NY, decided to build CW "junk-box" keys with spare parts he had around his station. They're all functional. [Jay Buscemi, NY2NY, photo]

Personal Radio Museum

Marcos Raijer, W3EZB (formerly LU3EZB), has been collecting early wire telegraphic equipment, in use circa 1850, for the past 40 years. He has devices from every major system, including Cooke and Wheatstone, Breguet, and Morse. When he retired a few years ago, he installed a small museum in his house, complete with a live telegraphic aerial wire line. His plan now is to speak with the local high school teachers, in order to share these telecommunications systems and devices with students. [Marcos Raijer, W3EZB, photo]

Surprise Contacts in BC

Phil Storey, VE7YBH/G3YBH, is a tour director based in Vancouver, British Columbia. In June, he met a customer from California and made a remark to her about attending Visalia every year. Unbeknownst to him at the time, he was speaking with Diane Wainwood, KJ6JEJ, from Thousand Oaks, California. On the following day, during a Vancouver City Tour, Phil brought two handheld transceivers and made a 2-meter simplex contact in Vancouver's Stanley Park with Diane, adding VE7/KJ6JEJ to her profile. [Phil Storey, VE7YBH/G3YBH, photo]

Code: "Grandpa"

Jeff VanMeter, KA8HQL, recently received a special message from his oldest daughter, Julia. With the help of Julia's sister, Katie, KD8WPD, Jeff discovered his new title of "Grandpa" via Morse code. He could not be happier.

From left to right: Julia Roberts, Jeff VanMeter, KA8HQL, and Katie VanMeter, KD8WPD. [Jeff VanMeter, KA8HQL, photo]

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Correspondence

Letters from Our Members

It's All Amateur Radio

People sometimes argue about what truly counts as ham radio. To me, ham radio is many things, but above all else it is communication. It is about people of different cultures talking to each other, learning about each other, and making friends. Whether they're operating on VHF or D-STAR, it is all amateur radio. It doesn't matter if you actually use a radio, a terminal (like I do), an app on your phone (like EchoLink or RCForb), or some other means of communication.

With amateur radio, we have the opportunity to talk to and learn about others. And with that knowledge and communication, we can spread positivity and awareness, rather than division.

In my opinion, we need more ham radio operators — in all modes.

John Davis, WA8YXM
Davison, Michigan
Life Member

Appreciation from Novices of 1970

Steve Ford's, WB8IMY, article, "Where are They Now? The Novices of 1970," in the June 2020 issue of *QST* had me reminiscing about when I was a 14-year-old Novice in 1969 – 1970, with the call sign WN6MWH.

I later upgraded to my General-class license, then passed my Amateur Extra-class exam along with a friend, Larry Deran. Larry became N6FE, while I received the call sign N6MI. In the 1970s, I began transmitter hunting and operating Field Day with the Santa Barbara Amateur Radio Club (**www.sbarc.org**). Larry and I became members of the N6VI Field Day team in 1980 — with a record score that stood for about a decade.

Larry and I still operate Field Day together when we can. He works in Silicon Valley as a software engineer, and I'm a lawyer in downtown Los Angeles, where I usually limit my operating to occasional contests from my mobile operating setup.

I have been a ham radio operator for more than 50 years. For most of that time, I have been a member of ARRL. I deeply appreciate the work that ARRL does on behalf of all ham radio operators. Thanks for the look back at my Novice days.

J. Scott Bovitz, N6MI
Rowland Heights, California

FirstNet® Follow-Up

Thank you for the great article from Randy Richmond, W7HMT, "Augment Your ARES® Mission with FirstNet®," in the September 2020 issue. The article helped to explain the connection between the federal government and AT&T®. There has been a common misconception, with many thinking that FirstNet is nothing more than a commercial offering from AT&T.

I work with the FirstNet Authority, the federal government agency that oversees this major advance in public safety communications. Our two physical locations, in Boulder, Colorado and just outside Washington, DC, have hams working there. Several of our remote field staff, including myself, are also hams.

Brent Williams, WB8TRL
Marshall, Michigan

The Black Widow

When I was re-reading the April 2019 issue of *QST*, I was intrigued by George Misic's, KE8RN, "Classic Radio" article on "Six-Meter AM Radios of the 1960s." My father had owned many of them, particularly Gonset Communicators and the G50.

One rig was not included in George's list, which I believe was a very good mobile rig as well. The Rogers Electronics Black Widow was a very capable rig that came from the US West Coast. The first one we owned was crystal-controlled and had a 2E26 output.

The follow-up to the Black Widow was VFO-controlled, using a 6146 output, and required a 600 – 800 V supply. For this, we initially used a dynamometer, then bought a solid-state supply made by Honeywell.

Both units worked very well and were acquired by my grandfather, Grandpa "Bill" McCutcheon, K3HWZ, who sold them on the East Coast.

Chris Maukonen, WA4CM
Garfield Heights, Ohio

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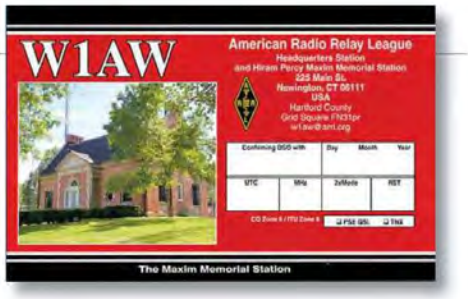
W1AW's QSL File

Every month, W1AW receives hundreds of QSL cards from hams all over the world, confirming contact with the Hiram Percy Maxim Memorial Station at ARRL Headquarters. Maybe you'll recognize an on-air friend — or even yourself — among these recent cards.



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Build a DSP Audio Filter

This adjustable bandwidth filter is a valuable addition to your QRP station.

Steve Allen, KZ4TN

I recently came across the LASERBEAM-VARI Modules Digital Signal Processing (DSP) filter available from SOTABEAMS at **www.sotabeams.co.uk/variable-bandwidth-filter-modules-ssb-cw**. This 1.4 × 1.4 inch module provides DSP band-pass filtering with an adjustable bandwidth of 200 to 3,500 Hz, and an adjustable center frequency of 200 to 3,500 Hz. I wanted to include a simple audio amplifier module, so I mounted both modules on a motherboard that fits into an extruded aluminum enclosure. In Figure 1, you can see the motherboard underneath the DSP module that is mounted in the upper left, and the audio module in the lower right. Figure 2 shows the configuration of the DSP and audio modules. The rotary encoder and LEDs are mounted on the left front of the motherboard. Be sure to download the wiring and outboard component detail documentation from the DSP module web page at **www.sotabeams.co.uk/content/LASERBEAM-VARI.pdf**.

Filter Functions

The filter is simple to operate. Press the knob of the rotary encoder (left knob in the lead photo) to switch between the bandwidth and the center frequency functions of the filter. LEDs indicate which function is active: yellow for center frequency, and green for bandwidth. A red LED indicates an overload to the filter audio input. The module includes a board-mounted pushbutton switch to save your favorite settings for the next time you power up the filter.

The DSP board requires outboard components — it has been designed so you can either solder the outboard component leads directly to the board, or you can solder header pins on the board and plug the DSP board into mating header sockets on a motherboard. I included a simple audio amplifier, and mounted both modules on a motherboard that would fit into a 70-millimeter-wide slotted extruded aluminum enclosure from Amazon (see Table 1). The slots are designed to hold a PCB off the bottom of the enclosure without using standoffs.

Figure 1 — The filter module is on the back left, and the amplifier is in the front right. Both are on top of the motherboard.

Construction

I first determined the location of the PCB assemblies on the motherboard. The amplifier has a volume control with an **ON/OFF** switch, and it is designed for incorporation into a larger build. A tricky part of the design was locating the amplifier module board on the motherboard and locating the mounting hole in the front panel. The volume control for the amplifier determines the position of the motherboard within the enclosure. The motherboard fits loosely in the enclosure slots, so tightening the volume control potentiometer nut to the front panel holds the motherboard in place. I prototyped several front panels out of card stock to get the location of the hole correct before committing to drilling the front panel.

The other front-panel components — the rotary encoder and LEDs — are wired to the motherboard, so their locations are not as critical as the volume control. I did a number of sketches of the locations of the rear-panel components — audio in and out jacks, the dc power jack, and the amplifier gain selector switch — to make sure everything would fit. My enclosure dimensions are seen in Figure 3.

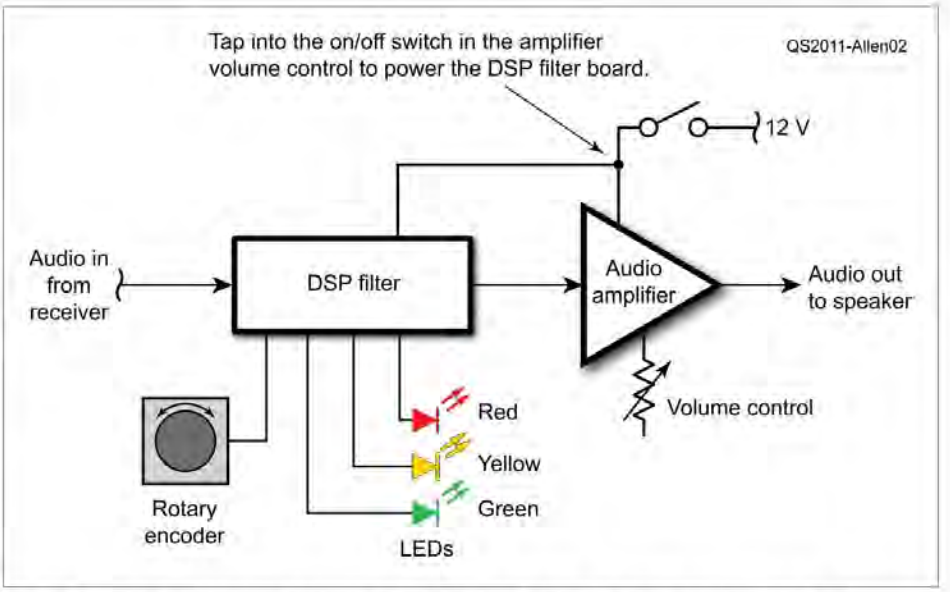

Figure 2 — The connections between the DSP filter and the audio amplifier modules.

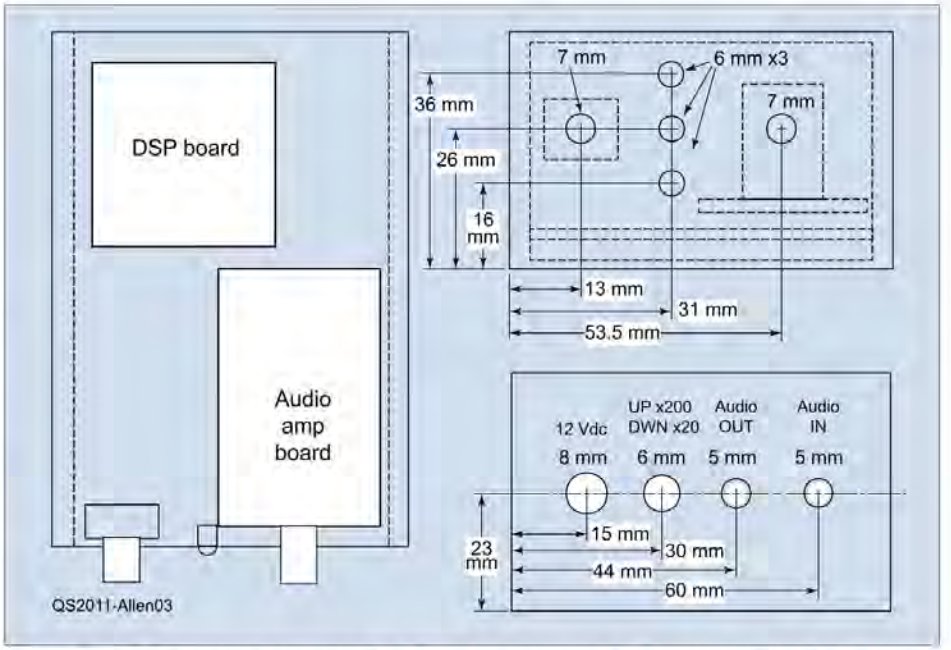

Figure 3 — A dimensional drawing of the front and rear panels. The positioning of the two modules is also shown.

Drilling the Enclosure

I laid out the location of the front and back panel's holes using a pencil that is easily erased with alcohol. I chose millimeters as my unit of measure for the layout. Using an optical magnifier, I carefully marked the locations for the panel holes. I first drilled a 1-millimeter pilot hole in each location. I then drilled out the holes to the proper dimension using a step drill. I next applied labels using a label maker.

The Audio Amplifier Assembly

I sourced the amplifier module from **www.parts-express.com** (see the bill of materials in Table 1). On the board, there is a jumper that sets the gain at either 20× or 200×. I wired those jumper pins to a toggle switch on the rear panel in the event I want to use the filter with a low output homebrew receiver. I used insulated screws, standoffs, and nuts to mount the amplifier on the motherboard. Depending on the

Table 1
DSP Audio Band-Pass Filter Bill of Materials

Item	Source	Part Number	QTY	Comment
Enclosure	Amazon.com	EWUBOX011	1	Electronic Project Box Case Black - 4.33 × 2.99 × 1.81 inches (LWH)
Motherboard	Amazon.com	—	1	100 × 70 mm Prototype PCB
DSP Filter Board	DX Engineering	SBM-LB-VARI	1	—
Audio Amp Board	Parts Express	320-612	1	—
LED Sockets, 3 mm	Multiple	—	3	—
Knobs	Multiple	—	2	—
3.5 mm Mono Audio Jacks	Parts Express	090-296	2	—
SPST Toggle Switch	Parts Express	060-350	1	—
2.1 mm DC Power Jack	Parts Express	090-5012	1	
Hardware to mount amplifier on motherboard	Miscellaneous	—	Screws, nuts, and 2.5 mm standoffs* (4 each)	

*NOTE: the height of the standoffs determines the height location of the hole in the front panel for the volume control.

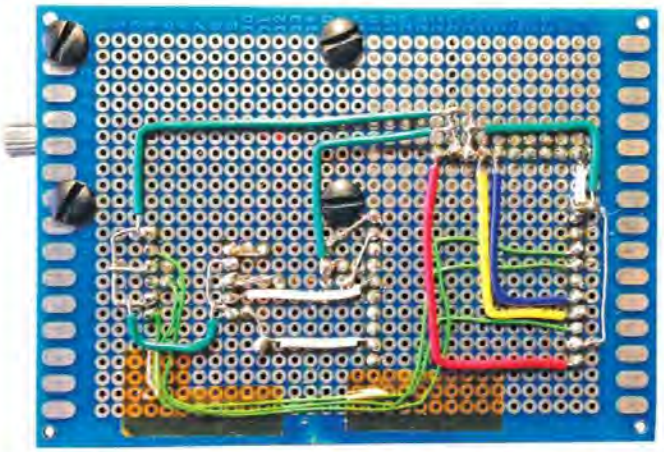

Figure 4 — Point-to-point wiring on the bottom of the motherboard. Soldering the two vertical rows of 10 pins each required high magnification and a soldering iron with a fine tip.

height of the standoffs, you may want to sandwich a sheet of insulating material between the bottom of the amplifier board and the motherboard. The amplifier volume control includes an **ON/OFF** switch, which I tapped to power the DSP board.

The DSP Board

I soldered ten-position header pins on the bottom of the DSP PCB so I could plug it into the motherboard. This makes wiring the circuitry for the encoder and LED dropping resistors easier, and it also assures the DSP board stays safe from electrostatic discharge or impact damage during the build.

Wiring the Motherboard

I used point-to-point wiring (see Figure 4) and header pins to make connecting the outboard components easier instead of trying to solder the wires into the plated-through holes in the motherboard. This requires careful soldering to make sure there are no solder bridges between the pins. Once the wiring was completed and checked, I flush-cut the pins.

Figure 5 — The audio spectrum analyzer image comparing the LASERBEAM-VARI (narrow trace) to a Collins 500 Hz mechanical filter (wide-skirts trace) in an FT-987. [Photo courtesy of SOTABEAMS]

Final Wiring and Testing

I wired the front panel first. It was tight going, but with care, all went well. The back panel was easy without any mishaps. I recommend that you go slowly, and continually refer back to drawings to make sure the wiring is correct. I found that using a high-power optical magnifier was mandatory.

Figure 5 compares my filter, set to 500 Hz bandwidth, to the wider skirts of a Collins 500 Hz filter in an FT-897 transceiver.

Final Comments

The filter/amplifier is a great addition to my simple ZZRX-40 direct-conversion receiver. The receiver has a low audio output, because it's designed for use with headphones, but by switching the amplifier gain from 20× to 200×, there is plenty of audio to drive a speaker. The DSP filter works wonders in increasing the selectivity. This filter/amplifier makes a great addition to a homebrew QRP station, or any receiver lacking in filtration or adjustable audio bandwidth.

Photos by the author, except where noted.

Advanced-class licensee and ARRL member Steve Allen, KZ4TN, received his Technician-class license in 1992. Steve has served as an ARRL Technical Specialist. He has been interested in radio communications since the early 1960s, and he is self-educated in electronics. Steve's father kindled this interest, and Steve started building crystal and vacuum-tube radios, and listening to amateur and shortwave radio at that time. He is retired from a career in supply chain management in avionics, biomedical, and industrial manufacturing. He also ran a freelance photography business and volunteered for 11 years as an emergency medical responder. Steve resides in Tennessee with his wife Cheryl, KB1JBT. You can reach him at **kk1vt@arrl.net**.

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Steve Stearns
K6OIK

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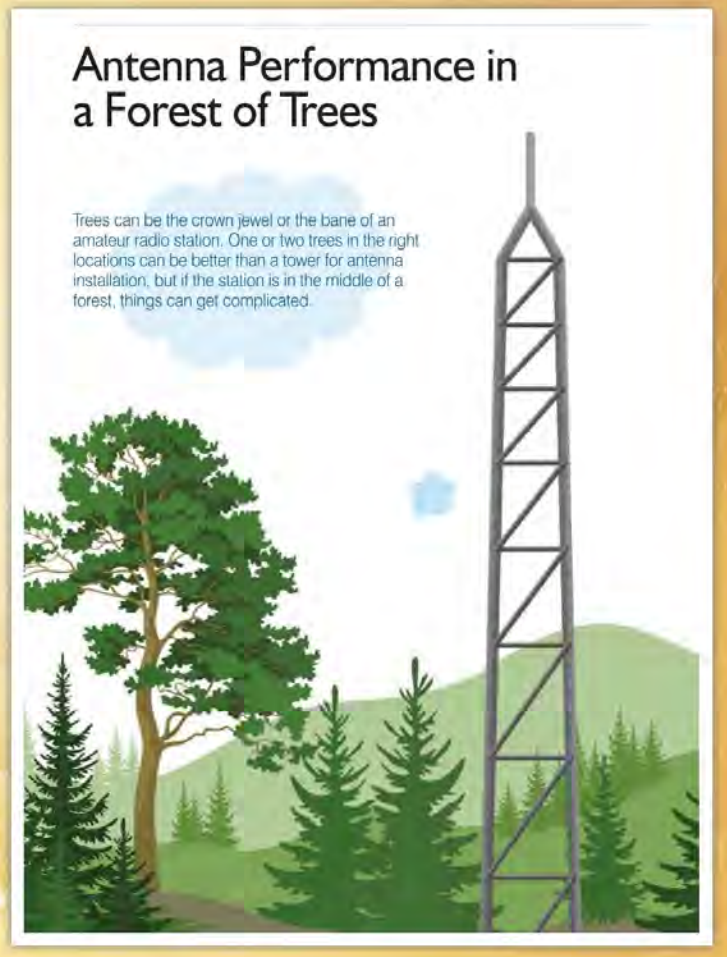

Exploring Radio Mathematics

Imaginary numbers can give real results.

Dave Casler, KEØOG

Everyone knows Ohm's law, $E = I \times R$, which is that voltage (in volts) equals the current (in amps) times the resistance (in ohms). And the power law is just as simple, $P = E \times I$, in which power in watts is equal to voltage times current. After all, both laws are quite basic and are part of the Technician-class license syllabus.

We can use these to answer all sorts of questions that might come up about important concepts in ham radio, including power, heat dissipation, capacitance (expressed in farads), and inductance (expressed in henries). Capacitors and inductors exhibit something called *reactance*, which, unlike resistance, varies with frequency. Capacitive reactance is given by $X_C = 1/(2 \pi \times f \times C)$, where X_C is the reactance in ohms, and π is the constant (3.1415927...), f is the frequency in hertz, and C is the capacitance in farads. We note that capacitive reactance goes down as frequency goes up. At zero frequency, or dc, capacitive reactance is infinite (essentially an open circuit).

Inductive reactance is the reciprocal and is measured in ohms. Inductive reactance is given by $X_L = (2 \times \pi \times f \times L)$, where L is the inductance in henries. At zero frequency, the inductive reactance is zero, meaning the inductor acts as a short circuit at dc.

Reactive devices don't consume energy. Rather, they accept some energy, store it in an electric field (capacitors) or a magnetic field (inductors), and then give the energy back to the rest of the system.

Now, here's a seemingly odd thing: X_C and X_L vary with frequency. The reactance cannot be found with just the capacitance or inductance; you must know the frequency. It's almost as though you're dealing with entirely different components if you change the frequency.

Usually, when considering reactance, we look at *resonance*. This happens when there is some capacitance and some inductance in a circuit, and when the capacitive reactance equals the inductive reactance, the two reactances cancel out, and we achieve resonance in which a circuit is purely resistive (but only at one frequency). Knowing that the key to resonance is the capacitive and inductive reactances equaling each other, given two arbitrary values of capacitance and inductance, we can discover the resonant frequency by setting the capacitive and inductive reactances equal to each other: $(2 \times \pi \times f \times L) = 1/(2 \times \pi \times f \times C)$. After a couple of steps, this leads to $f^2 = 1/(4 \times \pi^2 \times L \times C)$, and by taking the square root of both sides, you're left with $f_{resonance} = 1/(2 \times \pi \times \sqrt{(L \times C)})$.

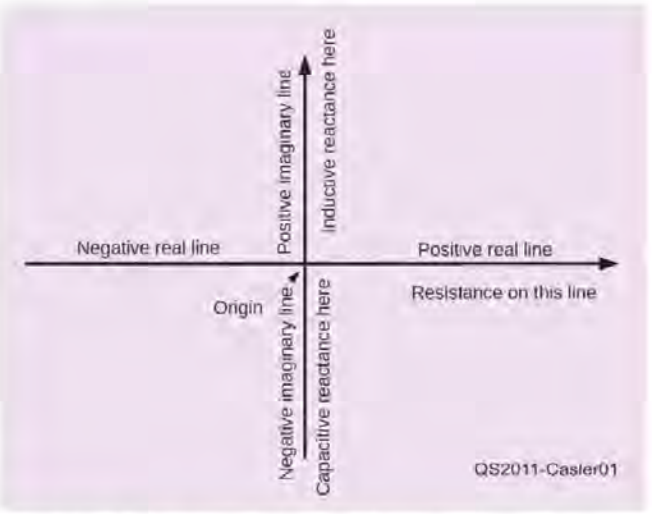

Figure 1 — The representation of real numbers (plotted on the horizontal axis) and imaginary numbers (plotted on the vertical axis).

Now, we must consider why X_C and X_L are given in ohms, just like resistance. The reason stems from the fact that the familiar $E = I \times R$ is only a special case of the more general Ohm's law, which has more to it as we dig into ac and RF circuits. The more general version of Ohm's law is $E = I \times Z$, where Z is the *impedance*, which has both resistive and reactive components. If we understand how impedance is defined, we can combine regular resistance with capacitive and inductive reactances. When we do that, we will learn that the resistance and reactance combine as impedance to affect ac waveforms, both in *amplitude* and *phase*.

Complex and Imaginary Numbers

To combine these, we need more math. Scientists long ago discovered that what we might think of as ordinary math (adding, subtracting, multiplying, and dividing real numbers) is insufficient to describe the way nature works, particularly in physics, including the physics of electromagnetic waves. So, additional mathematical tools are needed, such as *complex numbers*.

Squaring a number means multiplying the number by itself, and a negative number squared is always positive. Therefore, a square root is the number which when multiplied by itself yields a square. There should be no such thing as the square root of a negative number because no number multiplied by itself could ever be negative. In fact, if I try to take the square root of a negative number with my calculator, I get an error.

The big conceptual leap is having to imagine that there is an abstract thing that when multiplied by itself is minus 1. Because we know that no real number can be multiplied by itself to be –1, such a number is sheer imagination. So, mathematicians use the letter *i* for this thing that is defined this way: $i^2 = \sqrt{(-1)}$. Engineers (and amateurs) can't use *i* because *i* is used for current, so they instead use the letter *j* to denote that imaginary thing that when squared equals –1. It doesn't matter to any of the math, but *j* equals minus *i*.

When adding imaginary numbers, it is important to remember that real and imaginary numbers are separate and considered *orthogonal* (see Figure 1). Think of real numbers as apples and imaginary numbers as oranges. Adding apples to oranges doesn't give you more of either, but you have more fruit. We can do something similar with real and imaginary numbers by graphing them, as seen in Figure 1. The real numbers are plotted on the horizontal axis, and the imaginary numbers are plotted on the vertical axis, intersecting each other at the zero point, or the *origin*.

Now we are prepared to represent the combination of real and imaginary numbers, which is important for dealing with capacitive and inductive reactance. On the positive imaginary line would be inductive reactance (in ohms). So an inductance that at some frequency *f* has an inductive reactance of 3 ohms is represented by 3*j*. Capacitive reactance would go on the negative imaginary line. For instance, a capacitive reactance of 4 ohms is represented by –4*j*. Regular resistance is represented on the positive real line.

Now we have the tools we need to combine inductive reactance, capacitive reactance, and resistance. To add them, let's create a set of coordinates. Let's suppose we have a resistor of 3 ohms and an inductive reactance of 4 ohms. We would represent the combination of the two as 3 + 4*j* ohms (see point A in Figure 2). A combination of real and imaginary numbers is called a *complex number*, and when there are multiple complex numbers plotted, it's called the *complex plane*.

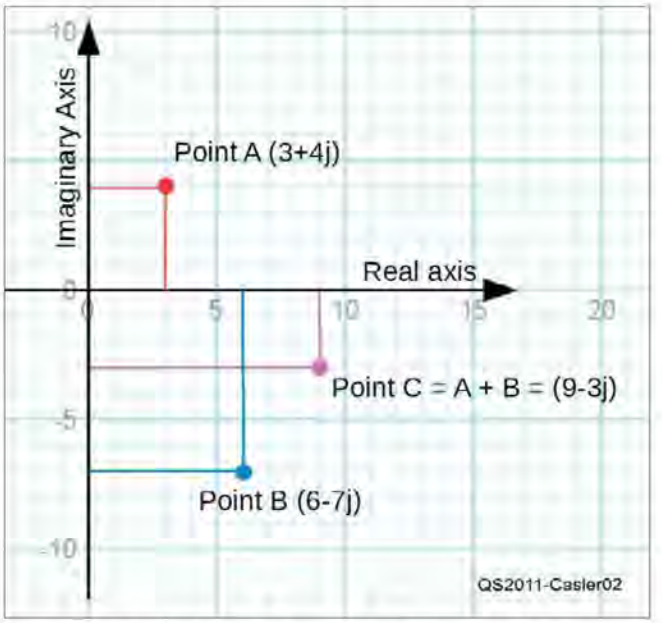

Figure 2 — A set of complex numbers plotted on a complex plane. Point A is the combination of a resistor of 3 ohms and an inductive reactance of 4 ohms, written as 3 + 4*j* ohms. Point B is another resistor of 6 ohms and a capacitive reactance of 7 ohms, written as 6 – 7*j*. Point C shows Point A and Point B added together, written as 9 – 3*j*.

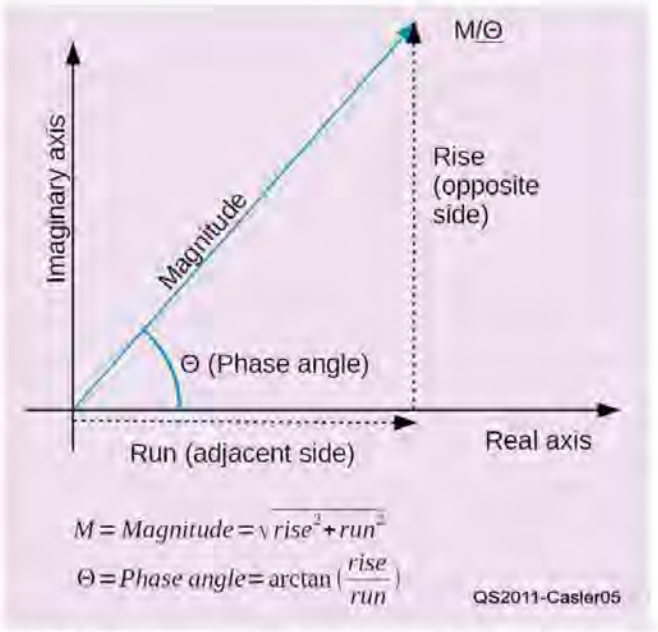

Figure 3 — The representation of converting from coordinates to vectors.

Interestingly, if we added another resistor of 6 ohms and a capacitive reactance of 7 ohms (see point B), we would add them thus:$(3 + 4j) + (6 - 7j) = 9 - 3j$ in ohms. The real parts and imaginary parts are added separately (see point C). Note that inductive and capacitive reactances cancel. If they cancel exactly, and the answer lies on the real line, then the circuit is resonant.

In electronics, we seem to see multiplication much more than mere addition. Multiplication can be done in Cartesian coordinates. It's just a bit awkward. But let's show it can be done. Let's take the same numbers as in the previous example, and multiply them.

$(3 + 4j)(6 - 7j)$

$= 3 \times 6 - 3 \times 7j + 4j \times 6 - 4j \times 7j$, by distributing $3 + 4j$ over $6 - 7j$

$= 18 - 21j + 24j - 28j^2$, but j^2 is just -1, so

$= 18 + 3j + 28$

$= 46 + 3j$

Polar Coordinates

Now we can look at a different coordinate system to represent the complex plane. This is where the real power of this approach lies. Using the real and imaginary perpendicular lines, we take a polar coordinates approach. So instead of representing a complex number as $a + bj$, we will represent it as a vector. The vector has a length and an angle. The length is often called the *magnitude*, and the angle is often called the *phase angle*. We can represent the number as magnitude/phase, such as 10/50°. Note that the magnitude is always zero or positive. The *phase reference* can end up being arbitrary (it is phase *differences* that are important in radio) and is usually taken as the phase of the voltage source.

We can convert from coordinates to vectors using the trigonometry formulas shown in Figure 3.

The magnitude is the square root of the sum of the squares of the *rise* and the *run*, and is the *hypotenuse* of the triangle. The rise is the imaginary component, and the run is the real component.

We can get the angle by using a calculator to determine the angle theta (Θ) using any of the following equations:

sin Θ = rise / hypotenuse

cos Θ = run / hypotenuse

tan Θ = rise / run

(Sometimes the rise is called the *opposite side*, and the run is called the *adjacent side*. The hypotenuse comes from the Pythagorean formula that says the square of the hypotenuse is equal to the sum of the squares of the rise and the run.)

Multiplication in the polar approach is simple. Multiply the magnitudes and add the angles (taking due heed for negative angles for capacitive devices or circuits). Note that division is the inverse of multiplication, so division means to divide the magnitudes and subtract the angles.

Suppose we have an RF signal of 3 V, and we place across it a network consisting of a 4 Ω resistor and an inductive reactance X_L of 4 ohms. The impedance of the network is $4 + 4j$ ohms. In the polar approach, the magnitude is the square root of $42 + 42 = 16 + 16 = 32$, so the magnitude is 5.66. The angle is clearly 45°, but we can calculate this as tan Θ = rise/run = 4 / 4 = 1. To get the angle itself from the tangent, we use the arctangent (inverse tangent) function — arctan(1) = 45°. So the impedance is 5.66/45° Ω.

Using $E = I \times Z$ to find the current, we rewrite Ohm's law as $I = E / Z$. The voltage is 3/0° (we're using the voltage phase as the reference). We have $I = 3/0° / 5.66/45° = 3/5.66 /–45° = 0.53/–45°$ amps.

Notice what this means. At this frequency, the current in this circuit lags the voltage by 45 degrees and is therefore inductive (see Figure 4). (Yes, the current can be out of phase with the voltage. What's happening here is that the inductor stores some of the energy in a magnetic field and then releases it a little bit later.) If the current leads the voltage, we say that the circuit is *capacitive*. The dividing line is 180°. If the phase angle is between zero and minus 180°, the circuit is inductive. If the phase angle is between zero and positive 180°, the circuit is capacitive.

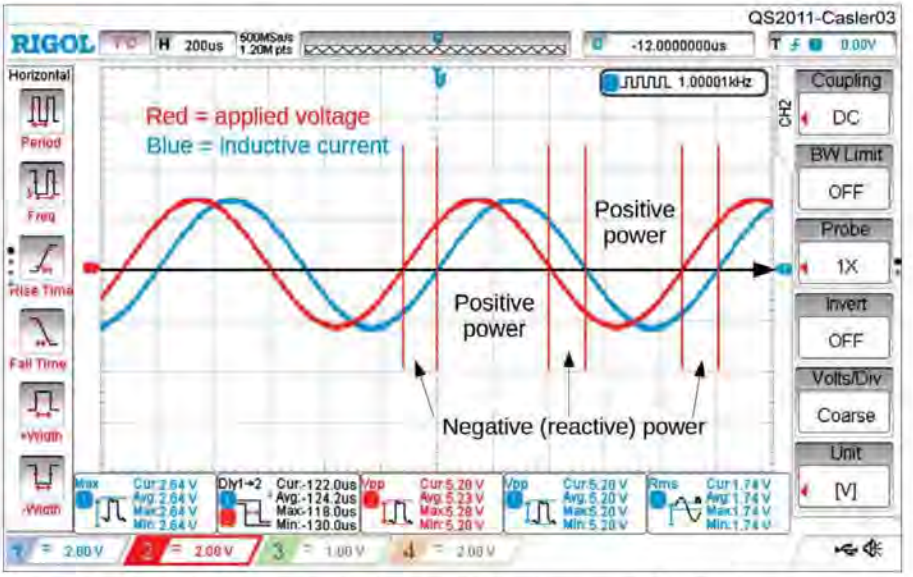

Figure 4 — A graph of the applied voltage and inductive current of a circuit.

Power in Systems with Reactance

As it turns out, the generalization of power in this circuit to the complex plane is in units of volt-amps. $P = E \times I$, so $P = 3/0°$ times $0.53/–45° = 1.59/–45°$. The magnitude of the power, in this case 1.59, is in units not of watts but of volt-amps. Let's convert the power back to coordinates to discover how much is real power (measured in watts) and how much is imaginary reactive power. Reactive power comes only from inductance and capacitance, and is not dissipated as heat, but rather is given back to the circuit, seen in $\sin(–45°) = \text{rise} / 1.59 \rightarrow \text{rise} = 1.59 \sin(–45°) = 1.59 \times 0.707 = 1.12$ W

By similar logic, the run is also 1.12. The power (in volt-amps) is $1.12 – 1.12j$. Note how reactive the power is. The real part of this, 1.12, is actual power in watts, meaning converted to heat. The imaginary part of this is reactive power, which means power consumed, and then later in the cycle given back. And, yes, this actually happens. This circuit is quite inductive.

As an aside, the problem for the electric utility is that it has to provide 1.59 volt-amps, but is then given back 0.47 volt-amps to deal with. Given that most utility loads are inductive (think electric motors), the utility will put capacitors here and there in its system to soak up this reactive power and release it in such a way as to cancel it. By the way, the cosine of the angle of the current to the voltage is called the power factor. In this case, it is $\cos(45°) = 0.707$. The higher the power factor, the closer the load is to being purely resistive.

In summary, the use of complex numbers allows us to use a more general version of Ohm's law, $E = I \times Z$. We can calculate the combined effect of both resistance, inductance, and capacitance for a given frequency. We can look at the magnitude of the effects and the phase, and see how much power is actually consumed versus how much is given back to the source.

Dave Casler, KE0OG, was first licensed as a Novice in 1975. An electrical engineer, most of his career involved the federal government and the Department of Defense in some way. He's an Air Force vet and retired from IBM in 2013 to focus on his YouTube channel at **www.youtube.com/user/davecasler**. Dave's channel also includes training videos for Technician-, General-, and Amateur Extra-class licensees. Dave's training videos follow the ARRL license manuals section for section and chapter for chapter. Dave focuses on the technical material and background information, and deliberately does not teach the test, so his videos are a supplement to the ARRL license manuals. Dave has been an ARRL member for over 40 years. Dave lives with his wife, Loretta, KBØVWW, near Ridgway, Colorado. See his website at **www.dcasler.com**. He can be reached at **ke0og@arrl.net**.

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Military Mast Problems and Solutions

Stabilize your portable mast with these simple steps.

Bob Dixon, W8ERD

Many of us use military surplus masts and tripods to hold up antennas, especially in portable situations. They work very well, but these masts have potential stability problems, because the adjacent mast sections and tripod are held together by their weight and by friction alone. If the mast is tilted by the wind or pulled by a wire, the mast joints and tripod can separate, and the entire structure can fall down catastrophically. Also, if you have a rotatable antenna on the mast, the mast sections can slip and rotate the antenna, or make it difficult to turn.

These problems can be fixed by pinning all the mast sections and the tripod together at their joints and fastening the tripod firmly to the ground. See **p1k.arrl.org/pubs_archive/138962** and **www.arrl.org/files/file/QST%20Binaries/Jun2011/QS0611Dixon.mp4** for more background on this.

How to Pin the Joints Together

I used 5⁄16-inch hitch pins, available on **amazon.com**. To use these pins, you must drill holes through both ends of all the mast sections, and all three legs of the tripod.

You should not just drill the holes at random, because then the various joints might not fit together. Instead, drill all the holes carefully so that all the mast sections and the tripod are interchangeable and will fit together, regardless of which ones you choose. To allow for flexibility and to make inserting the pins easier, make the holes slightly oversized at 3⁄8 inches. The holes in the female ends must all be at exactly the same distance from the end, and they must be exactly straight through, not at an angle. I used a drill press with a jig to hold the mast or tripod precisely in place while drilling. You can make your own jig, but I chose to buy mine, so it was extremely accurate. The jig comprises a V block and an end block, which controls how far the hole is from the end. Both pieces can be found online.

These problems can be fixed by pinning all the mast sections and the tripod together at their joints, and fastening the tripod firmly to the ground.

Bolt the V block and the end block to the drill press table. The various holes in my jig and block did not line up neatly, but I was able to jiggle them around to find a few mating holes. I used 1⁄4-inch bolts, nuts, and flat washers. Secure the bolts very tightly, because these blocks are the master standard for all the holes to be drilled, and they must be all the same.

