Quad Log-Periodic Fixed-Beam Antennas

The gain and broadband features of the log-periodic antenna are combined in the QLP to provide the characteristics of a five-element beam that makes a signal sound big.

By George E. Smith,* W4AEO

For the amateur who enjoys constructing his own antennas, the quad log-periodic offers the attraction of a multielement, single-band, fixed wire beam antenna that combines the good features of a simple single-band log periodic with the benefits of the quad. The effect of such a combination is to produce greater gain. In addition there is no need to tune or prune the elements after assembly.

A QLP antenna is in effect, a multielement, end-fire array that is broadband by virtue of being in a log-periodic formation. This produces a unidirectional beam antenna having a well-defined forward lobe and renders 10 to 12 dB of gain over a dipole placed at the same height. The bandwidth for both antennas described here is approximately 500 kHz. To achieve that frequency spread, five elements for the array seem about optimum. Also, five elements seem to be a good choice as far as gain is concerned.

The largest element (no. 1) in the quad log-periodic array can be considered the reflector while the three shorter forward elements (nos. 3, 4 and 5) may be thought of as driven directors. All quad elements are fed by means of a two-wire transmission line connected to the bottom terminals of the diamonds. No element is parasitically operated. The two-wire feed line within the array is supported by the terminal ends of each individual quad loop. Rf energy is applied to these elements by the method that is commonly used with conventional log-periodic antennas where feed wires are transposed. For more information on feeding log-periodic antennas refer to *The ARRL Antenna Book*, 13th Edition (1974), page 161.

As with any end-fire array, including the log-periodic antenna, rf currents in adjacent elements of the QLP must be out of phase with each other. This condition is satisfied by simply transposing the connecting wires from the transmission line of the array to the individual elements, as shown in Fig. 3. Phase reversal may also be accomplished by transposing the transmission line within the array as indicated.

The Arrays for 20 and 40 Meters

The quad log-periodic antenna for the 20-meter band is not too large to be impractical as a fixed-direction wire beam antenna. Actually, it is fairly simple and inexpensive to construct. Furthermore, it is not difficult to erect between two existing masts or trees. The basic design of the QLP is shown in Fig. 1, while Table 1 and Table 2 give the dimensions for both the 20- and 40-meter arrays.

Elements used are a full wavelength overall. The largest element in the 20-meter antenna is 18.5 feet (5.64 m) per side or 74 feet (22.56 m) total, and the smallest element is 12.5 feet (3.81 m) per side or 50 feet (15.24 m) total. Boom length is 24.9 feet (7.59 m).

Although it was realized that construction of a 40-meter QLP would be an ambitious project, it presented a challenge. For this band the antenna, of course, is twice the size of the 20-meter QLP. While there is no structural boom, such as with a rotary-beam antenna, there is a comparable boom length of 49 feet (14.94 m). Since the rear element is 36 feet (10.97 m) long per side, or 144 feet (43.89 m) overall, it requires a mast height of at least 70 feet (21.34 m). The width space requirement is a minimum of 80 to 100 feet (24 m to 30 m). The lengthwise space requirement or mast separation is 60 feet (18 m).

Comparative reports from several South American stations give a positive indication of improved gain achieved with the QLP. Generally, the more distant the station, the greater the difference noted in the QLP performance over that of the dipole standard.

Although the quad log periodic gives approximately two dB of gain over an equivalent dipole log-periodic antenna having the same number of elements, the quad type does require slightly more than twice the amount of wire. Worth considering is that in constructing a log-periodic antenna, it is most desirable to place the array in the clear, away from other wires or antennas.

Assembly of the Quad Log Periodic

The only items which are difficult to purchase for building a QLP are the five 4-hole spacing insulators for the two-wire transmission line. These may be fabricated easily and inexpensively. Fig. 2 is a drawing of the five diamonds, illustrating the element spacing of a monoband QLP. The dimensions required for constructing the 20-meter QLP are furnished in Table 1. Similar information for making the 40-meter QLP is shown in Table 2.

After collecting the required materials, the first step is to make the five spacing insulators. These four-hole

*1816 Brevard Place, Camden, SC 29020

spacers are easily cut from 1/4-inch-thick Lucite or Plexiglas. Each spacer measures 3/8 × 2 inches. Four holes are drilled into the insulators as indicated in Fig. 3.

