

A Portable 144 MHz 4-Element Quad

Element spacing for quad antennas found in the literature ranges from 0.14λ to 0.25λ . Factors such as the number of elements in the array and the parameters to be optimized (F/B ratio, forward gain, bandwidth, etc), determine the optimum element spacing within this range. The 4-element quad antenna described here was designed for portable use, so a compromise between these factors was chosen. This antenna, pictured in **Fig 56**, was designed and built by Philip D'Agostino, W1KSC.

Based on several experimentally determined correction factors related to the frequency of operation and the wire size, optimum design dimensions were found to be as follows.

$$\text{Reflector length (ft)} = \frac{1046.8}{f_{\text{MHz}}} \quad (\text{Eq 8})$$

$$\text{Driven element (ft)} = \frac{985.5}{f_{\text{MHz}}} \quad (\text{Eq 9})$$

$$\text{Directors (ft)} = \frac{937.3}{f_{\text{MHz}}} \quad (\text{Eq 10})$$

Cutting the loops for 146 MHz provides satisfactory performance across the entire 144MHz band.



Fig 56—The 4-element 144-MHz portable quad, assembled and ready for operation. Sections of clothes closet poles joined with pine strips make up the mast. (Photo by Adwin Rusczek, W1MPO)

Materials

The quad was designed for quick and easy assembly and disassembly, as illustrated in **Fig 57**. Wood (clear trim pine) was chosen as the principal building material because of its light weight, low cost, and ready availability. Pine is used for the boom and element supporting arms. Round wood clothes closet poles comprise the mast material. Strips connecting the mast sections are made of heavier pine trim. Elements are made of no. 8 aluminum wire. Plexiglas is used to support the feed point. **Table 17** lists the hardware and other parts needed to duplicate the quad.

Construction

The elements of the quad are assembled first. The mounting holes in the boom should be drilled to accommodate 1½ inch no. 8 hardware. Measure and mark the locations where the holes are to be drilled in the element spreaders, **Fig 58**. Drill the holes in the spreaders just

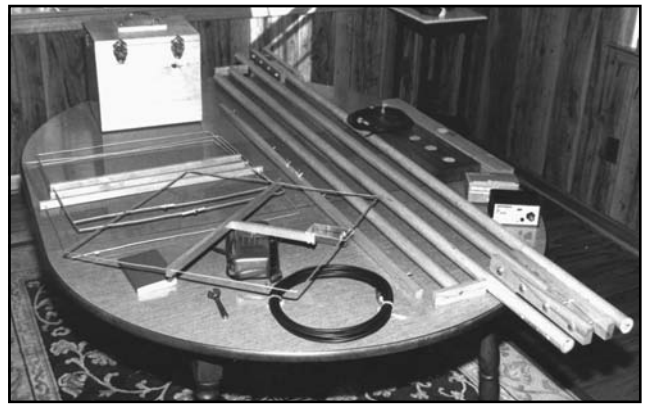


Fig 57—The complete portable quad, broken down for travel. Visible in the foreground is the driven element. The pine box in the background is a carrying case for equipment and accessories. A hole in the lid accepts the mast, so the box doubles as a base for a short mast during portable operation. (W1MPO photo)

