Notes on the V-Yagi

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In the May, 1998, issue of *QST*, Nathan Miller, NW3Z, and Jim Breakall, WA3FET, presented an article on "The V-Yagi: A Lightweight Rotatable Antenna for 40 Meters." (See pp. 38-40.) The antenna appears to have attracted some attention at the time of publication, but interest in the antennas seems to have waned over the last 7 years or so. Perhaps one reason for the dwindling interest is the idea that it is simply an evolutionary development based on the earlier G4ZU "Bird" Yagi. This antenna appeared in *The ARRL Antenna Compendium*, Vol. 2, 1n 1989. See G. A. Bird, G4ZU, "New Techniques for Rotary Beam Construction," on pages 58-60 of that volume.

In overall general outline, the 2 antennas appear to be similar, as shown in **Fig. 1**. Both use a linear driver element with Vee'd parasitic elements. However, the differences are also worth noting.

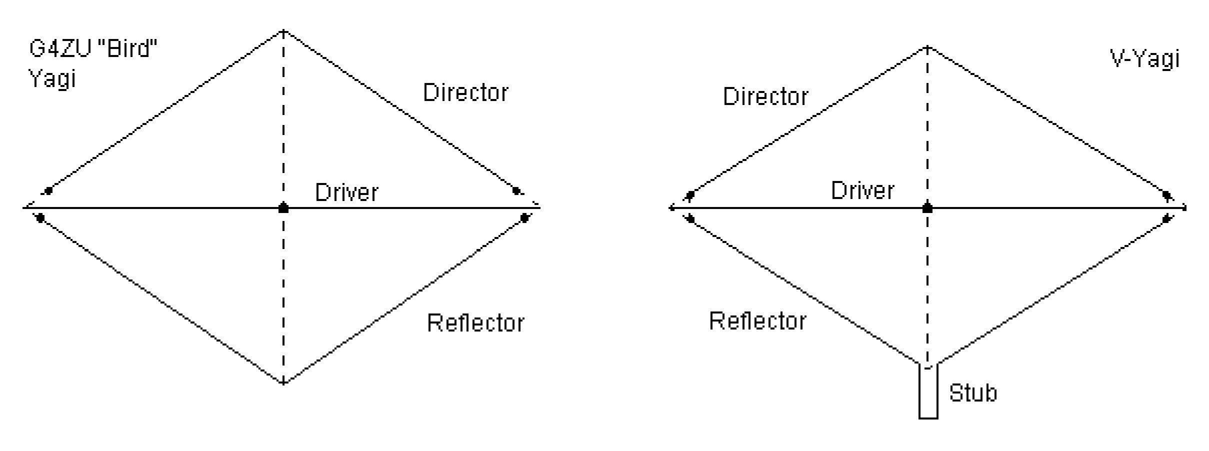
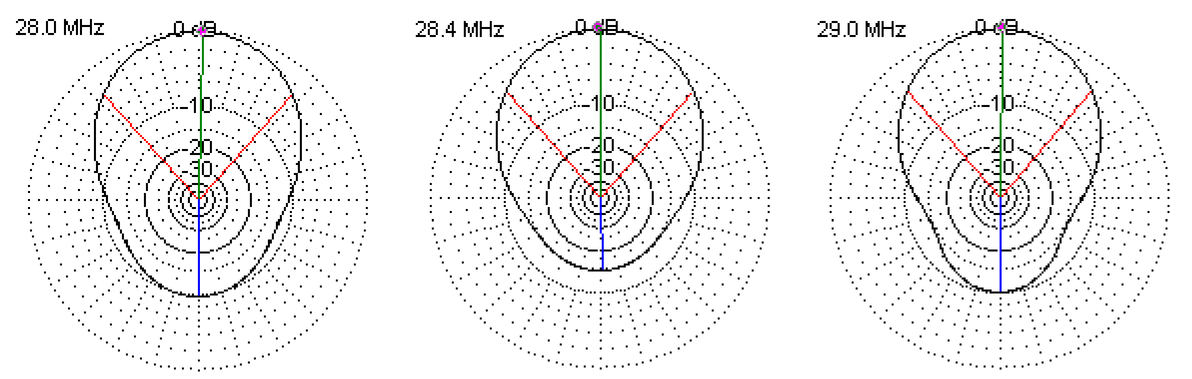


Fig. 1 Comparative General Outlines of the Bird and V Yagis

The Bird Yagi (designed for 10 meters) uses crossing tapered fiberglass supports. The linear driver is wire of the same size as the wire used for the Vee'd parasitic elements. Dick Bird only intended to obtain the best performance possible from a standard 3-element Yagi. Note the fact that the director and the reflector elements do not align their tips, but simply go as far as the element length requires. Under these conditions, the main inter-element coupling is the same as for a Yagi with 3 parallel linear elements. Since the parasitic elements have a slight Vee shape, there is radiation off the beam sides so that the side nulls that we expect with a set of parallel elements become weaker. **Fig. 2** shows 3 free-space 10-meter patterns for the Bird Yagi.

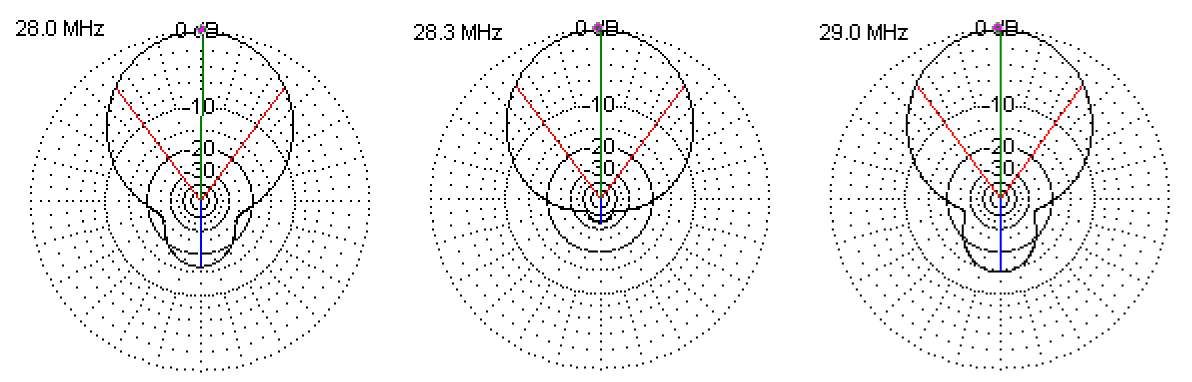


Free-Space Azimuth Patterns of a 10-Meter Bird Yagi Fig. 2

Nevertheless, the Bird Yagi provides a competent level of performance in a very lightweight structures and with a 50-Ohm feedpoint impedance. The design is also eminently adaptable. For example, the German multi-band Spiderbeam is an ingenious outgrowth of the Bird design, with some interesting additional techniques to cover the entire upper HF range. The **Spiderbeam** web site contains a wealth of information on the design, along with detailed model patterns, including information across the entire operating passband (a rarity in the world of commercial antennas). The antenna uses a single feedline with direct line coupling to all drivers for single-feedline use.

The V-Yagi on the right takes a somewhat different direction to obtain its particular characteristics. Note that the parasitic element ends are aligned and carefully spaced. The authors intended each element to function as a director, and they switched in a stub to one or the other to make it function as a reflector. Depending on wire size and other variables, the stubs require a reactance of 110 to 130 Ohms to increase the electrical length of the element enough to perform optimally as a reflector. As well, the driver element is a rather hefty tapered-diameter tubular element designed to support the weight of the lower-HF beam with the aid of top trusses. The fatter driver adds to the array gain, although the parasitic elements are wire.

