# PVRC Newsletter
## February 2020

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## President's Letter – Tom K3AJ

### Game Changer?

Like it or not, FT8/FT4 (FT modes) are here to stay. They are a game changer, all right – but maybe not always in a good way.

On the plus side, FT modes enhance the effectiveness of modest stations. They are beginner friendly and can be an entry drug to traditional ham radio pursuits like DX'ing and contesting. These modes are advantageous in weak signal realms such as Six Meter DX'ing. Surprising results can be attained using FT modes on bands otherwise left for dead here at the bottom of the sunspot cycle.

Every advance has its unintended consequences, though. The limitations inherent in the message coding preclude any semblance of the personal touch. The decoding doesn't rely on the human senses (although that is also true of RTTY and other digital modes) and that is a turnoff for some. Has the increase in FT mode activity caused a decrease in other, traditional ham radio communications? Some say it has – but no one has published data, that I know of.

Well, this is a hobby, after all, so each of us can decide for ourselves how we want to play. And there is no need to rain on someone else's parade. To each his own.

But those of you reading these words are here because we love contesting. And considering how the FT modes have, and may yet, affect the game is something we should be thinking about. There are two arenas in which this is relevant: RTTY contesting and VHF contesting.

In RTTY contesting, so far there hasn't been too much direct competition. The big CQ and other RTTY contests are still RTTY only. The ARRL RTTY Roundup has always permitted any digital mode, so FT modes are in play. Will FT Modes start squeezing RTTY out of RTTY Roundup? Not so far, it seems. Within the last couple of years, two FT mode only contests have been run: the FT Roundup and the World Wide Digi DX Contest. Both of those events have had good participation and are still evolving. To date, it doesn't look like the advent of FT modes has harmed RTTY contesting and probably

isn't likely to. The evolution of digital contesting appears to be moving in parallel paths for RTTY and FT modes.

VHF contesting may be a different matter, though. Has the advent of FT modes caused a drop in SSB and CW activity in VHF contests? Some say it has, and it sure seems that way to me, too. But a study of the data is needed to prove the point or dismiss the folklore. VHF and FT modes seem like a natural fit. The improved s/n ratio is especially important on VHF, and FT modes allow you to monitor all the workable stations on the mode simultaneously and find stations that would be otherwise widely separated. No dial spinning needed – just hang out at the watering hole looking for prey. It seems that some have fallen into the habit of sitting on the FT frequencies and staying there for most of the contest. A big downside of working someone on FT modes during the VHF contests is that it isn't possible to move that station to another band, as is common practice on the other modes.

The issue is this: is there a danger that VHF contests may turn into largely digital mode affairs? Does it matter? A good look at the data is needed to see where things are heading and open the debate. If it turns out that SSB/CW activity has suffered, what rules adjustments might make for more activity and more fun on all modes? A logical place to start is with the ARRL, as they sponsor the big three annual VHF contests. There is an ARRL Contest Advisory Committee, but it appears they only swing into action when directed by the Board Programs and Services Committee. If you want to see this matter investigated – speak up by contacting the members of that committee. Also, PVRC member Bob Teitel, W3IDT, is drafting a memo to be sent to the appropriate people involved in managing the ARRL and CQ VHF contests on behalf of the Wopsononock Mountaintop Operators VHF club (aka W3SO) on the impact of FT modes. If you have interest in this issue, please contact him as well.

73 Tom K3AJ

## Using the Steppir BigIR Vertical on 160 Meters (Sort Of…) – Ed N3CW

The following article presents a way of using the Steppir BigIR vertical as the foundation for a 160 meter inverted-L antenna. No irreversible modifications are made to the Steppir, and the concepts shown offer an easy way to mechanically erect a very useful inverted-L for 160 meters. Actually, having a Steppir vertical is not required, and in fact an extendable fiberglass mast (such as the ones available from MaxGain or DX Engineering) would also work. For those who already have a Steppir vertical in place, the addition of the inverted-L wires is especially easy.

### Introduction

The Steppir BigIR at the N3CW QTH is located in the backyard and was installed in the Steppir-recommended configuration using a DX Engineering radial plate and concrete-embedded aluminum mounting pole. The extensive radial field in place uses a mix of radials cut for both 80 and 40 meters, with about 60 radials in total. Having the Steppir fiberglass element and the existing radial field so readily available provided the motivation to put in place an inverted-L for 160 meters. The DX Engineering radial plate easily allows additional radials to be added.

To enhance performance of the new inverted-L, four additional 133-foot radials were added. Figure 1 presents the Steppir BigIR base before any inverted-L additions were made. The DXE radial plate can be seen, and the gray pipe emerging from the ground on the right carries the coax feedline and Steppir BigIR control cables. As an aside, sharp-eyed readers may spot the upgraded Steppir high wind kit, basically consisting of a thick fiberglass rectangular plate made to replace the old aluminum plate, which contributed to arcing in the EHU at high power on 80 meters.

Figure 1. Steppir BigIR base as installed before 160 inverted-L was added.

**Preparing the Steppir and Adding Wire**

The first thing I did to get this project underway was to add four longer radials for the 160 meter band. I was able to easily attach the added 133-foot radials to the radial plate and run them in four directions. As with all the other radials that were already in place, I used lawn staples every 6 to 8 feet, and within a few months the added radials were completely covered over by grass. Next, the Steppir vertical was lifted off its mounting pole, and laid flat on the ground.

I installed a cable clamp as shown in Figure 2 near the top of the fiberglass pole to prevent any possible downward slippage of the dacron guy ropes and pulley I was adding. The two ropes for top guys offset the pull of the horizontal inverted-L wire, and I added a small stainless pulley which allows me to pull up the new inverted-L wire, shown in Figure 3. I was careful to not disturb the vent tube in the Steppir top cap. I also used RTV to attach a couple of ½ inch diameter sections of PVC pipe to the Steppir EHU to act as standoffs for the inverted-L antenna wire.

Antenna wire length was determined by using the classic 234/f formula; in my tune-for-CW case length came out to about 128 feet. The Steppir element is only 32 feet in height, leaving about 92 feet for the horizontal portion of the inverted-L. The general rule for this type antenna is to go vertical as much as possible, so using the Steppir is a bit of a compromise over using a 40- or 50-foot fiberglass pole, or an existing tower. But a main feature of this antenna is “easy.”

Figure 2. Clamp added to top of Steppir fiberglass pole.

Figure 3. Top of Steppir pole showing two added guys and pulley.

**Observations, Notes, and Measurements**

Modeling by Dave, N3AC showed the inverted-L antenna to have an impedance of about 15 ohms. I chose to use a 1:4 unun from Balun Designs (Model 1435) giving a pretty good match to the feedline. Because I had only one available feedline in buried conduit going to the Steppir vertical, initial usage of the inverted-L required me to manually unhook the feedline from the Steppir and connect it to the unun. I later added an Ameritron RCS-4 coax switch, which allowed me to switch between the inverted-L and the Steppir vertical antenna without having to unhook the coax feedline.

