

## About this Article

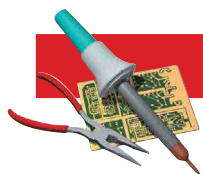
This material was included with the downloadable supplemental content accompanying the *ARRL Antenna Book*.

You may print a copy of this material for personal use. Any other use of the information requires permission from the ARRL.

## Copyright/Reprint Notice

In general, all ARRL content is copyrighted. ARRL articles, pages, or documents – printed and online – are not in the public domain. Therefore, they may not be freely distributed or copied. Additionally, no part of this document may be copied, sold to third parties, or otherwise commercially exploited without the explicit prior written consent of the ARRL. You cannot post this document to a website or otherwise distribute it to other through any electronic medium.

For permission to quote or reprint material from ARRL, send a request including the issue date, a description of the material requested, and a description of where you intend to use the reprinted material to the ARRL Editorial and Production staff at: **[permission@arrl.org](mailto:permission@arrl.org)**.



By Allen Baker, KG4JJH

# A 6 Meter Moxon Antenna

Discover 6 meters for the first time or enhance your existing operation with a rugged but portable version of this novel 2 element antenna.

I was amazed by the response to my Black Widow antenna in the May 2003 *QST*.<sup>1</sup> I subsequently helped quite a few builders locate the hard-to-find fishing pole spreaders and I also addressed several details about its construction. Many had never heard of this antenna configuration and enjoyed building it. While the wire version of the Moxon rectangle is a proven performer, a tubular version provides broader bandwidth and slightly more gain. The two antennas presented here are based on an article by L.B. Cebik, W4RNL.<sup>2</sup> The first is horizontally polarized for CW and SSB use at the low end of the 6 meter band (50-51 MHz) and the second is vertically polarized for FM use at the upper portion (52-54 MHz). For ease of reference, I refer to the first as H-POL and the second as V-POL. All materials have been chosen to withstand the elements and are available locally or via the Internet for under \$100.

## The Moxon Rectangle

I used the program *MoxGen*<sup>3</sup> to generate models at 50.5 and 53.0 MHz, using  $\frac{5}{8}$  inch OD aluminum tubing. I then fine-tuned them with *EZNEC*<sup>4</sup> to allow for the different tubing sizes. The 6 meter Moxon is built from  $\frac{5}{8}$  inch OD and  $\frac{1}{2}$  inch OD aluminum tubing with  $\frac{3}{8}$  inch OD solid aluminum for the corners. The detailed construction drawings, sheets and *EZNEC* models for both versions are available at [www.arrl.org/files/qst-binaries/6 meter moxon.zip](http://www.arrl.org/files/qst-binaries/6%20meter%20moxon.zip). A basic outline draw-

ing of the antenna is shown in Figure 1, while the full material list is available on the Web site. I built the antenna to the dimensions in the *EZNEC* model listed on Sheet 1.

## Construction

Drawing Sheet 1 presents an overview of the antenna assembly. Each component of the antenna is identified by a letter designation ( $A_0$ ,  $A_1$ ,  $A_2$ , etc). After choosing which version you want to build, follow the Material Cutting Schedule



Figure 2—A bottom view of the completed antenna clearly shows the fiberglass insulators separating the driven element from the reflector.

