A Five-Element Quad Antenna for 2 Meters

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If your station is located on the fringe of the repeater's coverage area, you've come to the right place. Why not build a 5-element quad antenna? It may be just the thing you and your radio need to provide a reliable communication link with the outside world.

My own location provides me with spotty coverage to the local repeater, and I knew that I needed a beam antenna to establish solid communication. I had seen designs for quad antennas in various books including The ARRL Handbook, yet I wondered how easily and inexpensively I could put one together for 2 meters. I chose low cost and simple construction as the main design goals. As a result, I ended up with an effective antenna that has the following features:

o A forward gain of at least 11 dBi o An SWR of 2:1 or better throughout most of the 2-meter band
o Total construction time under two hours using simple hand tools
o Total cost less than $8 (depending on where you purchase your materials)

"What, Me Build a Beam Antenna?"

I made sure that building this antenna would be simple. In so doing, I practically guaranteed that I'd be able to complete the project! (I'm the last person that should be building an antenna. I'm typically "all thumbs" when it comes to construction practices.)

As you can see from the photograph, the antenna uses wood for the boom and dowels for the wire spreaders. It's oriented in the classic diamond configuration. The all-wood design allowed me to use simple hand tools for its construction, and the total cost for materials was just under $8 (see Table 1).

Construction

Before beginning construction, you must first determine the physical dimensions of each of the antenna's elements. The five elements of this quad antenna are the reflector, a driven element and three directors. The reflector is at one end of the boom, followed in order by the driven element and the first, second and third directors. Maximum radiation is along the line of the boom, in the direction of the third director.

Because the director element is arranged into a square loop one wavelength long, the actual length varies from the naturally resonant length. The lengths of the reflector, driven, and first director loop elements can be computed using the following formulas:

LReflector = 1071 / F0
LDriven= 998 / F0
LDirector1 = 973/ F0

where:

LReflector = Length of the reflector element (in feet)
LDriven = Length of the driven element (in feet)
LDirector1 = Length of first director element (in feet)
F0 = Center frequency (in MHz)

The lengths of the second and third director elements are determined by following a 3% series. In other words, the length of the second director is approximately 3% less than the first director, and the length of the third director is about 3% less than the second director. [The equations given in the text and the final dimensions in Table 2 are based on an optimized design for this antenna modeled at ARRL HQ with the NEC2 computer program.-Ed.] Table 2 shows the element lengths, spreader lengths, and element spacings.

With the element dimensions in hand, it's time to get started. Begin by preparing the boom. I decided to use wood for construction because of its low cost, wide availability and ease of use. When building antennas using wood, be sure to select pieces that are well-seasoned and free of knots or damage.

Start with an 8-foot section of 2×2. Cut a 2-foot section from one end. (Don't discard it. It'll be used to make a "shorty" mast section.) Starting from 2.5 inches from one end of the boom, carefully measure and mark the locations for each of the spreader arms. Each element requires two dowels to form the cross-arm assembly, so offset the hole locations by 1/2 inch (see Figure 1). A drill press is ideal for drilling the holes, but an acceptable job can be done with a power hand drill. Be sure to mark which end is the reflector end and which end is the director.

Now carefully measure and mark the wood dowels that are used for the element spreaders. Use the dimensions in Table 2. You'll need two dowels cut to the same length for each element. After cutting the dowels, mount each pair into the appropriate hole locations on the boom, but don't glue them yet! Visually inspect the location of the spreaders on the boom. If everything's in place correctly, you should see the spreaders taper in length from the reflector end to the director end. Once you've verified the placement of the spreaders, you can secure them to the boom. Use a weather-proof glue or epoxy that is nonsoluble. Use a small saw or hobbyist's motor tool to carefully notch the ends of the dowels. These epoxy that is nonsoluble. Use a small saw or hobbyist's motor tool to carefully notch the ends of the dowels. These notches will be used to secure the wire elements.

Mount the boom to the remaining 2-foot length of 2×2. I used a simple butt-end joint reinforced by a small 1-inch long wood pin fashioned from a piece of scrap material from one of the dowels (Figure 2). Simply drill a small hole in the top of the mast about 1/2-inch-long and the same diameter as your doweling. Drill a corresponding hole in the boom. Glue or epoxy the pin into the mast and boom to form the joint. For further reinforcement, you could also fashion gusset plates made from triangular pieces of 1/4-inch plywood and attach them to both sides of the boom.

