or many operators, the antenna needs for VHF ration can be met with an omnidirectional an- ıa system. These antennas are simple and inexpen- to construct and have no need for azimuth or ation rotators. Such an antenna will deliver noise- pictures for the best passes of a given satellite ich occur twice each day), including the "worst- :" situation where a set of passes straddles the ınd-station location. The major advantage of such ıntenna system is that no tracking is required and ttended operation can be as simple as connecting ner to the station tape recorder.

Jnless you have the need to regularly access passes xtreme range, there is really no need for a beam enna with all the additional complexities that are ɔlved. Most of the TIROS/NOAA and Meteor im- s in this book were obtained using the omnidirec- ıal antenna to be described in the next section, and ɔhically illustrate its effectiveness. In the case of rhead passes, I can hold the signal at full quieting n Ellesmere Island, north of Hudson Bay, to just th of Yucatan. In the case of worst-case straddling ses, the coverage is reduced from central Hudson to just south of Florida.

AN OMNIDIRECTIONAL VHF ANTENNA

Vhen I published an article, shortly after the ap- rance of the first edition of the *Handbook*, which I :d "An Omnidirectional Circularly-Polarized An- na for Weather-Satellite Reception," a practical edi- at *73 Magazine* shortened the title to the "Satellite ıper." Despite my best efforts to return to the pom- ıs original, it remains to this day as the "Zapper." : Zapper is simple in concept in that it is nothing re than a short beam (two driven elements and two ectors) with such a wide beamwidth that, when nted straight up, it functions as an omnidirectional enna system that does not require any tracking for ses within your "best-pass" window. With a hot re- /er and relatively short transmission line, the Zap- performs quite well, although it is at its best when ɔw-noise preamp—either a JFET (*j*unction *f*ield-*e*f- : *t*ransistor)—or, better still, a GaAsFET (*gallium* enide *f*ield-*e*ffect *t*ransistor) is mounted at the an- na. With a preamp in place, the length of transmis- ı line between the antenna and receiver is basically :levant.

Γhe Zapper is an ideal first project because of its plicity of construction and ease of mounting. If you :r use a gain antenna to maximize your coverage at limits of reception, you'll still use the Zapper ularly for general monitoring, spotting new Soviet :llites by scanning various frequencies, etc.

\ few words might be in order for those of you who familiar with VHF-antenna design. If you are a ·ist, you should be prepared to be horrified by some aspects of the Zapper's design. You may be tempted to "clean up" the design by following accepted rules for such things as matching, and so on. Please keep in mind that we are not dealing with transmitting antennas; instead, we're looking for the best possible reception with the simplest possible approach to getting the job done. The earliest pre-Zapper started out following all the rules—and it didn't work particularly well. With each revision, the design became simpler and performance increased. The newest version shown here is the simplest and best yet. You can clean it up if you want to, but be advised that it may not work as well as this one. The evolution from orthodox to unorthodox has been quite purposeful, and you should keep that in mind before embarking on major "improvements."

