

The Long-Boom Quagi

What, you're not on 432 yet? If it's the need for an antenna that's stopping you, you've got the green light now — this 15-element quagi.

By Wayne Overbeck,* K8YNB/N6NB

No, a quagi is not the sound made by a certain species of duck found only in northern California and southern Alaska. A quagi is merely one of the most interesting amateur antenna designs to come down the pike in recent years. The author first described this combination of cubical quad and Yagi-Uda design techniques about a year ago¹ and the response from amateurs seemed to demand further work on the design. The result is a quagi for 432 MHz, a band of ever-increasing interest among vhf operators working direct, moonbounce and through the OSCAR 7 satellite.

What does the quagi have going for it that makes it an attractive alternative to both the quad and Yagi-Uda arrays? Easy, noncritical construction, for one thing, as well as simple matching of the feed line to the driven element. Also, quagi fans have been fed by recent discussions of the advantages of quad loops over rod-type driven elements (such as used in straight Yagi-Uda designs).² Not that there has been any doubt about that, as attested in past work by acknowledged experts Orr and Lindsay.^{3,4}

Finally, Danish scientist Appel-Hansen has produced results⁵ indicating that while quad loops make excellent driven elements and reflectors, rods seem to be superior directors. Thus, the quagi, for your 432-MHz pleasure.

The vhf quagis were designed by amateurs, using amateur methods. Although developed independently of Appel-Hansen's work, they are a practical

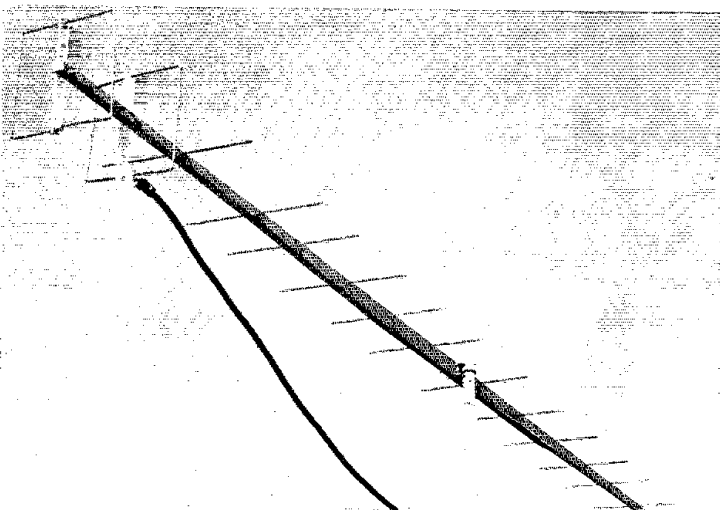
application of the principles he demonstrated. The effectiveness of the original quagi design is well known, and numerous amateurs have asked if the quagi principle could be applied to a super-long antenna for 432-MHz work.

The answer is the 15-element array to be described. It is just as easy to reproduce as the smaller eight-element quagi, but it offers nearly 15 dB gain over a dipole (dBd). Boom length of the antenna is 5λ (11.5 feet or 3.51 meters for 432 MHz). Obviously, this boom length makes such an

antenna impractical for use on the lower amateur frequencies, but at 432 MHz it fits nicely on a 12-foot (3.66 meter) length of 1 × 2-inch (25 × 50-mm) lumber.

Long-Boom Performance

The 15-element quagi has been tested repeatedly against other long-boom antennas, including the 16-element, log-periodic Yagi described by Holladay⁶ (made commercially by KLM Electronics), and the 21-element, F9FT Yagi. When the 15-element quagi was designed,



The long-boom quagi is elegant in its simplicity. Tapering the boom lends greater rigidity to the structure. The most difficult part of this project may be obtaining lumber straight enough for accurate alignment of the elements.

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¹References appear on page 21.

the KLM long Yagi was used as a reference standard against which to test the new array. In several test-range experiments the quagi's gain was found to be comparable to that of the 16-element, log-periodic Yagi.

To confirm the new design's performance and reproducibility, a second 15-element quagi was built directly from the dimensions that appear in Table 1, with the original antenna out of sight. This "cookbook" quagi was taken to the three major vhf antenna gain competitions in the United States in the spring and summer of 1977. In all three measurements, the quagi's performance was very similar to that of the larger, more expensive, commercial antennas. At the Central States VHF Conference, the 15-element quagi and 16-element KLM antenna were rated at identical gains, with the 21-element F9FT array about 1 dB greater than both. On the other hand, the quagi outperformed both the F9FT antenna and the KLM in the sun noise measurements at the East Coast VHF Society's session. When the same antennas were measured with a nearby signal source, however, the best F9FT and KLM antennas topped the quagi by 0.8 to 1.0 dB. That result was closely duplicated at the West Coast VHF Conference.

The consensus of all these measurements seems to be that all of these long-boom antennas are very good performers, with none holding a decisive advantage over any other in gain. Whether an amateur buys a long 432-MHz Yagi or "rolls his own" will depend on his budget, schedule and personal preferences. With this quad-driven array, gone are the days when first-rate, 432-MHz Yagis could be built only by those having special skills and elaborate test equipment. No longer must a builder match impedances and struggle with critical baluns to get a 432-MHz Yagi to take power efficiently. To duplicate this antenna, all the builder need do is cut the rods and wire loops to within about 1/32 inch (0.8 mm) of the dimensions given in Table 1.

