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GIANT Wire Antennas

—impress the neighbors

Have you ever found yourself wanting an antenna that was easy to put up, had gain over a dipole, was simple to match, and could work on more than one band? Then read on. This article shows how to design and build wire antennas which are longer than a half wavelength. These antennas may be operated as dipoles or V-beams. By careful choice of leg length, it is possible to build an antenna which will work on several amateur bands, but requires only a single feedline. The input impedance is about 200 Ohms and may easily be matched to 50-Ohm coax with a 4:1 balun.

Background

One advantage of the half-wave dipole is its low feedpoint impedance. The reason for this is shown in the upper drawing of Fig. 1. This drawing shows the standing waves of voltage and current which are present on a resonant antenna. From Ohm's Law, the input impedance is equal to the voltage divided by the current at the feedpoint of the antenna. For a half-wave dipole, the voltage at the feedpoint is low and the current is high, which gives a low value of impedance —typically, 50 to 70 Ohms.

Many hams use half-wave antennas, but it is also possible to make a dipole in which each leg is much longer than a quarter wavelength. Fig. 1 also shows the voltage and current distributions for 1-wavelength and 3/2-wavelength dipoles. Notice that the current in the center of a full-wave antenna is low and the voltage is high, resulting in a very high input impedance on the order of several thousand Ohms. However, the 3/2-wavelength antenna has a voltage minimum at its center, similar to the half-wavelength dipole. The feedpoint impedance is again relatively low—around 100 Ohms or so.

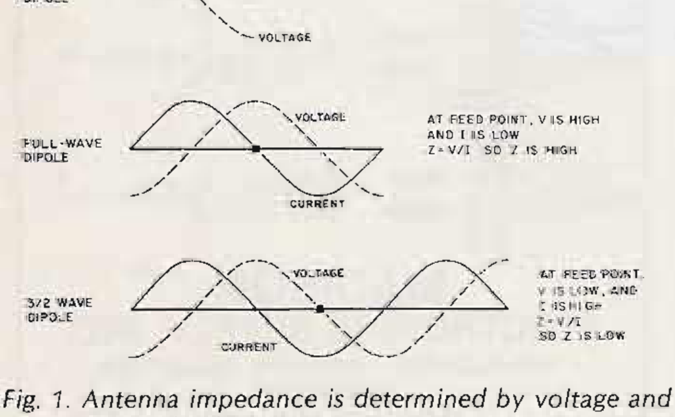

Fig. 1. Antenna impedance is determined by voltage and current at the feedpoint.

At the ends of each dipole drawn in Fig. 1, the current is shown to be at a minimum value and the voltage is maximum. This makes good sense if you think about it. The current flowing at the end of a piece of wire must be zero because it has nowhere to go. On the other hand, the voltage at the end of a wire easily can be quite high. The important point to remember is that to get a low value of input impedance, there must be a voltage minimum at the center of the antenna. In other words, each leg of the antenna must be an odd number of quarter wavelengths. For the half-wave dipole, each leg is ¼ of a wavelength, while for the 3/2-wavelength dipole, each leg is ¾ of a wavelength. Each of these antennas has a voltage minimum at its center, and each also has a low value of input impedance.

Determining the Correct Antenna Length

Table 1 shows the formulas to use in order to calculate the right length for each leg of the antenna at the frequency of interest, once you have chosen how many quarter wavelengths you want each leg to be. Notice that a ¾-wavelength leg is *more* than 3 times as long as a ¼-wavelength leg. This is because the influence of "end effect" diminishes as the number of quarter wavelengths in each leg increases.

The antenna may also be oriented as a V-beam rather than a dipole, if directivity is desired. Table 2 shows the included angle (angle between the two legs of the V) for several different V-beam leg lengths, as well as the approximate gain of each configuration.

For those of you with lots of real estate, Table 3 gives the data required to design and build antennas which are truly giants. The feedpoint impedance of these monsters is in the neighborhood of the 200-Ohm value given for the antennas of Table 1.

