log-periodic fixed-wire beams
for 40 meters

Extensive tests
with overseas Amateurs
have resulted
in an LP antenna
with excellent characteristics
and performance

During the testing of the various 75-meter antennas described in an earlier article,[1] QRN hadn't been too bad and many overseas contacts with New Zealand resulted in much useful data on antenna performance. During June, 1978, however, propagation conditions deteriorated and QRN on 75 meters became so bad that many of the morning DXers (usually on 3808 kHz) moved to 40 meters.

Because the QRN on 40 meters was generally less than that on 75 meters during the DX window (1000-12000 UTC), I decided to remove the three-element 75-meter beam[1] and replace it with a similar beam for 40 meters, also using an optimum LP design.

40-meter LP design

Using W6PYK's LP design data,[2] I built a 40-meter LP using taper factor $\tau, = 0.95$ and spacing factor $\sigma, = 0.18$. This beam would be about 18 meters (60 feet) above ground, or almost one-half wavelength on 40 meters, so it should give about the maximum gain possible. The design was a four-element truncated log periodic with a boom length of 22 meters (71.8 feet). Complete dimensions and VSWR response are shown in **fig. 1**.

I'd hoped to make this 40-meter LP a five-element array, but a tree near the center of the forward-element end of the antenna prevented extending the feeder to include a fifth element. However, two trees

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to the side and in line with the director.) This dipole was used as a standard for comparison with the beam. Both antennas were about the same height above ground, exactly parallel, and oriented broadside to the west.

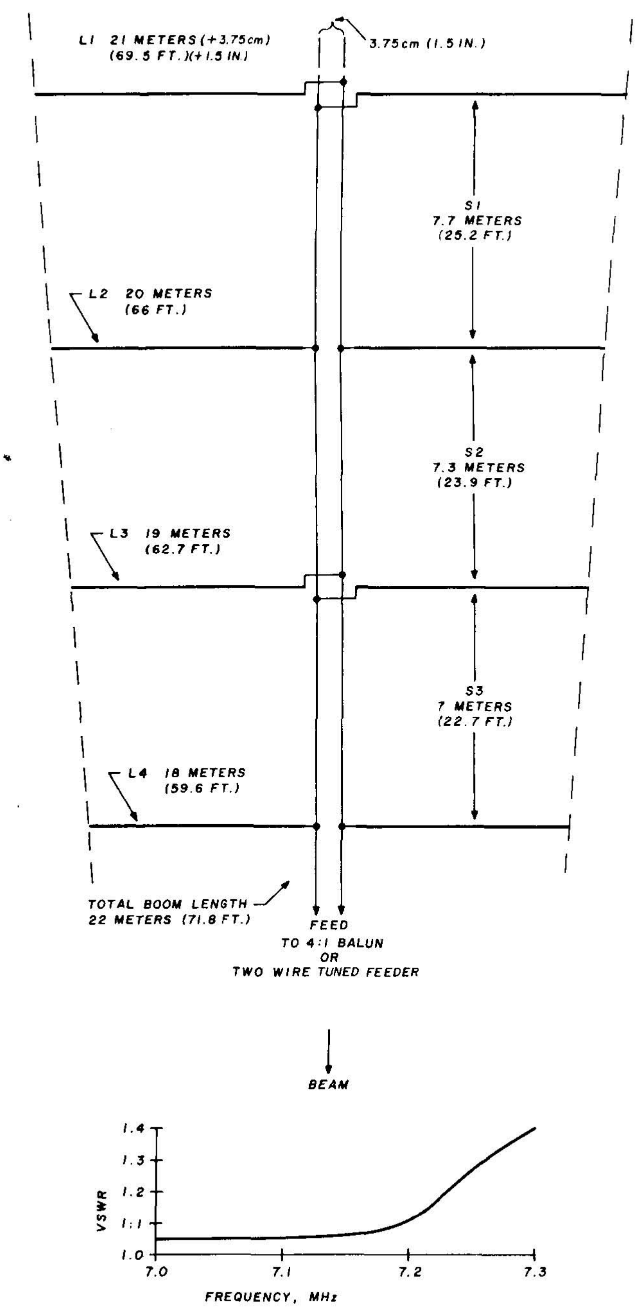

fig. 1. Four-element truncated LP antenna for 40 meters designed from data provided by W6PYK (reference 2). Curve showing VSWR is also provided.