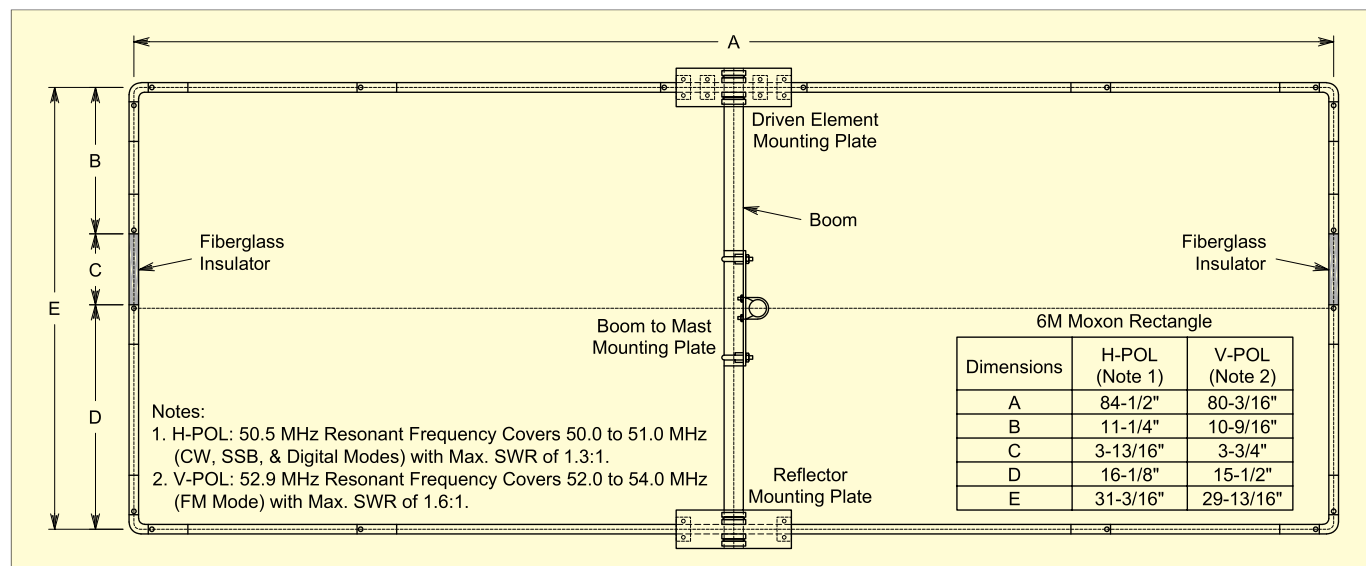


Figure 1—The 6 meter antenna design is based on a Moxon rectangle. Its basic dimensions are shown. Definitive construction details can be found on the ARRL Web site ([www.arrl.org/files/qst-binaries/6 meter moxon.zip](http://www.arrl.org/files/qst-binaries/6%20meter%20moxon.zip)).

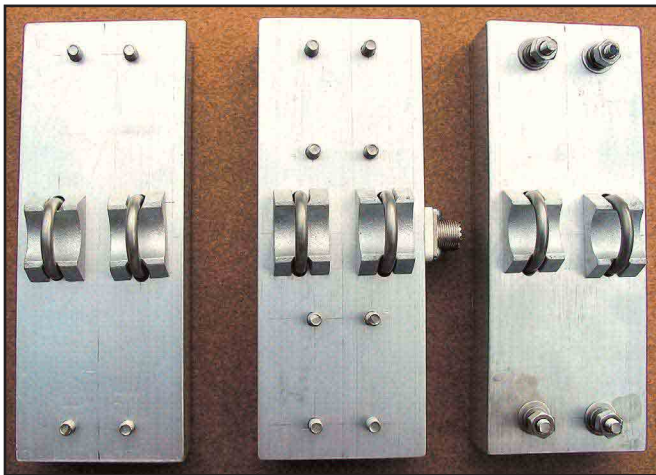


Figure 3—A top view of the antenna mounting plates.

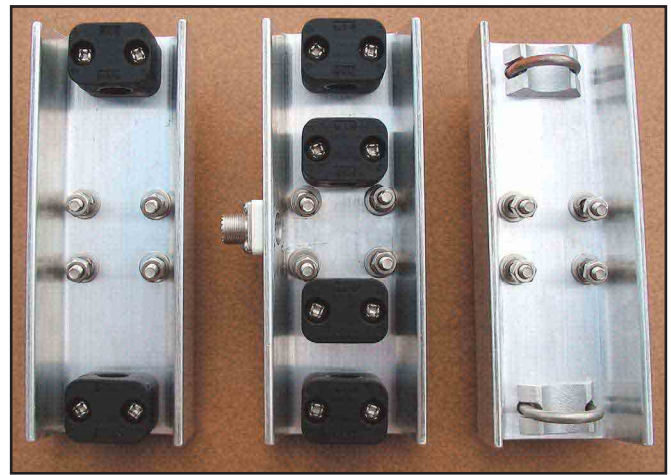


Figure 4—A bottom view of the mounting plates. Note the insulated element support blocks that are discussed in the text.