Not only do the insulators serve their usual purpose, but they also space and support the transmission line between the five quad elements. The feed point of each element is connected to the outside holes of the insulator. In turn the diamonds support the transmission line by means of these insulators. It should also be noted that the correct spacing distances between the elements are governed and maintained by these insulators which are secured to the feed line running the total length of the QLP.

Center Feed for the QLP

The center feed for the QLP is identical to that used for most hf dipole log-periodic beam antennas. It may take the form of a transposed line as used for the K4EWG rotary LP,[1] or it may be constructed as a two-wire transmission line with parallel conductors (such as the ones generally employed for the large commercial hf log-periodic fixed-direction beam antennas).

Although the parallel feed line required slightly more work to assemble, it has one mechanical advantage in that it is better suited for spacing the five quad elements. The writer has used both methods for the other LP beams with equally good results.

The assembly process is the same as for any open-wire transmission line using spacing insulators, except that instead of the insulators being spaced at equal distances they are separated with logarithmic spacing. The greater separation occurs at the rear and the closer spacing is used at the forward or short-element end. This arrangement is essential for a logarithmic antenna.

Transposition of the transmission line to the alternate quad elements is made by the connections between the quad terminations and the center feed line as illustrated by Fig. 3A. The alternative method of transposition using the criss-cross configuration is illustrated on page 145 in *The ARRL Antenna Book*, 13th Edition (1974).

Stranded copper wire (preferably soft drawn, rather than a stiff wire) is best suited for the center feeder. The two QLPs described here use plastic covered no. 16 stranded wire. Bare wire is more apt to short on the large 40-meter QLPs.

The Catenary Support Line

The next step is to assemble the catenary support line which will run between the two masts or trees. This line supports the top of the five quad elements. Polypropylene line (3/16-inch diameter) is well suited since there is little give or stretch under varying weather conditions. Although 1/4-inch nylon line is good for halyards,[2] if pulleys are used, nylon does have some "give" which may be desirable if trees are used for supports. Since the catenary system governs the spacing distance between the quads, there should be little or no give in this portion of the antenna.

With the overall length of the 20-meter QLP set at 24.9 feet (7.6 m), it is suggested that the rear end of this catenary be made long enough to be tied to the halyard. Thus, it will be within a few feet of the mast when raised to the maximum height. The rear (no. 1) element should be about five feet (1.5 m) in front of the mast or at least far enough to clear any obstructions which may be at the sides of the rear mast.

After the necessary spacing distance between the mast and the rear element is determined, proceed as follows. First tie a knot at the rear of the catenary to which the halyard will be secured when it is time to raise the QLP. A slipknot or bowknot is best suited in this application.

Next, measure the distance from the

[1] Footnotes appear on page 26.

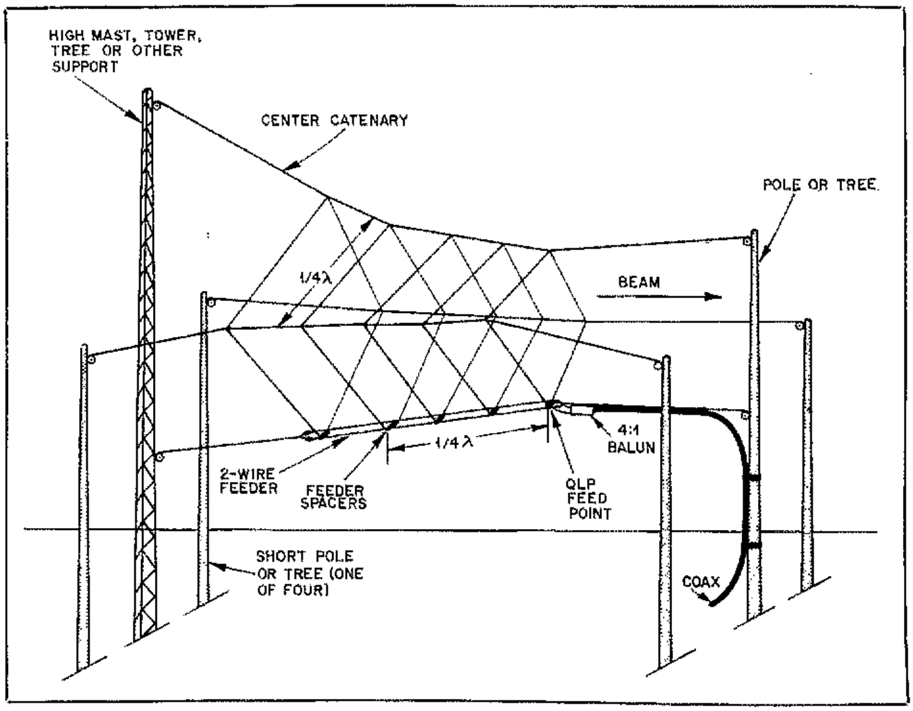

Fig. 1 — The general configuration of a quad log-periodic antenna.

