vertical monopole log-periodic antennas for 40 and 80 meters

How to build low-cost log-periodic antennas for complete coverage of the amateur 40- and 80-meter bands

George E. Smith, W4AEO 1816 Brevard Place, Camden, South Carolina 29020

In previous articles I have described some homebrew, dipole-type log-periodic antennas, including antennas for 20, 15 and 10 meters[1,3] and 40, 20 and 15.[2] The log periodics discussed in these articles have provided gain on the order of 8 to 13 dB, depending on their length, their height above ground, the number of elements and the apex angle.

While testing some log periodics for use on the 7-MHz band I decided to try to lower the vertical angle of radiation to obtain improved, long-range communications performance. One way this could be accomplished would be to raise the antenna to 1/2-wavelength above the ground (or better still, to raise the antenna to 140 feet, a full wavelength). However, this would require at least two, and preferably four, 70- or 140-foot masts, so the cost would be very high. My 40-meter log periodic, at 50-feet above the ground, was as high as I could go, since I was using pine trees as supports.

Another method of lowering the vertical angle of radiation would be to use a vertical log periodic. Although I had previously tried a 10-, 15- and 20-meter log periodic in the vertical configuration by suspending it from some tall pine trees, this would be impractical for the 40-meter antenna because the longest element is 70-feet long. However, it would be possible to do this with a single 75-foot mast.

A possible alternative would be to use quarter-wave vertical elements working *against ground* or a ground plane. This is similar to the vertical monopole log-periodic configurations used by some commercial stations for long-haul high-frequency circuits.

40-meter monopole log-periodic

I determined from a scale drawing that, by using only five elements, it would be possible to suspend a monopole 40-meter log periodic from a single catenary line strung between two high pine trees. With this construction, the horizontal radials would be about 20-feet off the ground (see **fig. 1**). A similar approach was used for a 75-meter log-periodic which I built later. The swr for both antennas was less than 1.5:1 over the entire design frequency range.

If this antenna could be installed a few feet above a salt marsh or a high-conductive ground, the radials could probably be eliminated. Some commercial monopole log-periodics use buried ground radials in place of the counterpose shown in **fig. 1.**

It should be noted that the ground radials become decreasingly shorter from the rear to the front of the antenna. They should be about the same length or slightly longer than their companion vertical elements.

Construction of the center insulators for this antenna is shown in **fig. 2.** These insulators are made from 1/4-inch thick lucite, 5/8-inch wide and 3-inches long. The two outside holes are for the radials; the holes on 1-1/2-inch centers are for the two-wire feeder. The center hole is for the quarter-wave vertical radiating element.

The vertical radiating elements and the ground-plane radials are fed by an open-wire feeder located at the bottom of vertical radiators. The transposed feed system required for log periodics is shown in **fig. 1.** A 4:1 balun is connected to the short-element end of the open wire feeder; a coaxial transmission line is used from the balun to the transmitter.

The driven or active element (element number 2) is approximately one quarter wave-length from the balun feed point. The quarter-wave line provides an impedance step-up. Since the impedance at the lower end of element number 2 is quite low, the quarter-wave transformer steps up the impedance to 200 to 300 ohms. The 4:1 balun provides a fairly good match to 50-ohm coax. The swr from 7.0 to 7.3 MHz is comparatively flat and less than 1.5:1 over the entire 40-meter band.

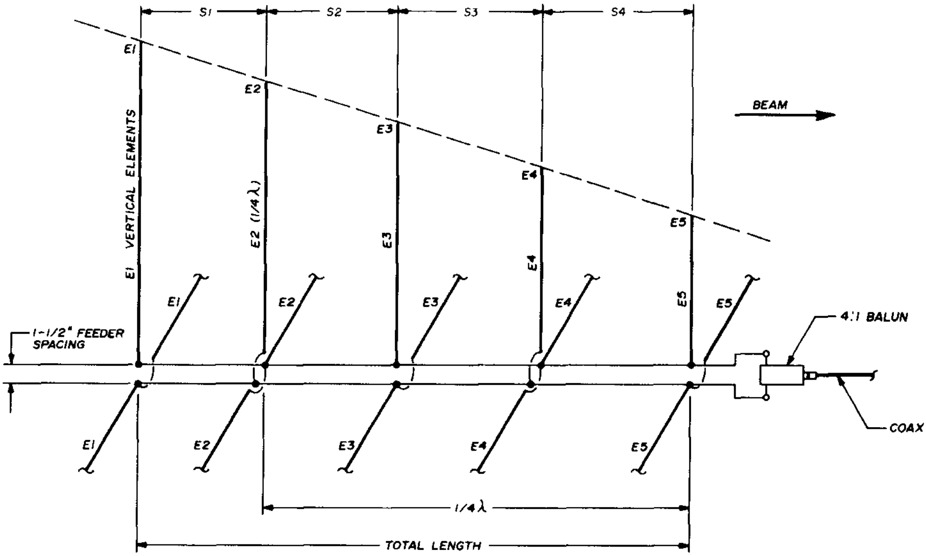
A 1/4-inch nylon line was used as the catenary to suspend the five vertical elements. This line was stretched between two supports as shown in **fig. 1.** The ground-plane radials were placed about 20-feet above the ground because clearance was necessary for some fruit trees which are located under the antenna. The outer ends of the radials are about 10-feet above the ground and are anchored to stakes or convenient posts or trees.