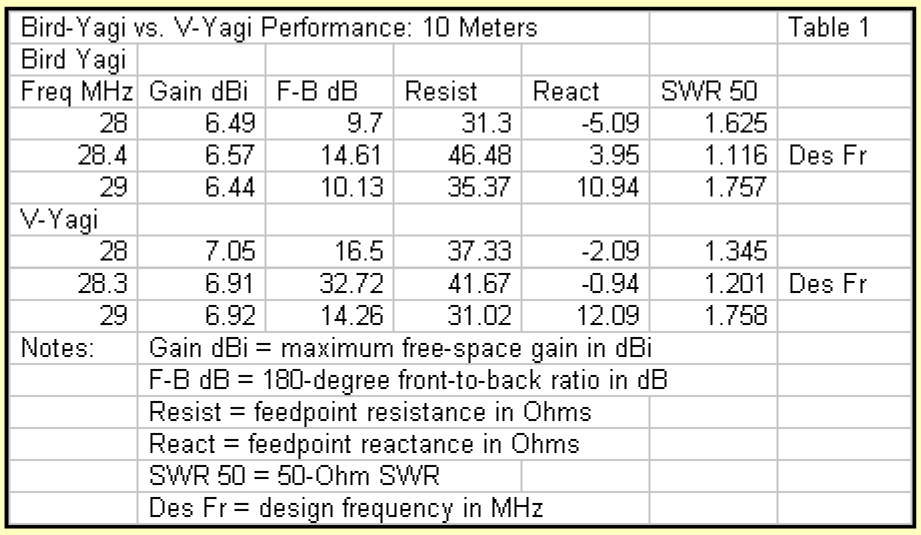
The original authors of the 40-meter version of the antenna used an optimizer program to arrive at the final dimensions. Unfortunately, optimizers arrive at good performance numbers, but do not tell the full story of how a given beam operates. The patterns, shown in a 10-meter version in **Fig. 3**, reveal more than the optimizer.



Free-Space Azimuth Patterns of a 10-Meter V-Yagi Fig. 3

The similarity between these patterns and those produced by a 2-element Moxon rectangle should not escape our attention. Not only do we find at the design frequency a very high front-to-back ratio, but we also discover other parallel properties to the Moxon. One such property is the expanded beamwidth relative to a standard Yagi pattern. The Veeing yields the equivalent of the Moxon tails. A second factor is the need to design the antenna for a frequency about 1/3rd of the way up the passband so that the front-to-back ratios at both ends of the passband are similar. A normal Yagi may use a mid-band design frequency. Third, we do not find standard rising gain curve across the passband. The key difference between a Moxon rectangle and the V-Yagi--besides the obvious 3rd element in the latter--is the wider spacing between the tips of the parasitic elements in the V-Yagi, a result of having the intervening driver element.

The V-Yagi is capable of superior performance relative to the Bird Yagi. **Table 1** presents performance number for 10-meter versions of both beams. The Bird can be tweaked for slightly higher performance, but it remains a competent lightweight performer just as originally designed. Its Veeing achieves part of what the V-Yagi achieves--namely, a wider beamwidth than we would normally obtain from a 3-element Yagi with linear elements. The V-Yagi performance highlights focus on the improved front-to-back ratio across the passband and a somewhat wider 50-Ohm SWR curve.



Bird-Yagi vs. V-Yagi Performance: 10 Meters						Table 1
Bird Yagi						
Freq MHz	Gain dBi	F-B dB	Resist	React	SWR 50	
28	6.49	9.7	31.3	-5.09	1.625	
28.4	6.57	14.61	46.48	3.95	1.116	Des Fr
29	6.44	10.13	35.37	10.94	1.757	
V-Yagi						
28	7.05	16.5	37.33	-2.09	1.345	
28.3	6.91	32.72	41.67	-0.94	1.201	Des Fr
29	6.92	14.26	31.02	12.09	1.758	
Notes:	Gain dBi = maximum free-space gain in dBi					
	F-B dB = 180-degree front-to-back ratio in dB					
	Resist = feedpoint resistance in Ohms					
	React = feedpoint reactance in Ohms					
	SWR 50 = 50-Ohm SWR					
	Des Fr = design frequency in MHz					

The V-Yagi shows an average of about 0.5-dB more gain than the Bird Yagi. However, the front-to-back ratio advantage of the V-Yagi is perhaps more significant. In a 2-element parasitic beam, the front-to-back ratio is largely a function of the relative current magnitude and phase angle at the center of the reflector compared to the same measurements at the center of the driver. With a 3-element Yagi, the director has the most influence in setting the front-to-back ratio. Let's set the driver at a constant current magnitude value of 1.0 with a zero-degree phase angle. If we independently drive each element of various 3-element designs in which the elements are linear, the requisite current magnitudes and phase angles for the reflectors will tend to vary with the boom length. However, the directors for a maximum 180-degree front-to-back ratio value will show considerable consistency, with relative current magnitudes of about 0.62 and -116-degree phase angles (relative to the constant driver values of 1.0 and 0.) When parasitic designs are down from a 50-dB front-to-back ratio by any significant amount, the actual front-to-back ratio will depend on the relationship of the director values to the reflector values. In general, front-to-back ratios are higher when both director and reflector relative current phase angles increase together.

The Bird Yagi at its design frequency shows a relative current magnitude of about 0.74 at -124 degrees. The higher than ideal relative current magnitude combines with a lower than ideal reflector phase angle. As well, the reflector relative current magnitude is about twice as high as ideal for 3-element designs. Hence, the front-to-back ratio is relatively low compared to what is possible with a 12' boom length. Remember that, in this context, ideal does not mean maximum gain or even the best combination of gain and front-to-back ratio. Instead, it means maximum front-to-back ratio.

In contrast, the V-Yagi shows a set of director relative current values of about 0.6 and 118 degrees. These values are only slightly off the ideal for maximum front-to-back ratio. As well, the reflector values are high in magnitude (about 0.65 compared to a more ideal 0.4) and low in phase angle (about 112 degrees, compared to a more ideal 123 degrees). The wider variance of the reflector from some idealized all-driven samples with parallel elements suggest the stronger influence of the director on the front-to-back ratio. The improvement in the current conditions for improved front-to-back performance of the V-Yagi over the Bird Yagi stem largely from the end coupling between the parasitic element tips, which the V-Yagi aligns and gaps for optimal performance.

V-Yagi Structure and Dimensions

To set the end gap of the V-Yagi, we cannot simply bring the line of the parasitic elements to a simple termination where the driver ends. The actual required angle is shallower than that line. Therefore, we either must extend the driver with non-conductive material to accommodate the shallower angle or we must add a cross piece near the end of the driver, just past where the parasitic element ends. **Fig. 4** shows the outline of the latter system of construction.