Position the drill press table so that when the drill bit is lowered, it fits neatly into the bottom of the V block. That will ensure that the holes will be through the center of the masts (see Figure 1). Lock the table into place.

The tripod is the most complicated and difficult component to drill, so I drilled it first. It then serves as the standard for the masts. Position one leg of the tripod into the V block, and up against the end block. Drill the hole as far from the end as possible, with the drill just clearing the vertical leg of the tripod. I used Bullet drill bits, which make drilling much easier because they have a tip that acts as a center punch and pilot hole driller. Alternatively, I suggest drilling a small pilot hole first (see Figure 2).

Figure 1 — The V block and end block.

Figure 2 — Positioning a tripod leg for drilling.

Figure 3 — Drill the hole through the female end of the mast by drilling through the existing hole in the male end.

For the first set of holes, I suggest using a procedure that is self-checking to be sure you are on the right track before proceeding with all the holes. Drill the hole all the way through the tripod leg. Remove the tripod from the jig. Position the female end of a mast section into the jig. This not easy, because the other end of the mast section hangs out onto the air, making it very difficult to operate the drill press while holding the mast. Have a helper hold up the far end of the mast. To make that accurate, be sure the drill press is level. Your helper should use a small level to keep the mast exactly horizontal.

Next, drill the hole all the way through the mast section. Remove the mast from the jig. Insert the male end of another mast section into the end of the female end you just drilled. Tape the joint temporarily (see Figure 3), so it does not move during the flip below.

Set the joint loosely on top of the jig. Drill passing through the outer mast hole to make a hole in the inner mast. Do not go all the way through to the other side of the mast, as this might not be straight through. Now flip the mast joint over and drill the hole through the other side. Remove the tape.

Now is the time for the crucial test. Put the male end of the mast you just drilled into the tripod leg that was drilled previously. The holes should line up almost exactly. If not, something is wrong, and you need to investigate your procedure. If the holes line up, you are ready to drill all the holes through all the tripod legs and masts in a more production-like manner.

If the holes do not line up exactly, but the pin still goes in, there is no problem. If the pin does not go in, you may need to drill a bigger hole. The end result looks like Figure 4.

Figure 4 — The mast after holes are drilled and the hitch pins inserted.

Figure 5 — Threaded eye bolt is screwed into a threaded hole in the vertical leg of the tripod.

Figure 6 — A view of how the tripod rope tightener and ground anchor are connected together using paracord.

Tripod Improvements

Drill and tap three ¼-20 holes around the tripod (see Figure 5). Screw in the eye bolts, which will prevent rotation of the mast, and they provide a place to loop around the tie-down cord.

Obtain an orange spiral screw ground anchor (available on **amazon.com**; see Figure 6). This is screwed into the ground below the tripod and tied above to the eye bolts with a cord. I recommend 550-pound paracord. The anchor prevents the tripod from lifting up or tipping over, whereas a typical tent stake does not resist vertical force.

Use a cord tightener to make it as tight as possible. I recommend the "Nite Ize Figure 9 Rope Tightener," which can be purchased online. Nite Ize also has a video on how to use the cord tightener, which can be found at **www.youtube.com/watch?v=hClHlj62t7A&feature=youtu.be**.

Figure 6 shows a view of how the tripod, cord tightener, and ground anchor are interconnected by the cord. Screw the anchor into the ground below the tripod. String the cord through the tripod, tightener, and anchor. Pull on the free end of cord as strongly as possible to tighten everything. Clamp the cord in the serrated teeth of the tightener.

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Ed Jones, K8MEJ, and Wally Kenyon, W8WLK, provided helpful ideas for this article.

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Steve Ford, WB8IMY, wb8imy@arrl.net

Eclectic Technology

Summits Via Satellite

The Qatar-OSCAR 100 satellite (QO-100) is the only spacecraft in geostationary orbit that carries an amateur radio transponder. From its position 22,000 miles away from Earth, the satellite "sees" almost the entire eastern hemisphere, including the UK.

Last spring, two British amateurs, Andrew Holland, G4VFL, and Nick Gregory, GØHIK, took advantage of QO-100 to successfully achieve a Summits on the Air summit-to-summit contact via satellite, possibly the first of its kind. Andrew was atop Holme Fell, while Nick was on Kirkby Moor. Both stations were using similar gear, including Yaesu FT-817 transceivers, microwave transverters, and 50-centimeter parabolic dish antennas. While contacts via terrestrial repeaters are not valid for Summits on the Air, contacts via satellite are permitted.

Figure 1 — Andrew Holland, G4VFL, established his OSCAR 100 satellite station on Holme Fell.

Figure 2 — Nick Gregory, GØHIK, set up his equipment on Kirkby Moor.

Packet Radio is *Not* Dead

Packet radio remains very much alive, especially for public service applications, and Chris Lance, WW2BSA, has created an interactive map that displays information for packet stations throughout the US and Canada. Visit his website at **www.ww2bsa.org**, then click on the link to access the map.

For the past 2 years, Chris has been compiling a list of Winlink, maildrop, BBS nodes (yes, a few are still out there), DX PacketClusters, and RACES/ARES packet stations for his online directory. The total number of stations now stands at more than 1,300.

Mark J. Wilson, K1RO, k1ro@arrl.org

Product Review

RFinder B1 Dual-Band DMR/FM Transceiver with Android Smartphone

Bottom Line

The RFinder B1 combines a dual-band DMR and FM handheld and Android smartphone into one highly capable package. The RFinder application eliminates the need for a DMR code plug, making operation easier.

Reviewed by Pascal Villeneuve, VA2PV
va2pv@arrl.net

The RFinder B1 is a modern Android smartphone, and it's also a DMR/FM dual-band handheld transceiver. I'm not sure which category this radio falls into, because it does so many things. This review will focus on the ham radio features, but the basic cellular phone features will be covered as well.

The RFinder B1 combines a smart cell phone and a radio into one piece of equipment that's about the size of a typical smartphone, but thicker. The unit requires the RFinder application, which allows the radio to be configured very easily using the integrated GPS location feature with the RFinder repeater database. For DMR, this capability removes the need to keep a code plug up to date, as you only need to select the talk group (TG), the color code (CC), and you are good to go.

Overview

The RFinder B1 supports DMR and FM modes on 2 meters and 70 centimeters, one band at the time, with a maximum transmit power of 4 W on both bands. It has a 4-inch touchscreen and is resistant to dust and moisture (the radio complies with the IP67 standard). Unlike most smartphones, this unit has a large removable battery on which you can attach a belt clip or optional swivel belt loop. The 7.2 V, 2,500 mAh battery can last a long time (more than a day) as a standby phone, and a little bit less when monitoring the bands with the radio application on. With two batteries, you should never run out of power, as they can charge without the radio in the desktop charger.

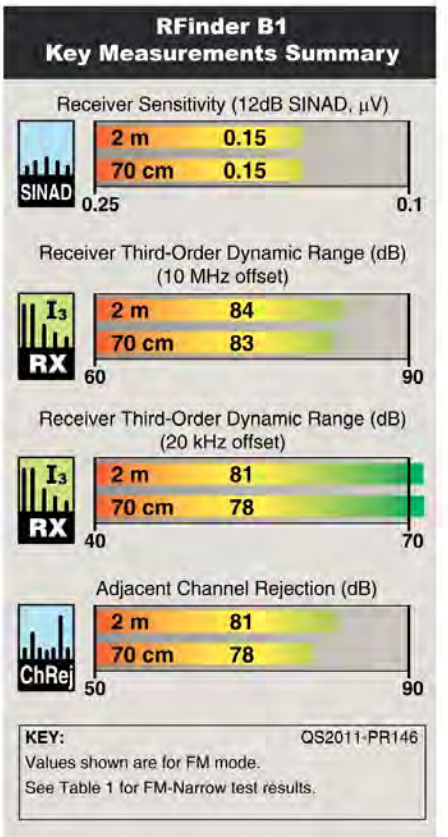
The package includes the B1 transceiver, a screen protector, a battery, a standard belt clip, a hand strap, a USB-C cable, and a desktop charger with the ac adapter. You can buy optional accessories, such as spare batteries, a speaker-microphone, a swivel belt loop, and a 13.8 V cigarette lighter power cable. (This cable needs to be used with the desktop charging cradle, not directly with the radio.)

The documentation does not say how much the radio supports in terms of memory channels, DMR talk groups (TG), digital contacts, and radio IDs, but with the RFinder app, it's irrelevant because it uses the phone's memory. The device has 4 GB of RAM and 64 GB of internal storage, plus you can add two microSD cards up to 128 GB each. You won't run out of memory with the B1.

Table 1
RFinder B1, serial number S202001130395

Manufacturer's Specifications	Measured in ARRL Lab
Frequency coverage: 136 – 174, 400 – 470 MHz.	Receive and transmit: 136 – 174, 400 – 500 MHz.
Modes: FM, FM-N (FM narrow), DMR Tier II.	As specified.
Power requirements: 7.4 V dc, 2,500 mAh removable battery.	As specified.
Receiver	**Receiver Dynamic Testing**
FM sensitivity: Not specified.	For 12 dB SINAD: *FM* / *FM-N* 146 MHz 0.15 µV / 0.13 µV 162 MHz 0.15 µV / 0.13 µV 440 MHz 0.16 µV / 0.14 µV
FM two-tone, third-order IMD dynamic range: Not specified.	20 kHz offset (FM/FM-N): 146 MHz, 81/83 dB 440 MHz, 78/80 dB. 10 MHz offset (FM/FM-N): 146 MHz, 84/85 dB; 440 MHz, 83/84 dB.
FM two-tone, second-order IMD dynamic range: Not specified.	146 MHz, 73 dB; 440 MHz, 83 dB.
Adjacent-channel rejection: Not specified.	20 kHz offset (FM/FM-N): 146 MHz, 81/83 dB; 440 MHz, 78/80 dB.
Squelch sensitivity: Not specified.	At threshold: 0.05 µV (min), 0.18 µV (max). Squelch range is very limited.
Transmitter	**Transmitter Dynamic Testing**
Power output: 4 W.	High/Low power at full charge: 146 MHz, 3.6/1.2 W; 440 MHz, 4.0/1.7 W.
Spurious signal and harmonic suppression: Not specified.	(High/Low power): 146 MHz, 65/51 dB; 440 MHz, >70/>70 dB. Meets FCC requirements.

Size (height, width, depth): 6.3 × 2.2 × 1.3 inches (including protrusions). Belt clip, add 0.5 inches to depth. Antenna, 6.5 inches. Weight: 15.6 ounces with belt clip and antenna.



Physical Description

This radio doesn't look exactly like a typical smartphone or handheld transceiver. Excluding the external antenna, the B1 is smaller than my iPhone XS Max, but is almost four times thicker. It's heavy — almost 1 pound with the antenna, battery, and belt clip — but I was able to use the B1 for a long time without feeling too much fatigue in my hand and arm.

This radio is very solid. I used it for a few months, and I dropped it several times by accident. Once, it fell 5 feet, right onto the outside metal doorstep of my shed with the display facing down, and there wasn't any damage or scratches. With the antenna, the B1 is about 12 inches long, so when it is standing vertically it does not take much force to make it fall over.

Figure 1 shows several views of the B1.

Front: The 4-inch IPS color touchscreen dominates the front, with the three typical Android buttons below. On the top left corner of the screen, there is a five-megapixel front camera.

Rear: At the top right, there's a 13-megapixel camera

Figure 1 — Two views of the RFinder B1.

that can record full HD video (1,920 × 1,080 pixels, 30 frames per second) and an integrated flash that is also a flashlight.

Left side: The top two buttons are for push-to-talk (PTT). The top button is for the radio, and you can use the other to operate half-duplex communication applications, such as Zello, which lets you use your phone as a walkie-talkie. Below there's a fingerprint sensor to unlock the phone. The sensor works okay, but it is not always responsive.

Right side: The connector for the optional external speaker-mic has no cover, so the pins are exposed, but the manufacturer said it's still IP67 weather resistant. There are up and down volume buttons and a USB-C port under a rubber cap. The USB port can only be used to connect the unit to a computer — it does not charge the battery.

Top: The dual-function step knob toggles between volume control or channel selection in the RFinder radio application, and on the other side, there is an inside-thread SMA male connector for the radio antenna. The GPS antenna is also on top, in between the knob and the radio antenna, under a cover with a satellite image engraved into the case.

Bottom: There is a latch to remove or secure the battery.

Under the battery: There is a rubber door that flips up to expose four slots, two for cellular service SIM cards and two for microSD memory cards.

Operation on the Air

The B1 is different from other DMR radios because it doesn't require CPS programming software for configuration. Instead, it uses its own RFinder application database from the internet. You can use it on a Wi-Fi network or on your cellular connection if you have a data plan. You can download and store your regional repeater database into the B1, if you need to use it offline. Another nice feature is that you can store your memories in the cloud, and you can restore them from the internet later. You can transfer any repeater found in the database to the B1's memory or create your own repeater listing. Unfortunately, there's no scanning feature in the RFinder application.

Figure 2 — The RFinder B1 application's main window.

Because the B1 relies on an Android application for operation, you will need a Google account to update the RFinder app. Just like all the other DMR radios, a DMR ID is required for operation in this digital mode (no charge for an ID; see **www.radioid.net**). You will also need a subscription to the RFinder application to use the radio. The software is preinstalled, and you can upgrade to the latest version using the Google Play Store.

The RFinder app comes with a free 30-day trial, but after that, you will need a subscription that costs $12.99 per year. It's a good value, considering that you always have access to the latest repeater and DMR ID databases. The first time you open the app, you will have to register before operating the radio. The app will ask for your DMR ID the first time you set the radio in the DMR mode.

The RFinder application main window is split into two sections — VFO settings on top and a list of nearby repeaters from the database at the bottom (see Figure 2). When in DMR mode, you can toggle to promiscuous (PROM) mode in the top section if you want to monitor all the TGs available on the repeater. There's also an **OPTION** button to activate minor settings.

The repeater database includes listings for repeaters on 10 meters through the UHF bands, and all modes including FM, DMR, D-STAR, and YSF. It's possible to filter the data for only the bands and modes supported by the B1, and that's what I did. Note that the screen is only showing DMR and FM repeaters on 2 meters and 70 centimeters.

At the bottom of the screen shown in Figure 2, three are different ways to sort the repeaters — by distance (**DIS**), frequency (**FREQ**), or repeater call sign (**CALL**). Next to **CALL** is a button to turn the radio on and off; it's grayed out when off and red when on. Next to that is a volume level indicator, adjusted using the knob on the top of the B1. You can toggle the knob between volume and memory channel by touching the indicator on the screen. If you touch **MAP**, it will show the repeaters on a map.

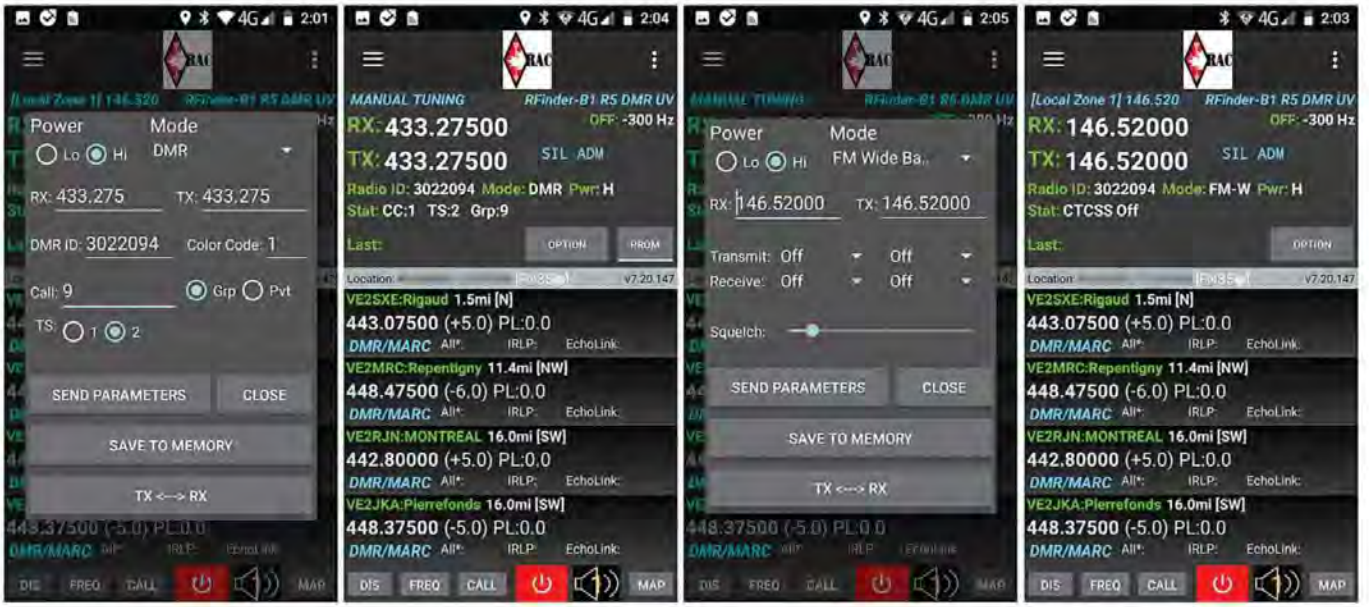


Figure 3 — Left to right, the DMR VFO setup screen, the applied DMR configuration from the setup screen, the FM VFO setup screen, and the applied FM configuration from the setup screen.

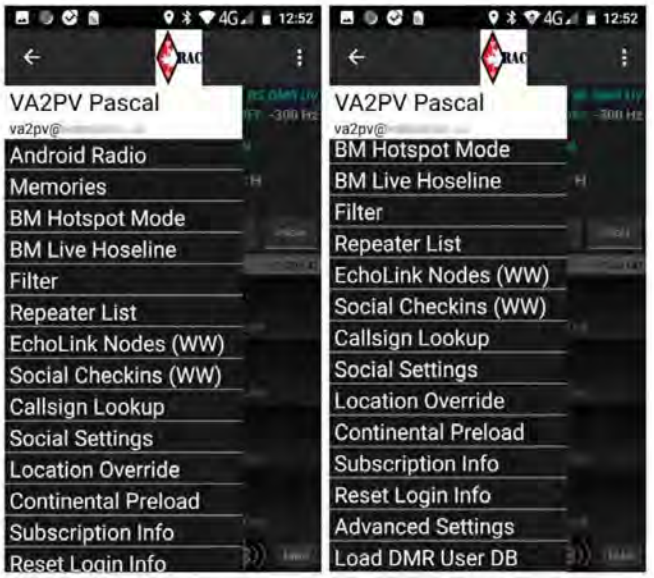


Figure 4 — The RFinder B1 menus.

Changing frequencies is easy and intuitive. Touch the top part of the screen (VFO), and it will pop up a window for manual settings. The fields will change depending on the mode, as shown in Figure 3. You must send the configuration to the radio before it's effective, and you can save the configuration in a memory. When finished, close the window manually.

When you touch the three lines on the top left corner of the screen, it will pop up the app menu (see Figure 4). Here's the description from top to bottom.

Call Sign, Name, and Email — your subscription information.

Android Radio — pops up the VFO window, same as touching the top of the screen.

Memories — to access your saved memories.

BM Hostpot Mode — call channel for your DMR hotspots to use with the Brandmeister network.

BM Live Hoseline — to listen to the latest activities on the Brandmeister network via the internet.

Filter — to filter bands and modes from the database.

Repeater List — update the repeater list on the bottom half of the screen.

EchoLink Nodes (WW) — repeater list with an EchoLink node.

Social Check-ins (WW) — If you log into Facebook from the app, your repeater check-in will be posted to your timeline. Your friends who follow you will now see your check-in on their newsfeed. If you choose to post to APRS, you will show up on APRS, and if you connect to an EchoLink node using the integration with the EchoLink app, your posting on APRS will be both local to you and local to the remote repeater. I did not test this feature.

Call Sign Lookup — search for the name and address for a call sign.

Social Settings — choose how to share your repeater check-in with APRS.

Location Override — Many app features require a GPS location, but if you're operating from an area with no GPS signals (such as from a basement), you can enter your location manually.

Continental Preload — to download your region's database into the B1 memory (for example, North America).

Subscription Info — your RFinder app subscription details, including the expiration date.

Reset Login Info — to restart the registration process. It will recognize your subscription with your email if you've already subscribed.

Advanced Settings — such as the offset for DMR (–300 Hz recommended). You will also find the OS version running on your device in this menu tab.

Load DMR User DB — to download the latest DMR ID database into the radio.

Figure 5 — The RFinder B1 Android 8.1 interface.

I tested the radio in both analog and digital modes, on both bands, using simplex, and on repeaters. It performed well in all situations and the receiver sensitivity is on par with the best amateur radio handheld I own. At first, I noticed some kind of digital DMR interference in my audio during a contact on a local repeater. This was solved by adding an offset of –300 Hz in the Advanced Settings menu.

I found one compromise compared to a standard handheld. The B1 uses an app to operate the radio, which makes changes slower to apply — even adjusting the squelch. However, with the app, you don't have to maintain a code plug, so I think the advantages outweigh the disadvantages.

The RFinder B1 application did crash on me several times, always when applying new configurations and never when operating. In the past 6 months, there were several software updates, and I'm hopeful that the future software versions will bring more stability and probably new features.

RFinder B1 as a Smartphone

The RFinder B1 runs on the common Android operating system (Android OS, see Figure 5). If you're familiar with this platform, setting it up will be easy — it's all the same, except for the dual-band radio, which has its own application.

I use an iPhone XS Max as my personal and professional cell phone, and it's the only smartphone I had on hand to compare with the B1. At first glance, I noticed that the B1 is bigger and heavier than the iPhone XS Max, and the B1's display is smaller and offers lower resolution. The iPhone weighs about 7 ounces while the B1 weighs about 15 ounces. The iPhone screen is 6.5 inches, 1,242 × 2,688 pixels versus 4.0 inches and 640 × 1,136 pixels for the B1.

The RFinder B1 uses the Mediatek 2 GHz version of the MTK6763 processor (the MTK6763V) that has eight cores. The MTK6763 was launched in 2017, so this processor is a little bit behind technologically, but is still a good choice. The B1 includes an LTE modem that supports dual-SIM (two SIM cards that can be used for separate networks). When using the B1, I noticed that it was sometimes slower to respond compared to my iPhone (which uses a newer processor) when running the same application (game), but the difference was not a showstopper.

The bottom line is the RFinder B1 is a very capable smartphone, but if you're planning on getting one to replace your current cell phone, you need to be certain that it's compatible with your network provider. Although the B1 is a global version that supports many cellular frequencies, it may not be compatible with all the cellular bands used by your provider, which may affect coverage. If you're not sure, check with your cell phone company and RFinder before buying.

These are the supported bands for the B1:

- 2G: GSM 850/900/1800/1900
- 3G: WCDMA 850/900/1900/2100
- LTE-FDD: B1/B2/B3/B4/B5/B7/B8/B17/B20
- LTE-TDD: B38/B39/B40/B41

For those not familiar with cellular terminology, 2G is the second generation network, 3G is the third generation, 4G is the fourth generation (also called LTE for Long-Term Evolution), and 5G is the newest generation.

The B1 requires a micro-SIM card, but my iPhone uses a smaller nano-SIM. In order to test the B1, I needed an adapter, which I found online for a few dollars. (Both SIM slots on the B1 are the same size.)

Technical Support

I consider myself an advanced user when it comes to digital modes, such as DMR, but the RFinder B1 confused me a bit. Before upgrading any of the software or firmware, make sure you understand the types of upgrades that are possible with this device. You can upgrade the Android OS version. You can upgrade the custom-build version with the FOTA (firmware over the air) upgrade, but this could be blocked by your internet or 4G provider, and it may be necessary to download the file manually.

RFinder recommends using their Facebook page to exchange information, ask questions, obtain the latest upgrade files, and request technical support. You will find the official Facebook group by searching for "RFinder Android Radio" or following this link: **www.facebook.com/groups/328426600855938**. You can also communicate with the company by phone or email.

Conclusion

The RFinder B1 is in a class of its own. Once you get used to using the application, it's extremely easy to operate. For DMR, it's the easiest and fastest way to get on the air, because there is no need to create or locate a code plug.

I could use the B1 as a daily cell phone, but I don't think that I would like to carry it on the job, as it's too large to fit into a pocket. On the other hand, if I were traveling and I needed a waterproof, rugged phone that can be used in the field for 16 hours without a recharge, the B1 with two spare batteries would be a very good choice. Plus, I could operate ham radio during my breaks. For travel, the B1 and RFinder app make it easy to quickly find and program nearby DMR and analog FM repeaters.

Larger versions of the illustrations in this review may be found at **www.arrl.org/qst-in-depth**.

Manufacturer: RFinder, 455 Sunrise Hwy., W. Islip, NY 11795; **www.rfinder.net** and **androiddmr.com**. Available in the US only at **gigaparts.com** and in the UK/EU only at **moonraker.eu**. Price: $999.

Visit https://youtu.be/meygFdrP_aw to see our review of the RFinder B1 Dual-Band DMR/FM Transceiver with Android Smartphone on YouTube.

Koolertron Dual-Channel DDS Signal Generator

Reviewed by Paul Danzer, N1II
n1ii@arrl.net

In my workshop, I have two simple signal generators, both with the same limitations: 1) They have a single output, and 2) after setting the frequency and waveform, there is no confirmation that the generators are actually supplying the waveform selected. The Koolertron GH-CJDS66 signal generator reviewed here overcomes both of these limitations. It has two output channels, and the front-panel color display offers a lot of information about the output signals.

This unit generates sine, square, triangle, pulse, digital, and arbitrary waveforms. In addition, it can measure frequency, count input signal values, and count pulse values including width and period. Sweep is selectable — both linear and log. The instructions include three pages devoted to listing the various operating mode capabilities.

The frequency accuracy is stated as ±20 ppm (parts per million) and the frequency stability as ±1 ppm over 3 hours. Waveform length is 2,048 points (total number of "pieces" a waveform can be synthesized from) and the sampling rate 266 MS/s (million samples per second). Vertical resolution is 14 bits (2^{14} = 16,384).

In the Box

The unit comes as a complete kit. The two output probes, one for each channel, have BNC connectors on one end, and red and black insulated alligator clips on the other. A third lead with BNC connectors on both ends is included. The ac power supply is a wall cube. A USB cable is supplied for connection to a PC, and a miniature CD-ROM contains the companion software.

The rear panel has an additional connector, but I didn't see any information about it. The instruction manual is very sparse, filled mostly with detailed specifications.

When set to generate a waveform, the 2.4-inch TFT color LCD confirms the settings and displays the selected waveform. It also serves as the readout for the measuring capabilities. The enclosure measures approximately 2.7 × 7.6 × 7 inches.

Each channel has its own BNC output port, and a separate BNC connector on the panel handles the measuring functions. Several similar models are available from this manufacturer. They differ mostly in the maximum sine wave frequency that can be generated — 15, 30, or 60 MHz. However, all versions are limited to 15 MHz for a square wave and 6 MHz for digital waveforms. Similar units are available from online vendors in different packages under several brand names.

Installation

The Koolertron signal generator requires no installation or calibration to use it standalone, controlling it from the front panel. Plug the power supply into an ac socket, press the large on/off button (lower left), and it is ready to use. You can choose labels in English or a Chinese dialect.

Bottom Line

The Koolertron GH-CJDS66 can generate a variety of waveforms and also measure frequency and other signal parameters. Although you can control all functions from the front panel, the unit is easier to use with the companion software.

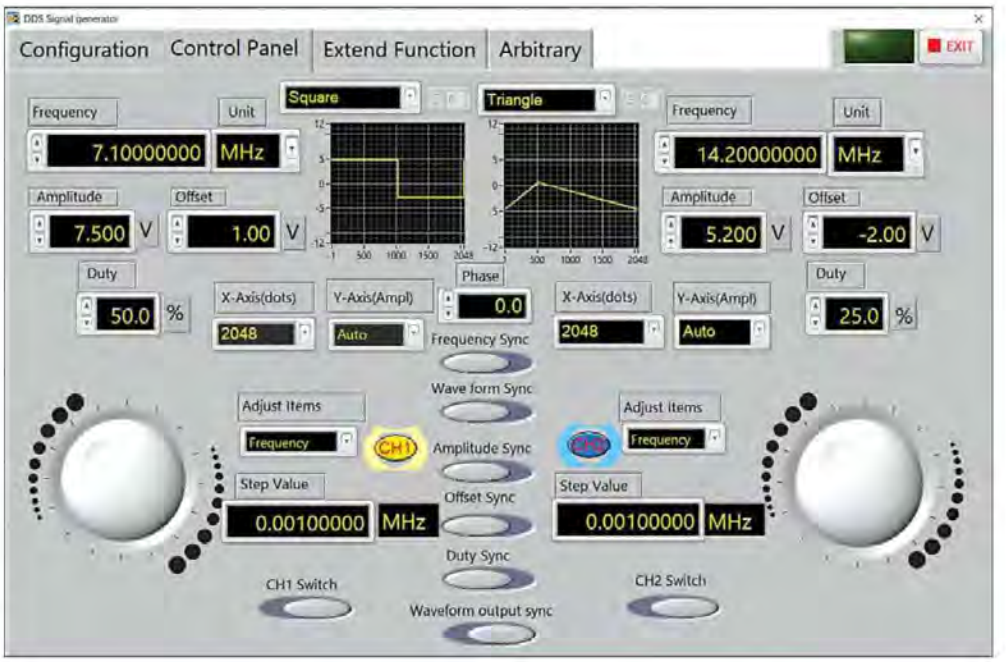


Figure 6 — The software control panel. Channel 1 settings are on the left and Channel 2 on the right.

As sometimes happens with software translated from another language into English, I had a little difficulty figuring out the installation and configuration process. Fortunately, buried in the software was an email address for support. An email to that address brought a response in a day or two, along with a link to another set of software. Note that the installation routine also downloads and installs the National Instruments *NI-VISA 5.4* instrument driver, Microsoft *Silverlight,* and Microsoft C++, which took quite a while.

Once I succeeded with the software installation, my PC displayed the screen shown in Figure 6. More information on my experience with the software installation may be found at **www.arrl.org/qst-in-depth**.

Basic Functions

The front-panel LCD screen is divided into three sections (see Figure 7).The top left shows the settings for one channel with text and an illustration of the selected waveform. The lower left shows a text description for the second channel. Either output channel (1 or 2) can be routed to the top or bottom area. On the right side of the screen are the function labels for the five front-panel buttons (soft keys) adjacent to the screen.

The LCD is not an oscilloscope screen. The illustrations are just that — pictorials of the selected waveforms. Generally, changing the parameters of a waveform (amplitude, offset, frequency) does not change the illustration, except for the CMOS waveform, which is a square wave that changes height with amplitude adjustment. The accompanying text, however, does change to reflect your adjustments.

The first step is to press ether the **CH1** or **CH2** button to make that channel primary. Your selections for this channel will now show in the top section of the screen, and your selections for the other channel show in the lower section.

Waveform selection is next. Press **WAVE** and the top center message turns red, and the text in this message describes the waveform selected. Turning the knob on the right selects the waveform. Choices include sine, square, pulse, triangle, and CMOS. Once the waveform is selected, its frequency, amplitude, offset, duty cycle, and phase can be set using the push-buttons next to the screen.

Figure 8 shows the output of the Koolertron signal generator viewed on an oscilloscope. Signal generator settings are as shown in Figure 7. In this example, Channel 1 is set to generate a square wave, 7.1 MHz, 7.5 V, +1 V offset, and a 50% duty cycle. Channel 2 is set for a triangle wave, 14.2 MHz, 5.2 V amplitude, –2 V offset, and a 25% duty cycle.

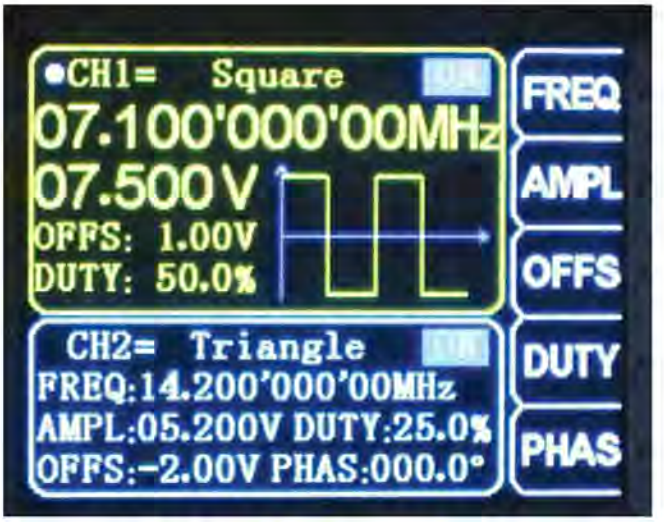


Figure 7 — The signal generator LCD shows both channels simultaneously. Channel 1, set to a 7.1 MHz square wave, is on the top. Channel 2, set to a 14.2 MHz triangle wave, is on the bottom. At the right are labels for the row of soft keys to the right of the display.

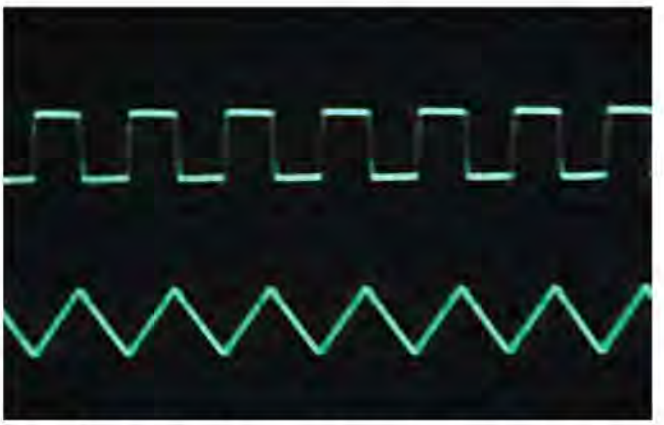


Figure 8 — The signal generator output viewed on an oscilloscope, with the settings in Figure 7.

Other Waveforms

Selecting **PARTIAL SINE** produces a waveform pretty much like a conventional sine wave. If **DC** is selected, the dc value does not change with the amplitude control, but does vary with the **OFFSET** control. **HALF WAVE** and **FULL WAVE** look like the output of a half-wave rectifier and full-wave rectifier. **POSITIVE LADDER** and **NEGATIVE LADDER** produce ladder waveforms whose frequency, amplitude, and offset can be controlled.

One interesting selectable output is **NOISE**, intended to be similar to an analog noise source. As seen on an oscilloscope, there is a random set of voltages whose frequency, amplitude, and offset can be controlled.

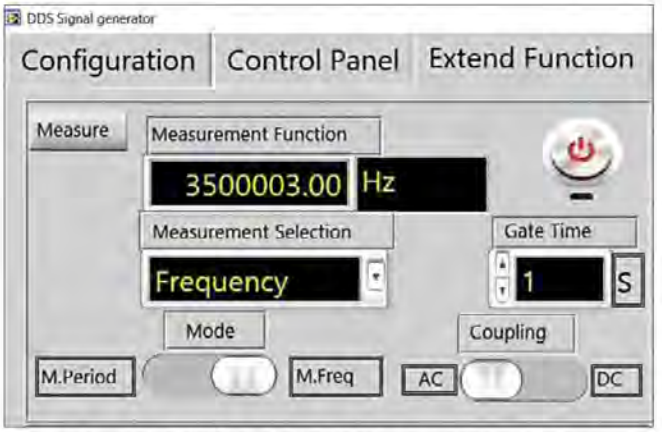


Figure 9 — The **EXTEND FUNCTION** tab allows the unit to be used for measurements. Here, frequency measurement is selected.

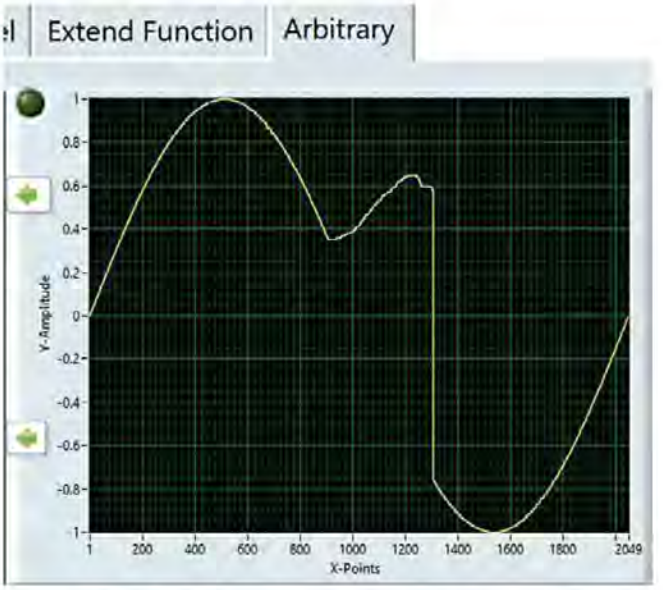


Figure 10 — The Arbitrary Waveform function allows creation of custom waveforms. Here, a modified sine wave is set to take up the full screen, 2,047 points. If the width is set to a lower value, several such waves can be generated.

EXP-RISE and **EXP-DECAY** are a set of pulses. **EXP-RISE** has an exponential leading edge on the pulse and a rapid return to the base value (fast fall time). **EXPDECAY** is the complement. The pulse appears to shoot straight up (fast rise time) and decays exponentially.

On an oscilloscope, **MULTI-TONE** looks like the dual-frequency output from pressing a button on an old telephone keypad. The frequency of the lower tone is adjustable using the front-panel buttons, but the frequency of the second tone is not.

On the LCD, the **SINC PULSE** waveform looks like a spectrum display of a narrow pulse. On the scope it is a train of spectrum-like pulses. A number of explanations of the **SINC** waveform can be found by searching online. It appears to be a waveform used in advanced filter design. Another advanced waveform, **LORENZ PULSE**, is also available.

Finally, there are 15 memory channels that can be programmed with waveforms of your choosing.

Counter and Measurements

Pressing the **MEAS** button switches the unit from generating signals to making measurements. The **EXT.IN** BNC connector provides an input connection. The soft switch labels on the LCD list various measurements you can make. Figure 9 shows a portion of the measurement screen in the PC software. The input frequency is 3500003.00 Hz, or 3.5 MHz. The gate size may be changed and the coupling is selectable between ac and dc. There are several choices for the **MEASUREMENT SELECTION** dropdown menu. Changing this selection from **FREQUENCY** to **CYCLE** produces a reading of about 2.857 microseconds. Other choices for measurement are positive pulse width, negative pulse width, and duty cycle.

Set Your Own Waveform

Selecting the **ARBITRARY** tab allows you to design your own waveform. Unfortunately, there are no useful instructions in the information booklet, but I did find a helpful online tutorial at **www.faceclips.net/video/dDGUn-ocnMg/koolertron-si.html**.

