An-Ten-Ten-nas

INFORMATION to help you decide on the best antenna for *you!*

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In each issue of the News, we shall try to clarify a significant cluster of ideas used in antenna work. Our object is to help you make the best decisions about the antennas you buy or build without imposing our own prejudices on you. The more you understand, the better your choices will be.

No. 60: A 7-Element Very Wide-Band Log-Call Yagi

In some of these episodes, I have presented antenna design that are eminently practical.With common materials, you can build the design or your favorite variation of it. On other occasions, I have presented antenna designs that are far less practical for the home crafts-person. The reason for showing these designs vary with the antenna. Some are simply interesting. Some are illustrations of the diverse ways in which we can get the job done. Still others show special ways in which we can do some very significant jobs with antennas.

Consider the typical commercially made amateur 10-meter Yagi. It tends to use the fewest number of elements and the simplest possible construction. Makers enlarge the profit margin by getting more out of less, and they tend to increase customer satisfaction and assembly success with fewer parts that go together in standard ways. The cost to operators are varied. Some commercial designs have a marginal operating bandwidth that goes from 28.0 MHz only up to 28.8 MHz. Other designs show a high rate of gain and/or front-to-back ratio change across the operating passband.

In this episode,we shall consider a complex antenna design. It uses a 19' boom, on which most commercial antenna makers would place 4 elements. This antenna will use 7 elements. What we obtain for the increase in element population is coverage of the entire 10-meter band from 28.0 MHz to 29.7 MHz. The average gain will be 9.0 dBi (free-space), about the same as we get from a 4-element Yagi with the same boom length. However, the gain will change by less than 0.5 dB from one end of the band to the other. The minimum front-to-back ratio will be over 26 dB, with over 30 dB from 28 to 29 MHz. The50 ohm SWR will not reach 1.5:1 anywhere on 10 meters. The antenna would serve almost all 10-meter interests from CW at one end to AM at the other, with SSB and skip (but not local) FM in between.

Fig.1 shows the general outline and the dimensions of the antenna**.** Since the design is not for reproduction, I have simplified the elements by using 3/4" uniform diameter tubing. The element lengths would change if we adapted the design to one of the normal 10-meter element-diameter taper schedules. However, the element spacing values would be unchanged. The antenna has an interesting name: log-cell Yagi. It uses only 2 parasitic elements, a reflector and a director. The central elements form a special version of a log periodic dipole array (LPDA). In this application, we call the driving section a log cell.

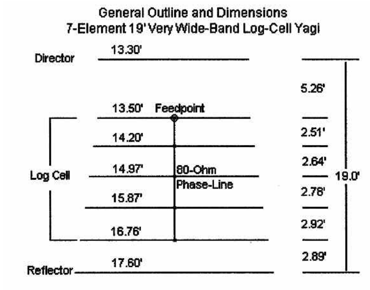
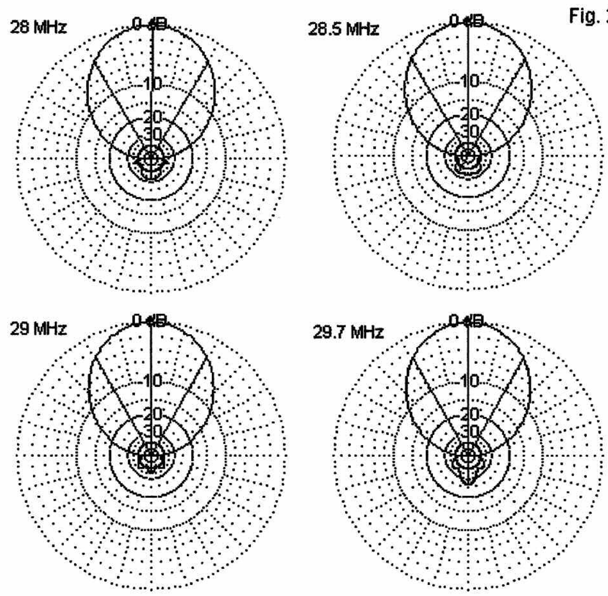


Fig. 1

Log cell drivers ranging from 2 to 7 elements have been around for a long time. However, most of them have ignored basic LPDA principles and used trial and error methods. This design develops its log cell using basic LPDA design principles to arrive at a good wide-band performance level on its own. Since the log cell has a wider bandwidth than we need, we can add the parasitic elements to enhance the gain, while narrowing the operating bandwidth only a bit.

The log cell consists of 5 elements with a T-value of 0.95 (the ratio of one log cell element length to the next longer one and the ratio of one cell space value to the next wider one). Each element is split at the center with an 80 ohm phase line connecting the elements. The line undergoes a half twist, that is, a phase reversal, at each element as we move from the feedpoint at the forward-most driver element to the rear-most element. It is likely that 75 ohm parallel line (if available) might work, but the line is designed for a velocity factor of 1.0. Generally, that requires bare conductors. One can use square or flat-strap conductors to achieve the low impedance with a manageable gap between the conductors. One of the complexities built into the design surrounds how to manage the phase-line reversal using thick conductors. Constructing this antenna (and not merely making a sloppy approximation of it) would require considerable mechanical ingenuity to preserve all of the electrical properties.