to the sides allowed the addition of a parasitic director as shown in **fig. 2**. Paul, W6PYK, estimated that this director should add about 1 dB additional gain.*

Fig. 2 also shows the method of suspending the 40-meter LP. (Also added later was a 40-meter dipole

*Before considering the addition of this director element in your design, note that 1 dB represents a power gain of 1.26. Note also that, to double the power, a gain of 3 dB is required. Considering the fact that a 1-dB increase in signal strength is virtually imperceptible at the receiving end of a radio circuit, adding the director hardly seems worthwhile. **Editor.**

test antennas

For the 40-meter tests I used four antennas for direct comparison with the 40-meter west beam illustrated in **figs. 1** and **2**. The comparison antennas were:

1) a 40/75 meter trap dipole sloper suspended over a pond;

2) a four-band Hustler trap vertical mounted on the roof of my house at about 9 meters (35 feet) above ground. Radial elements were used in the ground system;

3) the dipole shown in **fig. 2**;

4) a 40-meter LP-Yagi consisting of seven elements directed north.

The north-oriented LP-Yagi deserves special mention. I've had many requests for information about its design and performance.

40-meter north beam

This antenna had four driven elements and three parasitic directors. Boom length was 29 meters (93.8 feet). Height above ground was only 12 meters (40 feet). If the height above ground could have been increased to one-half wavelength, and if the antenna could have been beamed to the northeast, it probably would have been a good DX antenna for Europe. However, trees on my property aren't properly spaced for that direction.

The 40-meter north beam was constructed in an inverted-V configuration, with the center supported by a nylon line between two trees. Element ends were supported by two side catenary lines attached to trees at either end. An inverted-V configuration is shown in reference 3. This design is used by a number of commercial LP-antenna manufacturers.

The north beam was aimed about 90 degrees north of the west beam. It was interesting to switch from west to north when monitoring ZLs and VKs on 40 meters. At times, these stations were almost nil on the north beam but were received strongly on the west beam, which demonstrated the side attenuation of the north beam.

construction notes

The construction information presented in part 1 and its references apply to the 40-meter designs shown here.

