

The Prismatic Polyhedron and the Corner Reflector

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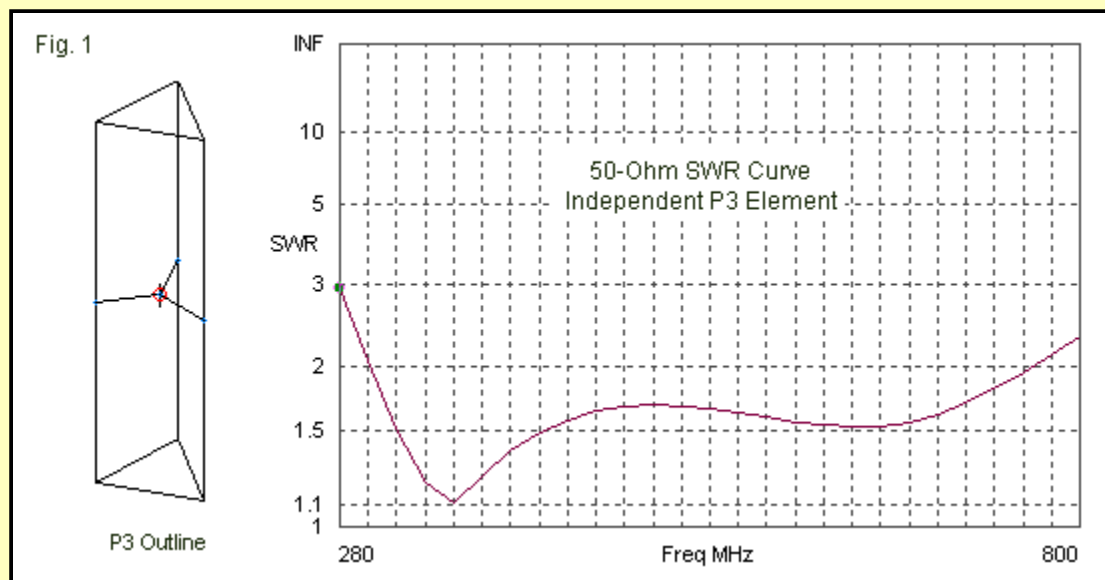
In "[The Prismatic Polyhedron and the Planar Reflector](#)," and with some supplementary data later added to the version at my web site, I explored the potential of converting the prismatic polyhedron very wide-band dipole into a directional array using a planar or flat reflector. In the course of those explorations, I discovered that the array offered us a choice: either we could retain the very broad 50-Ohm SWR curve (300 to 800 MHz) but with adequate patterns over only a limited part of the range or we could obtain a range of adequate patterns over a 2:1 frequency range, but with far less control of the feedpoint SWR. These results applied equally to the rectangular P2 element and to the triangular P3 element.

More specifically, with a fixed spacing between a P3 driver and the planar reflector (0.2 m), we preserved the SWR curve from 300 through 800 MHz at values close to those of the P3 used as an independent element. However, depending upon the reflector size, the usable pattern shapes extended only from 300 to about 400-500 MHz. By closing the spacing between the driver and the reflector, the usable pattern range extended to 600 MHz (and in one case all the way to 800 MHz). However, closing the spacing produced highly erratic 50-Ohm SWR curves, even with adjustments to the P3 phase lines. In all cases, the driver elements used only one set of dimensions, leaving one set of variables for future exploration.

In that safari through the many variables in creating the array, I left open the possibility that we might also wish to examine the prismatic polyhedron, especially the P3, in the context of a corner reflector. The option seemed on the surface to apply especially to the P3 triangular elements, with a single leg toward the apex of the corner reflector and the remaining two legs farther forward. In these notes, I shall trace some preliminary modeling experiments to see if we obtain any useful results from mating the P3 with a 90-degree corner reflector.

The P3 Driver

The P3 driver element emerged from the work of Dan Handelsman and David Jefferies. See the original article for a bibliography of articles on the prismatic polyhedrons. The P3 consists of 3 dipoles, each center fed, with triangular junctions at the outer ends. Unlike a cage dipole, where we draw the cage to a center feedpoint, the P3 uses continuous elements. From the center of each element to a central feedpoint, we employ short transmission lines, all the same length and impedance. Thus, we end up with three dipoles fed in phase with relatively close spacing and connected outer ends. **Fig. 1** shows the general outline, plus a free-space 50-Ohm SWR curve.



The copper wires are all 0.015 m (1.5 cm) in diameter. Fatter wires increase the operating bandwidth, but the requirements of modeling limit the usable wire diameter. Since the antenna has corners, some as narrow as 60 degrees, using too fat a wire places the surface of one wire within the center region of an adjacent wire segment, a situation that results in NEC warning or error messages. The modeled antenna height (or the length of each long wire) is 0.32 m. Each face (or top/bottom wire) is 0.083 m. The initial transmission lines from the dipole centers to the common feedpoint are each 300 Ohms, and with a velocity factor of 1.0, the length is 0.05 m. Mating the P3 to corner reflectors required some alterations in both the phase-line characteristic impedance (Z_0) and the line length. All modeling for the P3 and subsequent arrays used free-space as the environment.

Modeled as an independent dipole, the P3 showed a 50-Ohm SWR curve with approximate limits of 300 and 760 MHz, for better than a 2.5:1 frequency ratio or about an 87% bandwidth. Dan achieved slightly better results by judicious model tweaking, while some lab versions of the antenna tested by David showed a measured frequency range of more than 3:1. The resistance and reactance values vary over small ranges and undulate, resulting in a wide SWR curve with two low points. The wide SWR bandwidth of the P3 does not result solely from the antenna geometry. The selection of the phase-line Z_0 and length also help to shape the SWR curve and the impedance to which we reference the SWR.

