A Utility Antenna for 88 to 608 MHz

K4ERO describes an extremely flexible antenna for covering VHF through UHF frequencies.

Figure 1 — Ruth Stanley, WB4LUA, shows the utility antenna setup for 2-meter FM with vertical polarization.

John Stanley, K4ERO

I've often found a need for an antenna that works for FM, over-the-air (OTA) TV, and aeronautical and weather radio. I also need it to work on the 2-meter, 1.25-meter, and 70-centimeter ham bands. Some of these frequencies use vertical polarization, some use horizontal, and some even use diagonal. This article will explain my solution for such an antenna that's also easily taken to portable locations (see Figure 1).

The antenna is a half wave on 88 to 235 MHz, and three half waves from 235 to 608 MHz. The patterns on VHF and UHF are shown in Figure 2. The three half waves for UHF make side lobes at about 50 degrees on either side of the main lobe. However, unlike an end-fed ³⁄₂-wavelength antenna, such as a **J** pole operating on its third harmonic, the strongest lobe is directly off the sides of the dipole. There's an additional 1.5 dB gain in that narrowed lobe. See *QST* in Depth (**www.arrl.org/qst-in-depth**) for further discussion of this advantage. With vertical polarization, the azimuthal patterns on VHF and UHF are omnidirectional.

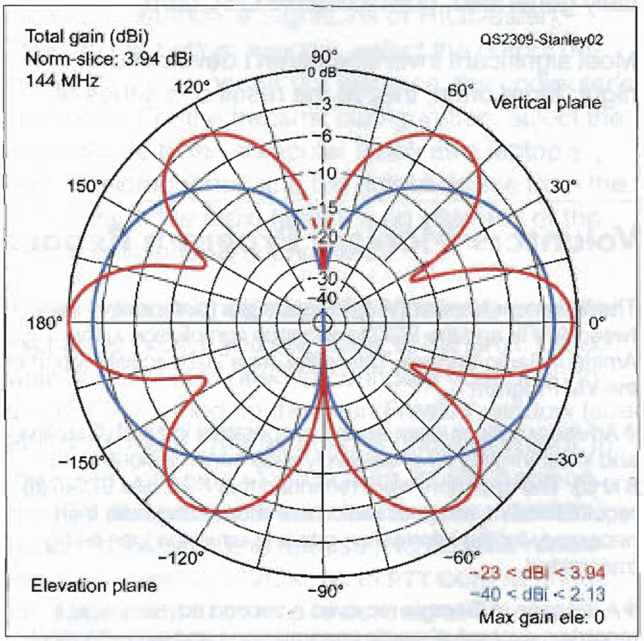

Figure 2 — The gain and pattern for VHF frequencies is shown in blue, and for UHF frequencies is shown in red. This is the azimuthal pattern with horizontal polarization. With vertical polarization, it's the elevation pattern.

Table 1 — Parts List		
Part	**Size**	**Quantity**
HDPE rod	1.25-inch diameter, 3.5 inches long	1
½-inch CPVC	5 inches long (½-inch CPVC has a ⅝-inch outside diameter)	1
Elbow for ½-inch CPVC	½ to ¾ inch	1
¾-inch CPVC	Length as desired for main support	1
Aluminum tubes*	⅝-inch outside diameter by 9.5 inches	2
	½-inch outside diameter by 10 inches	2
	⅜-inch outside diameter by 19 inches	2
Stainless-steel hose clamps	½ inch	6
Mix 43 ferrite beads	Must fit over your coax for a balun	
Coaxial cable (such as mini RG-8 with foam)	As long as you need to reach your radio	
Tape or cable ties		Enough to fasten coax to support pipes
Spade bit	⅝ inch	1

*Wall thicknesses must allow the aluminum tubes to slide freely inside each other.

Construction Using Low-Loss HDPE

The parts list can be found in Table 1. To avoid the losses of PVC as an insulating material at RF, use high-density polyethylene (HDPE) for the center piece. You can purchase an HDPE rod that's 1.25 inches × 4 feet for about $15, plus shipping. That's enough HDPE to make 13 utility dipoles, so the cost per dipole is no more than the cost of the similar PVC parts, making this a good club project. Aluminum tubes are also cheaper when longer pieces are cut to make several antennas.

Cut the HDPE rod to a length of 3.5 inches. Using a spade bit, make holes that are ⅝ inch in diameter and 1 inch deep on the ends. Drill a hole that's ¾ inch deep in the side to fit the ⅝-inch outside diameter (½ nominal size) CPVC piece. Assemble the pieces using hot-melt adhesive (such as hot glue) to achieve a tight fit for the elements and the CPVC support pipe. The support piece could be ½- or ¾-inch regular PVC, because with this design, the PVC isn't in contact with the metal parts of the dipole. A drill press is almost a necessity to get the holes straight. The dipole will work fine if you don't have one; it just won't look as professional. Finally, cut 1-inch slits in the ends of the larger-diameter aluminum tubes so that

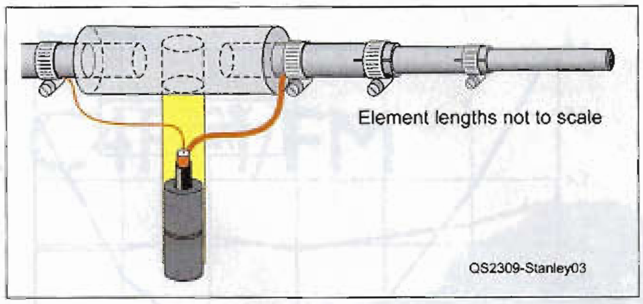

Figure 3 — Construction details for the utility antenna using HDPE for the center insulator.

