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440-MHz Folded Dipole Repeater Antenna

An antenna immune to almost all weather conditions, virtually static-free, and practically maintenance-free.

Commercial price tags and the unavailability in the 440-MHz range helped to prompt the home-brew construction of this 4-bay folded dipole antenna. The only array that could be located for amateur use was a dual 8-bay version that cost around $500.

The folded dipole is one of the most widely used antennas in the VHF/UHF public safety and commercial spectrum. One of the reasons for this is that the antenna is almost immune to lightning damage; another is that it virtually eliminates the static build-up problems common to other antennas.

Unlike many "dc-grounded" antennas, this one ensures that both the center conducter and the shield are at true dc ground potential for each radiating element. Other antennas that may show a dc ground with an ohmmeter may use phasing coils or other matching devices between radiating sections. Inductance is introduced and the static-reducing effectiveness is diminished. Gamma-fed elements are at ground, but the center conductor is not.

Each element in this array is uniquely designed to be 50 Ohms at the operating frequency. This makes it easier to modify the array to a one-, two-, four-, or eight-element configuration. I selected the four-element one because it gives considerable gain while still exerting good vertical beamwidth for use in hilly areas. Higher-gain antennas can actually perform more poorly for mobiles and portables at close range in some instances. Gain for the 4-bay array is approximately 6 dBd omnidirectional or 9 dBd for unidirectional radiation patterns. Vertical beamwidth is 15° for the half-power points. Power levels of up to 250 Watts can be used depending on the style of phasing harness used.

Construction

Construction of the antenna elements is much easier if you have access to a machine shop, and the necessary materials can usually be purchased there. A 3/8" and 5/8" solid aluminum rod was used for the radiating material and a 1" x 1/4" solid aluminum flat bar stock was used for the element support arm. Heavy duty materials not only provide strength, but insures that the aluminum parts will not warp from the heat when they are Heliarced together. The assembly was welded to eliminate noise generation from loose parts. Alloy aluminum (6061-T6) was selected because it machines well. Prior to welding, all parts should be completely cleaned with steel wool soap pads and water. Be sure to advise the person who is doing the welding what the alloy is.

Attachment points for the feed harness are made by drilling and tapping holes to accept 6–32 machine screws. The use of stainless steel screws and lockwashers is definitely recommended.

The element support arm should be drilled

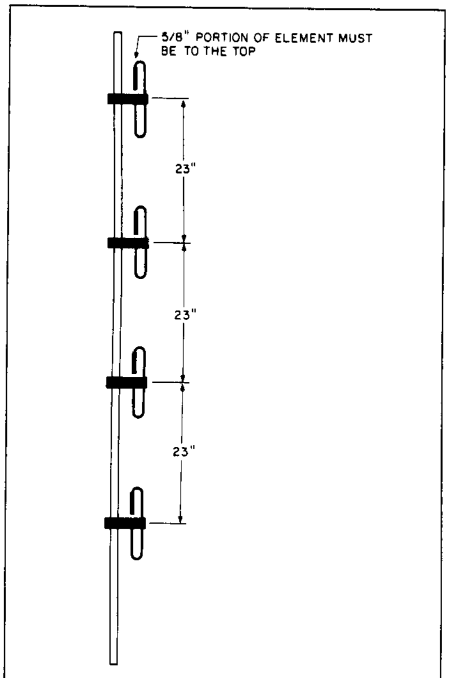

Fig. 1. Side-view diagram of the dipole mast and elements.

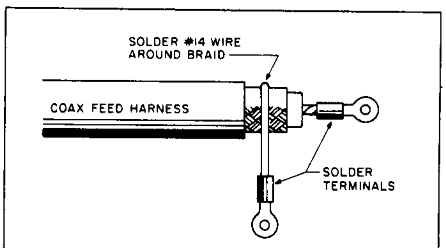

Fig. 2. Feedline attachments to the elements.