The Corner Reflectors

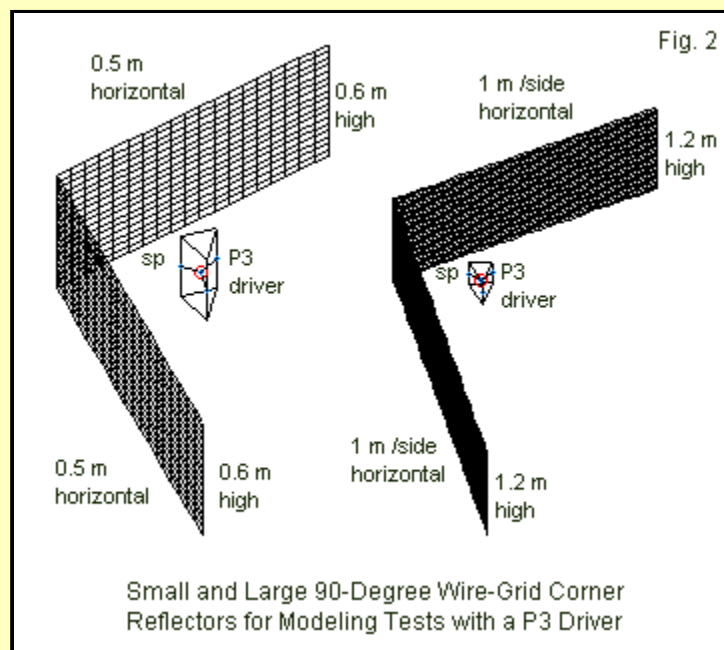
The corner reflectors for the P3 driver consist of two plane surfaces forming a 90-degree angle behind the driver. The apex of the angle forms a line that is parallel to the longer legs of the driver. In general, the distance from the apex of the reflector to the driver modifies three properties of the total array. 1. The spacing between the driver and the apex of a normal corner reflector sets the driver impedance in conjunction with the dimensions of the driver. In a narrow-band (less than 15% bandwidth) array, reducing the spacing also reduces the resistive component of the driver feedpoint. Since we shall retain a fixed driver dimension set--for reasons that will soon be very apparent--obtaining a satisfactory 50-Ohm SWR curve requires careful attention to the spacing. Small variations in the curve are possible by altering the phase-line length and Z_0 .

2. Changes in the driver-to-apex distance also create changes in the maximum forward gain of an array, given a specific frequency of operation. Resetting the spacing to a larger value tends to reduce array gain, while closer spacing (up to a certain point) yields higher array gain. 3. Larger driver-to-apex spacing values tend to yield broader operating bandwidths. For relatively narrow operating ranges, the operational bandwidth for gain and front-to-back ratio will normally exceed the 2:1 SWR bandwidth. In conventional corner reflector designs (covered extensively in *Planar and Corner Reflector Arrays*, available from *antenneX*), the designer must balance the three trends to yield a satisfactory performance level for a given application.

Conventional (that is, solid or screen) corner reflectors also tend to have ideal sizes relative to a design frequency. An E-plane dimension (that is, one in line with the driving element) should be about 1.4 wavelengths for maximum gain and very good front-to-back ratio values. Gain tends to increase for reflector side lengths (H-plane dimensions) up to about 2.4 wavelengths, although the rate of increase levels off above about 1.8 wavelengths. The H-plane dimensions is the length of each corner reflector plane. The distance across the reflector opening will be about 1.4 times the H-plane length of the reflector surfaces. The distance from the apex to the opening will be about 0.7 times for H-plane dimension for 90-degree reflectors.

The P3 driver seemed to be a fit candidate for a broadband corner reflector in part because of its triangular shape. With one leg forming the spacing between the reflector apex and the driver, the other legs form an angle, although not perfectly aligned with the angle of the reflector surfaces. The Brown-Woodward bent fan dipole achieved considerable operating bandwidth with a conventional corner reflector, and the P3 in part replicates the same driver shaping. However, before we see if it achieves its apparent promise, we have several reflector modeling issues to consider.

Like the planar reflectors shown in the earlier article, it is necessary to create wire-grid corner reflectors at 800 MHz so that the structure will not be self-resonant at any frequency within the sampling range (300 to 800 MHz). Because each grid segment will be shorter than had we set the wire-grid design frequency at 300 MHz, the models acquire considerable size very rapidly. Therefore, I settled on two reflector sizes to use in these initial notes, which form at most an initial feasibility study. **Fig. 2** outlines the two reflectors.



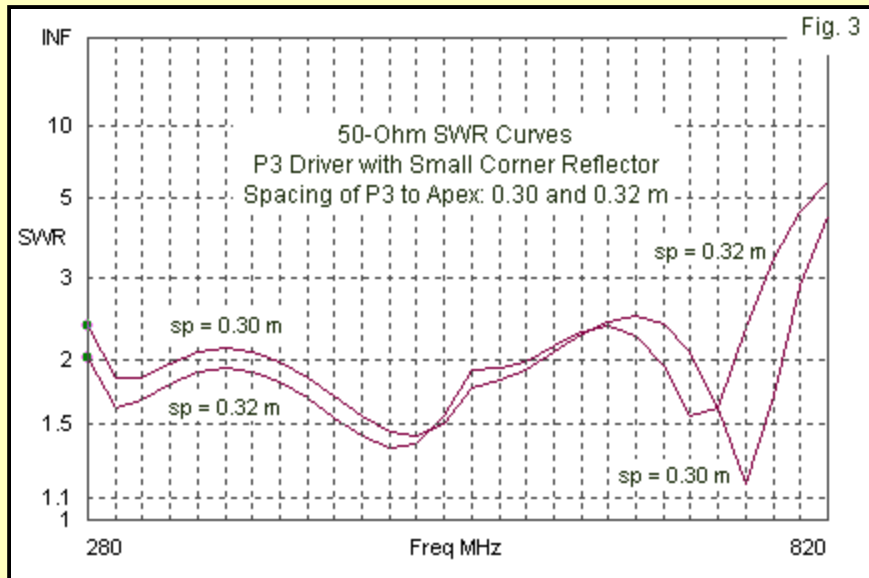
The larger of the two reflectors still falls far short of optimal dimensions as defined by narrow-band models of such arrays. The individual sides are 1 m long (although doubling the length would have brought the model closer to ideal at 300 MHz). The height is 1.2 m, a bit short of the 1.4-m ideal for 300 MHz. Nevertheless, with a P3 driver, the model contains 3715 segments, resulting in relatively long NEC run times, especially when performing a frequency sweep. Therefore, I reserved this model structure for special checks after initial modeling with a smaller reflector.

The smaller reflector is half size. That is, it uses a height of 0.6 m and side lengths of 0.5 m. The resulting model still requires 1411 segments. Like planar reflectors, corner reflector sizes do not radically affect the driver feedpoint impedance. However, the half-size reflector is actually small enough to allow some variation in that antenna property. Nevertheless, the model proved sufficient for the initial feasibility study and also saved considerable time in making adjustments to easily varied dimensions, such as the apex-to-driver spacing and the phase-line dimensions. However, varying the physical dimensions of the P3 to obtain (if possible) superior SWR curves fell outside the range of variables tackled in this study. Indeed, that project is best accomplished within the

context of a set of application specifications and goals rather than in a more abstract feasibility exploration.