That completes the construction of the main antenna structure. Now, carefully measure and cut the wire used for each of the five elements. *Do not* use insulated wire! (Or at least remove the insulation.) Once the wire elements have been cut, it's time to mount them to the spreader arms to form the closed loops.

The reflector and director elements are strung around their respective element spreaders and held in place by soldering the ends together. At this point, you must decide whether to use horizontal or vertical polarization. The feedpoint of the driven element determines the polarization. Use corner feed on the side if you want vertical polarization (Figure 3), or attach the transmission line to the bottom corner for horizontal polarization (Figure 4). I opted for vertical polarization since I wanted to use it for FM and repeater work. If you want to try your hand at SSB and CW work, choose horizontal polarization. Attaching the transmission-line to the driven element may prove to be a little tricky, so an extra pair of hands may help. I found it useful to tape the transmission-line spreader arm to hold it in place while I soldered it to the driven element.

I used RG-8X for my setup since I only had a short run (less than 20 feet) to my shack. For installations with longer runs, I recommend using standard RG-8 coax or better to deliver every dB you can to the antenna. Apply a silicone or similar sealer to the exposed end of the coax to prevent the possibility of moisture seeping into the line. The wood surfaces should also be varnished to help protect them from the weather.

This five-element quad is a real performer. If you build the antenna as shown, the computer model predicts 11 dBi gain and a front-to-back ratio of 20 dB. ARRL Lab measurements confirmed the computer-predicted antenna pattern.

You may wish to read further about tuning adjustments in The ARRL Handbook. It describes how to check the antenna with a field-strength meter, or by using a separate receiver in conjunction with a dipole antenna.

Field Results

After connecting the quad to my radio, I rechecked the SWR. Figure 5 shows the SWR readings I obtained throughout the 2-meter band. It's interesting to note that the lowest SWR occurs just below the center frequency of 146 MHz. This is due to the fact that I cut the elements a little long to allow for trimming. I suggest you do the same. Shortening the wires is simply a matter of cutting off the extra length and then deepening the notches in the dowels.

After I had established contact with a friend on the local repeater, we decided to try the quad by switching to simplex operation. (In the past, he and I were unable to communicate directly.) I punched in 146.535 MHz on my radio and rotated the quad toward his station. I nervously called him. After waiting for what seemed like an eternity, I heard his answer! We proceeded to carry on a casual ragchew discussing antennas, current events and so on without tying up the local repeater. (The joys of simplex!) Before signing off, I slowly rotated my quad while he talked in order to get an audible indication of the quad antenna's side and back directivity. His signal faded as expected, and then returned as the quad once again pointed in his direction.

When using the antenna connected to my hand-held transceiver with only 1.5 W of output power, I'm able to consistently access repeaters 40 to 50 miles away. Everyone says my signal is full quieting. That's not too bad, considering I had been unable to even hear those repeaters using my quarter-wavelength ground-plane antenna which is mounted about 10 feet higher than the quad.

Summary

I've been enjoying this antenna for the past few months without any problems whatsoever. I've logged a couple of

hundred contacts, both simplex and via repeaters. I've also used it with equal success for operating packet.

Don't be disheartened if you happen to live in a community with difficult antenna restrictions. In addition to being inexpensive and simple to construct, this quad antenna is also compact enough to be placed in an attic!

If you want an 11-dBi-gain beam antenna for less than $1 per dB, here it is!