Figure 10 shows a modified sine wave that I created by placing my mouse cursor on the waveform and dragging it up and to the right. Then I stored the modified waveform in **STORAGE LOCATION 1**. You can also use the mouse to hand-draw any waveform you want.

Final Thoughts

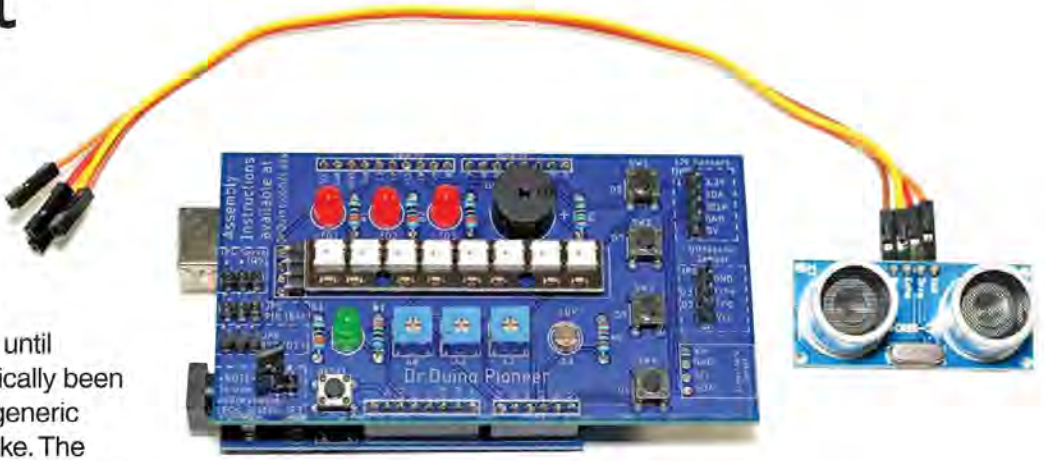
The Koolertron dual-channel signal generator offers a number of useful features for the amateur workshop. If you don't need to generate sine waves at 60 MHz, 15 and 30 MHz models are available at lower cost.

Additional illustrations for this review are available from **www.arrl.org/qst-in-depth**.

Manufacturer: Koolertron, **www.koolertron.com**. Available from several online sources. Price (Amazon): $149.95.

Dr.Duino Pioneer Edition Arduino Project Kit

Reviewed by Glen Popiel, KW5GP
kw5gp@arrl.net



One of the most common questions I'm asked about the Arduino is where to buy a good starter kit. Up until recently, my answer has typically been to search online and find a generic Arduino starter kit that you like. The Dr.Duino Pioneer Edition is part of a new series of products from Dr.Duino, the maker of the Dr.Duino Arduino Uno Starter Kit that I reviewed in the October 2019 issue of *QST*. The Pioneer Edition is an Arduino shield (see the sidebar, "Arduino Shields") that includes several of the most commonly used Arduino components. With these components on board, you can learn how to create basic Arduino projects, all mounted on a compact single-board development platform. The Pioneer comes as an easily assembled kit, and it includes an Arduino Uno-compatible board.

The Pioneer Edition is essentially a scaled-down version of the original Dr.Duino starter kit. The Pioneer kit (see Figure 11) has three red LEDs, a piezo buzzer, four pushbutton switches, a light dependent resistor, and an LED strip containing eight addressable RGB (red-green-blue) LEDs, all on one Arduino shield. The Pioneer also has header pins on board to connect to other devices, such as the included ultrasonic sensor.

The 81-page online assembly and user guide is well-written and includes a number of detailed color photos. The easy-to-follow step-by-step assembly guide includes a section on how to install the Arduino IDE programming software and USB port drivers needed to upload your sketches (Arduino programs) to the Pioneer, along with how to install the Arduino libraries used by the Pioneer sketches. Throughout the manual, there is an emphasis on customer support, and the manual lists many possible issues and solutions to those issues you may encounter as you construct the kit. Assembly of the Pioneer went smoothly, taking about 2 hours to complete. Dr.Duino also offers an online helpdesk ticket system to assist you if you have any problems.

The Pioneer kit includes five demo projects, along with an automatic test procedure (ATP) sketch that tests all of the functions of the completed Pioneer board. I really liked the idea of the ATP sketch as a way of knowing that the board works as it should before starting to build projects. What I like about all of the demo projects is that they are interesting and fun, while at the same time teaching how to use the various components and features of the Pioneer.

The Pioneer PLUS Edition adds an "expansion pack" with an inertial measurement sensor, a sound effects

Arduino Shields

An Arduino shield is a board that has connectors around the edge that allow it to be mounted, or "stacked," on top of an Arduino Uno-style board. Stacking shields allows for the quick and easy addition of features and devices to Arduino projects. Multiple shields can be stacked on top of each other to add even more functionality.

Bottom Line

The Dr.Duino Pioneer Edition is a good starter shield to learn the Arduino without having to wire up external parts on a breadboard.

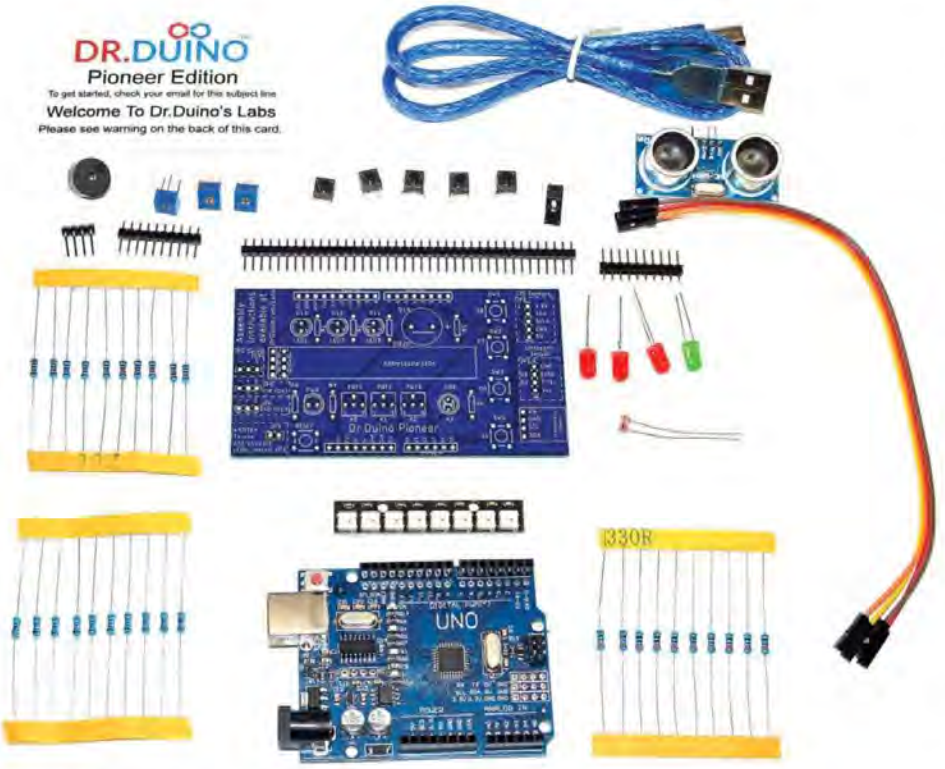


Figure 11 — The Dr.Duino Pioneer kit prior to assembly.

Figure 12 — The Pioneer PLUS Edition includes an expansion pack with additional sensors and cables.

module, a micro servo, an atmospheric sensor, and a passive infrared sensor, along with 120 breadboard and header connecting cables (see Figure 12). The Pioneer PLUS Edition also adds instructions for four more projects.

Included with the Pioneer Edition is a free 12-lesson Arduino video course from Programming Electronics Academy (PEA). Dr.Duino customers can also receive 20% off of PEA's paid Arduino course. For an additional $29.99, Dr.Duino offers the Education Package, which includes an additional five projects and a copy of *Arduino Course for Absolute Beginners* by Michael James. This is one of the better Arduino tutorials that I have seen and comes as a 298-page PDF and is offered during the checkout process. Also included is a postcard-sized "cheat sheet," with resistor color codes printed on one side and some basic Arduino programming information on the other.

I really like Dr.Duino's bundling of learning materials with their products, along with their emphasis on customer support. It's often difficult to find up-to-date learning materials for the Arduino, and Dr.Duino has done a nice job with their choice of instructional materials bundled with the Pioneer Edition. The Pioneer Edition is an excellent learning platform to begin working with the Arduino.

Manufacturer: Dr.Duino, **www.drduino.com/hamradio**. Price: Dr. Duino Pioneer, $99; Pioneer PLUS Edition, $129.

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

The Doctor is In

Some Vertical Antennas Need a Ground, Some Don't — Here's Why

Q Timothy, KD4IKY, asks: I would like to try a vertical HF antenna. There seem to be some that require a ground system and some that don't. Is there a reason to select an antenna that requires a ground wire system?

A There are two major types of tuned vertical monopoles — ¼-wave and ½-wave. These refer to the electrical properties, not always the physical length. In addition, a 43-foot non-resonant vertical used with a remote tuner is quite popular. Any can be used to good advantage.

A ¼-wave monopole either requires a large number (30 – 60) of buried (or on-ground) radial wires, or a small number (two to four) of elevated ¼-wave-long, resonant, insulated radials for each band, to work well. The radials act like the other half of a ½-wave dipole, so they're very important. Trap verticals usually operate as ¼-wave monopoles on multiple bands by separating sections with resonant traps. They can make use of buried radials of random length — the more and longer the better — or multiple elevated ¼-wave resonant ones, at least two per band. With coverage of a lot of bands, that can get rather busy.

Electrical ½-wave verticals act like a vertical dipole, so they don't require ground radials per se. Because they are usually end-fed, they do need short counterpoise rods, which look like radials but are usually only 4 – 6 feet long, to provide a connection point for the shield of the coax.

Either commercial ¼- or ½-wave monopoles generally offer a direct matched connection to coax, making for an easy feed arrangement. Unlike a horizontal antenna, a vertical does not require much height to work well. However, the ½-wave vertical raises the radiation center enough above the ground to provide a somewhat lower angle of the radiation peak — good for long distances — and also has the advantage of not being limited by the losses in the radial ground system that the ¼-wave requires.

Some have had good luck with a non-resonant 43-foot vertical. Unlike the others that can be fed directly with coax, the 43-footer requires a matching network or an antenna tuner — preferably at or near the antenna base — to work well, by providing a matched coax run to the station and avoiding the potential for the high loss of a mismatched coax run. Even with the extra hardware, the cost of the different options may be similar, because the 43-foot radiating element does not require any traps or tuned elements and can therefore simply be a length of wire or tubing. It will, however, also need a number of buried radials. The advantages are that it is electrically simple, without the gadgets on the antenna that can cause maintenance problems. It will also work the best of all on 20 meters, where it is the optimum height for low-angle DX work, ⅝ wavelength. It will also work quite well with a wide-range tuner on all bands from 80 through 10 meters, and probably at least as well as the others on most bands.

The ½-wave can be more efficient and simpler to install, with less of the surrounding ground taken up by complex ground systems, but is twice as high as the ¼-wave monopole, although the top can be bent at 90° if needed.

All things considered, if it were me, and I had room for radials, I would go with a 43-footer and a remote automatic antenna tuner. The cost will be reasonable if you run 200 W or less, but for high power you will need a high-power remote auto-tuner, which can get expensive. I guess for high power, I might go with one of the other options, probably the ¼-wave trap type. If you have no room or no interest in radials, one of the ½-wave types would also be a good option.

Q Bill, WA6SZE, asks: In a balanced two-wire transmission line, opposing currents cancel out fields and thus the line doesn't radiate. Given that, how is it that a two-wire folded dipole radiates?

A In a transmission line, the signal is applied at one end between the two wires — hence the fields from each wire are of opposite sense and cancel out, starting at a short distance from the line. In the antenna, the parallel antenna wires are connected together at their ends, so both wires have current in the same phase, and thus the fields add. Because each carries half the current, the total field is the same as it would be from a single wire; however, the parallel wires do act like a single thicker conductor, resulting in a somewhat wider SWR bandwidth.

Q Ron, WAØAJF, asks: I am debating installing either a 20-, 15-, and 10-meter rotatable dipole or the 20- through 6-meter Cobweb antenna from MFJ on a 55-foot tower. They would not be rotated, to avoid rotor expense and maintenance. I know the results I would get on the dipole, but have zero experience with the Cobweb. The 20-meter band would get the most use. Are these equal antennas on 20, 15, and 10 meters? Does the Cobweb favor any particular direction? Is there more loss in the matching circuit on the Cobweb?

A I happened to have reviewed the MFJ Cobweb as a *QST* Product Review item. That review should appear in an upcoming issue. I modeled the Cobweb at your height of 55 feet and compared it to a model of a two-band trap dipole. I would guess that the triband trap dipole would have about 0.5 to 1 dB additional trap loss on 20 meters. The ARRL Lab didn't measure the Cobweb's transformer loss, so my model doesn't include any losses for the MFJ transformer, but I would think they would not be very high — probably comparable to the loss of the traps in the dipole.

The Cobweb is not quite omnidirectional, but it has much more shallow nulls off the "ends" than a straight ½-wave dipole does. It is otherwise similar to a ½-wave dipole, with the maximum signal parallel to the fed side in both directions, but with a somewhat wider pattern, as shown in Figure 1.

Q Lee, K1LEE, asks: I see baluns described using different numbers, such as: 2:1, 4:1, 9:1, as well as others. What do the numbers mean, how are they determined, and how do we know which to use?

A The numbers refer to the impedance transformation ratios. While the primary function of a balun, or a common-mode choke, is to make a transition between an electrically balanced system (such as a center-fed dipole antenna) and an unbalanced system (such as coaxial cable, or an unbalanced antenna such as a ground plane), many baluns also provide an impedance transformation function.

Usually (but not always), the "1" side is designed to be connected to the unbalanced system, such as 50 Ω coax, while the other side is designed to be connected to the balanced load. So, for example, a 9:1 balun can be used to interconnect 50 Ω coax to a 450 Ω balanced transmission line, as shown in Figure 2. In some cases, a long transmission line run that would have high losses if run over 50 Ω coax will have significantly lower loss if transformed by a 9:1 balun at each end, with a long run of 450 Ω window line in between, but the small balun loss (typically less than 0.5 dB) needs to be part of the equation.

Often, you will see baluns used in wide-band non-resonant systems. For example, the popular center-fed Zepp antenna is just an 80- or 40-meter dipole used on multiple bands and fed by low-loss window line. The actual impedance at the bottom of the window line going into the balun will be different on each band, so the transformer will usually not be matched on any band. With luck, a length of line and a transformation ratio can be found that will allow an antenna tuner to match the system on any band. The point is that the baluns are not always connected to their design impedance loads.

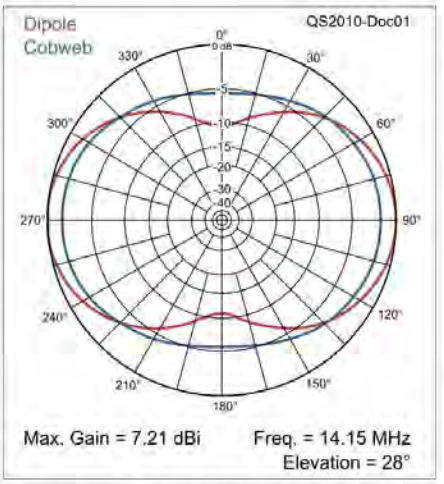


Figure 1 — *EZNEC* (**www.eznec.com**) azimuth plot of a model of the 20-meter Cobweb dipole (blue), compared to that of a straight-wire ½-wave-dipole (red). Both are at ½ wave above *EZNEC* medium ground. Note that while the Cobweb gives up a bit in the broadside direction, it has a wider azimuth coverage and gains considerably in the "off the ends" direction.

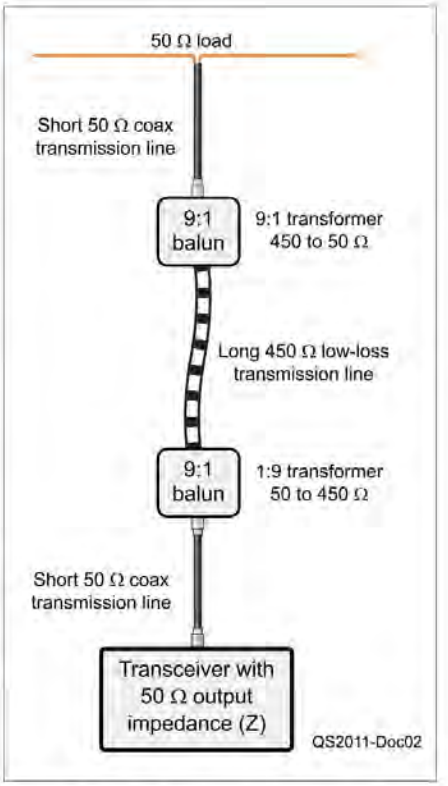


Figure 2 — An illustration of the use of window line, with 9:1 baluns at each end, to reduce losses in a long 50 Ω transmission-line system.

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

Listen to the archives of the *ARRL The Doctor is In* podcast on iTunes, Blubrry, Stitcher, or on the ARRL website at **www.arrl.org/doctor**.

Hints & Hacks

Install a Power Tap for Your Amplifiers; Bury a Stealthy Mast Holder

A Mast Holder That's Always Ready

If you often build and experiment with antennas, you know it can be a challenge to hold the antenna at an easy working level. I've seen sawhorses and custom-made fixtures being used, but here's an easy solution that will be ready whenever you need it.

First, find an area in your yard that you'll use as your antenna "workshop." Dig a hole and bury a short length of 2-inch inside diameter PVC tubing (see Figure 1). Make the hole at least 4 inches in diameter and deep enough to extend the tubing below the frost line (don't worry about the excess length of tubing sticking out of the hole yet).

Mix concrete and pour it into the hole so it surrounds the tube. Check to make sure the tube is perfectly plumb. Once the concrete sets, cut the PVC tube flush with the ground and attach a cap or just stuff an old rag into it. Now you can mow right over the tube with no harm done (see Figure 2).

Figure 1 — Dig a hole at least 4 inches in diameter and bury a short length of 2-inch inside diameter PVC tubing. [Robert Bastone, WC3O, photo]

Figure 2 — Whenever you need to set up a temporary mast to adjust an antenna, simply remove the cap and slide the mast into the tube. [Robert Bastone, WC3O, photo]

Figure 3 — Concrete should be poured into the hole so it surrounds the tube. [Robert Bastone, WC3O, photo]

When it's time to work on an antenna project, simply remove the cap or pull out the rag and slide the antenna mast into the tube (see Figure 3). The mast will be secure and vertical while you adjust. When you're finished, replace the cap and your experimental holder is ready for use another day. — *73, Robert Bastone, WC3O,* **radiofreebob@gmail.com**

A Relocatable Power Tap (RPT)

I've been thinking about ways to manage ac power distribution for my desktop amplifiers. Until recently, I selected an amplifier by manually switching power plugs under the operating table. One branch circuit was used, which consisted of a 30 A circuit breaker and a run of four-conductor #10 AWG electrical cable to a 30 A twist-lock wall-mounted receptacle. I use four-wire cabling because my older Alpha amplifiers use a neutral for the blower. The #10 AWG cabling to my shack helps to maintain stiff power supply regulation and reduce voltage drop losses over an 80-foot run. To start simultaneously feeding ac power into three amplifiers, I decided to construct a relocatable power tap (RPT), which is a 240/120 V version of a multiple outlet strip (see Figure 4).

[Note: Safety first! This project is intended for use as part of a high-voltage, high-current power circuit. While the wiring is simple and straightforward, if you haven't had much experience with high-voltage wiring, find a mentor to help, or better yet, hire a professional electrician. — *Ed.*]

Figure 4 — This remote power tap, like an outlet strip, can provide 240 V power hookups to several amplifiers. [Paul Christensen, W9AC, photo]

Figure 5 — A close-up view of one of the bus bars with the cover removed. The copper bus bars are rated at 130 A and provide a safe connection point for the four conductors. [Paul Christensen, W9AC, photo]

Figure 6 — The interior of the RPT box. The ac mains come in at the bottom, pass through the fuses on the left, and are then connected to the bus bars for distribution to the three output connectors exiting at the top. [Paul Christensen, W9AC, photo]

I wanted to come as close to being 100% compliant as possible for the relevant UL standard. UL 1363 had a significant limitation: the RPT was limited to 20 A service and all device connectors must be of the same type and current rating. Because the RPT was limited to 20 A, then so were the connectors. Consulting NEC guidelines, the plug was limited in size to 20 A, so the mating premise receptacle must be 20 A. Finally, NEC 210.21(B) in this application stated that the serving circuit breaker must match the receptacle rating. Use of the 20 A RPT forced a redesign of the branch circuit from 30 A to 20 A components, although the wiring could remain. UL 1363 limited the length of the supply-side cord to no more than 25 feet and no less than 1½ feet.

I started my design with 130 A copper bus bars that distribute service into three outputs (see Figures 5 and 6). I chose to use pigtails to install panel receptacles, because they allowed the use of different styles of 20 A plugs/receptacles, provided they remained the same type.

A summary of the RPT features includes: 1 × 3 device, designed for either three or four wire (240/120 V); #10 AWG wiring and hardware; Heyco compression cable entry/exit connectors; nickel-plated copper bus bars (with protective covers) rated at 300 V ac and 130 A; dual fuse holders with 20 A, ABC ceramic fuses; dual neon light ac power indicators, and 20 A Hubbell twist-lock connectors used on all cable ends.

If you want to add secondary-type surge protection devices (SPD) inside the RPT, their installation and type must comply with UL 1449, *Surge Protective Devices.* Place SPDs only between Line 1 and Line 2, and one each from the line to neutral — with no SPDs connected to the grounding conductor. Even then, I wouldn't use secondary SPD protection inside the RPT unless "whole-house" Type 1 or Type 2 protection is first used at the service entrance as the primary SPD. This is another reason why adding a neutral may make sense even if your present amplifier only requires three-wire service and no neutral. Adding the neutral also ensures that you can use older Alpha and Henry amplifiers in the future.

— 73, Paul Christensen, W9AC,
w9ac@arrl.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@arrl.org**. Please include your name, call sign, complete mailing address, daytime telephone number, and email address on all correspondence. Whether you are praising or criticizing an item, please send the author(s) a copy of your comments.

Feedback

In the August 2020 *QST* article, "Program an Arduino to Transmit WSPR," by Anthony Le Cren, F4GOH/KB1GOH, the modules in Figure 1 should have been labelled (top) ZS-042/DS3231 real-time clock; (left) Arduino Nano; (right) AD9850 DDS, and (bottom) SSD1306 display. In Figure 3, J4 should have been labelled "display module"; J5 "real-time clock" module; and the AD9850 DDS module was mislabeled, and should have been labelled "U2." *QST* regrets the error.

Mini DXpeditions on a Cruise with MARCO

Jay Garlitz, AA4FL

Before COVID-19, ham radio operators were able to enjoy the hobby without the complexities of the pandemic, specifically travel for DXpeditions. The Medical Amateur Radio Council (MARCO) is an amateur radio organization consisting of people who are professionals and ancillaries in the healing arts, and have an interest in issues related to patient care (physicians, dentists, nurses, pharmacists, veterinarians, psychologists, EMTs, etc.). Many of our members have been active in nets that discuss the pandemic, bringing a medical perspective to fellow hams in the early days, when information was difficult for the public to obtain due to rapid developments in the medical field.

When MARCO's annual business meeting isn't being held at the Dayton Hamvention®, the location is chosen by the organization President. As President in 2019, I chose Tampa, Florida, for last year's meeting.

The Medical Amateur Radio Council (MARCO) used a cruise as a chance to operate from Belize, Honduras, and Grand Cayman in 2019.

▲Bob, K4RLC; Mike, K9AJ; Maria, KI4WAX, and Chuck, N8CL, operated ZF2D in Grand Cayman using Eden's, ZF1EJ, guest station.

▶Keith, N3IM, and Chuck, N8CL, operated HQ9D in Honduras.

The location gave us the flexibility to hold a 4-day business meeting from April 24 – 28, 2019, followed by an 8-day cruise out of Tampa's port from April 28 – May 5. Because this meeting was scheduled prior to the pandemic, members from all over the world attended. (During COVID-19, cruise ships are available for travel, however, if you plan on traveling on one during the pandemic for a DXpedition or otherwise, be sure to take precautions and follow the CDC's safety guidelines, which can be found at **https://wwwnc.cdc.gov/travel/notices/warning/coronavirus-cruise-ship**.)

Chip, N5RTF, and Etsuo, JAØBXP, operated V31D in Belize.

Travel Logistics

Our cruise ship, *Carnival Miracle*, made four ports of call, in Belize, Honduras, Grand Cayman, and Mexico. MARCO was able to get through the logistics needed to operate DX on land in three of those ports, excluding Mexico. A group DXpedition was novel to our group, and this addition to our annual meeting was attractive to members whose schedules allowed it.

This DXpedition took 10 months of careful planning. First, our travel agent initiated a discussion with Carnival cruise lines. Once our trip was approved, I worked directly with Carnival's event-planning department regarding details of the radio operation, due to needing customs approval for items such as portable HF stations, planning boat-to-shore transport, and use of a 2-meter handheld transceiver aboard the ship.

Customs and public health clearance were required in each port. As expedition leader, I was on standby with ship staff in each port prior to departure as they met with local authorities. The approval process was unremarkable, with just a cursory exchange of information.

I spent 2 months arranging the on-land locations for our operations. International Amateur Radio Permits (IARP) were conveniently obtained through ARRL for on-ship 2-meter handheld transceiver use on the Panamanian-flagged vessel. Other licensing efforts started 6 months in advance. For Belize, we were required to obtain individual licenses at $20 each for a special call sign issuance for the group. The process was done via email, and a certificate of importation for radio equipment was provided. For Honduras, the Radio Club de Honduras handled and submitted our license request for a 1-day special event operation, which was approved at no cost to us. The Cayman Islands were also a pleasure to work with, as authorities handled the details by email and only required me to receive a local call (ZF2FL) and serve as a trustee for the special event group call and its participants. Both licenses and a certificate of importation for our equipment cost a total of $80.

Radio Operation

On April 28, 2019, 24 hams and spouses embarked with all the documentation needed to hold operating events in Belize as V31D, on the island of Roatán in Honduras as HQ9D, and on Grand Cayman as ZF2D. For our operations to occur, we needed cooperation from the weather, customs, cruise ship tenders, propagation, security, and many factors that would enable us to get back to the ship on time. The cruise ship was in port for 7 – 9 hours at each location. However, factoring in time for disembarking/embarking, tender time, transport to the operating location, and station setup/breakdown meant we only had 3 – 5 hours of radio operation at each location.

We didn't pursue any on-ship operation other than 2-meter handheld use. This allowed us time to enjoy social activities on the ship and focus our HF efforts on shore as DX adventures in three of the four ports visited.

The Medical Amateur Radio Council

The Medical Amateur Radio Council (MARCO) was created in 1966, and its purpose is to promote good will and fellowship internationally, among amateur radio operators who are professionals in the healing arts or have an interest therein. This is accomplished through on-the-air contacts; the MARCO newsletter, *Aether*; annual meetings; scholarship offerings to hams pursuing careers within health-related fields, and projects that benefit the public.

On-the-air network operation is an integral part of MARCO and is conducted for the purpose of discussing medical and technical information, and, when necessary, assisting in medical emergencies and other priority traffic.

Additional information about MARCO, including a membership application, can be found at **www.marco-ltd.org**. You can also visit their social media pages on Facebook (**www.facebook.com/HealthCareHams**) and Twitter (**https://twitter.com/HamsCare**).

Each DX location had a different set of operators. North Florida DX Association (NFDXA) members were on standby in Florida and many contacted us, with some of the best signals heard.

We activated V31D at a rental unit in Belize about 8 miles north of port. The station was set up on the rooftop under the cover of a three-story building with dipoles gently sloping down to trees on the property. Station 1 was an Icom IC-706MKIIG for 20-meter phone and CW operation. Station 2 was an IC-7000, primarily used for FT8 on 17 meters. Ropes were prepositioned in the trees for antenna support and we had help on the ground for hanging the antennas.

We were on the air for nearly 5 hours. Propagation on 20 meters was poor and noise levels were high until conditions improved later in the day. FT8 on 17 meters was active, with signals decoding throughout. At this first port of call, we made 114 contacts with hams in 19 countries. The operators were Chip, N5RTF; Etsuo, JA0BXP; Jay, AA4FL; Chuck, N8CL; Maria, KI4WAX; Bob, K4RLC; Mike, K9AJ, and Susan, K9XYL.

HQ9D was a short operation in Honduras at a diving and economy lodge 35 minutes from port, which is on the south side of Roatán. There's usually poor signal takeoff to North America due to being at the base of a mountain, however, our location on the coast afforded great takeoffs for North America, South America, and Europe. Operating time was less than 3 hours due to a short stay in port. Our operation was set up on the balcony of a second-floor cabana facing the water, and lodge staff assisted with the antenna placement. Propagation was better here and afforded us 122 contacts in six countries. The operators were Jeff, K6JW; Etsuo, JA0BXP; Jay, AA4FL; Chuck, N8CL; Maria, KI4WAX, and Keith, N3IM.

ZF2D in Grand Cayman was a very different operation. Eden, ZF1EJ, offered to let us use his guest shack, which is also the club station of the Cayman Island Radio Club. We brought along our IC-7000 for 17-meter FT8, but had two of his radios for 20-meter CW and SSB. Three stations were on the air at a time and each had its own tower and multiband antenna. A log-periodic antenna at 100 feet and a Mosley Electronics Pro-67-B antenna at 70 feet were accompanied by a Pro-67-C-3 antenna somewhere in the 50-foot range. In 4 hours, we made 315 contacts in 24 countries. The operators were Bob, K4RLC; Dave, NN4DF; Etsuo, JA0BXP; Susan, K9XYL; Mike, K9AJ; Jay, AA4FL; Chuck, N8CL, and Maria, KI4WAX.

Conclusion

Executing the DX portion of the trip as a bonding experience for a group of medical hams was invaluable, and the publicity generated getting on the air from DX locations made the amateur world aware of our organization.

This mini-DXpedition took a lot of effort and was a challenge in both planning and execution, but it was a memorable trip. Plus, new MARCO members have already joined after hearing about our unique journey!

All photos by the author.

Jay Garlitz, AA4FL, is a retired dentist. He earned his license in 1972 at age 13, and earned his Amateur Extra-class license in 1975. While in school at the University of Florida, he served as President of the Gator Amateur Radio Club and later became the faculty advisor. Jay is currently trustee of their club station, W4DFU. He is the Immediate Past-President and current Secretary of the Medical Amateur Radio Council (MARCO), CEO of Connected World Internet Ventures, Inc., and a past Vice Chair of the Council on Communications of the American Dental Association. Jay can be reached at **jay.aa4fl@gmail.com**.

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The State of Ham Radio in Japan

A close look at licensing rules and radio statistics in JA-land.

Ryota "Roy" Motobayashi, AC6IM

Japan was once considered the most ham-populated country. Those days have come and gone, and it's not just because of the inactive ionosphere. I'd like to go over some statistics about the state of amateur radio licensing in Japan, home of many well-known ham radio equipment vendors.

Japan's Licensing Structure

Amateur radio licensing structure varies by country. In Japan, there are two different licenses: an operator license (which never expires) and a station license (which is valid for 5 years).

Japan's Ministry of Internal Affairs and Communications (MIC) insists that hams have multiple station licenses under the same call sign, as shown in Figure 1. Typically, they're a movable station with 50 W output or lower, or a fixed station with power of over 50 W. In this case, the statistics count them as two separate stations. About 4% of the total call signs involves these multiple stations.

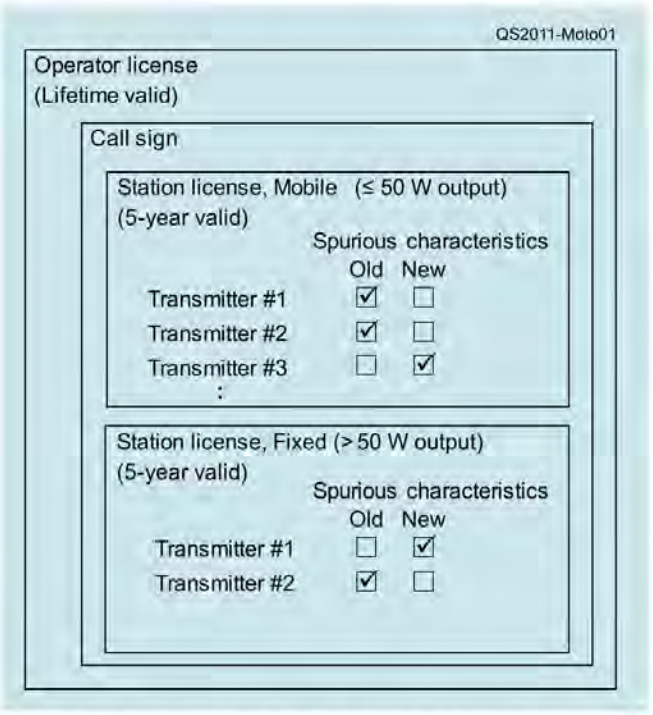

Figure 1 — An example of Japan station's licensing structure. Rigs with old, pre-WRC-2003 spurious emissions issues must be adapted and reregistered by November 30, 2022.

Additionally, Japan requires that each transmitter be declared by a licensee before operation. This requirement provides enough data for me to lay out a detailed analysis of licenses in Japan.

New Operator Licenses

Based on information from MIC's Information & Communications Statistics Database (**www.soumu.go.jp/johotsusintokei/field/index.html**), Figure 2 shows the transition of the number of the most entry-class new operator licensees each year. It roughly matches the FCC's Novice- or Technician-class licenses. The MIC had institutionalized the Amateur Telephone-class radio operator license in 1958 and modified it to Amateur 4th-class radio operator in 1990. The peak number of licensees in one year was 170,837 in the 1991 fiscal year (FY). In Japan, the government's fiscal year is from April 1 – March 31 of the next year.

There was a drastic increase in licensees before 1991 (possibly due to the influence of the 1987 movie, *Take Me Out to the Snowland*, which portrayed the use of transceivers during a ski trip). But in time, the number of licensees decreased.

In FY 2018, Japan welcomed 12,185 new licensees, including about 400 drone pilots for their non-commercial 5.6 GHz video downlink usages. This represents a 7.8% decrease from FY 2017 (which had 13,141 new licensees).

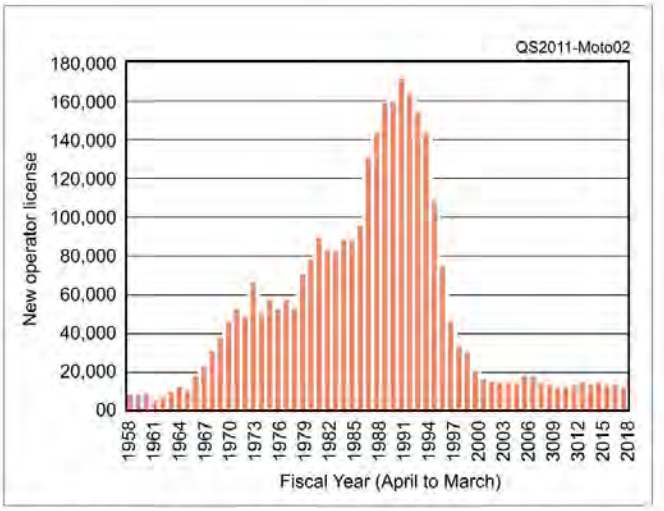

Figure 2 — New operator licensees each year (entry class makes up the majority of new licensees).

License-Class Distribution

Figure 3 shows an accumulated license-class distribution. The 4th class makes up the overwhelming majority of licensees in Japan, at 90%. It should be noted that those who earned their operator licenses sequentially (4th, 3rd, 2nd, and 1st) are counted in every class.

Figure 4 shows a similar analysis, but for Japan Amateur Radio Relay League (JARL) members. The total number of members, regular and family, is 57,453. Operators of a higher license class are more likely to subscribe to JARL. The annual membership fee is ¥7,200 ($66) for an individual and ¥10,800 ($100) for a club. The outlines of each license class are shown in Table 1.

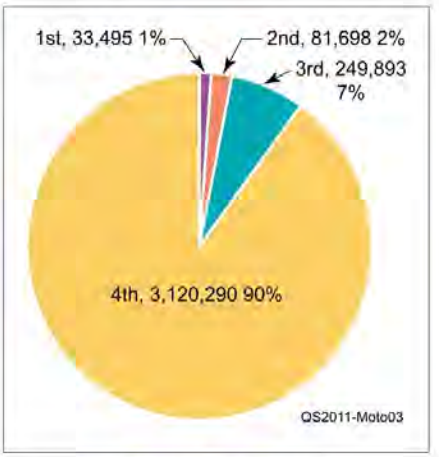

Figure 3 — Classes, all licensees.

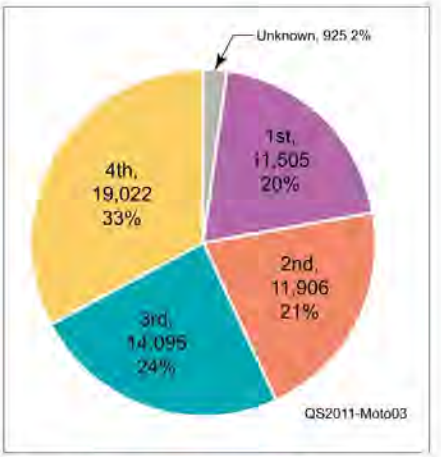

Figure 4 — Classes, only JARL members.

Station Licenses

Based on data from the Statistics Japan website regarding Information & Communications (**www.stat.go.jp/data/chouki/11.html**), Figure 5 shows the annual statistics of the total number of amateur radio stations in Japan. The peak was 1,364,316 stations at the end of FY 1994. FY 2018 shows 412,667, decreasing by 14,403 stations, or 3.3%, from the previous year (427,070 for FY 2017). In other words, the number of stations decreased by 39 per day. Contrasted with data from the US via Total Amateur Radio Station Licenses (**www.ah0a.org/FCC/Licenses.html**) by Joe Speroni, AH0A, the US surpassed Japan in November 2003.

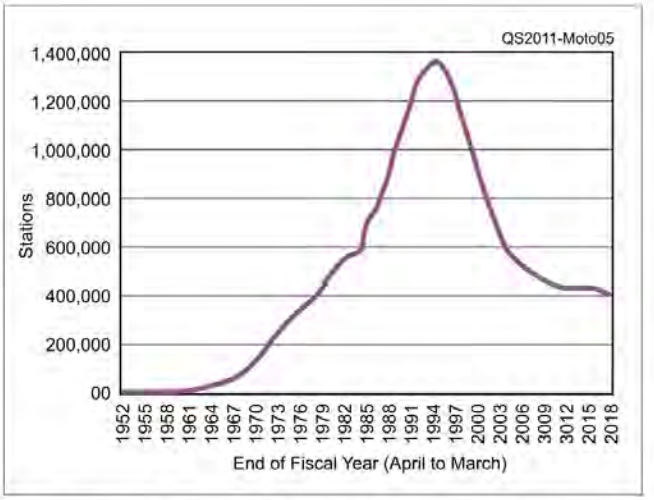

Figure 5 — Transition of the number of amateur radio stations.

