An-Ten-Ten-nas

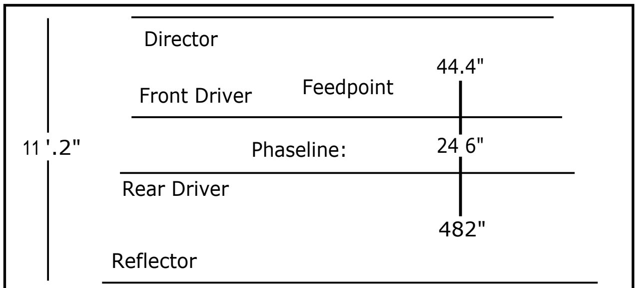
INFORMATION
To help you decide
On the best
Antenna for you

L. B. Cebik SK
W4RNL #41159

In each issue of the News, we shall try to clarify a significant cluster of ideas 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.

4-Element Very-Wide-Band 10-Meter Beam

In episode 53 of this series, I presented a short-boom, wide-band 10-meter beam that used 2-driver elements fed with a phase line, plus a single director. Although it used a shorter boom than most 2-element Yagis, the antenna showed higher gain and a much-improved front-to-back ratio. We may further improve performance by adding one more element to the antenna, with a few adjustments to the dimensions of the other elements. The total boom length is less than 10'. **Fig. 1** shows the general layout of the antenna. Note the new reflector element.



10-Meter Wide-Band Beam
General Layout
Fig. 1

The general outline does not include element lengths, because the exact lengths will depend on the method of construction and the length of each section of tubing that makes up each element. For these notes, I have selected sections of 5/8", ½", and 3/8" tubing. The inner sections, as shown in **Fig. 2**, are the same for all elements. Hence, only the tip sections (3/8" tubing) will change from one element to the next. I recommend the use of high-quality 6063-T832 tubing for a project like this. Hardware outlet tubing may not be strong enough to withstand long spells in changing winds and weather. For these elements, stainless steel sheet metal screw are fine for linking element sections. Use 2 screws at each junction.

Fig. 2

Element Center	Lighter Weight, Lower Wind Survival		Only 172 of element structure is shown.
Diameter	0.625" (5/5")	0.5" (UT)	0.375 (30)
Length	36"	33"	Up to 34"

A Possible Element Structure for the 4-Element Wide-Band Beam

Table 1. 4-element wide-band 10-meter beam element lengths and spacing

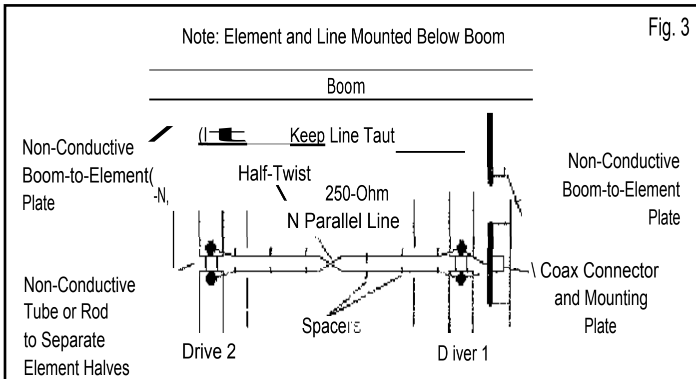
Medium-Duty Version using 0.625"/0.5"/0.375" elements

Element	Total Length	Tip (0.5") Length	Spacing from Rear El.
Reflector	220"	42"	-----
Rear Driver	206"	35"	48.2"
Forward Driver	194"	28"	72.8"
Director	188"	26"	117.2"

Table 1 lists the dimensions for the elements. These dimensions assume that the individual elements are insulated and isolated from any conductive boom a builder might use—or that the boom is non-conductive. In general, a 10' length of PVC would be too heavy for this small beam, so I recommend the use of aluminum tubing—about 1.25" in diameter—plus the use of polycarbonate plates and U-bolts to handle both the elements and the boom. All hardware should be stainless steel, both to prevent rust and to eliminate electrolysis between conductors made from different metals.

Like the 3-element beam in episode 53, the 4-element beam derives its wide-band characteristics from the use of phased drivers. **Fig. 3** shows the general construction of the 250-Ω phaseline and the drivers. Although the sketch shows the polycarbonate plates, it omits the U-bolts. 6" by 9" plates should secure the elements safely to the boom.

Fig. 3



Driver and Phase-Line Details

Since you need only 24.6" of phase-line (plus a bit of extra for connections to the elements), you likely should make your own. The following table lists the center-to-center spacing for 250-Ω lines using some common bare copper wires, listed by AWG size.