Figure 5—One of the insulators that separates the reflector from the driven element.

to get the correct quantity, material and length. All materials are easily cut with a tubing cutter, hacksaw or band saw. After cutting, use a  $\frac{3}{4}$  inch countersink bit and a file to deburr the inside and outside edges of the tubing. Add the common components (such as channel and stainless steel hardware) and you will be ready to begin assembly. All of the necessary materials are listed on Sheet 7 along with sources for each. Figure 2 gives a view of the completed antenna, without the mast.

## Mounting Plates

The driven element, reflector and boom to mast plates are fashioned from structural aluminum channel. This material is overkill for this application, but this method of mounting is sturdy enough to be used on tubular Moxons up to 20 meters or more (by scaling the mounts and tubing upward). There is absolutely no flexing or bending of the mounts and the finished antenna is very solid.

The channel is easily cut with a band saw and a metal cutting blade. Cut three pieces 8 inches long and lay out all holes according to the dimensions shown on Sheets 4 through 6. It's a good idea to smooth all sharp edges on the channel with a file. I use a center punch and a drill press with a  $\frac{1}{16}$  inch bit to get accuracy, then go back and enlarge each hole to its final dimension. Be sure to size the mast saddle clamps to match your mast and use the chart on the drawing for a drill guide. Tap the holes as specified and assemble using the stainless steel saddle clamps and radio support blocks listed. This was my first encounter with the support blocks and they provided a great way to support the elements rigidly while providing isolation from the metal brackets and boom. These blocks, actually industrial insulated tubing clamps, may also be found at hydraulic and piping distributors. Figures 3 and 4 show top and bottom views, respectively, of the completed mounting plates.

## Insulators

A pair of insulators that maintain a fixed distance between the tubing ends supports the ends of the antenna elements (within dimension C on Drawing Sheet 1). The insulators are made from  $\frac{3}{8}$  inch OD  $\times$  10 inch solid fiberglass and slide inside the  $\frac{1}{2}$  inch

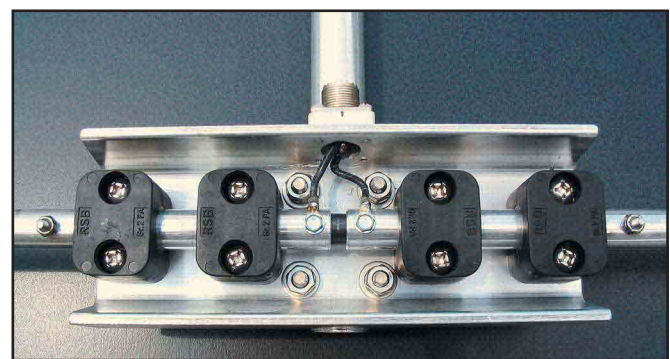


Figure 6—The driven element SO-239 wiring details. The driven element can also be wired directly, as outlined in the text.

OD aluminum tubing. Similarly, a  $\frac{1}{2}$  inch OD  $\times$  10 inch solid fiberglass rod is used to join the  $\frac{5}{8}$  inch OD tubing at the feed point. (Because tubing and fiberglass materials are usually sold in 6 foot lengths, the shipping costs can be more than the material itself. I recommend ordering enough material for a group of builders to keep the costs down.) An installed insulator can be seen in Figure 5.

