graphical design method for log-periodic antennas

A no-math approach to the log periodic design problem

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

Anyone who has designed or studied log-periodic antennas is aware of the math involved due to the many variables that enter into the design problem. References 1-5 contain several pages of formulas and refer the reader to four or five nomographs, log tables, etc. Probably this is one of the reasons the log-periodic antenna has been neglected by the amateur fraternity. Furthermore, little information has been published on the design of hf L-P antennas in amateur publications.

When I retired in 1970 I decided to make a study of high-frequency log-periodic antennas. The original antenna in use here has only 7 elements, is limited to 20 and 15 meters, is less than 40 feet (12.2m) long, and is pointed south. Over the past three years it has averaged 8-10 dB gain compared with a 20-meter dipole at the same height. The results obtained from this beam prompted a second, larger log-periodic for 20, 10 and 15 meters having a boom length of 70 feet (21.3m). Three log-periodics were erected and tested during 1970, and as of *this writing* 17 have been put up and tested.

This article presents a graphic design approach for log-periodic antennas that eliminates the work associated with the math involved. Four designs are presented first, each having essentially the same boom length and apex angle, but with different numbers of elements. Each should provide approximately 10-dB gain referenced to a dipole at the same location and height above ground.

Additionally, two more log-periodic designs are shown, one with a 54 foot (16.5m) boom that gives about 8-dB forward gain and one with a 100-foot (30.5m) boom. (Both boom lengths are nominal.) This last design is presented for those with enough real estate to accommodate it and the nerve to hang such a monster in the air. *It will give* 12-dB forward gain (referenced to a dipole) if properly designed and assembled and suspended at least 40 feet (12.2m) above ground. All designs cover 14 to 30 MHz.

the log-periodic antenna

For those readers not acquaintec with the log periodic, it is a broadband multi-element, unidirectional, end-fire array capable of 8- to 14-dB forwarc gain. The front-to-back ratio is usuall) 10 to 14 dB with side attenuation tc about 25 dB. The forward lobe of thı log-periodics tested here generally runs about 90 degrees in the H plane. Its vertical angle of radiation, or take-off angle, can be controlled fairly well by height above ground. The swr at the feedpoint remains relatively constant over the frequency range for which the antenna is designed, generally not exceeding 2:1 with 1.5:1 as typical; usually varying between 1.1:1 and 1.5:1.

A bandwidth of 10:1 is normal for fixed commercial log-periodics designed to cover frequencies between 3 to 30 MHz; however, they are quite long, usually 250-800 feet (76-244m), depending on gain required and beamwidth. Some of the commercial log-periodics having a limited bandwidth of 4-30 MHz are 150-350 feet (46-91m) long, and for 6-30 MHz, 100-250 feet (30-76m) long. The commercial rotary types generally have a boom length of 40 to 74 feet (12-22.5m). Some of these are used at MARS stations.

For amateur applications, a fixed log-periodic wire beam can be limited to a bandwidth slightly more than 2:1, covering 7-14.5 MHz for 40 and 20 meters or 14-30 MHz for 20, 15 and 10 meters without being excessively long. By limiting bandwidth still more, say 14 to 22 MHz, a log-periodic can be erected in a space 40x40 feet (12x12m) giving an 8- to 10-dB gain on 20 and 15 meters.

Most of the log-periodics used here have been of the horizontal dipole configuration and have been tested on 40, 20, 15 and 10 meters. One of the 20-, 15-, 10-meter log-periodics was also tested for a few weeks in the vertical plane. Three of the vertical monopole configurations using a ground plane or counterpoise have been tested on 40 and 80 meters. More recently two of the trapezoidal type, one the sawtooth structure and the other the zig-zag, have been tested on 20 meters. Some of these log-periodic antennas have been described in amateur publications[6-10] with complete dimensions and assembly details.

