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Title: Build a Weatherproof PVC J-Pole Antenna
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Build a Weatherproof PVC J-Pole Antenna

NEW HAM COMPANION

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After you've built this antenna, you may not need anything else.

The twinlead J-pole antenna has been around for quite some time. It was brought into the limelight by an excellent article written by John S. Belrose, VE2CV, in the April 1982 *QST*. While John provided an excellent theoretical discussion of the J-pole, his article did not offer great detail on precisely how to *build* this wonderful VHF/UHF antenna.

J-poles are easy to build—which is why you see so many versions in use. (And so many articles in print!) Even so, several misconceptions exist concerning the J-pole. One common mistake is to assume that all you have to do is attach a piece of coaxial cable to a length of twinlead, short the bottom section and cut a notch. Not quite!

Another misconception is that once the antenna is built and tuned, you can stuff it inside a PVC tube and expect it to work flawlessly. Unfortunately for many amateurs, the PVC treatment often results in a failed antenna—unless you do it *right*.

DENNIS BLANCHARD, K1YPP

The disassembled J-pole antenna. The twinlead antenna core is shown at the bottom with the M359 right angle connector removed. It's placed within a foam insert (middle) which keeps the antenna centered within the PVC tube (top). This is the construction technique used by the JADE Products "JADE-POLE" antenna.

Understanding J-Pole Construction

The J-pole antenna comprises two parts (see Figure 2): a 1/4-wavelength matching section, which is the *entire portion below the notch*; and the radiating section, which is the 1/2-wavelength section *above* the notch. The portion of the antenna below the notch is most affected by the type of insulation that surrounds it. It also has the most influence on the resonance of the antenna. The radiating section is not as greatly affected by the insulation or the type of wire used. (We'll discuss this effect in a moment.)

When installed inside a PVC tube, the J-pole is a rugged and weather resistant antenna. If you place a J-pole inside PVC, however, you must *center the antenna within the tube*. One way to do this is to place the antenna inside a piece of foam insulation, preferably the type used to insulate hot-water pipes, before you slide it into the tube. If you choose a 1.5-inch PVC tube, this insulation is often a perfect fit (see Figure 1).

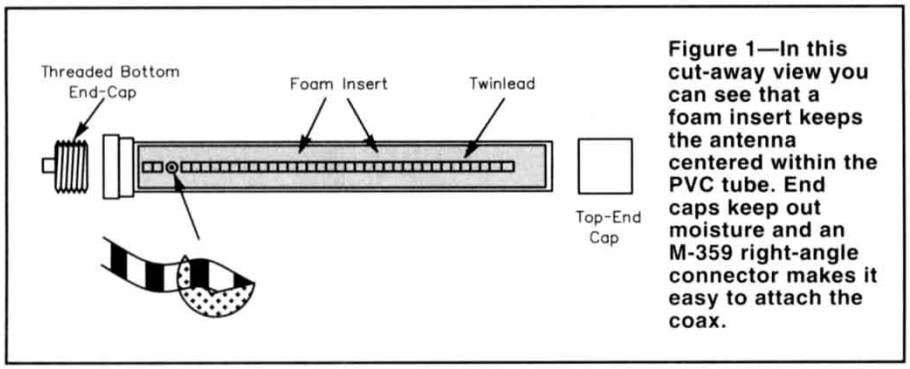


Figure 1—In this cut-away view you can see that a foam insert keeps the antenna centered within the PVC tube. End caps keep out moisture and an M-359 right-angle connector makes it easy to attach the coax.

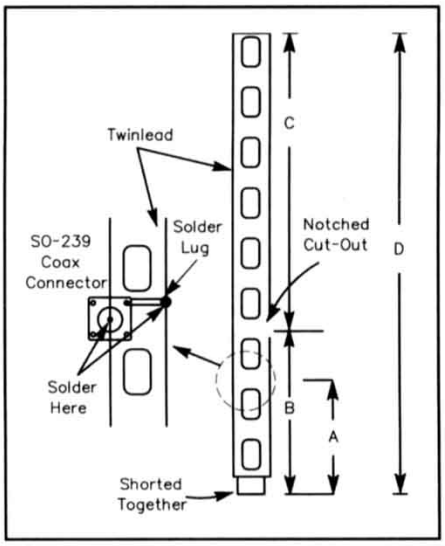


Figure 2—The critical lengths for the J-pole (see Table 1). Note the notch that's cut into one of the twinlead wires. The wires at the bottom are shorted together.