Small-Reflector Results

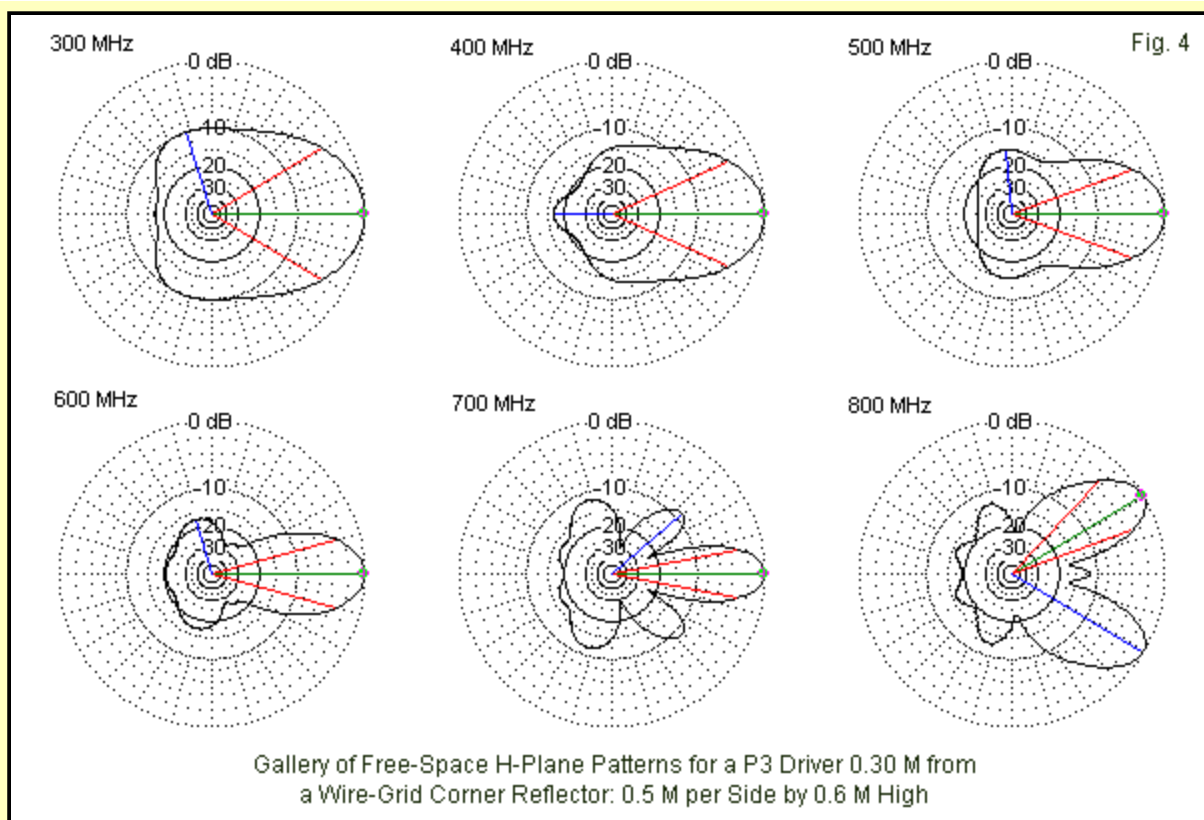
Because the patterns at some frequencies will show multiple lobes, the best procedure for studying the modeling results is to use a series of tables and galleries of H-plane patterns at selected frequencies. In this way, I can provide true 180-degree front-to-back ratio values relative to the bore sight of the array, rather than opposite an off-axis main lobe. The exception to this non-graphing procedure will be the 50-Ohm SWR curves for the arrays.



Using the small reflector, I selected two of the apex-to-driver spacing values for comparison: 0.30 m and 0.32 m. The 8" difference in spacing makes a considerable difference both to radiation performance and to the 50-Ohm SWR. The latter property appears in **Fig. 3**. In both cases, the driver uses 340-Ohm phase lines, each with a 0.06-m length. (The shortest physical length between a P3 leg and the central junction of phase lines is about 0.048 m.) The closer spacing value seems to offer the wider bandwidth before rising steeply. However, the wider spacing value yields lower 50-Ohm SWR values in the lower half of the spectrum, which will prove to be the vital end for acceptable radiation patterns.

For the version of the array with a spacing of 0.30 m between the driver and the reflector apex, **Table 1** and **Fig. 4** supply the relevant data and H-plane patterns.

N2DT P3 Driver with Small Corner Reflector							Table 1
0.5-M Horizontal on Each Side by 0.6-M Vertical							
Driver Spacing From Apex: 0.30 m				Phase Lines: $Z_0 = 340$, Length = 0.06 m			
Freq MHz	Gain dBi	F-B dB	BW deg	Feed R	Feed X	SWR 50	Pattern Notes
300	8.60	16.87	62	40.5	26.1	1.84	rear sidelobes -9.8 dB
400	9.95	16.60	49	83.0	-34.8	2.07	normal
500	11.19	25.66	40	39.5	-12.8	1.45	rear sidelobes -14.8 dB
600	11.54	20.58	31	37.9	26.0	1.91	rear sidelobes -17.0 dB
700	11.33	19.89	22	83.2	46.5	2.36	5-lobe pattern
800	12.78	18.88		21.5	22.4	2.88	2 forward lobes
Notes:	Gain dBi = maximum gain in dBi						
	F-B dB = ratio of maximum gain to 180-degree rearward gain in dB						
	BW deg = H-plane beamwidth in degrees (blank for split forward lobes)						
	Feed R and Feed X = resistive and reactive components of feedpoint impedance in Ohms						
	SWR 50 = 50-Ohm SWR						
	Pattern Notes: see associated gallery of H-plane patterns						



Interpreting the data requires an orientation and initial comparison with the data for corresponding planar reflectors. The small planar reflector used in the initial article was 0.5-m horizontal by 0.6-m vertical. This screen yields forward gain values between 6 and 8 dBi, with front-to-back ratios between 9 and 12 dB. The small corner reflector has the same height as the small planar reflector. However, each of the two angled sides of the corner reflector is as large as the complete planar reflector. In addition, the angled structure of the corner increases the shadow area behind the array and better focuses the rays in the forward direction. Hence, the forward gain ranges from a little under 9 dBi up to over 11 dBi for patterns with single forward lobes. The major advantage of the corner reflector occurs in the front-to-back category. Its values now range from 15 to 24 dB.