## Feed Point

The installation of an SO-239 coax connector on the 6 meter Moxon adds a bit of reactance to the feed and it is best to attach the coax directly to the driven element.<sup>5</sup> Unfortunately, this was not practical for me, as I use this antenna for portable use and prefer to separate the coax from the antenna. I tried several methods and ended up using the channel as a mount for the SO-239 connector. In the interest of isolating the feed from the antenna, I made an insulator from the end of a  $1\frac{1}{2}$  inch PVC cap and fastened this and the connector to the channel using nylon screws. Short pieces of 14 gauge insulated wire connect the SO-239 to the driven element. Apply a weatherproof sealant to the solder joints. Figure 6 shows the driven element connection.

An alternate method is to fabricate a bracket that mounts the SO-239 directly on the driven element (see Drawing Sheet 7 for details). The brackets are made from  $1\frac{1}{2}$  inch  $\times$   $1\frac{1}{2}$  inch  $\times$   $\frac{1}{8}$  inch aluminum angle. The connector is mounted on one bracket, which is attached to one side of the driven element. Cut the head off of a 6-32  $\times$  1 inch copper screw, file one end down to fit inside the SO-239 center pin and solder. Use 6-32 nuts on either side to clamp the second bracket, which is attached to the other side of the driven element. Apply a weatherproof sealant to the solder joint and copper materials.

## Corners

Cut the  $\frac{3}{8}$  inch OD aluminum rod into four 8 inch lengths and chuck each into your drill or drill press. While rotating the rod, use a file to smooth the edges to ensure a smooth fit inside  $\frac{1}{2}$  inch OD aluminum tubing. The  $\frac{3}{8}$  inch OD solid aluminum rod is fairly soft and easy to bend. My method is to mark the center and place a scrap piece of  $\frac{1}{2}$  inch OD  $\times$  12 inch aluminum tubing over each end (to give some leverage) and slide it near the mark. I then place the  $\frac{3}{8}$  inch rod over a vise-mounted  $\frac{1}{4}$  inch drill bit and smoothly push the tubing down until I have a 90° bend. See Sheet 7 for a corner detail. A completed corner can be seen in Figure 7.

## Fasteners

The 6-32 stainless steel fasteners were chosen to provide reasonable strength and corrosion resistance without having to drill very large holes in the tubing. The stop nuts provide a vibration-proof fastener without using lock washers.

## Assembly

I prefer to assemble the antenna parts loosely and then go back and install the fasteners. Mark the center of the  $\frac{1}{2}$  inch OD fiberglass rod ( $A_0$ ) and  $\frac{1}{8}$  inch on either side. Slide the fiberglass inside both pieces of  $\frac{5}{8}$  inch OD tubing ( $A_1$ ) up to the  $\frac{1}{8}$  inch marks and place inside the radio support blocks on the driven element mounting bracket. Center the assembly in the bracket and drill holes and install the feed line screws. Mark the center of the  $\frac{5}{8}$  inch OD aluminum tube ( $A_3$ ) and mount it in the Reflector Mounting Bracket. Place a line 3 inches from the end on the four  $\frac{1}{2}$  inch OD tubing lengths ( $A_2$ ) and slide each into the previously mounted  $\frac{5}{8}$  inch OD tubing ( $A_1$  and  $A_3$ ) up to the mark. Place a mark 1 inch from the centerline on each of the four  $\frac{3}{8}$  inch OD bent corners ( $A_4$ ) and insert each inside the  $\frac{1}{2}$  inch OD tubing ( $A_2$ ) up to that mark. Mark the centerline and a point 3 inches from each end on the  $\frac{3}{8}$  inch OD fiberglass ( $C_1$ ) and insert each into the  $\frac{1}{2}$  inch OD aluminum ( $B_1$  and  $D_1$ ).

At this point you should have a complete antenna layout. Referring to the Moxon dimensional chart, check each ABCDE measurement and adjust the assembly until you are satisfied. Keep in mind that there should be at least a 3 inch overlap on all tubing-to-tubing and rod-to-tubing transitions. When you are satisfied, clamp the tube positions (I used tape) and drill straight through, installing the stainless steel hardware as you go. Disassemble and clean all metal-to-metal joints. Then, apply an aluminum antioxidant compound to the joints to maintain good electrical contact by preventing oxidation. Reassemble and use an ohmmeter to ensure feed-point isolation from the boom and mounting brackets.