The RCS-4 uses 12 volts AC riding on the coax feedline to activate switching relays. It does not require any separate control lines, and that was attractive in my situation because I did not have any spare lines running in my conduit to the Steppir. The Ameritron relay box and the Balun Designs unun can be seen in Figure 4. There is some interaction between the vertical inverted-L wire and the Steppir vertical when the Steppir is used for transmit on 80 through 10 meters. However, it is easy to manually lower the inverted-L wire when desiring to use the Steppir to transmit. In my situation, I usually use the Steppir vertical for receiving, so the interaction is not a big problem. When using the inverted-L to transmit, the Steppir tape is stowed thereby eliminating any degradation in 160 inverted-L performance.

Figure 4. Steppir base with RCS-4 relay box, Balun Designs unun, and PVC standoffs .

Figure 5 shows the inverted-L in place.

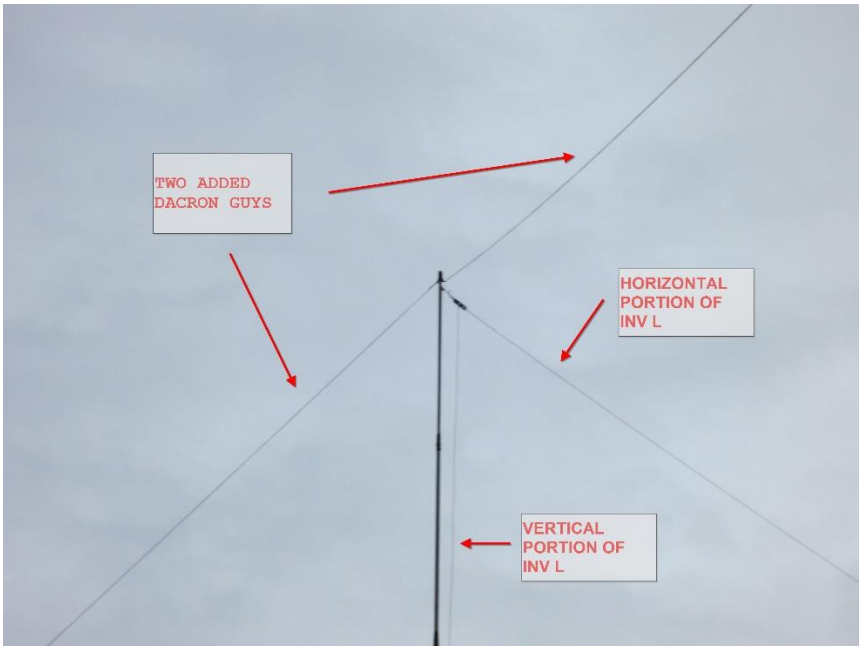



Figure 5. Top of Steppir showing inverted-L in place after being hoisted up.

Figure 6 presents another view of the antenna showing the far end of the horizontal section going to a 10 ft pole mounted on the side of the house. Of course, where to run the horizontal wire depends on each user's situation and desired orientation, but nearby trees would be another good alternative. The backyard slope is not nearly as bad as the photo makes it look!

Figure 6. The Steppir BigIR, and the inverted-L, with inverted-L wire highlighted in red.

Figure 7 presents SWR as measured with a Rig Expert AA-55 antenna analyzer.

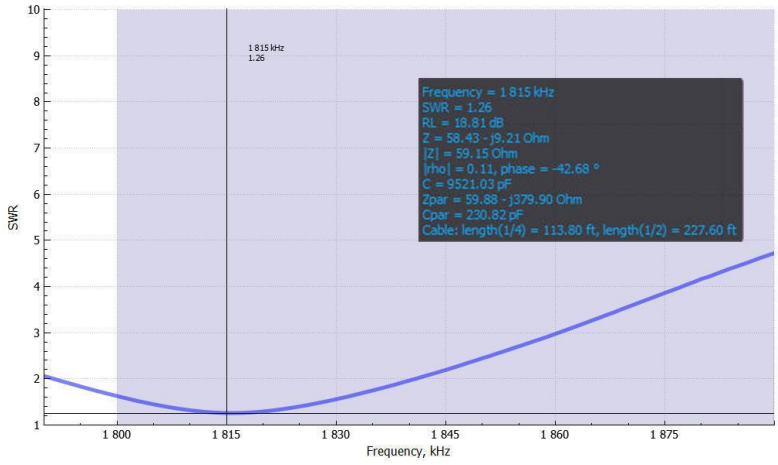



Figure 7. Inverted-L SWR.

### Possible Future Work

I would like to explore use of this inverted-L arrangement for 80 meters. There are many ways to do this, including installing a trap, lowering the wire cut for 160 meters and raising up a new wire cut for 80 meters, or perhaps designing a series LC resonant circuit with a shunt cap which should allow dual band operation. I would also like to experiment with angling the vertical wire away from the Steppir fiberglass pole to see if interaction effects with Steppir transmit operation can be eliminated. The Steppir continues to work well as a receiving antenna with the inverted-L wire in place as shown. Plans are in the works to add a couple of reversible Beverage-On-Ground receive antennas to supplement the transmit performance of this inverted-L.

### Summary

For those with an existing Steppir vertical already installed, the concepts presented allow a quick way to add a 160 meter antenna. For those without the Steppir, some additional work is required in the way of laying down a radial field and erecting a fiberglass pole. My recent 160 meter contest activity shows this inverted-L antenna to be a good performer.

## Ever Party Has a Pooper, That's Why We Invited Frank– Bruce WK3A

I found this picture still on my phone from Field Day. We were setting up a yagi and the background was beautiful blue sky, with some silly handiwork in view.

Frank W3LPL saw this and said "Take that down and I'll be back in 10 minutes! Are you guys nuts???"

## Dick W6MVW SK – Chas W3KC

Long time (since 1956) PVRC member Dick Wheelock W6MVW has become a Silent Key. I met Dick back in the 50's at a PVRC meeting. We operated in many events together. He was an excellent operator and a great guy. Dick's obituary is here.

## My Personal Experience with HamSphere – Rev. David E. Hamm K4EET

*(Editor's note: back in December I posted a note to the PVRC reflector about an upcoming contest in HamSphere, virtual ham radio environment software written by SM7NHC/5B4AIT. PVRCer Dave K4EET replied that he was a paying subscriber, enjoyed it and had seen non-hams turn into hams via HamSphere. Dave graciously agreed to write a short piece on HamSphere for the Newsletter – K3TN)*


**The HamSphere 4.0 Standard Transceiver**

Let me start by saying that there is a HamSphere 3.0 and a HamSphere 4.0 platform. The first HamSphere platform, Version 3, is mainly for folks that have never used a radio before. It is very scaled down from the Version 4 platform. The transmission path is still realistically simulated but the transceiver design is fixed. Once a HamSphere user becomes proficient with protocol and using the radio on the HamSphere 3.0 platform, then they are encouraged to try out the HamSphere 4.0 platform.