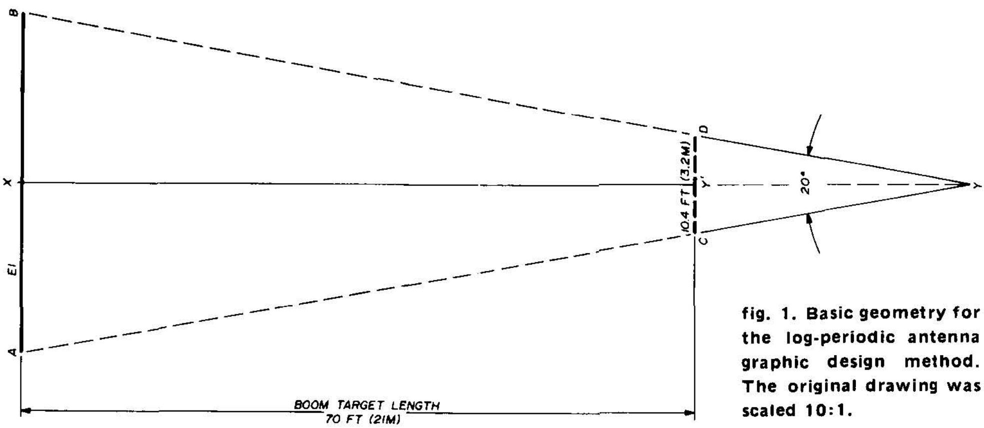
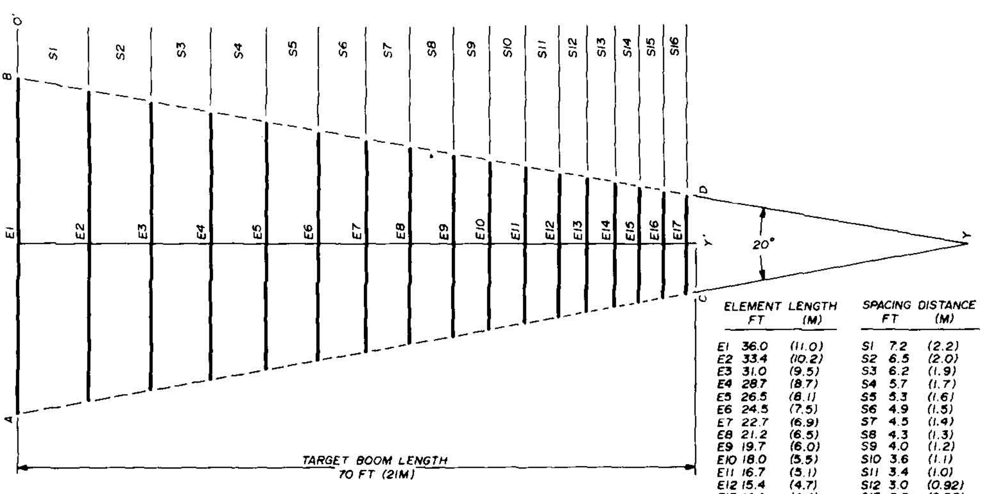


fig. 1. Basic geometry for the log-periodic antenna graphic design method. The original drawing was scaled 10:1.

In addition, several special log-periodics have been designed on paper covering other frequencies. Some covered both MARS and amateur bands; several were for special vhf and uhf TV channels; and, I blush to say, one covered 26-27 MHz for a CBer wanting a good skip antenna.

After designing my first three log-periodics the hard way with the formulas, I felt there must be an easier design method. When designing the



Element	Length FT	(M)	Spacing	Distance FT	(M)
E1	36.0	(11.0)	S1	7.2	(2.2)
E2	33.4	(10.2)	S2	6.5	(2.0)
E3	31.0	(9.5)	S3	6.2	(1.9)
E4	28.7	(8.7)	S4	5.7	(1.7)
E5	26.5	(8.1)	S5	5.3	(1.6)
E6	24.5	(7.5)	S6	4.9	(1.5)
E7	22.7	(6.9)	S7	4.5	(1.4)
E8	21.2	(6.5)	S8	4.3	(1.3)
E9	19.7	(6.0)	S9	4.0	(1.2)
E10	18.0	(5.5)	S10	3.6	(1.1)
E11	16.7	(5.1)	S11	3.4	(1.0)
E12	15.4	(4.7)	S12	3.0	(0.92)
E13	14.4	(4.4)	S13	2.9	(0.88)
E14	13.3	(4.1)	S14	2.7	(0.82)
E15	12.4	(3.8)	S15	2.5	(0.76)
E16	11.6	(3.5)	S16	2.3	(0.70)
E17	10.4	(3.2)			

fig. 2. Log-periodic antenna using 17 elements and a 69-foot (21m) boom. Approximate gain (referenced to a dipole) for this design and those in figs. 3 to 5 is 10 dB. All cover 14 to 30 MHz.

original antennas, I always made an assembly sketch on graph paper after arriving at the correct element lengths and spacing distances. Since the outline of a log-periodic results in an isosceles triangle, with the long rear element being the base and the shorter forward elements forming the triangle toward the apex, the following simple no-math graphic design method became apparent. I believe this simple design method will be of interest to any amateur wishing to design a log-periodic for a particular band, bandwidth, or to fit a log-periodic into a given space.

graphic design method

You will need the following materials: graph paper, 1/10 cross section, 8½x10½ inch (21.5x26.7 cm) or larger; an architect or engineer's scale; a protractor; and some French curves (not absolutely necessary but helpful in designing the side catenary lines).

For the first example we will design an L-P for 20, 15 and 10 meters or for operation on any frequency between 14 and 30 MHz.