Table 1
Section Lengths (See Figure 3)

Frequency (MHz)	*D, Total Length (in.)*	*A (in.)*	*B (in.)*	*C (in.)*
50.00	160.4	3.2	48.2	112.2
51.00	157.2	3.1	47.2	110.0
52.00	154.2	3.1	46.3	107.9
53.00	151.3	3.0	45.5	105.9
54.00	148.5	3.0	44.6	103.9
146.00	54.9	1.1	16.5	38.4
222.00	36.1	0.7	10.9	25.3

Tuning Your 6-Meter J-Pole

You can use a capacitive coupling strap to easily tune your 6-meter J-pole for a different portion of the band. No cutting or lengthening necessary!

You can make the strap from a 1-inch wide strip of aluminum foil. Wrap the foil around the lower section of the J-pole and hold it in place with electrical tape. The strap doesn't connect to the antenna. It merely increases the capacitance at that point where it's positioned. By moving the strap up and down along the lower section, you'll change the resonant frequency of the antenna. This technique works best on a J-pole designed for 50 MHz (See Table 1).

Building a J-Pole Antenna

STEP ONE: The Decision Phase

Choose a frequency for your J-pole. In the case of 144 or 220 MHz bands, the antenna bandwidth is many megahertz, so this isn't a critical decision. Simply use the middle of the band, 146 MHz and 222 MHz, respectively. However, on 50 MHz the antenna will not cover the entire band without readjustment. On 50 MHz the bandwidth will be approximately 2 MHz. This means you'll need to select a frequency that corresponds to your favorite portion of the band.

Table 1 gives you the cutting lengths for the antenna sections. But before you can start cutting, you need to consider the *velocity factor* of the twinlead you're using. Despite what you may have heard, RF energy does not flow through a cable at the speed of light in a vacuum. The wire and even the insulation act to slow the speed of the wave. So, the time required for the signal to travel through a length of cable is *longer* than the time required to travel the same distance in free space. This means that the full wavelength of the signal exists in a physically *shorter* length of cable. If you cut the cable for the wavelength of the signal in free space, you'll be off the mark!

Cable manufacturers test for the velocity factor and specify it as a decimal percentage of the speed of light. The lengths shown in Table 1 are based on windowed 300-Ω twinlead with a velocity factor of 0.85. If other twinlead is used, you may need to increase or decrease the lengths proportionally. For example, if a section length is 16½ inches long and you're using TV twinlead with a typical velocity factor of 0.83, reduce the length by 2%, to 16 3/16 inches. (A velocity factor of 0.83 is roughly 98% of 0.85. Putting it another way, it's 2% *less* than 0.85.)

Next, decide how the antenna will be used: indoors or outdoors, fixed station or portable. If the antenna is to be used indoors, weather sealing will not be needed. If you're going to use it outdoors, apply a sealant to cover the exposed metal (the coaxial cable connection and the copper wire in the twinlead).

To limit possible RF absorption, use schedule-40 PVC. Make sure it is ultraviolet resistant as well.

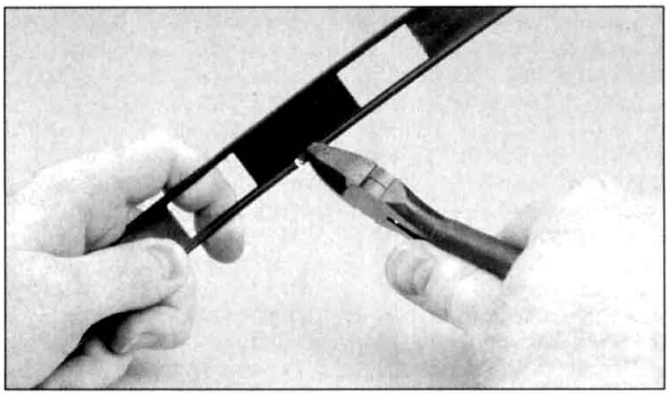
Applying a sealant directly to the twinlead will change the resonant frequency of the antenna. At first this may seem a bit odd. But, believe it or not, the sealant *does* affect the velocity factor of the twinlead. If the velocity factor changes, the resonant frequency of the antenna changes. Usually it will be lower than calculated. For example, an antenna cut for 146 MHz may resonate at 142 MHz after the exposed conductors are coated with sealant—a 4% change!