For me, I have used the HamSphere 4.0 platform from the get-go on my second go-around. Three or four years ago, maybe longer, when only HamSphere 3.0 existed, I had tried it out and found it to be a lot like EchoLink or QSONet's CQ100 so I did not subscribe. But in December 2018, I was invited to try out HamSphere 4.0 free for 30 days and I was immediately hooked. It was so realistic as compared to "real" radio, the transceiver configuration was fun to manipulate, and the DX entities were amazing. I even ran into a good Russian CW friend of mine from the ham bands on HamSphere! I could not believe the number of Amateur Radio callsigns that were using HamSphere too.

As it turns out, I am somewhat a "Rare DX Station" on HamSphere. There are currently only three stations in Maryland on HamSphere and only two are active; me being one of them. Many of the HamSphere stations need Maryland therefore on the various HamSphere bands to achieve Worked All States (WAS) and other awards for Stateside QSOs. Working pileups has been a real thrill on HamSphere. One can also "rent" remote locations in sought after locales and enjoy working split with huge pileups using SSB, CW, RTTY, etc. The fun is just beginning!

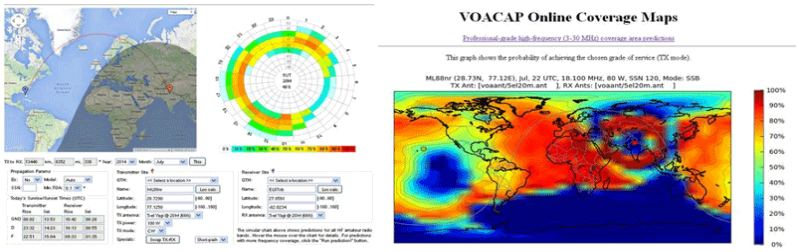

**Example of an enhanced HS4 transceiver constructed with multiple plugins**

Above you can see one of my transceivers that I have built for various applications; SSB, CW, SSTV, etc. Building transceivers and moving around modules to optimize operational speed and ease is a must.

In 2019 alone, there were 26 contests (schedule here) and every one of them was a blast. Four of the contests were 4 hours long with the remainder being 12 hours in duration. The contests were conducted in SSB and CW modes. Of course, being a CW op myself, I prefer the CW contests. But all of the contests have 3 tiers of winners on the various continents and First Place prize can be as much as €50.00 (Fifty Euros) to be spent on HamSphere transceiver modules and antennas.

Did I mention antennas? Gosh, this is where things get just a little imaginary (but are a whole lot of fun still). The antennas come in a whole bunch of configurations like Dipoles, Inverted-Vs, 4-Squares, Beverages, Delta Loops, Lazy-H, Verticals, Discones, Monopoles, 2/3/5/8 Element Yagis, Quads, Cardioids, etc. to name a few. LOL! What is really exciting is one can get a 2x2x5 Element Stacked Yagis on 160 Meters, 80 Meters, 60 Meters, 40 Meters, 30 Meters and all of the other bands up to 10 Meters. There is a forthcoming 6 Meter band. The 2 Meter and 70 Centimeter bands have linked repeaters worldwide. Only on HamSphere 4.0 will you be able to experience what it is like to have a rotatable 2x2x5 Element Stacked Yagis on 160 Meters that is designed and modeled correctly and incorporated into the HamSphere portfolio. I do not have the 160 Meter version but I do have the 80 Meter variety and it is a blast to use.

During most contests I will use the more conventional antennas with broader beamwidths because you have the whole world calling you to make Qs. Where my 2x2x5 Element Stacked Yagis on 80 Meters comes into play is during the two Radio Direction Finding (RDF) contests held each year. We form teams with team members usually based on the various continents to afford better triangulation measurements. The Stacked Yagis are especially useful in the RDF contests because they have very sharp nulls in their beam patterns. Note that I said null. A null is sharper so you can get a better heading/bearing on the remote fox. Of course the fox is a milliwatt transmitter placed somewhere in the world on one of the ham bands. The contest involves 4 foxes per 3 day period on 4 different bands over a 12 day period for a total of 16 foxes for each RDF Team to try to pinpoint. It is a whole lot of fun working together using Flopp's Map to do all of the triangulation work on.




**HamSphere Propagation and Prediction**

Finally, HamSphere 4.0 is also becoming a birthing place for new hams. I have seen several non-hams, those with a ###HS#### formatted callsign where the prefix is the country code and the suffix is the serialized number of the licensee, become Amateur Radio operators. Essentially, HamSphere 4.0 is able to so closely simulate what "real" Amateur Radio communications is like that users often inquire about getting their ham license. I also know of some HamSphere 4.0 users, both licensed hams and non-hams, that are learning Morse Code so that they can participate in the CW contests and work towards the CW awards.

I could go on and on about HamSphere but I understand that there is liability involved if somebody falls asleep, bashes their head on the floor and ends up in the hospital with a concussion. So with that, I must stop here. What you should do is at least do the free 30-day trial of HamSphere 4.0 by downloading the program here.

## N1RM Plants Tower Seeds in Northern VA – Mike W4RN

Rick planned and executed an impressive tower base installation at his new QTH

## The Magical One-Half Wavelength Feed line – Alan WA3EKL

Some time ago I responded to an antenna question on the Reflector and I mentioned the use of the One-Half Wavelength Feed Line length. I noticed responses from "he is just making the system more efficient" to "what is this guy talking about?" So, I decided to write a more detailed explanation of the practical use of this marvelous feed line length that many of us are not taking advantage of. I have been making use of the "one half wavelength" for more than 45 years and I want to share this information with all of you.

First, I want to give you the very easy theory on this wavelength then the practical use of it. Let us start with antenna Impedance whose symbol is "Z." First "Z" Impedance is not always equal to "R" Resistance although that is what most us have been taught or believe. You cannot measure 50 ohms Impedance with a common "resistance measuring" ohm meter. 50 ohms Impedance can be made up of many combinations of Resistance and Reactance and that Reactance can be Inductive or Capacitive. I finally realized that fact from Rol, K3RA's excellent teaching on the Smith Chart.

Please get a pencil and paper and draw a straight horizontal line across the piece of paper. At the left end, mark it with a Zero. In the middle write 180 and at the right end write 360. Half way between 0 and 180 write 90 and half way between 180 and 360 write 270. Those numbers represent degrees. Now look at the distance between the 0 and the 90-degree point. Extend the left side of the line that distance and mark its end – 90 degrees.