As with any uhf project, the quagi builder should use the materials specified or expect to do some extra "tweaking." Any sort of 1/8-inch (3-mm) rod stock will do for the directors, but the quad loop must be no. 12 AWG (2-mm) TW covered copper wire (available from electrical suppliers). If you use bare wire (or any other diameter wire) for the loop elements, be prepared to adjust the lengths. A wood (or other nonconductive) boom is used. The quad loops are supported by Plexiglas strips while the director rods pass through the boom.

As with the smaller eight-element quagis, the long-boom 15 should be fed directly with 52-ohm coaxial cable. A type N connector is soldered into the midpoint of the bottom side of the driven loop. The

About Building Quagis

Since the original "VHF Quagi" article appeared in *QST* for April, 1977, hundreds of hams have successfully reproduced these antennas. However, several builders have written the author that they were having difficulty getting their quagis to work. These difficulties stem from three causes:

1) *Failure to observe correct polarization* — The photos in *QST* show horizontally polarized arrays, but vertical polarization is standard in fm and repeater work. Several builders have written complaining that they built quagis and put them up "just like you showed it in *QST*" only to find that their groundplanes would get into the local repeater better! For fm service, the quagi must be vertically polarized. That means the directors must be vertical and the feed point must be on the side of the driven element. Despite its square shape, a quad-type loop is not universally polarized — it is vertical

or horizontal, depending on where it is fed.

2) *Failure to allow for overlaps at joints* — The dimensions given for the driven element and reflector are *net* dimensions. The builder must allow excess length for any overlap when the loop ends are soldered.

3) *Failure to use the specified wire type* — While any conductor of the proper diameter (1/8 inch or 3.2 mm) is fine for the directors, the driven element and reflector loops must be made of no. 12 TW wire with its insulation in place. Use of bare wire — or any other size wire — will require a correction in loop length. One builder used brazing rod for his driven element and had to increase the length 1.7 percent to get the VSWR down to a normal 1.2 at resonance. But once he made that correction, his eight-element quagi was measured at 13.8 dBd gain at the West Coast VHF Conference last May!

Table 1
432-MHz, 15-Element, Long-Boom
Quagi Construction Data

Element Lengths — Inches (mm)		Interelement Spacing — Inches (mm)	
R — 28" loop (711)	D7 — 11-3/8 (289)	R-DE — 7 (178)	D6-D7 — 12 (305)
DE — 26-5/8" loop (676)	D8 — 11-5/16 (287)	DE-D1 — 5-1/4 (133)	D7-D8 — 12 (305)
D1 — 11-3/4 (298)	D9 — 11-5/16 (287)	D1-D2 — 11 (279)	D8-D9 — 11-1/4 (286)
D2 — 11-11/16 (297)	D10 — 11-1/4 (286)	D2-D3 — 5-7/8 (149)	D9-D10 — 11-1/2 (291)
D3 — 11-5/8 (295)	D11 — 11-3/16 (284)	D3-D4 — 8-3/4 (222)	D10-D11 — 9-3/16 (233)
D4 — 11-9/16 (294)	D12 — 11-1/8 (283)	D4-D5 — 8-3/4 (222)	D11-D12 — 12-3/8 (314)
D5 — 11-1/2 (292)	D13 — 11-1/16 (281)	D5-D6 — 8-3/4 (222)	D12-D13 — 13-3/4 (349)
D6 — 11-7/16 (291)			

Boom — 1 x 2-inch x 12-ft (25 x 51-mm x 3.66-m) Douglas fir, tapered to 5/8 inch (16 mm) at both ends.
Driven element — No. 12 TW copper-wire loop in square configuration, fed at center bottom

with type N connector and 52-ohm coax.
Reflector — No. 12 TW copper-wire loop, closed at bottom.
Directors — 1/8-inch (3.2 mm) rod passing through boom.

feed-line coax is brought perpendicularly to the antenna feed point, running along the boom or (preferably) directly to the supporting mast.

Like the smaller quagis and other antennas, long-boom 15s can be stacked in pairs, fours, eights or 16s for additional gain. With this much gain over a dipole for each bay, a stacking distance of six to seven feet is recommended at 432 MHz. Since these antennas can be built of much lighter materials than the 16-element, log-periodic Yagi, they represent a practical as well as economical approach for moon-bounce work. Allowing for normal feed-line losses, 16 long-boom quagis should deliver nearly 26 dB gain over a dipole, while about 23 dB would be attainable with only eight bays. Even the larger 16-bay array would be only about 20 x 20 feet (6 x 6 meters) in size, not that big by EME standards!

However, any EME system consisting of long-boom antennas poses special mechanical problems because all bays must track accurately enough so that they all point at the moon at once. As the

author learned during an Alaskan moon-bounce DXpedition, this can be difficult under adverse environmental conditions.⁷

Conclusion

There you have it, a long-boom version of the quagi antenna that offers very high gain without high cost or undue construction complexity. Anyone who takes reasonable precautions to follow the listed dimensions should be able to achieve the same results! The author again wishes to thank WB6RIV for his antenna-range assistance! [E73]

References

- ¹Overbeck, "The VHF Quagi," *QST*, April, 1977.
- ²Belcher and Casper, "Loops vs. Dipoles — Analysis and Discussion," *QST*, August, 1976.
- ³Orr, *Quad Antennas*, 2nd ed., Radio Publications, Inc., Wilton, CT 1970.
- ⁴Lindsay, "Quads and Yagis," *QST*, May, 1968.
- ⁵Appel-Hansen, "The Loop Antenna with Director Arrays of Loops and Rods," *IEEE Transactions on Antennas and Propagation*, July, 1972, p. 516.
- ⁶Holladay, "High Gain Yagi for 432 MHz," *Ham Radio*, Jan., 1976.
- ⁷Overbeck, "Moonbounce Boondoggle," *QST*, Feb., 1977.