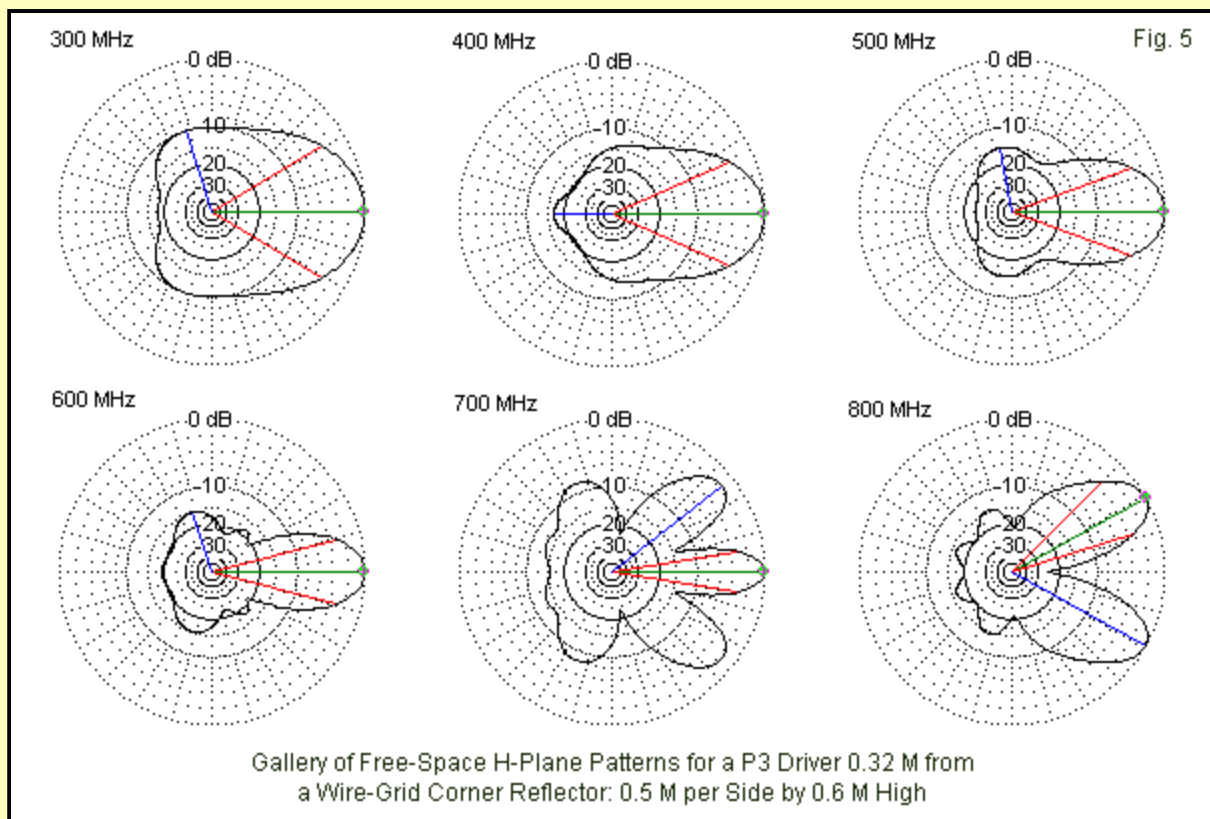
Table 1 does show evidence that the corner reflector falls short of optimal size at the lower end of the operating spectrum. Maximum gain for patterns with a single forward lobe occurs at 600 MHz. For reference, the corner size is about 1 wavelength per side horizontally and about 1.2-wavelengths in height at that frequency. Nevertheless, the relatively strong rear sidelobes in the patterns at the middle frequencies indicate two problems. First, the reflector remains somewhat undersized when compared to ideal dimensions. Second, at 600 MHz, the driver is about 0.6-wavelength forward of the corner apex, a considerable distance if a tight pattern is desired.

The operational limits of the small-corner array with the smaller of the 2 sampled spacing values (0.30 m) is perhaps 600 MHz or so. Above 600 MHz, the patterns show more complex lobe structures. In addition, the SWR values relative to a 50-Ohm reference exceed 2:1 by noticeable amounts. Even though some receiving applications accept SWR values up to 3:1, the combination of pattern complexity and SWR combine to suggest that we might do further work on the model. The goal should be to retain the 2:1 operating range for the corner array, but to obtain as well an SWR curve with values less than 2:1 at least through 600 MHz.

Fig. 3 revealed that if we increase the spacing between the driver and the corner apex by 0.02 m (to 0.32 m), we need make no other changes to the array to produce a satisfactory SWR pattern through 600 MHz. In fact, the 50-Ohm SWR remains below 2:1 through 700 MHz, although the pattern at that frequency is not especially desirable. See **Table 2** and **Fig. 5** for the relevant data and gallery of H-plane patterns.

N2DT P3 Driver with Small Corner Reflector							Table 2
0.5-M Horizontal on Each Side by 0.6-M Vertical							
Driver Spacing From Apex: 0.32 m				Phase Lines: $Z_0 = 340$, Length = 0.06 m			
Freq MHz	Gain dBi	F-B dB	BW deg	Feed R	Feed X	SWR 50	Pattern Notes
300	8.62	17.79	62	45.5	22.4	1.61	rear sidelobes -10.0 dB
400	9.92	16.50	48	74.9	-30.8	1.89	normal
500	11.16	24.31	40	38.8	-7.4	1.35	rear sidelobes -14.5 dB
600	10.98	19.18	29	46.6	33.4	1.98	rear sidelobes -15.2 dB
700	9.33	15.41	18	93.8	-13.8	1.93	3 forward lobes
800	12.68	20.20		17.3	36.7	4.56	2 forward lobes

Notes: Gain dBi = maximum gain in dBi
F-B dB = ratio of maximum gain to 180-degree rearward gain in dB
BW deg = H-plane beamwidth in degrees (blank for split forward lobes)
Feed R and Feed X = resistive and reactive components of feedpoint impedance in Ohms
SWR 50 = 50-Ohm SWR
Pattern Notes: see associated gallery of H-plane patterns



The data and patterns show only small changes in the operating values and pattern shapes over the 2:1 frequency range that we obtained with slightly smaller spacing. On average, but not for every sampled frequency, the gain and front-to-back ratio are down numerically, but the amount is not operationally significant. However, as we closely examine the patterns from 600 MHz upward, we find interesting trends. The tiny emergent forward sidelobes at 600 MHz have become more noticeable, and their growth at 700 MHz is very evident for a mere 8" change in the driver position. In fact, as the 700-MHz sidelobes have grown, the strength of the center lobe has decreased by 2 dB.