Station Power Distribution

Figure 6 shows the output power distribution, including non-JARL members, based on information from a license search via MIC's website (**www.tele.soumu.go.jp/musen/SearchServlet?pageID=1**). Stations with 20 W output or lower (the lowest 4th-class adequate) occupy three-fourths majority.

In contrast, Figure 7 is an analysis on JARL members. The majority output power distribution for members is 50 W or lower. This may be due to the convenience of mobile

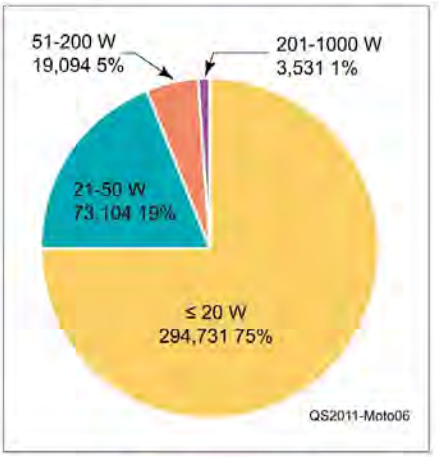

Figure 6 — Distribution of the licensed output power, all station licensees (based on each call sign).

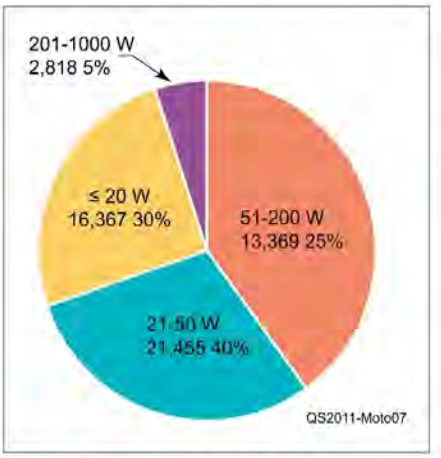

Figure 7 — Distribution of the licensed output power, only JARL members.

operation (including fixed portable) being restricted to a maximum of 50 W output in Japan. If operators want to exceed the limitation, they have to establish another fixed station at each physical location.

Table 1
Privileges for Each Amateur Radio Operator Class

Amateur class	1st	2nd	3rd	4th
Output power	1 kW	200 W	50 W	20 W (VHF and higher) 10 W (HF and lower)
Prohibited bands			30 meters 20 meters	30 meters 20 meters 17 meters
Prohibited mode				CW
Equivalent US classes (from US to Japan)	Amateur Extra	Advanced General Conditional	Novice Tech Plus*	Technician, no code

*Requirement: Technician with any new CSCE (1A, 1B, OR 1C), or a license dated on February 14, 1991 or before.

Operator Ages

The most common age range for radio amateurs in Japan is 51 – 75. This may be similar to the US and other countries. Figure 8 shows the age distribution of JARL members. The average age is increasing to around 63 years old. JARL only has 684 members who are 20 years old or younger — about 1% of membership.

To improve this, JARL took the following steps for youth ham development: waiving school club station membership fees, holding an annual event for young hams, offering a 1-year free trial membership program for hams under 22 years old, and giving free entry to the JARL Ham Fair.

Additionally, in 2018, several volunteers organized a "YOTA-Japan" (Youngsters on the Air) community to support young hams (visit **http://jouban.jp/yota-ja** for more information).

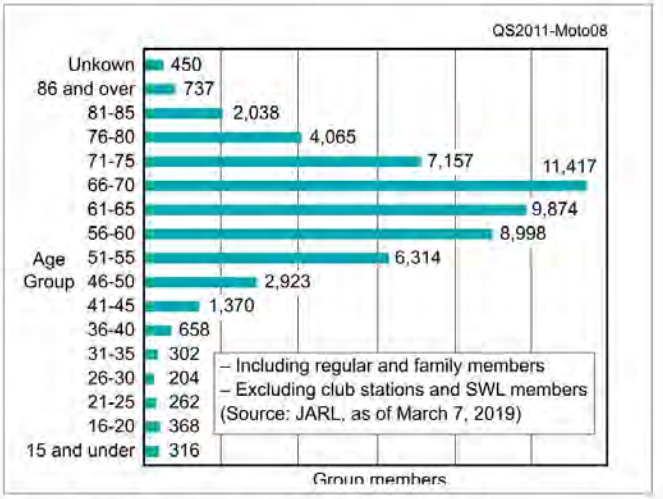

Figure 8 — Age group distribution of JARL members.

The New Spurious Regulation

In Japan, all hams must adjust their radios to meet the new spurious regulation, which was revised at WRC-2003. They must verify that their vintage equipment meets the new regulation by November 30, 2022. Most radios comply, but some licensees have to make adjustments (attaching an external filter, for example) to be certified by an agent — the Japan Amateur Radio Development Association (JARD) or the Technical System Service (TSS). JARD charges ¥2,600 ($24) for the basic rate including one transmitter, and ¥1,000 ($9) for each additional one.

Conclusion

Japan has about 3,000,000 operator licensees (mostly entry-class), 400,000 station licensees (decreasing over time), and 60,000 JARL members, with rights to access the QSL bureau. Unfortunately, the country that was once known as being the most ham-populated is steadily decreasing in radio operators.

Ryota "Roy" Motobayashi, AC6IM, earned his Japanese amateur telephone-class radio operator license in 1979, at age 14. In 1983, he earned the station license, JR0GLJ and JJ1WTL in 1988, after graduating from university and moving to Tokyo. He earned his US ham radio license, AC6IM, in 1994, and has visited the US many times since. He has been a delegate of JARL since 2015, and the webmaster of the website **callsign.jp**. Roy can be reached at **jj1wtl@jarl.com**.

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Science Fair Adventures in Ham Radio

A teenage ham's journey in trouble-shooting and improving his radio-related project.

Roy Gross, KM6EOO

With just 15 minutes until the Terman Middle School Science Fair in Palo Alto, California, I decided to test my project once more — but something went wrong. After the first transmission, my push-to-talk (PTT) circuit failed and the radio was stuck transmitting noise. I desperately tried replacing the metal-oxide-semiconductor field-effect transistor (MOSFET) with a new one, and, thankfully, the problem was fixed.

After setting up my poster and laying out my prototype, I began my speech: "Imagine the aftermath of a natural disaster: power lines down, cell towers destroyed, no phone, no internet, no communications. What would you do? How could you contact your loved ones? How could you call for help? My invention lets you use your own smartphone to send and receive emergency messages when normal communications are down."

Roy troubleshot his project to prepare for the Silicon Valley Science and Technology Championship.

I opened the app on my Android phone to send a message: "Testing 1, 2, 3." It didn't go through. I tried again. Finally, on my third try, the message made it through, but things went downhill from there.

Most of my demonstrations failed, and my Bluetooth connection disappeared. The Android phone and my Bluetooth module wouldn't talk to each other. When the day was over, all that could have gone wrong did, and at the worst possible time. I trudged home, disappointed but determined to improve my project.

Inspiration to Help

My science fair journey began 5 months earlier while watching a news story about Hurricane Maria's devastating effects to Puerto Rico. Mobile phones, land lines, radio towers, and the internet were all rendered useless. Lack of communication meant that food, water medicine, and generators couldn't get to where they were desperately needed. I listened to the *Amateur Radio Newsline* report and heard how ham radio operators were able to relay messages around the island and to the mainland. However, with communication in high demand, only a limited number of civilians could be helped.

I was determined to find a way to help. My idea was to prototype a decentralized communication system — a network that would let people communicate using their own phones, even when all other systems had failed.

I needed a way to wirelessly send information from one user to another. I bought a used BaoFeng UV-3R PLUS Two-Way Radio, which became my transceiver for prototyping. For testing purposes, I chose an unused simplex frequency in the 2-meter band.

Roy Gross, KM6EOO, with his project.

My next task was to find a mode to send data. Inspiration came from a talk I attended at the 2017 Pacificon, the ARRL Pacific Division Convention. A local radio club had built a GPS tracker that could send position data over automatic packet reporting system (APRS) radio networks. This inspired me to try using APRS packets for my own data, which meant I could test receiving and transmitting circuits separately, without having to build and debug both at the same time. I completed a breadboard receiving circuit, based on a design by Mark Qvist, OZ7TMD, of LibAPRS (**https://github.com/markqvist/LibAPRS**). An Arduino microcontroller monitors the audio line voltage and uses a public domain Arduino library to demodulate tones from the APRS message. I attached the breadboard to the receive circuit of the radio, which could then decode and log APRS messages from nearby trucks, boats, and equipment.

Next, I added the ability to transmit packets, using a four-bit digital-to-analog converter. This circuit was based on a design by Bill Nikolopoulos, SV1QFV. I also added a Bluetooth module to the breadboard.

This primitive breadboard prototype that I brought to the science fair had failed in every way. Fortunately, it was only my school science fair. The Silicon Valley Science and Technology Championship was for the whole county, and I had 2 months to prepare.

Product Design Structure

I called my unit WAEF-EL (When All Else Fails—Emergency Link), pronounced "waffle." I wanted to build a device that could actually be used in an emergency. Based on my research of the Puerto Rico disaster, I chose the following design criteria:

- I wanted the system to support long-distance unit-to-unit messages and have compatibility with existing communication satellites. I also wanted to support simple mesh networking to allow messages to propagate across larger distances.
- Individual units needed to be compact, rugged, compatible with multiple antennas, and waterproof to survive floods and storms.
- Units needed to run for many hours and be rechargeable by solar power or car batteries.
- I wanted to keep the unit price below $50. Using the screen, keyboard, and GPS on users' existing phones would reduce the cost.

These were good goals, but in practice I couldn't even get my radio to stop transmitting. After sending a packet, the PTT circuit would sometimes stay on, causing the radio to transmit until the power was cut off. Whenever I hooked my computer to the Arduino to debug, the problem went away. As soon as I was back on battery power it would reemerge. It took me days to figure out that the problem was improper grounding.

Once I had a working design, I optimized my circuit to fit on a small prototyping board. I added a lithium-ion battery with a voltage-regulating circuit. I added proper grounding between the radio and the Arduino and placed it all inside a waterproof case.

I then wrote a messaging application for smartphones, using MIT App Inventor. It uses Bluetooth to send and receive text and GPS data to the unit. Finally, I made a second unit, so I could perform true system testing.

Then, another problem arose. After sending a packet, the device would immediately send a second, garbage packet. The wire on the serial line (from the Bluetooth to the Arduino) was acting as an antenna. When the radio transmitted, random bits were being generated on the serial port. The Arduino thought it had received new Bluetooth data, and transmitted another packet. My solution was to add a special code to the Bluetooth messages from my WAEF-EL app. If this code wasn't present, I knew it wasn't a real message and ignored it.

Slowly, the pieces came together. I was sending and receiving text messages between phones using only APRS packets on 2 meters, which felt amazing. But it only worked occasionally. Most messages weren't getting through.

Andy Korsak, KR6DD, a member of my ham radio club, gave me an old oscilloscope, which helped me debug bad sine waves. It turned out I had the wrong resistor in my digital-to-analog circuit. Mark, OZ7TMD, answered my APRS format questions and encouraged me to continue improving my design.

As my system improved, I began field testing. First around the block, then around the neighborhood. I added automated testing and logging to my Android app. I tested with vertical antennas, J-poles, quarter-waves, and Yagis. I even tested the units underwater to see if they were truly waterproof. The second of my two units needed some more silicone sealant before it passed this test.

The Final Test

On the day of the county science fair, I was tired and nervous. At least 1,000 other junior scientists and engineers stood in line with me.

As the judging began, I felt more comfortable and fell into a rhythm of questions and answers about the challenges I faced and how I overcame them. I talked about the bugs and other problems, and how I worked through each one.

I described my satellite communication test. Using free software, I had located an APRS satellite. I aimed a directional antenna at the satellite and sent a message from my cell phone through the WAEF-EL unit. It was received by the satellite and retransmitted back to Earth. An amateur radio operator 800 kilometers away received the message and posted it online, confirming the contact.

I showed the judges my homemade antennas. My units come with a small rubber duck antenna, but for extra range, I wanted to make it easy to connect the WAEF-EL to larger, handmade antennas. I designed and tested three antennas made from common household materials: a portable quarter-wave handheld antenna, a copper-wire vertical, and a stripped-coax dipole antenna.

I talked about the power system and showed how it could charge in 4 hours from a small solar cell, and then recharge the user's phone as well!

Finally, I performed a functional end-to-end test for each judge. The judges got really excited when I showed them my prototypes and demonstrated how easy it was to send and receive messages. I quickly learned that 10 seconds of showing is better than 10 minutes of talking.

Roy debugged sine waves for his project with the help of an old oscilloscope given to him by Andy Korsak, KR6DD.

For me, the project had been a success. I had solved technical problems, learned technical skills, improved my soldering, and built something I was proud of.

The Verdict

Three weeks later at the awards ceremony, I found out that I won first place in the Electronics and Electromagnetics category. I won an award from the Institute of Electrical and Electronics Engineers (IEEE), the US Coast Guard Auxiliary, and the International Systems Safety Society.

I was also selected as a finalist for the Broadcom MASTERS national science fair. Thirty students were chosen from across the country and flown to Washington, DC.

Conclusion

My science fair ham radio adventure was an amazing experience that showed me ham radio is alive and well. After earning my General-class license last year, I used the prize money to buy my first HF radio. I'm currently studying for my Amateur Extra-class license, so if you hear me on 20 meters, say hi!

Roy Gross, KM6EOO, became interested in ham radio after receiving his first shortwave radio in second grade. He earned his Technician-class license in fifth grade and upgraded to his General-class license 1 year later, in 2017. Roy enjoys building and experimenting with antennas and radios, as well as talking locally on VHF and UHF. He also likes operating at reduced power on HF while mountain biking. He can be reached at **km6eoo@arrl.net**.

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

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

The QSO Today Virtual Ham Expo

An account of this fully online event, which featured presentations, exhibits, and opportunities to socialize.

Bob Inderbitzen, NQ1R,
nq1r@arrl.org

The QSO Today Virtual Ham Expo held in August offered the amateur radio community an opportunity to connect and learn. The fully interactive online event was hosted on a professional trade show platform, allowing for the familiar hallmarks of an in-person hamfest including a keynote address, presentations and learning forums, and exhibits from manufacturers and resellers.

A virtual exhibit hall set against the backdrop of Arizona's Painted Desert gave attendees the experience of wandering from booth to booth to interact with representatives from across amateur radio businesses and organizations. The platform supported live text in group settings, and one-on-one audio and video chat. Some exhibitors used their booths as launch pads, moving additional interactions to Zoom for product demonstrations and support.

The event was organized by Eric Guth, 4Z1UG/WA6IGR, who since 2014 has produced the *QSO Today* podcast, profiling the individual stories of radio amateurs. "We had over 16,000 people attend the expo for the live and on-demand days," said Guth, Chairman for the QSO Today Virtual Ham Expo.

Unlike virtual events that rely solely on lengthy agendas with back-to-back presentations, attendees of this expo were treated to an online experience that included variety and flexibility. One could truly wander throughout the expo, deciding for themselves the right mix of programming and real-time networking. Some of the fun was virtually bumping into friends and well-

A 3D virtual lobby guided attendees to the various sections of the event including the auditorium, exhibit hall, and help desk. A convenient menu bar provided additional navigation.

known experts and personalities from throughout the amateur radio community.

Besides offering a solution to pandemic restrictions of in-person gatherings, virtual events offer some additional benefits. In a recent ARRL study — which included a majority of responses from members who are employed (34%) or retired (60%) — 22% of respondents indicated they do not routinely attend hamfests and conventions. The most cited contributing factors include the high cost of travel and long distances to in-person events. This expo's presentation agenda was also published in an accessible format to support blind and vision-impaired participants and included duplicate versions of pre-recorded programs on YouTube.

"Our plan is to offer the expo twice a year," Guth said. With feedback from attendees and exhibitors, he and his small coordinating team expect to build on their success with the next QSO Today Virtual Ham Expo, to be held March 13 – 14, 2021. The event will include a variety of international speakers, more content for all skill levels, and more exhibitors.

In Their Own Words

ARRL Member Comments

Because 81% of attendees were ARRL members, we asked them to share their thoughts about the QSO Today Virtual Ham Expo.

"One of my favorite things about the expo was all of the great speakers on many topics. I could watch them as presented and participate in the live Q&A afterwards or watch on-demand anytime." — *ARRL Diamond Club member Melanie Glemser, AG4YL, Marietta, Georgia*

"We really enjoyed the virtual event and are looking forward to seeing what we can do in March. We had team members from around the globe as we had booth staff from Japan, as well as Icom Europe and Icom Spain." — *ARRL Life Member Ray Novak, N9JA, Senior Sales Manager, Icom America. Icom was a principal sponsor of the QSO Today Virtual Ham Expo.*

"From keynote presenter Scott Wright, KØMD, to the very last speaker, the 2 days were chock full of wonderful information on various forms of amateur radio. My own interests led me to talks on portable operating and simple antennas. In between sessions, it was a delight to have so many manufacturers and dealers at the Virtual Expo showing their wares (in some detail, if you wanted). You didn't even have to push and shove to get to the front. Overall, it was super!" — *ARRL member Bob Seaquist, W9LSE, La Crosse, Wisconsin*

"It was so much like large professional meetings I'd attended in person…but online. Since I'm a relatively new ham, I focused on the track that had more entry-level talks and was impressed with the speakers and content. Very step-by-step. Due to my schedule, I went back later to catch some things I had missed." — *ARRL member Barbara Irby, KC1KGS, Natick, Massachusetts*

"As the owner of a very small company in the ham radio community, I don't have the budget or staff to attend many in-person gatherings. The QSO Today event provided an affordable manner to exhibit." — *ARRL Life Member Gary Sutcliffe, W9XT, Unified Microsystems*

"It was great to see speakers and attendees from around the world present, learn, and interact with each other in the virtual platform. As a speaker, it was really exciting to present to such a large group of attendees on an international stage! I've already given multiple presentations to club meetings around the US as a result of this conference." — *ARRL Life Member Marcel Stieber, AI6MS, San Jose, California*

"This is the closest thing to a hamfest we've had since all this mess with the pandemic began. This gave lots of people a chance to meet with and talk to the vendors and get questions answered in real time with screen demonstrations. It was nice just getting to say hello to folks we haven't heard from in a long time too." — *ARRL member Karin Thompson, KØRTX, RT Systems*

"The amateur radio community is ever adaptive and makes necessary changes to enhance the hobby. The QSO Today Virtual Ham Expo was a perfect example of that! The chatroom for ARRL was one of the most active and fun chatrooms during the event. I especially enjoyed the live video tour of W1AW [the Hiram Percy Maxim Memorial Station in Newington, Connecticut], as I have yet to be able to visit in person. I'm very much looking forward to the next one!" — *ARRL member Catherine Andrews, AC4YL, Marietta, Georgia*

ARRL Seeks Nominations for the 2020 Bill Leonard Award

The ARRL Public Relations Committee is looking for your help in identifying the newspaper, radio, or television news stories that did the best job of showcasing what amateur radio is all about.

Bill Leonard, W2SKE (SK), was the President of CBS News and an avid amateur radio operator.

The Committee is now soliciting nominations for the 2020 Bill Leonard Award, which honors professional journalists or journalistic teams whose outstanding coverage highlights the enjoyment, importance, and public service value the Amateur Radio Service has to offer. The award was created as a tribute to the late CBS News President Bill Leonard, W2SKE, who was an avid amateur radio operator and advocate.

An award is presented in each of three categories: print/digital, audio, and visual. Nominations are judged by members of the ARRL Public Relations Committee, and the final decision will be made by the ARRL Board of Directors at their annual meeting in January 2021. The award winner in each category, either an individual or a group, will receive an engraved plaque, and a $250 contribution will be made in each winning entry's name to the charity of their choice.

The Bill Leonard W2SKE 2019 Professional Media Award for Audio Reporting was presented to Roman Battaglia of Jefferson Public Radio in Oregon for a feature on amateur radio emergency services in and around the listening area. The award for video reporting was presented to Jim Altman of Fox 61 News in Hartford, Connecticut, for Altman's report on ARRL's participation in an emergency drill conducted in association with the American Red Cross. The award for print/digital reporting was presented to Zack Plair of the Columbus and Starkville Dispatch in Mississippi, for a feature describing how amateur radio has proven fulfilling to various participants, including new and experienced radio amateurs.

To be considered, each nominee must be a professional journalist or a professional journalistic team in print, electronic media, or multimedia. Also, the nominee's work must have appeared between December 1, 2019 and November 30, 2020 in English in a commercially published book, recognized general-circulation (non-trade) daily or weekly newspaper, general or special interest magazine (except publications predominantly about amateur radio), commercial or public radio or television broadcast (including services delivered via cable), a website operated by a generally recognized journalistic organization (e.g. newspaper, magazine, broadcast station, or network), or multimedia format intended for and readily accessible to the general public within the US. The scope of the work nominated may be a single story or series.

The story must be truthful, clear, and accurate, reflecting high journalistic standards. Submission may be made by the author of the work, or on their behalf by another individual who believes the work merits the award.

Hudson Division Director Ria Jairam, N2RJ (left), and Vice Director William Hudzik, W2UDT (right), present the 2018 Leonard Award for Outstanding Video Reporting to NJTV correspondent Andrew Schmertz.

Entries must be received at ARRL Headquarters, in care of Executive Manager, American Radio Relay League, 225 Main St., Newington, CT 06111, by 5 PM EST on November 30, 2020.

For more information about the award, contact ARRL Executive Manager Carla Pereira, KC1HSX, at **cpereira@arrl.org** or 860-594-0242. Visit **www.arrl.org/bill-leonard-award** for the rules about the award and scroll down for the link to download a copy of the nomination form.

Rick Lindquist, N1RL, n1rl@arrl.org

Happenings

Board of Directors Elects New ARRL CEO David Minster, NA2AA

The ARRL Board of Directors has elected David Minster, NA2AA, of Wayne, New Jersey, as ARRL's new Chief Executive Officer. Minster is currently Managing Partner at Talentrian Partners, a management consulting firm serving the consumer goods and luxury goods industries.

Minster began his career as a software engineer, moving into management at Unilever, as a Chief Information Officer of the globally recognized portfolio of brands. From there, he moved to fine jewelry manufacturer and retailer David Yurman, where he served as COO and CIO. More recently, Minster served as CEO of jewelry brands Scott Kay and Judith Ripka.

"My initial focus will be working with the Board on establishing strategic goals and concrete plans to navigate ARRL through the digital transformation required for the coming decades of its Second Century," Minster said. "This includes exciting and innovative ways to be engaged in amateur radio, while growing activity and membership."

Minster has been a ham since 1977. He holds an Amateur Extra-class license. His background includes National Traffic System training and participation in public service events, and contesting from home, club stations, and contest stations in the Caribbean — particularly on Bonaire, where he is a member of PJ4G. Primarily a CW operator, Minster collects unique and vintage bugs and keys.

David Minster, NA2AA

Minster earned a bachelor's degree in computer engineering from The Ohio State University and has a special interest in satellites, digital communications, remote operation, and ham radio computing and software. He has written keyer software for the commercial market, and contest logging, packet, and satellite telemetry software for personal use.

In addition to being an ARRL member, Minster is a member of AMSAT, the Frankford Radio Club, the Straight Key Century Club, CWops, and the North American QRP CW Club.

"I spend every day of my life, one way or another, engaged in amateur radio. It is more than just a hobby for me; it is my community. It is where I live, [and] where I have built lifelong friendships. Amateur radio allows me to dream and to experiment," he said.

ARRL President Rick Roderick, K5UR, said, "We are excited to welcome David as our new CEO, and look forward to his progressive leadership. His experience in management and operations, plus his activities in amateur radio, will serve our organization and members well."

Minster succeeds Barry J. Shelley, N1VXY, who had been serving as ARRL's Interim CEO since January 2020.

FCC Proposes to Institute Amateur Radio Application Fees

Amateur radio licensees would pay a $50 fee for each amateur radio license application if the FCC adopts rules it proposed in August. Included under the FCC's fee proposal are applications for new licenses, renewals, and upgrades. The $50 fee would also apply to vanity call sign applications.

"Although there is currently no fee for vanity call signs in the Amateur Radio Service, we find that such applications impose similar costs in aggregate on Commission resources as new applications and therefore propose a $50 fee," the FCC said. Amateur radio will remain exempt from annual regulatory fees.

The FCC also proposes to assess a $50 fee for individuals who want a printed copy of their license, and for licensees seeking a rule waiver. Administrative updates, such as changes of address, are exempted if handled online by the licensee.

The FCC proposal is contained in a *Notice of Proposed Rulemaking*

(*NPRM*) in MD Docket 20-270, which was adopted to implement portions of the "Repack Airwaves Yielding Better Access for Users of Modern Services Act" of 2018 — the so-called "Ray Baum's Act."

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

As *QST* was going to press, ARRL was reviewing the *NPRM* with the intention of filing comments in opposition. File comments via the FCC's Electronic Comment Filing System (ECFS), posting to MD Docket No. 20-270.

Candidates Set for 2020 ARRL Division Elections

The candidates for the 2020 ARRL Division elections are now official. Unfortunately, incorrect information regarding electronic balloting in ARRL Division elections was disseminated in the Midwest Division. ARRL does not use electronic voting. The only way to cast a vote is by US Postal Service mail. We urge you to participate by casting and mailing your ballot. Ballots, accompanied by a photograph and a 300-word statement (if provided) from each candidate, will be mailed out to members by October 1. If you do not receive your ballot by October 16, contact Carla Pereira, KC1HSX, at **cpereira@arrl.org**. Completed ballots are due back at ARRL Headquarters no later than noon Eastern Time on Friday, November 20, 2020. — *The Ethics & Elections Committee of the Board of Directors*

Contested Seats

♦ In the Dakota Division, incumbent Director Matt Holden, KØBBC, in office since 2018, is being challenged by Vernon "Bill" Lippert, ACØW.

♦ In the Great Lakes Division, incumbent Director Dale Williams, WA8EFK, who has held the seat since 2014, will face off against Michael Kalter, W8CI, who is treasurer of the Dayton Amateur Radio Association.

♦ In the Great Lakes Division, members will choose from among three candidates to succeed incumbent Vice Director Thomas Delaney, W8WTD, who is not running for another term. They are current Ohio Section Manager Scott Yonally, N8SY; Jim Hessler, K8JH, who is vice president of the Grand Rapids Amateur Radio Association, and Frank Piper, KI8GW, Yonally's predecessor as Ohio Section Manager.

♦ In the Midwest Division, members will choose between Dave Propper, K2DP, a current Assistant Director, and Lloyd Colston, KC5FM, a past Oklahoma Section Manager, to fill the Vice Director's chair that Art Zygielbaum, KØAIZ, is vacating.

Balloting for contested seats will take place this fall, and successful candidates will be announced in November.

Declared Elected Without Opposition

♦ In the Atlantic Division, Director Tom Abernethy, W3TOM, who has held the seat since 2015, and Vice Director Bob Famiglio, K3RF, elected to a 3-year term (2015 – 2018) and then appointed in 2019 to fill a vacancy when the incumbent stepped down.

♦ In the Dakota Division, Vice Director Lynn Nelson, WØND, in office since 2018.

♦ In the Delta Division, Director David Norris, K5UZ, who's served in that office since 2012, and Vice Director Ed Hudgens, WB4RHQ, appointed in 2013.

♦ In the Midwest Division, current Vice Director Art Zygielbaum, KØAIZ, will become the new Director in January, succeeding incumbent Rod Blocksome, KØDAS, who is not seeking a new term. Zygielbaum has been Vice Director since 2014.

James Armstrong, NV6W, Named Santa Clara Valley SM

James Armstrong, NV6W, of San Jose, California, was appointed as Santa Clara Valley (SCV) Section Manager following the untimely death on July 28 of incumbent Bill Ashby, AA6FC, just 4 weeks after he took office. An ARRL Life Member, Ashby was 66. Armstrong will fulfill the remainder of the term, which expires on June 30, 2022. His appointment by ARRL Radio-sport and Field Services Manager Bart Jahnke, W9JJ, followed consultation with ARRL Pacific Division Director Jim Tiemstra, K6JAT.

James Armstrong, NV6W

Puerto Rico SM Rene Fonseca, NP3O

Rene Fonseca, NP3O, Elected as Puerto Rico Section Manager

Rene Fonseca, NP3O, has been elected as ARRL Puerto Rico Section Manager (SM), defeating two other candidates, including incumbent Oscar Resto, KP4RF, who had served since 2016. Fonseca, of Fajardo, received 85 votes; Juan Sepulveda Mercado, KP3CR, garnered 48 votes, and incumbent Section Manager Oscar Resto, KP4RF, got 31 votes. An ARRL Life Member, Fonseca is returning as SM, having served from 2012 to 2016. The Puerto Rico SM election was the only contested election in the summer round of voting.

♦ In Minnesota, Bill Mitchell, AE0EE, of Minneapolis, is the new Section Manager this fall. Mitchell was the only nominee when the nomination deadline arrived in early June. Incumbent Skip Jackson, KS0J, chose not to run for a new term after a 16-year run that began in 2004.

♦ In North Dakota, Richard Budd, W0TF, will begin a full 2-year term of office after being appointed in June to succeed Nancy Yoshida, K0YL, who stepped down.

The following incumbent SMs ran unopposed and were considered elected. Chuck Motes, K1DFS (Connecticut); Dan Marler, K7REX (Idaho); Scott Yonally, N8SY (Ohio); Kevin O'Dell, N0IRW (Oklahoma); Barry Porter, KB1PA (Southern Florida); Fred Kleber, K9VV (Virgin Islands), and Laura Mueller, N2LJM (Western New York).

All new terms began on October 1.

First Element of ARISS Next-Gen Radio System Now Operating on ISS

The initial element of the Amateur Radio on the International Space Station (ARISS) next-generation radio system has been installed in the ISS *Columbus* module, and initial operations were in FM cross-band repeater mode. The InterOperable Radio System (IORS) replaces the Ericsson radio system and packet module originally certified for spaceflight in mid-2000.

The IORS consists of a "space-modified" JVC-Kenwood D710GA transceiver, an ARISS-developed multi-voltage power supply, and interconnecting cables. The design, development, fabrication, testing, and launch of the first IORS culminated a 5-year engineering effort by the ARISS hardware team of volunteers. The new system offers higher power, a voice repeater, a digital packet radio (APRS) capabilities, and a Kenwood VC-H1 slow-scan television (SSTV) system.

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*

Rick Palm, K1CE, k1ce@arrl.net

Public Service

+ Amateur Radio

◀ NOAA and NESDIS's satellite image of Category 4 Hurricane Laura on August 27, 2020.

▲ From left to right: NHC Director Ken Graham, WX4KEG; John McHugh, K4AG, and Julio Ripoll, WD4R. [Julio Ripoll, WD4R, photo]

Hurricane Laura, a Category 4 hurricane, was one of the strongest hurricanes on record to make landfall in the US. As the first major hurricane of the 2020 Atlantic hurricane season, it began as a tropical storm in Lesser Antilles and Puerto Rico. It later traveled to the island of Hispaniola (Haiti and the Dominican Republic), killing 35 people in its path. Once it reached the US, it hit southwestern Louisiana and southeastern Texas. During these devastations, many amateur radio operators were available for emergency communications, as well as reporting data from the affected areas.

The National Hurricane Center

The National Hurricane Center's (NHC) amateur radio station, WX4NHC, is in its 40th year of public service at NHC, and has worked over 100 hurricanes. WX4NHC is activated when a hurricane is about 300 miles from landfall, depending on speed and other factors. The station operations are coordinated with, and require approval from, NHC Director Ken Graham, WX4KEG, and the National Oceanic and Atmospheric Administration (NOAA) Technology and Science Branch Chief.

WX4NHC was on the air for Hurricane Laura from 8 AM EDT, August 26 – 2 PM EDT, August 27, and received about 70 reports. Some reports from the affected area included pictures of the storm surge.

During Hurricane Laura, WX4NHC was active on several radio nets and modes including the Hurricane Watch Net, Voice over Internet Protocol (VoIP) Hurricane Net, Winlink, and online report forms.

NHC Surface Reports from affected areas during hurricanes fill in gaps of weather data and give a real-time, first-person perspective of what's happening on the ground. When a hurricane occurs, remember not to take any chances and to evacuate when requested by the local authorities.

In addition to the work done by the NHC, the Hurricane Watch Net (HWN) had many net control stations on the air for more than 30 hours on 20 and 40 meters, and relayed Surface Reports from stations in affected areas.

VoIP Hurricane Net

During Hurricane Laura, the VoIP Hurricane Net was active for 20 continuous hours supporting WX4NHC, as well as stations in affected areas, as Laura tore through western Louisiana and eastern Texas. About three dozen reports were handled by the net from radio amateurs in the affected areas, as well as relaying reports from online weather stations and storm chasers on social media.

The highest wind measurement received into the VoIP Hurricane Net was from Lake Charles, Louisiana, with a sustained speed of 102 MPH, and a maximum gust of 137 MPH. This report came from an online weather station at the local Emergency Operations Center (EOC), and was sent to WX4NHC, as well as the National Weather Service (NWS) Lake Charles Louisiana office via NWS Chat, and was utilized in the NWS Local Storm Report. It was consistent with a 133 MPH wind gust at the Lake Charles Regional Airport. Both instruments malfunctioned after recording these extreme wind gusts.

Through the efforts of the VoIP Hurricane Net Technical Coordinator, Tony Langdon, VK3JED, the network had direct connection to many other digital modes through Tony's advanced VoIP-linked system, which were tested for the first time during the net's activation for Hurricane Laura. Through his system, EchoLink, Internet Radio Linking Project (IRLP), AllStarLink, Digital Mobile Radio (DMR), Project 25 (P25), Yaesu's System Fusion, and Digital Smart Technologies for Amateur Radio (D-STAR) were connected directly into the system. During activations over the last 2 years, only EchoLink, IRLP, AllStarLink, and occasionally DMR and D-STAR were directly linked, depending on resource availability through the efforts of Lloyd Colston, KC5FM. Tony's system will be utilized for future activations of the VoIP Hurricane Net as required, and the net intends to upgrade the current *WX_TALK* EchoLink conference node: 7203/IRLP 9219 system to have this capability for the 2021 Atlantic Hurricane Season.

ARRL Headquarters

When Hurricane Laura was a tropical storm, the NHC was consulted daily, and ARRL Headquarters was mobilized to prepare for impact on Texas and Louisiana. The Headquarters Emergency Response Team (HQERT) was activated and its members provided daily updates on the storm's progress. While the precise area of landfall was still uncertain, ARRL Headquarters was ready.

Emails were sent to all of the Gulf Coast Sections, including South and North Texas; Louisiana; Alabama; Mississippi, and North, West Central, and South Florida, asking to include ARRL Emergency Preparedness Assistant Manager Ken Bailey, K1FUG, on messages with requests for assistance, and to send situation reports where amateur radio was being utilized in activations and operations. The reports were published in the "News" section of ARRL's website. On Friday, August 21, W1AW was placed on alert and Station Manager Joe Carcia, NJ1Q, was on standby throughout the weekend in case W1AW was needed to relay any emergency or priority traffic. The HQERT was also placed on alert, and communications maintained between members.

In 2018/2019, emergency communications kits from ARRL Headquarters were pre-positioned in Louisiana and other states along the Gulf Coast in preparation for emergency weather events and could have been redeployed in the region to meet emergent needs.

ARRL Headquarters maintained regular communications with Section leadership in Louisiana and Texas, as Hurricane Laura was predicted to make landfall in Louisiana near its border with Texas before heading toward Arkansas and affecting parts of Oklahoma, Tennessee, and Kentucky, eventually moving toward the northeast. When Hurricane Laura reached west Louisiana and east Texas on late August 26 and early August 27 as a Category 4 hurricane, it left devastation in its wake before losing strength and being downgraded to a tropical storm later that day.

Once Hurricane Laura weakened and storm-related traffic decreased, amateur radio operations in Texas, Louisiana, and W1AW returned to standby on Thursday afternoon, August 27.

Field Organization Reports

August 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**.

795
KD8TEE

655
WA3EZN

571
WA7PTM

495
W7PAT

485
N9VC

405
ND8W

340
KB3YRU

310
K1REZ

309
KD2LPM

305
KE8KOC

275
KE8BYC

271
WA2CCN

270
KW9EMG

265
AL0Y
W9GRG

250
KF5OMH

235
AC0KQ

228
W9RY

226
AD8CM

215
WB9WKO

200
KD2NMG

195
AD3J
KI5GRH

190
K8AMH

186
K3FAZ

185
W4CMH

180
K3JL

175
W2PH

163
N2WGF

160
KB8RCR

156
N3KRX

155
K9LGU

150
W8DJG
KD8ZCM

149
WA2BSS

145
N8SY
K0RCJ
WO2H

140
N1LL
W3GWM
K4IWW
W0LAW

137
KT2D

130
WB9QPM
AF4NC
N4CNX
AC8NP
KW1U

N2JBA
N5MKY
WD8USA

129
AI9F

127
K8RDN

125
K2TV

123
WM2C

122
KY2MMM

120
WA4VGZ
W4NWT
WC4FSU
AG9G
KA9QWC
WK4WC
KC8WH
KY2D
WB4ZIQ

119
W4DNA
KA8ZGY

115
AD4DO
KC9FXE
N1TF

110
K6HTN
KA9MZJ
KO4OL
WB8YLO
KA5AZK
KE5IOU
KI7TIG
K1IQI
KD2JKV
W1RVY
WA3QLW
WB8TQZ

108
W7EES

106
WS4P

105
W2PAX

KF5IOU
K1XFC
W5XX

101
K8MOA

100
WB6UZX
WB4RJW
KZ8Q
KN9P
NX9K
AC8RV
WB8SIQ
K3RC
KD8MSZ
KG5NNA
KB2QO
W7PHX
N1LAH

98
KB1NMO
WV5Q

96
KA2GQQ
KE1ML

95
KL7RF
KD8UUB
K1STM

94
K1HEJ

93
W9EEU
N3SW
KC8YVF

91
K7ASA
KC1HHO

90
KM4WHO
AA4XZ
AB9ZA
AA3SN
K8KRA
KB8HJJ
KA1G
K2MJF
KA2HZP
W2AH
W3CJD
K3MIY
KC1KVY

N2TSO
WB8WKQ
K8ED

89
N6IET
WB8YYS

88
W4TTO
WA1LPM

86
WB6NCT
KF7GC

85
K8JT

84
KB0DTI

83
KV8Z

82
K9GDF
N8CJS

81
K7OED

80
W9BGJ
N8MRS
KJ7BHO
KG7QWR
WB8R

79
K8OVO

77
W3ZR

75
KF5IVJ

74
K6RAU

73
NV1N

72
W2CTG

71
KN4AAG

The following stations qualified for PSHR in July, but were not reported in this column: W4CMH 175, W2PH 150, WB4ZIQ 120, WF2Y 106, WS4P 105, W2PAX 105.