Table 17

Parts List for the 144 MHz 4-element Quad

Boom:	¾ × ¾ × 48-in. pine
Driven element support (spreader):	½ × ¾ × 21¼ in. pine
Driven element feed point strut:	½ × ¾ × 7½ in. pine
Reflector support (spreader):	½ × ¾ × 22½ in. pine
Director supports (spreaders):	½ × ¾ × 20¼ in. pine, 2 req'd
Mast brackets:	¾ × 1½ × 12 in. heavy pine trim, 4 req'd
Boom to mast bracket:	½ × 1⅝ × 5 in. pine
Element wire:	Aluminum ground wire (Radio Shack no. 15-035)
Wire clamps:	¼-in. electrician's copper or zinc plated steel clamps, 3 req'd
Boom hardware:	6 no. 8-32 × 1½ in. stainless steel machine screws 6 no. 8-32 stainless steel wing nuts 12 no. 8 stainless steel washers
Mast hardware:	8 hex bolts, ¼-20 × 3½ in. 8 hex nuts, ¼-20 16 flat washers
Mast material:	1⅝ in. × 6 ft wood clothes closet poles, 3 req'd
Feed point support plate:	3½ × 2½ in. Plexiglas sheet
Wood preparation materials:	Sandpaper, clear polyurethane, wax
Feed line:	52-W RG-8 or RG-58 cable
Feed line terminals:	Solder lugs for no. 8 or larger hardware, 2 req'd
Miscellaneous hardware:	4 small machine screws, nuts, washers; 2 flat-head wood screws

large enough to accept the #8 wire elements. It is important to drill all the holes straight so the elements line up when the antenna is assembled.

Construction of the wire elements is easiest if the directors are made first. A handy jig for bending the elements can be made from a piece of 2×3 -inch wood cut to the side length of the directors. It is best to start with about 82 inches of wire for each director. The excess can be cut off when the elements are completed. (The total length of each director is 77 inches.) Two bends should initially be made so the directors can be slipped into the spreaders before the remaining corners are bent. See **Fig 59**. Electrician's copper-wire clamps can be used to join the wires after the final bends are made, and they facilitate adjustment of element length. The reflector is made the same way as the directors, but the total length is 86 inches.

The driven element, total length 81 inches, requires special attention, as the feed attachment point needs to be adequately supported. An extra hole is drilled in the driven element spreader to support the feed-point strut, as shown in **Fig 60**. A Plexiglas plate is used at the feed point to support the feed-point hardware and the feed line. The feed-point support strut should be epoxied to the spreader, and a wood screw used for extra mechanical strength.

For vertical polarization, locate the feed point in the center of one side of the driven element, as shown in **Fig 60**. Although this arrangement places the spreader supports at voltage maxima points on the four loop conductors, D'Agostino reports no adverse effects during operation. However, if the antenna is to be left exposed to the weather, the builder may wish to modify the design to provide support for the loops at current maxima points, such as shown in **Fig 60**. (The element of **Fig 60** should be rotated 90° for horizontal polarization.)

Orient the driven element spreader so that it mounts properly on the boom when the antenna is assembled. Bend the driven element the same way as the reflector

and directors, but do not leave any overlap at the feed point. The ends of the wires should be $\frac{3}{4}$ inch apart where they mount on the Plexiglas plate. Leave enough excess that small loops can be bent in the wire for attachment to the coaxial feed line with stainless steel hardware.

Drill the boom as shown in **Fig 61**. It is a good idea to use hardware with wing nuts to secure the element spreaders to the boom. After the boom is drilled, clean all the wood parts with denatured alcohol, sand them, and give them two coats of glossy polyurethane. After the polyurethane dries, wax all the wooden parts.

The boom to mast attachment is made next. Square the ends of a 6-foot section of clothes closet pole (a miter box is useful for this). Drill the center holes in both the boom

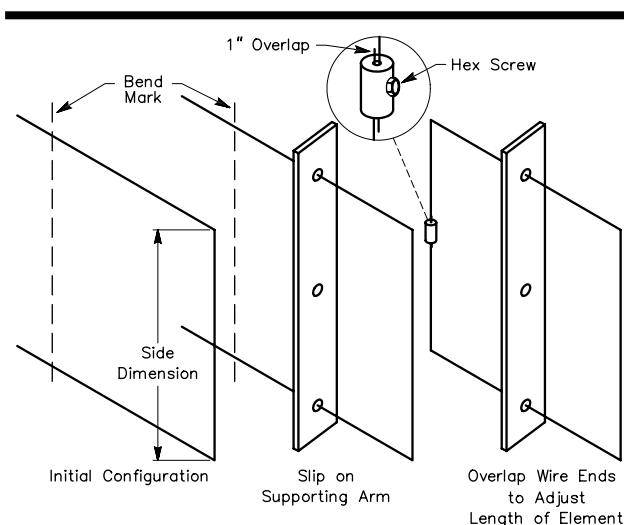


Fig 59—Illustration showing how the aluminum element wires are bent. The adjustment clamp and its location are also shown.

