How to Turn a Deaf Ear

... with your antenna.

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A short while ago, I was approached by a friend with a problem. It appears that he was suffering from an interfering signal, on one frequency, from a specific direction. "Could I," he asked, "suggest an antenna with good rejection in one direction but a broad polar response otherwise?"

Dropping this in my lap, he sauntered away with a smile—or was it a smirk?—on his face.

Before going into detail of what finally emerged, let me stir your memory regarding transmission lines. One useful feature of a quarter-wavelength transmission line, or odd multiples thereof, is its ability to transform impedance. Thus a low impedance at one end of a quarter-wavelength becomes a high impedance at the other end, the transformation ratio depending on the impedance of the line.

The following equation allows the calculation of the resulting impedance when the initial impedance and the line impedance are known.

$$Z_r = \frac{Z_l^2}{Z_i}$$

where Z_l = line impedance, Z_i = low impedance at one end of the quarter-wave line, and Z_r = impedance seen at the other end of the line.

Substituting in the equation above, we see that if the low input impedance is 50 ohms and the line impedance 300 ohms, then an impedance of 1800 ohms will be apparent at the high impedance end of the quarter-wave transmission line. If you don't believe me, get your kid to work this with his calculator.

Well, that's the worst part. Now all we need to do is a simple application of Ohm's Law. Assuming pure resistance, then the equation of $R_t = 1/(1/R_1 + 1/R_2)$ can be applied successfully.

Substituting 50 ohms and the value of 1800 ohms, calculated above, the total resistance would be 48.648 ohms. This is so little different from 50 ohms that it could be neglected when being fed with 50-ohm coaxial cable from a transmitter.

So what?! What has this to do with directional antennas? The answer is, quite a lot when combining driven elements in an antenna!

In referring to my library of antenna publications, I found that it looked like phasing two half-wave antennas to produce a cardioid-like pattern would solve my friend's problem. With a spacing of one-quarter wavelength and a phasing of 90 degrees (one-quarter wavelength) or 270 degrees (three-quarters wavelength), the desired pattern may be achieved. Assuming a set direction of null, the feedpoint would have to be changed from one half-wave dipole to the other depending on whether the transmission line (phasing line) was one-quarter or three-quarters wavelength.

My wife will tell you that I am a born skeptic, so I chose a boom one wavelength long and centered the two driven elements on the boom. This left three eighths of a wavelength on each end of the boom for experimentation. Also, being naturally lazy, and suffering from arthritis, I then instructed my friend to build the antenna and test it at his location. Using a one-inch boom and three-eighths-of-an-inch tubing, my friend proceeded with his task. The insulators were good-condition TV ones, the securing screws three-sixteenths-inch stainless steel.

When erected on a rotator, the antenna had its pattern measured; it was found to be as theory suggested, but the null was insufficient for his problem signal. The next step was to install a reflector element a fifth of a wave-