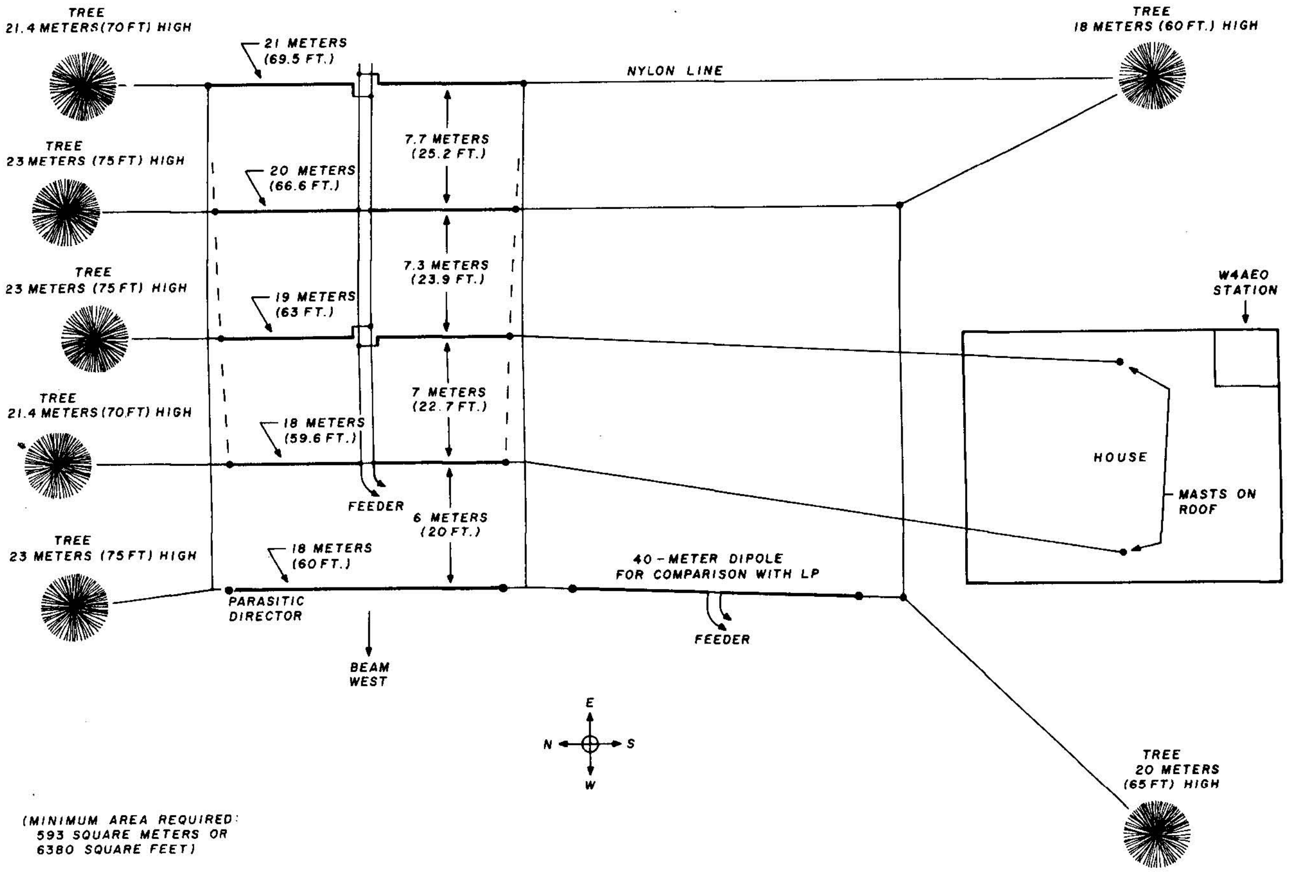

fig. 2. Author's 40-meter LP west beam using four driven elements and a director. A dipole was added for comparison in the 40-meter tests described in the text.

My 75- and 40-meter LPs required no side catenaries because enough trees and other supports were available on either side of the antenna elements for halyards, which made construction and suspension simple and easy — each antenna element could be adjusted separately for proper tension and alignment.

The two lines shown on either side of the 40-meter LP (**fig. 2**) aren't support catenaries; they're merely spacing lines of nylon to keep the ends of the elements parallel. This gives the same spacing as determined by the center feeder.

If you don't have trees available for supports, you'll need four masts or towers and you'll need two side catenaries to support the one- and two-element sections between the rear (no. 1) element and the forward element.

Feedline considerations. Little information has been published on the spacing of the two-wire intra-array feedline for high-frequency LP wire beams, so I tried various spacing distances from 3.75 to 15 cm (1½ to 6 inches). All LPs constructed here since 1975, including the 75- and 40-meter arrays described, have used a feedline spacing of 3.75 cm (1½ inches) and no. 16 (1.3 mm) insulated wire.

With this wire size and spacing, the feedline impedance appears to be near 450 ohms, which is about right for use with a 4:1 balun feeding 52-ohm coax. The driving-point impedance appears to be approximately one-half that of the feedline characteristic impedance for LP arrays.