At the zero mark start to draw a sine wave starting at zero and rising to the highest point at 90 degrees then descending back to the line at 180 degrees. Now repeat except make the other half of the sine wave, starting at 180 go below the line and then return back up to the line at the 360 degree mark. You now have a full sine wave on your paper. Mark this line with a capital "I" for current. We are now going to draw another sine wave with the same amplitude as the first but shift it 90 degrees to the left. Draw a new sine wave just like the first starting at the - 90 degree point.

Mark this line with a big "E". It is the Voltage Line. If you have drawn the lines correctly then the peak of the first line "I" should be over the 90 degree mark and the lower peak should be over the 270 degree mark. The peak of the second line "E" should be over the zero mark and the lower peak should be over the 180 degree mark. Please take the time to draw this out then the explanation will be much easier to understand as I am explaining it. Note at halfway between zero and 90 degrees AND halfway between 180 and 270 degrees the I and E waves cross. This is where the current and voltage amplitudes are the same. Now for the Last alteration to your drawing! At zero Degrees draw a vertical straight line. At 180 degrees draw a vertical straight line and at 360 degrees draw a vertical straight line.

Look at the curves between the zero- and 180-degree lines. At 90 degrees the current" I" is very high and the voltage is very low. Here is where our ½ wavelength dipoles are normally fed or in the middle. Remember R = E/I, so very low E and very high I yields a low R. This is why our center fed dipoles are low resistance current fed devices. If you feed a dipole on the end the voltage is very high and the current is low thus a very high resistance R or impedance Z.

Now suppose you have a 20-meter dipole that is working perfectly fine. Now you try to feed it a 10 meter signal. That dipole is now one wavelength long. Look at your drawing. You would be feeding it at the 90-degree point or to the 10 meter signal it would be looking into the ends of two half waves dipoles on either side of its feed point. The end of a dipole is very high voltage and low current, thus a very high impedance point. This is one reason multi band antennas are hard to match and need some type of impedance matching device which is commonly called an antenna tuner.

Now, why have I given you all this information about antennas and had you draw the diagram? Because feed lines are basically like antennas.

Go back to the diagram. Look at the curves at the zero point on the line. The voltage is high and the current is low; a high impedance. Now look at the curves the 180-degree point. The voltage is high (except reversed) and the current is low; again a high impedance. The exact same impedance as the zero point. Now look at the 360 degree point curves. The voltage is high and the current is low. The exact same impedance as the zero- and 180-degree point. The point is simple, no pun intended, which has finally been published recently in numerous amateur sources; Impedance Repeats ever 180 degrees or every One-Half Wavelength.

Now for the Secret. Whatever impedance you attach to one end of a ½ wavelength feed line that exact same impedance will be reflected to the other end. It will also be reflected to any multiple of a ½ wavelength.

Now let us take it and step deeper and you are going to really like this information and some of you will never believe it until you prove it to yourself. What I am about to share with you I have proved from 1.8 MHz all the way to 450MHZ. This is information is what dramatically increased our contest scores over the years starting 45 years ago.

Many years ago, Bill Orr W6SAI wrote numerous antenna books. In one of his books he wrote the following. I don't have the exact wording, but this is how it went: If you use a ½ wavelength feed line, or multiple thereof, then the impedance of the "Load" will be accurately reflected back to the "Generator" **regardless of the impedance of the feedline**. What did that mean to me back then and us today? If your antenna is tuned to 50 ohms to begin with then you can use any impedance feed line between your antenna and your transmitter as long as it's a multiple of a half wavelength and you will get a 1 to 1 SWR. The feed line impedance does not have to be 50 ohms to get a 1 to 1 match. That means we can use 75 ohm, 62 ohm, 100 ohm 450 ohm etc feed lines and still get a 1 to 1 SWR match.

What did that do for me over 40 years ago? The cable company was installing cable all throughout Anna Arundel County. I got to be friends with the head engineer because of some leaks in their lines in my community. I asked what they did with the "end spool" lengths of cable. (leftover short pieces 50 to 300 feet.) He replied "We just trash it." I asked if I could have some and he said take as much as you want. It was 75 ohm semi rigid hard line with a solid aluminum outer shield covered in plastic and an inner conductor of solid aluminum coated with copper so I could solder to it. Though the use of a standard ½ inch brass compression plumbing fitting and a PL259 I was able to make end connectors for about $5.00 each at that time. Now days the plumbing fittings run about $5.00 apiece and the PL259 connectors about $2.50 apiece.

The Loss factor per 100 feet of the ½ inch cable TV 75 ohm hard line is 0.01 dB at 30 MHz. Yes, the decimal is in the correct place. I had been contesting in Glen Burnie Md and had a regular crew. At the time all our antennas were fed with RG213 and RG214 Teflon. One summer Paul, K3ZZ and I changed out all the RG213 for the 75-ohm Cable TV hard line. That fall the exact same crew came back. The conditions were considerably worse than the year before for the CQWW SSB contest. We turned in 800 Thousand more points than the year before. The operators asked if we had put up new antennas over the summer. When we told them what we did one op said it was as if we had added an extra element to every antenna for both receive and transmit!

All my antennas have a ½ wave length of RG312 coming from the antenna feed point. I attach an antenna analyzer at that point and tune the antenna for minimal SWR at a specific frequency. Then attach the RG213 to a random length of the Cable TV hard line which goes back to the shack. At the shack end of the hard line I attach a random length of RG213 and adjust it's length until I get the exact same SWR reading at the exact same frequency as I did at the antenna end. Now I know I have an exact multiple of a half wavelength from the antenna feed point to the shack end. The RG213 end in the shack then attaches to the antenna distribution panel.

What other uses does the ½ wavelength have? If you put up a half wavelength dipole and attach a random length of 50-ohm coax and expect it to be 50 ohms, you have no idea what impedance of the antenna actually is. An antenna analyzer will only be measuring the impedance of the antenna system meaning the coax impedance combined with the antenna impedance. However, if you feed the antenna with a ½ wavelength of coax or multiple of a ½ wavelength then measure your impedance with your analyzer you will know exactly what your antenna is doing and can tune the antenna accurately for lowest SWR.

What else can the magic Half Wavelength feed line do for you? Suppose you have set up some antenna, dipole, loop, yagi, with a random length of feed line and the lowest SWR you can get at resonance is 1.4 to 1. Your 2 to 1 SWR bandwidth is going to be just so wide. Now you go to a ½ wave feed line or multiple of a ½ wavelength and you find out your antenna is not tuned correctly. You re-tune your antenna so the SWR is now 1 to 1 at resonance. You have just increased your 2 to 1 SWR bandwidth considerably and your power output over that bandwidth. With our new solid state rigs as the SWR goes up the radio reduces the power going out so that the reflected power coming back does not burn up the final transistors. This reflected power also is what makes the amplifier tubes glow brighter red than normal! The reflected power is being burned up as heat in the tube's plates or the transistor's heatsinks.

