No. 35: A 10-Meter, 6-Element OWA Yagi

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There is a very interesting 20-meter Yagi design called the Optimized Wideband Antenna, or OWA. Although only one of several designs within this genre, developed by Nathan Miller, NW3Z and Jim Breakall, WA3FET, the 20-meter version is one of the most adaptable. It employs 6-elements in the space that many other designs use 5. **Fig. 1** shows the general proportions of the antenna.

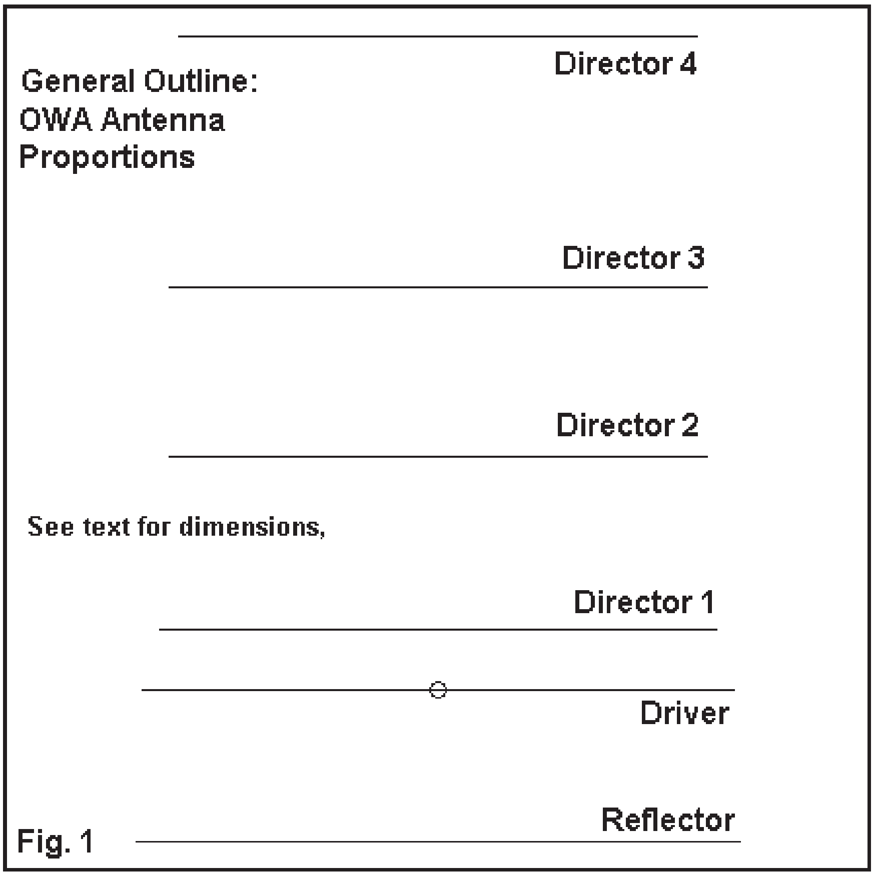

Fig. 1

The 20-meter antenna has several features that deserve special note. Director 1 is perhaps the most significant, since it represents the added element to previously standard 5-element designs. By the use of this parasitic element, the driver can be more closely spaced to the reflector and still show a feedpoint impedance very close to 50 Ohms resistive. Moreover, the antenna shows wideband VSWR characteristics, with values less than a 1.3:1 from 14.0 through 14.35 MHz.

Not only is the feedpoint impedance quite stable, so too are the other main operating characteristics, including both gain and the front-to-back ratio. The antenna shows better than 10 dBi forward gain in free space models across the entire 20 meter band, with more than a 20 dB front-to-back ratio across the same span. Many 5-element designs show much larger variations in all three of the main Yagi parameters: gain, front-to-back ratio, and feedpoint impedance.

The remaining elements of the OWA are also interesting. Directors 2 and 3 are either the same length or the forward director is slightly longer than the rearward member of the pair. Director 4 and the reflector are available for making small changes in the upper and lower frequency limits of the design to spread the operating characteristics across the desired bandwidth. The 20-meter band is about 2.5% of its center frequency. The OWA is capable if significantly greater operating bandwidths with little loss in any of its main characteristics.