Table 1
Dimensions for the 20-m QLP

QUAD ELEM. NO.	*SIDE LENGTH*	*TOTAL ELEM. LENGTH*
1	20′ (6.10 m)	80′ (24.38 m)
2	18′ (5.49 m)	72′ (21.95 m)
3	16.25′ (4.95 m)	65′ (19.81 m)
4	14.75′ (4.50 m)	59′ (17.98 m)
5	13.5′ (4.11 m)	54′ (16.46 m)
S-NO.	*S-LENGTH*	
1	7.4′ (2.26 m)*	
2	6.7′ (2.04 m)*	
3	6.0′ (1.83 m)*	
4	4.8′ (1.46 m)*	
	*See Fig. 2	

For each individual quad element of the beam, this table shows the length of a side of that element followed by the total wire length for the element. Also shown are the S-measurements for the spacings shown in Fig. 2. The total length of wire for the five quads should include two ft (0.61 m) per quad element for connections. The total length of wire for the center feeder, as shown, is for both conductors, and includes 20 ft (6.10 m) of additional wire required during assembly. Materials: 340 ft (103.63 m) no. 16 soft-drawn copper wire. (See notes above.) 70 ft 21.34 m) no. 16 stranded copper wire for the two-wire feeder. 5 Plexiglas insulators for center feeder. 600 ft (182.88 m) 3/16-inch polypropylene rope (water-ski type). Spool of monofilament fish line, 40 to 50 lb. (18-22 kg) test. Roll of 3/4-inch masking tape.

rear halyard knot to the location of the rear quad. At this point tie a small slipknot with the loop large enough to pass the quad wire through it. There will be five of these knots which hold the five quad elements in place at the required spacing. The wire feeder with the five spacer insulators can be used to measure these spacing distances. The measurements can also be made with a steel tape. The spacing distances between the five slipknots will be identical to the spacing distances S1, S2, etc., given in Tables 1 and 2.

As each loop is made, check the distance to the previous one. If correct, the knot should then be tightened before proceeding to the next. After all five knots for supporting the loops are completed, place this portion of the catenary beside the feeder to make certain that the knots of the catenary and the five spacer insulators have equivalent positions for the entire length of both the catenary and the feeder.

Getting RF to the Antenna

The simplest method of supplying rf energy to the array is through a length of coaxial cable. This cable is terminated in a 4:1 balun that is connected to the short-element end of the array. Because of the inherent impedance step-up characteristic of the QLP antenna, an impedance of between 200 and 300 ohms will appear across the terminals of the forward element.

A second and possibly more efficient method is to use a tuned open-wire feeder. Use of a Matchbox or comparable tuner with this system will present a low SWR at the transmitter as well as attenuate any harmonic content.

Results

In tests comparing the two 5-element monoband 20- and 40-meter quad log-periodic beam antennas with the dipole log periodic used here, the quad configuration shows advantages. When compared with a log-periodic dipole array at the same height, the QLP appears to be 2 dB better. This is about the same difference that is generally claimed for a quad versus a Yagi.

The front-to-back ratio is approximately 16 dB for the QLP and about 14 dB generally measured on the dipole LPs. Side attenuation also is better. The forward lobe or beam width is sharper (narrower) for the QLP. SWR measurements made on both the 20- and 40-meter quad log periodics indicate a slightly flatter response across each band when compared with an equivalent five-element monoband DLP. The bandwidth is from 300 to 500 kHz before exceeding an SWR of 1.5:1. It has also been observed from test measurements that the impedance at the feed point is approximately 300 ohms, making a good match to a 4:1 balun when used with 72-ohm coaxial cable.

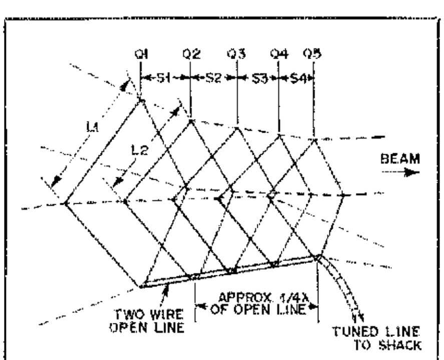

Fig. 2 — Spacing of the elements is indicated in this illustration. See text and Tables 1 and 2 for details.