1. First determine the low- and high-frequency cutoff required or frequencies over which the L-P is to operate, or its bandwidth.

2. Next determine the amount of space available when the L-P is aimed in the desired direction. If there is a space limitation, it may be necessary to reduce the boom length, losing some gain. This is discussed later.

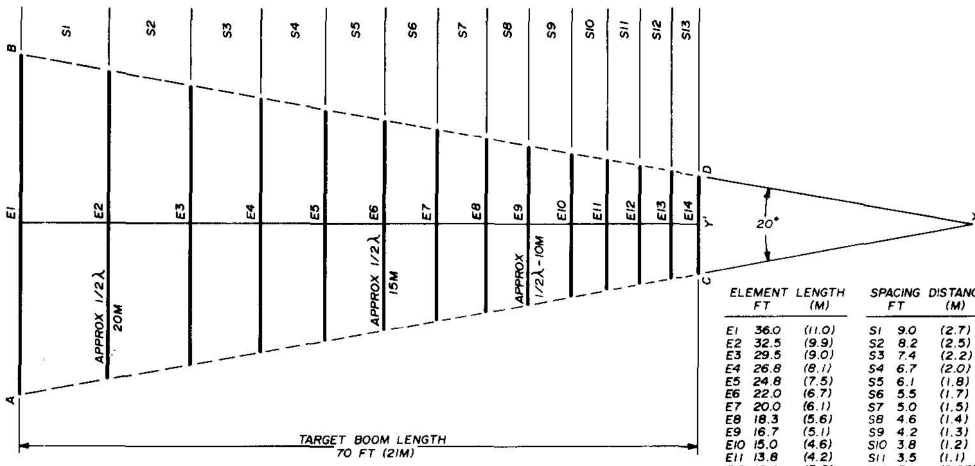
3. Determine the length of the longest (rear) element and the shortest (forward) element:

Rear element. The rear element should be at least 5% longer than the lowest cutoff or operating frequency. Using the usual formulas:

½ wavelength = 468/MHz = 468/14
= 33.4 feet (10.2m)

33.4 + 5% ≈ 34.4 + 1.7
≈ 35.1 feet (10.7m)

Since a slightly longer length is better, we will use 36 feet (10.9m) for the rear



ELEMENT	LENGTH FT	(M)	SPACING	DISTANCE FT	(M)
E1	36.0	(11.0)	S1	9.0	(2.7)
E2	32.5	(9.9)	S2	8.2	(2.5)
E3	29.5	(9.0)	S3	7.4	(2.2)
E4	26.8	(8.1)	S4	6.7	(2.0)
E5	24.8	(7.5)	S5	6.1	(1.8)
E6	22.0	(6.7)	S6	5.5	(1.7)
E7	20.0	(6.1)	S7	5.0	(1.5)
E8	18.3	(5.6)	S8	4.6	(1.4)
E9	16.7	(5.1)	S9	4.2	(1.3)
E10	15.0	(4.6)	S10	3.8	(1.2)
E11	13.8	(4.2)	S11	3.5	(1.1)
E12	12.4	(3.8)	S12	3.1	(0.93)
E13	11.4	(3.5)	S13	2.9	(0.87)
E14	10.4	(3.2)			

fig. 3. An L-P with 14 elements and a 70-foot (21.3m) boom.

element. This element length will resonate at 468/36 = 13.0 MHz.

Forward element. The shortest element should resonate 45 to 50% higher in frequency than the desired high-frequency cutoff. From my experience, the swr will be lower by using a high-frequency cutoff plus at least 50%:

30 MHz + 50% = 45 MHz

½ wavelength at 45 MHz = 468/45
= 10.4 feet (3.2m)

We now have the required length of the rear element, 36 feet (10.9m) and the forward element, 10.4 feet (3.2m)

4. We will now estimate a boom target length to determine a practical distance from the long rear element (E1) to the short forward element. From experience, an L-P designed to cover an octave (2:1 bandwidth) should have a boom length from 1.5 to 3 times the length of the rear element. If the boom length is less than 1.5 times the rear-element length, the apex angle will exceed 40 degrees and the forward gain will suffer. In other words, the gain drops off quite rapidly for a boom length less than E1 x 1.5, or with an apex angle of more than 40 degrees.

From the L-P formulas and nomographs in the references it will be noted that the α angle (which is 1/2 the apex angle); relative spacing, σ; design or scale factor, τ; and other variables all govern the forward gain, front-to-back ratio, etc. The design factor, τ, given by references 4 and 5, is of special interest because it gives gain figures between 7.5 to 12 dB for various combinations of these formulas. However, the purpose of this article is to eliminate all formulas, so the information above is for those wishing to pursue further study.