## Antenna Models

**H-POL**—The resonant frequency is 50.5 MHz at a height of 15 feet. This antenna is intended to cover the lower end of the 6 meter band with less than a 1.3:1 SWR, and tests conducted with an MFJ-259B antenna analyzer verified this. The *EZNEC* model predicts the antenna to have a gain of 11 dBi and front-to-back ratio of 25 dB at resonance. The H-POL antenna completed and mounted is shown in Figure 8.

**V-POL**—The resonant frequency is 53 MHz at a height of 15 feet. This antenna is intended to cover the upper end of the 6 meter band with less than a 1.6:1 SWR. The *EZNEC* model predicts the antenna to have a gain of 6.7 dBi and front-to-back ratio of 36 dB at resonance. The completed V-POL antenna is shown in Figure 9.

## SWR Measurement

Upon completion of the H-POL version, I wanted to compare the SWR curve predicted by *EZNEC* with my MFJ-259B



Figure 7—A corner of one of the elements.

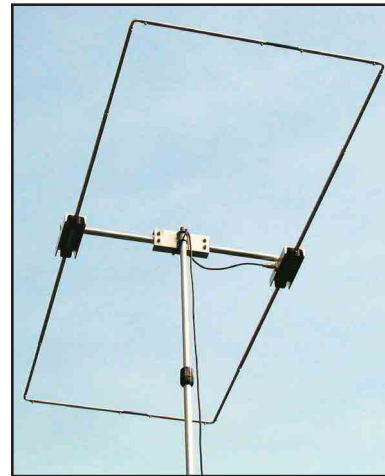


Figure 8—The completed 6 meter Moxon in the horizontal position.

analyzer. At first, I was completely baffled by the results. The analyzer showed a much broader curve than I thought possible. W4RNL provided the following explanation:

“If you made the measurements at the end of a length of coax, they will be flatter than at the antenna itself, due to losses in the coax. These losses increase with thinner coaxes and are less with 1.2 inch diameter low loss coax cables. Hence, RG-58/U will show a flatter SWR than some of the latest coax types. This is normal behavior. As well, the longer the coax run, the greater the losses and, hence, the flatter the curve. If you are measuring the low SWR at the antenna terminals, then it becomes more likely that the flat curve is a function of equipment limitations.”

Armed with this knowledge, I replaced the 50 feet of RG-8X coax that I had been using with a 3 foot run and got much better results with the analyzer. Figure 10 shows the antenna mounted and ready for testing.

## Mounting

The finished antenna weighs 8½ pounds and is light enough for my trusty painter's pole at a height of 15 feet. The antenna will mount horizontally or vertically by loosening the boom to mast plate saddle clamps and rotating the antenna (see Sheets 2 and 3). If you're industrious, you could mount the H-POL and V-POL on the same boom with different feeds.<sup>6</sup>

## 6 Meter Activity

Listen for beacons at the lower end of the band. If you hear one, chances are the band is open. Here is a short list of where I have found the most activity:

CW	50.000 to 50.100 MHz
SSB	50.100 to 50.200 MHz
PSK	50.290 MHz
FM	52.000 to 54.000 MHz (simplex and repeaters)