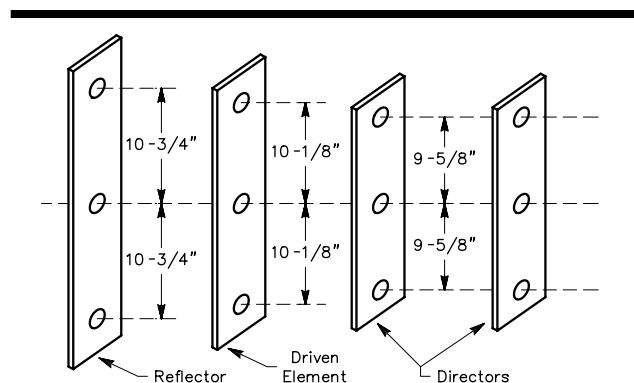


Fig 58—Dimensions for the pine element spreaders for the 144-MHz 4-element quad.

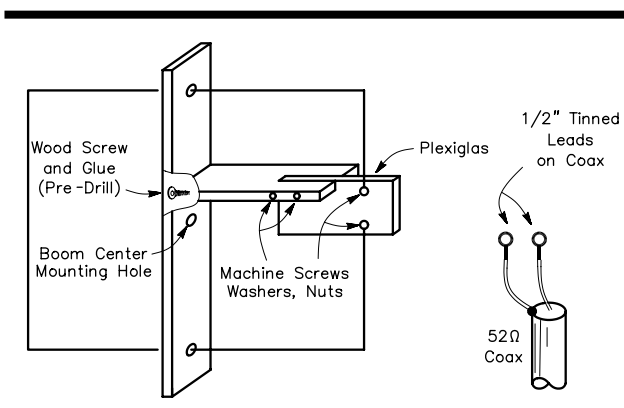


Fig 60—Layout of the driven element of the 144-MHz quad. The leads of the coaxial cable should be stripped to $\frac{1}{2}$ in. and solder lugs attached for easy connection and disconnection. See text regarding impedance at loop support points.

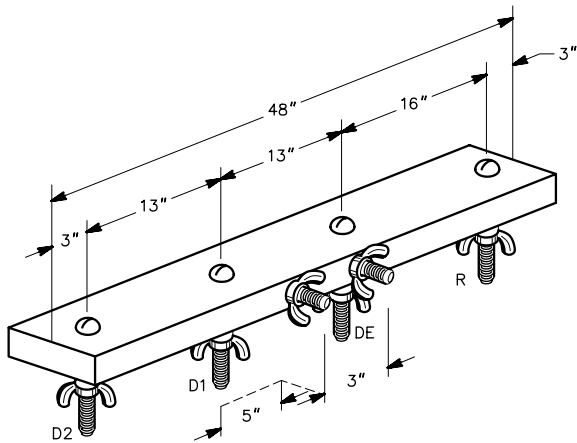


Fig 61—Detail of the boom showing hole center locations and boom to mast connection points.