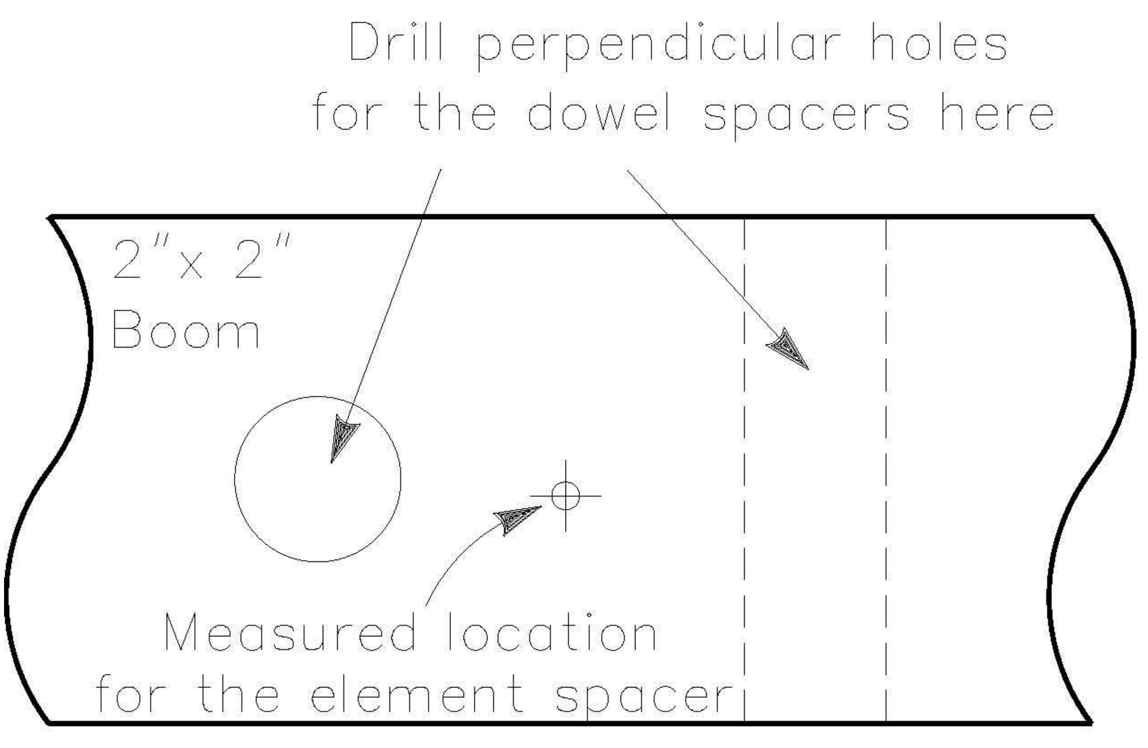

Figure 1 Close-up look at the boom shows mounting the hole offsets used for the dowel spacers.

