

A Light and Sturdy Quad for 10 and 15 Meters

Fishin' for DX? A few fishin' poles and a hank of wire can help you snag the Big One!

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Antennas—every active ham's station has at least one. Antennas continue to satisfy many a ham's desire to build a part of their station's equipment, and homemade antennas can compete with commercial ones. When we launched our DX-antenna project in the summer of 1987, we soon discovered the real challenge: building the antenna using readily available materials. Here's what we did and how you can build a two-element, lightweight 10- and 15-meter quad using parts available at local hardware and radio-parts stores and a sporting-goods mail-order supplier.

Basic Design Considerations

Compared with a Yagi of similar boom length (or with the same number of elements), a quad performs better at low heights and requires only about 70% the horizontal span of the Yagi. Whereas multiband operation of Yagis requires the use of traps, interlaced elements or stacked single-band antennas, a multiband quad can be built with little additional material and weight. The quad does have its disadvantages, however: It's cumbersome, requires a taller mast to clear nearby obstacles, and unless it's well built, it won't stand up to weather as well as a Yagi. Also, you won't be able to put anything else on the mast.

The heart of a quad is its spreaders. For strength and ease of construction, we chose to use the boom-and-cross-arms arrangement rather than a spiderweb (or "boomless") quad. Using a boom, all major parts are mounted at 90-degree angles to each other, which is mechanically simple to achieve. It's also relatively easy to neatly align the spreaders and wires for the desired dimensions.

Our decision to build a two-element quad (driven element and reflector) was primarily based on material availability. The largest

locally available aluminum tubing is only 1 1/4 inches OD. This appeared to be strong enough for a two-element quad boom, but not much more. Also, the low wind loading of a two-element quad minimizes requirements on the supporting structure. Lastly, as with any directional antenna, additional elements improve performance less than proportionally, so we decided to gain experience building a basic quad before undertaking a larger project.

We chose a spacing of 4 feet 8 inches between the driven and reflector elements. On both bands, this spacing provides feed-point impedances that are close enough for direct connection of 50-ohm feed lines.¹ To minimize electrical interaction, we use separate feed lines for each band. A diamond configuration (rather than the

¹Notes appear on p 32.

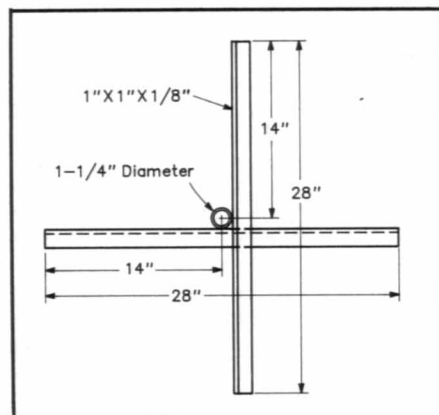
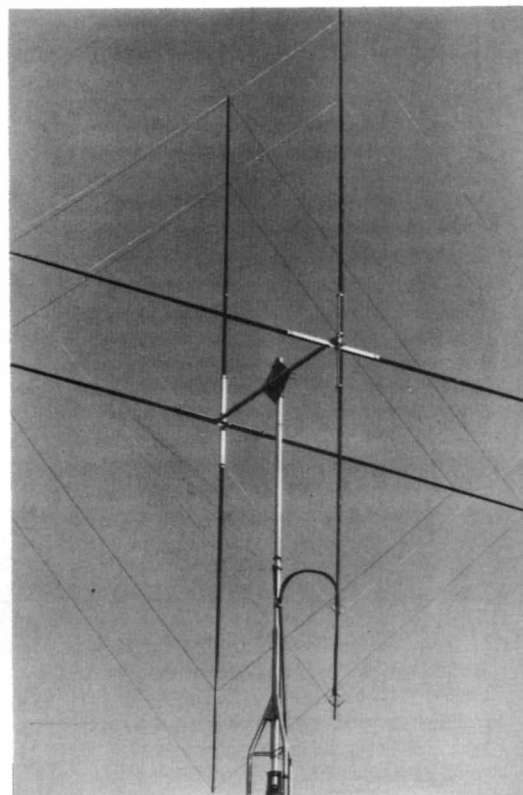


Fig 1—Cross-arm and boom dimensions; view from one end of the boom.