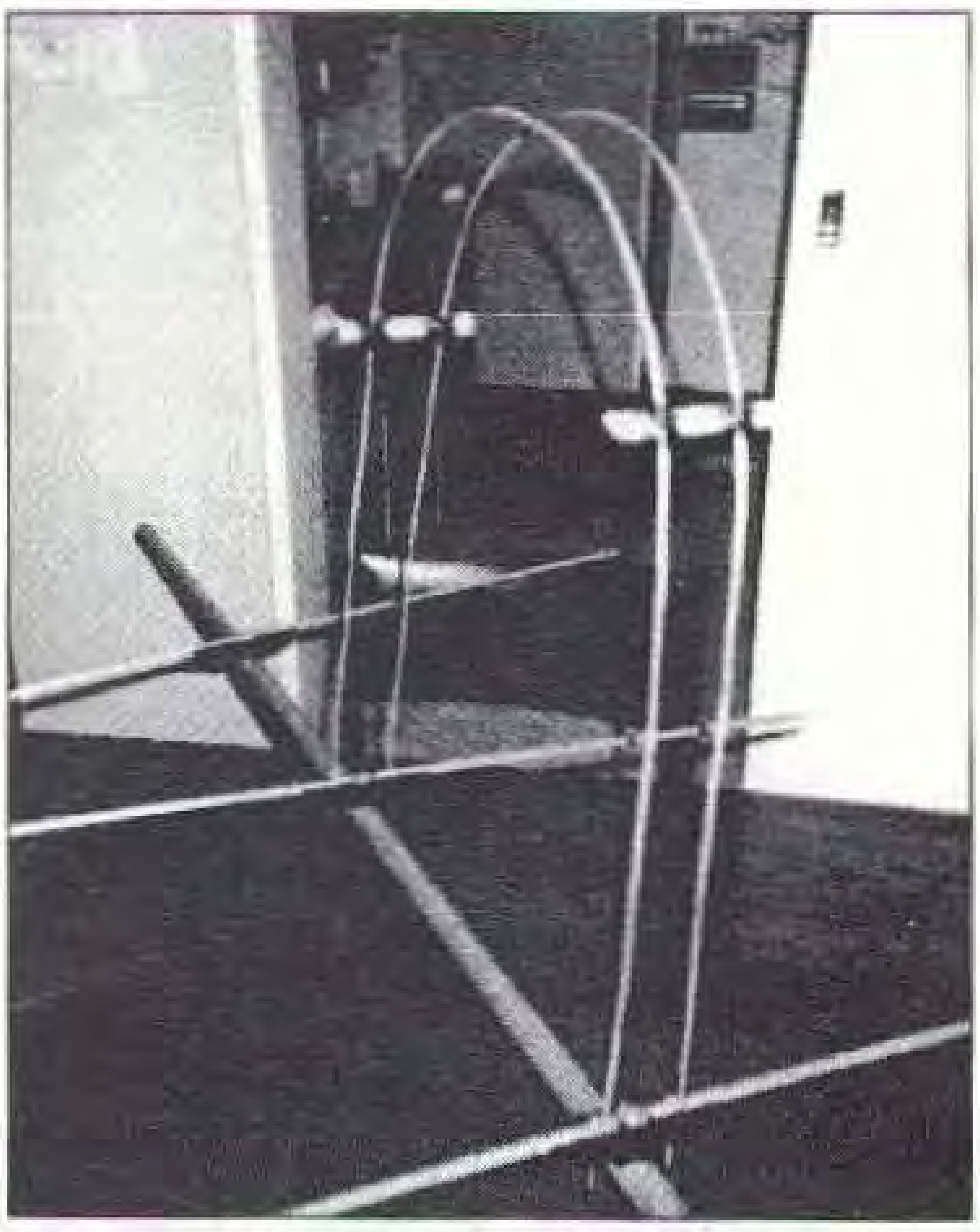
Photo A. The prototype hooped it up pretty well.

length behind one of the driven elements. To maintain symmetry, it was also mounted on a TV insulator, with an aluminum strip joining both halves in the center. On testing the pattern, the rear rejection was greatly improved and sufficient to solve the interference problem. However, the front lobe now exhibited a small dip.

While the antenna was satisfactory in operation as far as my friend was concerned, I stubbornly wanted to add the final touch to the antenna. After considering a parasitic director and a driven element, I chose the latter with the hope that it might give a broader frequency response. This meant that a driven element of the same size was added a quarter of a wavelength in front of the other two.

On test, the side response dropped and the front response increased while exhibiting a deep rejection to the rear. The small lengths of boom material were trimmed purely for aesthetic reasons. In the original test antenna (**Fig. 1**), a three-quarter-wavelength line was used between the two original driven elements, with the feedline connected to the dipole farthest from the reflector. The third driven element was connected to the feedpoint with a quarter-wavelength line, thus retaining the feedpoint on the central dipole. The phasing line was 3 mm-diameter solid aluminum spaced approximately 26 mm apart center to center. This was to suit the driven element center spacing of the stainless steel screws.

The three-quarter-wavelength line needs to have the slack of a half-wavelength taken up. In **Photo A**, you can see that the prototype uses a "hoop" between the driven elements. After the photo was taken, a plastic support was fastened between the boom and the center of the "hoop." The practical side of this arrangement left something to be desired. Another way to achieve 270-degree phasing is to use a quarter wavelength (90 degrees) and cross the feeder (180 degrees). The final antenna used this method (**Fig. 2**) and proved quite satisfactory in performance. Note that the quarter-wave spacing should be retained, but because of the crossed feed, the harness will be slightly longer than a quarter wavelength.

The SWR was quite low on the antenna. Remember, theoretically the resistive impedance for two elements was 48.65 ohms, suggesting a possible SWR of 1.03:1. Adding the third driven element would lower this to 47.37 and produce an SWR of 1.05:1.