Leg Length in Wavelengths	Leg Length in Feet (f in MHz)
1/4	234/f
3/4	738/f
5/4	1230/f
7/4	1722/f
9/4	2214/f
11/4	2706/f
13/4	3198/f
15/4	3690/f
17/4	4182/f
19/4	4674/f
21/4	5166/f
23/4	5658/f
25/4	6150/f
27/4	6642/f
29/4	7134/f
31/4	7626/f
33/4	8118/f
35/4	8610/f
37/4	9102/f
39/4	9594/f
41/4	10086/f
43/4	10578/f

Table 1. Determining the correct leg length.

Leg Length in Wavelengths	Included Angle in Degrees	Gain in dB
11/4	60	5.3
13/4	56	5.8
15/4	52	6.3
17/4	48	6.8
19/4	46	7.2
21/4	44	7.6
23/4	42	8.0
25/4	40	8.4
27/4	38	8.8
29/4	37	9.2
31/4	36	9.6
33/4	35	10.0
35/4	34	10.3
37/4	33	10.5
39/4	32	10.7
41/4	31	10.9

Table 2. Gain and included angle for V-beams.

The formulas shown in these tables will give leg lengths which are approximately correct, but these values should be used only as starting points. All antennas should be cut a little bit long to allow for trimming to the exact length which is required. The actual resonant frequency of any antenna is affected by factors such as height above the earth and proximity to other objects.

Multiband Use

Certain leg lengths will resonate on more than one amateur band, which can be very convenient. I used to work in a small coal-mining town deep in the hills and hollows of southern West Virginia. I lived in a mobile home and had 340 feet of RG-8 coax which ran from my ham shack up the hollow to a hilltop behind my trailer. I badly needed an antenna which could cover several bands with a single feedline and which had some gain to make up for the cable losses.

While reading Ed Noll's book, *73 Dipole and Long-Wire Antennas*, I came across the information given here as Table 1. Ed explained that multiband operation was possible, so I got out my calculator and made a list of antenna lengths which would be resonant in the bands I wanted to operate (80 and 20 meters). Then I looked through my list to see if any of the numbers matched. It turned out that a ¾-wavelength leg on 80 meters was the same size as a 11/4-wavelength leg on 20 meters—about 190 feet in length.

This antenna was built from #12 copperweld wire and fed through a W2AU balun with a 4:1 impedance ratio. The swr was below 2:1 across the whole 20 meter band. On 80 meters, the resonant frequency was lower than I had planned (3.7 MHz versus 3.9 MHz), but I still was able to operate my Triton II on 75 meter phone with the swr around 3:1.

Other suitable combinations can be found by plugging desired frequencies of operation into the various equations and making a list of the resulting leg lengths. For example, a leg length of about 440 feet should resonate on both 80 and 40 meters, while 428 feet looks good for 20 and 15 meters. It has been my experience that the actual leg lengths on 80 meters are somewhat shorter than the formula values, so a leg length of 428 feet may work well on all bands from 80 to 15 meters. A leg length of 362 feet should work on 40 and 20 meters, 330 feet on 10 and 15 meters, and 310 feet on 80 and 15 meters. For really big antennas, a leg length of 710 feet looks good on 40, 20, and 15 meters, 943 feet for 160 and 80 meters, and 673 feet for 160 and 20 meters.

Conclusion

This article has described large centerfed antennas where the length of each leg is an odd number of quarter wavelengths. Multiband use of a single antenna is possible by a judicious choice of leg length, and low-standing wave ratios are achieved by placing a 4:1 balun at the feedpoint. These large antennas show gain over a normal dipole and may be oriented in either straight-line or V-beam configuration. ■

Acknowledgement

Formulas and tables in this article were taken from *73 Dipole and Long-Wire Antennas* by Ed Noll W3FQJ.

Leg Length in Wavelengths	Leg Length in Feet (f in MHz)
45/4	11070/f
47/4	11562/f
49/4	12054/f
51/4	12546/f
53/4	13038/f
55/4	13530/f
57/4	14022/f
59/4	14514/f
61/4	15006/f
63/4	15498/f
65/4	15990/f
67/4	16482/f
69/4	16974/f
71/4	17466/f
73/4	17958/f
75/4	18450/f
77/4	18942/f
79/4	19434/f
81/4	19926/f
83/4	20418/f
85/4	20910/f
87/4	21402/f

Table 3. Leg lengths for very long antennas.