Now for the good news: If you have tuned your antenna to 50 ohms to begin with, or the lowest SWR you can get, by using a ½ wavelength feed line you won't need an antenna tuner. Next you will have increased your 2 to 1 SWR bandwidth and you will now be radiating more power out over a greater bandwidth. Are these reasons not enough to adjust your feed line length to ½ wavelength?

If you come across some free TV hard line like I did you can still obtain a 1 to 1 SWR, have a much more efficient system on both transmit and receive and a greater SWR bandwidth power even though the feed line is 75 ohms.

Most important: Whenever you create a ½ wavelength of feed line of RG213, RG11, RG58, RG59, RG62 or any coax or open wire line, make sure you calculate in the velocity factor. Don't ever assume the velocity factor. Polyethylene, foam, gas filled foam, Teflon, etc., cables all have different velocity factors. Carefully check the manufacturer specifications for your type of cable or better yet measure it with an antenna analyzer especially at VHF and UHF frequencies.

492 x VF / Freq in MHz = Length in feet of a single ½ wavelength piece.

I hope this information has helped you gain a better understand of the ½ wavelength feed line length and will help all of us to bigger and better scores!

## W4DR Has 70 Years of QSOs in the Log – Ed KG4W


Now hear this! Our own Bob W4DR made his 1st QSO **70 years ago!** I don't know about that 1st QSO, but I cannot imagine he was anymore enthused then than he is now. Congrats Bob, and hope you have many more Q's.

Bob's current countries worked per band are

6 meters = 152
10 meters = 338
12 meters = 337
15 meters = 339
17 meters = 339
20 meters = 339
30 meters = 338
40 meters = 338
60 meters = 198
80 meters = 338
160 meters = 324

Outstanding job, Bob

## Notes from the Annapolis Chapter January Meeting – Dan K2YWE

Fifteen people attended the Annapolis chapter dinner meeting this evening, including potential new member Dave W3MAM. He is a bicycling friend of K3AJ's and was encouraged by Tom to attend a local meeting as soon as Dave moved here from Frederick county.

Bruce WK3A showed us the 1929 Hartley transmitter (and power supply) that he built for and used in the AWA Bruce Kelley Memorial CW QSO Party recently. Whoop, whoop!

Bill W3UL will be on Nevis in February for several contests as V47UM. Look at the V47UM QRZ page for his operating plans.

Chas KJ6LDA announced his upcoming retirement from a career in the US Navy. He expects to have more time for ham radio in his new career with Northrop Grumman Underseas near the Bay Bridge.

The attendees

WK3A explaining his Hartley power oscillator and power supply to KW2A. The Hartley is authentic 1929 design using parallel type 27 tubes.

## State QSO Party Challenge Announced


WN4AFP, K4SBZ, WB9CIF, N2CU and PVRC's own N8II have announced the yearly and year-long State QSO Party Challenge, details here. All you need to do is participate in as many state QSO parties as possible and post your scores to 3830scores.com and you will be in the hunt. There will be a rolling score total shown during the year here.

The first QSO parties (Vermont, British Columbia and Minnesota) are the first weekend in February. The QSO Party Challenge web site has a full list of all participating QSO parties

## Upcoming Contests – from WA7BNM

| February 2020 | |
|---|---|
| + North American Sprint, CW | 0000Z-0400Z, Feb 2 |
| + CQ WW RTTY WPX Contest | 0000Z, Feb 8 to 2359Z, Feb 9 |
| + ARRL Inter. DX Contest, CW | 0000Z, Feb 15 to 2400Z, Feb 16 |
| + CQ 160-Meter Contest, SSB | 2200Z, Feb 21 to 2200Z, Feb 23 |
| + REF Contest, SSB | 0600Z, Feb 22 to 1800Z, Feb 23 |
| + North American QSO Party, RTTY | 1800Z, Feb 29 to 0559Z, Mar 1 |

## Editor's Last Word – John K3TN

A huge newsletter this week! Back in the late 1990's when I did the Newsletter and sent it out via snail mail, we would have gone broke with the printing and mailing costs! Thanks to for contributions to this month's PVRC newsletter go to Ed N3CW, Dave K4EET, Mike W4RN, Chas W3KC, Alan WA3EKL, Bruce WK3A, Ed KG4W and Dan K2YWE..

I got back from bicycling across Florida just in time to put a few hours into the CQ WW 160 contest. The amazing conditions almost, but not quite, made me say "We don't need no steenken sunspots…."

If you are into bicycling, by the way, send Jim N3JT an email – we have a number of hams who discuss biking and Jim is thinking of setting up a group distribution if there is interest.

The quality and usefulness of the PVRC newsletter depends on contributions from members. If you have photos from club meetings, screen shots of new contest software, or brief writeups on station improvements or contest war stories, send them in any format to jpescatore at aol dot com.

## From the PVRC Treasurer – Dan K2YWE

PVRC has chosen not to implement an annual dues requirement. We depend on the generosity of all our club members to finance our annual budget. In addition, active PVRC members are expected to participate and submit logs for at least two PVRC Club Competition contests per year.

When contemplating your donation to PVRC, each member should consider the benefit you are receiving from PVRC and its many opportunities for your personal growth in our wonderful hobby, then donate accordingly.

Direct donations to PVRC via Credit Card or PayPal may be made by clicking this "Donate" button and clicking the next Donate button that appears on your screen:

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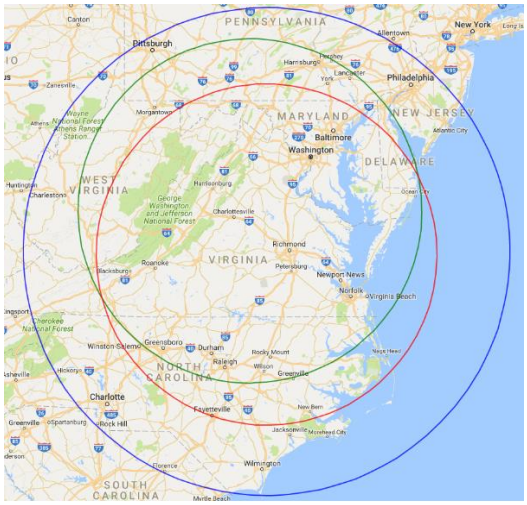
**Donations to PVRC are not tax deductible**

## Eyeball QSO Directions

The latest info on local club meetings and get togethers will always be sent out on the PVRC reflector and posted on the PVRC web site.