## Testing

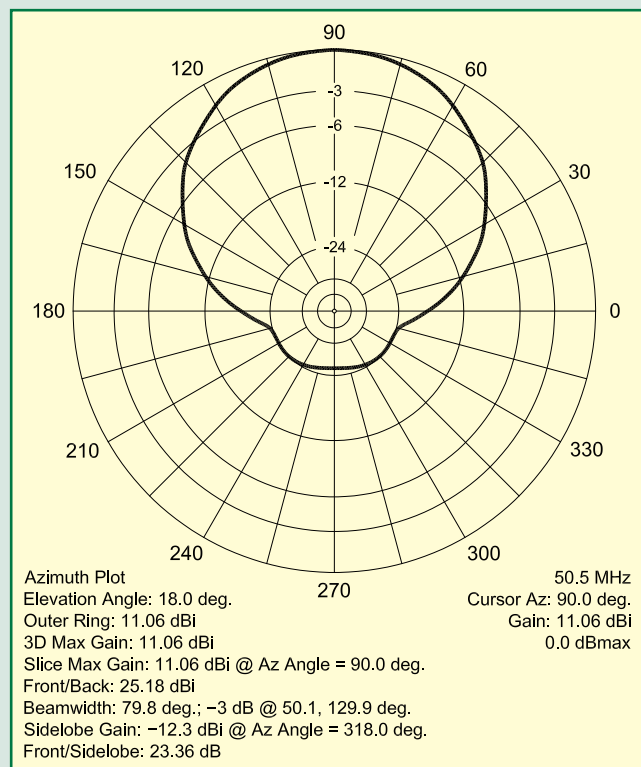
I decided the best way to test the antenna was to go camping

## Antenna Patterns and SWR Plots

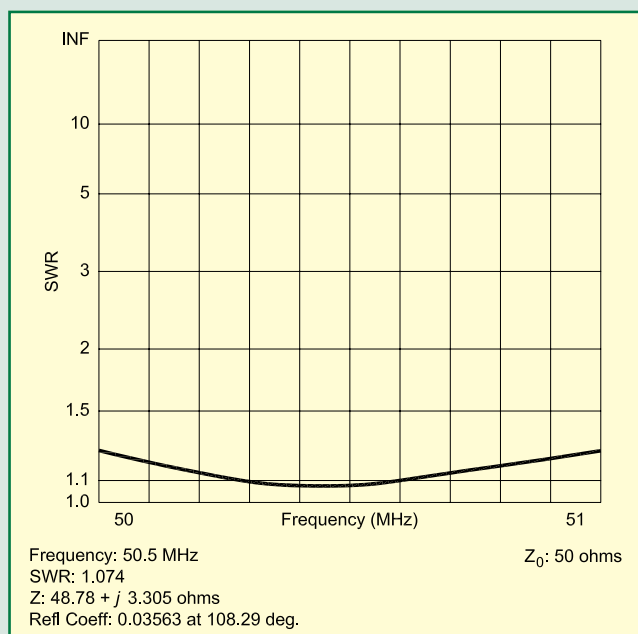
Here are the both azimuth and elevation antenna patterns for the 6 meter Moxon antenna, including the SWR plots. These are presented for both the vertically and horizontally polarized antennas and were made at a modeled test height of 15 feet. All of the plots

were made using *EZNEC* software.

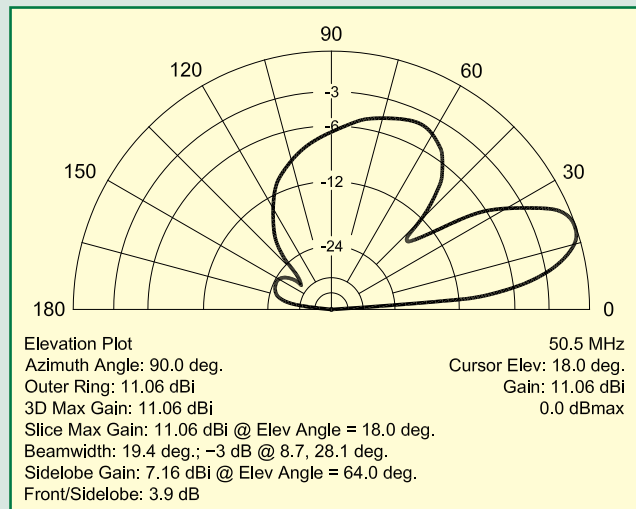
*EZNEC* predicts a gain of 11.06 dBi for the horizontally polarized Moxon and the constructed antenna appears to verify that model. The SWR has, likewise, been confirmed.