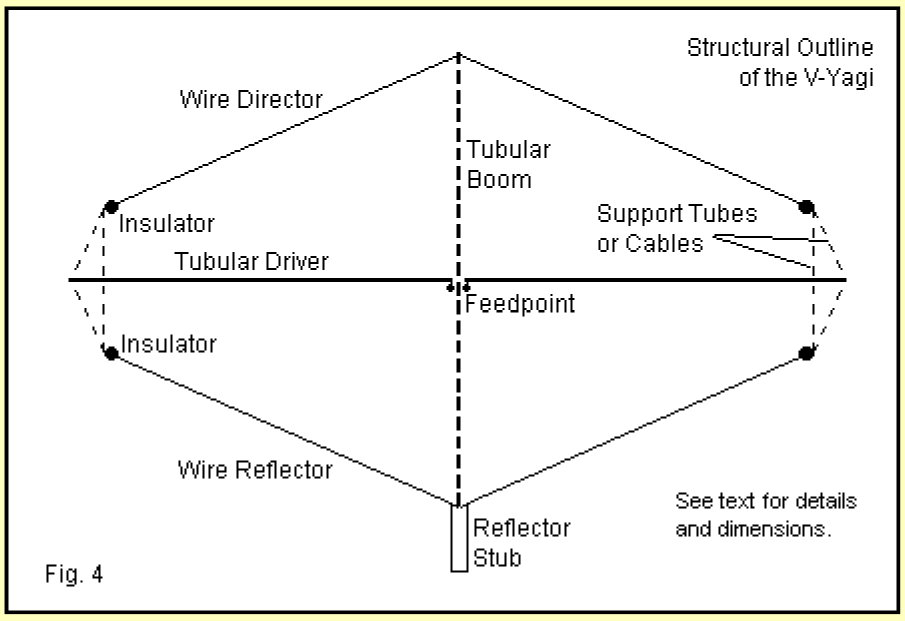


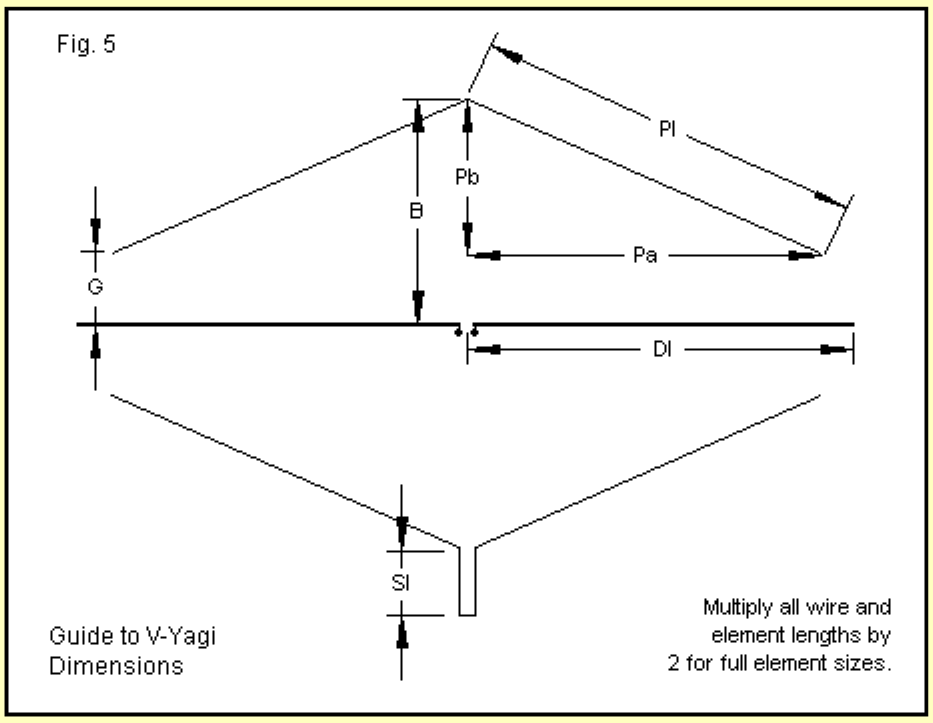
Fig. 4

The cross pieces near the driver ends are ideally non-conductive material. On the lower HF bands, the lengths of these supports may require a combination of conductive and non-conductive materials to maintain a light weight and insignificant sag. In the upper-HF region, light fiberglass tubes (UV protected, of course) will work as well. The sketch also shows insulators terminating the parasitic elements. Remember that parasitic elements have high voltages at their ends, even though not directly driven. If we use support ropes or cords that can handle the voltages, the insulators can be of any type that provide strain relief for both the support cords and the parasitic wire ends. We shall also need a spacing insulator at the peak of the reflector Vee for the installation of the stub.

To support the peaks of the parasitic wire elements, we shall need a lightweight but rigid boom. The boom can be metallic so long as we insulate and isolate the parasitic elements from it--just as we would for a standard Yagi. However, since the boom only supports light-weight wire parasitic elements, the boom does not require the heavy structure of a standard Yagi boom. Instead, it can take on the structure that we might normally use for an active element of the length required. That length will vary from 40' on 40 meters to 10' on 10 meters.

In contrast, the driven element will need to be stronger (and hence fatter) than most elements that we might find in standard Yagis. We are loading the ends with the weight of the cross supports and the wire terminations. The fatter driven element does provide a small increment of additional gain for the array by increasing the mutual coupling between the driver and both thin parasitic elements.

Fig. 5

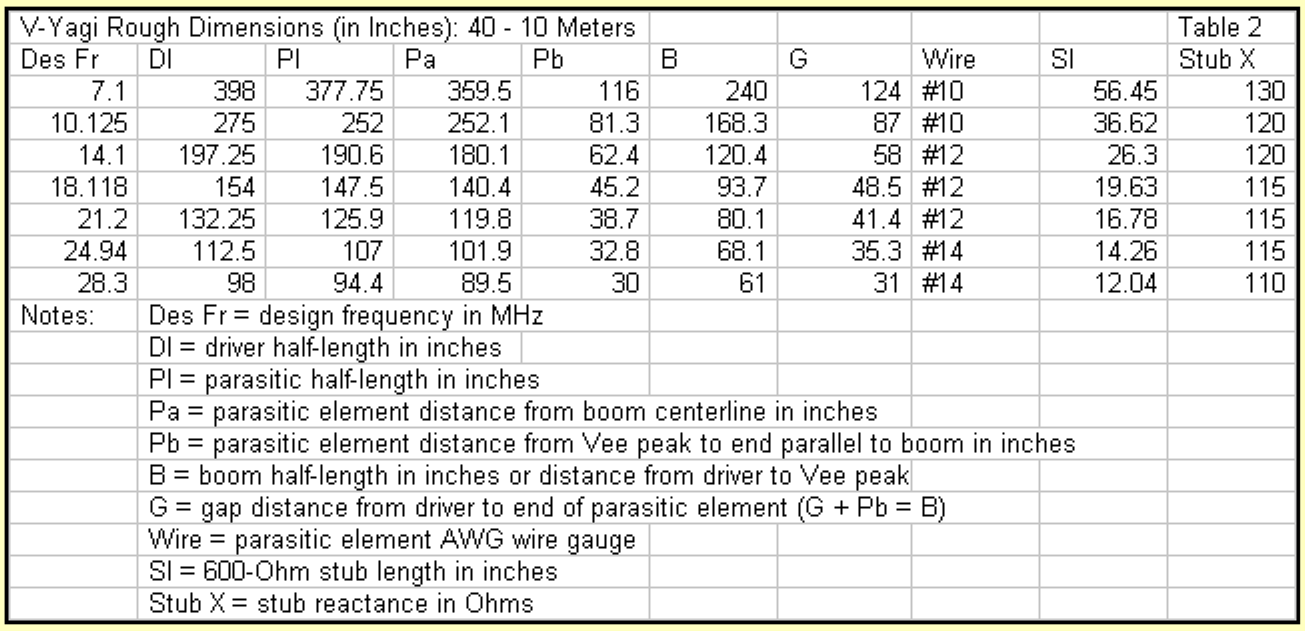


Guide to V-Yagi Dimensions

Fig. 5 redraws the outline of the V-Yagi without the support lines in order to provide guidance to the table of rough dimensions (**Table 2**). The driver length (Dl) is the driver half-length from the boom centerline outward and is a function of the taper schedule used. The more severe the taper schedule, the longer will be the driver length compared to an equivalent uniform-diameter element set in its place. However, uniform-diameter elements are highly impractical as drivers for the V-Yagi, since they would lack the wind-stress strength needed for the array.