A total of 13 ground radials were used with this antenna: one to either side of the five vertical elements, plus two to the rear (element 1) and one to the front (element 5). Monofilament fish line (40-pound test) is used as guys and insulators for the radials.

performance

At distances greater than 400 miles, this antenna showed 8- to 10-dB gain over a commercial 40-20-15-10 trap vertical which works quite well for DX. The vertical is mounted on a roof 35-feet above ground and has all the radials, including four for 40 meters. The extra radial for 40 is necessary to lower the swr on that band.

Signals off the back of the log periodic



	dimensions (feet)			
	3.5-4.0	3.8-4.0	7.0-7.3	14.0-14.35
E1	70	65	35	17.5
E2	67	62	33	16.5
E3	58	55	28	14.0
E4	50	45	24.5	12.25
E5	43	40	20	10.0
S1	30	26	14	7.0
S2	27	24	13	6.5
S3	24	23	12	6.0
S4	19	18	9	4.5
total length	100	91	48	24
mast height	80	75	50	30
pole height	45	40	25	20

were just about the same as the trap vertical. As would be expected, stations just past the skip zone reported better signal strength from my half-wave doublet, 50-feet in the air (due to its higher angle of radiation). At distances greater than about 400 miles, however, the log periodic started paying off. This greatly enhances 40-meter operation during the daylight hours. It was difficult to do much testing after dark because of the heavy QRM from foreign broadcast stations.

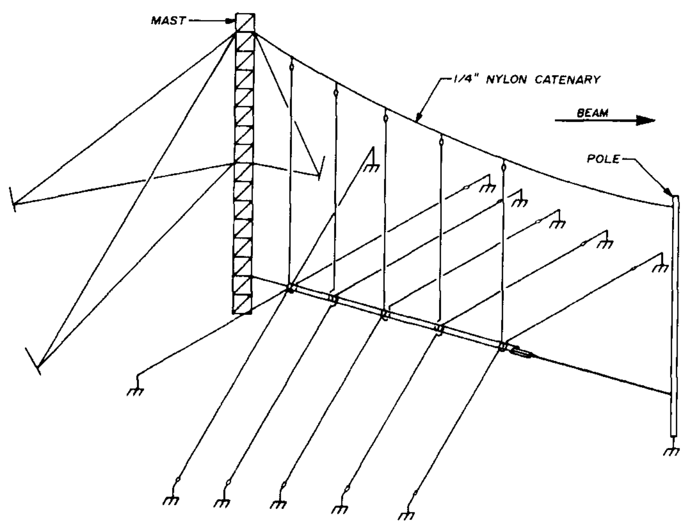


fig. 1. Five-element monopole log-periodic. Elements and radials are made from no. 15 aluminum wire. The 3.8-4.0 and 7.0-7.3 MHz designs (columns 2 and 3) have been built and tested. The swr was less than 1.5:1 over the entire frequency range. The designs for 3.5-4.0 and 14.0-14.35 (columns 1 and 4) have not been tested.

On reception, however, the vertically-polarized log periodic is much more susceptable to man-made noise than the horizontal doublet. As with any vertically-polarized, high-frequency antenna, it should be located as far as possible from industrial plants and busy streets. My antenna is about a block from the nearest street and is comparatively quiet except when cars come into my driveway.

80-meter log periodic

Since the 75-meter log periodic was erected only temporarily for test purposes, the ground radials and the open-wire feeder were only 3- to 4-feet above the ground. For a permanent installation this height should be increased to 10- to 15-feet. Since some of the radials have rf current circulating through them, the increased height above ground would prevent accidental contact with the radials. Also, this increased ground-to-radial height would increase the effective height of the antenna.