Nevertheless, with the small corner reflector, it has been possible to obtain over a 2:1 frequency range (a 67% bandwidth) relatively acceptable corner array performance in terms of both radiation performance and SWR. We had been unable to achieve both goals together using a planar reflector. The results of these initial models with an inadequately sized reflector provided incentive to construct large models with a more adequate reflector structure.

Large-Reflector Results

The large corner reflector uses sides that are 1.0 m long, with a height of 1.2 m. Each corner-reflector size is equal to the large planar reflector described in the original article. The planar reflector produced gain values that ranged from 7 to 9 dBi, with front-to-back ratios running from 17 to 20 dB. These values are consistent with the values produced with a dipole driver optimally spaced ahead of an optimally sized reflector. We should expect improvements using the large corner reflector in place of the flat screen. However, the large corner reflector produces challenges relative to the 50-Ohm SWR curve.

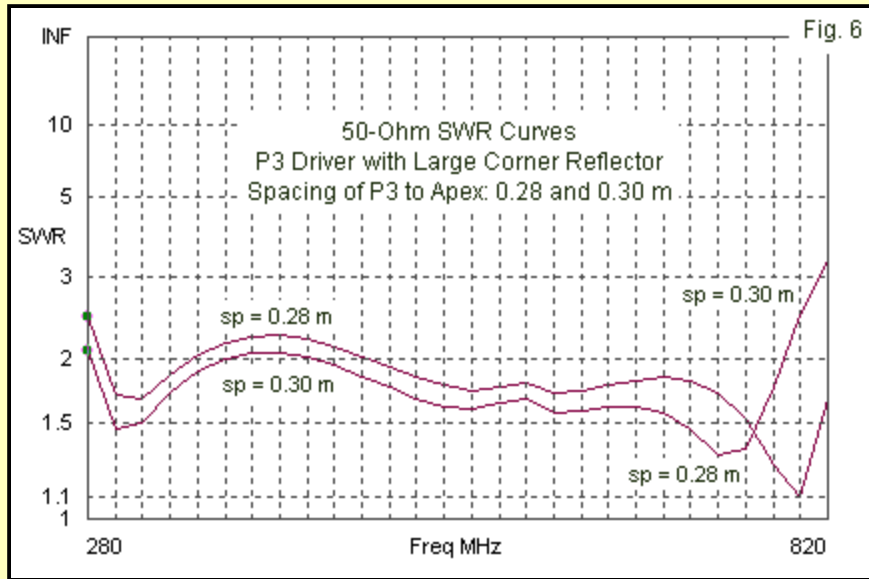
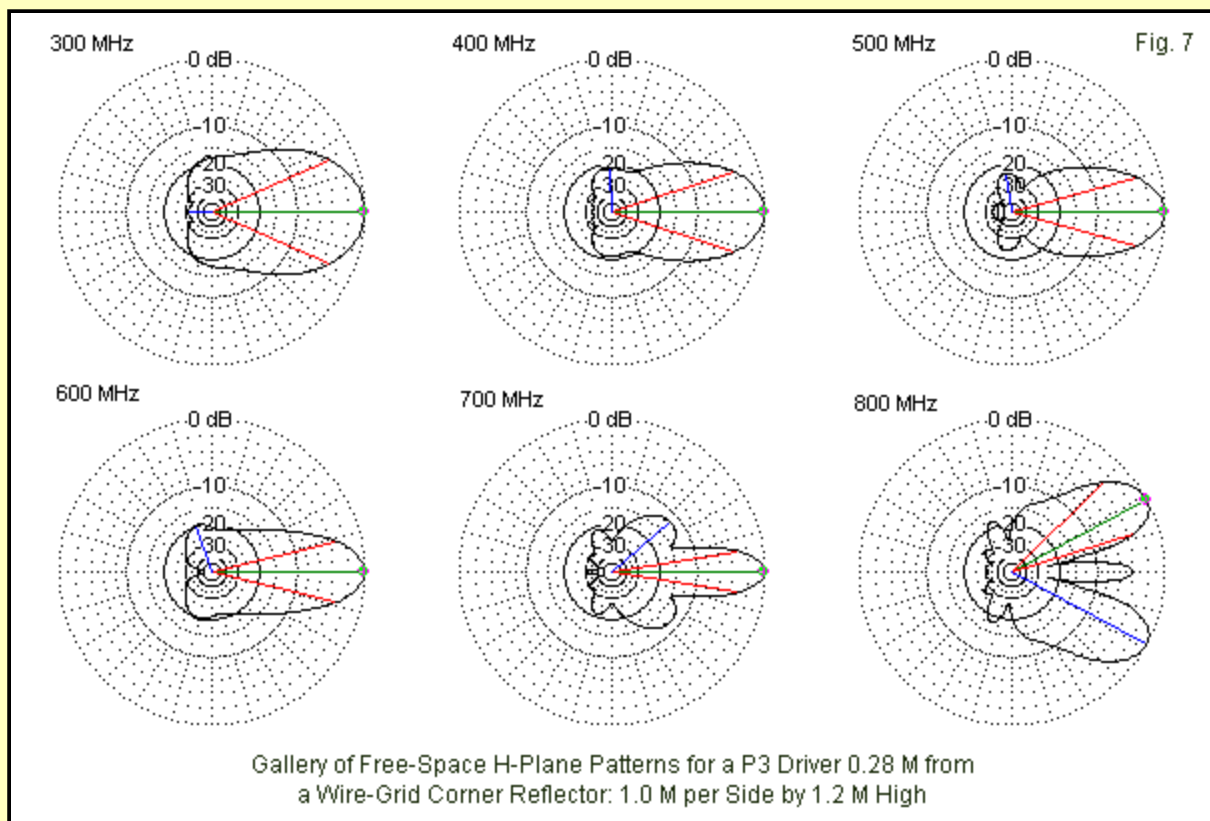


Fig. 6 shows the SWR curves for two spacing values of the driver from the corner apex: 0.28 m and 0.30 m. With the larger reflector, the phase lines return to a Z_o of 300 Ohms, but use a 0.55-m length. Without altering the driver structure, these curves are about the best obtainable from the array, although one might continue systematically searching for other combination of Z_o and length that might do slightly better.