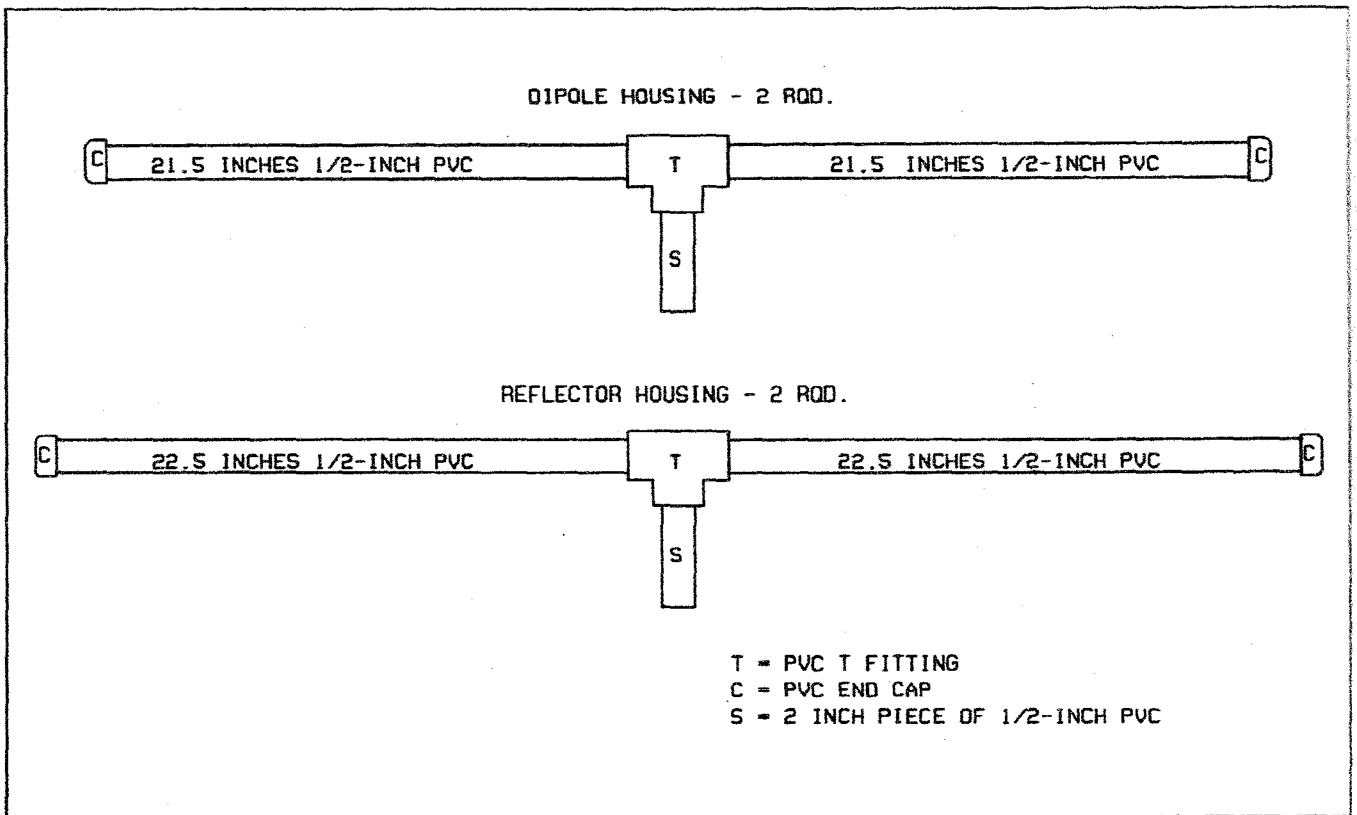
The Zapper requires a vertical mast, two reflectors, and two driven elements. The driven elements mount at right angles to each other at the top of the mast, offset vertically by a distance of two inches. The reflectors mount approximately ¼ wavelength below the driven elements, with each reflector parallel to a driven element. The overall antenna is quite compact and unobtrusive. This is an important factor in many areas where restrictive deeds and real-estate covenants can severely restrict the kind of antennas that can be erected.

Materials

The original Zapper, which appeared in the second and third editions of the *Handbook*, was fabricated from various sizes of aluminum tubing. Such tubing can be hard to obtain and is relatively expensive from most sources. Assembling the antenna required careful drilling of holes that never seemed to line up properly, and the hardware always seemed to corrode, no matter how carefully the antenna was weatherproofed. For this edition, I redesigned the Zapper (let's call it Zapper II) so that it requires no aluminum, no drilling, no assembly hardware, and it won't corrode. It works as well as the original, costs less, and looks quite a bit better hanging up in the breeze.

The secret to this new version of the antenna is the use of standard ½-inch CPVC plumbing pipe and fittings that you can obtain from almost any hardware or discount store. (From here on, I'll refer to CPVC simply as PVC.) The antenna-element housings and their supporting framework are constructed entirely of PVC pipe and fittings, providing both the rigidity required and complete weatherproofing of the actual antenna elements. To build the antenna you'll need the following materials:

- 2 10-ft (3 m) lengths of ½-inch (1.27-cm) PVC pipe
- 8 PVC **T** fittings for ½-inch pipe
- 11 ½-inch PVC end caps