(photos by Gregory Wellenius)

square) is used so that the feed lines can run down along a spreader arm rather than weigh down the midpoints of the driven-element wires.² This also reduces ice and snow accumulation on the wire elements.

Construction

Table 1 lists the parts, suggested sources and approximate prices. The quad is built in four stages: spreaders, cross-arms and boom, spreader assembly and element-wire installation. See Figs 1-7.

Spreaders

We used fiberglass rather than bamboo for the spreaders: Fiberglass is much lighter and sturdier, doesn't warp, requires no maintenance and lasts longer. Fiberglass can be costly, but Bass Pro Shops (a catalog supplier of fishing equipment) sells relatively inexpensive "Crappie Catcher" telescopic fiberglass fishing poles in various lengths. The 14-foot pole, which comes in sections tapering from about 1- to 1/8-inch diameter, is the foundation of our quad, which we promptly dubbed the "Crappie Quad."

Eight poles are required—four for each of the two elements. Use care not to damage the poles. Fiberglass resists bending well, but breaks readily along cuts or scratches. Prepare the poles by removing the vinyl-wrap handles and plastic ends from the fishing poles. Clip the line guides. Cut each pole to a length of 9 feet, discarding the thin end. Glue and seal the joints of the remaining sections using epoxy.

Wrap quality vinyl electrical tape over a 1 1/2-foot length at the large-diameter (butt) end of each pole to protect it from friction

Table 1
List of Materials

Item	Qty	Suggested Source and Cat. No.	Approx. Price (\$)
14' telescopic fiberglass fishing poles	8	Bass Pro Shop 111-467*	112
Aluminum tubing 1-1/4" diam, 0.057" wall, 6' length	1	Hardware store (eg, EASE 2631)†	10
Aluminum angle 1 x 1 x 1/8", 8' long	2	Hardware store (eg, EASE 2225)	25
TV mast U bolts clamps††	4	Radio Shack 15-826	5
70' of heavy duty no. 14, 7-strand bare copper wire	4	Radio Shack 278-329	24
Ceramic insulators	2	Radio Shack 278-1335	4
Stainless-steel hose clamps	16	Hardware store	19
Wood dowels, epoxy glue, marine varnish, vinyl electrical, tape, masking tape, solder		Hardware store	10
Total price			209

*Bass Pro Shops, PO Box 4046, Springfield, MO 65808-4046, tel 800-227-7776. Model type and price vary from time to time. Items may be available at sale price. (Another supplier of similar poles [Tuff-Lite Crappie Master, RFP 123 12-foot fiberglass poles] is B & M, PO Box 231, West Point, MS 39773, tel 601-494-5092 for the name of your nearest dealer.—Ed.)

†Eastern Aluminum Sheet and Extrusion, Inc.

††Use stainless-steel U bolts for longevity.

once mounted. Make sure the tape is wound uniformly, so that the spreader fits flat against the supporting cross-arm. Apply the tape end without tension so that it does not unwind later.

Use hardwood dowels to strengthen the butt ends of the spreaders and prevent them from flattening when clamped. Standard-diameter dowels don't provide an exact fit, so some filing and sanding is necessary to achieve a uniform, snug fit. Each dowel should be about 4 inches long. To improve weather resistance, coat each dowel with marine varnish before inserting it into the base of the pole.

Cross-Arms and Boom

The cross-arms (see Fig 1) are made of 1- x 1- x 1/8-inch aluminum angle. Four 28-inch sections are required. For the boom, use a 5-foot length of aluminum tubing, 1-1/4-inch diameter (0.057-inch wall thickness), fitted with hardwood dowels in both ends.

Attach the cross-arms to the boom as shown in Fig 2, using TV-mast U bolts and clamps. Drill the U-bolt holes exactly along the center line of the cross-arms (see Fig 3).