Flexible stranded feeder wire is desirable so that the two wires will be straight and parallel with little fore and aft tension required on the center feeder. Insulated wire is used should the two wires touch in a high wind. I use trees for supports, so it's important to reduce element and center-feeder weight to a minimum. Reference 4 gives suggested feed methods for the high-frequency LP beams tested here and may be of interest if one of these LPs is to be assembled.

If you don't want to make the two-wire feeder you might consider the 450-ohm, low-loss, open-wire TV line offered by Saxton Products.* This line has been used for years by Amateurs for feedlines and stubs. It uses no. 18 AWG (1-mm) wire spaced at 25.5 mm (1

*Saxton Products, Inc., 215 North Route 303, Congers, New York 10920 (Catalog no. 2500 or C-4-500-6).

inch) and has molded insulators spaced every 153 mm (6 inches). It's available in standard lengths of 30.5, 76, and 153 meters (100, 250, and 500 feet).

I've received inquiries as to whether standard 300-ohm TV line (ribbon) can be used for the intra-array center feedline. The answer is absolutely *no*. This is because the 0.82 velocity factor of TV line would not be compatible with the required element spacing, as given by the LP formulas. To confirm this I removed the two-wire center feeder from one of the LPs here and replaced these sections with a good grade of 300-ohm TV feeder. The LP immediately showed a loss in gain, both on transmission and reception. Therefore, some types of two-wire open feeder (air dielectric) *must be used*. A velocity factor of at least 95 per cent or better is recommended, which rules out any solid-dielectric 300-ohm feeder, including the tubular-shaped 300-ohm uhf "low loss" TV line (velocity factor of 0.82).

W6PYK mentions the requirement of air dielectric "to be used to prevent excessive phase shift within the array feed. Any other dielectric has the effect of increasing the spacing factor, σ, in a complex manner."[2]

Now, the above remarks don't rule out the use of 300-ohm solid-dielectric line between the 4:1 balun and the feed point of the intra-array center feeder (LP feed point at the short element, or front of the array). I've used this method of feeding many of my LPs; some use 31-61 meters (100-200 feet) of good grade 300-ohm TV line.

Most of my LPs are supported by trees, so weight must be kept to a minimum. The weight of a 4:1 balun plus the weight of RG-8/U, or even RG-58/U, coax would cause the front end to sag, resulting in a height loss of the forward end (above ground).

Even the best, or rather highest gain, LP used here to date and described in reference 6 was fed by about 76 meters (250 feet) of 300-ohm TV line between this 17-element LP feed point and the 4:1 balun, which was located at about 3 meters (10 feet) above ground to the rear of the LP. From the balun I used RG-8/U coax, buried to the station. The 300-ohm feeder was suspended from the forward element and draped under the full length of the 17-element array.

Insulators. I've been unable to locate four-hole "off-the-shelf" insulators suitable for the two-wire center feeder-spacer insulators, so homemade Lucite insulators[5] are used. Reference 5 also shows the best method for securing these insulators to the open-wire feedline as well as an assembly sketch of a seven-element LP showing the transposition method of feed to alternate elements.

If the open-wire TV line described above is used, the homemade Lucite center insulators can be replaced by standard 64-mm (2.5-inch) ceramic or porcelain ribbed insulators. These insulators are available from dealers selling antennas for shortwave listeners.

The two outside ribs of these SWL-antenna insulators are spaced at about 25.5 mm (1 inch), and the 450-ohm TV line can be secured to, and suspended below, these insulators. The two insulator holes secure the element centers. Connect short jumper wires between element-center ends and the feedline.

As I mentioned in previous articles, small strain insulators (Johnny Ball) are suggested for the center and end insulators used on the long, rear element (S1) and the short forward element.

a higher-gain LP

Should you have the available space and necessary supports and want a 40-meter wire beam having a gain of 10 dB over a dipole, you can build a monoband LP giving this gain. Referring to W6PYK's article[2] **table 1** ($B = 1$), and using $\tau = 0.972 - 0.978$ and $\sigma = 0.180 - 0.181$, will give about maximum gain for an LP.