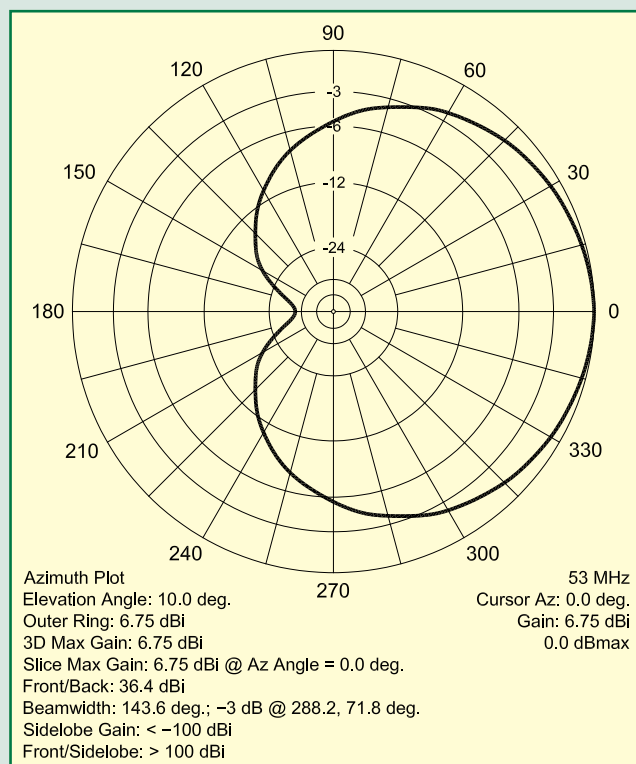
**Figure A—The 6 meter horizontally polarized Moxon azimuth plot at 15 feet.**



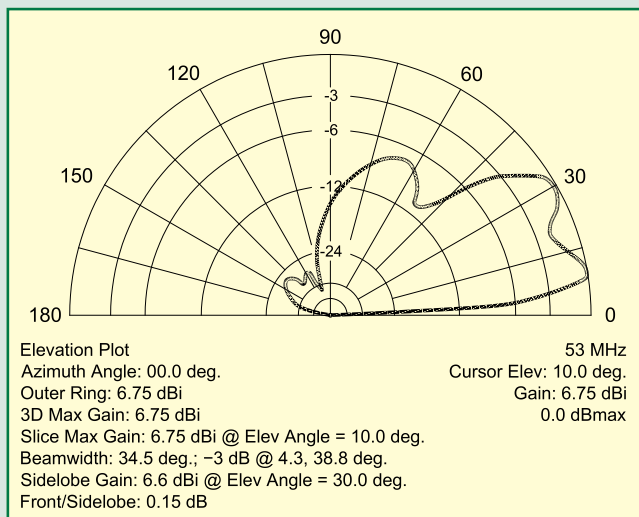
**Figure C—The SWR of the horizontally polarized Moxon at 15 feet at 50.5 MHz.**



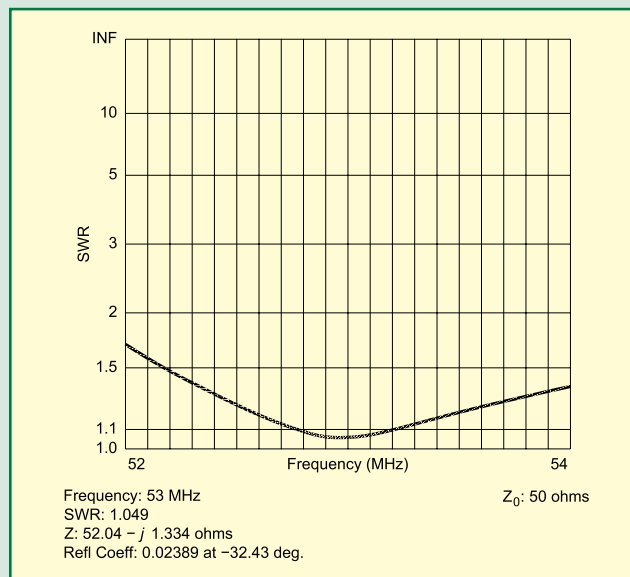
**Figure B—The elevation plot for the horizontally polarized Moxon at 15 feet.**