THE WEATHER SATELLITE HANDBOOK
FIGURE 2.1
ZAPPER II - ELEMENT HOUSINGS

1 bottle of PVC pipe cement compatible with your pipe
1 5-to 6-foot (ca. 2-m) length of aluminum TV mast
4 stainless-steel hose clamps

In addition, you'll require the following antenna items from your local electronics outlet or mail-order outlet:

1 20-ft length of RG-58 coaxial cable (Belden 8219 or equivalent), plus enough additional cable for the run from the antenna to your station location
1 8-ft length of 300-ohm TV twinlead
2 double-female BNC adapters
5 BNC plugs for RG-58 cable and an additional connector to match your receiver antenna-input jack
1 BNC **T** adapter (female arms, male common)

Use a hacksaw to cut the following lengths of ½-inch pipe:

3 1 inch (2.6 cm)
4 2 inch (5.2 cm)
4 21.5 inch (54.5 cm)
4 22.5 inch (57 cm)
1 8 inch (20.32)

Use a file to deburr the cut ends of the tubing and put them aside with the PVC fittings.

Reflectors

We'll start antenna assembly with the reflector elements because they're the simplest to fabricate. In the steps that follow, temporarily assemble the indicated pieces and check to make sure you have them properly aligned. When you're ready to make the assembly permanent, coat one end of the indicated piece of PVC tubing with the tubing cement and insert the piece firmly into the indicated fitting.

Using the reflector housing diagram in Figure 2.1, cement two 22½-inch pipe sections into the side arms of one of your PVC **T** fittings. Cement a 2-inch length of pipe into the lower position of the fitting, then cement a PVC cap onto one end of the housing, leaving the other end open. Repeat this entire assem-