The reason for making extensive note of the OWA design is that it scales quite easily (but not without some readjustment) to create very usable Yagis for 10 meters. Although only a few hams have the wherewithal to construct a 48' boom Yagi for 20 meters, 24'-boom Yagis for 10 are more common--and more manageable. The resultant beam shows a free space gain above 10 dBi across the band, a front-to-back ratio always in excess of 20 dB, and very low 50-Ohm SWR values for direct coax feed systems.

Scaling the initial OWA to 10 meters involved converting the 20-meter design into its equivalent uniform diameter element equivalent, scaling this antenna, and then creating a set of tapered diameter elements suitable for 10 meters, adjusting their lengths to be equivalent to the substitute model. The table lists the overall element length, the spacing from the reflector, and the exposed tubing lengths of each size tubing used on one side of the element. (Be sure to double the length of the largest size tubing and to have extra inches on the remaining sections for the tubes to nest.) All dimensions are in inches.

Element	**Overall Length**	**Spacing from Refl.**	**0.5" Inner**	**0.375" Middle**	**0.25" Outer**
Reflector	**216.8**	**------**	**35.75**	**35.75**	**36.9**
Driver	**209.2**	**44.68**	**35.75**	**35.75**	**33.1**
Dir 1	**199.36**	**69.26**	**35.75**	**35.75**	**28.18**
Dir 2	**193.23**	**132.40**	**35.75**	**35.75**	**25.12**
Dir 3	**193.24**	**192.83**	**35.75**	**35.75**	**25.12**
Dir 4	**186.05**	**282.96**	**35.75**	**35.75**	**21.53**

The antenna was scaled and reset to cover the span from 28 to 29 MHz. Some adjustment of the reflector and 4th director was required to achieve the added bandwidth. The first MHz of 10 meters represent a 3.5% operating bandwidth, about 40% greater than demanded of the 20-meter antenna. The following table shows representative modeled figures for 5 points across the band. All figures are based on free space models using NEC-4.1 with Leeson corrections invoked for greatest accuracy.

Parameter	**28.0**	**28.25**	**28.5**	**28.75**	**29.0**
Gain dBi	**10.00**	**10.10**	**10.19**	**10.26**	**10.27**
F-B dB	**20.29**	**26.57**	**30.22**	**24.47**	**21.34**
Feed Z:					
R	**38.4**	**41.9**	**44.4**	**44.6**	**36.5**
jX	**+5.0**	**-1.1**	**+1.3**	**+0.5**	**-2.6**
50-Ohm SWR	**1.33**	**1.20**	**1.13**	**1.12**	**1.38**

The greater bandwidth demanded of the 10-meter design shows most clearly in the rise in SWR and decrease in feedpoint impedance at the low and high ends of the bandpass. Nonetheless, the design meets all of the objectives. The gain changes only by about a quarter dB across the band. With further tweaking, the feedpoint impedance might be brought upward toward 50 Ohms a bit, but the reactance figures are extremely low for an antenna covering a full MHz of 10 meters. All of this suggests that the OWA design concept is capable of significant expansion beyond its original implementation.