We now have sufficient dimensions to start drawing the graphic L-P. In laying out the first antenna, use a scale of 10:1. Referring to **fig. 1**, proceed as follows:

5. First draw the longitudinal center line, X-Y. Now draw the longest element, E1, (line A-B) determined by **step 3** to be 36 feet (10.9m).

6. A boom length of 2 x E1 will be used for the first example; 36 x 2 = 72 feet (21.6m). We will use 70 feet (21m) as the target length and try not to exceed this length.

It will be found later that this overall length may vary plus or minus a few feet, but we will try not to exceed an overall length of 70 feet (21m). This will also give us a target length for fore and aft mast spacing.

Now measure 70 feet (21m) along the X-Y centerline from point X (or the rear element) toward Y, making a dot at exactly 70 feet (21m), which will be called Y'.

7. Next draw a temporary (dotted) line, C-D, at the 70 foot (21m) point, making this line 10.4 feet (3.1m), which is the length of the shortest (forward) element. Make certain that the X-Y axis bisects this line, or that the two ends of line C-D are equidistant from X-Y. A permanent line is not drawn here as this is a temporary, or target line. It is a step of the graphic method needed to generate the triangle outline to which the other elements will be added. The final, short element, may not coincide exactly with the boom target length. It may miss this distance by a few feet; however, this has little effect on the performance of the antenna.

8. Draw line A-C and extend it until it crosses the X-Y axis. Next draw line B-D, extending it to also cross X-Y. If all drawings to this point have been accurate, these lines will meet, forming the apex, (Y), of an isosceles triangle, A-Y-B.

9. The next step is to add the remaining elements between the rear element, E1, (line A-B) and the short, forward, target element, which should fall near the temporary element (line C-D).

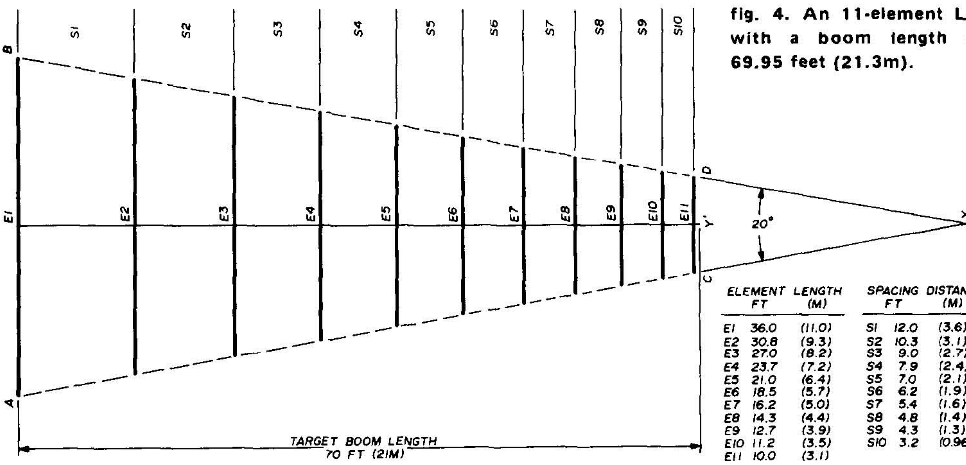


fig. 4. An 11-element L-P with a boom length of 69.95 feet (21.3m).

ELEMENT	LENGTH FT	(M)	SPACING	DISTANCE FT	(M)
E1	36.0	(11.0)	S1	12.0	(3.6)
E2	30.8	(9.3)	S2	10.3	(3.1)
E3	27.0	(8.2)	S3	9.0	(2.7)
E4	23.7	(7.2)	S4	7.9	(2.4)
E5	21.0	(6.4)	S5	7.0	(2.1)
E6	18.5	(5.7)	S6	6.2	(1.9)
E7	16.2	(5.0)	S7	5.4	(1.6)
E8	14.3	(4.4)	S8	4.8	(1.4)
E9	12.7	(3.9)	S9	4.3	(1.3)
E10	11.2	(3.5)	S10	3.2	(0.96)
E11	10.0	(3.1)			

Precise measurements must be made for the remainder of this design. For this reason an accurate scale must be used and the lengths should be read or estimated to 0.1 foot (3cm). **Fig. 2** will now be used to complete the L-P. Our next objective will be to determine a correct spacing ratio between the elements.

element spacing

Since a log-periodic antenna can be considered a unidirectional, end-fire array having a series of driven elements, a spacing distance of 0.05 to 0.2 wavelength should provide the best gain, as the two adjacent elements are out of phase because of transposition between elements, which is required for a log-periodic antenna.