Pl gives the wire length for each half of the parasitic elements, counting from the boom centerline outward. Since the wire is angled, Pa gives the distance from the centerline outward parallel to the driver, while Pb gives the distance from the Vee peak back toward the driver along the boom. B is the half-length of the boom, counting from the driver either forward to the director or backward to the reflector. The gap or G is the distance from the driver element to the tip of either parasitic element. Remember that the reflector requires a gap for the installation of the shorted transmission line stub. The Wire column lists the AWG wire size for each of the models. The parasitic wires decrease in diameter as we increase the model's frequency.

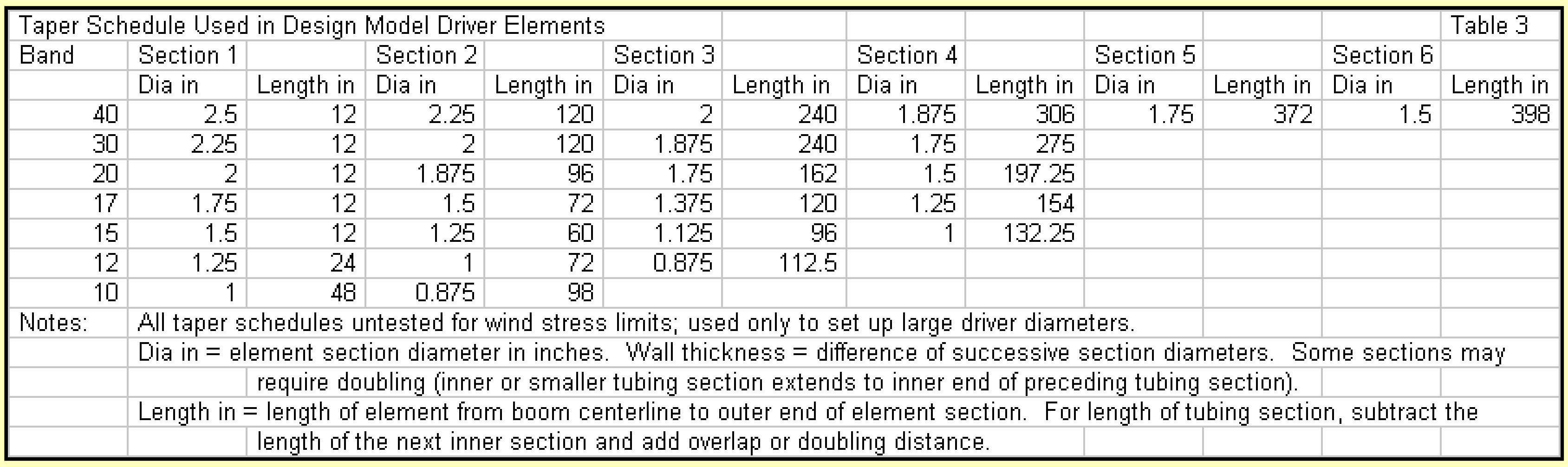
The value of Sl is the length of a 600-Ohm transmission line stub providing the correct reactance to lengthen the reflector element electrically so that the array shows close to maximum front-to-back ratio at the design frequency--about 30 dB or so. The adjoining column lists the corresponding reactance. The modeled stubs use lossless transmission lines, so the actual front-to-back ratios may be slightly higher than the values reported later for modeled array performance.



V-Yagi Rough Dimensions (in Inches): 40 - 10 Meters									Table 2
Des Fr	Dl	Pl	Pa	Pb	B	G	Wire	Sl	Stub X
7.1	398	377.75	359.5	116	240	124	#10	56.45	130
10.125	275	252	252.1	81.3	168.3	87	#10	36.62	120
14.1	197.25	190.6	180.1	62.4	120.4	58	#12	26.3	120
18.118	154	147.5	140.4	45.2	93.7	48.5	#12	19.63	115
21.2	132.25	125.9	119.8	38.7	80.1	41.4	#12	16.78	115
24.94	112.5	107	101.9	32.8	68.1	35.3	#14	14.26	115
28.3	98	94.4	89.5	30	61	31	#14	12.04	110
Notes:	Des Fr = design frequency in MHz								
	Dl = driver half-length in inches								
	Pl = parasitic half-length in inches								
	Pa = parasitic element distance from boom centerline in inches								
	Pb = parasitic element distance from Vee peak to end parallel to boom in inches								
	B = boom half-length in inches or distance from driver to Vee peak								
	G = gap distance from driver to end of parasitic element (G + Pb = B)								
	Wire = parasitic element AWG wire gauge								
	Sl = 600-Ohm stub length in inches								
	Stub X = stub reactance in Ohms								

Every array has a myriad of construction variables that require field adjustment to bring the array to its desired performance level. The length of the director and the gap between the reflector and director tips will have the greatest affect on the frequency of the front-to-back peak. The stub length will have some role to play in the front-to-back peak frequency, but will more greatly affect the feedpoint impedance at resonance. The driver requires adjustment to place resonance either on the design frequency or on a frequency that yields the most desired SWR passband. Its adjustment in terms of diameter or length has little affect on either the gain or the front-to-back peak.

For reference, **Table 3** shows the taper schedule used in the models. These taper schedules served only to establish plausible driver elements of larger than normal diameter. They have not been tested for wind stress in programs such as YagiStress. This step is essential before building any Yagi for the HF region. Remember that the ends of the driver are weight-loaded by the cross supports and the wire ends. Where the step between sections is 0.25", the tubing of the larger section may require doubling with the intermediate size of standard thickness (nominally 1/16" but actually 0.058" in 6063-T832 or 6061-T6 tubing). Use sufficient overlap for each section, and if strength requires, extend the smaller section all the way back to the inner end of the preceding section.