Green: ARRL VHF Circle
175 mile radius
Around 38.075N,
78.171W

Red: ARRL HF Circle
175 mile radius
Around 37.43168N,
77.858482W

Blue: CQ HF Circle
250 mile radius
Around 37.43168N,
77.858482W

## Now a Word From Our Sponsors

*PVRC doesn't ask for dues, but the Club does have expenses. You can also support the Club by buying from the firms listed who advertise in the newsletter!*

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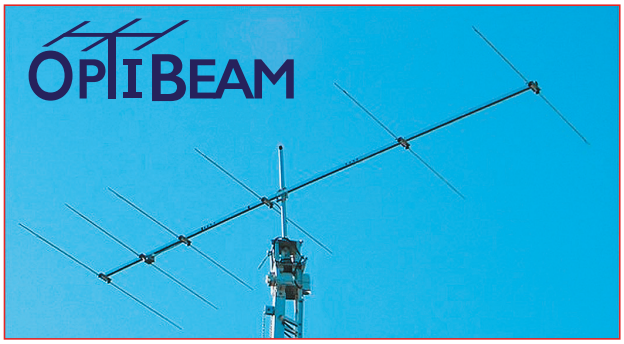
# Get on the Air with Superior Products from DX Engineering!


RF-KIT POWER AMPLIFIER

### *RF-KIT RF2K-S Amplifier*

DX Engineering is the exclusive North American retailer of RF-KIT's powerful new RF2K-S solid-state linear amplifier, featuring full legal limit capabilities across 160 through 6 meters. It comes with updated fast PIN diode switching, 1,500W RF power output, low-noise speed-controlled fans, internal antenna tuner, and dual LDMOS devices. Available as a kit. Fully assembled model has not been approved by the FCC and may not be offered for sale or lease, or be sold or leased, until approval of the FCC has been obtained. Enter "RF-KIT" at DXEngineering.com to learn more.




### *DX Engineering Exclusive—OptiBeam Antennas*

Proven in stations around the globe, OptiBeam's German-engineered, handcrafted directional monoband and multi-band Yagi and log cell Yagi antennas deliver the highest possible gain, cleanest radiation patterns, optimum band coverage, and power handling without compromise. Many popular models are in stock and ready for fast shipment. Enter "OptiBeam" at DXEngineering.com for information on 66 available HF directional models.

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DX ENGINEERING


### *NCC-2 Receive Antenna Variable Phasing System*

Use the NCC-2's phasing and balance controls to reduce interference and enjoy improved reception. Have antenna space constraints? Easily null out noise by phasing your transmit and receive antennas, or use two active verticals or loops with built-in bias tee that operates from +13.8 up to +21 Vdc. The NCC-2 has internal slots for plug-in versions of the Receiver Guard 5000HD and RPA-2 preamplifier. Plus, exclude interference-causing signals by adding filters for the 160-10 meter bands. Enter "NCC-2" at DXEngineering.com for full details.

**DXE-NCC-2...$794.99**

ACOM


### *HF Amplifiers*

ACOM has built a reputation among serious HF contesters and DX chasers for its high performance Amateur Radio gear. Nowhere is this more evident than with ACOM's stunning line of RF power amplifiers, including the 1200S 1,000 Watt HF+6 and 2100 1,500 Watt HF linear amplifiers. Enter "ACOM" at DXEngineering.com for detailed features and specs on the entire lineup.

**Free Standard Shipping for Orders Over $99*.**
If your order, before tax, is over 99 bucks, then you won't spend a dime on shipping. (Additional special handling fees may be incurred for Hazardous Materials, Truck Freight, International Orders, Next Day Air, Oversize Shipments, etc.).

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# Array Solutions Your Source for Outstanding Radio Products

## Professional Grade Equipment from Array Solutions

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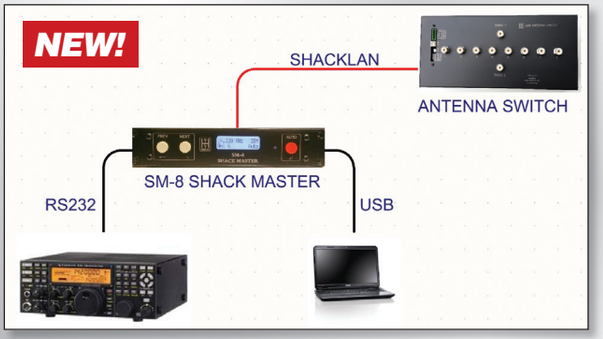
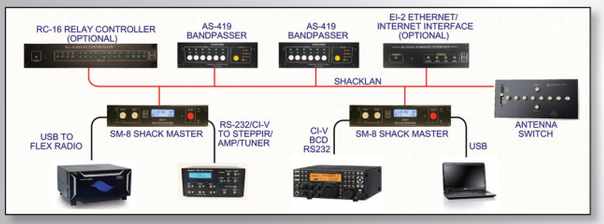
## Hamation Station Automation

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 chains 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.




## JK Antennas Are Now Sold by Array Solutions

HIgh Quality HF Antennas for the Contester and DXER. We Focus on Quality and it Shows in Everything We Do. Call or email for antenna systems.

JK ANTENNAS

## 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.


## RatPack Remote Antenna Switch

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

## 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.

ARRAY SOLUTIONS

**OM Power Amplifiers, The New RF Power Benchmark!**

OM Power

## OM Power Amplifier Sales Program

**Lower prices than the competition's equivalents, most modern design, and strongest warranty in the market!**

OM10C amplifier combiner

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

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

## OM4000A – OM4000HF OM2500A – OM2500HF

The A-series are automatic band change amplifiers.
The HF-series are manual band change and tuning amplifiers.
**OM4000**: 4 kW SSB and CW, 3 kW RTTY, AM and FM
**OM2500**: 2.5 kW SSB and CW, 2 kW RTTY, AM and FM

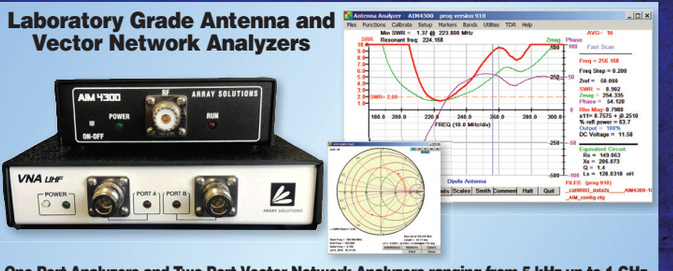
## OM2000A+ – OM2000+

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

**Frequency coverage:**
Amateur bands 1.8 – 29.7 MHz including WARC + 50 MHz

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

## Laboratory Grade Antenna and Vector Network Analyzers




**One Port Analyzers and Two Port Vector Network Analyzers ranging from 5 kHz up to 1 GHz**

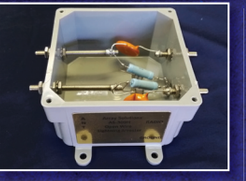
| | |
|---|---|
| AIM 4300 | $599 |
| VNA UHF | $1,295 |

## Surge Arrestors

**AS-302, AS-303** Coaxial cable arrestors. DC to 500 MHz. N-type or SO-239 connectors. **AS-300SB** Stacking fixture available. **AS-309H**, ladder line arrestor. All have static bleed function. **AS-8SP**, **AS-12SP** and **AS-16SP** control cable arrestors. Protect your rotator's and other control cables.