For starters we'll use an element *spacing of approximately one-tenth* wavelength between elements such as the rear (longest) element, E1, and the following element, E2; and between E2 and E3, etc. An easy method of approaching this spacing is to divide the rear-element length by 5: 36/5 = 7.2 feet (2.2m). For this simple design method, this might be considered similar to the "relative spacing ratio, σ, = dN/21n," or "the mean spacing factor, σ', = dn/21n;" or "design ratio, τ, = 1n/L1-1;" in the log-periodic design formulas, which can be obtained from references 1-5 and 11. We shall, however, proceed with our no-math design method.

10. Refer to **fig. 2** and accurately measure 7.2 feet (2.2m) from the center of element E1 (point X) down X-Y and mark the position with a dot. This point will be the location of the second element, E2. Now draw E2 and measure its exact length between the sides of the triangle. As shown by **fig. 2** this length will be 33.4 feet (10.2m). (The remaining elements and element spacing will be referred to as E3...En and S2...Sn, respectively.)

11. Next determine the second spacing distance, S2: E2/5 = 32.5/5 = 6.5 feet (2.0m). Mark this distance, S2, draw E3, and measure its length, which will be 31.0 feet (9.4m).

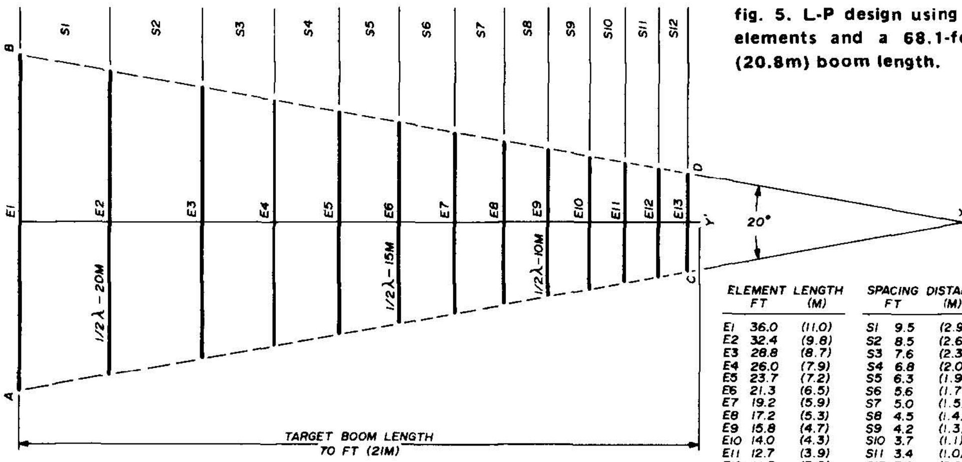


fig. 5. L-P design using 13 elements and a 68.1-foot (20.8m) boom length.

ELEMENT	LENGTH FT	(M)	SPACING	DISTANCE FT	(M)
E1	36.0	(11.0)	S1	9.5	(2.9)
E2	32.4	(9.8)	S2	8.5	(2.6)
E3	28.8	(8.7)	S3	7.6	(2.3)
E4	26.0	(7.9)	S4	6.8	(2.0)
E5	23.7	(7.2)	S5	6.3	(1.9)
E6	21.3	(6.5)	S6	5.6	(1.7)
E7	19.2	(5.9)	S7	5.0	(1.5)
E8	17.2	(5.3)	S8	4.5	(1.4)
E9	15.8	(4.7)	S9	4.2	(1.3)
E10	14.0	(4.3)	S10	3.7	(1.1)
E11	12.7	(3.9)	S11	3.4	(1.0)
E12	11.5	(3.6)	S12	3.0	(0.9)
E13	10.2	(3.2)			

12. Continue the mark-draw-measure-divide procedure, very accurately, to obtain the remaining spacing distances and element lengths until the last and shortest element is reached, which should be close to 10.4-feet (3.2-m) long and should be approximately ±1 foot (30cm) from our boom target length, depending on how accurately the measurements have been made and drawn. We now have all element lengths and spacing distances for a 17-element log-periodic for 14-30 MHz having a boom length of approximately 69 feet (21m). As measured by the protractor, the apex angle is approximately 20 degrees. Considering this angle, number of elements, and the boom length, this

L-P should give a forward gain of approximately 10 dB if the antenna is one-half wavelength above ground, or at least 35 feet (10.7m) on 20 meters.

Although 17 elements are good from an swr standpoint, a smaller number of elements can be used, as mentioned later. Twelve to 13 elements are generally ratio L(E)/3 is used, resulting in only 11 elements. As 12 to 13 elements are a minimum for a 2:1 bandwidth, **fig. 5** is generated using a ratio L(E)/3.8, which gives 13 elements. This should be the optimum of the four L-Ps all having approximately the same final boom length and apex angle.