The curve for the closer spacing value shows a low SWR value at 800 MHz. However, the values over the primary region of concern from 300 to 600 MHz are uniformly higher than the SWR values for the wider spacing. Even the wider spacing was unable to produce a curve with all values less than 2:1, although the maximum SWR in the 400-MHz region is about 2.06:1. Although the result is less than perfect, it is adequate enough to let us examine the remaining data for the two large-reflector models.

The information for the model with closer spacing (0.28 m) appears in **Table 3**, with an associated gallery of H-plane patterns in **Fig. 7**.

N2DT P3 Driver with Large Corner Reflector							Table 3
1.0-M Horizontal on Each Side by 1.2-M Vertical							
Driver Spacing From Apex: 0.28 m				Phase Lines: $Z_o = 300$, Length = 0.055 m			
Freq MHz	Gain dBi	F-B dB	BW deg	Feed R	Feed X	SWR 50	Pattern Notes
300	11.46	31.67	48	36.4	18.2	1.69	normal
400	12.99	34.27	37	83.0	-41.1	2.22	rear sidelobes -21.1 dB
500	12.96	35.63	32	38.9	-27.0	1.92	rear sidelobes -23.4 dB
600	10.47	42.59	27	28.2	3.7	1.79	rear sidelobes -19.5 dB
700	9.48	31.61	19	43.5	27.8	1.83	2 forward sidelobes
800	9.78	32.37		46.0	-1.4	1.09	3 forward lobes, sides stronger
Notes:	Gain dBi = maximum gain in dBi						
	F-B dB = ratio of maximum gain to 180-degree rearward gain in dB						
	BW deg = H-plane beamwidth in degrees (blank for split forward lobes)						
	Feed R and Feed X = resistive and reactive components of feedpoint impedance in Ohms						
	SWR 50 = 50-Ohm SWR						
	Pattern Notes: see associated gallery of H-plane patterns						



As we expected, the increased corner reflector size provides three advantages over the smaller version. First, the gain values increase by an average of almost 2 dB, with the most significant increases occurring at the lowest frequencies. At 300 and 400 MHz, the smaller reflector was seriously undersized, but is now closer to a more optimal size. The fact that the highest gain does not occur at 300 MHz indicates that further reflector size increases might be useful, since the frequencies at which maximum gain does occur have higher than optimal apex-to-driver spacing values.

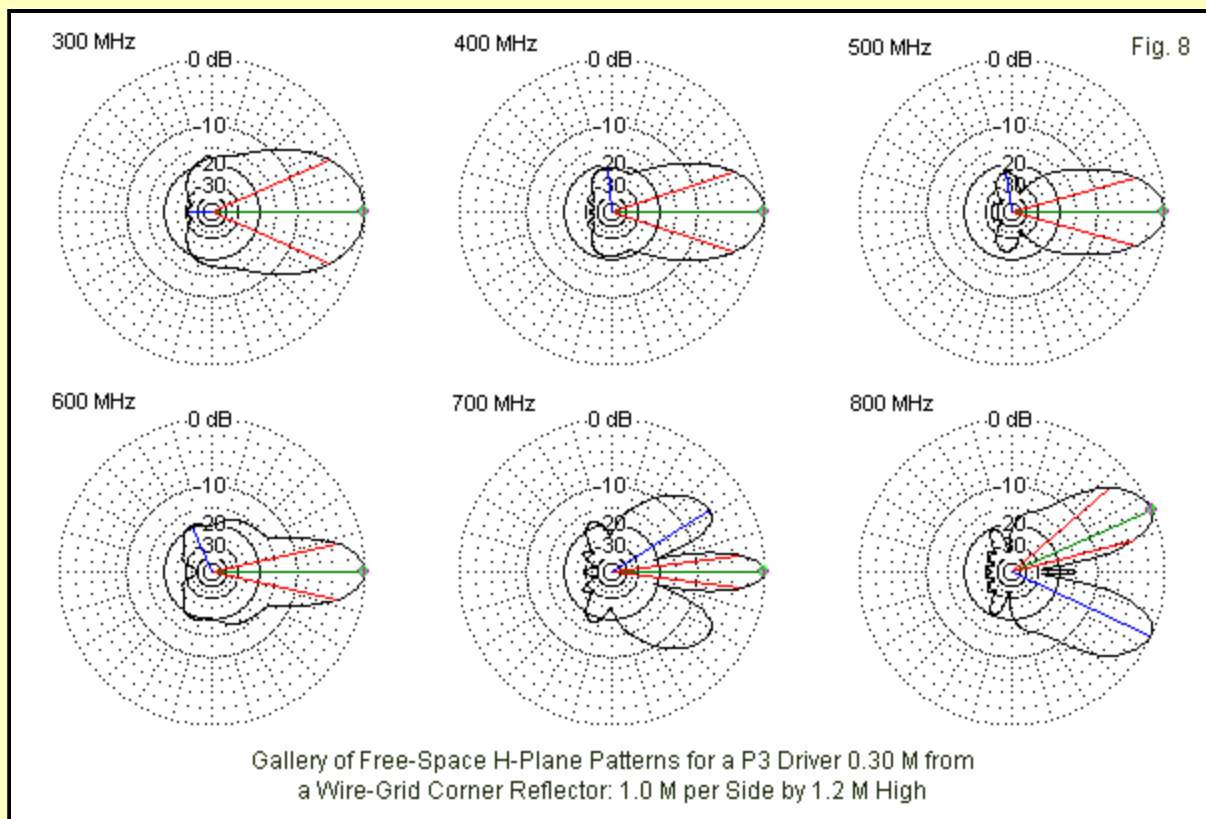
Second, the front-to-back ratios increase by an average of about 15 dB. The smaller reflector produced values that ran from 15 to 24 dB; the larger array range runs from 31 to 42 dB. Related to the improvement in rearward performance is the size of rearward sidelobes: they have decreased by 8 to 10 dB relative to levels using the smaller reflector.

If the SWR curve had cooperated, the patterns with the 0.28-m spacing of the driver to the reflector apex would have allowed us to use this version of the P3+corner through 700 MHz. The 600-MHz pattern shows no emergent sidelobes, and the forward sidelobes at 700 MHz are small enough to be tolerated in many applications. Only at 800 MHz does the pattern break into multiple forward lobes and thereby lose its utility.

To improve the SWR curve to the degree possible, we increased the apex-to-driver spacing to 0.30 m. Note that this spacing value is the smaller of the two values used with the diminutive reflector. We expect that the increased spacing will change the performance values in areas other than SWR alone. **Table 4** and **Fig. 8** provide the information on how much change occurs.