This antenna was originally designed to cover the entire 3.5- to 4.0-MHz band, but I discovered that there wasn't sufficient mast height for the rear element, which was 70-feet long. I decided to build a monopole log-periodic to cover only 3.8

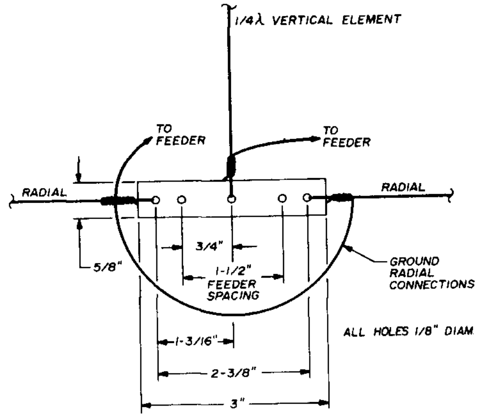


fig. 2. Construction of the center insulators. Material is 1/4" thick lucite. Connections to the open-wire feedline are shown in fig. 1.

to 4.0 MHz; this reduced the length of all elements by about 5 feet.

The overall length from the rear to forward element is 91 feet. A minimum width of 135 feet is required at the rear and 80 feet at the front for installing the radial ground-plane system.

After the antenna was completed, I ran a series of vswr tests to determine if the swr was greater than 1.5:1 at any point in the band. The vswr readings were as follows:

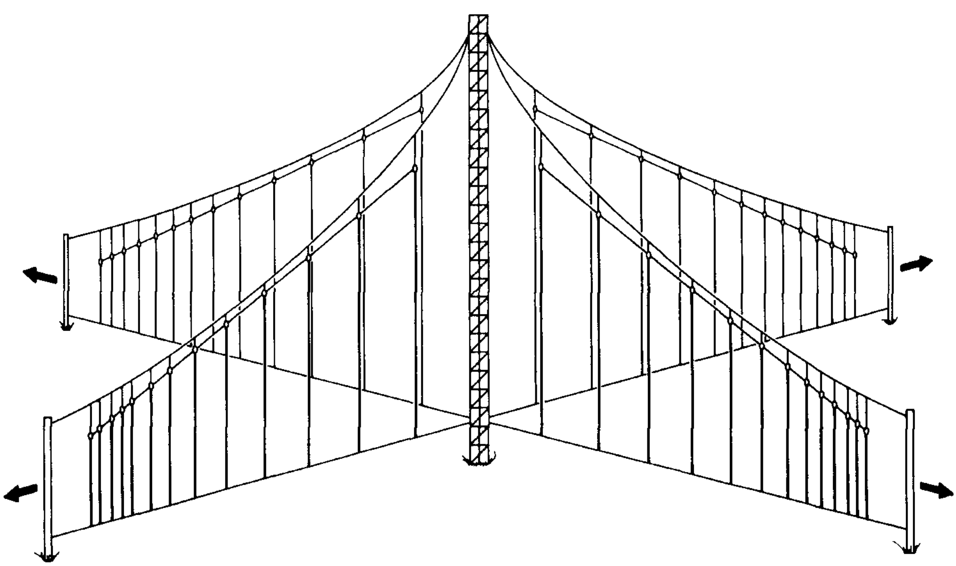


fig. 3. Suspending four vertical log-periodics from a single mast to obtain complete 360° coverage.

4.0 MHz	1.25:1	3.7 MHz	1.1:1
3.9 MHz	1.4:1	3.6 MHz	1.2:1
3.8 MHz	1.2:1	3.5 MHz	1.2:1

Although the swr is relatively flat over the entire 80-meter band, it is doubtful that the antenna has much directivity at the lower end of the band since it was designed to cover 3.8 to 4.0 MHz. On-the-air tests were confined to the upper 2 MHz of the band because the dipole I use for comparison purposes is limited to this meter bands, but further tests are needed to confirm this.

I was unable to obtain any data on front-to-back ratio as few stations were received off the back of the antenna. Side attenuation seems about the same as other log periodics I've used.

construction

The cost of assembling this antenna is quite reasonable, considering it will pro-