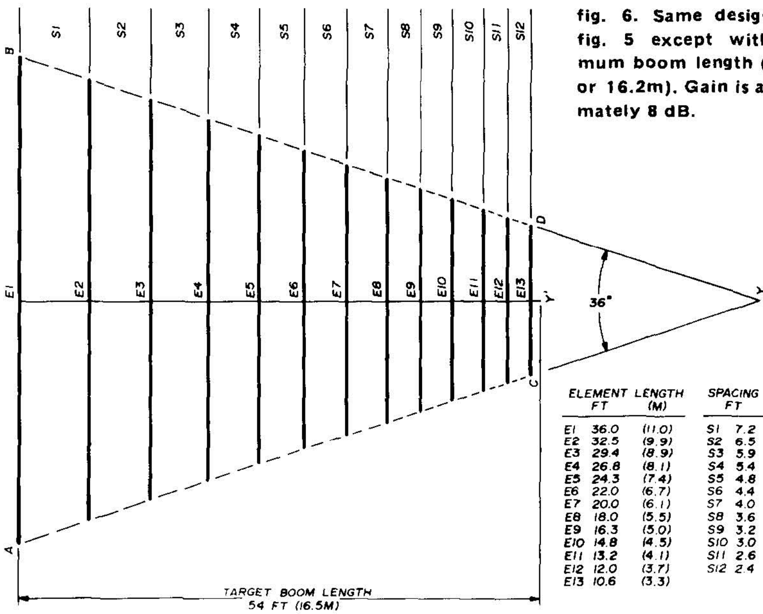


fig. 6. Same design as in fig. 5 except with minimum boom length (53 feet or 16.2m). Gain is approximately 8 dB.

ELEMENT	LENGTH FT	(M)
E1	36.0	(11.0)
E2	32.5	(9.9)
E3	29.4	(8.9)
E4	26.8	(8.1)
E5	24.3	(7.4)
E6	22.0	(6.7)
E7	20.0	(6.1)
E8	18.0	(5.5)
E9	16.3	(5.0)
E10	14.8	(4.5)
E11	13.2	(4.1)
E12	12.0	(3.7)
E13	10.6	(3.3)

SPACING	DISTANCE FT	(M)
S1	7.2	(2.2)
S2	6.5	(2.0)
S3	5.9	(1.8)
S4	5.4	(1.6)
S5	4.8	(1.4)
S6	4.4	(1.3)
S7	4.0	(1.2)
S8	3.6	(1.1)
S9	3.2	(0.96)
S10	3.0	(0.90)
S11	2.6	(0.78)
S12	2.4	(0.72)

the minimum required for an L-P designed to cover an octave. Using less than 17 elements will reduce weight, cost and labor.

a 14-element design

Fig. 3 illustrates a similar 14-30 MHz L-P also using a 70-foot (21.3m) boom target length but instead of the ratio L(E)/5, a ratio of L(E)/4 is used, resulting in 14 elements. Note that the boom length is almost exactly 70 feet (21.3m) and the apex angle remains the same as the 17-element L-P, **fig. 2**.

11- and 13-element designs

Fig. 4 is an equivalent L-P but the

Any one of these designs would have about equal forward gain; however, the 11-element design would probably not have as smooth or flat an swr across its bandwidth due to a minimum number of elements vs bandwidth. The swr might exceed 2:1 on some frequencies.

The 13-element array is one of the L-Ps assembled and being used here. Note that an odd number of elements is suggested from a mechanical assembly standpoint, as explained in some of my previous articles.

From the four L-Ps illustrated in **fig. 2, 3, 4** and **5**, it will be noted that the elements vary as follows: 11 for L(E)/3, 13 for L(E)/3.8, 14 for L(E)/4, and 17 for L(E)/5, each having essentially the same boom length and apex angle. Each should give approximately 10 dB gain.

14-30 MHz log-periodic with minimum boom length

If space is not available for a 70-foot (21.3m) boom length, the minimum length of 54 feet (16.5m) (E1 x 1.5) can be assembled per **fig. 6**. The ratio of L(E)/5 is used, which gives 13 elements. Since this antenna has a length only 1.5 times that of the rear element (or approximately 3/4 wavelength boom length), and the apex angle is 36 degrees, its gain will probably not exceed 8 dB.

14-30 MHz L-P with 100 foot (30.5m) boom length

For those desiring maximum gain from an L-P for 20, 15 and 10 meters and if space is available, the 14-30 MHz L-P boom length can be extended to approximately 100 feet (30.5m) as illustrated by **fig. 7** which, if properly assembled and suspended at least 40 feet (12.2m) above ground, will give a gain of 12 dB.