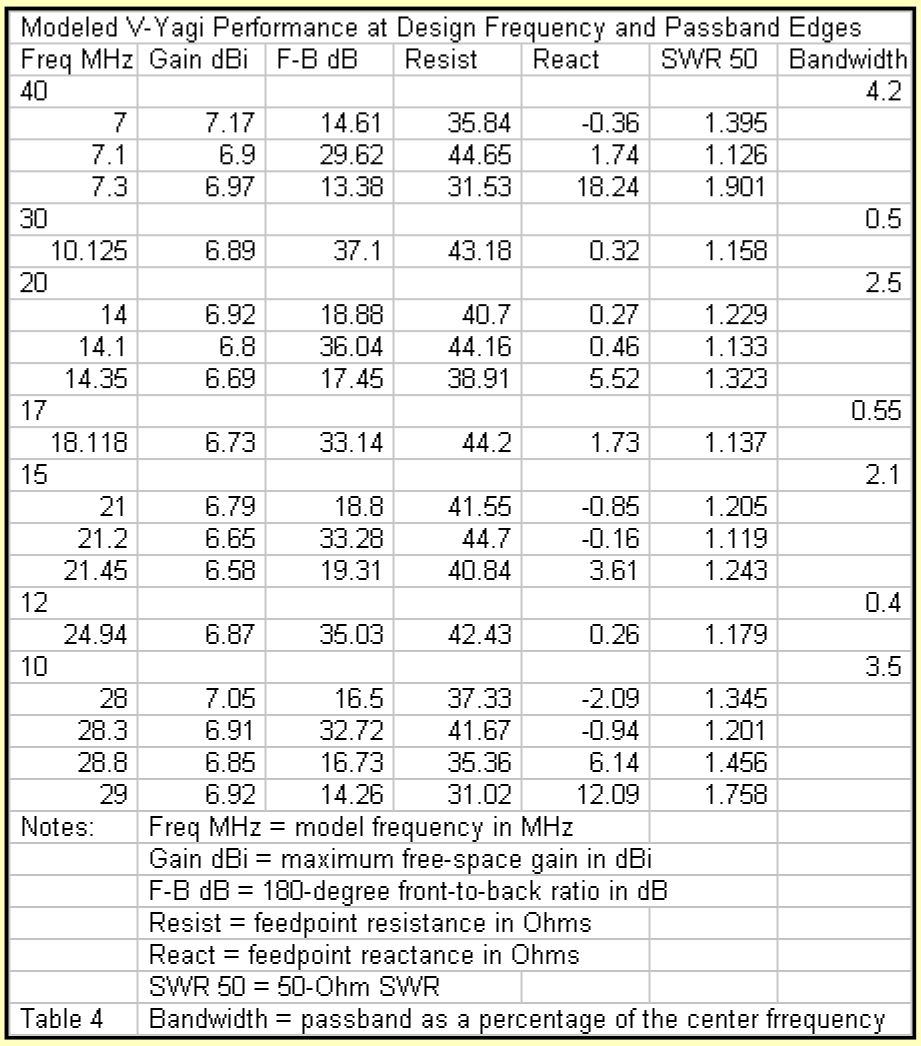


Taper Schedule Used in Design Model Driver Elements												Table 3
Band	Section 1		Section 2		Section 3		Section 4		Section 5		Section 6	
	Dia in	Length in	Dia in	Length in	Dia in	Length in	Dia in	Length in	Dia in	Length in	Dia in	Length in
40	2.5	12	2.25	120	2	240	1.875	306	1.75	372	1.5	398
30	2.25	12	2	120	1.875	240	1.75	275				
20	2	12	1.875	96	1.75	162	1.5	197.25				
17	1.75	12	1.5	72	1.375	120	1.25	154				
15	1.5	12	1.25	60	1.125	96	1	132.25				
12	1.25	24	1	72	0.875	112.5						
10	1	48	0.875	98								
Notes:	All taper schedules untested for wind stress limits; used only to set up large driver diameters.											
	Dia in = element section diameter in inches. Wall thickness = difference of successive section diameters. Some sections may											
		require doubling (inner or smaller tubing section extends to inner end of preceding tubing section).										
	Length in = length of element from boom centerline to outer end of element section. For length of tubing section, subtract the											
		length of the next inner section and add overlap or doubling distance.										

For further hints at structuring the driver or the wire-support boom, see the original *QST* article.

V-Yagi Performance

The V-Yagi provides consistent performance as a monoband 3-element parasitic array as we move through the HF spectrum from 40 meters to 10 meters. **Table 4** shows the modeled free-space performance values for each version of the antenna. For bands having a bandwidth of at least 1%, the performance values include the band edges as well as the design frequency. Bandwidth is simply the width of the band divided by the center frequency, with the result converted to a percentage. The final column of the table shows the rounded bandwidth for each of the amateur bands covered. Because 10-meter operators have an interest in 28.8 MHz as well as the defined band limit of 29.0 MHz, I have included that set of figures within the table.



Modeled V-Yagi Performance at Design Frequency and Passband Edges						
Freq MHz	Gain dBi	F-B dB	Resist	React	SWR 50	Bandwidth
40						4.2
7	7.17	14.61	35.84	-0.36	1.395	
7.1	6.9	29.62	44.65	1.74	1.126	
7.3	6.97	13.38	31.53	18.24	1.901	
30						0.5
10.125	6.89	37.1	43.18	0.32	1.158	
20						2.5
14	6.92	18.88	40.7	0.27	1.229	
14.1	6.8	36.04	44.16	0.46	1.133	
14.35	6.69	17.45	38.91	5.52	1.323	
17						0.55
18.118	6.73	33.14	44.2	1.73	1.137	
15						2.1
21	6.79	18.8	41.55	-0.85	1.205	
21.2	6.65	33.28	44.7	-0.16	1.119	
21.45	6.58	19.31	40.84	3.61	1.243	
12						0.4
24.94	6.87	35.03	42.43	0.26	1.179	
10						3.5
28	7.05	16.5	37.33	-2.09	1.345	
28.3	6.91	32.72	41.67	-0.94	1.201	
28.8	6.85	16.73	35.36	6.14	1.456	
29	6.92	14.26	31.02	12.09	1.758	
Notes:	Freq MHz = model frequency in MHz					
	Gain dBi = maximum free-space gain in dBi					
	F-B dB = 180-degree front-to-back ratio in dB					
	Resist = feedpoint resistance in Ohms					
	React = feedpoint reactance in Ohms					
	SWR 50 = 50-Ohm SWR					
Table 4	Bandwidth = passband as a percentage of the center frrequency					

In general, the design process for a dual-coupled parasitic array, such as the Moxon rectangle, calls for a design frequency about 1/3 of the way upward from the lower frequency limit to the upper frequency limit. In the 2-element array, the reflector is a principle component in setting both the driver resonant drequency and the front-to-back ratio peak frequency. As a result, the two curves tend to track each other. Setting the front-to-back ratio peak frequency at a point about 1/3 up from the lower frequency limit results in band-edge values for both the front-to-back ratio and the 50-Ohm SWR that closely correspond with each other.

The V-Yagi differs in design due to having 3 elements, with the parasitic elementxs sloping back toward the driver. The director has the greatest affect on the peak front-to-back frequency, while the driver tends to set the resonant frequency. The reflector and the gap have a strong influence on the resistive impedance at resonance. Since the beam is symmetrical with respect to the driver, the front-to-back ratio peak frequency and the feedpoint resistance represent compromise values. As a result, the potential builder is free to redesign the array in a slightly asymmetrical manner to change the feedpoint resistance if the beam is not intended for reversing by the use of switched stubs that convert either director into a reflector. However, tip alignment appears to be essential to the design.

Since the driver length does not significantly affect other performance values, the length can be adjusted to place resonance anywhere within the operating passband. For these explorations, I have left its resonant frequency roughly coincident with the front-to-back peak frequency. As a result, the 50-Ohm SWR is higher at the high end of the band than at the low end.