Care is needed to ensure that the cross-arms at each end are perpendicular to one

another, and that both cross-arm sets are perpendicular to the boom and parallel to each other. First, mount one cross-arm with the inside of the aluminum angle piece facing towards one end of the boom, with the outer edge 1 inch from the boom end. Then mount the companion cross-arm back-to-back (ie, with the angle facing towards the far end of the boom) with the first piece. Use a carpenter's square to check that the second arm is perpendicular to both the boom and the first cross-arm piece.

Using a vise or C clamps, secure the boom horizontally, with the exterior arm exactly horizontal (check with a bubble level). Mount the second exterior arm at the far end of the boom; ensure that it is both horizontal and perpendicular to the boom. Mount the remaining interior arm and verify that it is perpendicular to both the boom and its companion arm. Recheck the horizontals at both ends. The two cross-arms should now be square and parallel. Double-check by looking from one end of the boom, then tighten all U-bolt hardware.

Spreader Assembly

Mount the boom vertically at a convenient working height above ground for assembly and wiring.³ Make sure the whole antenna remains clear of obstacles throughout assembly, and that there is no risk of people or pets running into it. Take special care throughout construction not to trip on the wires!

Mount the fiberglass spreaders using stainless-steel hose clamps, as shown in Fig 2. Form the clamps to the shape of the aluminum-angle cross-arms. The end clamps can be tightened quite firmly—the dowels will prevent flattening of the spreaders. Use a somewhat lighter hand on the other clamps.

Element-Wire Installation

Drill 1/8-inch holes in the spreaders at the appropriate points (see Fig 4) to pass the element wires. Start by marking the center points of the spreaders for reference. Mark which set of spreaders will be used for the reflector and which will support the driven element. On each spreader, mark the hole locations at proper distances from the center. Wrap masking tape around the fiberglass spreader to facilitate marking and to prevent the drill bit from slipping. Drill holes through the spreaders at each mark, perpendicular to the boom, then remove the masking tape and any burrs.

Use no. 14 stranded bare copper wire for all elements. An 80-W (or larger) soldering iron is required. First prepare the wire for the 10-meter reflector. Solder one end of the wire to prevent the strands from unraveling and clamp that end of the wire in a bench vise. Unroll the wire and straighten it out by pulling hard along the length of the wire while holding it tightly between two pieces of wood (don't use your bare hands!). Measure and cut the necessary length of wire for the 10-meter reflector

plus 12 inches. Then solder the wire strands at the other end.

Thread the wire through the holes in the reflector spreaders. If all is well, the wire ends should overlap about 12 inches without excessive sag or tension (see Fig 5). The wire should be as taut as possible without bending the spreaders. Temporarily connect the wire ends by bending them back on one another. Slip the wire back and forth

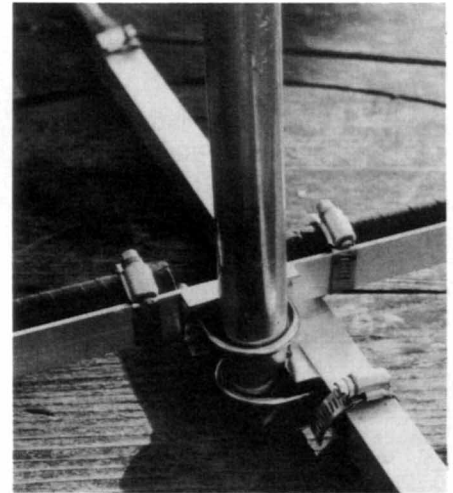


Fig 2—Cross-arm and boom assembly. U bolts secure each cross-arm to the boom; hose clamps fasten the tape-wrapped butt ends of the fiberglass poles to the aluminum-angle cross-arms. Two hose clamps are used for each pole: one at the butt end near the boom and another near the end of each cross-arm.

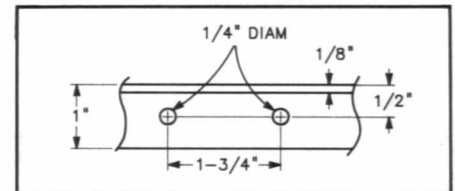


Fig 3—Dimensions for drilling the U-bolt holes in the aluminum-angle cross-arms.