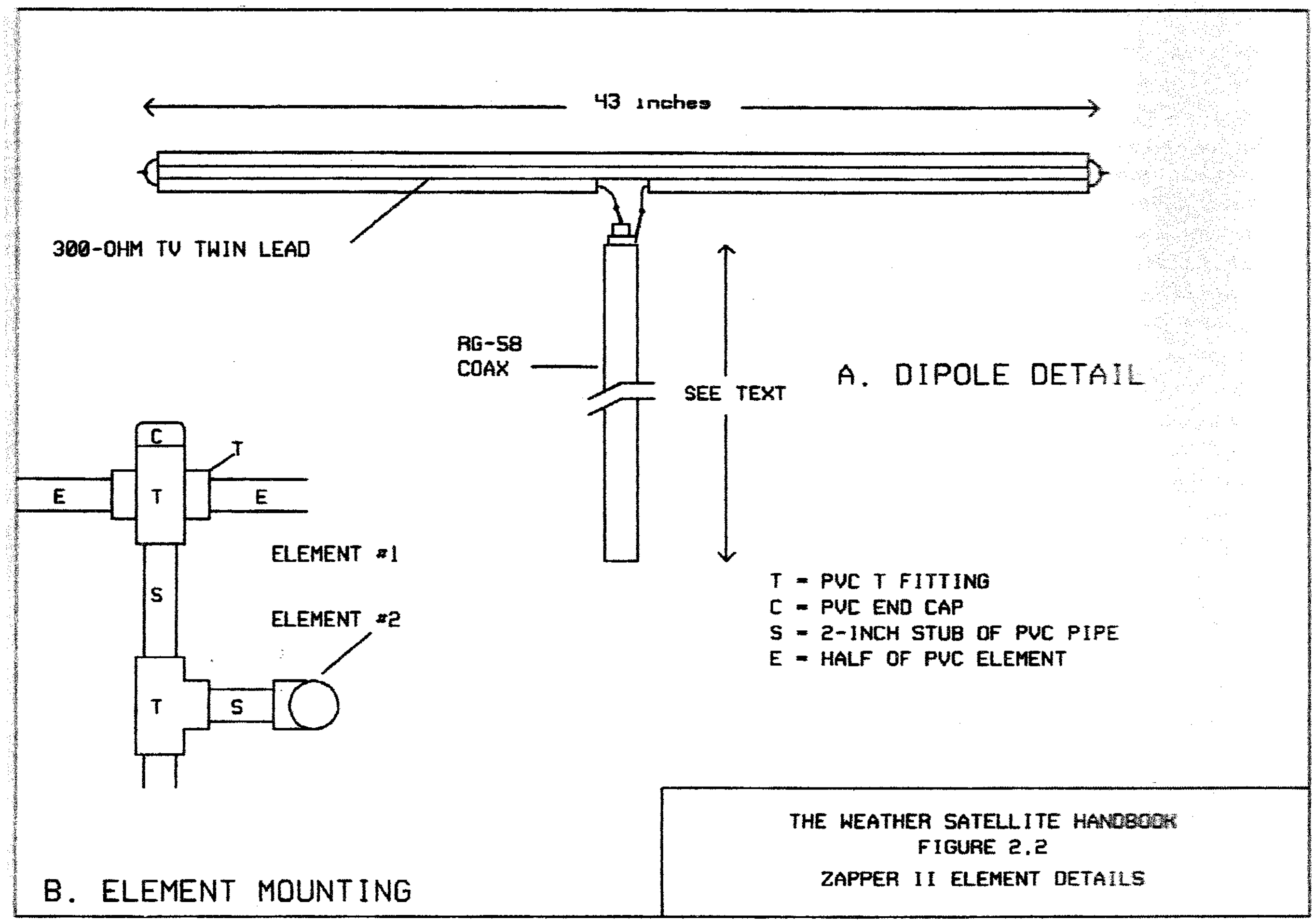


Figure 2.2—Zapper II element details. At A, one conductor of a piece of twinlead has been cut and soldered to a length of coaxial cable. At each end of the twinlead, the two conductors are twisted together and soldered (see text). At B, the method of mounting two elements at right angles to each other. In this view, you're looking at the back of the top **T** (element #1), with a PVC pipe cap at the top. A two-inch stub connects the lower end of the top **T** to a second **T**. The second **T** is attached to a third **T** by another two-inch stub. The third **T** (part of element #2) is viewed end-on from the capped end of the element.

bly sequence with a second set of pieces and set both reflector housings aside for at least one hour to let the cement cure.

Cut two 45-inch lengths of RG-58 coaxial cable. When the reflector housings have set, insert one piece of the cable down the length of each housing, cement a PVC cap to the open end, and lay the assembly aside.

The following assembly steps refer to Figure 2.2B. Insert a 1-inch length of tubing into one end of the cross-arm of a **T** fitting and cement a cap to the end of this stub. Insert a 2-inch piece of pipe into the opposite end of the fitting. Insert the pipe stub from one of the reflector housings into the side arm of this fitting so that the element is at right angles to the long axis of the fitting, as shown in the upper part of Figure 2.2B. Your orientation should be accomplished quickly because the cement sets rapidly.

Add a second **T** fitting to the free end of the 2-inch stub, oriented at right angle to the upper fitting. Insert a 1-inch length of pipe into the bottom of this lower fitting and cap it. Now insert the 2-inch stub from your second reflector housing into the side arm of the lower **T** fitting. You should end up with your two reflector housings at right angles to each other and separated by about 2 inches. Lay aside the complete reflector assembly, but keep it near at hand so you can refer to it as you assemble the driven-element housings.

Driven Elements

Construction of the two driven elements begins with the assembly of two dipoles, illustrated in Figure

2.2A. Cut two 4-foot (1.2-m) lengths of RG-58 cable. Carefully cut through the plastic jacket at a point about ⅔ inch (2 cm) from one end of each piece. Score the jacket lengthwise from this point and peel the jacket away. Unravel the shield braid, then twist it together into a single, short stub. Remove the insulation from the upper half of the exposed center conductor. Use a soldering iron to tin both the center conductor and the tip of the braid stub.

Cut two 44-inch (111.8-cm) lengths of the 300-ohm TV twinlead. For each piece, cut enough of the webbing from between the conductors at each end so that you can strip the two conductors, twist them together, and solder the connection. Mark the middle of each piece and cut through one of the conductors at that point. Strip ½ to 1 inch (1 to 2 cm) of insulation from the wires on each side of the cut. For each piece, solder the center conductor of one of the pieces of coax to one wire and the braid to the other. You should now have two dipole assemblies like the one illustrated in Figure 2.2A.