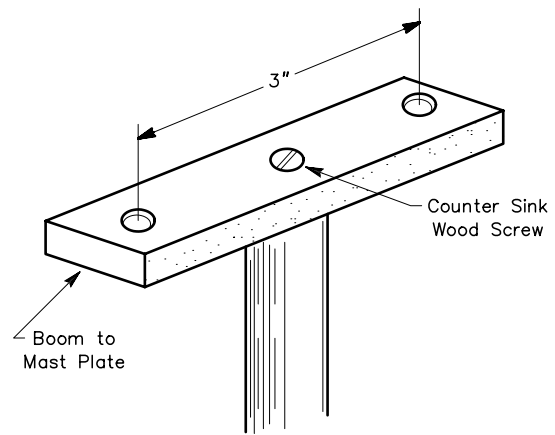


Fig 62—Boom to mast plate for the 144-MHz quad. The screw hole in the center of the plate should be countersunk so the wood screw attaching it to the mast does not interfere with the fit of the boom.

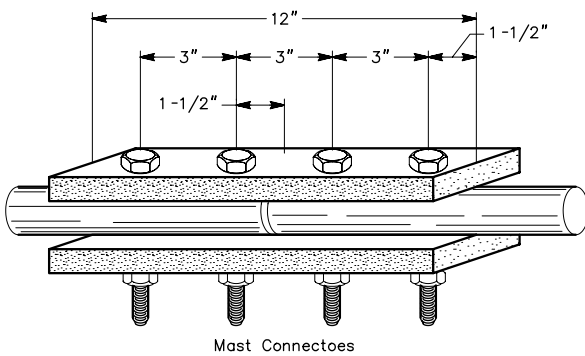


Fig 63—Mast coupling connector details for the portable quad. The plates should be drilled two at a time to ensure the holes line up.

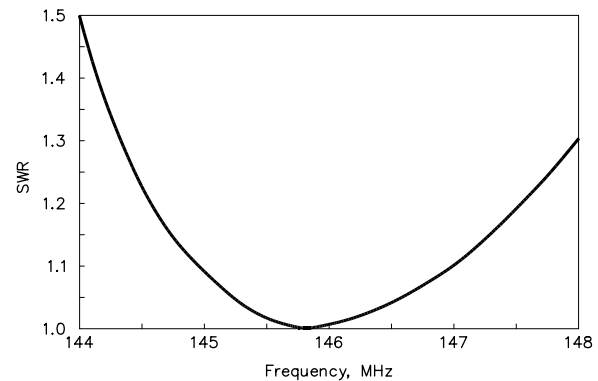


Fig 64—Typical SWR curve for the 144MHz portable quad. The large wire diameter and the quad design provide excellent bandwidth.

attachment piece and one end of the mast section (**Fig 62**). Make certain that the mast hole is smaller than the flat-head screw to be used to ensure a snug fit. Accurately drill the holes for attachment to the boom as shown in **Fig 62**.

Countersink the hole for the flat-head screw to provide a smooth surface for attachment to the boom. Apply epoxy cement to the surfaces and screw the boom attachment piece securely to the mast section. One 6 foot mast is used for attachment to the other mast sections.

Two additional 6-foot mast sections are prepared next. This brings the total mast height to 18 feet. It is important to square the ends of each pole so the mast stands straight when assembled. Mast-section connectors are made of pine as shown in **Fig 63**. Using $3\frac{1}{2} \times \frac{1}{4}$ -inch hex bolts, washers, and nuts, sections may be attached as needed, for a total height of 6, 12 or 18 feet. Drill the holes in two connectors at a time. This ensures good align-

ment of the holes. A drill press is ideal for this job, but with care a hand drill can be used if necessary.

Line up two mast sections end to end, being careful that they are perfectly straight. Use the predrilled connectors to maintain pole straightness, and drill through the poles, one at a time. If good alignment is maintained, a straight 18-foot mast section can be made. Label the connectors and poles immediately so they are always assembled in the same order.

When assembling the antenna, install all the elements on the boom before attaching the feed line. Connect the coax to the screw connections on the driven element support plate and run the cable along the strut to the boom. From there, the cable should be routed directly to the mast and down. Assemble the mast sections to the desired height. The antenna provides good performance, and has a reasonable SWR curve over the entire 144 MHz band (**Fig 64**).