Section Traffic Manager Reports

The following Section Traffic Managers reported: AK, AL, AR, AZ, CO, CT, DE, EMA, EPA, IL, IN, KS, KY, LA, LAX, MI, MN, MS, MT, NC, ND, NFL, NLI, NM, NNJ, NTX, NV, OH, OR, SC, SD, SFL, SJV, TN, WI, WMA, WPA, WV, WY.

Section Emergency Coordinator Reports

The following Section Emergency Coordinators reported: AR, DE, EWA, KY, MDC, MI, MN, MO, MS, MT, ND, NLI, NM, NNJ, NV, OH, OR, PAC, SCV, SFL, SNJ, STX, VI, WCF, 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.

KY2D 1,532, NX9K 1,366, WB9WKO 932, K6HTN 818, N1IQI 533, KW1U 504.

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

Contest Corral November 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	0000	1	0400	3.5-14	North American SSB Sprint Contest	Ph	Other's call, your call, serial, name, SPC	ssbsprint.com/rules
1	0600	1	0859	3.5, 7	Silent Key Memorial Contest	CW	RST, ITU zone or SK call you wish to recognize	www.skmc.hu/en
1	1400	4	0800	1.8-144	Classic Exchange, CW	CW	Name, RST, SPC, rig	www.classicexchange.org
1	1500	1	1800	3.5-28	High Speed Club CW Contest	CW	RST, mbr or "NM"	www.highspeedclub.org
2	0000	2	0100	3.5-14	K1USN Slow Speed Test	CW	Max 20 WPM; name, SPC	www.k1usn.com
2	2000	2	2130	3.5	RSGB 80-Meter Autumn Series, Data	Dig	RST, serial	www.rsgbcc.org/hf
3	0100	3	0159	1.8-50	Worldwide Sideband Activity Contest	Ph	RS, age group (OM, YL, or youth)	wwsac.com/rules.html
3	0200	3	0400	3.5-28	ARS Spartan Sprint	CW	RST, SPC, power	arsqrp.blogspot.com
4	1700	4	2000	144	VHF-UHF FT8 Activity Contest	Dig	4-char grid square	ft8activity.eu/index.php/en
4	2000	4	2100	3.5	UKEICC 80-Meter Contest	Ph	6-char grid square	ukeicc.com/80m-rules.php
5	1800	5	2200	28	NRAU 10-Meter Activity Contest	CW Ph Dig	RS(T), 6-char grid	www.nrau.net
5	2000	5	2200	1.8-50	SKCC Sprint Europe	CW	RST, SPC, name, mbr or power	www.skccgroup.com
7	0500	7	1200	3.5-28	IPARC Contest, CW	CW	RST, serial, "IPA" if member	www.iparc.de
7	1200	8	1200	1.8-28	Ukrainian DX Contest	CW Ph	RS(T), 2-letter oblast if Ukraine	urdxc.org/rules.php?english
7	1200	8	2359	1.8-50	SKCC Weekend Sprintathon	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
7	2100	9	0300	1.8-28	ARRL November Sweepstakes, CW	CW	Serial, precedence (Q/A/B/U/M/S), your call, check (year licensed), ARRL/RAC section	www.arrl.org/sweepstakes
7	2300	15	2300	1.8-14	AWA Bruce Kelley 1929 QSO Party	CW	RST, name, QTH, equipment year, rig type, power	antiquewireless.org
8	0500	8	1200	3.5-28	IPARC Contest, SSB	Ph	RST, serial, "IPA" if member	www.iparc.de
8	0800	8	1200	All	EANET Sprint	CW Ph Dig	RS(T)	fediea.org/news/?news=20201108
9	0000	9	0100	3.5-14	K1USN Slow Speed Test	CW	Max 20 WPM; name, SPC	www.k1usn.com
9	0100	9	0300	1.8-28	4 States QRP Group Second Sunday Sprint	CW Ph	RS(T), SPC, mbr or power	www.4sqrp.com
10	0100	10	0159	1.8-50	Worldwide Sideband Activity Contest	Ph	RS, age group (OM, YL, or youth)	wwsac.com/rules.html
11	1700	11	2000	432	VHF-UHF FT8 Activity Contest	Dig	4-char grid square	ft8activity.eu/index.php/en
11	2000	11	2130	3.5	RSGB 80-Meter Autumn Series, SSB	Ph	RS, serial	www.rsgbcc.org/hf
14	0000	15	2359	3.5-28	WAE DX Contest, RTTY	Dig	RS, serial	www.darc.de/der-club/referate/referat-conteste/worked-all-europe-dx-contest/en
14	0000	16	2359	1.8-7	PODXS 070 Club Triple Play Low Band Sprint	Dig	RST, SPC	www.podxs070.com
14	0001	15	2359	28	10-10 International Fall Contest, Digital	Dig	Name, mbr or "0," SPC	www.ten-ten.org
14	0700	15	1300	3.5-28	JIDX Phone Contest	Ph	RST, JA prefecture or CQ zone	www.jidx.org/jidxrule-e.html
14	1200	15	1000	50-1296	SARL VHF/UHF Analogue Contest	CW Ph	RS(T), 6-char grid	www.sarl.org.za
14	1200	15	1200	1.8-28	OK/OM DX Contest, CW	CW	RST, 3-letter OK/OM district code or serial	okomdx.crk.cz
14	1900	16	0500	1.8-432	CQ-WE Contest	CW Ph Dig	Name, location code, years of service	cqwe.cboh.org/rules.html
15	1300	15	1700	3.5, 7	Homebrew and Oldtime Equipment Party	CW	RST, serial, class	www.qrpcc.de/contestrules
15	2300	16	0100	1.8-28	Run for the Bacon QRP Contest	CW	RST, SPC, mbr or power	qrpcontest.com/pigrun
16	0000	16	0100	3.5-14	K1USN Slow Speed Test	CW	Max 20 WPM; name, SPC	www.k1usn.com
16	2000	16	2130	3.5	RSGB FT4 Contest Series	Dig	4-char grid	www.rsgbcc.org/hf
17	0100	17	0159	1.8-50	Worldwide Sideband Activity Contest	Ph	RS, age group (OM, YL, or youth)	wwsac.com/rules.html
19	0130	19	0330	3.5-14	NAQCC CW Sprint	CW	RST, SPC, mbr or power	naqcc.info
20	1600	20	2200	3.5	YO International PSK31 Contest	Dig	RST, serial, YO county or country	www.yo5crq.ro/Rules.htm
21	1200	22	1200	3.5-28	LZ DX Contest	CW Ph	RS(T), 2-letter LZ district or ITU zone	lzdx.bfra.org/rulesen.html
21	1600	21	2359	1.8	All Austrian 160-Meter Contest	CW	RST, serial, OE district or serial	www.oevsv.at
21	1700	22	0100	1.8	REF 160-Meter Contest	CW	RST, serial, department code	concours.r-e-f.org/contest
21	1900	21	2059	1.8-50	Feld Hell Sprint	Dig	RST, mbr, SPC, grid	sites.google.com/site/feldhellclub
21	1900	21	2300	1.8	RSGB 1.8-MHz Contest	CW	RST, serial, district code (if UK)	www.rsgbcc.org/hf
21	2100	23	0300	1.8-28	ARRL November Sweepstakes, Phone	Ph	Serial, precedence (Q/A/B/U/M/S), your call, check (year licensed), ARRL/RAC section	www.arrl.org/sweepstakes
23	0000	23	0100	3.5-14	K1USN Slow Speed Test	CW	Max 20 WPM; name, SPC	www.k1usn.com
24	0100	24	0159	1.8-50	Worldwide Sideband Activity Contest	Ph	RS, age group (OM, YL, or youth)	wwsac.com/rules.html
25	0000	25	0200	1.8-28	SKCC Sprint	CW	RST, SPC, name, mbr or power	www.skccgroup.com
25	2000	25	2100	3.5	UKEICC 80-Meter Contest	CW	6-char grid square	ukeicc.com/80m-rules.php
26	2000	26	2130	3.5	RSGB 80-Meter Autumn Series, CW	CW	RST, serial	www.rsgbcc.org/hf
28	0000	29	2359	50-1296	ARRL EME Contest	CW Ph Dig	Signal report	www.arrl.org/eme-contest
28	0000	29	2359	1.8-28	CQ Worldwide DX Contest, CW	CW	RST, CQ zone	www.cqww.com
30	0000	30	0100	3.5-14	K1USN Slow Speed Test	CW	Max 20 WPM; name, SPC	www.k1usn.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 WA7BNM Contest Calendar at* **www.contestcalendar.com** *and is extracted for publication in* QST *2 months prior to the month of the contest. ARRL gratefully acknowledges the support of Bruce Horn, WA7BNM, in providing this service.*

Frequency Measuring Test — November 2020

Updates to the popular two-session format.

Ward Silver, NØAX,
n0ax@arrl.org

This November, a new detail will be added to the venerable Frequency Measuring Test (FMT). In past FMTs, the test transmission was made on the same frequency as the call up transmissions. In this year's FMT, the test transmission will be close to the same frequency as the call up, but not exactly the same frequency. The test signal will be somewhere within ±10 Hz of the call up. You'll be able to hear the frequency shift a little bit. In addition, the test period is reduced from 2 minutes to 1 minute.

The two-session, early run/late run format remains the same. Geomagnetic conditions and sunspot activity are expected to be similar to last year, so stations on both the east and west coasts will have a good chance to make a solid measurement.

To keep reporting reasonably fair, the minimum resolution recognized in the result's green bar will be measurements within 1 Hz of the actual test frequency.

Making the Measurement

You don't need special lab equipment to enter the FMT. Modern HF transceivers can make frequency measurements quite accurately, as can SDR transceivers and PC software.

If you've never entered an FMT before, information on how to measure the frequency of a carrier is available at **www.k5cm.com**.

FMT Schedule and Format

The FMT "runs" will start with a call up at 0200 and 0500 UTC on November 13 (Thursday evening in North America). FMT Manager Connie Marshall, K5CM, notes the call up will start earlier than the listed times to establish a clear frequency, if necessary, but every effort will be made to start the key down at the published time in Table 1. A single, unmodulated carrier will be transmitted near (but not exactly on) those FMT frequencies.

Transmissions will be made from K5CM in Oklahoma, giving the entire continent an opportunity to receive and measure a strong signal. It's okay to make measurements during both the early and late runs, but only one frequency for 40 meters and one frequency for 80 meters should be reported.

Be prepared to tune to find the call up transmissions, if necessary. The call up frequencies will be the same for both early and late runs, so be patient and K5CM will start as soon as the frequency is clear enough for measurements.

Submit your measurements using the data entry website at **fmt.arrl.org/fmtentry.php**. Results will be published immediately following the data entry deadline, 0200 UTC on November 16 (Sunday evening, November 15, in North America). Be sure to describe your setup when you submit your measurements online, too.

Table 1
Frequency Measuring Test Schedule

Start: November 13 at 02:00 and 05:00 UTC (Thursday evening in North America)

Results: Submit measurements online until November 16 at 02:00 UTC (Sunday evening in North America)

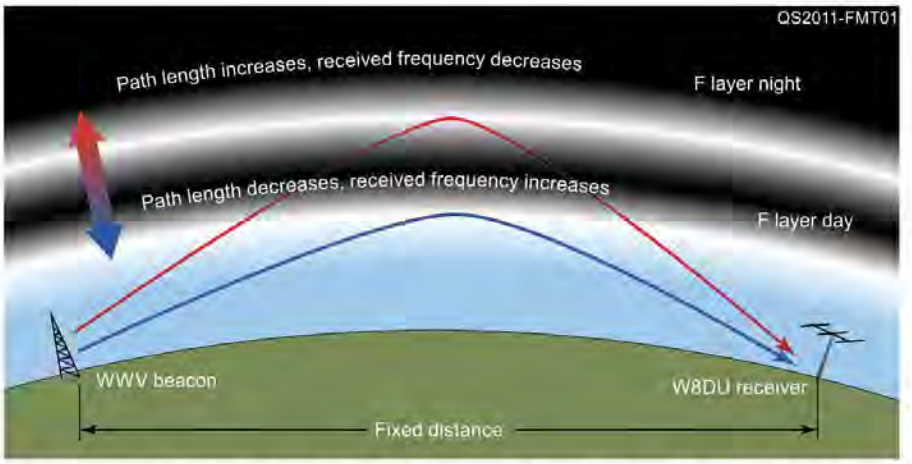
Early Run: 40 meters near 7064 kHz
02:00 Call up
02:03 Key down
02:04 End 40-meter run

Early Run: 80 meters near 3598 kHz
02:20 Call up
02:23 Key down
02:24 End 80-meter run

Late Run: 40 meters near 7064 kHz
05:00 Call up
05:03 Key down
05:04 End 40-meter run

Late Run: 80 meters near 3598 kHz
05:20 Call up
05:23 Key down
05:24 End FMT

If there's interference on the published frequency, tune around to find the FMT transmissions.



During an annular solar eclipse in the eastern hemisphere on June 21, 2020, HamSCI volunteers made frequency measurements assessing the Doppler effect due to the motion of the ionosphere's refracting layers. Learn more about the experiment at **https://hamsci.org/june-2020-eclipse-festival-frequency-measurement**.

The 2020 ARRL 10-Meter Contest

0000 UTC Saturday, December 12 – 2359 UTC Sunday, December 13

The 2020 ARRL 10-Meter Contest is just around the corner. Whether you're new to the hobby or a seasoned operator, this event offers something for hams of all experience levels. Join in the fun!

This contest relies in part on winter E-skip, so propagation may favor higher activity during daylight hours. Watch for unexpected band openings and favorable propagation. Ten meters can offer up surprises even during lower sunspot years.

There are categories for both Single-Operator and Multioperator entrants. Stations can be contacted on CW, phone, or both.

Multipliers include US and Mexican states, Canadian provinces, and DXCC countries (excluding the US, Mexico, and Canada). Complete rules, multiplier lists, and forms can be found at **www.arrl.org/10-meter**.

7-Day Log Deadline: ARRL 10-Meter Contest logs must be uploaded via our web app (**http://contest-log-submission.arrl.org**) or postmarked by 2359 UTC December 20, 2020 and sent to ARRL 10-Meter Contest, 225 Main St., Newington, CT 06111.

Adam Donahue, KØJWQ, and his dog operated portable in Genesee Mountain Park in Colorado for the 2019 ARRL 10-Meter Contest. [Adam Donahue, KØJWQ, photo]

Complete rules can be found at www.arrl.org/10-meter

The December 2020 ARRL Rookie Roundup — CW

1800 UTC – 2359 UTC, Sunday, December 20

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

Rookies will attempt to make as many contacts as possible during this 6-hour event. Rookies work everyone, and non-Rookies work only Rookies. Stations exchange each other's call signs, first names, a two-digit year, and state (US or Mexican), Canadian province, or "DX."

Eleven-year-old Elixander Valladares, Jr., N4EVJ, making contacts in the April 2020 ARRL Rookie Roundup. [Elixander Valladares, Sr., W7HU, photo]

You can enter as a Rookie if:

- You made or will make your first-ever contact this year or during the previous 3 calendar years (send the last two digits of the year of your first contact in your exchange)
- Or you haven't made any contest contacts using the contest mode (CW) before (send the last two digits of the current year in your exchange).

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

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

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

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

Complete rules can be found at www.arrl.org/rookie-roundup

The 2020 ARRL 160-Meter Contest

2200 UTC Friday, December 4 – 1600 UTC Sunday, December 6

The ARRL 160-Meter Contest gives participants a chance to log that elusive state for WAS, a new country for DXCC, or even a new continent. Even if you don't have a dedicated 160-meter antenna, you can load up a random length of wire to make contacts. Give it a try and you could be surprised by the results!

Markus Hansen, VE7CA, operated during the 2019 ARRL 160-Meter Contest using his restored station. He finished in third place in the Single Operator, Low Power category in the British Columbia Section. [Markus Hansen, VE7CA, photo]

- Operate using CW only (1.830 – 1.835 MHz should be used for intercontinental contacts only).
- Categories include Single Operator or Single Operator, Unlimited (spotting assistance allowed), at the high, low, or QRP power levels. There's also the option of operating Multioperator, Single Transmitter (use of spotting networks is permitted) at high or low power.
- DX stations work stations in ARRL/RAC Sections. W/VE stations work stations in ARRL/RAC Sections and DXCC entities.
- KL7, KH0 – KH9 (including KH6), and KP1 – 5 stations count as US sections and may be contacted by DX, US, and VE stations.

7-Day Log Deadline: ARRL 160-Meter Contest logs must be uploaded via our web app or mailed with postmark by December 13, 2020. Upload logs via web app to **http://contest-log-submission.arrl.org**. Paper logs can be sent to ARRL 160-Meter Contest, 225 Main St., Newington, CT 06111.

Complete rules can be found at
www.arrl.org/160-meter

Melissa Stemmer, KA7CLO, mstemmer@arrl.org

At the Foundation

The ARRL Foundation Board of Directors is pleased to announce four new scholarships established to assist amateur radio operators with college or university costs.

The Rev. Paul E. Bittner, WØAIH, Memorial Scholarship

Successful fundraising efforts by Scott Neader, KA9FOX, and Paul Husby, WØUC, have established an endowment for The Rev. Paul E. Bittner, WØAIH, Memorial Scholarship. The $1,000 scholarship will be awarded to a student pursuing a degree in science, technology, engineering, or mathematics, with preference given to applicants residing in the ARRL Central Division.

The Chick Allen, NW3Y, Scholarship

Chick Allen, NW3Y, has established a $3,000 scholarship for students working toward a degree in electronics, electrical engineering, aerospace engineering, computer science, or a similar scientific field. Preference will be given to applicants residing within 250 miles of Seaford, Delaware.

The Gulf Coast Amateur Radio Club Scholarship

The Gulf Coast Amateur Radio Club has endowed a $2,000 scholarship for students pursuing a degree in fields related to science, technology, or mathematics. Preference will be given to residents of Pasco County, Florida or counties of the West Central Florida Section.

The Pikes Peak Radio Amateur Association (PPRAA) Memorial Scholarship

This $1,000 scholarship was established by the Pikes Peak Radio Amateur Association for an applicant pursuing studies in engineering, physical science, or mathematics. Preference will be given to applicants residing in the state of Colorado attending any accredited 4-year college or university.

Full scholarship eligibility requirements for all scholarships can be found at **www.arrl.org/scholarship-descriptions**. The 2021 Scholarship Program will be accepting applications online from October 1, 2020 until December 31, 2020. If you are a high school senior or attending college next year and are an FCC-licensed, active amateur radio operator, you are encouraged to apply. Awards will be announced in May 2021. Awards are sent directly to recipients' colleges.

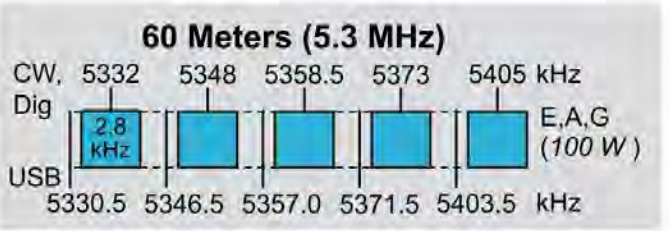
To learn more about the ARRL Foundation Scholarship Program, go to **www.arrl.org/scholarship-program**.

Bernie McClenny, W3UR, w3ur@arrl.org

How's DX?

60 Meters — An Overview

The Federal Communications Commission (FCC) authorized the use of the 60-meter, 5 MHz band for American amateur radio operators on March 5, 2012. Since then, many countries have gained access to amateur radio's newest band. For this month's column, former ARRL President, current Arkansas DX Association President, and DXer Joel Harrison, W5ZN, provides a history of the band and some words of caution. As a reminder, at this time ARRL does not recognize any 60-meter contacts for awards we sponsor.



A graphic showing the five discrete channels radio amateurs can use on 60 meters, from the 2016 Amateur Radio Extra-Class License Syllabus.

Sixty meters is quickly becoming an extremely popular amateur radio band with more and more countries gaining access, but US radio amateurs need to be aware of what our frequency allocation is. Currently, we can only operate on five discrete channels within the band and that is all, with a maximum effective isotropic radiated power (EIRP) of 100 W.

The US was the first country in the world to obtain a 5 MHz allocation. ARRL was able to coordinate with the FCC and the National Telecommunications and Information Administration (NTIA) to allow an amateur allocation at 5 MHz on a secondary basis. In order to accomplish this, a compromise with a discrete fixed channel and power limitation was finally agreed to, and amateurs gained access to a brand-new band. Once this occurred, a few other amateur radio societies approached their government and were able to gain limited access to 5 MHz.

At the 2015 World Radiocommunication Conference (WRC), ARRL led the effort through the International Amateur Radio Union (IARU) to obtain a worldwide allocation at 5 MHz for the Amateur Radio Service. Thanks to ARRL's leadership within the IARU, as well as IARU's member-society influence with local governments, a small bandwidth allocation with a 15 W power limit was adopted.

Next Steps

This did not immediately expand the US allocation. Even though an allocation is adopted at a WRC for each country's regulatory administration, in the case of the US, the FCC must approve access and use of a new allocation. ARRL has petitioned the FCC for access; however, the FCC has not yet authorized use on the new 5 MHz frequency subband. Access in the US is still limited to five discrete channels.

Many new countries are currently gaining access to 60 meters based on the WRC adoption and authorization by their country's regulatory agency. Those countries are operating in accordance with their authorization and most of it is currently outside the US allocation. That has not stopped some US radio amateurs from moving outside of our allocation to work a DX entity, some knowingly and willingly doing so. This is in direct violation of FCC rules and puts your license, and everyone else's continued access to the band, in jeopardy. Hopefully in the near future, the FCC will act on ARRL's petition to gain access to the new WRC allocation, but as of now they have not, and we are still restricted to five discrete channels. If you don't know what those channels are, please navigate to **www.arrl.org** and search for the US Band Allocation chart. This is a very handy reference to keep at your operating position, to ensure you're operating within your license authorization.

Sixty-meter contacts are also not accepted for DXCC credit, even for the Mixed award. If you submit a 60-meter card, it will be rejected. The basis for this is tied to the stated purpose for acquiring the initial 5 MHz allocation many years ago. In order to justify the new allocations, ARRL cited the usage of the band for "emergency communications," so permitting awards would have negated this position. For those of us who were licensed when the amateur service gained the 30-, 17-,

and 12-meter allocations at the World Administrative Radio Conference in 1979 (WARC-79), you will recall it was several years before those bands were accepted for DXCC credit.

Power Limits

We must also be aware of the US current power limit of 100 W ERP on 60 meters. This means that it is acceptable to run 100 W to a dipole, but if you're using a gain antenna then you are violating the power limit. I know of one radio amateur in the US who claims he is running a four-square antenna and 100 W, which violates the rule because of the antenna gain. He would need to reduce his power to around 50 W or less in order to be legal. If the US becomes authorized to operate on the new 60-meter allocation, there is likely to be a 15 W ERP power limit. I mention this because many of the new solid-state amplifiers available today will operate on 60 meters, and they openly include that band on their band chart. You can definitely run 1,500 W on 60 meters with one of these amplifiers. If you own one of the new solid-state amplifiers, please be aware that we share these five channels with federal agencies and they have priority. If a few amateurs interfere with this, we could all lose access to the band. If you're regularly heard to be "too loud," there is a chance you could get a knock on the door from an FCC inspection team and a multi-thousand dollar fine.

If you would like more history on the 60-meter band, please read the "It Seems to Us" editorial by David Sumner, K1ZZ, in the July 2003 and December 2014 issues of *QST*.

Wrap-Up

For those interested in more details on the 60-meter band, check out ARRL's "60 Meter Channel Allocation" web page at **http://www.arrl.org/60m-channel-allocation** and the "Recommended Operating Practices" page at **http://www.arrl.org/files/file/Regulatory/Recommended_Practices_Version_6_5.pdf**. Don't forget to send your DXpedition news, about any large-scale or holiday-style operations, to **bernie@dailydx.com**. Until next month, see you in the pileups!
— Bernie, W3UR

All ARRL members can now enjoy the digital edition of *QEX* as a member benefit. Coming up in the November/December 2020 and future *QEX* issues are articles and technical notes on a range of amateur radio topics. These are at the top of the queue.

- Eric Nichols, KL7AJ, in his essay series, discusses setting up a home electrical engineering lab, and dealing with EE math.
- Harry Bloomberg, W3YJ, remotely operates *fldigi*/*flrig* and *WSJT-X* modes using a Raspberry Pi and NoMachine.
- Bob Fontana, AK3Y, uses the NanoVNA to design an SSB ceramic resonator filter.
- Joe Purden, W6AYC, explores the limitations of the transmission line resonator approach to broadbanding 80-meter dipoles.
- Steve Stearns, K6OIK, introduces *HOBBIES* software for computational electromagnetics.
- Al Yerger, K2ATY, describes a UHF quadrature coupled power amplifier.

QEX, a forum for the free exchange of ideas among communications experimenters, is edited by Kazimierz "Kai" Siwiak, KE4PT, (**ksiwiak@arrl.org**) and is published bimonthly. All ARRL members can enjoy the digital edition of *QEX* as a member benefit. The *printed edition* annual subscription rate (six issues per year) for members and non-members in the United States is $29. First-class delivery in the US is available at an annual rate of $40. For international subscribers, including those in Canada and Mexico, *QEX* can be delivered by airmail for $35 annually (see **www.arrl.org/qex**).

Would you like to write for *QEX*? We pay $50 per published page for full articles and *QEX* Technical Notes. Get more information and an Author Guide at **www.arrl.org/qex-author-guide**. If you prefer postal mail, send a business-size self-addressed, stamped (US postage) envelope to: *QEX* Author Guide, c/o Maty Weinberg, ARRL, 225 Main St., Newington, CT 06111.

Jon Jones, NØJK, n0jk@arrl.org

The World Above 50 MHz

The Perseid Meteor Shower

The Perseid meteor shower has long been considered the best annual shower for amateur radio meteor-scatter work. It is reliable and peaks overnight on August 12 with a peak (zenith hourly rate) of around 100 per hour. In the past, the Perseid meteor shower was considered one of the year's highlights for VHF DX work. The dates of the Central States VHF Society (late July) were established, in part, for people to meet at the conference and set up meteor-scatter schedules. This was before the internet, cell phones, and when long-distance phone calls could be expensive. DX records were set during the Perseids, such as K5UR's record-setting meteor-scatter contact with KP4EKG on 144 MHz on August 13, 1985, and K2DRH's contact with N6RMJ on August 13, 2009.

Particularly for 220 and 222 MHz operators, the fast Perseid meteors at 60 kilometers per second helped complete SSB and CW contact on the 1.25-meter band. The faster the meteor, the greater the ionization as it burns up in the E-layer and the higher the MUF that it can support. 222 MHz contacts, such as AF6O's contact with W7XU, and K5QE's contact with NY2NY were made during the Perseids.

It seemed different in 2020. Reviewing posts on the Ping Jockey website, activity seemed down on August 11 and 12. Not many stations were active, and operators seemed to have trouble completing contacts. Finally, on August 13, Ping Jockey was busy, and there were contacts reported. I recall more activity on Ping Jockey in the Quadrantid and Geminid meteor showers.

I believe one factor for the change could be *WSJT-X* MSK144. To complete random contacts on SSB and CW, it required a good station, lots of persistence, and luck. It was much easier to complete random or scheduled SSB and CW contacts during a meteor shower. With MSK144, random meteors are now used daily for 144 and 222 MHz contacts. It is easier to be persistent when your computer helps. Stations such as NØLL, W9RM, and K7ULS completed numerous 144 and 222 MHz random meteor-scatter contacts this summer (see Figure 1). This has increased band activity and interest. But there is also less incentive to focus on the Perseids. The Perseids also occurred in the middle of the week in 2020, limiting the number of stations active.

Figure 1 — Mike's, K7ULS, custom-built 650 W, 222 MHz rover setup. [Paul Newcombe, N2EME, photo]

Another factor was that stations were operating at the wrong time. Most random meteor-scatter activity is in the morning around and after dawn. For random meteors, this is when the meteor rate is highest. But dawn is not the best time for the Perseids. This is due to the *radiant effect*. The radiant is the spot in the sky from which meteors appear to fall — in this case, the constellation Perseus. The most productive spot for the radiant is at an elevation of about 45 degrees and an azimuth of 90 degrees from the path you are trying to work. For the Perseids, the best times and paths are: NE-SW (0900-1100) and SE-NW (0100-0300). Time is local at mid-path. On August 13, I worked W3XTT (FN01) on 144 MHz MSK144 at 1501Z. (path midpoint time 1000 local) in 1 minute with +13 dB signals. I was running just 50 W to a seven-element Yagi. WØRT (EM27) and others worked W3XTT easily. Operating at the peak time was very productive. I gather from posts on Ping Jockey operators seemed unaware of the radiant effect. Using it may helpful for completing meteor-scatter contacts.

On the Bands

50 MHz. Larry, NØLL, did another pop-up operation from EN20 on August 2, making 13 MSK144 6-meter contacts. He was active dur-

ing the Perseid meteor shower from rare EN02 on August 12. He made 83 contacts on MSK144 with only 60 W, including K7ULS at 0434Z on August 12.

August 15 was one of the best days. Matt, KW3DX (FN21), made contacts from Kansas to Florida. He uses a Comet CHA250B multi-band vertical. I, NØJK, worked KP4AJ (FK68) at 1842Z and many stations on the east coast. John, WA1EAZ (FN42), decoded PY2XB (GG66) on FT8. D4VHF worked stations as far west as Iowa. Peter, WA2GFN, found August 15 to be good as well, working K7ULS for Peter's 46th state on 6 meters. The last significant E_s opening that I noted was on August 17 to the Pacific Northwest. I worked Lew, W7EW (CN84), at 1743Z. WW1L spotted European stations on a number of days in August.

144 MHz. Meteor scatter picked up in August. Mike, K7ULS (DN41), worked Rafael, XE2OR (DL98), on August 5 via MSK144 "on a big rock." On August 12, I (EM28) worked WØVTT (EN33) on MSK144, and I suspect there was tropo. K7ULS noted, "The meteors (during the Perseids) were explosive, but there was a lack of operators." Rick, WØRT (EM27), worked W3XTT to the east, and Arizona and Utah to the west for nine MSK144 contacts. Tropo occurred in the Midwest. Sam, K5SW (EM25), worked north to WBØULX (EN04) in South Dakota. There was more tropo on August 16 for K5SW. He worked stations from Texas to South Dakota, and east to Wisconsin. Greg, WQØP (EM19), now has his 2-meter beacon on 144.287 MHz with 5 W to a big wheel antenna at 30 feet. K7ULS worked 9H1TX via JT65 EME on August 20 and YB2MDU in Indonesia on August 21 with signals as low as –33 dB. On August 25, K7ULS worked K5DOG (EM00) on a 15-second burst.

Figure 2 — Paul, N2EME, operating from Kentucky in August 2020. [Paul Newcombe, N2EME, photo]

Figure 3 — Paul, N2EME, operating from West Virginia in August 2020. [Paul Newcombe, N2EME, photo]

There was also trans-Atlantic tropo in August. There was a strong opening from the Canary Islands across the Atlantic to the Caribbean. On August 27, EA8CXN worked NP4BM at 5,243 kilometers. On August 29, FG8OJ (FK96) worked EA8CXN (IL18) on 144.279 MHz.

Steve, N4PZ (EN52), and AA9MY (EN50) has been running nightly schedules with KX4R (EM74) on 222.105 MHz CW. On August 8, John, K1OR, worked ACØRA/p in EM29 on FSK441 for Kansas. On August 9, K7ULS worked KU8Y (EN61) on MSK144 for his 24th state at 2,112 kilometers and K7KQA on August 11. Dave, N9HF (EL99), worked K1WHS (FN43) using FSK441 (older digital mode).

Paul, N2EME, activated two states during the Perseids on MSK144. He was on from Kentucky and worked K1OR, K5QE, AA5C, and NØLWF (see Figure 2). From West Virginia, he put K1ØR, W7UX, NØLWF, ND0B, AA5C, and KA9CFD in the log (see Figure 3). KL6M (BP51) operated EME and made a number of 222 MHz state hunters very happy. K7ULS worked him on August 14 at 1556 UTC. N9HF (EL99) and K1OR also worked KL6M. John, K1OR, noted "a sharp increase" in activity on the band.

After the Perseids, K7ULS worked KE7NR/p in DM54 on random meteors on August 16. Mike found K1WHS in Maine on JT65 EME on August 18 for another new state. Mike logged W4ZST (EM84) in Georgia for his 27th state.

1296 MHz. K5SW (EM25) worked KFØM (EM17) on CW on August 16.

Here and There

There was a potential Brendan Trophy tease from the late August trans-Atlantic tropospheric opening. On August 28, Alex, EB1DJ, in the northwest of Spain, reported that he got one single decode of the FT8 signal from KP4EIT in Puerto Rico.

US Amateur Radio Bands

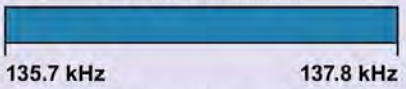
Operator license classes: **E** = Amateur Extra **A** = Advanced **G** = General **T** = Technician **N** = Novice
CW operation is permitted throughout all amateur bands. Except as noted, all frequencies are in megahertz (MHz).

= 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

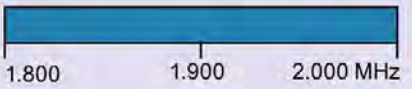


MF – Medium Frequency bands

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**

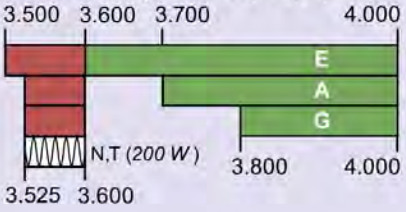
160 Meters (1.8 MHz) E,A,G



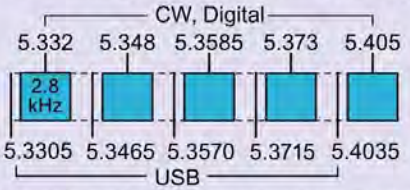
Amateurs wishing to operate on **2200 or 630 meters** must first register with the Utilities Technology Council online at **https://utc.org/plc-database-amateur-notification-process/.** You need only register once for each band.

HF – High Frequency bands

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

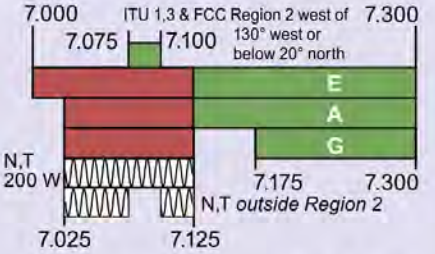


60 Meters (5.3 MHz) E, A, G (100 W)

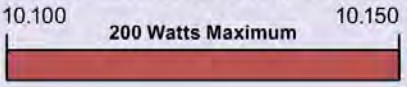


Gen, Adv, and Extra licensees may operate on a secondary basis with a maximum ERP of 100 W maximum.