N2DT P3 Driver with Large Corner Reflector							Table 4
1.0-M Horizontal on Each Side by 1.2-M Vertical							
Driver Spacing From Apex: 0.30 m				Phase Lines: $Z_0 = 300$, Length = 0.055 m			
Freq MHz	Gain dBi	F-B dB	BW deg	Feed R	Feed X	SWR 50	Pattern Notes
300	11.44	31.59	48	41.4	14.9	1.45	normal
400	12.94	33.62	36	74.4	-37.7	2.06	rear sidelobes -21.1 dB
500	12.77	34.45	31	38.5	-22.0	1.75	rear sidelobes -23.0 dB
600	9.34	38.95	25	32.4	10.9	1.66	rear sidelobes -19.0 dB
700	8.15	28.95	15	64.0	21.5	1.57	3 lobes, sidelobes down 4.8 dB
800	13.01	33.15		20.7	6.4	2.46	2 forward sidelobes

Notes: Gain dBi = maximum gain in dBi
F-B dB = ratio of maximum gain to 180-degree rearward gain in dB
BW deg = H-plane beamwidth in degrees (blank for split forward lobes)
Feed R and Feed X = resistive and reactive components of feedpoint impedance in Ohms
SWR 50 = 50-Ohm SWR
Pattern Notes: see associated gallery of H-plane patterns



The 8" change in spacing does not seriously affect the performance values from 300 through 500 MHz. From 600 through 800 MHz, we do find quite significant changes, especially in the categories of forward gain and pattern structure. The gain at 600 MHz drops by a full dB relative to the closer driver spacing, even though the pattern does not identify any significant forward sidelobes. However, note in the pattern gallery the severe bulges in the sides of the forward lobe, bulges that become very significant sidelobes at 700 MHz. With closer spacing, the 700-MHz forward sidelobes had shown very small development. With the increased driver spacing, the sidelobes are less than 5 dB weaker than the main forward lobe. As a comparison of the gain columns in **Table 3** and **Table 4** will show, they obtain their energy at the expense of the central forward lobe.

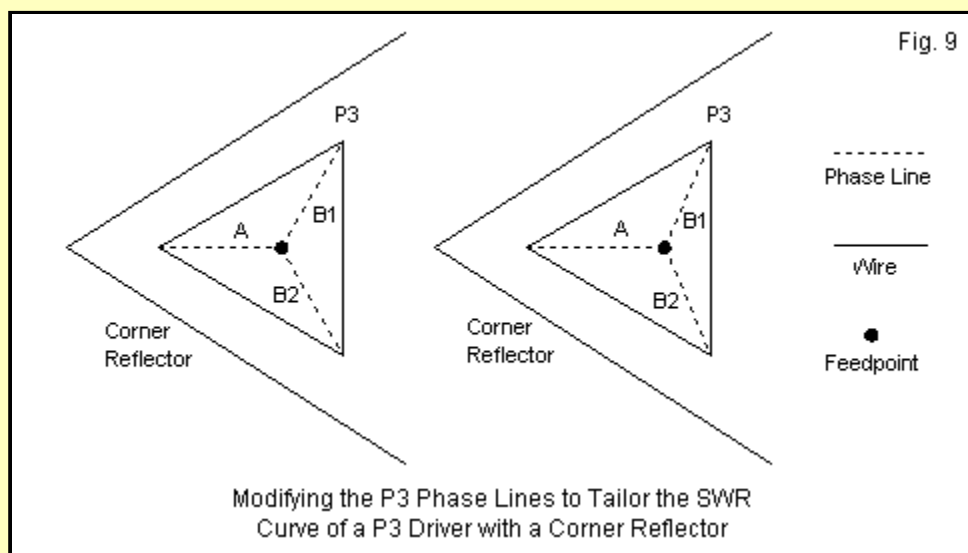
The exercises using the larger corner reflector suggest that we may have lost more in the pursuit of a more perfect SWR curve than we actually gained in overall performance, especially since the curve is still not below 2:1 from about 350 to 450 MHz. We lost significant gain at 600 MHz and we also lost the possible use of the 700 MHz pattern. (Adding 700 MHz to the range of usable patterns would have increased the frequency range to 2.3:1, for a 13% bandwidth increase to 80%.) The peak SWR values were 2.06:1 for lesser 600-MHz performance and 2.20:1 for performance through 700 MHz.

Modifying the P3 Driver

Using the larger corner reflector, we might set as an interim goal trying to improve the 50-Ohm SWR curve to match at least the level achieved with the 0.30-m driver-to-apex spacing, while preserving the patterns obtained for the closer 0.28-m spacing. We would want to obtain the improved SWR curve for at least the 300-600-MHz range to allow a 2:1 frequency range. Two strategies remain untried. One, as noted, lies outside the range of these notes, since it involves modifying the P3 driver wire structure in small increments until this avenue of effort is exhausted in terms of improved performance curves. The size of the reflector model makes this a somewhat daunting endeavor. For each new set of dimensions, we shall also have to check various phase line impedance values and lengths for the best results.

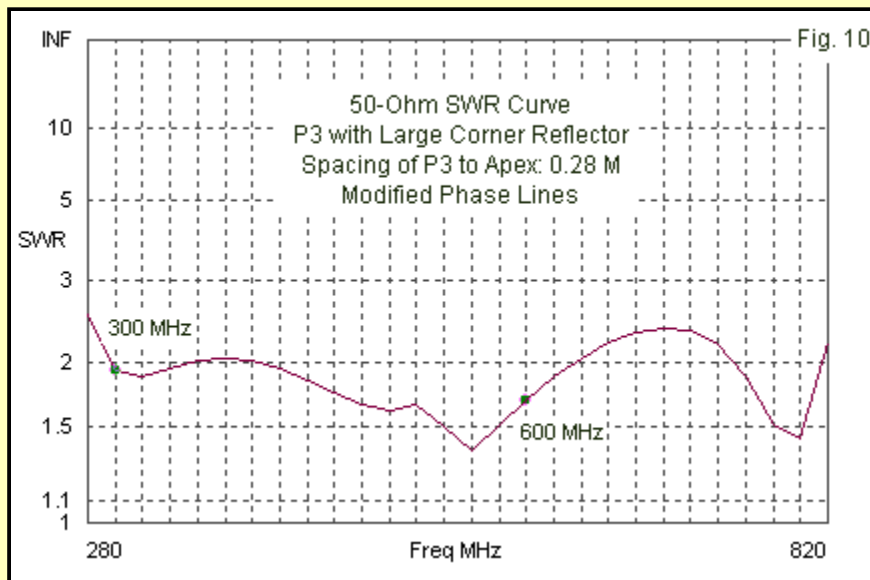
Some preliminary modeling using the smaller reflector is suggestive. Without altering the length of the P3 (in the model's Z-axis, that is, 0.32 m), we may obtain some improvement by enlarging the face dimension. The present face dimension is 0.083 m. Enlargements up to about 1.10 m appear to flatten the SWR curves within the lower 300 MHz of the total passband, but each dimension change requires finding the correct phase-line Z_o and length. Since there are differences in the P3's behavior depending upon which of our two reflectors we use. We may leave this option at this suggestive stage.