For reception the quad configuration seems less subject to man-made noise and precipitation static than open-ended Yagis and dipoles. It is noted that other amateurs have made similar comments concerning quads for reception. This benefit may result from the closed loops of the quads. The entire QLP is at ground potential with respect to dc because there is a ground return through the balun, providing a static drain.

There are no critical dimensions or adjustments required of the element lengths, as are usually required for high-*Q* Yagis. No stub adjustments are required for a quad having a parasitic director and reflector. The dimensions for constructing a QLP are not critical since the log-periodic configuration makes it a broadband antenna covering the entire band for which it is designed, with a relatively flat SWR.

The quad log periodic, being a fixed direction wire beam, is inexpensive. It should cost no more than $20 or $25 to construct including the wire, insulators and nylon or polyethelene line. Not included, of course, is the cost of masts if it becomes necessary to use one or more for support instead of trees. QST

Footnotes

[1] Rhodes, "The Log-Periodic Dipole Array," *QST* for November, 1973.

[2] See information on this in *The ARRL Antenna Book*, 13th Edition (1974), p. 268.

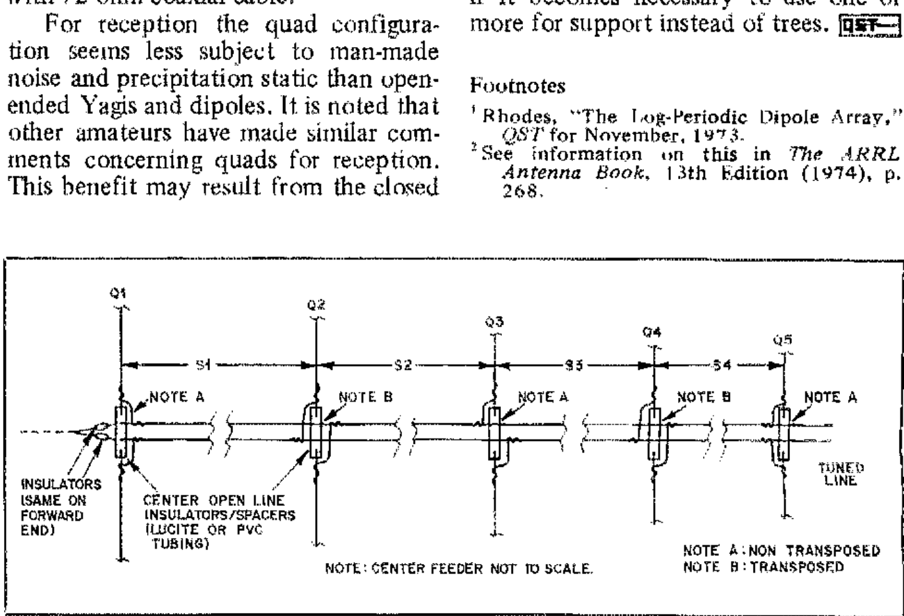

Fig. 3 — This illustration shows the physical arrangement of the internal transmission line of the QLP array.

Table 2

Dimensions for the 40-m QLP

QUAD ELEM. NO.	*SIDE LENGTH*	*TOTAL ELEM. LENGTH*
1	40′ (12.19 m)	160′ (48.77 m)
2	36′ (10.97 m)	144′ (43.89 m)
3	32.5′ (9.91 m)	130′ (39.62 m)
4	29.5′ (8.99 m)	118′ (35.97 m)
5	27.0′ (8.23 m)	108′ (32.92 m)

S-NO.	*S-LENGTH*
1	14.8′ (4.51 m)*
2	13.4′ (4.08 m)*
3	12.0′ (3.66 m)*
4	9.6′ (2.93 m)*

*See Fig. 2

For each individual quad element of the beam, this table shows the length of a side of that element followed by the total wire length for the element. Also indicated is a tabulation of the measurements for the spacings shown in Fig. 2. Materials: 670 ft (204.22 m) no. 18 copper-clad electric fence wire. (See notes with Table 1.) 120 ft (36.58 m) no. 16 stranded copper wire for the two-wire feeder. 5 Plexiglas insulators for the center feeder. 600 ft (182.88 m) polypropylene rope (water-ski type). Roll of monofilament fish line, 40 to 50 lb (18-22 kg) test. Roll of 3/4-inch masking tape.