Referring to the four-element 40-meter LP described above, **fig. 1**, for which I used ($\tau = 0.95$ and $\sigma = 0.18$); this beam can be extended to seven elements and will require a length of only 40.7 meters (133.4 feet). This will, of course, increase gain and bandwidth over the four-element model tested here, which was only 22 meters (71.8 feet) long. Thus by using an open space about 30 meters (100 feet) wide by 46 meters (150 feet) long in the desired beam direction, an excellent 40-meter wire LP beam can be erected. **Fig. 3** illustrates this LP with dimensions for element lengths and spacing.

If the length of the open space can be extended to about 69 meters (225 feet), a 40-meter LP beam having 10.6-dBd gain can be erected, as shown by W6PYK's article. This requires ten elements. Parameters are: $\tau = 0.978$ and $\sigma = 0.181$, resulting in an array length of ($/\lambda = 1.48$), or overall LP length of $\lambda O = 984/7\ (MHz) = 140.6\ feet \times 1.48 = 208\ feet$ *(63.39 meters)* boom. It's assumed that this array would be at least 18 meters (60 feet) above ground to provide maximum possible gain.

summary of 75- and 40-meter LP antenna tests

These tests were made to determine if there is any type antenna or beam best suited for long-haul, multi-hop DX on 75 or 40 meters.

At my location, the last 75-meter LP, designed for 3808 kHz with $\tau = 0.94$ and $\sigma = 0.175$ (reference 1), appeared to be the best of the various beams tested. Second best were the first 75-meter LPs and the