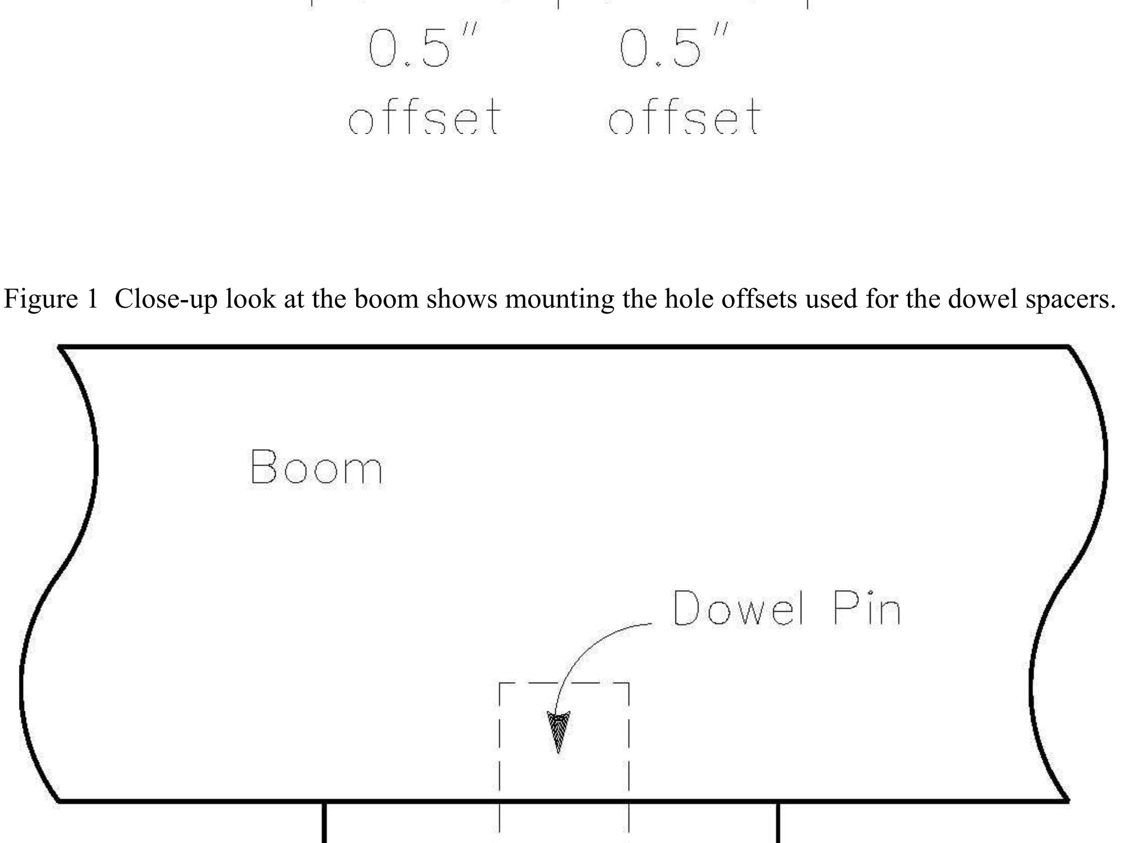

Figure 2 Use a 1-inch scrap piece from one of the dowels as a joint pin to secure the boom to the "shorty" mast section.

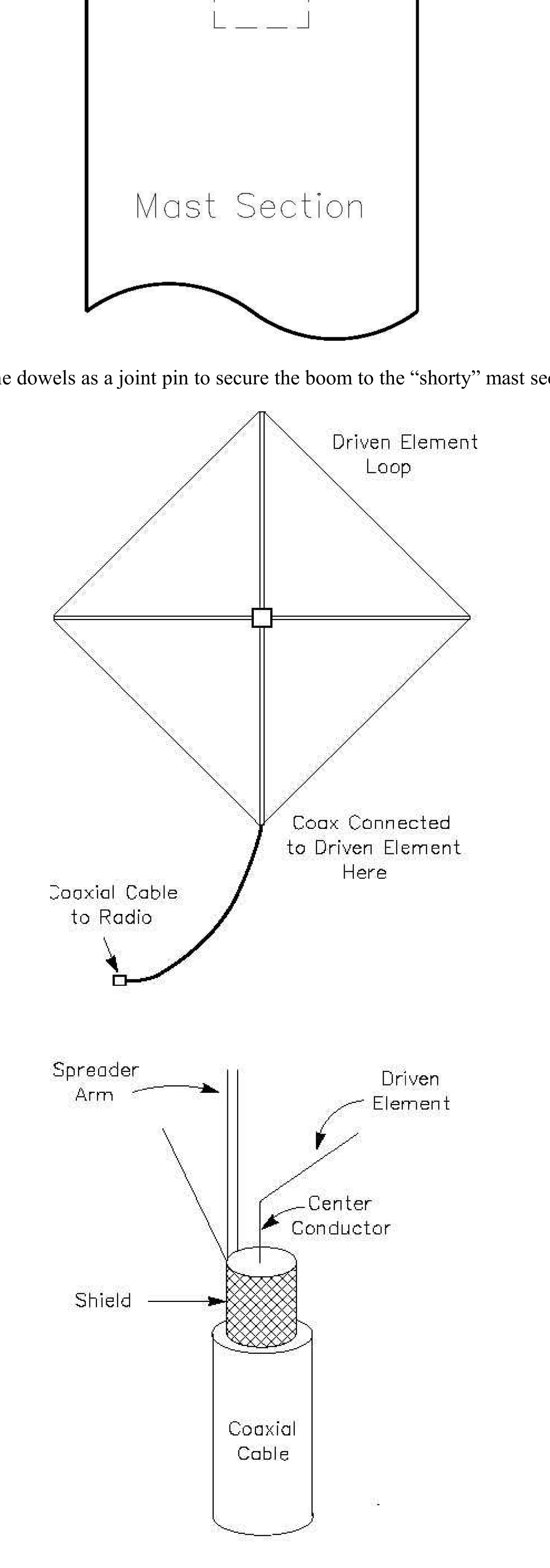

Figure 3 Feed the side corner of the driven element for vertical polarization.