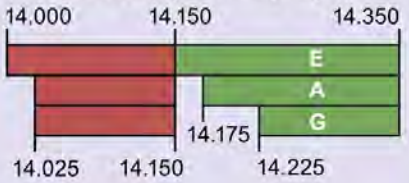
40 Meters (7 MHz) E,A,G,T,N



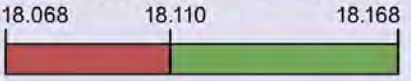
30 Meters (10.1 MHz) E,A,G



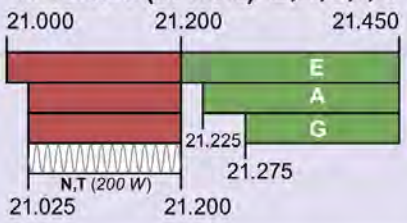
20 Meters (14 MHz) E,A,G



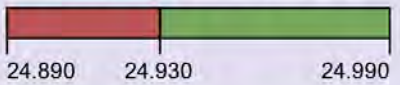
17 Meters (18 MHz) E,A,G



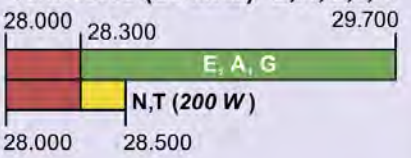
15 Meters (21 MHz) E,A,G,T,N



12 Meters (24 MHz) E,A,G

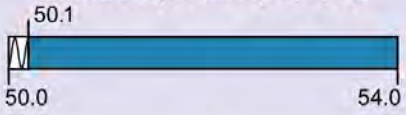


10 Meters (28 MHz) E,A,G,T,N

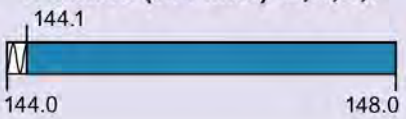


VHF – Very High Frequency bands

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



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

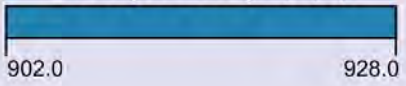


1.25 Meters (222 MHz) E,A,G,T,N

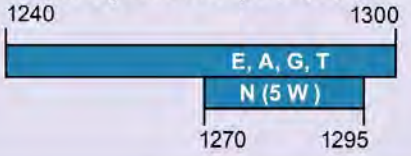
UHF – Ultra High Frequency bands

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**

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

Special Event Stations

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

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.*

Through Dec. 31, 0000Z – 2359Z, W5YD, Mississippi State, MS. W5YD Mississippi State University Amateur Radio Club. **W5YD Centennial Celebration**. 80, 40, 20, and 17 meters. QSL. Mississippi State University Amateur Radio Club, Dept. of Physics & Astronomy, P.O. Box 5167, Mississippi State, MS 39762-5167. **www.w5yd.org.msstate.edu**

Through Dec. 31, 0000Z – 2359Z, various calls, various cities, IA. Great River Amateur Radio Club. **Iowa State Parks On-the-Air Centennial Celebration**. All bands, all frequencies, as available. Certificate & QSL. IASPOTA-2020, c/o Great River Amateur Radio Club, P.O. Box 1384, Dubuque, IA 52004. *Members will operate with their own call signs from state parks throughout Iowa. Operating as time permits, mostly weekends. QSL for contact; certificate for five parks. See website for complete information.* **www.w0dbq.org/iaspota**

Sep. 14 – Oct. 13, 0000Z – 2359Z, K5DX/50, Houston, TX. Texas DX Society. **Texas DX Society 50th Anniversary**. 14.074 14.040 7.074 7.040; FT4 and FT8. QSL. Texas DX Society — K5DX/50, 5303 S. Mason Rd., Apt. 212, Katy, TX 77450. **https://k5dx-50.tdxs.net**

Oct. 24, 1100Z – 1700Z, W1CK, Milford, CT. Woodmont Amateur Radio Association. **The Captain Kidd DX Hunt**. 50.885 28.885 14.285 7.285. QSL. Woodmont Amateur Radio Association, 128 Kings Hwy., Milford, CT 06460. **www.wara.club**

Oct. 31, 1400Z – 2230Z, K5ZRO, Transylvania, LA. Vicksburg Amateur Radio Club. **Halloween from Transylvania, Louisiana**. 7.270 SSB 14.270 SSB. Certificate. Malcolm Keown, 64 Lake Cir., Vicksburg, MS 39180. **info@vicksburgarc.club** *or* **www.vicksburgarc.club**

Oct. 31 – Nov. 1, 0000Z – 0559Z, KC5BOO, Cleburne, TX. KC5BOO. **Boo to You!** 14.240. QSL. Judy Cox, 3701 Park Rd. 21, Cleburne, TX 76033. **kc5boo@yahoo.com**

Oct. 31 – Nov. 1, 2100Z – 0500Z, WA4TRS, Fairview, NC. The Road Show Amateur Radio Club, Inc. **A Night on Bald Mountain**. 7.250. Certificate & QSL. The Road Show ARC, 57 Echo Lake Dr., Fairview, NC 28730 **roadshowarc.org**

Nov. 1, 1400Z – 2100Z, W4CA, Roanoke, VA. Roanoke Valley Amateur Radio Club. **Star City of the South**. 14.245 7.245. QSL. Roanoke Valley ARC, P.O. Box 2002, Roanoke, VA 24009. **www.millmountainstar.com** *or* **www.w4ca.com**

Nov. 1 – Nov. 8, 0800Z – 0621Z, W2G, Freeport, NY. USCG Auxiliary Division 13 Station Jones Beach. **USCG Auxiliary 81st Anniversary**. 14.200 10.118 7.190 3.885. QSL. W2G, 3813 Verleye St., Seaford, NY 11783. *USCG Station Jones Beach, NY; maritime operations from CG 45706 are possible.*

Nov. 1 – Nov. 11, 0000Z – 0023Z, K7LHC, Lake Havasu City, AZ. London Bridge Amateur Radio Association. **4th Annual 27 Lighthouses in the South West Desert**. 21.300 18.145 14.250 7.250. Certificate. LBARA, P.O. Box 984, Lake Havasu City, AZ 86405. **www.lbara.org**

Nov. 1 – Nov. 14, 0000Z – 0000Z, N5VET, Cleburne, TX. Club KC5NX. **Veterans Day**. 14.270 14.235 14.045 7.235. QSL. Club KC5NX, 9200 Summit Ct. W., Cleburne, TX 76033. **club.kc5nx@gmail.com** *or* **www.dxwatch.com/dxsd1/dxsd1.php?f=0&c=N5VET&t=dx**

Nov. 1 – Nov. 30, 0000Z – 2359Z, W8XK, K3A, K3D, K3K, Pittsburgh, PA. KDKA 100 Group. **KDKA 100 Year Anniversary**. 14.260 14.030 7.260 7.030. Certificate & QSL. K3A/D/K to Robert Bastone, 308 Garden Hill Dr., Tarentum, PA 15084; W8XK to Greater Pittsburgh DX Association, P.O. Box 216, Saxonburg, PA 16056. *Work all four call signs for a special commemorative certificate. See website for QSL information.* **radiofreebob@gmail.com** *or* **www.qrz.com/db/w8xk**

Nov. 2 – Nov. 16, 0000Z – 2359Z, W8F, Livonia, MI. Livonia Amateur Radio Club. **45th Anniversary of the Sinking of the SS *Edmund Fitzgerald***. 14.260 14.040 7.240 7.040. Certificate. Tas Foley, K8TAS, 37255 Eureka Rd., Romulus, MI 48174. *Saturday, Nov. 14, 1600 – 2000 UTC, W8F will operate from the Dossin Great Lakes Museum on Belle Isle, Detroit, MI.* **www.livoniaarc.com**

Nov. 6 – Nov. 8, 0001Z – 2359Z, W1H, Elkins, NH. US Coast Guard Auxiliary. **81st Anniversary of the Coast Guard Auxiliary**. 14.301 7.195 3.941. QSL. Bill Hopwood, P.O. Box 272, Elkins, NH 03233-0272.

Nov. 6 – Nov. 8, 0000Z – 2359Z, N2G, Copiague, NY. US Coast Guard Auxiliary Division 1 (Central Long Island) First Southern Region. **US Coast Guard Auxiliary 81st Anniversary**. 7.247. QSL. George Tranos, P.O. Box 657, Copiague, NY 11726. *We plan to be active in ARRL November Sweepstakes CW.*

Nov. 6 – Nov. 8, 1500Z – 2355Z, WØJH, WØF, Stillwater, MN. Stillwater, MN Amateur Radio Association. **Remembering the *Edmund Fitzgerald***. 21.360 14.260 7.260 3.860. Certificate. Via email to **EdFitzgerald2020@radioham.org**. Call signs: WØJH (for phone) and WØF (for CW & Digital). *We will have multiple stations simultaneously using the same call signs, as they are operating on different bands. In keeping with COVID-19 social distancing requirements, we will operate from our individual QTHs this year.* **www.radioham.org**

Nov. 6 – Nov. 8, 1400Z – 2200Z, N1A, Plainville, CT. US Coast Guard Auxiliary District 13 North. **Commemorating the US Coast Guard Auxiliary 81st Anniversary**. 14.265 7.265. QSL. Charles I. Motes, Jr., 22 Woodside Ln., Plainville, CT 06062.

Nov. 6 – Nov. 8, 1400Z – 2200Z, W8C, Rochester, MI. US Coast Guard Auxiliary District 9 Central. **Commemorating US Coast Guard Auxiliary 81st Anniversary**. 21.335 14,275 7.275 3.975. QSL. USCGAUX 81st Anniversary, 1853 Willowood Rd., Rochester, MI 48307. **https://uscgauxnational.blogspot.com/2020/06/81st-anniversary-of-us-coast-guard.html**

Nov. 6 – Nov. 8, 1400Z – 2300Z, N6Z, San Jose, CA. US Coast Guard Auxiliary, District 11 North. **US Coast Guard Auxiliary 81st Anniversary**. 14.074 21.074 7.074 14.225. QSL. Alan T. Stanton, 1524 Rosecrest Ter., San Jose, CA 95126.

Nov. 6 – Nov. 22, 1500Z – 2359Z, WAØSDO, Sedalia, MO. Sedalia Pettis Amateur Radio Klub. **85th Anniversary of Amateur Radio in Sedalia/Pettis County Missouri**. 80, 40, 20, and 10 meters. Certificate. Paul Withers, 19449 Hwy. H, Hughesville, MO 65334. *Certificate will also be available as a download.* **www.wa0sdo.org**

Nov. 7, 1500Z – 2200Z, WØFSB, Waterloo, IA. Five Sullivan Brothers Amateur Radio Club. **Honoring Veterans for Veterans Day**. 18.124 14.240 7.240. Certificate & eQSL. Five Sullivan Brothers ARC, 3186 Brandon Diagonal Blvd., Brandon, IA 52210. *See website for details.* **www.qrz.com/db/w0fsb**

Nov. 7, 1600Z – 2300Z, K9M, Mooseheart, IL. Fox River Radio League. **Mooseheart Founders Day, Celebrating 107 Years**. 21.265 14.265 7.265 3.815. QSL. Moose International, Attn: Gordon Dailey, Activities, 155 S. International Dr., Mooseheart, IL 60539-1172. *We will also work FT8; check website for band(s).* **www.frrl.org**, **www.mooseheart.org**

Nov. 7 – Nov. 8, 1400Z – 2100Z, NB9QV, Manitowoc, WI. USS *Cobia* Amateur Radio Club. **USS *Cobia* World War II Submarine Celebrating Veterans Day**. 14.240 7.240. QSL. Fred Neuenfeldt, 4932 S. 10th St., Manitowoc, WI 54220-9121. **www.qrz.com/db/nb9qv**

Nov. 7 – Dec. 4, 1800Z – 2000Z, GB200FN, Romsey, United Kingdom, RSGB. **Florence Nightingale Bicentenary 2020**. 14.210 3.665. QSL. John Wakefield, Oakhurst, Lower Common Rd., Romsey SO51 6BT, United Kingdom. **www.qrz.com/db/gb200fn**

Nov. 9, 1300Z – 1700Z, N9H, Rochester, NY. Roc-Ham Special Events. **Hedy Lamarr Day 2020**. VoIP EchoLink ROC-HAM/531091, DODROPIN/355800; ALLSTAR 2585, 47620, 47918. QSL. John Derycke, W2JLD, 85 Amherst St., Apt. 2, Rochester, NY 14607. *Email for more information.* **w2jld2@gmail.com**

Nov. 10 – Nov. 20, 1100Z – 0500Z, WO4L, W1G, East Berlin, PA. **157th Anniversary of Lincoln's Gettysburg Address**. 18.155 14.275 7.180; FT8. Certificate & QSL. eQSL or direct to Robert Hess, 74 Curtis Dr., East Berlin, PA 17316. *See instructions on QRZ (W1G or WO4L) on how to receive a certificate and/or QSL card. No LoTW.* **bigbob7388@gmail.com**

Nov. 11, 1500Z – 2100Z, W4D, Sevierville, TN. Sevier County Emergency Radio Service. **Thank You Veterans**. 7.180 LSB; 7.080 PSK31. QSL. Thomas Baxter, 2054 James Rd., Sevierville, TN 37876. **www.eventqsl.webs.com**

Nov. 11, 1600Z – 2130Z, W5KID, Baton Rouge, LA. Baton Rouge Amateur Radio Club. **Veterans Day Observance**. 14.250 14.035 7.225 7.035. QSL. USS *Kidd* Amateur Radio Club, 305 S. River Rd., Baton Rouge, LA 70802. *Operation aboard the USS* Kidd *(DD-661), World War II Fletcher class destroyer.* **qrz.com/db/w5kid**

Nov. 11, 1800Z – 2359Z, N9V, Indianapolis, IN. The American Legion Amateur Radio Club. **The American Legion's National Salute to America's Veterans**. 20 meters, 14.275; 40 meters, 7.225; *CROSSRDS* EchoLink Conf. Node IRLP Node 9735. Certificate & QSL. The American Legion Amateur Radio Club, 700 N. Pennsylvania St., Indianapolis, IN 46204. **k9tal@legion.org** *or* **www.legion.org/hamradio**

Nov. 12 – Nov. 16, 1100Z – 0500Z, K3M, Wilkes Barre, PA. Murgas Amateur Radio Club. **Father Murgas Anniversary**. 14.250 7.250 14.074 14.035. Certificate. Murgas ARC, Box 1094, Wilkes Barre, PA 18703. **www.murgasarc.org**

Nov. 12 – Nov. 19, 0400Z – 2359Z, W3A, Harleysville, PA. WV2M. **Adoption of the Articles of Confederation and Perpetual Union**. 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.wv2m.com**

Nov. 14, 1700Z – 2359Z, NI6IW, San Diego, CA. USS *Midway* (CV-41) Museum Ship. **Celebrating Veterans Day and USMC Birthday**. 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.

Nov. 17, 1500Z – 2359Z, K7GST, Paulden, AZ. Yavapai Amateur Radio Club. **NRA's 149th Birthday Party**. 21.335 14.250 14.040 7.250. Certificate. YARC, P.O. Box 11994, Prescott, AZ 86304. *E-certificate available, see website for details.* **www.w7yrc.org/nrabirthday**

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

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

Submissions must be received by ARRL HQ no later than the 1st of the second month preceding the publication date; a special event listing for **February** *QST* would have to be received by **December 1**. In addition to being listed in *QST*, your event will be listed on the ARRL Web Special Events page. Note: All received events are acknowledged. If you do not receive an acknowledgement within a few days, please contact us. ARRL reserves the right to exclude events of a commercial or political nature.

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

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
Tl = Talk-in frequency
Adm = Admission

ALABAMA STATE CONVENTION

November 21, Montgomery ARC

D F H Q R S T V

8:30 AM – 4 PM. *Spr:* Montgomery ARC. Alcazar Shrine Temple, 555 Eastern Blvd. *Tl:* 146.84. *Adm:* $8. **https://w4ap.org/marc/hamfest**

Florida (Coral Gables) — Nov. 21 F T

7 AM – noon. *Spr:* Flamingo Net ARC. University of Miami Parking Lot 1 – 109, 1300 Campo Sano Ave. *Tl:* 147.15+.600 (94.8 Hz). *Adm:* Free, must pay university parking fee. **www.flamingonet.8m.net**

Florida (Fort Walton Beach) — Nov. 13 – 14

D F H Q R S V

Friday 4 – 8 PM, Saturday 8 AM – 2 PM. *Spr:* Playground ARC. C.H. "Bull" Rigdon Fairgrounds, 1958 Lewis Turner Blvd. *Tl:* 146.79 (100 Hz). *Adm:* $7. **www.w4zbb.org**

Florida (Pinellas Park) — Nov. 14 F R T

8 AM – noon. *Spr:* St. Petersburg ARC. Freedom Lake Park, 9990 46th St. N. *Tl:* 146.07. *Adm:* Free. **www.sparc-club.org**

Florida (West Palm Beach) — Nov. 28 D F H R T V

8 AM – 1 PM. *Spr:* Palms West ARC. Lampert Family Service Center, 5841 Corporate Way. *Tl:* 147.045 (110.9 Hz). *Adm:* $5. **www.palmswestradio.org**

Indiana (Mitchell) — Nov. 7 D F H R S T V

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

CENTRAL DIVISION CONVENTION

November 14 – 15, Fort Wayne, IN

D F H Q R S V

Saturday 9 AM – 4 PM, Sunday 9 AM – 2 PM. *Spr:* Allen County AR Technical Society. Allen County War Memorial Coliseum, 4000 Parnell Ave. *Tl:* 146.88. *Adm:* $6 for both days, $3 for Sunday only. **www.fortwaynehamfest.com**

Michigan (Madison Heights) — Dec. 6 D F H R V

8 AM – noon. *Spr:* L'Anse Creuse ARC. Madison Place, 876 Horace Brown Dr. *Tl:* Receive 147.08, Transmit 147.68 (100 Hz). *Adm:* $5. **www.n8lc.org**

Mississippi (Ocean Springs) — Nov. 13 – 14 D F H Q R V

Friday 4:30 – 8 PM, Saturday 8 AM – 3 PM. *Spr:* Jackson County ARA. St. Martin Community Center, 15008 Lemoyne Blvd. *Tl:* 145.11 (123 Hz). *Adm:* $5. **www.jcmsara.com**

Nebraska (Norfolk) — Nov. 21 D F H R S V

8:30 AM – 2 PM. *Spr:* Elkhorn Valley ARC. Knights of Columbus Hall, 105 Elm Ave. *Tl:* 146.73 (131.8). *Adm:* $5. **www.qsl.net/evarc**

New Jersey (Fair Lawn) — Nov. 27 H R

5:30 PM. *Spr:* Fair Lawn ARC. Fair Lawn Senior Center, 11-05 Gardiner Rd. *Tl:* 145.47 -600 (167.9 Hz). *Adm:* Free. **http://auction.fairlawnarc.org**

Ohio (Delta) — Dec. 5 D F H R V

8 AM. *Spr:* Fulton County ARC. Village of Delta Memorial Hall, 401 Main St. *Tl:* 147.195 (103.5 Hz). *Adm:* $5. **www.k8bxq.org/hamfest**

To All Event Sponsors

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

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

The deadline for receipt of items for this column is the **1st of the second month preceding publication date**. For example, your information must arrive at HQ by **November 1** to be listed in the **January** issue. Information in this column is accurate as of our deadline; contact the sponsor or check the sponsor's website for possible late changes, driving directions, and other event details. Please note that postal regulations prohibit mention in *QST* of games of chance, such as raffles or bingo.

Promoting your event is guaranteed to increase attendance. As an approved event sponsor, you are entitled to special discounted rates on *QST* display advertising and ARRL web banner advertising. Call ARRL's toll-free number at 1-800-243-7768, or email **ads@arrl.org**.

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Email your proposal to **qst@arrl.org** (no telephone calls, please). Send a short outline of your idea, including a list of chapter topics, and a sample of your writing.

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.

June 2020

Michael P. Essi, K8WZY	10
Richard J. Gibilisco, NE0J	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, K0HD	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, WB0U	25
Murray A. Scott, KE8UM	25
Jay P. Jenkins, WE2KEY	40

July 2020

John T. Clement, Sr., NM2R	10
Andrew M. Majot, K5QO	10
John P. Scruggs, N4JRC	10
Samuel P. Unruh, K0SPU	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. Arciuolo, W1ZAH	30
Juan P. Munoz, KC2FKM	40

August 2020

Gary G. Gimmestad, K9KOE	10
John D. LeJeune, KR4CC	10
John D. LeJeune, KR4CC	15
Brian E. Lewis, KO4AXD	15
Gary G. Swenson, KA2HAN	15
Christopher H. Tenev, K2QFA	15
Nancy K. Wigginton, N1GFV	20
Philip L. Graitcer, K3UT	25
Larry A. Miller, NR3R	25
Michael E. Snook, W7LG	25

September 2020

William A. Freeman, KE1G	10

Congratulations to all the recipients.

November 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.

November 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 K9JM on Wednesday, November 18 at 9 PM PST (0500 UTC on November 19) on 3590 and 7047.5 kHz. Unless indicated otherwise, sending speeds are from 10 to 35 WPM.

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

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

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

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

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

W1AW Code Proficiency Schedule — November 2020
(All times in Eastern Standard Time)

Monday	Tuesday	Wednesday	Thursday	Friday
11/2 4 PM – 2100Z 10 – 35 WPM	**11/3** 7 PM – 0000Z **(11/4 – UTC)** 35 – 10 WPM		**11/5** 10 PM – 0300Z **(11/6 – UTC)** 10 – 40 WPM	**11/6** 9 AM – 1400Z 10 – 35 WPM
	11/10 4 PM – 2100Z 10 – 35 WPM		**11/12** 9 AM – 1400Z 35 – 10 WPM	**11/13** 10 PM – 0300Z **(11/14 – UTC)** 10 – 35 WPM
	11/17 9 AM – 1400Z 10 – 35 WPM	**11/18** 10 PM – 0300Z **(11/19 – UTC)** 35 – 10 WPM	**11/19** 7 PM – 0000Z **(11/20 – UTC)** 10 – 35 WPM	**11/20** 4 PM – 2100Z 10 – 40 WPM
11/23 10 PM – 0300Z **(11/24 – UTC)** 10 – 40 WPM		**11/25** 9 AM – 1400Z 35 – 10 WPM	**Thanksgiving**	**Thanksgiving**

W1AW Schedule

PAC	MTN	CENT	EAST	UTC	MON	TUE	WED	THU	FRI
6 AM	7 AM	8 AM	9 AM	1400		FAST CODE	SLOW CODE	FAST CODE	SLOW CODE
7 AM-1 PM	8 AM-2 PM	9 AM-3 PM	10 AM-4 PM	1500-1700 1800-2045	VISITING OPERATOR TIME (12 PM-1 PM CLOSED FOR LUNCH)				
1 PM	2 PM	3 PM	4 PM	2100	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE
2 PM	3 PM	4 PM	5 PM	2200	CODE BULLETIN				
3 PM	4 PM	5 PM	6 PM	2300	DIGITAL BULLETIN				
4 PM	5 PM	6 PM	7 PM	0000	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE
5 PM	6 PM	7 PM	8 PM	0100	CODE BULLETIN				
6 PM	7 PM	8 PM	9 PM	0200	DIGITAL BULLETIN				
6^{45} PM	7^{45} PM	8^{45} PM	9^{45} PM	0245	VOICE BULLETIN				
7 PM	8 PM	9 PM	10 PM	0300	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE
8 PM	9 PM	10 PM	11 PM	0400	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.

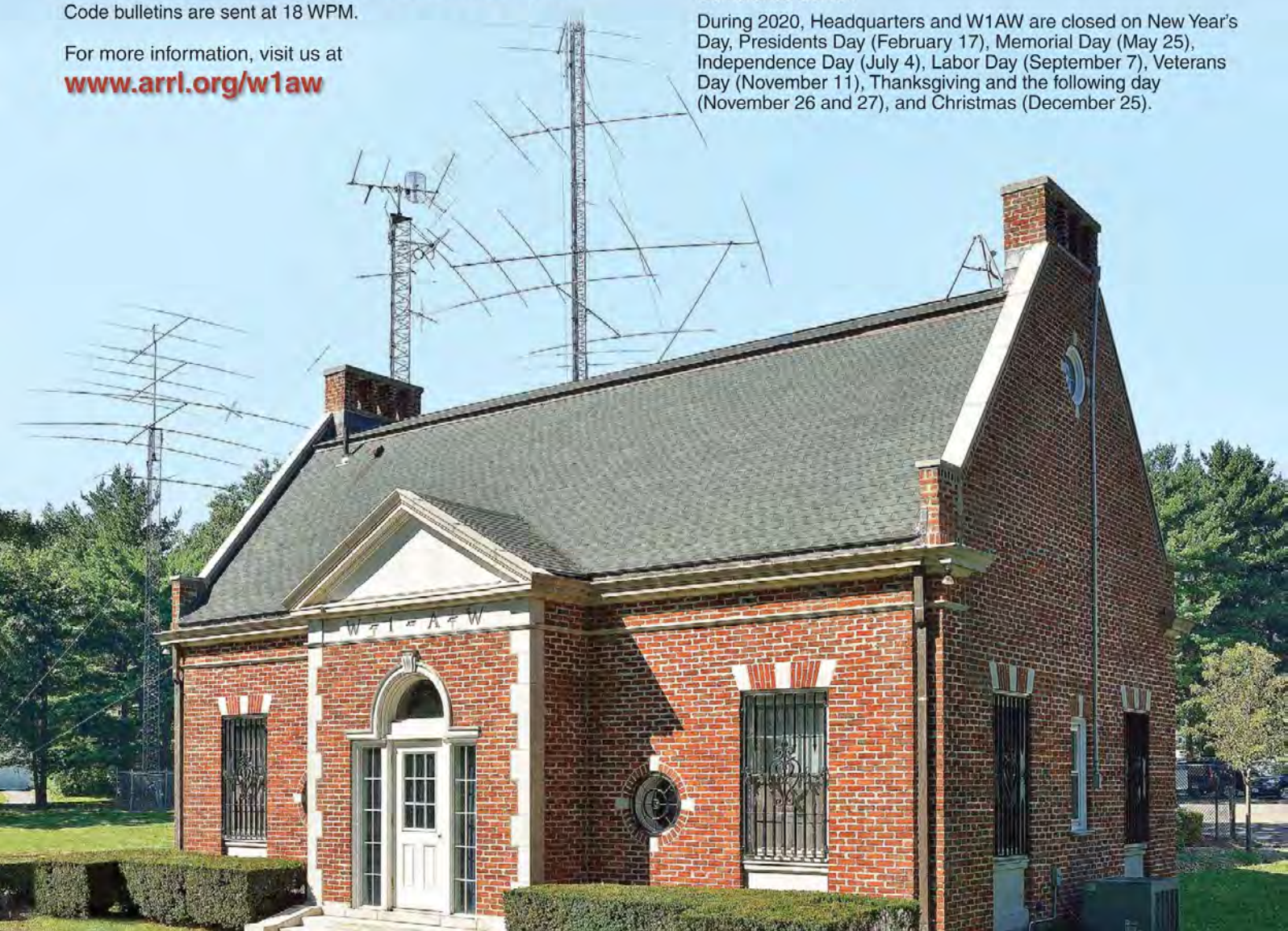
Keplerian elements for many amateur satellites will be sent on the regular digital frequencies on Tuesdays and Fridays at 6:30 PM Eastern time using Baudot and PSK31.

♦ 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).



A Look Back

QST
January 1971
75 Cents
devoted entirely to
amateur
radio
OFFICIAL JOURNAL OF THE ARRL

Gimmicks and Gadgets

The Compact-A-Test

A Complete Test Instrument for the Amateur Station[1]

BY BOB PALMER,* G5PP

MANY TEST instruments have been designed for radio amateur use, and if all were to be built a great deal of expense would be incurred, particularly for meters in things which are only used occasionally. Individual units take up a fair amount of space in the shack. In view of these considerations a basic design was drawn to find how many functions would be practicable in a compact switchable instrument.

Having an 8 1/2 X 4 3/4 X 3-inch box available, all that remained was to find out just what could be fitted into it. A 6-position, 8-pole, 4-section switch, S1, was used as a means of function selection. (See Fig. 1.) A field-strength meter with a-m phone-monitor facilities was the first unit built. A transistor-radio type telescopic antenna was added for making more distant measurements. Apart from using the coil L1 as a pickup medium, a link was connected to a coaxial socket so that a probe could also be used. Construction information for the probe is shown in Fig. 2.

The second unit built was a grid-dip meter. This oscillator also drives the third unit, an antenna impedance bridge. A tube oscillator is used. (A transistor oscillator would perhaps have been more convenient but would not have provided sufficient drive.) The coil, L1, is wound to suit the frequency to be covered, and is tapped at 1/7 of the total turns from the cold end to provide a cathode tap for the 6C4 tube. The tap can be used to feed the diode of the field-strength meter in place of the link, L2, which is shown in Fig. 1. The probe output and telescopic antenna are switch-connected to the circuit to widen its use.

The third function is that of an antenna impedance bridge. The bridge is driven by the GDO by means of the probe link coil, L2. The circuit whose impedance is to be measured is connected at J3. The bridge may be calibrated by means of known-value composition resistors placed across this jack, and the range is approximately 10 to 500 ohms. The meter is driven to full scale by advancing the GDO gain control, R1, and when the bridge knob is turned, a null or dip in meter reading will be noted. The impedance is read off against the calibration. The 150-pF differential capacitor must be insulated from the chassis and also shielded from the rest of the circuit.

*22 Sherlock Road, Coventry, Warwickshire, England.

[1]Adapted from *The G5PP Compact-A-Test*, published by the Midland Amateur Radio Society.

The Compact-A-Test, a device which performs many functions while using a single meter. The probe is seen in the foreground, and the telescoping antenna and probe-link coil are seen on the left end of the instrument.

SWR Indicator, Frequency Marker

The fourth function is that of a standing-wave-ratio indicator. This circuit is built into the top 8 1/2 X 3-inch face which contains the SWR-meter gain control and GDO gain control, together with the input and output coaxial sockets for the SWR indicator. The FORWARD/REVERSE switch is on the front panel. SWR is determined by the following ratio:

$$\frac{FWD + REF}{FWD - REF}$$

First, drive the meter to full scale by adjusting the gain control, R2, using the FORWARD position of the switch. This value will be read as 1. A second reading is now taken with the switch in the REVERSE position. If this was, say, 0.2, then using the formula, the SWR would be:

$$\frac{1 + 0.2}{1 - 0.2} = \frac{1.2}{0.8}$$

or a ratio of 1.5 to 1.

The reflectometer pickup line is made from 1/4-inch OD copper tubing approximately 9 inches long. A solder lug is attached to each end of the tubing. The hole in each lug fits over the center conductor of the coax sockets, and is soldered there. The tube is bent to fit between the box flange and the meter. At the exact center of the

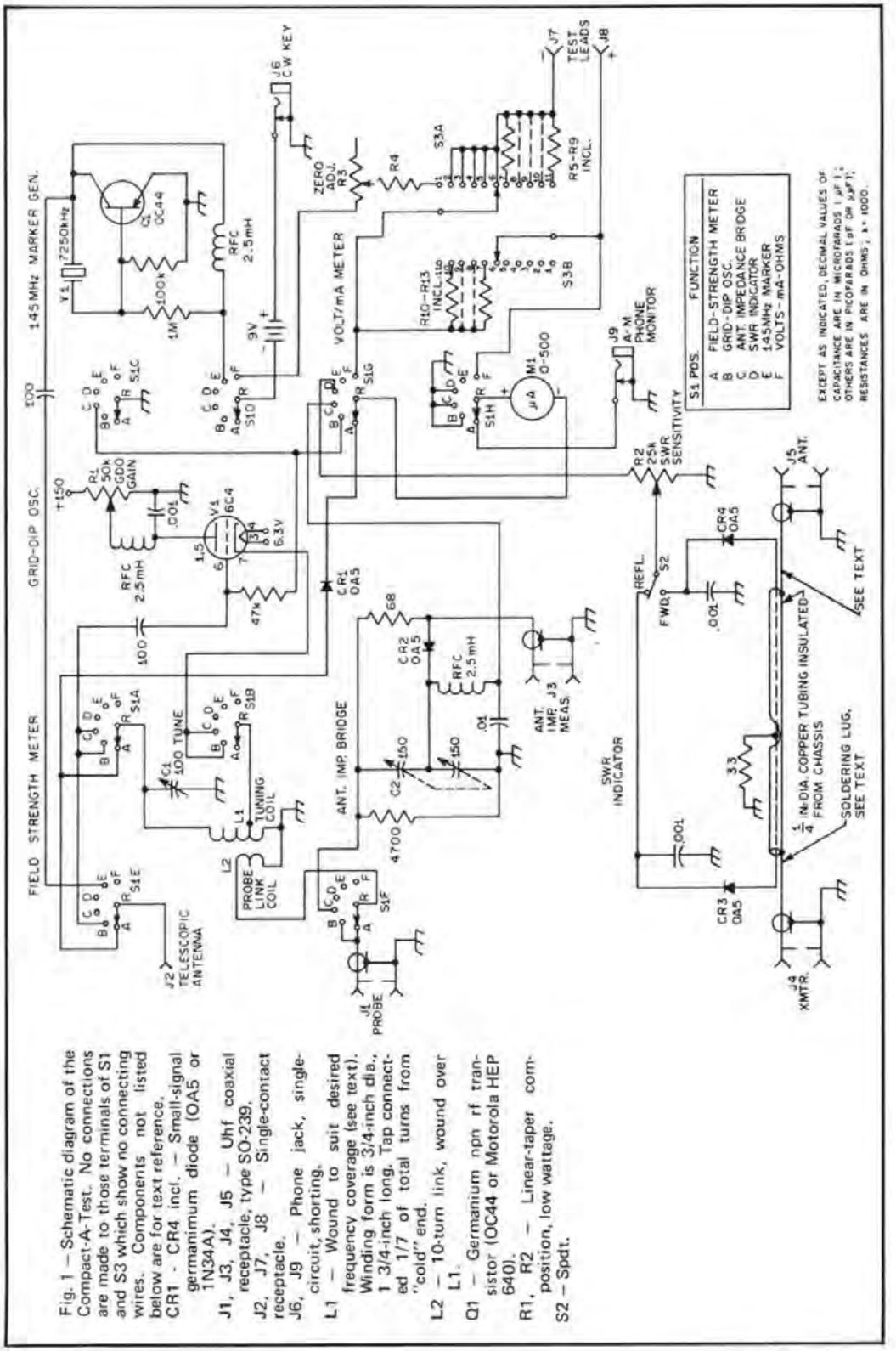


Fig. 1 — Schematic diagram of the Compact-A-Test. No connections are made to those terminals of S1 and S3 which show no connecting wires. Components not listed below are for text reference.
CR1 - CR4 incl. — Small-signal germanimum diode (OA5 or 1N34A).
J1, J3, J4, J5 — Uhf coaxial receptacle, type SO-239.
J2, J7, J8 — Single-contact receptacle.
J6, J9 — Phone jack, single-circuit, shorting.
L1 — Wound to suit desired frequency coverage (see text). Winding form is 3/4-inch dia., 1 3/4-inch long. Tap connected 1/7 of total turns from "cold" end.
L2 — 10-turn link, wound over L1.
Q1 — Germanium npn rf transistor (OC44 or Motorola HEP 640).
R1, R2 — Linear-taper composition, low wattage.
S2 — Spdt.

The interior of the Compact-A-Test. In this view S1 is visible in the lower-right corner of the enclosure, with C1 positioned just above it. In the lower-left corner is the 145-MHz marker generator circuit, and partially hidden by the crystal, is S3. The copper tubing in the SWR-indicator circuit is seen along the top edge of the enclosure. The two-tone oscillator board is visible on the side panel.

tube the metal is filed away on one side to form a slot in the wall of the tubing. The inner core of a length of 1/4-inch coax is now fed through the tube from each end and brought our via the slot in the center. The center of this coax inner conductor is returned to the chassis through a 33-ohm resistor. The far ends of this conductor connect to the diodes.

The fifth unit is a 145-MHz frequency marker. This consists of an OC44 transistor oscillator, with its 20th harmonic falling at 145 MHz. The signal is quite readable on this frequency and is also usable in the 70-cm band. The telescopic rod is used to radiate the low-level signal. By keying the battery lead, cw is obtained for Morse code practice and is receivable on 7250 kHz, or at any harmonic thereof.

The last unit controlled by the 6-position switch is a voltmeter/milliameter and short-circuit tester. This could be calibrated for ohms, if required. The voltmeter series resistors and the current-metering shunt resistors can be calibrated by Ohm's law to individual requirements, taking into account the resistance of the meter itself.

Having completed the units and checked that they worked, it was found that a large vacant space remained in the middle of the box. At the suggestion of G3OVQ, who kindly supplied the circuit, a two-tone oscillator was incorporated and made to fit into this space. See Fig. 3. This all-transistor unit is powered from the internal 9-volt battery, the negative lead being picked up with a small plug and socket, and fed through an ON/OFF switch.

(continued on page 42)

Fig. 2 — The probe is constructed from 1/4-inch diameter coaxial line such as RG-58/U. The shield is stripped from the coax and the center conductor is used to form the four turns.

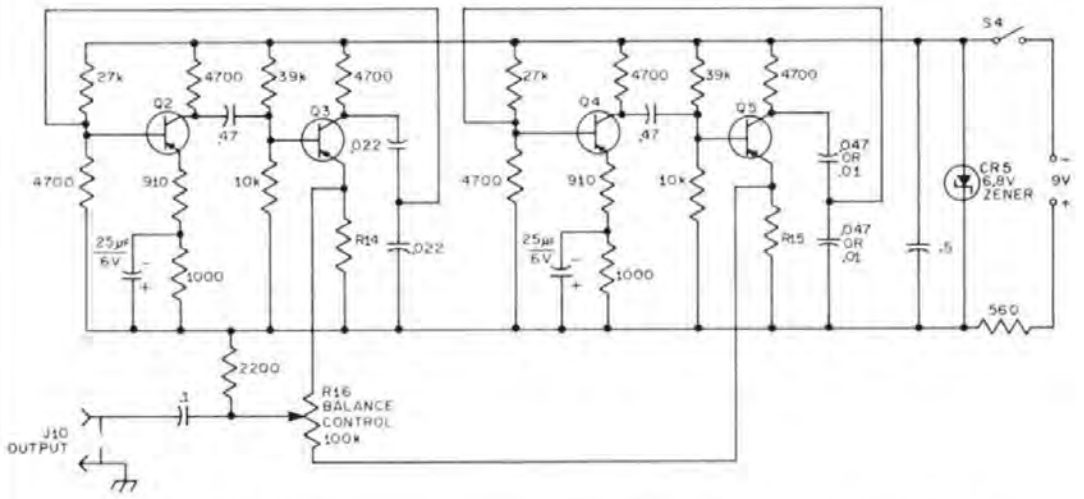


Fig. 3 — Two-tone oscillator.
J10 — Phono jack.
Q1 — Q5 incl. — Silicon pnp audio or rf transistor (BCY30 or 2N4059).
R14, R15 — Approximately 3000 ohms. Determine value experimentally to give sine-wave output.
S4 — Spst.

How It Works

All of the information we have seen on these antennas points out that this is a one-band-only antenna. But, it was discovered that the antenna received quite well on 15 meters. In fact, switching back and forth between it and the multiband vertical showed that the beam consistently outperformed the vertical on 15 and 20 meters. In true ham spirit, we decided to feed some power to the antenna on 15 meters and check the SWR. After all, nothing ventured, nothing gained! We were quite surprised to find that the SWR checked out at 1.5 to 1 at 21,260 kHz, and was fairly flat across the band.

The antenna has a spacing of 0.15 wavelength between the elements at 21 MHz, and what is a 135-degree phasing line on 20 meters becomes 202 degrees on 15 meters. There seems to be no more than a couple of dB difference on front-to-back ratio. In any case, the real proof is how the antenna performs, and in that respect we have no complaints. A lot of rare DX was worked on 21 MHz, and excellent reports were obtained.

Does the shortened ZL-Special work on 20? I'll say it does! No claims are made for forward gain, but I would guess it to be about 5 dB. Front-to-back ratio checks show that the antenna has about 20 dB of rejection off the back. With the antenna up 40 feet, and while running 350-watts input, about 50 new countries were worked in ten days of random operating. Many of them came back on the first call. The antenna hasn't been tried on 10 meters, it might even work there too. The 21-MHz results came as an unexpected bonus from what was built as a 14-MHz-only beam. One thing for sure, you can hardly beat the cost and simplicity of the antenna. QST

Gimmicks & Gadgets

(Continued from page 29)

Switch Functions

Perhaps the easy way to understand the wiring is to follow the switching functions which are next described.

Position A: FIELD-STRENGTH METER AND A-M PHONE MONITOR: The coil and tuning capacitor are connected to the OA5 diode, then through the meter and closed-circuit jack to ground. The probe circuit is energized from the link coil and the telescopic antenna is connected.

Position B: GRID-DIP OSCILLATOR: The coil and tuning capacitor are now connected to the 6C4 grid capacitor. The coil tap is connected to the cathode. The grid lead is returned to ground via the meter, whose positive terminal is grounded. The probe circuit is energized from the link coil, and the antenna is connected.

Position C: ANTENNA IMPEDANCE BRIDGE: The meter is switched to the output of the bridge diode. The 6C4 grid resistor is returned directly to ground. Output from the GDO (which remains operative in this switch position) is used to drive the bridge, again using the link coil which feeds the probe in positions A and B. The connection to the bridge for measuring the antenna impedance is made at J3. The impedance value is read on the calibrated dial associated with C2. The drive to the bridge is controlled by the GDO gain control, R1.

Position D: STANDING-WAVE-RATIO INDICATOR: The meter is transferred to the output of the two rectifiers, CR3 and CR4. The transmitter and station antenna are connected together by means of coaxial sockets, J4 and J5. Full-scale deflection in the FORWARD position is obtained by advancing the SWR sensitivity control, R2. The SWR is determined as outlined previously.

Position E: 145-MHZ FREQUENCY MARKER: The meter is not used in this circuit. The collector of Q1 is connected to the telescopic antenna, the 9-volt battery is switched on, and the key is plugged into the closed-circuit jack in the battery lead.