**Figure D—The 6 meter vertically polarized Moxon azimuth plot at 15 feet.**

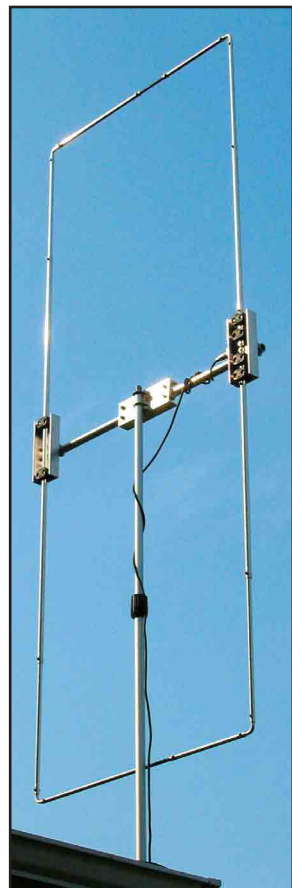


**Figure E—The elevation plot for the vertically polarized Moxon at 15 feet.**



**Figure F—The SWR of the vertically polarized Moxon at 15 feet at 53 MHz.**

during the July 4 holiday. As luck would have it, tropical storm Bill was passing through our area, so it was raining heavily. We set up camp in a light drizzle and then mounted the Moxon on the painter's pole. A quick check with NG4T (about 50 miles



**Figure 9—The Moxon mounted for vertical polarization.**



**Figure 10—A temporary lash-up for testing and adjustment purposes at the author's location.**

away) told me that the antenna was working. I was S7 on his dipole while running 30 W SSB. Our contact was quickly joined by WB4GBI, who gave me a 20 dB over S9 report. It continued to rain throughout the night and the next day brought some welcome sunshine and NG4T (my brother) to the campsite. Thanks to an unusual 6 meter opening that weekend, we logged numerous contacts to California, Colorado and Texas on SSB and PSK. On FM, 6 meter repeaters were easily worked with full quieting. I am still on the lookout, however, for that first 6 meter DX contact!

## Results

The antenna easily withstood the wet weather and the performance was flawless, with excellent gain, directivity and F/B ratio. The fact that the assembled antenna is small enough to fit in a pickup truck makes it a great portable for camping, Field Day, or an afternoon in the park. So start building—and discover why 6 meters is called the “Magic Band.”

## Acknowledgments

I would like to thank L.B. Cebik for his advice and expertise, my wife Ann for her continued encouragement and support, and the late Oddis Baker, my father, for his quest for knowledge that he passed on to me.

## Notes

<sup>1</sup>A. Baker, KG4JJH, “The Black Widow—A Portable 15 Meter Beam,” *QST*, May, 2003, pp 35-39.

<sup>2</sup>[www.cebik.com/6m.html](http://www.cebik.com/6m.html).

<sup>3</sup>[www.qsl.net/ac6la/moxgen.html](http://www.qsl.net/ac6la/moxgen.html).

<sup>4</sup>[www.eznec.com](http://www.eznec.com).

<sup>5,6</sup>See Note 2.

All photos by the author.

Allen Baker, KG4JJH, received his license in September 2000, after a lifelong dream of becoming a ham. He holds a BS in Industrial Engineering from Tennessee Technological University and works as an Instrument and Controls Engineer for the Department of Energy in Oak Ridge, Tennessee. Allen is active on the digital modes (6 through 40 meters) and loves to experiment with antenna designs. He can be reached at [kg4jjh@arri.net](mailto:kg4jjh@arri.net).