log-periodic antennas
for the high-frequency Amateur bands

Design data for two LP wire beams: one for 10, 15, and 20 meters, and one for future ham bands in the 10-30 MHz region

In a recent article[1] W6PYK illustrated the design of a log periodic (LP) antenna covering the 10-, 15-, and 20-meter Amateur bands using a simplified approach. The antenna design parameters were $\tau = 0.875$ (the taper factor) and $\sigma = 0.13$ (the spacing factor). This design provides a ten-element LP with a boom length of 15.6 meters (51 feet) and a gain of 6.7 dB over a dipole. All element lengths and element spacing dimensions were provided for those wishing to build a good three-band fixed-wire beam with a fair amount of gain.

measurement accuracy

You'll note that W6PYK[1] rounds off the values for element lengths and spacing distances. Some authors describing LP-antenna designs for Amateurs often show these measurements with decimals to the fourth, fifth, or even sixth place! Probably many Amateurs have been discouraged after seeing this amount of measurement precision. No doubt some of this showmanship is to impress the reader that the author has access to a computer. But as Paul, W6PYK, says, "The LP is very forgiving of construction and design tolerances." I've found this to be true in my LP antenna designs.

Over the past eight years I've assembled and tested more than thirty high-frequency LP antennas for various frequency ranges and gains including monobanders and two- and three-banders. Using a four-function calculator, lengths and spacings can be shown to four or five decimal places, but I always round off to no more than *two* places for ease in measuring, usually converting the measurements to feet and inches (meters and centimeters) for the lower-frequency bands and certainly no closer than 6 mm (0.25 inch) for the higher-frequency bands, which is plenty close.

By George E. Smith, W4AEO, in collaboration with **Paul A. Scholz, W6PYK.** Mr. Smith's address is 1816 Brevard Place, Camden, South Carolina 29020. Mr. Scholz's address is 12731 Jimeno Avenue, Granada Hills, California 91344

calculation example

Let's run through some LP design calculations using W6PYK's data (reference 1). We'll use his **table 1** and antenna 3 ($B = 2$), with fourteen elements and $\ell/\lambda = 1.37$.

table 1. 14-element LP designed to $\tau = 0.917$ and $\sigma = 0.17$. $\ell/\lambda = 1.37$; *gain* $= 8$ *dBd*.

element	length meters	(feet)		spacing distance meters	(feet)
1	10.0	(33.4)	S1	3.7	(12.0)
2	9.4	(30.7)	S2	3.4	(11.0)
3	8.5	(28.0)	S3	3.0	(10.0)
4	7.9	(25.8)	S4	2.8	(9.2)
5	7.2	(23.6)	S5	2.6	(8.5)
6	6.6	(21.7)	S6	2.4	(7.8)
7	6.0	(19.9)	S7	2.2	(7.1)
8	5.6	(18.2)	S8	2.0	(6.5)
9	5.1	(16.7)	S9	1.8	(6.0)
10	4.7	(15.3)	S10	1.6	(5.4)
11	4.3	(14.0)	S11	1.5	(5.0)
12	3.9	(12.9)	S12	1.4	(4.6)
13	3.6	(11.8)	S13	1.3	(4.2)
14	3.3	(10.8)	total:	29.7	(97.3)

Since we start with 14 MHz as our low-end cutoff frequency, f_L, the free-space wavelength, λ_0, will equal 984/14 or 21.4 meters (70.3 feet). The boom length will be 29 meters (94.9 feet). If these dimensions aren't too large for the available space, we proceed as follows:

1. As our $f_L = 14\ MHz$, the length of the E1 rear element will be $468/14 = 10$ *meters (33.4 feet)*. Under the τ column of the table note that $\tau = 0.917$ and $\sigma = 0.17$. These parameters determine the taper factor, τ, and spacing factor, σ, for the remaining calculations.

2. Next we calculate the spacing distance between E1 and E2. $S1 = \sigma \times \lambda_0 = 0.17 \times 70.3 = 11.96$ *feet*. Make it 3.7 meters (12 feet).

3. Next we calculate the other element lengths, E2, E3 . . . En, where En is the *nth* element. From **step 1** $E1 = 10$ *meters (33.4 feet)*. $E2 = E1 \times \tau = 9.4$ *meters (30.7 feet)*. The remaining element lengths are calculated similarly.

4. The remaining spacing distance, S2, S3 . . . Sn are calculated thus: $S2 = S1 \times \tau = 3.3$ *meters (11 feet)*. $S3 = S2 \times \tau = 3$ *meters (10 feet)* and so on for S4 . . . Sn.

design aid

For those who don't wish to compute an LP using W6PYK's easy design method, complete dimensions are given in **tables 1** and **2** for two 14-29-MHz LPs for 20, 15, and 10 meters.

about cost

Some hams with whom I've discussed LPs feel that the LP requires quite a bit of wire for the number of bands covered, especially one covering a 2:1 ($B = 2$) frequency range (one octave). This is true for a large LP covering 80 and 40 or even 40 and 20 meters; however, since an LP covering 14-29 MHz includes three bands (20, 15, and 10) you get more for the money. My antenna for these bands cost about $35.00 to $50.00 for wire, nylon line, and lucite insulators (coax, baluns, and towers not included). For these reasons I feel that LPs for 80 or 40 meters should be limited to a monoband LP ($B = 1$) since the range between 4.0 and 7.0 MHz or 7.3 and 14 MHz isn't needed.