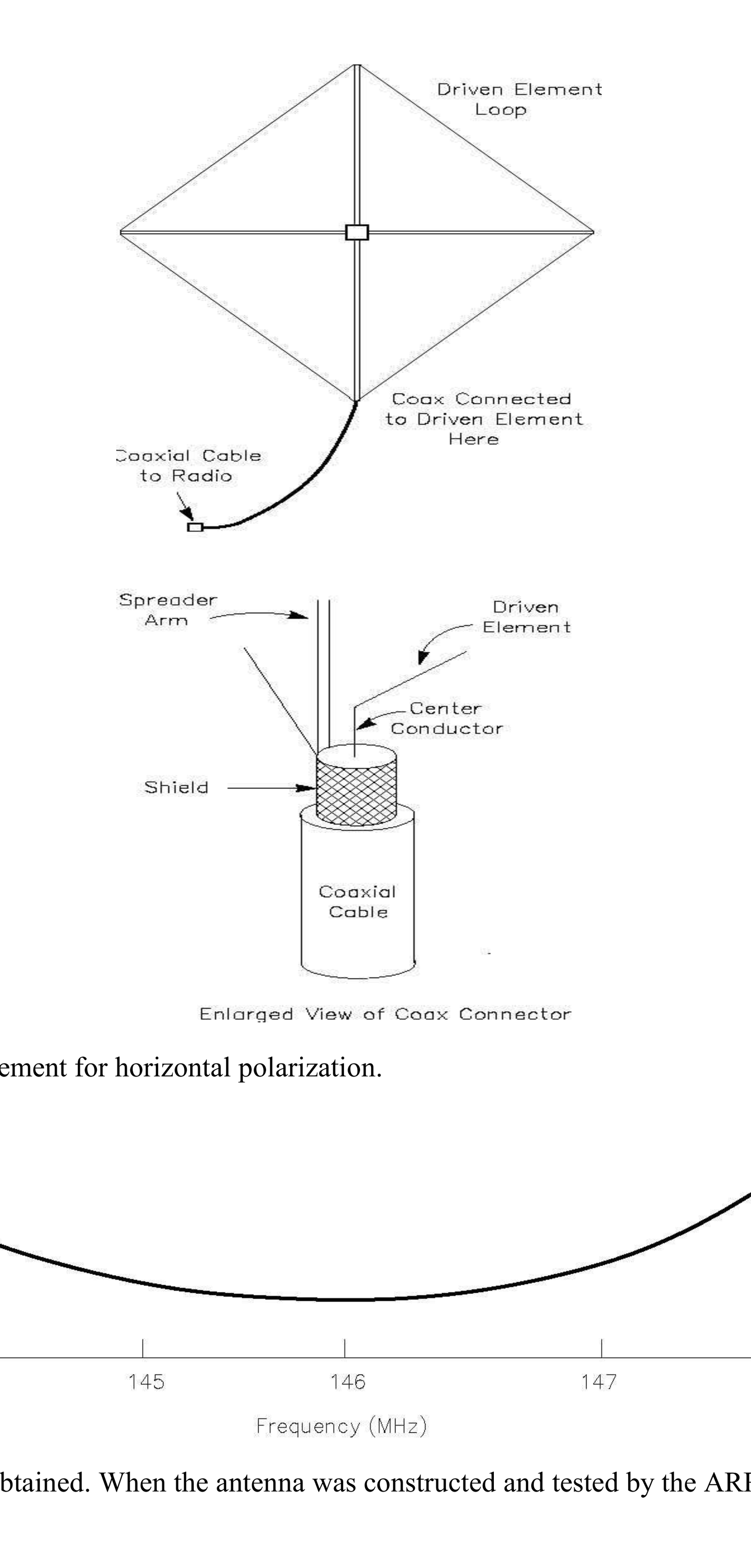

Figure 4 Feed the bottom corner of the driven element for horizontal polarization.

Figure 5 Here are the SWR readings the author obtained. When the antenna was constructed and tested by the ARRL Lab, even better SWR results were obtained.

Table 1

Materials List

Quantity	*Description*	*Typical Cost*
1	12×2×8-inch wood piece	$1.99
10	5/8-inch dowels, 30 inches long	$2.10
34 feet	#10 AWG bare copper wire	$3.06

Table 2

Lengths and Spacing

Element	Element length (inches)	Spreader length (inches)	Spacing from end of boom
Reflector	**88**	**31.25**	**2.5 inches**
Driven	**82**	**29**	**19.5 inches**
1st Director	**80**	**28.5**	**32.5 inches**
2nd Director	**78**	**27.75**	**48.5 inches**
3rd Director	**76**	**27**	**67.5 inches**