Dipole Housing

We'll now build the PVC housing around each of the dipoles you have just constructed. Feed the two ends of the dipole through the base of a **T** fitting, routing one side of the dipole out one side arm opening and the other out through the remaining opening. Work the individual dipole legs outward from the fitting until the solder connections to the coaxial cable are located up inside the **T** fitting. Slide one 21 ½-inch piece of pipe over one leg of the dipole and cement it to the **T** fitting, repeating the operation with the other dipole leg and a second 21½-inch piece of tubing. Cap the open ends of the tubing. Now take a 2-inch length of pipe, slide it up the coax and cement it to the remaining opening in the fitting. You should now have a pair of dipole assemblies, enclosed in the PVC pipe with the coaxial cable coming out the 2-inch pipe stub on each housing.

All that remains now is to use the remaining caps and **T** fittings to make a complete driven element assembly (two elements) exactly as you did with the reflectors. The orientation of all the pieces should be just the same as the reflector assembly. Because the lengths of coax have to be threaded through the **T** fittings, I suggest the following assembly sequence:

1) Thread the free end of the coax from one dipole through the side hole of a **T** fitting (assuming the final vertical orientation of the **T** fitting) and out the lower hole.

2) Cement the 2-inch dipole stub to the side hole, orienting the fitting at right angles to the dipole assembly.

3) Repeat the preceding two steps with the second dipole assembly and the remaining **T** fitting.

4) For the uppermost dipole, insert a 1-inch pipe stub in the upper hole and cap it.

5) Slide a 2-inch piece of tubing up the coax of the upper dipole and cement it to the lower hole of the **T** fitting where the coax exits.

6) Feed the upper coax cable through the upper hole of the lower **T** fitting and out the bottom hole with the coax from the lower dipole, cementing the pipe from the upper fitting to the upper hole of the lower fitting. Be sure the two dipoles are at right angles to each other before the cement has a chance to set.

7) The lower **T** fitting should now have two cables exiting from the lower hole. Slide the 8-inch pipe piece up both cables and cement it to the lower **T** fitting.

After the dipole assembly has set, install BNC connectors on the free ends of the two lengths of coax. One cable (the one from the lower dipole) will appear longer than the other. Do NOT trim them to equal length when installing the connectors!

Cut a 13-inch length of coaxial cable and install BNC connectors on each end. This piece of cable is our phasing line.

Final Mounting

Stainless-steel hose clamps are used to mount the dipole and reflector assemblies on the length of aluminum pipe or TV mast. If circumstances permit, it's usually easier to mount the assemblies with the mast in place. Alternatively, you can mount them on the mast and then install the mast section. The dipole assembly should go at the top of the mast, with the ends of the upper dipole facing E-W. The reflector assembly should be mounted so that the upper reflector is parallel with the upper dipole and 17 inches (44 cm) below it. Your mounted antenna should look similar to that shown in Figure 2.3—but with the reflector and driven elements properly oriented!

For the best possible results, the antenna should be mounted as high as possible with a minimum of obstructions within 5 degrees of the horizon. If a preamplifier is mounted at the antenna, the length of transmission line between the antenna and receiver is irrelevant, allowing you to choose the best possible site for the antenna without worrying about transmission-line losses.

Cables

The longer cable from the dipole assembly should be connected to one arm of the BNC **T** connector. Connect the phasing line to the other arm and use a double-female BNC connector to connect the free end of the phasing line with the shorter cable from the dipole assembly.

For the best possible performance, the preamplifier should be mounted at the antenna with a housing to