## Baluns & RF Transformers

Ratios 1:1, 1:2, 2:1,4:1 and more. RF line isolators. Ratings 3, 5, 10 kW+. Get the most out of your antenna by stopping the coaxial cable from becoming part of it.



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## NOBODY BEATS AN HRO DEAL!


### IC-9700 | *All Mode Tri-Band Transceiver*

• VHF/UHF/1.2GHz • Direct Sampling Now Enters the VHF/UHF Arena • 4.3" Touch Screen Color TFT LCD • Real-Time, High-Speed Spectrum Scope & Waterfall Display • Smooth Satellite Operation

### IC-7851 | *HF/50MHz Transceiver*

• 1.2kHz "Optimum" roofing filter • New local oscillator design • Improved phase noise • Improved spectrum scope • Dual scope function • Enhanced mouse operation for spectrum scope

### IC-7700 | *HF/50MHz Transceiver*

The Contester's Rig • HF + 6m operation • +40dBm ultra high intercept point • IF DSP, user defined filters • 200W output power full duty cycle • Digital voice recorder

### IC-7610 | HF/50 MHz *All Mode Transceiver*

• Large 7-inch color display with high resolution real-time spectrum scope and waterfall • Independent direct sampling receivers capable of receiving two bands/two modes simultaneously

### IC-7300 | *HF/50MHz Transceiver*

• RF Direct Sampling System • New "IP+" Function • Class Leading RMDR and Phase Noise Characteristics • 15 Discrete Band-Pass Filters • Built-In Automatic Antenna Tuner

### IC-718 | *HF Transceiver*

• 160-10M** • 100W • 12V operation • Simple to use • CW Keyer Built-in • One touch band switching • Direct frequency input • VOX Built-in • Band stacking register • IF shift • 101 memories

### IC-R8600 | *Wideband Software Defined Receiver*

• 10 kHz to 3 GHz Super Wideband Coverage • P25, NXDN™, dPMR™, D-STAR Mode • Large Dot Matrix LCD Display w/ Quick Spectrum Scope • SD Card Slot • Remote Control Function

### IC-7100 | *All Mode Transceiver*

• HF/50/144/430/440 MHz Multi-band, Multi-mode, IF DSP • D-STAR DV Mode (Digital Voice + Data) • Intuitive Touch Screen Interface • Built-in RTTY Functions

### IC-2730A | *VHF/UHF Dual Band Transceiver*

• VHF/VHF, UHF/UHF simultaneous receive • 50 watts of output on VHF and UHF • Optional VS-3 Bluetooth® headset • Easy-to-See large white backlight LCD • Controller attachment to the main Unit

### IC-2300H | *VHF FM Transceiver*

• 65W RF Output Power • 4.5W Audio Output • MIL-STD 810 G Specifications • 207 alphanumeric Memory Channels • Built-in CTCSS/DTCS Encode/Decode • DMS

### ID-5100A Deluxe

*VHF/UHF Dual Band Digital Transceiver*

• Analog FM/D-Star DV Mode • SD Card Slot for Voice & Data Storage • 50W Output on VHF/UHF Bands • Integrated GPS Receiver • AM Airband Dualwatch

### ID-4100A | *VHF/UHF Dual Band Digital Xcvr*

• Compact, Detachable Controller for Flexible Installation • DV/FM Near Repeater Search Function • Apps for iOS™ and Android™ devices • Wireless Operation with VS-3 & UT-137 Bluetooth® Headset & Module • MicroSD Card Slot

### IC-V86 | *VHF 7W HT*

• 7W OutputPower Plus New Antenna Provides 1.5 Times More Coverage • More Audio, 1500 mW Audio Output • IP54 & MIL-STD 810G–Rugged Design Against Dust & Water • 19 Hours of Long Lasting Battery Life • 200 Memory Channels, 1 Call Channel & 6 Scan Edges

### IC-R30 | *Digital/Analog Wideband Xcvr*

• 100 kHz to 3.3 GHz Super Wideband Coverage • P25 (Phase 1), NXDNTM, dPMRTM, D-STAR Mode • 2.3" Large LCD Display & Intuitive User Interface • MicroSD Card Slot for Voice & Data Storage • USB Charging & PC Connection

### ID-51A PLUS2

*VHF/UHF D-STAR Portable*

• RS-MS1A, free download Android™ application • New modes for extended D-STAR coverage • Terminal Mode & Access Point Mode allow D-STAR operation through Internet • DV & FM repeater search function • Dplus reflector link commands


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### FTDX5000MP Limited | *200W HF + 6M Xcvr*

• Internal Power Supply • Two Totally Independent Receivers • Super Sharp "Roofing" Filters • High Performance Yaesu Custom- designed 32-bit Floating Point DSP • True Analog Meter Precision

### FTDX3000 | *100W HF + 6M Transceiver*

• 100 Watt HF/6 Meters • Large and wide color LCD display • High Speed Spectrum Scope built-in • 32 bit high speed DSP /Down Conversion 1st IF

### FT-991A | *HF/VHF/UHF All ModeTransceiver*

Real-time Spectrum Scope with Automatic Scope Control • Multi-color waterfall display • State of the art 32-bit Digital Signal Processing System • 3kHz Roofing Filter for enhanced performance • 3.5 Inch Full Color TFT USB Capable • Internal Automatic Antenna Tuner • High Accuracy TCXO

### FTDX101D | *HF + 6M Transceiver*

• Narrow Band SDR & Direct Sampling SDR • Crystal Roofing Filters Phenomenal Multi-Signal Receiving Characteristics • Unparalleled - 70dB Maximum Attenuation VC-Tune • 15 Separate (HAM 10 + GEN 5) Powerful Band Pass Filters • New Generation Scope Displays 3-Dimensional Spectrum Stream

### FT-891 | *HF+50 MHz All Mode Mobile Transceiver*

Rugged Construction in an Ultra Compact Body • Stable 100 Watt Output with Efficient Dual Internal Fans • 32-Bit IF DSP Provides Effective and Optimized QRM Rejection • Large Dot Matrix LCD Display with Quick Spectrum Scope • USB Port Allows Connection to a PC with a Single Cable • CAT Control, PTT/RTTY Control


### FT-857D | *Ultra Compact HF/VHF/UHF*

• 100w HF/6M, 50W 2M, 20W UHF • DSP included • 32 color display • 200 mems • Detachable front panel (YSK-857 required)