The least expensive, or rather the most "cost effective," LPs built here have been those designed for 14-21.5 MHz ($B = 1.5$) for 20 and 15 meters only. The first LP put up here was a seven-element array with a boom length of 11 meters (37.5 feet). It was described in reference 2.

table 2. 19-element LP designed to $\tau = 0.943$ and $\sigma = 0.175$. $\ell/\lambda = 1.97$; *gain* $= 8.9$ *dBd*.

element	length meters	(feet)		spacing distance meters	(feet)
1	10.0	(33.4)	S1	3.7	(12.3)
2	9.6	(31.5)	S2	3.5	(11.6)
3	9.1	(29.7)	S3	3.3	(10.9)
4	8.5	[illegible]	S4	3.1	(10.3)
5	8.1	(26.4)	S5	3.0	(9.7)
6	7.6	(24.9)	S6	2.8	(9.2)
7	7.2	(23.5)	S7	2.7	(8.7)
8	6.8	(22.2)	S8	2.5	(8.2)
9	6.4	(20.9)	S9	2.3	(7.7)
10	6.0	(19.7)	S10	2.2	(7.3)
11	5.7	(18.6)	S11	2.1	(6.8)
12	5.3	(17.5)	S12	2.0	(6.5)
13	5.0	(16.5)	S13	1.9	(6.1)
14	4.8	(15.6)	S14	1.7	(5.7)
15	4.5	(14.7)	S15	1.6	(5.4)
16	4.2	(13.9)	S16	1.5	(5.1)
17	4.0	(13.1)	S17	1.4	(4.8)
18	3.7	(12.2)	S18	1.3	(4.5)
19	3.5	(11.6)	total:	43.0	(140.8)

Fig. 1 is a drawing of the 14-29-MHz LP suggested by W6PYK for 20, 15, and 10 meters with an array length of 15.6 meters (51 feet). Note how the three cells for 20, 15, and 10 meters overlap in a fairly short (array length) LP. All elements are used (no waste of wire), as compared with an LP for 80 and 40 or 40 and 20 meters.

a 10-30 MHz-LP for future Amateur bands

An LP designed to cover 10-30 MHz may be of future interest, as W6PYK mentioned in his article.[1] Hopefully, we'll be awarded the proposed ham