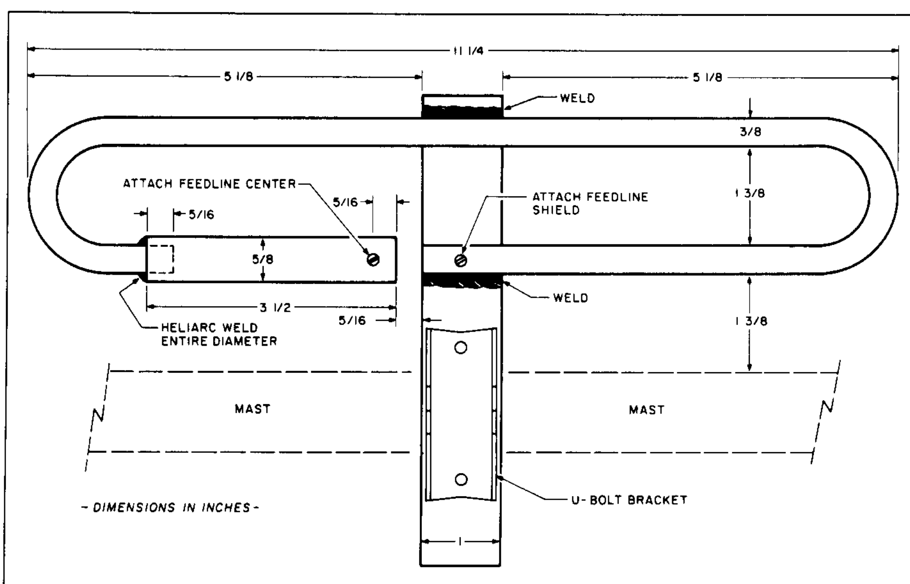

Fig. 3. Diagram of an element.

to accept an appropriate U-bolt and associated toothed bracket so that spacing is maintained (see Figure 1). This can be a little tricky because various diameter masts and U-bolts will change the spacing. Do not complete this step until the element is welded together. It is not known how critical this dimension is.

For the easiest element fabrication, the 5/8″ section should be drilled in one end to accept the 3/8″ material. The fit should be snug and the hole should be about 5/16″ deep. This allows the 5/8″ piece to slip into the open part of the element.

The builder has some options on the style of phasing harness to use. The original antenna utilized a 4-way power splitter which was put together using test equipment not normally available to most hams. Construction is not included in this article. KLM offers a similar unit which should work as well. A phasing harness can also be made with odd quarter wavelengths of 75-Ohm coax. This method is described in the *ARRL Handbook*, and in others as well. Remember that all elements must be equal lengths of 50-Ohm cable if a 4-way power divider is used. Excess cable can be attached to the mast. The divider is best positioned at the middle of the array to minimize cable lengths. It is best to use an RG-8 "flooded-braid" to help keep water from migrating up the shield. A flooding compound is put in the braid by the manufacturer to accomplish this. In any case, the ends of the cable must be weatherproofed, particularly where they attach to the elements.

Crimp-on ring terminals should be used to attach feed-line to each element. Prepare the end of the cable in the same fashion you would to attach a PL-259 connector. Use a piece of 14-guage copper wire to encircle the braid, and solder it all the way around the coax braid. Install a ring terminal to the end of the wire and put another terminal on the center conducter. Solder all terminals and position them so as to put the least amount of strain on the assembly. Weatherproof with *good* grade black vinyl electrical tape such as the Scotch 33 Plus. Stretch the tape slightly while applying, making sure to release all the tension during the last four or five windings down the cable. Additional heat-shrink tubings would not hurt, either. If you choose to use nylon cable ties to attach the feedlines to the mast, make sure that they are rated for outdoor use. Otherwise, use black vinyl tape over the each tie so that it will not deteriorate from ultraviolet light.

The array should be mounted on a mast, this then becomes part of the antenna. Masting must extend above and below the top and bottom parts of the elements by at least a few inches, at least six inches on the top if the antenna is to be top-mounted. I suggest galvanized pipe for top-mounting. If the antenna is mounted on the side of a tower, a piece of electrical conduit can be used and bent with offsets at each end to allow for top and bottom attachment to the tower leg. Spacing between mast and tower is 1/4 wavelength.

Spacing between the elements is 23″ center-to-center. When attaching the element to the mast, the mast should be on the same side of the support arm as the element rod material. Make sure that all the elements have the 5/8″ diameter part at the top. In tower side-mounting, the elements align one over the other, and face away from the tower. Top-mounted installations for omnidirectional coverage should have the elements arranged around the mast in 90° increments. I don't recommend this configuration.

Comments

Vswr across the band should be 1.5:1 or less. The bandwidth is at least 20 MHz wide.

In constructing the elements you should use the exact dimensions shown in Figure 3, since any deviation may produce an undesired effect. Most of the engineering in this project was trial and error rather than design.

The prototype was placed in service in the summer of 1986 and has performed beyond expectations, and the winter weather conditions at the site are harsh, often with seventy mile/hr winds and snowdrifts of up to 15 feet. Still, I expect several maintenance-free years out of it.

Thanks go to the following people who provided construction assistance: Phil Hiller WA2EQX for masting and installation; Jon Henning WA2BTW for the power divider and for providing test results; and Dan Wood and Dave Nelson for prepping and welding the antenna. ■