### FT-2980R | *Heavy-Duty 80W 2M FM Transceiver*

• Massive heatsink guarantees 80 watts of solid RF power • Loud 3 watts of audio output for noisy environments • Large 6 digit backlit LCD display for excellent visibility • 200 memory channels for serious users

### FTM-100DR | *C4FM FDMA/FM 144/430 MHz Xcvr*

• Power Packed System Fusion Transceiver • High Audio Output Power • Rugged Powerful Transmitter • Integrated 66ch High Sensitivity GPS • 1200/9600 APRS Data Communications

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

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

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

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

### FT-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 Flash-light, Alarm and Quick Home Channel Access

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

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

5 Ways to Shop!

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### TS-990S | *200W HF + 6M Transceiver*

• World's first dual TFT display • 200W output on all bands • ±0.1ppm TCXO ensures both high stability and reduced power consumption • Triple 32-bit DSP's dedicated to main/sub receivers and band scope • Main receiver employs full down conversion, new mixer & narrow band roofing filters • Third order intercept point (IP3) +40dBm for highest level of RX performance ( main receiver)

**Call For Special Price!**


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

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


### TS-590SG | *HF/50MHz Transceiver*

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


### TM-D710G | *2M/440 Dualband*

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

**Call For Special Price!**


### TM-V71A | *2M/440 DualBand*

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

**Call Now For Your Low Price!**


### TM-281A | *2 Mtr Mobile*

• 65 Watt • 200 Memories • CTCSS/DCS • Mil-Std specs • Hi-quality audio

**Call For Special Low Price!**


### TS-480SAT/HX | *HF + 6M Transceiver*

• 480HX 200W HF & 100W 6M (no tuner) • 480SAT 100W HF & 6M w/AT • Remotable w/front panel/speaker • DSP built-in

**Call Now For Low Price!**


### TH-D72A

*2M/440 HT w/extended RX*

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

**Call For Special Low Price!**

### TH-D74A

*2M/220/440 HT w/D-STAR!*

• D-STAR compatible • APRS ready w/built in GPS • Color weather station information • Built-in KISS mode TNC • High-performance DSP voice processing • Standard compatibility for Bluetooth

**Call For Low Price!**


### TH-K20A | *2M Handheld*

• 2M 5.5W • VOX • CTCSS/DCS/1750 Burst built-in • Weather alert

**Call For Special Low Price!**

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**ANAN-7000DLE MKII** HF & 6M 100W SDR

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- Amazing IMD (-60dB below PEP)
- Open Source Software & Firmware
- Class leading Receiver performance
- True Diversity reception
- OpenHPSDR design made for Hams by Hams

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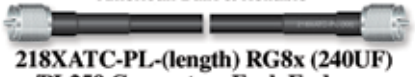
American Built & Reliable



**218XATC-PL-(length) RG8x (240UF) w/PL259 Connectors Each End. Weather-Proof Heat Shrink Tubing.**

- Stranded Center Conductor.
- 95% TC Braid + bonded 100% Foil Shield.
- Very Flexible, Light Weight, and Smaller than RG8 sizes.
- Non-Contaminating-UV Resistant-Direct Burial-Black Jacket.

**233/2-G4-(length).**

- Unique design **(Nickel Grommets 4" Spacing)** allows for easy attachment to a vehicle's body or truck bed to create a "ground-plane".
- Good option as a "buss-bar" in the shack.
- ½" wide tinned copper 38x48x8/384 10ga 53 Amps.
- Stocked in 1.5', 3', 5', and 10' foot lengths.


## The SDRplay RSP FAMILY

**THE WORLD'S FAVORITE SDR RECEIVERS**

- Continuous SDR coverage from 1kHz to 2GHz (NO GAPS!)
- All RSPs can receive, monitor and record up to 10MHz spectrum at a time (up to 10MHz of visualization)
- Introducing the new RSPdx for enhanced MF/LF performance
- Integrated scanner in SDRuno for all RSPs
- RSPduo can simultaneously receive on 2 totally independent 2MHz spectrum windows, anywhere between 1kHz & 2GHz
- Diversity tuning in SDRuno for dual tuner RSPduo giving enhanced signal capture or extra noise reduction options
- Downloadable SD Card image for use with Raspberry Pi3 & 4
- Excellent dynamic range for challenging reception conditions
- Built-in High performance Front-end Filters
- Use as a stand-alone general coverage receiver, or as a high resolution Panadapter
- SDRuno Windows SDR software provided free-of-charge
- The perfect gift for newcomers & returners to the radio hobby
- Calibrated S meter/RF power & SNR measurement with SDRuno
- Only needs a computer and an antenna
- Backed by large and growing SDR receiver user community

www.SDRplay.com

US TOWER

**MA-40**

• 40' Tubular Tower

***Call For Sale Pricing!***

**MA-550**

• 55' Tubular Tower • Handles 10 sq. ft. at 50 mph • Pleases neighbors with tubular stream-lined look

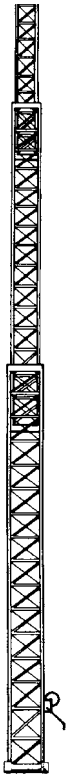
***Call For Sale Pricing!***

*All US Towers shipped by truck; freight charges additional.*

**Big Sale on all Towers!**

**TX-455**

• 55' freestanding crank-up • Handles 18 sq. ft. @ 50 mph • No guying required • Extra-strength construction • Can add raising and motor drive accessory • Towers rated to EIA specifications • Other models available at great prices!



ZUMspot-kit


ZUMRadio

**ZUMspot is an advanced radio module kit. When paired with a Raspberry Pi and the MMDVM software it becomes a small and efficient multi-mode digital hotspot.**

- Supports D-STAR, DMR, System Fusion, P-25 and NXDN
- Open source software (MMDVM) and hardware design
- Onboard LEDs to show status (Tx, Rx, Mode)
- 1.3 inch OLED screen
- Mounts cleanly on all current Raspberry Pi's including Pi Zero

**The ZUMspot Kit Package Includes:**

- ZUMspot RPi UHF board and antenna fully assembled and tested
- Pi Zero WH (Wireless With Header Installed)
- Nylon standoffs
- Pre-imaged 16 GB MicroSD card with Pi-Star software
- 1 Year warranty

Available exclusively from all HRO locations!

**5 Ways to Shop!**

- RETAIL LOCATIONS – Store hours 10:00AM - 5:30PM - Closed Sunday
- PHONE – Toll-free phone hours 9:30AM - 5:30PM
- FAX – All store locations
- ONLINE – WWW.HAMRADIO.COM
- MAIL – All store locations

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Contact HRO for promotion details. Toll-free including Hawaii, Alaska and Canada. All HRO 800-lines can assist you. If the first line you call is busy, you may call another. Prices, specifications and descriptions subject to change without notice.