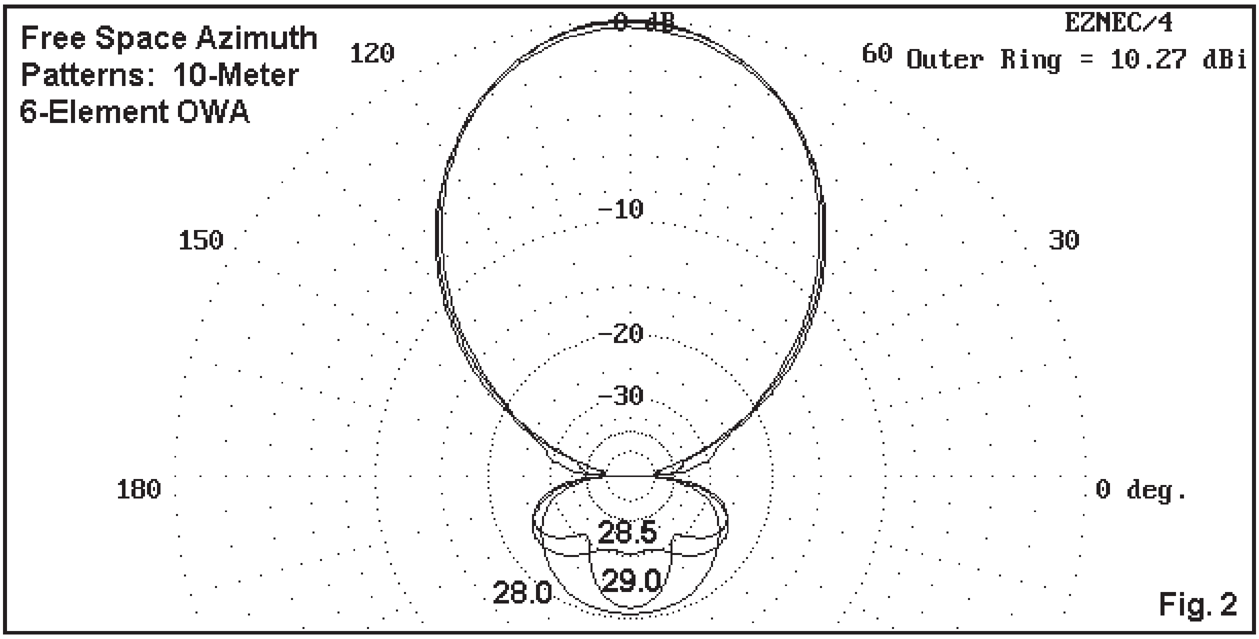

Fig. 2

The antenna pattern itself is a model of good behavior, with no undesirable side or rear lobes. Note in **Fig. 2** the change in the shape of the rearward lobe across the band, which is a normal progression for well-behaved antennas of this type.

Just for the drama, **Fig. 3** shows the 50-Ohm SWR sweep, taken at 0.1 MHz intervals across the band. There are no impedance spikes anywhere in the bandpass of the antenna.

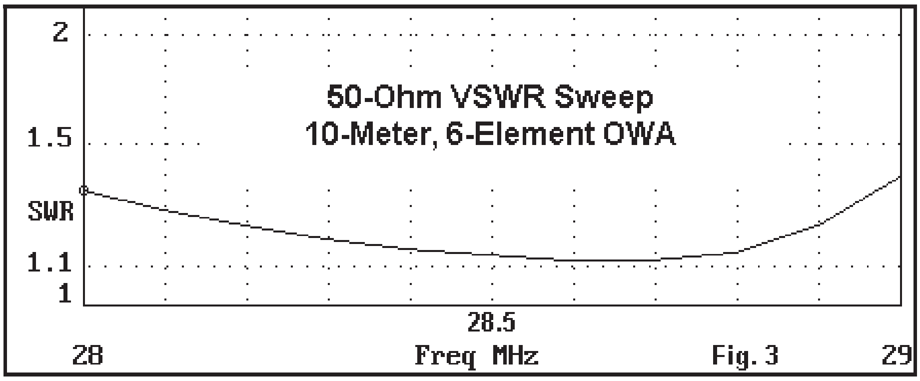

Fig. 3

As a high-performance 10-meter antenna covering all of the first MHz of the band, the 24' 6-element OWA is a worthy monoband competitor with other designs for the band.

For those who prefer somewhat beefier construction, here are the dimensions of the NW3Z model on a 24' boom using 0.75" diameter inner tubing, 0.625" diameter middle tubing, and 0.5" diameter tip sections. Note that the element lengths and spacing are slightly different than the slim-element version above. When adapting Yagi designs, do not simply take the dimensions you find in an article and use whatever materials you have. Differences in element diameter and where the steps in the diameter occur will make a difference in the required element lengths and spacings. A hasty near-copy may not perform to full specifications.

Element	Overall Length	Spacing from Refl.	0.75" Inner	0.625" Middle	0.50" Outer
Reflector	215.04	------	24.00	18.00	65.52
Driver	207.18	43.86	24.00	18.00	61.59
Dir 1	195.80	69.18	24.00	18.00	55.90
Dir 2	191.76	131.30	24.00	18.00	53.88
Dir 3	192.34	192.70	24.00	18.00	54.17
Dir 4	183.14	282.00	24.00	18.00	49.57

All credit for the OWA design belongs to its originators. Further details can be found at the following website: http://www.contesting.com/nw3z/. This exercise has only shown that one of the implementations of the basic design can be advantageously adapted to other bands. None of the models presses any limit of the NEC and, therefore, they are quite reliable, both as analyses of the antennas and as guides to construction. Of course, using still another element diameter taper schedule than the ones shown will require resetting the element lengths to accommodate the materials used.

In addition to being rather good Yagis of their size, the OWA designs may also serve as a standard against which to measure other designs that present themselves. Even if you never build one of these designs, the data provided here may be useful for comparative purposes.