STEP TWO: Cutting the Wire

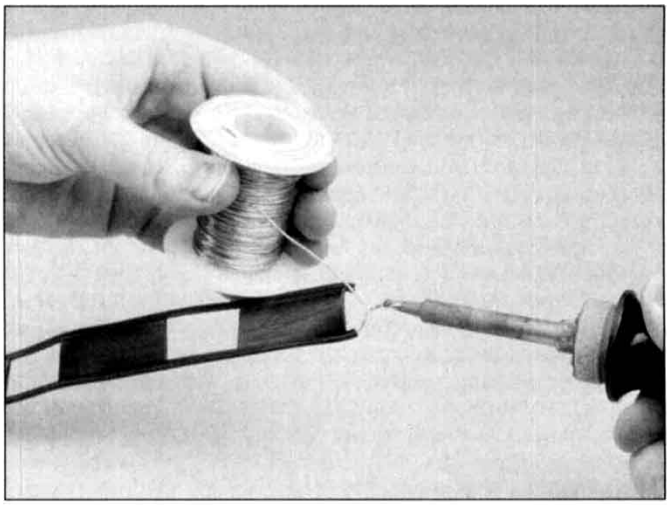
Select a good grade of 300-Ω twinlead, one that is tough and will withstand abuse. Avoid TV-grade twinleads that tend to crack easily. Windowed 300-Ω twinlead is available from several *QST* advertisers.

Measure a length of twinlead that is approximately 10% longer than the amount needed. Measure it so that the notch will be cut where there is insulation all the way across between the two conductors, not at a "window."

Cut the notch. Cut only one wire; the other will run the full length of the antenna. The notch can be a small V or square. Make it at least a ¼ inch long. Measure from the notch to the bottom of the antenna cut off the excess wire. Strip about ¼ inch of insulation off each of the wires at the bottom. Take a small piece of bare wire and wrap several turns between the two exposed wires at the bottom. Now measure from the bottom to the top of the antenna and cut off the excess. Using a razor knife or other sharp knife, remove the insulation where the coax will be connected.



Cut the notch in only *one* of the twinlead wires. The twinlead shown in these photographs is 450 Ω. However, the same techniques apply to 300-Ω twinlead.



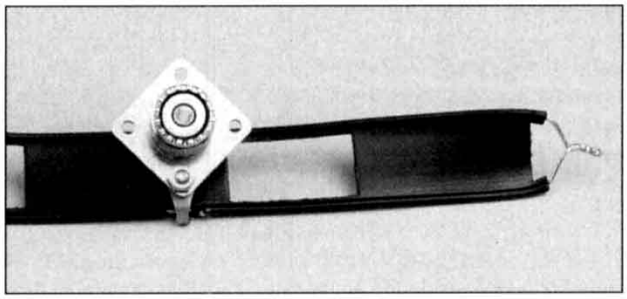
Strip the insulation from the end of the twinlead and twist the conductors together. A little solder ensures a good electrical connection.

STEP THREE: Connect the Coax

You have two choices: You can solder the coaxial cable directly to the twinlead, or install a UHF or BNC coaxial connector. A connector is highly recommended because it allows quick connections and disconnections. It also provides some strain relief, so the connection is less likely to break.

If you decide to use a connector, first file a slot in the center conductor of the connector and set the antenna wire into the slot. For the other connection, mount a solder lug on one of the holes on the connector. Wrap the lug around the wire, or slot the lug and slip the wire into it. Solder both conductors. One word of caution: Make sure the center conductor is connected to the wire that runs the full length of the antenna and that the braid side of the coax is connected to the notched side.