L(E)/3.3 was used for generating this L-P. The boom target length was 100 feet (30.5m). For this drawing the last element, E17, is 101 feet (30.82m) from the rear element starting point, which overshot our target by 1.1 foot (34cm). Sixteen elements could be used, which would be 98.0 feet (29.9m), but as mentioned previously, an odd number of elements is desirable from a mechanical standpoint; therefore, the extra 1.1 feet (34cm) should be acceptable.

gain vs boom length and apex angle

By the graphic design method we have generated three 14-30 MHz dipole log-periodic antennas having three different boom lengths, apex angles and gain:

boom length feet	meters	*apex angle* (degrees)	*approximate gain* (dB)
54	16.5	36	8
70	21.3	20	10
100	30.5	15	12

Thirteen elements are suggested for the shorter 50- and 70-foot (15.2 and 21.3m) L-Ps and 17 elements for the 100-foot (30.5m) length. I have tried all three configurations. A 70-foot (21.3m) L-P is used for my northeast beam and the 100-foot (30.5m), 17-element array for the beam directed west, which has given outstanding performance.

Since the 10-meter band may not be of interest now due to propagation conditions, this portion of the L-P designs can be eliminated by deleting elements shorter than 15 feet (4.6m); i.e., for the 13 element L-P, **fig. 5**, elements 10, 11 12 and 13 can be deleted, reducing the length by 14.3 feet (4.4m) leaving a 9-element L-P covering 14-21.5 MHz for 20 and 15 meters.

For the shortest L-P, **fig. 6**, deleting the four forward elements would reduce the length by 10.9 feet (3.3m) or a boom length of 41.2 feet (12.6m). This 20- and 15- meter beam could then be erected in a space 40 x 45 feet (12.2x13.7m). Likewise, for the 100-foot (30.5-m) L-P, **fig. 7**, elements 12, 13, 14, 15, 16 and 17 can be deleted, reducing its length 23 feet (7m), leaving an 11-element L-P with boom length of 78.2 feet (23.9m). The deletion of the 10-meter section of these L-Ps will have little effect on the gain on 20 and 15 meters, since the apex angle is unchanged.

40- and 20-meter log-periodics

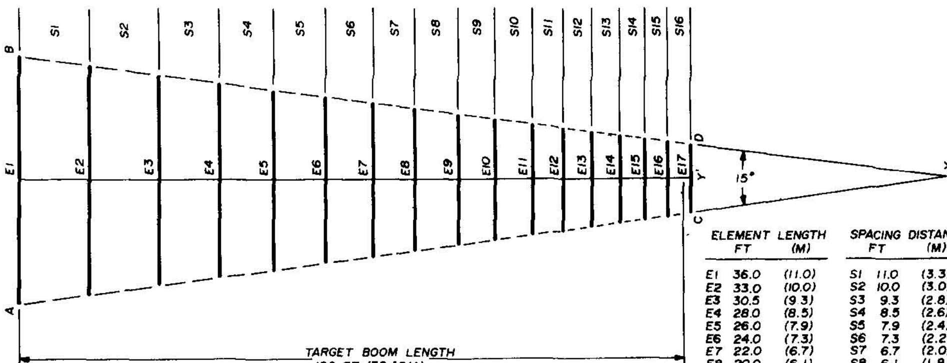
The same graphic approach can be used for designing an L-P covering 7-14.5 MHz for operation on 40 and 20 meters; however, by doubling the element lengths, spacing distances, and boom length of the 20-, 15- and 10-

meter L-Ps (**fig. 2** through **7**), 40- and 20-meter L-Ps can be assembled, except possibly that of **fig. 7**, since it would be over 200 feet (61m) long, The L-Ps of **fig. 2, 3, 4** or **5** would become 140 feet (42.7m) long; however, the shortest L-P, (**fig. 6**), would be only 108 feet (32.9m) long.

By adding four or five short forward elements and extending the boom length slightly, a 40- and 20-meter L-P can be modified to cover 7 to 21.5 MHz for operation on 40, 20 and 15 meters, which are probably the most-used bands at present. A 40-, 20- and 15-meter L-P was described in reference 7, which was of the skip-band type having a portion deleted between 7 and 14 MHz. An L-P for 40 meters should be at least 70 feet (21.3m) high for DX work.

For those wishing to design an L-P covering a bandwidth greater than a single octave, 12 to 13 elements are about the minimum that should be used. Additional elements can be used as the boom length is increased. For a 3:1 bandwidth, no less than 18 or 19 elements will be required; for 4:1 approximately 21 will be required.

In reference 7 a single-band L-P for 40 meters was described which has been tested here. Single-band L-Ps can be assembled for any of the high-frequency bands using the graphic design method. Five elements are sufficient and the swr remains relatively flat across the band for which the antenna is designed. A total of five different single-band L-Ps have been tested here on several bands. With an apex angle of 32 - 36 degrees, the single-band L-P will generally show a gain of 8 to 10 dB provided it is suspended approximately one-half wavelength above ground.