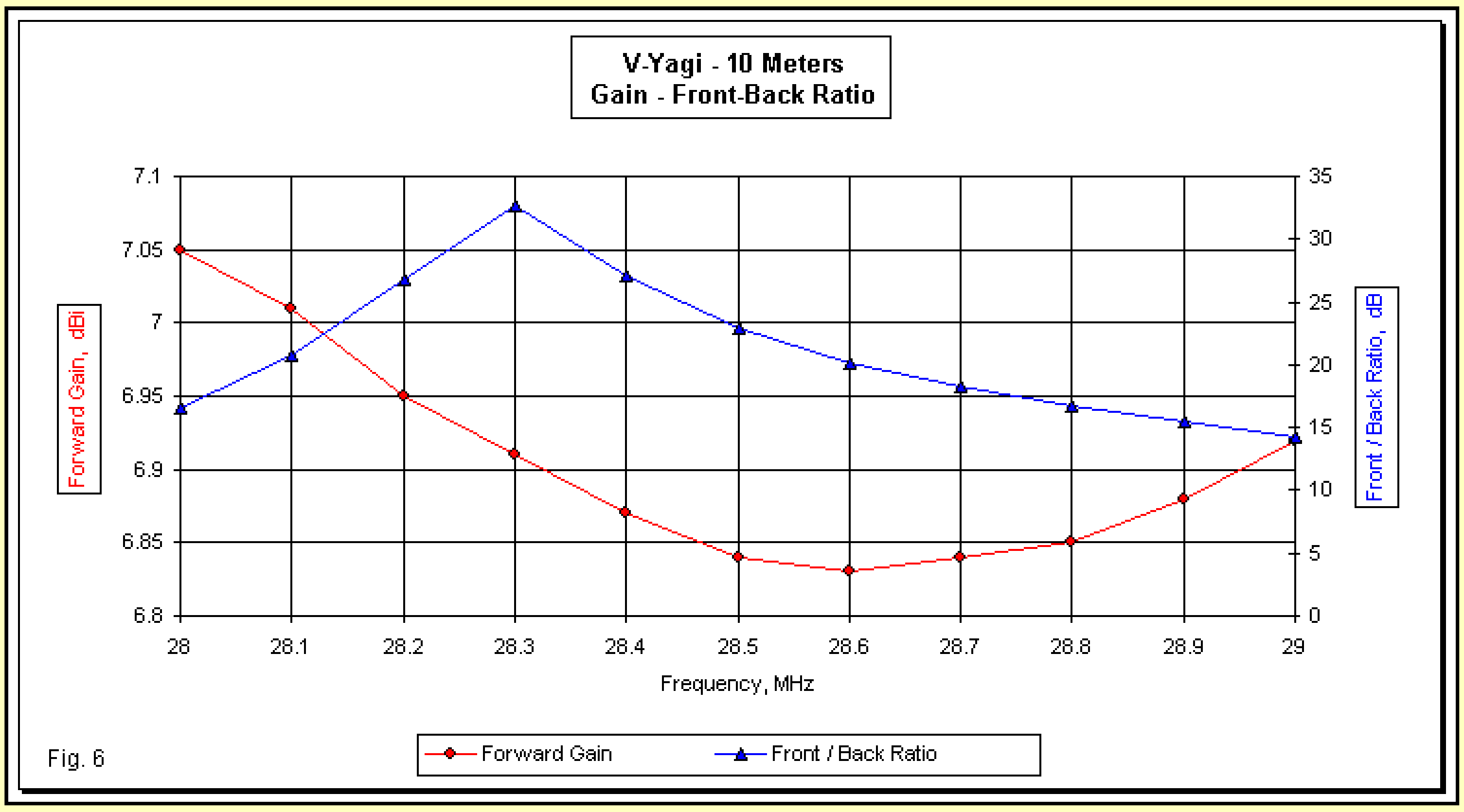


Fig. 6

Fig. 6 provides a frequency sweep of the gain and 180-degree front-to-back values for the 10-meter version of the V-Yagi. 10 meters and 40 meters are the widest of the bands for which the design is applicable. Hence, they both show the tendency of the gain value to decrease over part of the band and then increase toward the upper band edge. Narrower bands, such as 20 and 15 meters show only the decreasing gain in the tabulated values. The total gain range for the array across even the widest of the HF bands in the table is less 0.25 dB, an amount that an operator could not notice in practice. The V-Yagi shows a fairly sharp peak in the front-to-back ratio with reasonable band-edge values. Judicious re-design of the array can center the highest front-to-back value anywhere within the passband.

The patterns in **Fig. 3** explain why the graph does not include values for the worst-case front-to-back ratio. Essentially, the 180-degree and the worst-case front-to-back values are the same across the band. Unlike Yagis with parallel elements, the V-Yagi does not develop a deep 180-degree null while leaving very significant quartering sidelobes that require a separate performance accounting.

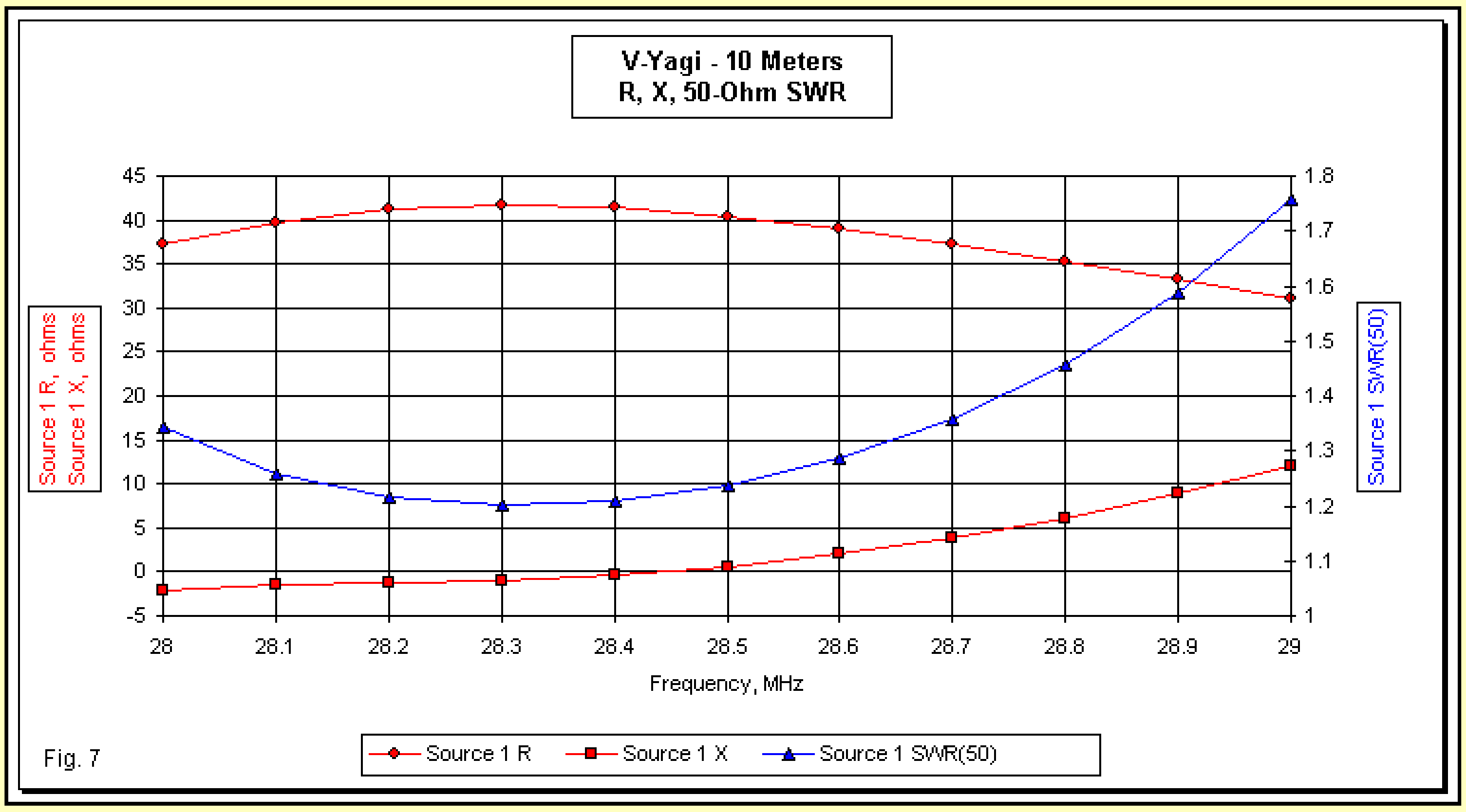


Fig. 7

Fig. 7 supplies the sweep graphs for the feedpoint resistance, reactance, and 50-Ohm SWR of the 10-meter version of the array. As noted earlier, you may move the minimum SWR point by judiciously changing the driver length to change the resonant frequency. The resistive component of the feedpoint impedance changes slowly, reaching a high value at or near resonance. However, as is the case with the Moxon rectangle, both the front-to-back ratio and the 50-Ohm SWR change more rapidly below the design frequency than above it. Hence, you would not need to move the resonant frequency upward very much to achieve roughly equal SWR values at the band edges.