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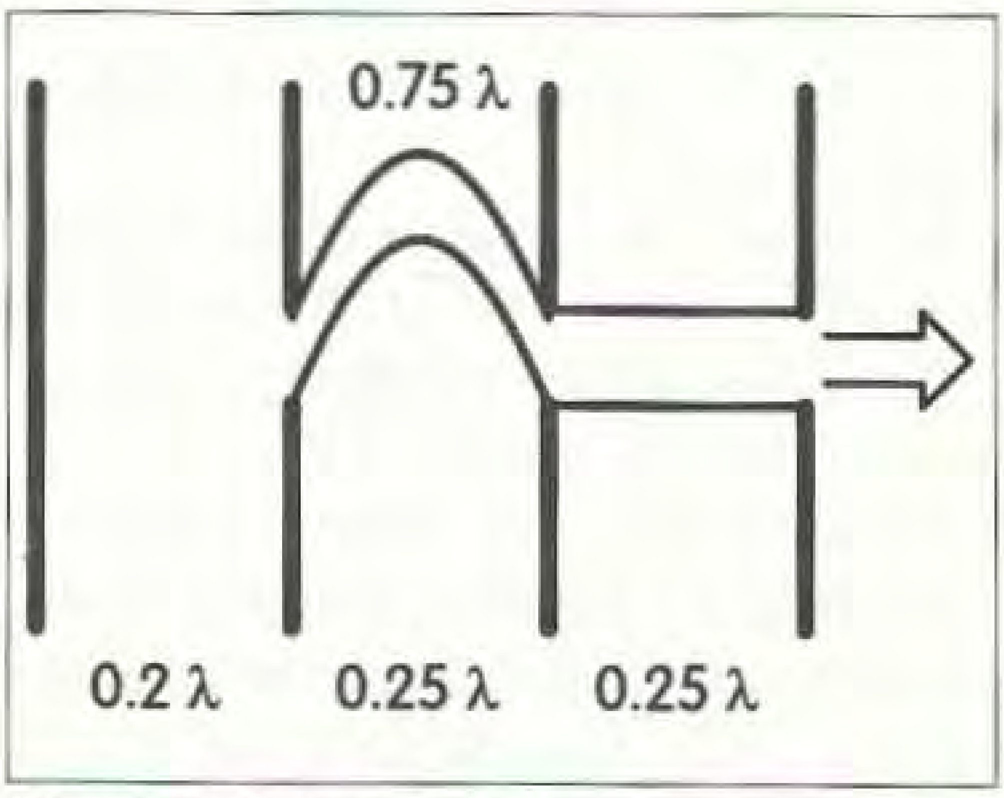

Fig. 1. Original test antenna.