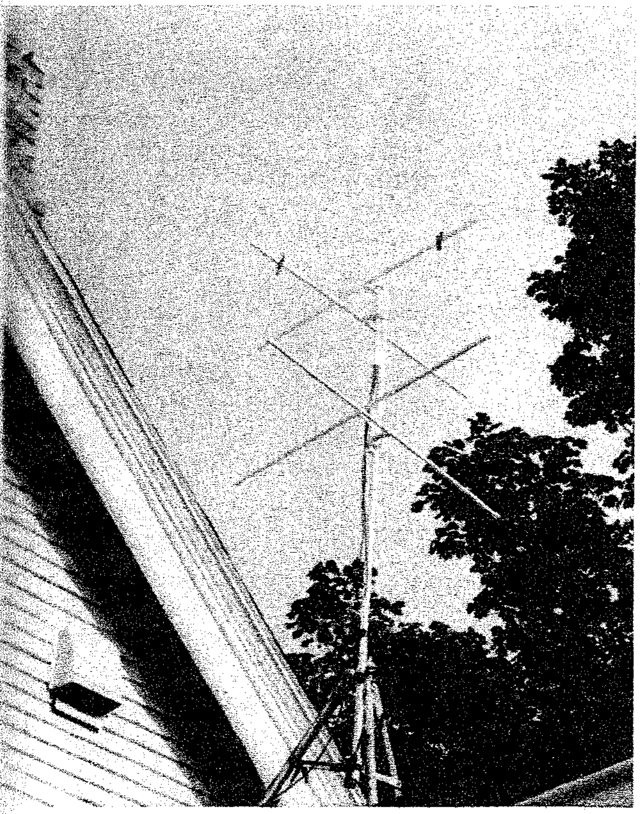


Figure 2.3—A photograph of the prototype of the Zapper II antenna. The antenna is quite unobtrusive and can be installed using a small tripod or other minimal support. You should take care where the assembly notes indicate that the reflector and driven element assemblies have the same orientation. With this prototype I didn't, and ended up with the lower reflector on the other side of the mast from the lower driven element. Although this should skew my pattern a bit to the east in one plane, there doesn't seem to be any obvious effect.

keep rain or snow off the unit. A suitable housing can be made from a plastic freezer container, secured to the mast with hose clamps. The top of the container should face down and the cover should be equipped with holes to let the cables pass up from below. These holes also vent the case so that condensation does not build up inside the enclosure. The male connector of the BNC **T** fitting can connect directly to the preamplifier input, or you can use a short length of interconnecting cable. The transmission line to the station receiver can connect directly to the preamplifier output. If your preamplifier is powered through the transmission line, your installation is now complete. Otherwise, you'll need to run a wire with the transmission line to carry 12 V dc to the preamplifier. A ground wire is not required because the coaxial cable shield provides the ground return.

Although the antenna performs best with a mast-mounted preamplifier, a direct run of cable (using another double-female BNC adapter) can be connected to the BNC **T** connector. For best results, the receiver should have a low-noise front end, and no more than 50 feet (15 meters) of transmission line should be used—preferably less.

Finishing Touches

Prior to taking care of the final details, run a reception check on the antenna system. Using a vintage Vanguard receiver and a Hamtronics GaAsFET preamplifier, I can expect to hear a satellite on the horizon with full quieting by the time the satellite has reached an elevation of 3 to 4 degrees, assuring a minimum of 12 to 14 minutes of coverage for a worst-case situation with a pair of straddling passes. With the exception of a few examples of West Coast passes, all the polarorbiter images in this book were obtained with the omnidirectional antenna system.

As a final check on polarization, observe a number of NOAA passes. If there are deep nulls in the pattern, as evidenced by noise at moderate to high satellite elevation, switch the phasing line position from the short to the long cable.

Once you know the antenna is working, use plastic electrical tape to cover all exposed connectors. Once they have been taped, cover them with the putty-like sealer available at most electronics shops that carry TV or CB antenna supplies, and tape them again. The sealer can also be used to seal the base of the dipole assembly where the cables exit. Electrical tape can then be used to secure the cables neatly to the mast. A coat or two of paint will protect the tubing from the effects of UV radiation and assure an almost unlimited service life for your antenna assembly.

One area where you can experiment concerns the spacing between the driven element and reflector assemblies. The 17 inches (57 cm) specified represents approximately 0.2 wavelength at 137 MHz, and is a good starting point. Increasing this spacing changes the pattern slightly in ways that might prove useful to you. At a maximum spacing of ⅜ wavelength (32.25 inches [82 cm]), the gain directly overhead is decreased slightly, but gain improves closer to the horizon. You should not exceed this value of ⅜ wavelength because beyond that point, the pattern breaks down from a single broad lobe to a series of minor lobes that will lead to very erratic reception.

Commercial Options

Omnidirectional antennas similar to the Zapper have now become quite fashionable and a number of vendors offer designs that represent an alternative to building your own. Most feature integrated weatherproof preamps as options or as standard equipment.