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E3	30.5	(9.3)	S3	9.3	(2.8)
E4	28.0	(8.5)	S4	8.5	(2.6)
E5	26.0	(7.9)	S5	7.9	(2.4)
E6	24.0	(7.3)	S6	7.3	(2.2)
E7	22.0	(6.7)	S7	6.7	(2.0)
E8	20.0	(6.1)	S8	6.1	(1.8)
E9	18.5	(5.7)	S9	5.7	(1.7)
E10	12.0	(3.7)	S10	5.2	(1.6)
E11	15.8	(4.8)	S11	4.8	(1.5)
E12	14.5	(4.5)	S12	4.4	(1.3)
E13	13.3	(4.1)	S13	4.0	(1.2)
E14	12.2	(3.8)	S14	3.7	(1.1)
E15	11.3	(3.5)	S15	3.4	(1.03)
E16	10.4	(3.2)	S16	3.1	(0.94)
E17	9.5	(3.0)			

fig. 7. Big Daddy — an L-P with 17 elements and a boom length of 101.1 feet (30.8m). Gain is approximately 12 dB.

vertical monopole log-periodic antennas

The vertical monopole L-Ps for 40 and 80 described in reference 9 were also assembled by the graphic design method. The ratio L(E)/5 is best for a single-band, 5-element dipole or monopole L-P since element E2 will be spaced approximately one-quarter wavelength from the shortest element; and the open-wire center feeder, which is one-quarter wavelength from the feedpoint to E2, or the active element, also serves as an impedance-matching transformer between element E2 and the higher impedance at the feedpoint, which is of the order of 200 - 300 ohms. Thus a 4:1 balun can be used.[12]

summary

Of the nearly twenty different log-periodic antennas I have built and tested, all but the first three (erected in 1970) have been designed by the graphic method. Although this simple procedure may seem crude, and may not be as accurate as an L-P designed entirely by the formulas, all antennas have produced the same results. In addition to the dipole log periodics, I have erected and tested three of the monopole L-Ps, which have quarter-wavelength vertical radiators and ground radials. These were tested on 40 and 80 meters. My graphic design method has also been applied to two of the trapezoidal sawtooth and zig-zag log-periodic designs now being tested on 20 and 15 meters.

I hope the simple non-math graphic design method will be of help to those wanting a special L-P for a particular frequency range or to fit in a limited space. To obtain maximum gain, make the L-P as long as possible for the given space; this will in turn give a minimum apex angle. Also use a sufficient number of elements to keep the swr relatively flat across the band for which the antenna is designed.

If you plan an L-P for 20, 15 and 10 meters, try to make the boom at least 54 feet (16.5m) long and use a minimum of 13 elements. If you are not interested in the 10-meter band, it would be better to design the L-P to cover 14 to 22 MHz only for 20 and 15 meters, using the 54-foot (16.5-m) boom length for a 9-element 14 to 22 MHz L-P. This would reduce the apex angle to 32 degrees and the gain would be approximately 10 dB vs 8 dB for the 20-, 15- and 10-meter antenna on the same boom length.

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references

1. H. Jasik, "Log Periodic Design," *Antenna Engineering Handbook*, McGraw-Hill, New York, 1961.
2. R. Carrell, "Analysis and Design of the Log Periodic Dipole Antenna," *IRE National Convention Record*, McGraw-Hill, New York, 1961.
3. Carl E. Smith, *Log-Periodic Antenna Design Handbook*, Smith Electronics, Inc., 1966.
4. International Radio Consultative Committee - C.C.I.R., *Handbook on High-Frequency Directional Antennae*, International Telecommunications Union, Geneva, 1966, page 26.
5. A.E. Blick, VE3AHV, "The Design of Log Periodic Antennas," *73*, May, 1965, page 62.
6. G.E. Smith, W4AEO, "Three-Band High-Frequency Log-Periodic Antennas," *ham radio*, September, 1972, page 28.
7. G.E. Smith, W4AEO, "40-Meter Log-Periodic Antennas," *ham radio*, May, 1973, page 16.
8. G.E. Smith, W4AEO, "High-Gain Log Periodic for 10, 15 and 20," *ham radio*, August, 1973, page 18.
9. G.E. Smith, W4AEO, "Vertical Monopole Log-Periodic Antenna for 40 and 80 Meters," *ham radio*, September, 1973, page 44.
10. G.E. Smith, W4AEO, "Mono-Band Log-Periodic Antennas," *73*, Part 1 August, 1973, Part 2 September, 1973.
11. "MF/HF Communications Antennas," Defense Communications Engineering, Installation Standards Manual, DCAC 330-175-1, Addendum 1, 1967.
12. G.E. Smith, W4AEO, "Feed Systems for Log-Periodic Antennas," *ham radio*, October, 1974, page 30.

ham radio