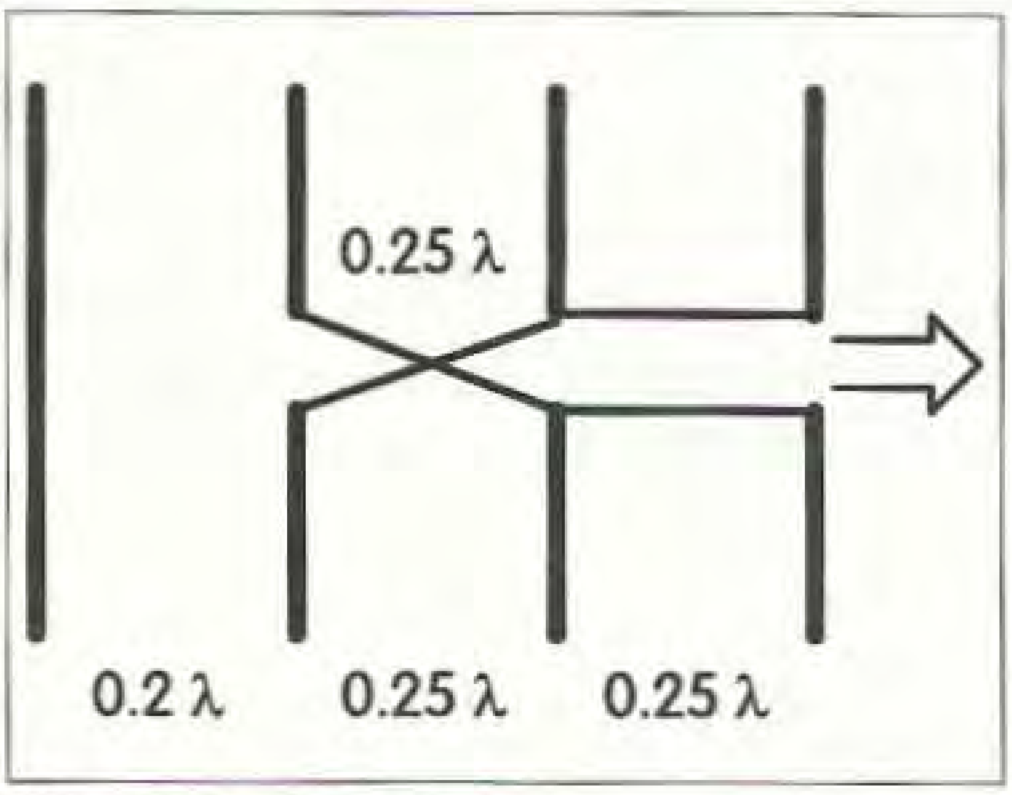

Fig. 2. Final version.

unless you have lots of RF in the shack. Ground returns for PTT and +13.8 VDC are made via the cable shields of Tx and Rx Audio, so there's no need to run redundant wires. If your transceiver doesn't supply +13.8 VDC at an accessory socket, you'll have to look for a place to "tap in" internally, or use an external supply (which will then require a ground return). A 9 V battery might do the job!

There you have it. The PSKI ties those minor loose ends together and you're up and running. Hope to "see" you soon on PSK!

Notes

1. PSKI kits are available. For details, write Lectrokit, P.O. Box 1856, Sandusky, OH 44871; or visit the Lectrokit Web site at [www.sanduskyohio.com/lectrokit].

2. To read more about PSK31, refer to the May 1999 issue of *QST,* page 41.

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The reflector element, in practice, added little to the SWR of the antenna. The phasing line used would have a much higher impedance than 300 ohms, lowering the effect of the extra driven elements on the SWR. Note that if you do use 300-ohm line, it must be of the air-spaced variety with dumbbell insulators—otherwise, it would upset the length of the transmission line because of the velocity factor.

The original antenna used three-eighths-inch-diameter elements; this was taken into consideration in calculating element lengths. The lengths and spacing for the antenna with a center frequency of 147 MHz are as follows: reflector, 40.5"; driven elements, 38.7"; spacing between driven elements, 20.1"; spacing between reflector and driven element, 16.1"; quarter-wavelength harness, 20.1"; three-quarter-wavelength harness, 60.3".

Simple scaling should be suitable for any center frequency in the two meter band when using three-eighths-inch-diameter elements. The TV insulators used for the prototype had a spacing of one inch between the inner ends of the driven elements, the securing screws being one-half inch out from the inner tips of the elements. Remember that the driven element lengths need to be cut in half. The reflector length is the calculated length shown from tip to tip. This length is correct only if insulated from and elevated above the boom. The TV insulators used held the elements approximately one-half inch above the boom.

This antenna was not designed for high forward gain but maximum rear rejection, so do not expect high gains. However, the forward gain is sufficient to be useful.

For those who have not realized it at this stage, I will point out that this antenna is a combination of two cardioid simulation antenna elements and a reflector element. Enjoy building this interesting antenna, which needs no involved matching system (see below). With horizontal polarization, no problems should arise with mounting the antenna. If vertical polarization is what you have in mind, then use a nonmetallic support between the elements. Otherwise, mount the antenna, or a pair of them, offset from the main support pole.

Finally, I suggest that when feeding the antenna you make use of a 1:1 balun or an RF choke. I have found that winding some RG-58CU coaxial cable into a close-wound coil on a length of one-inch plastic conduit is satisfactory. Seven to ten turns is sufficient with mounting close to the feedpoint of the antenna.

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(100 k and 10 k) shown in **Fig. 4**, the hysteresis is about 0.1 V. The output switches high when the input is below 4.09 V and switches low when the input is greater than 5.05 V.

If switching ambiguities are not a concern, the non-inverting input is just returned to the desired reference voltage, +5 V in the example, and no positive feedback is needed. Without hysteresis, the output switches from