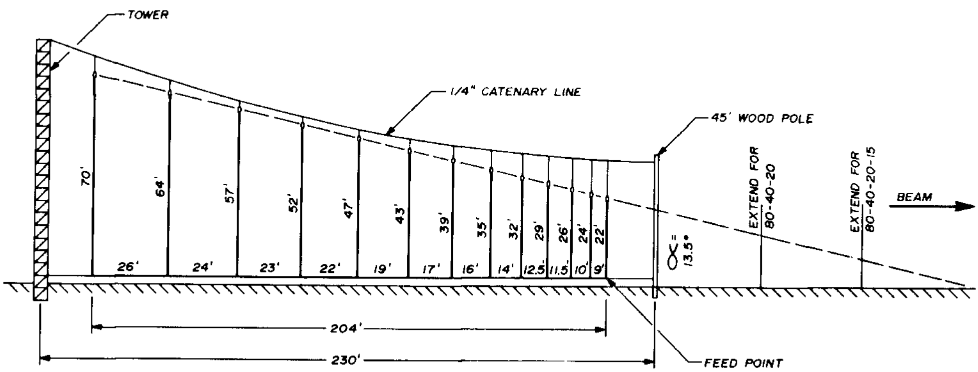


fig. 4. The vertical log-periodic can be extended to cover all frequencies from 3.5 to 7.3 MHz. This log-periodic uses 13 elements and requires a mast separation of 230 feet.

frequency range since the swr is greater than 1.5:1 below 3.8 MHz.

On-the-air tests indicated that the 80-meter monopole log periodic was best suited for distances greater than 500 to 600 miles during the daylight hours, and 1000 miles or more after dark. For shorter distances the horizontal dipole was usually one to three S-units better. However, at greater distances the lower radiation angle of the log periodic really began to do its stuff, and stations reported up to two S-units improvement with the log periodic.

For about one hour before and after sunrise and sunset, the log periodic is quite erratic, regardless of the distance. During these hours the dipole exhibited considerably less fading than the monopole log periodic. Also, the forward lobe of the log periodic appeared to be narrower than that experienced with log periodics on the 40-, 20-, 15- and 10-

vide up to 10-dB gain for DX. About 850-feet of wire is required for the elements plus another 185 feet for the open-wire feeder. I used number-15 aluminum wire which is manufactured for electric fences and can be purchased in quarter-mile coils for $8.70. Costs are also cut by using homemade lucite insulators and 40-pound-test monofilament fish line. The most expensive item in the installation is the 4:1 balun, which retails for $8.95. Total cost is about $25.00 (the 40-meter monopole log periodic is somewhat less, costing about $17.00).

other configurations

If space permits, two of these antennas could be mounted back to back, the rear elements suspended from a single mast. For more complete coverage three, or even four, beams could be supported by the same mast (see **fig. 3**). If you have enough real estate, the 80-meter log periodic can be extended as shown in **fig. 4** to provide operation on both the 3.5- and 7.0-MHz bands. This two-band arrangement is about 205-feet long and would require a mast separation of 230 feet. A total of 13 elements are used in this antenna, about the minimum suggested for a log-periodic covering a 2:1 frequency range.

Since most amateurs aren't interested in the 3-MHz segment between the top end of 80 and the low end of 40, considerable space can be saved by breaking the antenna into two parts as shown in **fig. 5**. However, with this system two separate feedlines are required.

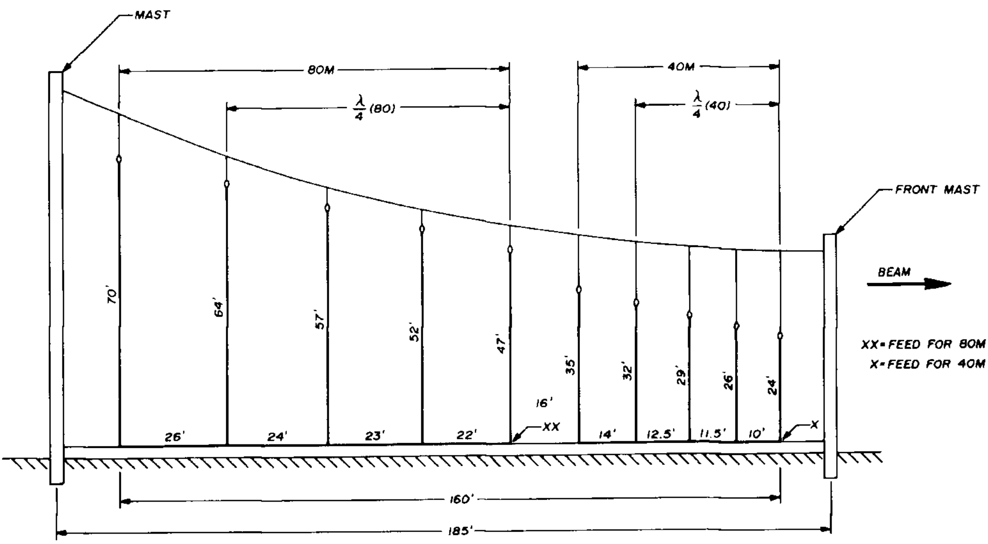


fig. 5. Breaking the log-periodic into two separate sections, one for 40 and one for 80, saves considerable space, but requires a separate feed system for each section. This antenna covers the frequency range, 3.5 to 4.0 MHz and 7.0 to 7.3 MHz.

inverted monopole log periodic

After I completed the tests on the 40-meter log periodic shown in **fig. 1**, as an experiment I decided to try this antenna inverted, with the radials at the top. By using several trees as supports, I was able to suspend two nylon catenary lines to support the radials. This allowed the radials and the center open-wire feeder to be suspended approximately 50-feet above the ground. The five quarter-wave monopole elements were suspended from the center feeder insulators. Since the rear element is 35-feet long, its lower end was about 15-feet above the ground (see **fig. 6**).