Position F: VOLTS - MILLIAMPERES AND SHORT-CIRCUIT TEST: The meter is transferred to the voltmeter-control switch.

The negative battery terminal is connected in the short-circuit test position (ohms).

Conclusion

Having set out to save money by doing away with the extra meters that would be required for separate instruments and using only one for the complete set, it seems logical to isolate the meter completely from the other functions. In this way it may be used for any other purpose which may come along. This is done by moving the selector switch to position F and the mA switch to position 6. The meter is thus available at the test leads. QST

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George Misic, KE8RN, ke8rn@comcast.net

Classic Radio

Hallicrafters Joins the Modern Age

Using lessons learned from the Collins S-Line and Drake 4-Line, Hallicrafters released two pairs of transmitters and receivers in 1962, leading the company's transition into the modern age. The SX-117 and companion HT-44 (plus a separate power supply) and the SX-146 and companion HT-46 (with a built-in power supply) were the two pairs that could transceive together.

The SX-117 and HT-44 shared a tunable intermediate frequency (IF) of 6500 – 6000 kHz, and a first fixed IF of 1650 kHz. The receiver used a last IF of 50.75, which is not used by the HT-44 transmitter. The receiver used the low-frequency IF to achieve selectivity. The transmitter used the phasing method to remove the unwanted sideband in the 1650 kHz range. No filters of any kind were used. The SX-146/HT-46 pair were single conversion and had an IF of 9.0 MHz. Selectivity for the SX-146 and HT-46 pair was achieved with crystal lattice filters at 9.0 MHz in each unit.

The SX-117 Receiver

The SX-117 was on the market between 1962 and 1965, and it cost $380 to $400. The receiver was fairly small and light at 15 inches wide, 7.75 inches high, and 14.75 inches deep; it weighed 18.5 pounds. It used a crystal-controlled first conversion, as first seen in the Collins 75A in 1946. The tuning control VFO tunes a fixed range, as did the similar stage in the companion HT-44 transmitter. Only 28.5 to 29.0 MHz of the 10-meter band was included, with band-switch positions for the three additional crystals that were needed to cover the complete 10-meter band. The receiver could tune 85 kHz to 3.0 MHz, if the HA-10 low- and medium-frequency converter was added. The SX-117 included a product detector for SSB and CW, and a diode detector was provided for AM use. A 100 kHz crystal calibrator was included, but it looks like Hallicrafters had originally planned it as an option, because it plugged in.

The HT-44 Transmitter

The HT-44 (see Figure 1) was sold between 1962 and 1965. It cost $395, and the power supply was $99.95. Just as its predecessor, the HT-37, the HT-44 used the phasing method to remove the unwanted sideband. The transmitter used a pair of 6146 final amplifier pentode tubes. Hallicrafters rated the HT-44 200 W peak envelope power (PEP) input on SSB and CW. The VFO and the first conversion crystal oscillator were linked together to enable the HT-44 and SX-117 to transceive. Both pieces covered 80/75, 40, 20, and 15 meters, as well as the 28.5 to 29.0 MHz portion of 10 meters. The HT-44 and SX-117 were the same size and were styled to match. The solid-state PS-150-120 ac power supply was sold to accompany the SR-150 and SR-160 transceivers in addition to the HT-44 transmitter.

Figure 1 — The Hallicrafters HT-44 transmitter. [Mike Dodd, N4CF, photo]

The SX-146 Receiver

The SX-146 (see Figure 2) was 13.125 inches wide, 5.875 inches high, 11 inches deep, and weighed 18 pounds. It was sold from 1965 to 1968 and cost between $250 and $295. The SX-146 receiver covers 80/75, 40, 20, and 15 meters, as well as the 28.5 to 29.0 MHz portion of 10 meters. Crystals could be added to fully cover 10 meters. WWV and the WARC bands were not covered. The SX-146 was a single-conversion design with a 9.0 MHz IF. The receiver premixed the band-defining

Figure 2 — The Hallicrafters SX-146 receiver. [Photo courtesy of **www.universal-radio.com**]

Figure 3 — The Hallicrafters HT-46 transmitter. [Photo courtesy of **www.universal-radio.com**]

crystals with the VFO; 80/75 and 20 meters was made by adding 20 meters or subtracting 80/75 meters of the VFO from the 9.0 MHz IF. The SX-146 came with a 2.1 kHz crystal lattice filter installed and tailored to SSB reception. A 0.5 kHz filter for CW and a 5.0 kHz filter for AM operation could be added and selected from a front-panel switch. The speaker was not built in, but it was an option. The SX-146 transceived only with the matching HT-46 transmitter. It was the last Hallicrafters receiver aimed at the ham radio market.

The HT-46 Transmitter

The HT-46 (see Figure 3) was the companion transmitter for the SX-146 receiver and was introduced on the ham radio market in 1965. It sold for $349.95. The SX-146 and HT-46 were vastly lighter and less expensive than heavyweights like the HT-32 and SX-101 or SX-115.

The HT-46 generated an SSB signal by using a crystal lattice filter in the 9.0 MHz IF. The transmitter was a single conversion design with a built-in solid-state ac power supply. The HT-46 weighed only 26 pounds with the internal power supply; a great reduction when compared to the HT-32, which was 86 pounds. The HT-46 contained an internal antenna relay, which its predecessors did not come with.

The HT-46 was rated at 180 W PEP on SSB and 140 W on CW. A 6HF5 color-TV horizontal-sweep tube was used as the final amplifier. The 6HF5 was not pushed to its RF power limits, as the same tube was used in transceivers from both Galaxy and Swan, where they were rated for more power. Hallicrafters also used a pair of 6HF5s in their SR-400 transceiver, where they were rated at 400 W PEP and 360 W on CW.

The End of Hallicrafters Transceiving

Companies like Heathkit, KW Electronics, Swan, Kenwood, Yaesu, and Icom adopted the Collins and Drake ideas of receiver/transmitter pairs quite rapidly, leaving Hallicrafters to catch up. Both the SX-117/HT-44 and SX-146/ HT-46 had most of what could have been the keys to success, but the SX-117/HT-44 and SX-146/ HT-46 receiver/transmitter station pairs were the last products released from Hallicrafters.

Hammarlund, National, RME, Heathkit, and Hallicrafters all gave up the battle with Japanese manufacturers for market share around the same time. Hallicrafters was not able to sustain itself as a ham radio manufacturer, and the impacts of the Northrop purchase and business ventures in the communications electronics business were not sufficient to save Hallicrafters.

Drake, Collins, and Heathkit were still able to compete, with receiver/transmitter pairs on the market past 1968, and other ham radio products being produced into the 1970s. After that, Collins, Drake, and Heathkit found success in other areas of electronics, and Hallicrafters was left in the past.

Strays

Antique Wireless Association 2020 Virtual Conference Videos Available Online

The Antique Wireless Association's 2020 Virtual Conference presentations are available on YouTube. To access the conference playlist of 14 videos, visit the Antique Wireless Museum's YouTube channel, and search for the AWA 2020 Conference playlist.

ARCA Awards

In July 2020, the Arizona Radio Council of Arizona (ARCA) bestowed annual awards and scholarships in an online meeting. Winning the statewide ARCA Ham of the Year Award was Angie Buchanan, N7EMB, best known for starting the "Gal's Night Net" 6 years ago, geared toward helping female amateur radio operators. Annika Smith, KE7JOY, was awarded the ARCA Young Ham of the Year Award. The 17-year-old is an active ham radio participant in special events and serves as the net control station for the Saguaro NTS Net. ARCA also awarded a $2,500 scholarship to Charles Loftus, Jr., KI7DUV, who will be pursuing a degree in engineering. Charlie was a major contributor in the refit of the Pinal repeater site owned by the Arizona Repeater Association.

Celebrating Our Legacy

A Lifelong Mentor

I first heard about ham radio and Morse code when I was a Boy Scout in 1964. It interested me, but no hams lived in my neighborhood and I didn't have a shortwave radio to learn Morse code. I looked up Clara Reager, W2RUF, after finding her name in my local newspaper, and she let me visit her station. She gave me some code records and ARRL study guides and told me to let her know when I was ready for the code test.

The following year, my family moved to a new house that was a great distance from Clara. One night, on my way to the corner store, I heard code from across the street. I stopped and saw a man in his basement with two huge radios on his desk. The next day, I introduced myself. He was Ed Wilcox, K2TOV. It turned out that he also knew Clara. I spent as much time as I could listening to the code records and the study guide from Clara, and Ed even gave me a 1964 copy of *The ARRL Handbook*, as well as other books to study.

That July, I went to Ed with my radio and he gave me my test. It didn't sound like the five words per minute (WPM) I was accustomed to, but I copied my required 1 minute and then some. After the test, he told me it was 10 WPM! A few weeks later, I took the written test and waited for the results. Upon arriving home from the first day of school, I received a letter from the FCC. I officially earned my Novice-class license, WN2VJL. With help from my dad and some money I had been saving, I purchased a used Eico 720 transmitter and a Hammarlund HQ-110 receiver from Amateur Electronic Supply (AES). My dad and I installed a 40-meter dipole from my bedroom upstairs to the garage. That night, Ed and I went on 40 meters CW, and he was my first of many contacts as a Novice. By 1982, I had upgraded to an Amateur Extra-class license.

When I was older, I moved to Texas. I kept in touch with Ed until he became a Silent Key in 1999. After his passing, his wife told me to expect two packages but wouldn't tell me what they were. It turned out they were Ed's B&W 5100B and Hammarlund HQ-180 that I first saw him using back in 1965. What a gift! I look back now and think how fortunate I was to have Ed as a neighbor.

Alfred Wasielewski, WA2VJL
San Benito, Texas

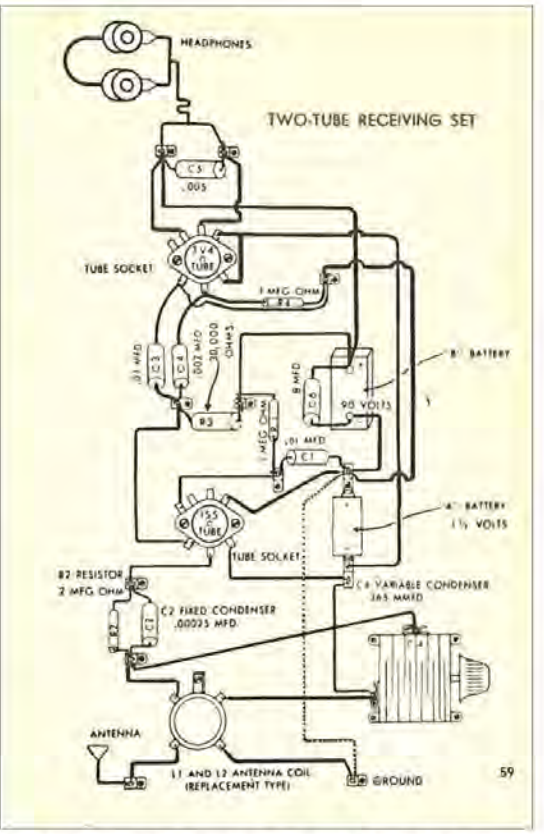
Cub Scout Turned Ham Radio Operator

My first experience building a radio was as a Cub Scout in 1956, with the crystal radio project in the *Wolf Cub Scout Handbook*. Most of the parts were easy to find locally in New Jersey, except for the crystal materials. However, because my father had worked on Radio Row in New York City before World War II, we went on a trip to New York to find what we needed.

In due time, I was able to receive some of the local AM stations along the New Jersey shore and the radio beacon from the Ambrose Lightship stationed 7 miles off Sandy Hook, New Jersey, marking the entrance to New York Harbor. I'm sure if I had built the two-tube receiver in the 1954 *Lion-Webelos Cub Scout Book*, I would've been able to hear a lot more stations. I'm impressed at the circuits that Cub Scouts were expected to build in those days.

There were a number of hams living in our neighborhood, due in part to the fact that my father and a number of neighbors worked at Fort Monmouth, a former installation of the US Army, where the electronics command was located. By simply looking for antennas behind neighbors' houses, I found a friend who was a couple of years older and had a ham station. I was able to watch and hear him make contacts all over the world. I also helped him respond to a few television interference (TVI) complaints from neighbors and confirm whether or not he was the culprit. Finally, after I graduated from college years later, I was able to pass the code test and get my own license.

Ira Goldman, KA2WNV
Penn Yan, New York



Two-tube receiving set from the 1954 *Lion-Webelos Cub Scout Book*.

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.

Al Brogdon, W1AB

100, 50, and 25 Years Ago

November 1920

- The cover art shows the linking of telephones to radiotelephones, discussed in this issue.
- The editorial, "Stolen Autos," reports that Headquarters is working with the Hartford Police Department to develop a plan for hams to circulate reports of stolen automobiles among themselves and the public.
- S. Kruse, of the Bureau of Standards, presents Part I of "The Bureau of Standards — A.R.R.L. Tests of Short Wave Radio Signal Fading."
- L. A. Hazeltine presents Part II of "Bulb Oscillators for Radio Transmission."
- "Radiophone-Telephone Linking" explains how the telephone line can be linked to the ham radiotelephone station.
- A. L. Groves presents "Addendum to Mr. Groves' August Article," based on his own experiments.

November 1970

- The cover photo looks inside W1QVF's high-power 6-meter amplifier, described in this issue.
- The editorial, "The Strength of Organization," discusses the importance of a unified voice for hams, which would be needed for the World Administrative Radio Conference in June 1971.
- In "A VTO for 80 through 10 Meters," Di Ming Lee gives us the details of his varactor-tuned oscillator.
- Thomas McMullen, W1QVF, and Ed Tilton, W1HDQ, describe Thomas' work in building "A 3-500Z Grounded-Grid Amplifier for 50 MHz."
- In 1968 – 1969, amateur phone patches became legitimate. George Schleicher, W9NLT, takes a look at "Phone Patching — One Year Later."
- Lew McCoy, W1ICP, describes his latest project, "A Station Control Unit for the Blind Amateur."
- W8KKF gives us a description of some excellent Public Service work in "Miami Valley F.M. Association Goes to the Boat Races."
- George Pataki, ex-YO2BO, reports on ham radio usage in several European countries (and some great travelogue information) in "Visiting My Relatives in Europe."

November 1995

- The cover photo collage shows various hams enjoying Field Day.
- The editorial, "A Golden Anniversary," looks back on the end of World War II, and recounts how hams started getting back on the air — some of them as service members, still in faraway places.
- Floyd Koontz, WA2WVL, relates his experiences with "Broadband Transmitting Wire Antennas for 160 through 10 Meters."
- "The Door to Damascus," by Rusty Epps, W6OAT; Tom McShane, NW6P, and Glenn Vinson, W6OTC, tells the tale of the first major ham operation from Syria by non-Syrian hams.
- Rick Campbell, KK7B, built "A Small High-Performance CW Transceiver" for 20 meters that features full break-in and single-signal reception, with 1 W output — and it will fit in your pants pocket.
- Mark Mandelkern, KN5S, shares the plans for "The AMSAFID: An Automatic Microphone Switcher Amplifier Filter Integrator Distributor."
- In "South Texas Stealth Sweepstakes," Paul Schaffenberger, KB8N, writes about operating in Sweepstakes with "invisible" antennas, and shares some good operating tips for the QRP and stealth-antenna hams.
- "Airborne Amateur Television," by Ronald Berkman, KA9CAP, recalls tales of his exploits flying radio-controlled model planes with an ATV camera on board.

Silent Keys

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

♦K1AG **Sullivan**, William J. "Bill," Bangor, ME
N1ATO **Larner**, James A., Bangor, ME
♦WB1BRE **Burden**, William A., Strafford, VT
WA1DRR **Ring**, David J., Quincy, MA
K1FCS **Souza**, Frederick C., York, ME
• KA1FGQ **Patenaude**, Oakley F., Chester, VT
KA1GYB **Miller**, Craig S., East Hartford, CT
K1LC **Colclough**, Lindsley D., Hingham, MA
WA1LFW **Belvin**, Thomas E., Brownville Junction, ME
• K1LXO **James**, Robert E., Skowhegan, ME
KB1QVY **Faverman**, Howard M. "Howie," Canton, MA
K1WJY **Frost**, Donald M., Bar Harbor, ME
NJ1Y **Parker**, Don E., Bryant Pond, ME
KF2AB **Slocum**, Donn C., Clifton Park, NY
AB2DE **Struble**, Glenn K., Stillwater, NJ
♦W2FF **Petersen**, Timothy J. "Tim," Ridgefield, WA
WA2HCV **Pinchin**, Roy H., Sr., Sarasota, FL
AA2KS **Alderiso**, Richard J., Brick, NJ
N2KVN **Cirillo**, Victor, North Plainfield, NJ
♦K2KWK **Hill**, Dwight B., Rochester, NY
N2PTA **Bonney**, Barton "Bart," Davenport Center, NY
KC2WAS **Tartell**, Harold E., Newburgh, NY
KC3AVX **Heller**, Maurice C., Nazareth, PA
K3BYV **Mantell**, John Robert, Jr., Matthews, NC
WB3DYE **Reynolds**, Robert B., White Haven, PA
♦K3EYO **Mullen**, Kenneth H., Camp Hill, PA
W3GNQ **Drevo**, Richard N., Lewes, DE
N3MIQ **Fallon**, Brian J., Pasadena, MD
K3NXH **Gress**, Charles F., Jr., Pompano Beach, FL
K3RGB **Chitwood**, John S., Saint Petersburg, FL
K3SA **Lovelace**, Mary E., Gettysburg, PA
• W3YCI **Dickerson**, Lynn J., Philadelphia, PA
WX4ALA **Best**, Bobby J., Jr., Jasper, AL
N4AYZ **Walker**, David E., Wetumpka, AL
W4BGV **Wallace**, Roger N., Bedford, MA
AG4BJ **Gavin**, John M., Raleigh, NC
• KG4CAM **Olvesen**, Nils E., Jensen Beach, FL
KW4DD **Satterfield**, Hulbert F., Lillington, NC
AK4DF **Gaines**, Stephen L., Sr., Warner Robins, GA
♦W4DGH **Ringer**, Raymond E. "Ed," Valley Head, AL
KJ4EGN **Neiman**, Roy L., Fort Lauderdale, FL
N4EHD **Troutman**, Charles J., Chesterfield, VA
KD4FD **Dillard**, Deyla F., Camp Hill, AL
N4GBJ **Dodd**, Frank J., Jacksonville, FL
K4HBI **Swiderski**, Michael J., Norcross, GA
N4HWF **Barbour**, Richard E., Clayton, NC
W4HYU **Perkins**, John H., Hagan, GA
WA4IFM **Milligan**, Robert H. "Bob," Harrison, TN
K4JEJ **Lucas**, Richard R., Pendleton, SC
KJ4JPE **Hopkins**, Janice K., Swansboro, NC
KK4MCU **Caldwell**, Jack L., Macon, GA
KD4MMJ **Roggenkamp**, Thomas C., Jr., "Tom," Charlotte, NC
KS4NB **Lazar**, Lawrence, Wellington, FL
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♦KP4PQ **Madera**, Victor, Guaynabo, PR
NZ4S **West**, Richard D., Virginia Beach, VA
WA4SJD **Liechty**, James R., Leeds, AL
K4SNN **Boles**, George W., Knoxville, TN
KN4SXR **Schaefers**, Jeremiah, Oxford, AL
NV4T **Watson**, William E., Clarksville, TN
W4WMA **Austin**, William Mirl, Raleigh, NC
♦W4YP **Spindle**, Robert L., Haymarket, VA
• W5BWA **Miller**, Huie A. "Tony," Alexandria, LA
N5CTD **Murray**, John C. "Curtis," Arlington, TX
KD5EDP **Dickerson**, Jackie D., Altus, OK
♦W5FRG **Cater**, Brent A., Clarksville, AR
NF5J **Colburn**, Roger J., Plano, TX
WA5JHJ **Mraz**, Edwin J., Iola, TX
W5KC **Bradley**, Carl E., Lewisville, NC
KD5LVC **Walker**, John C., League City, TX
N5MOT **Moore**, John D., Jonesboro, AR
♦WB5QMT **Zone**, Robert M., Santa Fe, NM
WA5RBS **Scheibner**, James E. "Jim," Albuquerque, NM
N5SGV **Gray**, Patrick, Guthrie, OK
KD5SQO **Bledsoe**, Noah R., Dickinson, TX
NM5TX **Riley**, Horner F., Albuquerque, NM
W5UOM **Bowen**, Thomas B., Jr., Moore, OK
KE5ZED **Golden**, John S., Jr., El Paso, TX
KD6ACV **Pfingsten**, John E., Hemet, CA
W6AXD **Wynn**, Franklin L. "Larry," Minden, NV
KD6BSL **Kappler**, Arnold Frederick, Sr., Glendora, CA
NN6CW **Weiss**, Conrad M., Morgan Hill, CA
W6DEO **O'Hair**, Donald E. "Don," San Diego, CA
K6DT **Shuler**, Edward H., Bakersfield, CA
AA6FC **Ashby**, William L., San Jose, CA
KM6HA **Familian**, Arnold J., Henderson, NV
WB6MVP **Saltzman**, Daniel R., Las Vegas, NV
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N6UHX **Morgan**, Carol J., Folsom, CA
• W6VE **McConnell**, Roger A., Snohomish, WA
♦KF6XX **Bisson**, Wilfred W., Mission Viejo, CA
WA6YEU **Nystrom**, Darrell D., Vallejo, CA
K7AP **Brock**, Homer M., Saint Helens, OR
W7BNL **Mast**, David A., Whitehall, MT
WA7DO **Oaks**, Daniel G., Yakima, WA
♦AH7G **Darling**, Richard S., Sr., Keaau, HI
KC7HOU **Gardner**, Grant G., Cottonwood Heights, UT
W7LWS **Schaefer**, Leland W., Sunriver, OR
KB7MMV **Hallowell**, Robert G., Everett, WA
K7NBR **Ross**, Norman B., Millcreek, UT
N7QD **LeSieur**, Stanley B., Sandy, UT
N7RQP **Haggard**, Michael T., Erie, KS
KF7VKV **Phillips**, John E., Yakima, WA
WB8CCK **Playford**, Donald F. "Don," Jonesville, MI
N8GDM **Thurtle**, Richard V., Battle Creek, MI
WA8HNS **Gray**, Michael D., Washington Court House, OH
KB8IDJ **Hogg**, Clayton L., Chagrin Falls, OH
KA8IEC **Jordan**, Gerald F. "Jerry," Hillsdale, MI
• KE8IK **Feke**, John T., Painesville, OH
W8JGS **Sneed**, John G., Rock Hill, SC
W8JNC **Campbell**, John N. "Nick," Gahanna, OH
WD8QAZ **Headley**, Ronald L., Georgetown, KY
W8RM **Yount**, Richard H., Bradford, OH
WA8UGC **Stirzaker**, James R., North Ridgeville, OH
W8VMC **Gimpert**, John, Sterling Heights, MI
W8YL **Reed**, Rozetta I., Manitou Beach, MI
• N9AGM **Ulrich**, Robert L., Eureka, IL
• N9BOM **Caslin**, William E., Alexis, IL
W9CYI **Immekus**, Robert J. "Bob," Cedarburg, WI
AA9DE **Clevenger**, James T., Farmland, IN
WA9EIY **Bullock**, Kenneth L., Muncie, IN
KD9IQE **Clarke**, Paula, Verona, IL
• W9NNS **Jablonske**, William J., Chippewa Falls, WI
♦WB9NUG **Popiela**, Robert E., Saint John, IN
♦• K9PCB **Moersch**, Richard R., Ormond Beach, FL
W9ULS **Olson**, Francis S., Urbana, IL
N9XTG **Hepfer**, Gregory J., Bloomington, IN
NE9Z **Rinker**, William G., Moran, WY
• N9ZNC **Adee**, Eugene K., Clare, IL
K9ZRL **Robison**, Ray W., Mitchell, IN
WA9ZYE **Carver**, Thurman D., Lebanon, IL
KE0IEZ **Dowdey**, Randall S. "Randy," Canton, SD
N0JHW **Piatt**, William E. "Bill," Gideon, MO
W0OE **Gray**, Edith M., Salem, SD
♦K0OSL **Amundson**, Lester W., East Grand Forks, MN
KB0QC **Miller**, Richard C., Arvada, CO
AA0RV **Boone**, Melanie R. "Mel," Macon, MO
WB0YUL **Shaffer**, Samuel F. "Sam," Saint Paul, MN
♦KA0ONY **Berg**, Byron R., Fort Collins, CO
VA3BEK **Koutis**, Basile "Bill," Windsor, ON, Canada
VE3IIP **Chisholm**, Terry, McGregor, ON, Canada
VE4SE **Mills**, Thomas A., Winnipeg, MB, Canada
ZP6CW **Woolley**, Douglas, Caacupé, Paraguay

♦ Life Member, ARRL
• Former call sign

For information on how to list a Silent Key in *QST*, please visit **www.arrl.org/silent-key-submission-guidelines**.

Note: Silent Key reports must confirm the death by one of the following means: a copy of a newspaper obituary notice, a copy of the death certificate, or a letter from the family lawyer or the executor. Please be sure to include the amateur's name, address, and call sign. Allow several months for the listing to appear in this column.

Many hams remember a Silent Key with a memorial contribution to the ARRL Foundation or to ARRL. If you wish to make a contribution in a friend or relative's memory, you can designate it for an existing youth scholarship, the Jesse A. Bieberman Meritorious Membership Fund, the Victor C. Clark Youth Incentive Program Fund, or the General Fund. Contributions to the Foundation are tax deductible to the extent permitted under current tax law. Our address is: The ARRL Foundation Inc., 225 Main St., Newington, CT 06111.

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

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

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

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

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

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

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

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

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

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

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TS-890S | *HF/50MHz Transceiver*

• Receive performance on a whole other level from narrow bandwidth roofing filters that only full down conversion can provide • CW Morse code decode/encode possible with stand-alone unit • 150dB Blocking dynamic range (BDR) • Expanded touch operation scope • Kenwood Sky Command® II Support • Remote operation achieved without host PC Direct remote-control function (KNS)

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• Equipped with 500 Hz/2.7 kHz roofing filter as standard • ALC derived from TS-990S eliminating spike issues • Antenna output function (shared with DRV connector) • CW - morse code decoder function • Improved 1st mixer • New PFB key with multi-function knob • New split function enabling quick setting • LED backlight with selectable color tone

TM-D710G | *2M/440 Dualband*

• V+V/V+U/U+U operation • Built-in GPS • Built-in TNC for APRS & DX-Cluster operation • 50W 2M & UHF • 1,000 memories • Dual receive • Green or amber backlight colors • Latest APRS firmware w/new features • Sky Command II remote functions

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TM-V71A | *2M/440 DualBand*

• High RF output (50W) • Multiple Scan • Dual receive on same band (VxV, UxU) • Echolink® memory (auto dialer) • Echolink® Sysop mode for node terminal ops • Invertible front panel • Choice of green/amber for LCD panel • 104 code digital code squelch • "Five in One" programmable memory • 1000 multifunction memory

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• 5W TX, RX 118-524 MHz, VxU, VxV, UxU • APRS w/built-in 1200/9600 TNC • Built-in GPS, Built-in USB, digipeater • Echolink® compatible • Mil-Spec STD810

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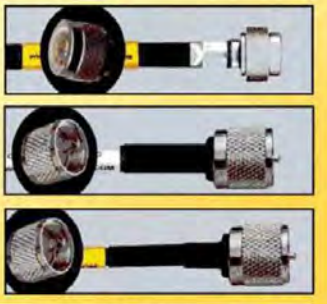

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HAM-VI – $809.95 with DCU-2
HAM-VII – $959.95 with DCU-3

HAM IV and HAM V Rotator Specifications	
Wind Load Capacity (inside tower)	15 square feet
Wind Load (w/mast adapter)	**7.5 square feet**
Turning Power	800 in.-lbs.
Brake Power	**5000 in.-lbs.**
Brake Construction	Electric Wedge
Bearing Assembly	**Dual race/96 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	26 lbs.
Effective Moment (in tower)	**2800 ft.-lbs**

TAILTWISTER SERIES II – $869.95

For Large Medium Antenna Arrays up to 20 sq. ft. wind load.

Has 5-second brake delay, Test/Calibrate functions. Low temp grease, tough alloy ring gear, indicator potentiometer, ferrite beads on potentiometer wires, weatherproof AMP connectors plus 8-pin plug at control box, triple bearing race with 138 ball bearings for large load bearing, electric locking steel wedge brake, North/South center of rotation scale meter, low voltage control, $2^{1}/_{16}$" max mast. **MSHD, $139.95**. Above tower heavy duty mast support. T2X, HAM-IV, HAM-V, HAM-VI. Accepts $1^{7}/_{8}$-$2^{5}/_{8}$" OD.

T-2XD2 – $979.95 with DCU-2
T-2XD3 – $1039.95 with DCU-3

TAILTWISTER Rotator Specifications	
Wind Load Capacity (inside tower)	20 square feet
Wind Load (w/mast adapter)	**10 square feet**
Turning Power	1000 in.-lbs.
Brake Power	**9000 in.-lbs.**
Brake Construction	Electric Wedge
Bearing Assembly	**Triple race/138 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	31 lbs.
Effective Moment (in tower)	**3400 ft.-lbs**

CD-45II – $499.95

For antenna arrays up to 8.5 sq. feet mounted inside tower or 5 sq. ft. with mast adapter.

Low temperature grease good to -30 F degrees. New Test/Calibrate function. Bell rotator design gives total weather protection, dual 58 ball bearing race gives proven support. Die-cast ring gear, stamped steel gear drive, heavy duty, trouble free gear train, North center scale, lighted directional indicator, 8-pin plug/socket on control unit, snap-action control switches, low voltage control, safe operation, takes maximum mast size to $2^{1}/_{16}$ inches. MSLD light duty lower mast support included.

CD-45D2 – $599.95 with DCU-2
CD-45D3 – $659.95 with DCU-3

CD-45II Rotator Specifications	
Wind Load Capacity (inside tower)	8.5 square feet
Wind Load (w/mast adapter)	**5.0 square feet**
Turning Power	600 in.-lbs.
Brake Power	**800 in.-lbs.**
Brake Construction	Disc Brake
Bearing Assembly	**Dual race/48 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	22 lbs.
Effective Moment (in tower)	**1200 ft.-lbs**

New!

Hy-Gain Programmable DCU-3 Digital Rotator Controller

DCU-3 – $499.95

Hy-gain DCU-3 Digital Controller lets you program 6 beam headings! Gives you full automatic or manual control of your hy-gain HAM or Tailtwister Rotators.

Press a memory button or dial in your beam heading or let *Ham Radio Deluxe* (or other) take control. Your antenna auto rotates precisely and safely to your DX.

DCU-3 automatically jogs your antenna free and safely unlocks it before rotating begins (*great for older rotators with "sticky" brakes*) then turns off your motor before reaching its final heading. Your antenna gently coasts to a stop before the brake re-locks -- greatly reducing damaging overshoots and extending rotator life.

Simply press *Left* and *Right* buttons for full manual control and fine tuning.

Bright blue LCD shows current, dialed in and computer controlled beam headings in one degree increments and your call.

Calibrate lets you accurately match your display to your true beam heading. Has USB/RS-232 ports for computer control. Adjustable LCD sleep time. Field upgradeable firmware. 8.5Wx4.3H x9D".

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DCU-2 Digital Rotator Controller – $459.95
Like DCU-3, but less programmable memories. 110 VAC. Order **DCU-2X**, for 220 VAC.

AR-40 – $399.95

For compact antenna arrays and large FM/TV up to 3.0 square feet wind load area.

Dual 12 ball bearing race. Automatic position sensor never needs resetting. Fully automatic control -- just dial and touch for any desired location. Solid state, low voltage control, safe and silent operation. $2^{1}/_{16}$ inch maximum mast size. MSLD light duty lower mast support included.

AR-40 Rotator Specifications	
Wind Load Capacity (inside tower)	3.0 square feet
Wind Load (w/mast adapter)	**1.5 square feet**
Turning Power	350 in.-lbs.
Brake Power	**450 in.-lbs.**
Brake Construction	Disc Brake
Bearing Assembly	**Dual race/12 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**5**
Shipping Weight	14 lbs.
Effective Moment (in tower)	**300 ft.-lbs**

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YRC-1 – $369.95

Hy-gain YRC-1 – more features, more robust, far less prone to lightning damage. Costs less than repairing!

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YRC-3, $449.95. Like YRC-1 and adds 6 memories.

AR-500 Rotator/Controller – $169.95

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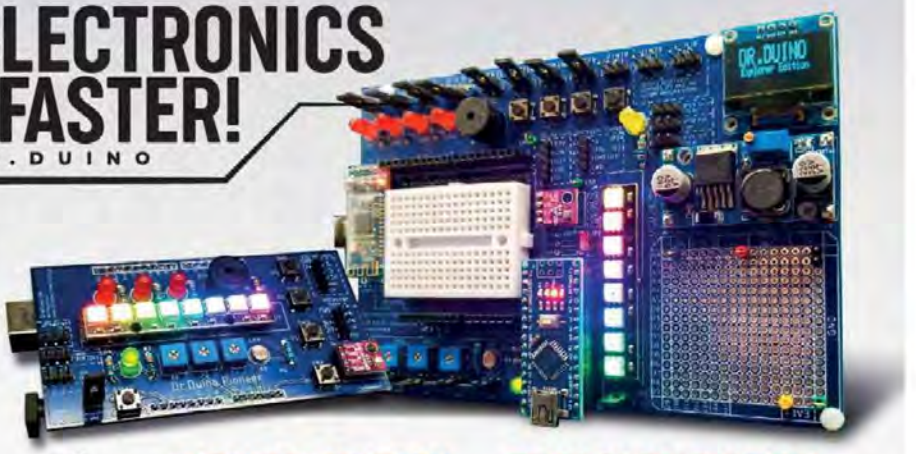

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MFJ-4230DMP, $159.95. Same as MFJ-4230MVP but has bright orange LCD digital volt/amp display.

Selectable input voltage of 120 or 240 VAC at 47-63 Hz lets you carry it with you and use it worldwide.

Front-panel rocker switch lets you choose Amp or Volt meter for continuous monitoring. Cool operation with excellent 75% efficiency. Extra low ripple and noise is less than 100 mV.

It's quiet! Continuous air-flow gently cools the power supply and a heat sensor increases the fan speed if the temperature rises above 70 degrees celsius.

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MFJ-4245MV Switching power supply gives 45A surge/40A continuous. 9-15 VDC out. 85-260 VAC in. Low ripple, highly regulated. 5-way posts, cig lighter, quick connects. 5 lbs., 7 1/2W x 4 3/4H x 9D".

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MFJ-4235MV switching power supply gives 35A surge and 30A continuous. 4-16 VDC with 1% voltage regulation. < 9 mV peak-to-peak ripple. AC input 90-125 or 200-240V. 7W x 4 1/4H x 8 3/4D", 4 lbs.

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MFJ-4115 Tiny! 17A surge, 15A cont. 13.8 VDC. 110/ 220 VAC. 3 3/4W x 2 1/4H x7 3/4D", 1.5 lb. 5-way posts. Switcher.

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MFJ-4225MV Switching power supply gives 25A surge, 22A continuous. Adjustable 9-15 VDC output, 85-260 AC input. Large 3" dual Amp/Volt meters, Binding posts, Cigarette lighter socket. 3.7 lbs. 5 1/4W x 4 1/2H x 6D inches.

25-Amps, $99.95

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MFJ-4128 28A surge, 25A cont. at 13.8 VDC. AC input voltage 85-135/170-260 VAC. 5-way binding posts, cigarette lighter socket, 7W x 2 1/4H x 7 1/2D", 4 lbs.

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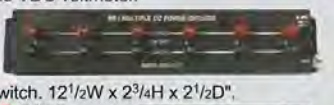
MFJ-1118, $99.95. Power two HF and/or VHF rigs and six accessories from rig's 12VDC supply. 35A high-current and 15A accessory binding posts, Voltmeter, on/off switch. Master fuse, RF bypass.

MFJ-1116, $69.95. Like MFJ-1118 but 15A total, 8 pairs 5-way posts. "On" LED, 0-25 VDC voltmeter.



MFJ-1112, $54.95. Like MFJ-1116 but 6 pairs 5-way binding posts, no meter or switch. 12 1/2W x 2 3/4H x 2 1/2D".

MFJ-1117, $79.95. High-current. Powers four HF/VHF radios simultaneously -- two at 35A each and two at 35A combined. 8W x 2H x 3D".

MFJ-1129, $139.95. 10 outlets. Installed fuses: two 1A, three 5A, three 10A, two 25A, one 40A. Outlets 1, 2, 4-8 are PowerPoles™. Outlet 3 is a 35A high current binding post, outlet 9, 10 are 15A binding posts. On/off switch, 0-25 VDC voltmeter. 12 1/2W x 1 1/4H".

MFJ-1128, $129.95. 12 fused *PowerPoles*™: three 1A, four 5A, four 10A, one 25A, one 40A. Switch. Meter.

MFJ-1126, $99.95. 8 fused *PowerPoles*™: One 1A, three 5A, two 10A, one 25A, one 40A. Switch. Voltmeter. 9W x 1 1/4H x 2 3/4D".

MFJ-1124, $79.95. Four pairs 35A *PowerPoles*™, two pairs 35A high current binding posts.

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Dual In-Line

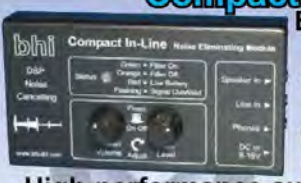
Fully featured amplified DSP noise canceling in-line module - Separate mono or stereo input and outputs - Headphone socket - Latest bhi DSP noise canceling technology - Suitable for all radios, receivers and SDR - Use with headphones and speakers at the same time

New NES10-2MK4

New improved NES10-2MK4
- 5W audio power - Latest bhi DSP noise cancelling
- Up to 65dB tone reduction
- Function switch on top of speaker for ease of use
- Power on, filter on and audio overload LED

DESKTOP 10W Amplified DSP noise canceling speaker - Easy to use controls - 8 DSP filter levels - Line and speaker level inputs - "Real time" audio adjustment - Suitable for all radios incl' SDR - Dims 7.90"(H) x 5.90"(D) x 6.29"(W)

Compact In-Line



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MFJ G5RV Antennas

Operate all bands 10 through 160 Meters with a single wire antenna!

***The famous** G5RV antenna is the most popular ham radio antenna in the world!*

It's an efficient, *all* band 102 foot long antenna – shorter than an 80 Meter dipole. Has 32.5 foot ladder line matching section ending in SO-239 connector for your coax feedline.

MFJ-1778
$69.95

Use horizontally or as Inverted Vee or Sloper with just one support. 1500 Watts.

Operate all bands 80-10 Meters with an antenna tuner and even 160M with ground.

Fully assembled with *ceramic* end and fiberglass center insulators. *Hang and Play*™ – add coax, rope to hang and you're on air!