When we began this exploration into the operation and scaling of the V-Yagi, we compared its performance to the performance of a Bird Yagi. We made that comparison to show the differences in design between the 2 arrays that both use Vee'd parasitic elements. However, anyone who contemplates building a V-Yagi for any band will be interested in assessing the V-Yagi performance numbers against 3-element Yagis of standard design. Therefore, I have taken from my files 2 different standardized Yagi designs that I call short-boom and long-boom models. Their models use 0.5" diameter elements on 10 meters. Fatter elements can increase gain by 0.1 to 0.2 dB, depending on element design. However, the basic elements of performance do not change. For comparative purposes, both designs have resonant drivers at their design frequency (28.5 MHz). However, the resistive impedance is in the 25-28-Ohm range, calling for a matching network or a quarter-wavelength line between the antenna feedpoint and the usual 50-Ohm cable used to feed amateur antennas.

One feature of considerable interest to the potential antenna builder is the azimuth pattern shape for each beam at the design frequency. **Fig. 8** overlays the free-space patterns for the 3 beams. The long-boom design, taken from a modified model originally developed by K6STI for 20 meters, obviously has slightly more gain (about 1 dB) than the other 2 versions. The short-boom model, adapted from an N6BV design in the program YW, has insignificantly greater gain than the V-Yagi. As we move away from the heading of peak forward gain, we may notice a more significant difference. The standard Yagis show deep nulls 90 degrees away from the maximum gain heading. However, the Vee'd parasitic elements of the V-Yagi move the side nulls to a position roughly 120 degrees behind the maximum forward gain heading. The V-Yagi pattern is nearly cardioidal and has a wider beamwidth than a standard Yagi.

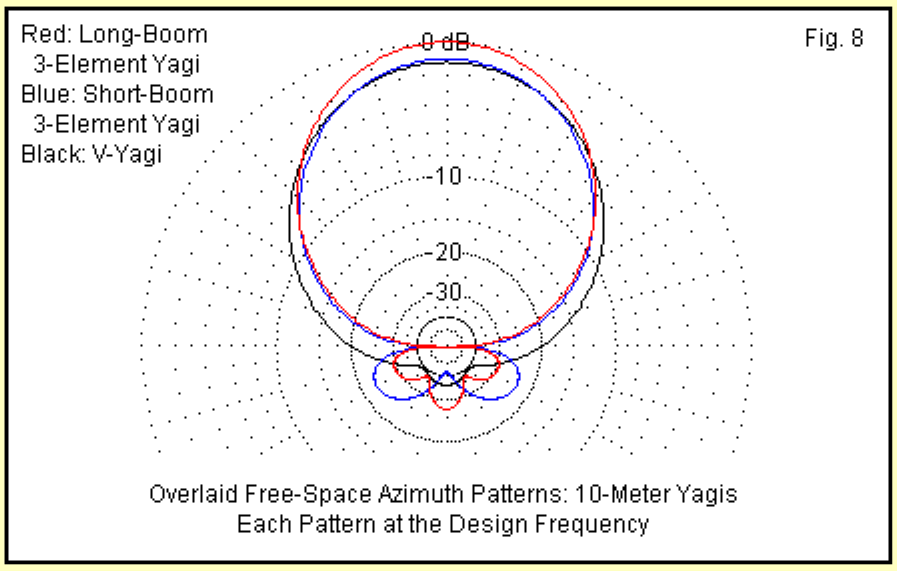
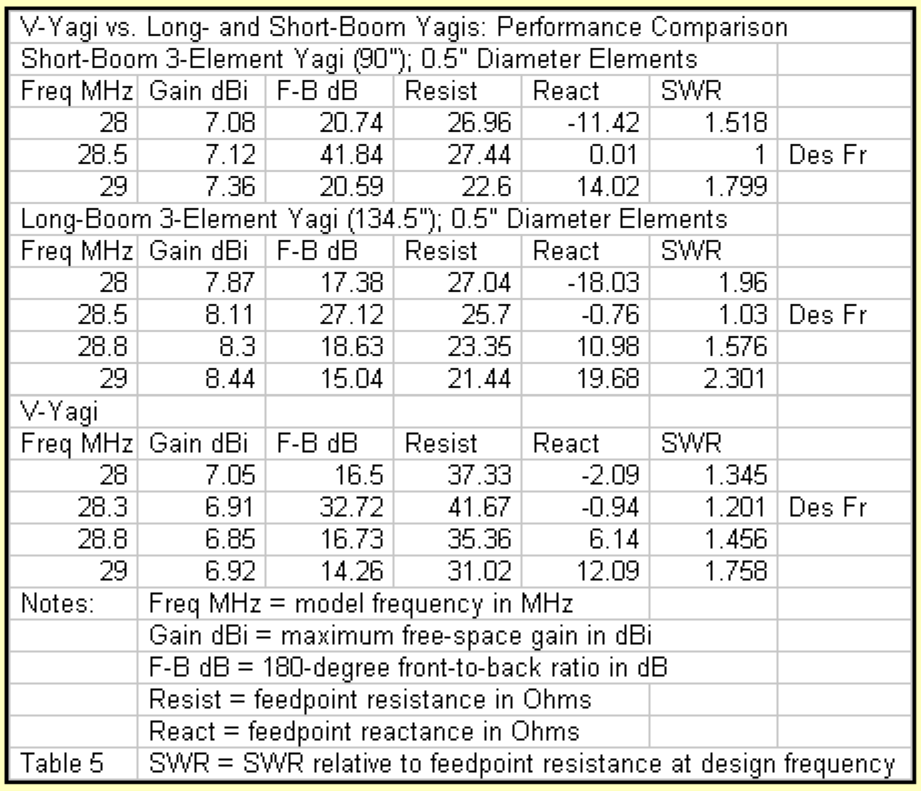


Fig. 8

Overlaid Free-Space Azimuth Patterns: 10-Meter Yagis
Each Pattern at the Design Frequency

The rear lobes illustrate 2 of the conditions that are typical for standard Yagis. The long-boom version of the antenna is not capable of a deep 180-degree null that produces an extremely high front-to-back ratio. In fact, if we force the model to have on each element the relative current magnitude and phase angle that yields such a null, the forward gain drops by nearly 1 dB. Hence, the long-boom standard Yagi shows a typical 3-lobe rearward pattern. I have modified the original short-boom design to place the maximum front-to-back ratio at the design frequency. As a result, the 180-degree ratio is actually better by nearly 10 dB than the 180-degree value for the V-Yagi. However, the standard short boom Yagi has very significant rearward sidelobes with as much or more energy than the rearward lobes of the long-boom design. In contrast, the V-Yagi has a small, simple, single rearward lobe.

For a broader view of the comparative performance of these 3 beam designs, **Table 5** presents the design and band-edge frequency performance data for all 3 arrays. Both of the standard Yagis show the typical gain pattern that rises in value with increasing frequency across the band. Longer-boom Yagis (for a set number of elements) tend to show a more rapid change of gain as a function of the narrower bandwidth that accompanies longer booms. The short-boom Yagi shows a range of variation more like the modest figure of the V-Yagi--about 0.25 dB.