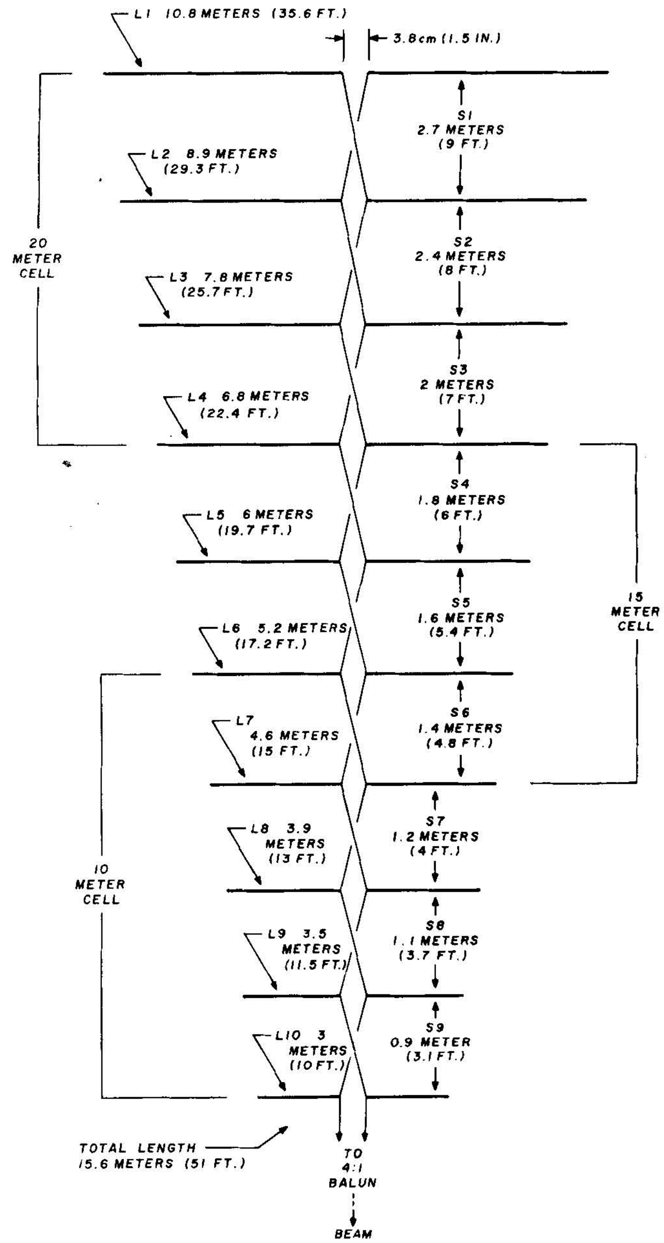

fig. 1. Ten-element 14-29-MHz log periodic antenna for 10, 15, and 20 meters. Designed to τ = 0.875 and δ = 0.13. Gain = 6.7 dBd. Note how the three "cells" for 10, 15, and 20 meters overlap — no waste of wire.

bands: 10.1, 18.1, and 25.25 MHz at the forthcoming WARC Geneva conference. An LP designed to cover the entire 10-30-MHz spectrum will then be usable on six bands: 10.1, 14, 18.1, 21, 25.25 and 28 MHz.

As Paul states it would be difficult, and quite a mechanical challenge, to design a practical six-band rotatable Yagi similar to the present triband Yagis.

Fig. 2 shows dimensions for a nine-element ($B = 3$) 10-30 MHz LP designed to $\tau = 0.8$ and $\sigma = 0.142$, which gives an array length of 17.7 meters (58 feet) and a 5.9-dBd gain. Although this is a moderate gain, it's probably about as good as some of the present tribanders and about as good as can be expected from an LP with such a short boom length. A big advantage is that gain and SWR are relatively constant over the entire range of 10-30 MHz. A further advantage is that it covers our present 14-, 21-, and 28-MHz bands plus the proposed 10.1-, 18.1-, and 25.5-MHz bands.

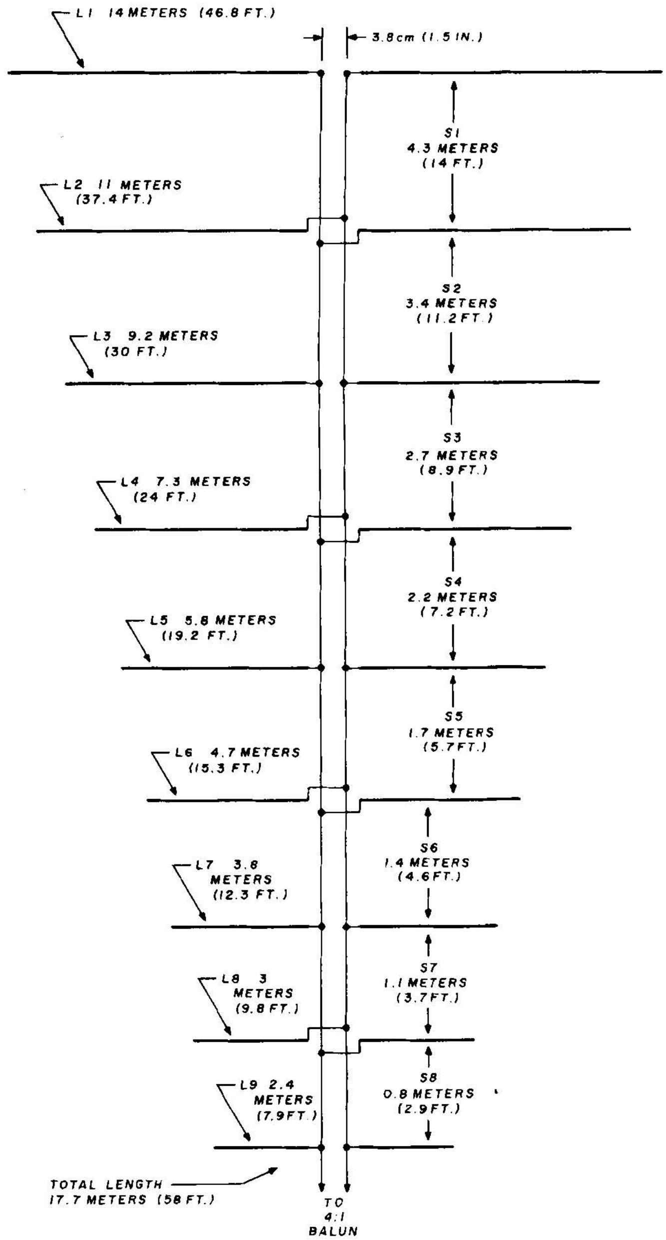

fig. 2. Nine-element LP designed for 10-30 MHz, using τ = 0.80 and δ = 0.142. Gain = 5.9 dBd. This will cover future Amateur bands as proposed in the WARC conference in Geneva.

references

1. Paul A. Scholz, W6PYK, "Another Approach to Log-Periodic Antenna Design," *ham radio*, December, 1979, page 34.
2. George E. Smith, W4AEO, "Log Periodic Beam for 15 and 20 Meters," *ham radio*, May, 1974, page 6.

ham radio