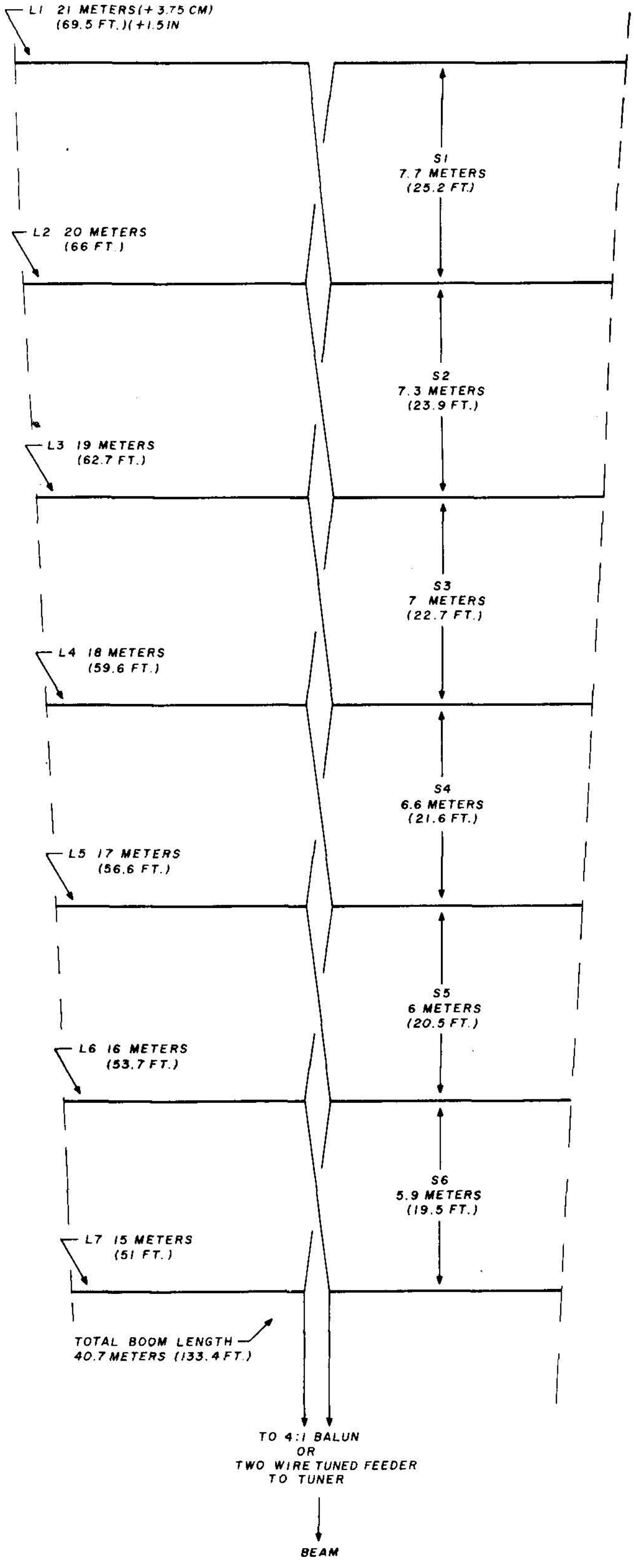

fig. 3. Seven-element LP for 40 meters with improved performance. You'll need an open space about 30 meters (100 feet) wide by about 46 meters (150 feet) long in the desired beam direction.

Yagi. These were compared with the more common antennas.

The LPs and the Yagi were the only unidirectional beams tested. There was little difference between the LPs (prior to the last) and the Yagi; however, the Yagi had the disadvantage of smaller bandwidth and it didn't cover the entire 75-80 meter band, which the LPs did. The Yagi was used only for a short time before being destroyed by lightning.

The other 75-meter antennas tested were nongain. However, some were bidirectional, as mentioned in part 1, and were thus no more than 50 per cent effective because of half the power, or radiation loss, in the undesired direction.

One of the three delta loops performed fairly well and was used throughout the test. One of the verticals was also used during most of the test; however, both of these antennas were generally about 10 dB below the LPs.

The 75-meter beams were all less than one-quarter wavelength above ground, so their radiation angle was probably far from optimum for the DX path. However, multi-element end-fire arrays should tend to lower the takeoff (and arrival) angle, compared with a dipole at the same height. The latter, of course, has most of its radiation straight up when only one-quarter wavelength above ground.

It appears that, for my location, a radiation angle of about 35 degrees for 75 meters and 25-30 degrees for 40 meters is about optimum for the early morning (local time) DX path. At another location a lower angle could possibly be more effective.

No single-type antenna is best suited for *all* locations. An antenna that may perform well at one location may give poor DX performance at another. Anyone desiring a good antenna for a long-haul DX circuit on 40 or 80 meters should first try, at least, two *entirely different* types of antenna; possibly a quarter or half-wavelength vertical, with *at least* 50 radials to start and a good dipole at least 22 meters (72 feet) above ground. Then compare these antennas directly for a few days, preferably with the same DX station. Then repeat the test several times during the DX opening for that day.

references

1. George E. Smith, W4AEO, with collaboration of Paul A. Scholz, W6PYK, "Log-Periodic Fixed-Wire Beams for 75-Meter DX," *ham radio*, March, 1980, page 40.
2. Paul Scholz, W6PYK, "Another Approach to Log-Periodic Antenna Design," *ham radio*, December, 1979, page 34.
3. George E. Smith, "Mono-Band Log-Periodic Antennas, part 1," *73*, March, 1975, page 106 (fig. 5).
4. George E. Smith, W4AEO, "Feed System for Log-Periodic Antennas," *ham radio*, October, 1974, page 30.
5. George E. Smith, W4AEO, "Log-Periodic Beam for 15 and 20 Meters," *ham radio*, May, 1974, page 6.
6. George E. Smith, W4AEO, "High-Gain Log Periodic Antenna for 10, 15 and 20," *ham radio*, August, 1973, page 18.

ham radio