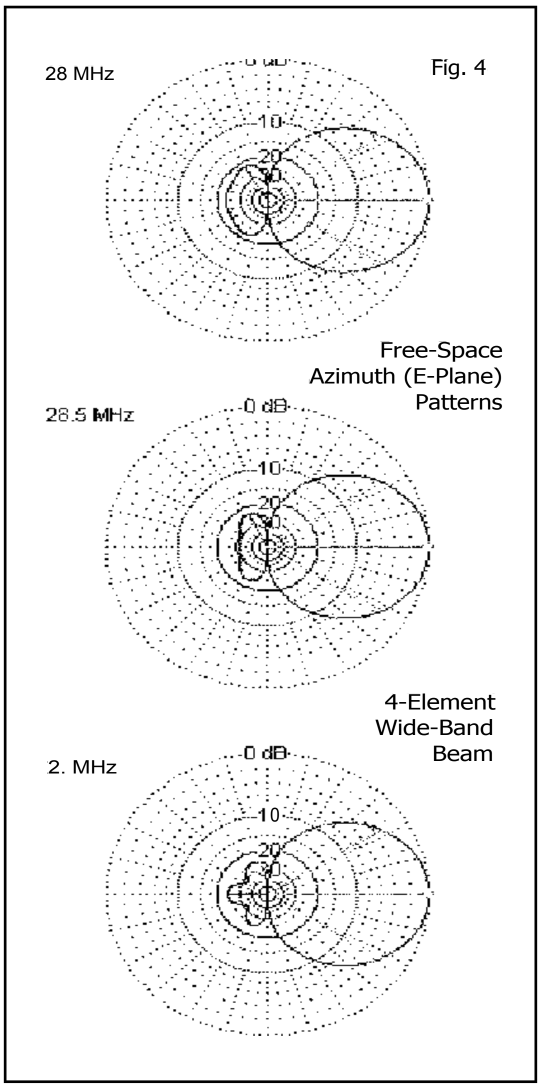
250-O Transmission Line Dimensions

AWG Wire Size	Wire Diameter	Center-to-Center Spacing
#14	0.0641"	0.262"
#12	o.0808"	0.330"
#10	o.1019"	0.416"
#12	0.1285"	0.525"

You will need spacers about every 3" to maintain the wire spacing accurately. The best way to make spacers is to drill the wire holes in a long strip of plastic (such as polycarbonate or similar). Then cut the spacers to size after you complete the drilling. Do not make the holes too large; you want a tight fit. If you do not de-burr the holes, the spacer will tend to stay in place through all kinds of weather. However, you may also fix the spacers in place by adding a tiny drop of super-glue to the junction of spacer to wire.

See episode #53 for further construction hints. The entire beam weights only 12-15 pounds, depending on the exact construction method. Hence, you can support it on a light-duty tower or even a mast—if not too high and if well guyed.

Although the antenna provides as much gain as any Yagi that uses a boom shorter than 10 feet, gain is not the main feature of the antenna. Rather, the hallmark of the antenna is its consistent performance all across the first MHz of 10 meters. Fig. 4 shows free-space patterns for the beam at the passband edges and at the center frequency. Note that there is very little change in the appearance of the three patterns.

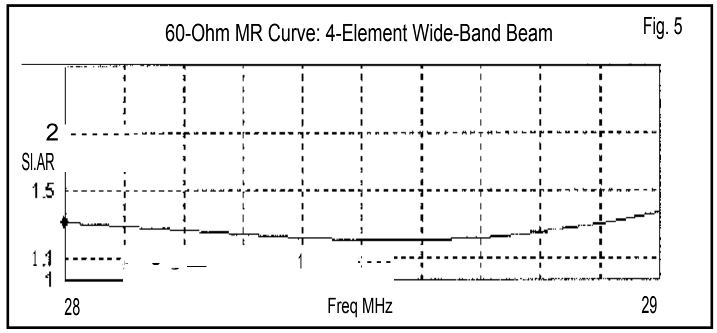


To confirm the impression left by the patterns, Table 2 lists some essential performance data at the sampled frequencies. From the data, you can infer the numbers for the intermediate frequencies.

Table 2. 4-element wide-band beam performance (free-space values)

Frequency	28.0	28.5	29.0
Gain dBi	7.19	7.26	7.43
F-B dB	23.1	27.0	24.0
Feed Z	38.4-j0.2	41.9-j1.8	39.9-j9.4
50-ohm SWR	1.30	1.20	1.36

Between the lowest CW frequency and the beginning of the FM portion of 10 meters, the gain changes by only about 0.2 dB. The front-to-back ratio is 23-dB or higher across the operating passband. In addition—as shown in the curve in **Fig.** 5 the SWR never climbs to 1.4:1 anywhere in the band.



The phasing system that uses 2 driver elements does not produce a deep SWR null, that is, 1:1. However, it is designed to show a very low figure at every operating frequency within the first MHz of 10 meters.

In fact, consistent performance is the design goal of this beam. There are 3-element Yagis that perform as well using the same boom length. For the cost of one more lightweight element and an easily constructed phase line, we obtain the closest thing to flat performance curves across the band. In fact, with just a little re-design, one might be able to use the beam over the entire 1.7 MHz of 10 meters.

In the course of these 62 explorations of antenna ideas, we have looked a many different designs for beams. There is simple way to judge which one is the best. What is best is what fits your needs, desires, and limitations. The present 4-element design with phased drivers shows that there may be no end to the variations on beams for 10 meters.