Figure 4 — Match by spreading the coax leads where they connect to the aluminum elements. In this version, K4ERO used a single, large toroid with two turns of coax.

the hose clamps can tighten them to the next smaller tubing size. See Figure 3 for the assembly details.

A half-wave dipole far from ground or metal objects will have an input impedance of 72 Ω at resonance. This gives an SWR of 1.44:1 with 50 Ω coax. While this is good enough for most VHF transmitters, we can do better. With the dipole split at the center, there's a bit of capacity between the two halves. If we leave a bit of inductance in the lead wires, this will form a balanced L network, which reduces the 72 Ω to 50 Ω for a perfect match (visit the *QST* in Depth web page for more information). This is why I left the two leads (braided and insulated center wire) about 3 inches long and attached them to the aluminum tubing at a short distance from the center of the dipole (see Figure 4). You can adjust these lengths and attachment points to get a 1:1 match. While the match was optimized for the 2-meter band, it's also very good when just the dipole length is readjusted for the other ham bands (see Figure 5).

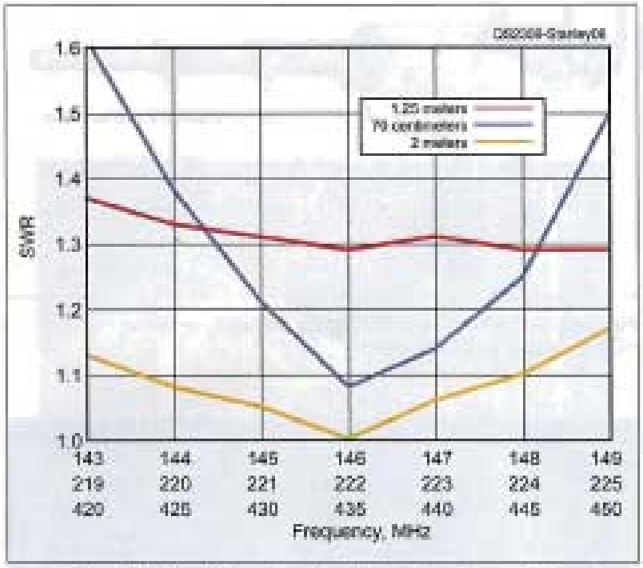

Figure 5 — SWR on three ham bands with tuning optimized for the 2-meter FM band. Only the element lengths were changed for the other bands. The SWR was measured with a 6-foot length of RG-58.

It's important to use a choke balun on the coax at the feed point. This keeps the coax from being part of the antenna, which can distort the pattern and make the SWR change when you touch the coax. To make the balun, add three mix 43 ferrite beads or pass two turns of coax through a large ferrite bead or toroid. Route the coax at a right angle from the dipole for about 6 inches. Then, turn it 90 degrees to run down the support pole. The exact distance is not critical, because the choke balun makes the coax more or less invisible to RF. One or two additional ferrite beads along the coax help even more with keeping RF off the coax. If touching the coax, SWR bridge, or radio doesn't affect the SWR, you're well decoupled. Read my article, "Controlling Unwanted Feed Line Resonance in VHF Vertical Antennas," in the November 2016 issue of *QST* for more information about decoupling coax from antennas.

Tuning and Matching

Make sure that the ferrite bead common mode choke is in place prior to tuning the antenna. To change the frequency, slide the aluminum tubes inside each other until you have a dipole that's a half wave long, or one and a half wave for UHF. Use 5600/f(MHz) for the VHF dipole in inches, and three times that for UHF. Then, adjust the length as needed to center the frequency using an SWR meter (see the *QST* in Depth web page for recommended dimensions). The various frequencies can easily be selected with a tape measure (½ or 3⁄2 waves), and marks can be made on the tubing to allow for an easy return to your favorite frequencies. Polarization is changed by swinging the dipole into horizontal, vertical, or diagonal positions. Do not glue the rotating joint, because the friction fit allows the dipole to rotate to change the polarization. The aluminum tubes slide inside each other to allow you to select the frequency by making the total length ½ or 3⁄2 waves long. Slits on the tubing ends with hose clamps prevent them from slipping in operation.

What You Can Hear While Using This Antenna

FM broadcast: 88 – 108 MHz
Amateur 2-meter band: 144 – 148 MHz
Weather reports: 162.4 – 162.55 MHz
OTA TV VHF high band: 174 – 216 MHz
Amateur 1.25-meter band: 219 – 225 MHz
Amateur 70-centimeter band: 420 – 450 MHz
Utility UHF (police, fire, etc.): 450 – 470 MHz
OTA TV UHF: 470 – 608 MHz

Final Thoughts

Enjoy this flexible antenna! An alternate version of the antenna using PVC parts found at local home stores is available on the *QST* in Depth web page.

See *QST* in Depth for More!

Visit www.arrl.org/qst-in-depth for the following supplementary materials and updates:

- ✓ A discussion on patterns when operating on the 3⁄2-wave mode
- ✓ An alternate version of the antenna using PVC parts
- ✓ More figure references
- ✓ A handy frequency-versus-length chart

All photos by the author.

John Stanley became KN4ERO when he earned his license 68 years ago. One year later, the N was dropped, and he has been K4ERO ever since. Ham radio led him to earning a degree in electrical engineering and experiencing a lifetime of teaching, design, and consulting, mainly at Christian shortwave broadcast stations all over the world, with Ruth Stanley, WB4LUA, his wife of 54 years. As an ARRL Technical Advisor and Editor, John has written or edited many articles for *QST*, *QEX*, and other ARRL publications. He and Ruth now live in their self-built, off-the-grid home in northwest Georgia atop Lookout Mountain. John can be reached at **jnrstanley@gmail.com**.

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