V-Yagi vs. Long- and Short-Boom Yagis: Performance Comparison						
Short-Boom 3-Element Yagi (90"); 0.5" Diameter Elements						
Freq MHz	Gain dBi	F-B dB	Resist	React	SWR	
28	7.08	20.74	26.96	-11.42	1.518	
28.5	7.12	41.84	27.44	0.01	1	Des Fr
29	7.36	20.59	22.6	14.02	1.799	
Long-Boom 3-Element Yagi (134.5"); 0.5" Diameter Elements						
Freq MHz	Gain dBi	F-B dB	Resist	React	SWR	
28	7.87	17.38	27.04	-18.03	1.96	
28.5	8.11	27.12	25.7	-0.76	1.03	Des Fr
28.8	8.3	18.63	23.35	10.98	1.576	
29	8.44	15.04	21.44	19.68	2.301	
V-Yagi						
Freq MHz	Gain dBi	F-B dB	Resist	React	SWR	
28	7.05	16.5	37.33	-2.09	1.345	
28.3	6.91	32.72	41.67	-0.94	1.201	Des Fr
28.8	6.85	16.73	35.36	6.14	1.456	
29	6.92	14.26	31.02	12.09	1.758	
Notes:	Freq MHz = model frequency in MHz					
	Gain dBi = maximum free-space gain in dBi					
	F-B dB = 180-degree front-to-back ratio in dB					
	Resist = feedpoint resistance in Ohms					
	React = feedpoint reactance in Ohms					
Table 5	SWR = SWR relative to feedpoint resistance at design frequency					

The narrower bandwidth of the long-boom Yagi also appears in both the front-to-back and the SWR columns. The 180-degree front-to-back ratio is well below 20 dB at the defined band edges (28.0 and 29.0 MHz). As well, SWR at the upper band edge is well above the 2:1 ratio usually taken as the amateur limit. In contest, the short-boom version of the antenna trades gain for a broader bandwidth. It shows a 20-dB front-to-back value at the band edges and has an SWR below 2:1 at those operating extremes.

The V-Yagi does not achieve the gain of the long-boom Yagi or the high 180-degree front-to-back ratio of the short-boom Yagi across 10 meters. However, it does match the short-boom Yagi in the low rate of gain change across the band and shows an improved SWR curve. Incidentally, the boomlength of the V-Yagi is about halfway between that values for the 2 standard Yagis (10' vs. just under 8' and just under 12'). In the end, the selection of design will depend in part in what you want to get out of the design.

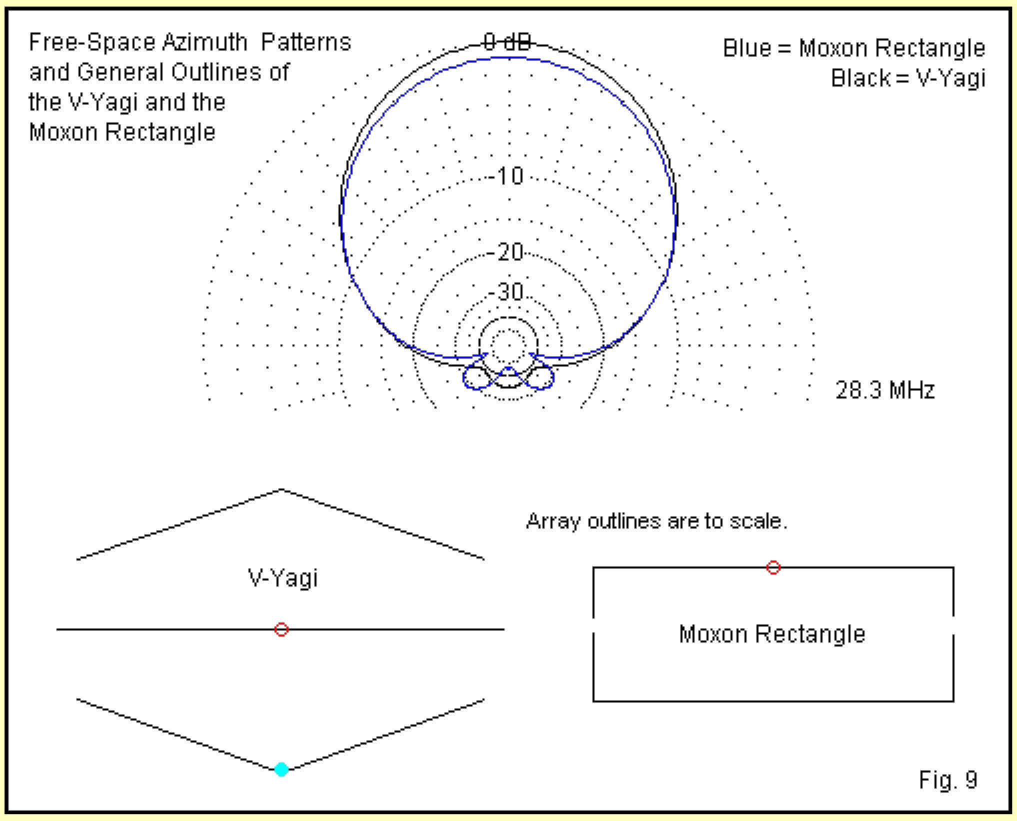
Conclusion

I have explored the properties of the V-Yagi more out of curiosity than from a motive of recommending the design. It seemed at least marginally important to see how the design differs from the older Bird Yagi and to see why the design exhibited properties that partially resemble those of a Moxon rectangle. The critical factor turned out to be the alignment of the parasitic element ends and the shallower angle of the parasitic elements, relative to the Bird Yagi. These features appear in the original design that set up 2 directors in order to be able to reverse the beam direction by switching in the stub to create a reflector--all without needing a rotator.

As a matter of course, I scaled the design to each of the amateur bands from 40 to 10 meters. My interest lay in tracing the performance characteristics on bands of varying width. The narrow WARC bands, of course, show virtually no change of performance from one band edge to the other. The more modest wider bands (20 and 15 meters) show very good performance over a wider span of frequencies. We might rate the performance on 10 and 40 meters--the widest bands--as highly usable at the band edges and very good to excellent near the design frequency (depending upon the stress we place on any particular performance parameter).

The V-Yagi trades lighter weight for some unusual construction, especially with respect to the crossing end supports for the wire parasitic elements. Weight reduction, of course, is far more important in the lower HF region than at higher HF frequencies. Whether or not the V-Yagi becomes a true candidate for construction, the design deserves more than a single print appearance.

The V-Yagi performance has numerous correlations to the performance of the 2-element Moxon rectangle. **Fig. 9** overlays the free-space azimuth patterns for both antennas using a common design frequency. The V-Yagi has nearly a dB gain advantage over the smaller Moxon with a similar near-cardioidal pattern and a similar broad bandwidth.



However, the outlines of the 2 antennas reveal more than casual differences in the scaled sketches. The Moxon tails come to a small gap that varies with the diameter of the element. In contrast, the aligned tips of the V-Yagi parasitic elements form a very wide gap, casting doubt on the amount--if any--of end coupling between them. If there is no end coupling, then the V-Yagi achieves its performance characteristics solely by virtue of the angle of the parasitic element slope. From a practical perspective, the question may be moot: if an operation needs the kind of performance characteristics provided by the V-Yagi, then just how the antenna yields those characteristics becomes secondary to having them. Still, the question exists to tweak our curiosity and to give an added dimension of interest to the V-Yagi design.

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