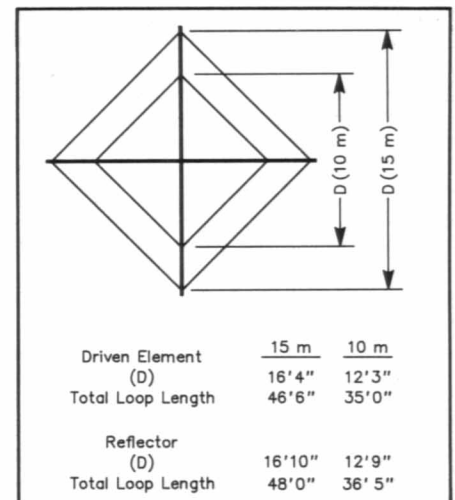


Fig 4—Dimensions for the quad elements.

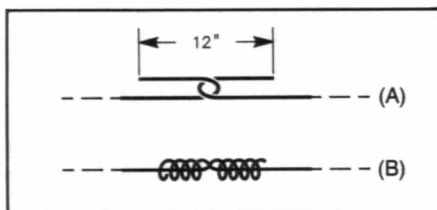


Fig 5—At A, temporarily bend back the ends of the element wires to check for wire tension and alignment of the spreaders. The extra 12-inch wire length allows for adjustment. When tension and alignment are set, wrap the wires firmly (B) and solder the wraps.

through each hole until the spreaders are aligned (look end-on to check each pair of opposite spreaders). Slightly bend the wire at both sides of each hole for a neater square. Check again for excessive sag or tension, and adjust overlap if necessary.

Repeat the wire-threading process for the 15-meter reflector. Some minor readjustment of the 10-meter reflector may be needed if the spreaders bend under the combined tension of both reflectors. Note that the 15-meter reflector, being longer and farther from the center, cannot be stretched as tightly as the 10-meter element without bending the spreaders, so the wire will sag slightly more.

Now, wrap the wire ends permanently. Add positioning-wire bridges (see Fig 6) at each spreader/wire junction to prevent the wire from slipping. Solder all connections.

Wire the driven elements using essentially the same procedure, with the following differences. Identify and mark the spreader that will be pointing down when the quad is mounted in its final position. Using no. 14 stranded wire, mount short ceramic insulators close to each side of the holes in the downward-pointing spreader (see Fig 7). Using some spare wire, determine how much material will be needed to secure each end of the driven element to its insulator. Add *twice* this length (in addition to the 12 inches prescribed for the reflectors) when cutting the wire for the driven elements. Thread the element wires through the spreader holes and attach the wire ends to the insulators, leaving equal lengths of wire at each end. Enough wire should remain to reach straight across from each insulator to the spreader with about 6 inches to spare.

Secure the feed lines to the boom, run them along the down-pointing spreader, and connect them to their respective driven elements. Cut off any surplus wire. Solder and waterproof cable ends with electrical tape. Seal the tips of the spreaders with electrical tape to prevent water entry. The Crappie Quad is ready to mount!

Installation

Excluding cables, the Crappie Quad weighs less than 10 pounds and has a wind-load area of only about 4 square feet. We mounted our antenna 36 feet above ground.

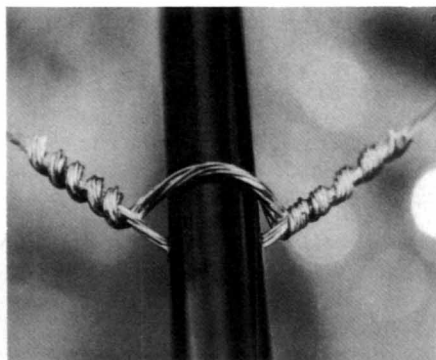


Fig 6—Close-up of a wire-positioning bridge. Bridges such as this one are used at each element-wire pass-through point on the spreaders.