MFJ-1778M, $59.95. *Half-size*, 52 foot *G5RV JUNIOR for limited space*. 40-10 Meters with tuner. Full 1500 Watts.

MFJ All Band Classic Doublet

MFJ 102 foot *all band* doublet covers 160-6 Meters with balanced line tuner. Super strong custom fiberglass center insulator relieves stress on 100 foot ladder line.

MFJ-1777
$79.95

Glazed ceramic end insulators. 1500 Watts.

RF Isolator

MFJ-915 *RF Isolator* prevents unwanted RF from traveling on the outside of your coax shield into your transceiver. This unwanted RF can cause painful RF "bites" when you touch your microphone or volume control, cause your display or settings to go crazy, lock up your transceiver or turn off your power supply. In mobile installations, stray RF could cause your car to do funny things even blow your car computer. Clear up these problems, plug an MFJ-915 between your antenna and transceiver. 1.8-30 MHz, 1500 Watts. 5 x 2 inches.

MFJ-915
$39.95

MFJ-919, $69.95. 4:1 current balun,1.5 kW.
MFJ-913, $39.95. 4:1 balun, 300 Watts.

True 1:1 Current

Balun & Center Insulator

True 1:1 *Current Balun/Center Insulator* forces equal radiator currents in dipoles for true dipole radiation pattern. Reduces coax radiation and field pattern distortion – your signal goes where *you* want it. Reduces TVI, RFI and RF hot spots. *Don't build a dipole without one!* 50 hi-permeability ferrite beads on high quality RG-303 *Teflon®* coax and *Teflon®* SO-239. 1.5kW 1.8-30 MHz. Stainless steel hardware. 14 gauge stranded copper wire is *directly* connected to your antenna. 5 x 2 inches. Heavy duty weather housing.

MFJ-918
$39.95

2-Position Antenna Switch

MFJ-1702C, $49.95. 2-position antenna switch, lightning surge protection, center ground. SO-239s.

Lightning surge protectors

MFJ-270, $24.95. 400W. **MFJ-272, $34.95.** 1500 W. Gas discharge tube shunts 5000 amps peak.< 0.1 dB loss. 1 GHz. SO-239s.

MFJ-16C06, $9.45. 6-pack *glazed ceramic* end/center ant. insulators.

MFJ-16B01, $24.95. Molded high strength center insulator. SO-239.

MFJ-16D01, $9.95. 450 Ohm fiberglass end/center insulator with ladder line stress relief and SO-239 mount.

MFJ-18H100, $44.95. 100 feet, 450 Ohm ladder line, 18 gauge copper clad.

80-10 Meter End-Fed Half Wave antenna

Cover all bands with one single wire and no tuner!

MFJ-1982HP
$109.95

No tuner needed!
All band 80-10M EFHW antenna

Get-on-the air on all bands 80-10 Meters with just one wire and one support (pole or tree) and no tuner or long counterpoise.

Installs anywhere in minutes! Rugged *insulated*-wire radiator prevents detuning when contacting limbs/branches. "*No-snag*" end insulator slides over branches, leaves.

Toss over a high limb for inverted-V or sloper or go vertical with an inverted-L.

Dark jacketed wire is virtually invisible – *don't let antenna restrictions keep you off the air!* Great for emergencies.

EFHWs naturally resonate on the 1/2-wave fundamental frequency and odd/even harmonics. Covers 80/40/30/20/17/15/12/10 Meters without traps, stubs or resonators.

Broad-band matching transformer at feed point gives SWR so low you may never need a tuner. Compensating inductor optimizes SWR. 800 Watts SSB/CW. 132 feet jacketed antenna wire.

MFJ-1984HP, $89.95. Like MFJ-1982HP but 40-10M. 66 feet jacketed wire.

See www.mfjenterprises.com for 30 Watt QRP and 300 Watt models.

Dual Band Dipoles

MFJ-17758, $99.95. Operate 80/40 Meters with a short 85 foot dipole. Full-size on 40 Meters with ultra-efficient end-loading on 80 Meters. 1500 Watts. Super-strong custom molded center insulator with SO-239 connector and hang hole. Ceramic end insulators. 7-strand, 14 gauge hard copper wire. No tuner needed!

MFJ-17758
$109.95
80/40 Meters

MFJ-17754, $69.95. Like MFJ-17758 but is only 42 feet. Operate 40/20 Meters. Full-size on 20 Meters, ultra-efficient endloading on 40 Meters. 1500 Watts.

Single Band Dipoles

Ultra high quality center fed dipoles give years of troublefree service. Custom injection-molded UV resistant center insulator has built-in SO-239 and hanging hole. Glazed ceramic end insulators. 7-strand, 14-gauge hard copper antenna wire. 1500 Watts. Use horizontally or as sloper or inverted vee. Simply cut to length with provided cutting chart.

MFJ-1779A
$79.95
160M, 265 ft.

MFJ-1779B
$59.95
80-40M, 135 ft.

MFJ-1779C
$39.95
20-6M, 35 ft.

OCFD Dipoles

MFJ-2012
$89.95
1500 Watts

MFJ-2010
$69.95
300 Watts

No tuner needed!

MFJ *Off-Center Fed Dipoles* use MFJ's exclusive *ExactRatio*™ RF broadband transformer to give low SWR and maximum bandwidth on 40/20/10/6 Meters. A Guanella current balun kills feedline radiation, pattern distortion, SWR shifts, RFI and noise pickup. Install anywhere and get the same predictable performance regardless of feedline length. You get ground reinforced gain over verticals. Use horizontally, inverted vee, sloper. 98% efficient, 14 gauge, 7-strand copper wire, ceramic end insulators.

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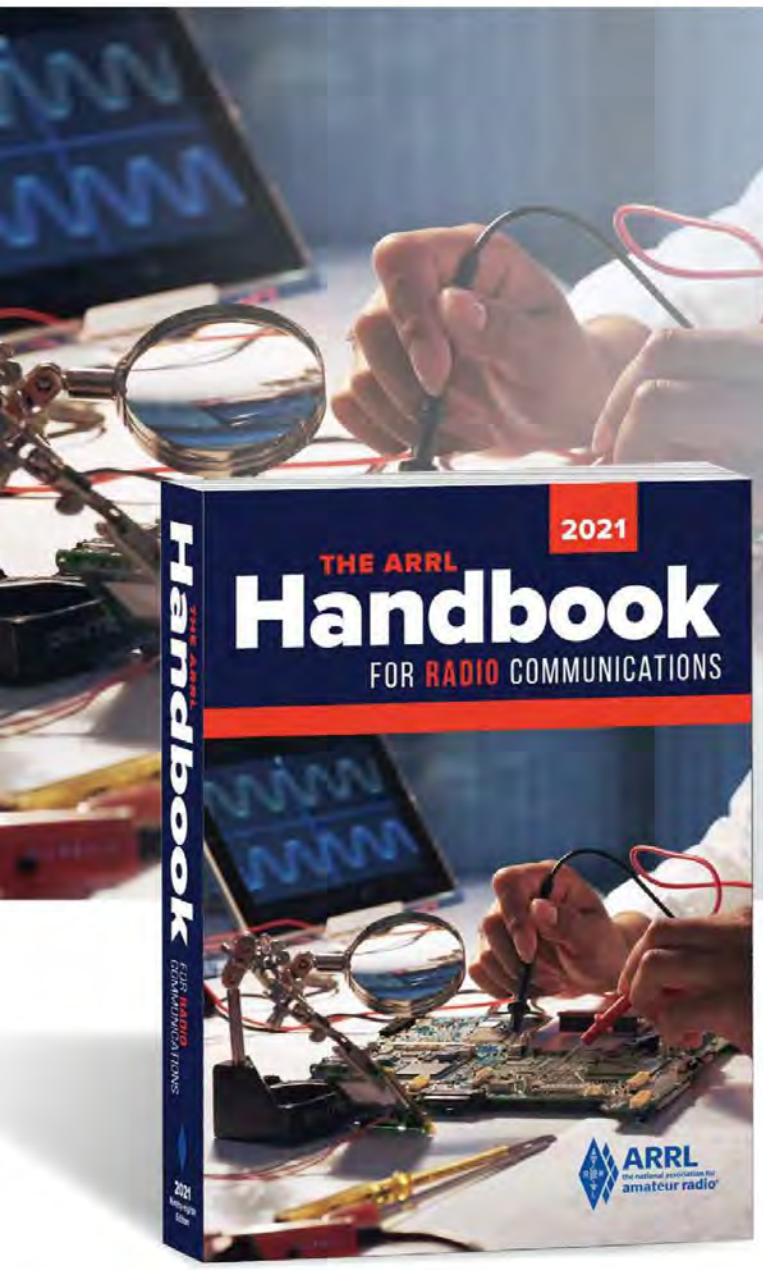

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MFJ Cobweb Antenna

6-Bands: 20/17/15/12/10/6 M...Outstanding Performance!

Restricted space spoiling your operating fun? MFJ Cobweb puts your call back on the map!

This six-band (20, 17, 15, 12, 10, 6 Meters) full half-wave *Cobweb Antenna* is perfect for restricted space or portable operation. Sky-gray fiberglass spreaders and *nearly invisible* wire elements (flat 9 x 9 x 1/2 feet square. 8 pounds), blend in with your surroundings while standing tough against nasty weather.

Outstanding performance! Horizontally polarized for less local noise pickup plus solid gain over verticals will allow you to work DX easily – even on QRP. Omni-directional. No radials needed! Works great at low heights. Low SWR is due to MFJ's exclusive *Spider-Match*™ broadband network. Use lightweight TV hardware to mount on your chimney, balcony, mast.

Low in cost, but big on performance. MFJ *Cobweb Antenna* turns your space problem into a stack of QSL cards from far away places.

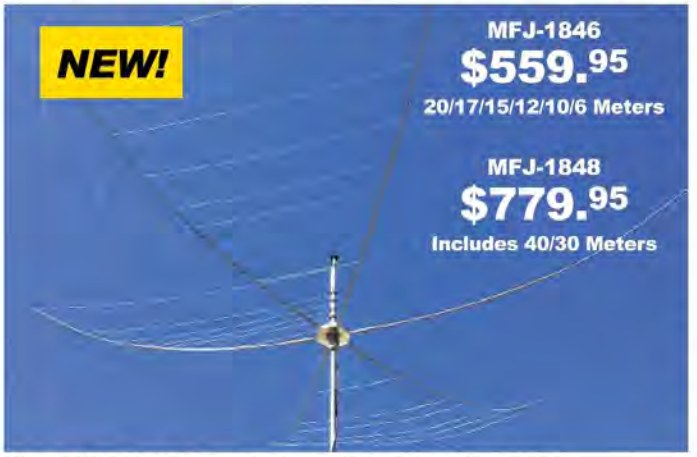
MFJ-1836HK34, $139.95. Add-on kit adds 40/30 Meters to MFJ-1835/1835H and MFJ-1836/MFJ-1836H cobweb antennas.

MFJ-1838
$459.95

40-6 METER Cobweb Super Heavy-Duty, 1.5 kW

New! Super heavy-duty 40-6 Meter Cobweb Antenna. Built to survive harsh northern winters, heavy snow, ice and strong winds – has super-strong large diameter fiberglass and heavy-duty 14 gauge stranded hard copper wire. 8-bands: 40, 30, 20, 17, 15, 12, 10, 6 Meters, 1500 Watts. Turning radius: 12 feet, 23 lbs.

MFJ 20/17/15/12/10/6 Meter *Hexbeam*



New MFJ HexBeams deliver solid gain and directivity on 20/17/15/12/10/6 Meters with two elements on each band.

MFJ uses an updated G3TXQ element configuration for excellent gain, improved bandwidth, superior front-to-back ratio and low SWR!

MFJ takes the HexBeam`s unique balanced-tension framework to a new level with rugged mounting hardware, exceptionally durable spreaders and sliding antenna-wire guides – designed to ensure years of reliable service.

MFJ-1846, $559.95. 6 Bands: 20/17/15/12/10/ 6M, 2-elements per band, full 1500W. 25 lbs. 11 ft.turning radius.

MFJ-1848, $779.95. 8 Bands: 20/17/15/12/10/ 6M, 2-elements per band; 40/30M, single elements, full 1500W. 28 lbs. 14 ft. turning radius.

www.mfjenterprises.com

3-Element Hexbeam

MFJ-1856 is ***six*** individually stacked monoband yagis!

6 Bands: 20/17/15/12/10/6M. Full 1500 Watts.

Three *full-size* elements on each band gives high gain, high front-to-back ratio and wide bandwidth. Works great at 20 feet. 30lbs. 17 feet turning radius. Ideal for a small rotator like hy-gain's CD-45II, $449.95.

MFJ Isolator and 1:1 Balun

MFJ-915, $39.95 Stop *RF* traveling down coax line, painful RF "bites" and erratic operation. 1.5 kW 1.8-60 MHz. 2W x 5H". SO-239s.

MFJ-918, $39.95 True 1:1 Current balun & center insulator forces equal antenna currents in dipole elements.

MFJ Dry Dummy Load

MFJ-260C, $49.95. Air-cooled, 300 Watt dry dummy load with a noninductive resistor in a perforated metal housing. SO-239 connector. Full load 30 seconds. Silk-screened derating curve to 5 minutes. SWR below 1.1:1 to 30 MHz, 1.5:1 from 30 to 650 MHz.

MFJ 2-Pos. Antenna Switch

MFJ-1702C, $49.95. 2-position antenna switch has center ground, auto grounding of unused position, handles 2.5 kW PEP and works to over 500 MHz. Lightning surge protection. Quality SO-239 connectors, heavy duty diecast.

MFJ-1704, $109.95. Like MFJ-1702C but has 4 positions.

MFJ G5RV Antenna

MFJ-1778, $69.95. G5RV antenna covers 160-10 Meters with antenna tuner. 102 ft. long. Inverted vee or sloper. Use on 160 Meters as Marconi. 1500 Watts. Super-strong fiberglass center/feed-point insulators. Glazed ceramic end insulators. Hand-soldered. Add coax, some rope and you're *on the air!*

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MFJ Magnetic Loop Antennas

MFJ 36-inch magnetic loop antenna lets you operate 7 to 22 MHz or 10 to 30 MHz continuously -- including the WARC and MARS bands! Easily handles a full 150 Watts on SSB/CW/Digital for any transceiver.

Ideal for limited space -- apartments, small lots, motor homes, attics, or mobile homes.

Work exciting DX with low angle radiation and local close-in contacts with high angle radiation when mounted vertically.

Super easy-to-use! MFJ remote control auto tunes to your desired band. Fast/slow tune buttons, Cross-Needle SWR/Wattmeter lets you quickly tune to your exact frequency. No control cable needed.

***World's** most efficient small loop antenna has all welded construction, welded butterfly capacitor with no rotating contacts, large 1.050 inch diameter aluminum radiator -- gives you highest possible efficiency.*

Every capacitor plate is welded for extremely low loss and polished to prevent high voltage arcing. Nylon bearing, anti-backlash mechanism, limit switches, continuous no-step DC motor gives smooth precision tuning. Heavy-duty ABS plastic housing has ultraviolet inhibitor protection.

MFJ-1782, $459.95. Like MFJ-1786 but with fast/slow tune manual remote control.

MFJ-1780, $369.95. 20-10 Meters, 150 Watt *Portable* 24x24x24" *box fan loop with carrying handle.* Highly efficient all-welded contstruction, no-rotating contact butterfly capacitor. Fast/slow tune remote control. No control cable needed. *See QST July 2019 review.*

MFJ-1780XX, $449.95. Like MFJ-1780 with auto band tune remote control, SWR/Wattmeter.

Build your own Mag loop!

Motorized Butterfly Capacitors

Super low loss butterfly capacitors, no rotating contacts, all plates welded with no mechanical electrical contacts. Anti-backlash mechanism. DC motor with gear reduction box. Handles at least 150 Watts SSB/CW/Digital.

1. **p/n: 282-1786, $189.95.** 11-128 pF.
2. **p/n: 282-1788, $249.95.** 15-260 pF.
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4. **p/n: 80-1782-2, $79.95.** Manual remote control, fast/slow tune buttons.

Butterfly Capacitors

5. **MFJ-19, $79.95.** 12-67 pF.
6. **MFJ-23, $109.95.** 18-136pF.
7. **p/n: 729-0142, $19.95.** 6:1 vernier gear reduction drive for loop tuning capacitor.

8. 36-inch Aluminum Circular Loop with Integrated welded capacitor and mast mounting brackets
p/n: 10-1786-11, $129.95. 1.05 inch OD heavy duty tubing.

See MFJ Youtube reviews at: *https://m.youtube.com/results?search_query=mfj*

MFJ Magnetic Loop Tuners, 150 Watts

C ***Turns wire or coax into a small, high efficiency multi-band transmitting magnetic loop antenna!***

B **Work** the world 3.5 to 30 MHz with a *full 150 Watts* SSB/CW/Digital. No ground, radials or counterpoises needed.

A ***New*** larger matching capacitor is 313 pF. Increases matching range. Butterfly capacitor has no rotating contacts.

Very quiet receiving antenna -- you'll hardly notice static crashes. High-Q reduces QRM, overloading, harmonics. Perfect for apartments, antenna restricted areas and portable operation.

A 13' wire loop covers 30-20 Meters (4' for 17-10M; 7' for 20-15M; 28' for 60-40M; 50' for 80M). Tune *any* shape loop -- circle, square, rectangle, *etc.*

A wire length gives about 1.5 to 1 frequency range (i.e.7-10, 18-28 MHz).

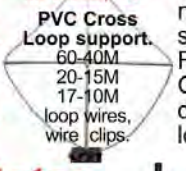
Easy-Carry handle. Mount for PVC Cross loop support on cabinet top. Included tripod/mast mount.

A. MFJ-936C, $299.95. Antenna current meter, Cross-Needle SWR/Wattmeter. 9¼Wx5½Hx9½D".

B. MFJ-935C, $249.95. Antenna current meter. 6¼Wx5½Hx9½D".

C. MFJ-933C, $209.95. 6¼Wx5½Hx9½D".

MFJ-58B, $59.95



MFJ Low-Noise Receiving Mag Loop

Clearly hear signals 50 KHz to 30 MHz you never knew existed. Power line noise and static disappears. Rotating MFJ-1886 eliminates interfering signals or greatly peaks desired signals. Excellent antenna and preamplifier balance gives deep null. Gives excellent strong and weak signal performance without overload. Fully protected state-of-the-art push-pull Gali MMICs preamplifier gives you high dynamic range, low IMD and 25 dB of low noise gain. Use inside or outside.

QRP Mag Loop Tuner

MFJ-9232 **$69.95**

Turns wire around a bookcase, window, tree, etc. *into a small, high efficiency transmitting loop antenna!* Operate 40-10 Meters with included flexible wire loop (80/60 Meters with your bigger loop). No counterpoises, radials, ground needed. 25 Watts. Very quiet reception. Hi-Q reduces QRM, overload, harmonics. Great for apartments, antenna restrictions, portable ops.

VIDEOS: https://m.youtube.com/results?search_query=MFJ-9232

Antenna Rotator

Perfect for magnetic loops, VHF/UHF, small HF beams, TV, FM antennas. Weather-proof cast aluminum housing with precision all metal gears, steel thrust bearings and automatic braking. Includes rotator, controller, remote control, clamps, hardware. 12 Memories. Digital display. 110/220 VAC.

$169.95

MFJ Tripods/Masts

Strong, black *steel* triangular braced base. Non-skid feet, strong mast locks.

MFJ-1919, $109.95, Supports 100 lbs. Extends a *whopping* 7.8 ft. Base spreads up to 4.8 sq. ft. 1.4" dia. mast. Collapses to 54" by 6" diameter. 9¾ lbs.

MFJ-1919EX, $179.95. Tripod *plus* mast. 18' extended. 5' collapsed. 1/8" wall, 3/4" dia. top, 1½" dia. bottom.15 lbs.

MFJ-1918, $69.95, 6'extended. 38" collapsed, 6¾ lbs.

MFJ-1918EX, $109.95. Small tripod with extension mast. 9½', 3.8 ft. collapsed. ¾"top, 1" bottom. 6.5 lbs.

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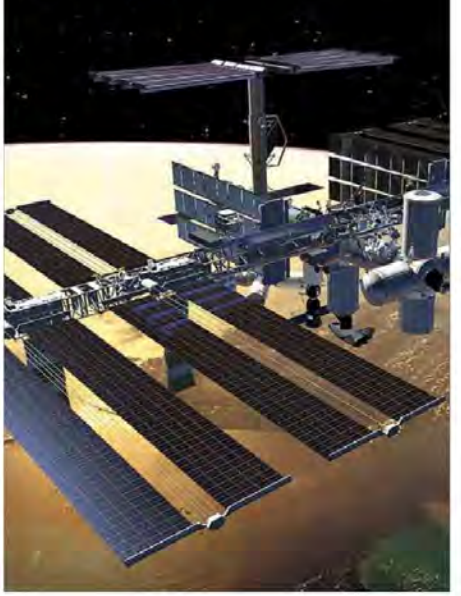

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MFJ Weather-Proof Window Feedthrough Panels

Weather-proof window feedthrough panels bring coax, balanced lines, HF/VHF/UHF antennas, random wire antennas, ground, rotator/antenna switch cables and DC/AC power into your hamshack without drilling through walls!

MFJ Weather-Proof Window Feedthrough Panels mount in your window sill. Lets you bring all your antenna connections into your hamshack without drilling holes through walls.

Simply place in window sill and close window. One cut customizes it for any window up to 48 inches. Use horizontally or vertically. Connectors are mounted on inside/outside stainless steel plates and attached to a 4 foot long, 3 1/2 inch high, 3/4 inch thick pressure-treated wood panel.

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Inside/outside stainless steel plates ground all coax shields. Stainless steel ground post brings ground in.

MFJ-4603 Universal Window Feedthrough Panel

MFJ-4603
$109.95

Four 50 Ohm Teflon® SO-239 coax connectors lets you feed HF/VHF/UHF antennas at full legal power limit.

A 50 Ohm Teflon® coax N-connector lets you use any antenna up to 11 GHz, including 450 MHz, UHF, satellite, moon bounce and 2.4/5.8 GHz Wi-Fi antennas.

A 75 Ohm, 1 GHz F-connector makes it easy to bring in television, Satellite, HD, cable TV and FM radio signals.

A pair of high-voltage ceramic feedthru insulators lets you bring in 450/300 Ohm balanced lines directly to your antenna tuner.

Has random/longwire antenna ceramic feedthru insulator.

5-way binding posts lets you supply 50 Volts/15 Amps DC/AC power to your outside antenna tuners/relays/switches.

Stainless ground post brings in ground connection, bonds inside/outside stainless steel panels together and drains away static charges.

MFJ's exclusive Adaptive Cable Feedthru™ lets you bring in rotator/antenna switch cable, etc. without removing connectors (up to 1 1/4 X 1 5/8 in). Adapts to virtually any cable size. Seals out rain, snow, adverse weather.

3 Coax, Balanced Line, Random Wire

Best Seller! 3 Teflon® coax connectors for HF/VHF UHF antennas. Separate high voltage ceramic feed-thru insulators for balanced lines and longwire/random wire, Stainless steel ground post.

MFJ-4602
$79.95

6 Coax

6 high quality Teflon® coax connectors for HF/VHF/UHF antennas. Stainless steel ground post. Full 1500 Watt legal limit.

MFJ-4601
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4 Balanced Line, 2 Coax

4 pairs of high-voltage ceramic feed-thru insulators for balanced lines and 2 coax connectors.

MFJ-4600
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5 Cables, any-size

5 Adaptive Cable Feedthrus™. Pass any cable with connector: 2 cables with large connectors up to 1 1/4 x 1 5/8 inches and 3 cables with UHF/N size coax connectors. Seals out weather.

MFJ-4604
$114.95

All-Purpose FeedThru/CableThru™

Stacks MFJ-4603 and MFJ-4604! Gives you every possible cable connection you'll ever need through your window without drilling holes in wall – including UHF, N and F coax connectors, balanced lines, random wire, ground, DC/AC power and cables of any size for rotators, antenna switches, etc.

MFJ-4605
$179.95

Bring cables through the eave of your house

MFJ-4616
shown with standard full size vent (not included) it replaces. For 6 Cables
$34.95

MFJ-4613
shown with standard half size vent (not included) it replaces. For 3 Cables
$19.95

Replace your standard air vents on the eave/sofitt of your house with these MFJ AdaptiveCable™ Air Vent Plates and...

Bring in coax, rotator, antenna switch, power cables, etc. with connectors up to 1 1/4 x 1 5/8 inches!

Sliding plates and rubber grommets adjust for virtually any cable size to seal out adverse weather, insects and varmints. Use existing vent hole, mounting screws and screw holes.

AdaptiveCable™ Wall Plates

MFJ-4614
For 4 Cables
$44.95

Bring nearly any cable -- rotator, antenna switch, coax, DC/ AC power, etc. -- through walls without removing connectors (up to 1 1/4x1 5/8 inches). Sliding plates and rubber grommets adjust hole size to weather-seal virtually any size cable.

Includes stainless steel plates for each side of wall, sliding plates, rubber grommets, weather stripping and screws.

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MFJ-259D is a complete ham radio test station including – frequency counter, RF signal generator, *SWR Analyzer*™, RF Resistance/Reactance Analyzer, Coax Analyzer, Capacitance/Inductance Meter and more!

You can read Complex Impedance as series resistance and reactance (R+jX) or as magnitude (Z) and phase (degrees).

Determine velocity factor, coax cable loss in dB, length of coax and distance to short/open.

You can read SWR, return loss and reflection coefficient at any frequency simultaneously.

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Every MFJ Analyzer is protected by MFJ's famous one year **No Matter What**™ limited warranty. We will repair or replace your MFJ analyzer (at our option) for a full year.

Read inductance (uH) and capacitance (pF) at RF frequencies.

Large easy-to-read two line LCD screen and side-by-side meters clearly display your information.

Built-in frequency counter, Ni-MH/Ni-CD charger circuit, battery saver, low battery warning, smooth reduction drive tuning.

Super easy to use! Just set the bandswitch and tune the dial – just like your transceiver. SWR and Complex Impedance are displayed instantly!

Fully portable, take it anywhere – remote sites, up towers, on DX-peditions. Use 10 AA or Ni-Cad or Ni-MH batteries (not included) or 110 VAC with **MFJ-1312D, $19.95**. Rugged metal cabinet only 4 x 2 x 6 3/4 inches.

MFJ-249D, $299.95.

If digital display is all you need MFJ-249D does everything MFJ-259D does without analog meters.

More hams use MFJ analyzers than all others in the world!

MFJ-269D

280 KHz - 230 MHz *plus* 415-470 MHz, 280-230 MHz plus 2200Meters!

MFJ-269D
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MFJ-269D is a *super* MFJ-259D that adds 415-470 MHz and 12-bit A/D converter that gives you much better accuracy. *Complex Impedance Analyzer* reads series/*parallel* equivalents and magnitude/phase *CoaxCalculator*™ gives line length from electrical degrees and vice-versa for any frequency, Velocity Factor, coax loss in dB. Use any characteristic impedance 10-600 Ohms. Has LCD log SWR bargraph, N-connector.

MFJ-223

1-60 MHz Color Graphic VNA Analyzer

MFJ-223
$339.95

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!

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- **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

1.5-180 MHz *continuous* Two-Port Graphic Analyzer

Out in the field, MFJ-225 is a compact completely *self-contained handheld graphing analyzer*. On the bench it becomes a full-fledged two-port (S21) desktop machine when teamed up with your PC. Using powerful IG-miniVNA freeware, you'll run detailed data analysis and print out stunning color-graphic plots to document your work!

MFJ-225
$339.95

Built-in back-lighted *3-inch LCD graphic* display. Make fine adjustments using fullscreen easy-to-view SWR bargraph, capture vivid swept displays for SWR, impedance, return loss, phase angle, more. DDS generator.

MFJ-269DPRO™ Analyzer

MFJ-269DPro, $459.95

Like MFJ-269D, but UHF range covers ***430 to 520 MHz*** to include commercial and industrial frequencies. Rugged protective shell protects knobs, switches, meters, digital display for commercial, industrial and lab work.

MFJ VNA Antenna Analyzer

MFJ VNA Antenna Analyzer covers 1 to 230 MHz, 1Hz resolution.

- ***Frequency sweep plots:*** *SWR, Impedance, Resistance, Reactance, Phase Angle, Complex Return Loss, Smith Chart*
- ***Sign of reactance*** positively identifies inductive or capacitive reactance
- ***Amazing accuracy with OSL (Open-Short-Load) calibration*** – calibrate through feedline/test cable at different frequencies and store in memory. Measure directly or through feedline with exceptional accuracy, correcting for line loss/phase angle. ***Smith Chart*** plots S11 magnitude/phase over any frequency span. ***Capture screens*** in 32 memories to download to PC via USB.

MFJ-226
$359.95

MFJ SWR Analyzer Accessories

- **A. MFJ-29D/MFJ-39D, $39.95.** Carrying Pouch for MFJ-259D/269D.
- **B. MFJ-92AA10, $39.95.** 10-Pack 2500 mAh Ni-MH Supercells.
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- **E. MFJ-917, $39.95.** 1:1 Current balun for SWR Analyzers to test balanced line antennas, other loads.
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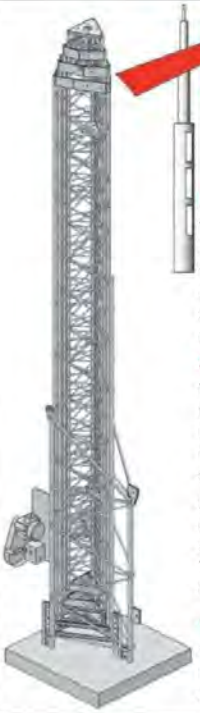

TASHJIAN TOWERS CORPORATION

Tower Model	Antenna Area EIA H 100 MPH	Price 2018
MW-33	45	$4,437
WT-51	12	$3,621
WT-67	11	$5,916
LM-237	20	$2,856
LM-354	18	$5,151
LM-354HDSP	45	$9,231
LM-470	24	$10,404
LM-584	13	$11,169
DX-70	45	$15,606
DX-70HD	70	$22,899
DX-86	26	$16,779
DX-86HD	38	$24,582
DX-100	24	$29,070
DX-100HD	40	$32,130
TM-370HD	28	$12,597
TM-490HD	42	$16,932
TM-5100HDR	32	$27,285

Engineered Towers

Tashjian Towers are engineered to hold today's bigger amateur antenna. Tashjian Towers are rated to meets the current ANSI EIA RS 222 Standard, Rev. "H". Stamped plans to your specific wind speed, topography are available by experienced registered professional civil engineers.

Superior Strength

Tashjian uses ASTM A513 1026 Type 5 tubing for tower legs. This high strength tubing allows for larger antennas at code wind speeds. W towers have pulley frames on one side, LM tower 2 sides, and DX towers all three sides.

All Tashjian Towers include the tower base, an operation manual, and winch. Delivery or lead time are 3 months but currently building towers to ship from stock. Cost to ship a Tashjian Tower is lower than other crank up tower manufacturers. Installation is available in California by Tashjian Towers a licensed contractor in Ca.

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600 Watt MFJ Automatic Antenna Tuner

MFJ-994B, $379.95. Like MFJ-993B but handles 600 Watts SSB/CW/Digital, matches 12-800 Ohms. 10,000 memories. Doesn't have LCD, antenna switch, balun, audio SWR meter. 10Wx2¾Hx9D inches.

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World's most advanced Automatic Antenna Tuners feature world renowned MFJ AdaptiveSearch™ and AutomaticRecall™ algorithms -- world's fastest ultra-wide range tuning. Nine World Class models! Choose your features: Digital/Analog/Audio SWR-Wattmeter, Antenna Switch, Balun, Radio Interface, Digital frequency readout, Remoteable, Coax/Balanced Lines/Wire Tuning, Field Upgradeable . . .

1500 Watt *Legal Limit*

for Ameritron AL-1500/1200/82 amps

Roam the entire HF spectrum 1.8- 30 MHz *hands-free* with full *1500 Watt* legal limit on SSB/CW/Digital and near-perfect SWR! Lighted LCD/Cross-Needle Meter.

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SWR/Wattmeter, 10000 VA Memories

Extra *wide matching range at less cost.* MFJ's *exclusive* dual power level: 300 Watts for 6-1600 Ohms; 150Watts for 6-3200 Ohms. Cross-Needle SWR/Wattmeter.

MFJ-991B **$259.95** *Full Digital Power!*

200 Watt ...Compact

Digital Meter, Ant Switch, Wide Range

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World's fastest compact auto tuner uses MFJ *Adaptive Search*™ and *InstantRecall*™ algorithms. 132,072 tuning solutions instantly match virtually any antenna with near perfect SWR. Bright LCD Display.

200 Watt *MightyMite*™

Matches IC-706, FT-857D, TS-50S

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Get greatly reduced losses and high efficiencies with long coax runs and high SWR antennas. *Full Digital Power!*

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MFJ-993BRT, $339.95. 300W.
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New, TrueActive™ peak reading Cross-Needle SWR/Wattmeter lets you read true peak power on all modes.

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Includes six position ceramic antenna switch, 50 Ohm dummy load, indestructible multi-color Lexan front panel with detailed logging scales and legends.

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New, crank knob lets you reset your roller inductor quickly, smoothly and accurately.

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New, cabinet maintains components' high-Q. Generous air vents keep components cool. $12^{7}/_{8}$W x 6H x $11^{5}/_{8}$D inches.

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MFJ-986 Two knob Differential-T™

MFJ-986 **$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

Superb, AirCore™ Roller Inductor tuning. Covers 6 Meters thru 160 Meters! 300 Watts PEP SSB. Active true peak reading lighted Cross-Needle SWR Wattmeter, QRM-Free PreTune™, antenna switch, dummy load, 4:1 balun, Lexan front panel. $10^{1}/_{2}$W x $3^{1}/_{2}$H x $9^{1}/_{2}$D inches.

MFJ-969 **$259.95**

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 7D 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 7D in. **MFJ-941EK, $139.95.** Tuner Kit -- Build your own!

MFJ-941E **$169.95**

MFJ-945E HF/6M mobile Tuner

Extends your mobile antenna bandwidth so you don't have to stop, go outside and adjust your antenna. Tiny 8W x 2H x 6D in. Lighted Cross-Needle SWR/Wattmeter. Lamp and bypass switches. Covers 1.8-30 MHz and 6 Meters. 300 Watts PEP. **MFJ-20, $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 6D 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 3D inches, full 150 Watts, 80-6 Meters, has tuner bypass switch, for coax/random wire. **MFJ-904H, $169.95**. Same but adds Cross-needle SWR/Wattmeter and 4:1 balun for balanced lines. $7^{1}/_{4}$W x $2^{3}/_{4}$H x $2^{3}/_{4}$D inches.

MFJ-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 3D in.

MFJ-921/924 **$109.95**

MFJ-931 Artificial RF Ground

Eliminates RF hot spots, RF feedback, TVI/RFI, weak signals caused by poor RF grounding. Creates artificial RF ground or electrically places far away RF ground directly at rig. **MFJ-934, $249.95**, Artificial ground/300 Watt Tuner/Cross-Needle SWR/Wattmeter.

MFJ-931 **$129.95**

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

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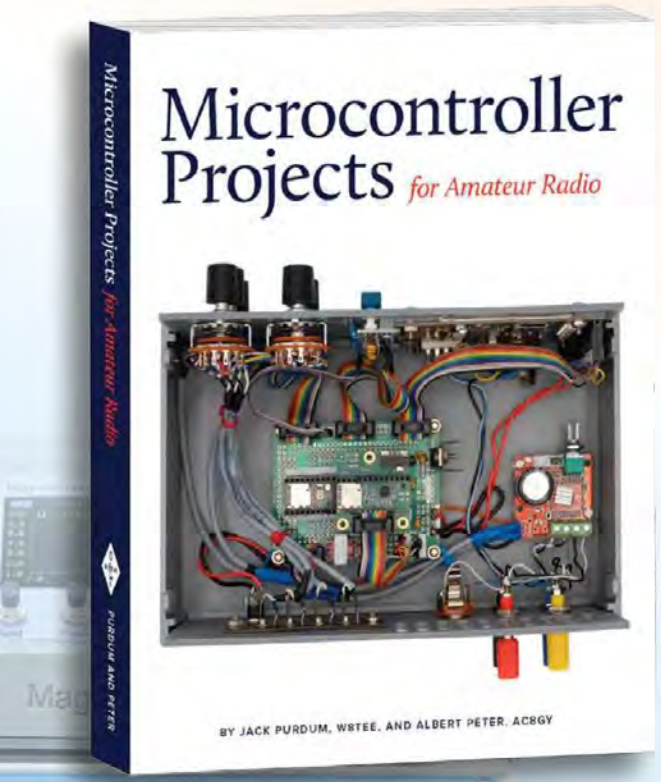

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- The Mini Dummy Load is small enough to fit in a shirt pocket, can handle up to 30W, includes an OLED display that shows RF power, yet can be built for around $20!
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MFJ-9234, $69.95. Like MFJ-9232 but connects directly to your transceiver SO-239 antenna connector.

VIDEOS: https://m.youtube.com/results?search_query=MFJ-9232

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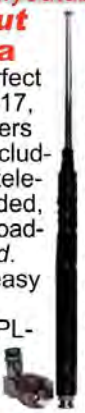

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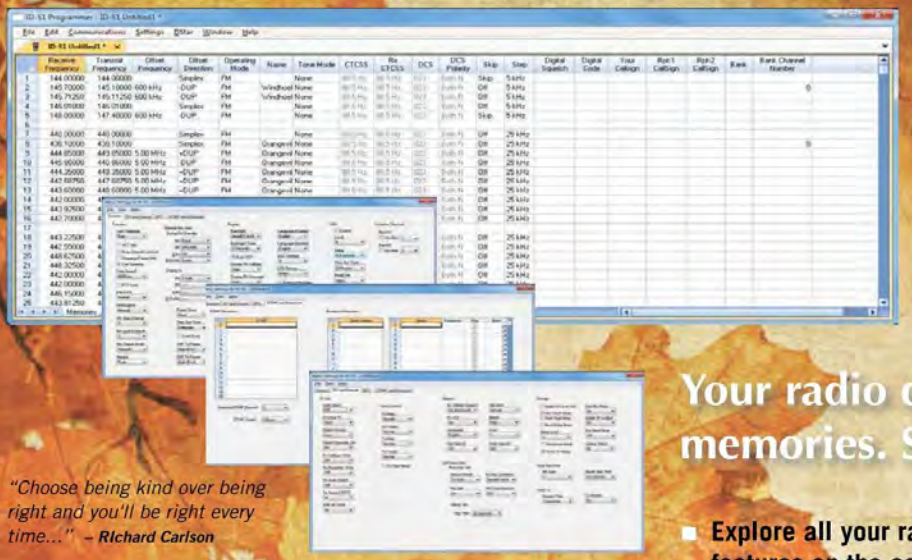

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