After you install your **J**-pole in a PVC tube, an M-359 right-angle coax connector comes in handy. It makes it much easier to bring the coax connection outside the tube. You can create a flat spot on the tube with a heat gun. Heat the PVC carefully until it softens, then press down with a narrow piece of wood. By creating this flat surface and using a small rubber gasket, you'll have a waterproof seal for the coax connector.



The center pin (not shown) of the SO-239 coaxial connector is soldered to the wire that runs the full length of the antenna. You can use a file to notch the pin. This will make it easier to solder. Then, attach a solder lug to the exterior of the SO-239 using the appropriate screw and nut. Strip away enough insulation to expose the wire on the opposite side of the twinlead and solder the lug in place.

STEP FOUR: Test the Antenna

You can tune the antenna with an SWR analyzer, if you have one, or just an accurate SWR meter. The resonant frequency of your **J**-pole is where you'll find the lowest SWR. The 144 and 220-MHz versions have a bandwidth almost twice as wide as the bands themselves, so tuning should not be necessary. The 50-MHz version may require minor tuning to make it resonant at the correct frequency (see the sidebar, "Tuning Your 6-Meter **J**-Pole"). Place the antenna in the foam core and PVC *before* you check for resonance.

If you find that you need to tweak your **J**-pole, make the matching section at the bottom slightly longer. Usually this will not be necessary.

STEP FIVE: Installation

You can install your PVC **J**-pole on a mast, or against a flat nonconductive wall. Plastic clamps for 1.5 and 1.0-inch PVC are available from JADE Products, PO Box 368, East Hampstead, NH 03826. Consider drilling a tiny hole in the bottom of the tube to allow any water to escape.

Conclusion

In his original work, VE2CV recommended placing a choke near the coaxial connection. To fashion a simple choke, take a cylindrical ferrite (Amidon 2X-43-251) and attach it to the coax at the feed point.

The **J**-pole antenna does not need radials, so it has a very narrow profile and low wind resistance. This is particularly important if you live in an area where icing is a problem. If the PVC enclosure has a threaded bottom, the antenna can be attached to a short piece of mating PVC and mounted above surrounding surfaces. QST

Radio Tips: Hamfests, A Summer Tradition

Where can you find a thousand fellow hams, scads of bargain-priced radio and computer gear (especially obscure and hard-to-find goodies and electronic assemblies and components), interesting forums and lectures, and the best bratwurst sandwiches in a hundred mile radius? Hamfests, of course!

Large multiday hamfests, such as the annual Dayton (Ohio) *Hamvention* or ARRL Division Conventions, attract many thousands of hobbyists. Small regional or local hamfests may draw only a hundred. At Dayton, you'll find more than a dozen specialized forums; at the annual "Corn Feed" hamfest in Abercrombie, North Dakota, you probably won't find any. You will have fun, however, at both extremes.

Nearly every hamfest will have a swapfest or flea market where individuals and commercial dealers hawk their wares—with a few regional differences. Generally, flea markets on both coasts will have more exotic hardware such as microwave assemblies and transistors, but prices tend to be higher. A small hamfest in the Midwest may not offer as much high-tech stuff, but there will usually be a surplus of good, used HF gear. A transceiver that will fetch $500 in New England will probably go for $300 in Iowa.

Hamfest Shopping Tips

❑ **Budget your money**. If you're like most folks, you don't have an unlimited budget for ham radio acquisitions. Plan your spending in advance.

❑ **Negotiating skills are helpful**. Haggling over the price of used gear or components (in a friendly and generally reasonable manner) is appropriate and expected.

❑ **Get there early, or stay late**. The best hamfest deals are usually made in the first and last hours of each event. Getting to the hamfest early will allow you to snap up some of the best merchandise. If you wait too long, your favorite stuff may be all gone. Alternately, if you play the waiting game, sellers will be quick to discount stuff that did not sell previously.

❑ **Always test expensive gear**. If you're buying a major item such as a transceiver or receiver, make sure you're able to plug the thing in somewhere and see if it works.

❑ **Returns?** In a similar vein, make sure you get the seller's name, address and phone number—just in case. Although you don't expect to have major problems with a piece of gear you've thoroughly inspected and casually tested, you should be prepared. If the seller is truly compassionate, you may be able to negotiate a return policy. It never hurts to try!—*NTØZ*