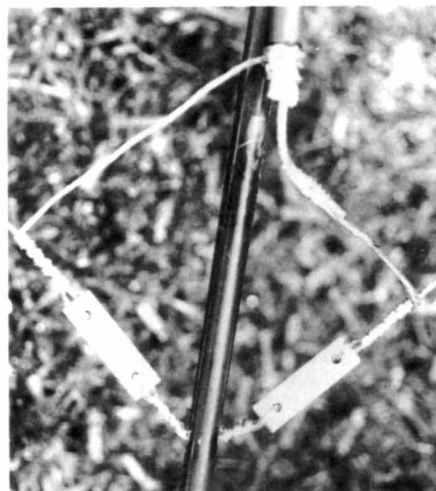


Fig 7—Close-up view of the 15-meter feed point. The coax center conductor is connected directly to one end of the driven element, and the shield to the other end. Seal the coax and connections with vinyl electrical tape for weatherproofing.

Using a 1/8-inch thick, 8- × 8-inch square aluminum plate and four U bolts, the antenna boom is attached to a light electrical-conduit mast. The mast extends about 6 feet over three 10-foot sections of unguyed Rohn 25G tower bracketed to the house 18 feet above the base. A hinged base and a boat-winch and pulley arrangement allow one person to tilt the tower and antenna to ground level for easy maintenance and experimentation.⁴ The tower is connected to a ground rod near the base and the coaxial-cable braids are grounded to the tower. A CD-45 heavy-duty TV rotator does an adequate job turning the antenna and keeps it steady under most conditions.

Results

The Crappie Quad has proven itself well. Two 80-mph windstorms, three years' exposure to air temperatures ranging from 10 to 105 °F, and moderate snow and ice, have left the quad as new. Although the sight of the antenna twisting and bounc-

ing in strong wind is frightening, the structure promptly settles down to its original shape. Against the backdrop of trees, the antenna and tower are barely noticeable from the street. Using a transmitter output power of 80 W, occasional operation during the first 18 months logged over 150 countries and many a DX rag-chew. We can confidently say the Crappie Quad's nickname is no reflection on its performance!

Notes

¹A separation of 4' 8" between the driven and reflector elements is equivalent to about 0.1 λ on 15 meters and 0.13 λ on 10 meters. Although these spacings are slightly below and above (respectively) what would provide optimum gain, the resulting feed-point impedances of 40 and 60 ohms are close to that of 50-Ω coax, so a matching device is not essential. With the dimensions given, our antenna has an SWR of less than 1.1 at 21.25 and 28.35 MHz, and remains below 2 from 21.1 to 21.45 and from 28.05 to 28.7 MHz.

²The preferred way to secure the coaxial cables depends on the arrangements made to mount the antenna on the mast and tower. As shown in the title photo, we clamped the coaxial cables to the mast rather than the boom, and looped the cable ends on to the down spreader somewhat above the 10-meter drive point. Some experimentation was needed to ensure that the coaxial cable loop did not deform the down-pointing spreader from vertical.

³We placed the boom end-on above a large, wooden patio table, and taped the boom to a section of TV mast standing in place of the table umbrella.

⁴We've found this arrangement to work satisfactorily. Rohn's standard installation instructions recommend that the tower should be tilted *alone*, without the antenna in place.

Kevin Wellenius is a senior at the Washington International School in Washington, DC, and plans to study civil engineering. He obtained his Novice-class license in 1985 at age 12, and now holds an Advanced-class license. Kevin's efforts to develop the interest of young persons in Amateur Radio include establishing a radio club station at his school in 1988, and training a first batch of student operators licensed shortly thereafter. An article ("The Future Generation", QST, Jan 1989, pp 55 and 57) presented his early views on attracting youth to ham radio.

Björn Wellenius, Kevin's father, has been a licensed ham since 1957. He was especially active in 20-meter DX in the early 1960s with a fully home-made station. Björn has an MSC in electrical engineering and a PhD in telecommunications. He is Principal Telecommunication Specialist at the World Bank in Washington, DC, focusing on telecommunications policy and investment in developing countries. Björn's other interests include gardening and photography.

Strays



I would like to get in touch with...

□ anyone who has a schematic for a Spectronics DD-1C digital display. This unit works with the Collins KWM-2. Spectronics was in Signal Hill, California. Wally Mitchell, KH6EEU, Honolulu ARC, 2417 Parker Pl, Honolulu, HI 96822-1972.