The object of this test was to elevate the current loop as high as possible, possibly lowering the vertical angle of radiation. Getting the current loop as high above ground as possible is similar to the old Bruce array which uses quarter-wave vertical elements in phase, spaced one-half wavelength.

Although time did not permit conclusive testing of this particular antenna, after a week of testing its gain seemed to be greater, or to increase, the more distant the station (over 500 or 600 miles). For stations just past the skip zone the horizontal dipole had the edge.

I had hoped to beam this experimental antenna to the west or northwest to run tests with W5s and W7s, since there seems to be a great deal of 40-meter activity there, but unfortunately, the trees I use for supports were all in the wrong places.

Therefore, I had to beam the experimental log periodic to the south. This limited the maximum distance to about 600 miles (Miami) as few stations further south were operating on 40 meters.

The forward lobe of this experimental antenna seemed to be narrower than that exhibited by the horizontal log periodic described in the previous article.[2] This is in line with other vertically polarized log-periodics I tried on the higher frequency bands which also had sharper forward lobes than their horizontal counterparts.

If the trees had allowed this "upside-down" monopole to be aimed to the northwest I'm sure I could have made some interesting tests. This configuration might also have possibilities as a low-angle beam for working DX on 80.

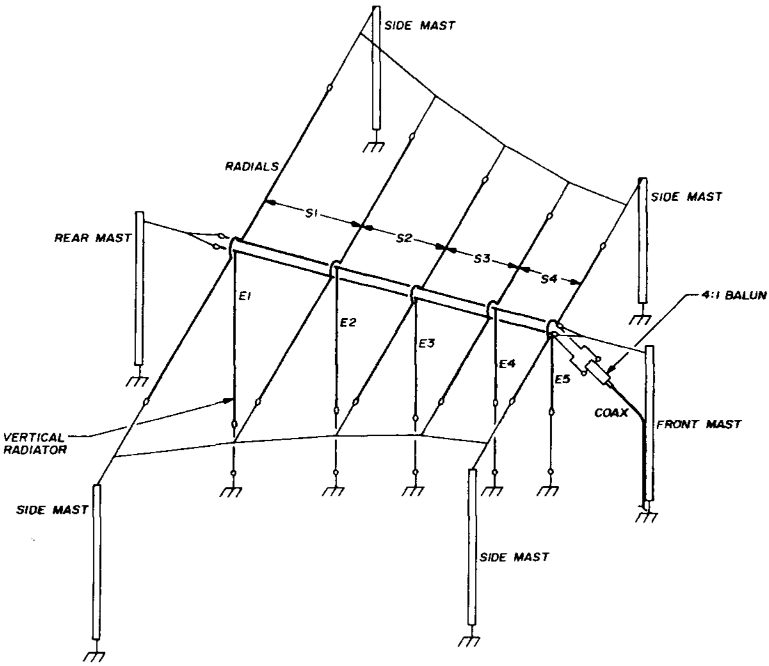


fig. 6. Inverted vertical monopole log periodic for 40 meters.

dimensions (feet) for 40 meters

E1	35	S1	14
E2	32	S2	13
E3	28	S3	12
E4	24.5	S4	9
E5	20		

summary

The 40-meter log-periodic antennas are capable of 8 to 10-dB gain in the forward direction. Compared to the 3- to 5-dB gain provided by most 40-meter beams, the log periodic is worth consideration. The horizontal or inverted-vee log-periodic is suited for normal operation and compares favorably with a doublet except for its higher gain in the forward direction. The vertical monopole log-periodic is better suited for working DX.

references

1. G.E. Smith, W4AEO, "Three-Band High-Frequency Log-Periodic Antennas," *ham radio,* September, 1972, page 28.
2. G.E. Smith, W4AEO, "Log-Periodic Antennas for 40 Meters," *ham radio,* May, 1973, page 16.
3. G.E. Smith, W4AEO, "High-Gain Log-Periodic Antenna for 10, 15 and 20." *ham radio,* August, 1973, page 18.

ham radio