However, there is a second alternative that might initially escape attention. As shown on the left in **Fig. 9**, we have imported the P3 driver just as it was when used as an independent dipole. Each phase line (A, B1, and B2) is identical in length and Z_o , as is appropriate to independent use as a complete antenna in itself. However, within the context of the corner reflector, the mutual coupling between the individual legs of the P3 and the reflector differs relative to leg A on the one hand and to legs B1 and B2 on the other. (B1 and B2, of course, undergo equivalent mutual coupling.) Therefore, one may wish to experiment with adjusting the lengths of the phase lines by reference to each specific leg. The sketch on the right in **Fig. 9** suggests that making line A longer than lines B1 and B2 may provide improved results.



In a trial model, I retained the P3 dimensions with respect to the wire structure. I also used the large reflector and a driver-to-apex spacing of 0.28 m. The line Z_o remained 300 Ohms. However, lines B1 and B2 increased their length to 0.06 m, while line A became 0.08 m. The physical routing of these lines may present some challenges, since the distance between the legs and the physical center point within the legs is about 0.048 m. However, for the present feasibility test, we may bypass this challenge.

Fig. 10 presents the 50-Ohm SWR curve for the array using the modified unequal phase lines. Compare these curves to the ones appearing in **Fig. 6**. Over the range from 300 to 600 MHz, the new curve is superior in general to either of the previous curves, with a maximum SWR values of 2.03:1 at 380 MHz, but at the narrower driver-to-apex spacing.



The smaller spacing between the driver and the apex promises better pattern behavior. In fact, the patterns for the modified P3 are so close to those in **Fig. 7** that we do not need an additional gallery. Any pattern shape differences would be virtually invisible at the scale of the plots used in the galleries. We may detect the small differences by examining the data in **Table 5**. Except for the impedance columns, there are no significant differences between the reported performance potentials in the present table and in **Table 3**, which reported on the model prior to modification.

N2DT P3 Driver with Large Corner Reflector							Table 5	
1.0-M Horizontal on Each Side by 1.2-M Vertical								
Driver Spacing From Apex: 0.28 m							Phase Lines: $Z_0 = 300$, Lengths: A. 0.08 m; B 0.06 m	
Freq MHz	Gain dBi	F-B dB	BW deg	Feed R	Feed X	SWR 50	Pattern Notes	
300	11.46	31.90	48	38.8	27.0	1.92	normal	
400	13.03	34.10	37	75.1	-35.6	2.00	rear sidelobes -21.01 dB	
500	13.24	29.77	32	33.7	-11.0	1.61	rear sidelobes -21.6 dB	
600	10.99	35.33	27	36.2	17.6	1.68	rear sidelobes -30.3 dB	
700	9.59	31.72	19	52.2	45.1	2.36	2 forward sidelobes	
800	10.00	33.67		46.8	16.8	1.42	3 forward lobes, sides stronger	
Notes:	Gain dBi = maximum gain in dBi							
	F-B dB = ratio of maximum gain to 180-degree rearward gain in dB							
	BW deg = H-plane beamwidth in degrees (blank for split forward lobes)							
	Feed R and Feed X = resistive and reactive components of feedpoint impedance in Ohms							
	SWR 50 = 50-Ohm SWR							
	Pattern Notes: see associated gallery of H-plane patterns							
	Phase Lines A and B: See Fig. 9							

The development of a smooth SWR curve for the P3+corner reflector array is not--unfortunately--a matter of selecting a different reference impedance. In all of the tables, we find a series of resistive values less than 50 Ohms, but with a set of resistance values higher than 50 Ohms in the 350-450-MHz region. The goal is to minimize the range of variation as much as may be possible. Compare the values in **Table 3** with those in **Table 5** to see the degree of improvement and potential directions for additional improvement.

The modified P3 phase lines do not necessarily provide us with the last word in performance improvement. Rather, the use of unequal phase lines in conjunction with optimized dimensions may allow additional improvements in the overall performance curves for the cornered P3.

Conclusion

These initial modeling studies suggest that the P3 driver may in fact provide wider-band directional performance with a corner reflector than with a planar reflector. With a planar reflector, the effects of changing the spacing between the driver and the reflector yielded opposing tendencies with

respect to SWR on the one hand and to radiation patterns on the other. In contrast, a 90-degree corner reflector appears to yield usable SWR curves and a set of radiation patterns that are acceptable at least through 600 MHz, that is, through a 2:1 frequency range. These results use fairly tight criteria of acceptance. Although some past corner-reflector arrays have claimed a 2:1 frequency range, the results appear to rest on relaxed SWR requirements associated with television reception (in ancient times that required outdoor antennas). The results shown in these preliminary notes use a 2:1 SWR limit with a 50-Ohm reference. As well, the gain values--with an adequately sized reflector--are close to normal for comparable narrow-band reflector arrays.

Slightly larger reflector sizes would likely yield better gain at the 300-MHz end of the passband. In addition, taller (E-plane) dimensions might improve rearward performance--mostly in terms of further reductions in rearward sidelobes. Such investigations remain for more dedicated application-specific modeling, since the model size grows exponentially with each increase in any reflector dimension. In addition, once the designer selects a satisfactory reflector model, the driver dimensions require experimental modification to arrive at the best performance, both in terms of radiation patterns and in terms of the flattest SWR curves for a selected reference impedance. In addition, one may also wish to explore narrower corner-reflector angles so that the reflector planes better parallel the sides of the driver structure.

Like all initial feasibility studies, this one ends with notes on possible further work. However, we have gone some distance in establishing that using a P3 prismatic polyhedron driver with a 90-degree corner reflector can achieve a true 2:1 operating frequency range with good performance in the key operating parameters.



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