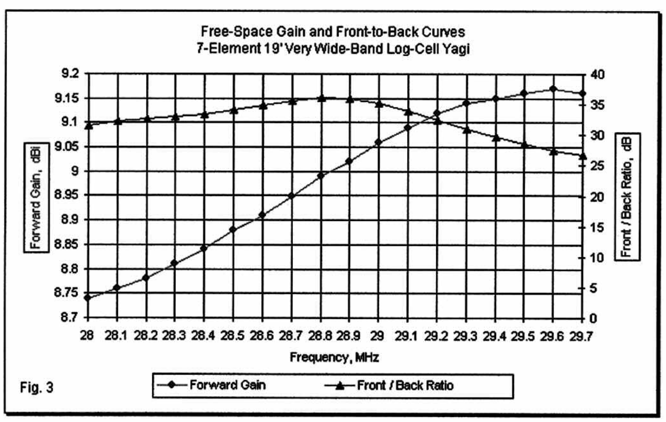
Fig. 2



Free-Space E-Plane (Azimuth) Patterns
7-Element 19' Very Wide-Band Log-Cell Yagi

Fig.2 shows what we get for our efforts-at least in terms of the free-space E-plane (azimuth) patters. Although the gain is standard for the boom length, the patters are remarkably clean at every frequency within the band. Even at the worst frequency (29.7 NHz), the front-to-back ratio is superior to the average value achieved by commercial Yagis. Across the band, the beamwidth is remarkably consistent at about 60 degrees.

In **Fig.3,** we can see the free-space gain and front-to-back curves from 28.0 to 29.7 MHz in 0.1 MHz intervals. Although the gain curve looks steep, note the Y-axis values and the very small range that they include. The gain range is only.43 bB



across the band, which is much lower than we find in many commercially made Yagis that cover only half the operating bandwidth. The 180 degrees front-to-back ratio exceeds 30 dB until we hit 29.4 MHz and then gradually tapers off down to just below 27 dB.

A very high front-to-back ratio has both advantages and disadvantages. On the plus side, stations to the sides and rear of this antenna will simply not be heard. On the negative side, stations to the sides and rear of this antenna will simply not be heard. If we want to eliminate QRM to the sides and rear, then the very high front-to-back ratio is a positive attribute. However, in a net-type operation, with check-ins in many directions, the antenna may null out stations that we wish to hear. Very often, for net operations, lower gain 2-element Yagis with some but not very high front-to-back ratio are often useful.

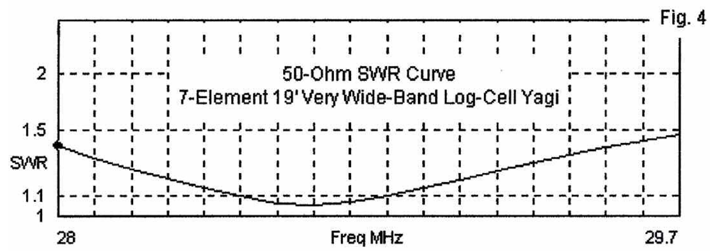
The following list checkpoint modeling results for the antenna as a guide to performance potential.

Modeled Performance of the 7-Element 19' Very Wide-Band Log-Cell Yagi

Frequency	**28.0**	**28.5**	**29.0**	**29.7**
Gain dBi	**8.74**	**8.88**	**9.06**	**9.16**
F-B Ratio dB	**31.6**	**34.0**	**35.2**	**26.7**
FP Resistance Ω	**40.5**	**48.1**	**57.0**	**68.8**
FP Reactance Ω	**-11.8**	**-4.2**	**-0.4**	**-13.1**
50-Ohm SWR	**1.40**	**1.01**	**1.14**	**1.47**

Because the driving section is an LPDA, we do not see the usual single-driver reactance pattern. The dipole driver would usually show capacitive reactance below the design frequency and inductive reactance above it. However, the LPDA driver cell shows a slight capacitive reactance across the band.

The SWR curve is remarkably smooth, despite the bandwidth



covered by the antenna. **FIg.4** shows the curve.

10 meters is the widest HF amateur band above 80 meters. Registered as a percentage, the bandwidth is 5.9%. (We generally calculate bandwidth as a percentage by taking the frequency difference between the lower and upper ends, dividing it by the center frequency, and multiplying by 100 to get a percentage). Antennas that cover the full bandwidth with relatively constant performance are quite rare. To find one with several very impressive performance specifications is even rarer.

We can close with a brief foray into terminology. Calling the antenna a log-cell Yagi emerges from early attempts to use two cross-phased drivers with a reflector and one more directors. Some folks called them log-Yags in the early days, although that was eventually dropped due to its inelegance. (However, the name was no more inelegant than the quagi-a Yagi with a quad-loop driver and reflector the Jagi-a small Yagi with a J-pole driver and the zagi- a Yagi with zigzag elements.) As designers studied the driver cell more carefully, larger cells with true LPDA roots emerged, but the old name stuck. In the same late 20th century period, designers also experimented with adding a parasitic element to each end of a standard LPDA to improve either low-end or high-end performance or both. These antennas, which ranged from 10 to 25 elements, remained LPDA as with special notations to indicate the use of one or more parasitic elements. Our 7-element 19' 10- meter very wide-band antenna falls right in the middle. So you may call it a log-cell Yagi or an LPDA with parasitic elements with equal justice.