ham radio TECHNIQUES

Bill Orr W6SAI

broadband 80/160-meter antenna

One of the very interesting advantages of writing this column is the feedback I get from readers. A case in point: in my October, 1983, column I discussed the problem of building a simple broadband antenna that would cover the whole of either the 80- or 160-meter bands with a reasonably low value of SWR on the feedline. Some of the newer solid-state transmitters are quite sensitive to an SWR other than 1.0:1, and they react by reducing the output power of the final amplifier stages at high values of SWR.

One of the antennas I discussed was the crossed-dipole array described by Mason Logan, K4MT, in the May, 1983, issue of this magazine. His basic antenna design is shown in **fig. 1**. The measured SWR curve of this antenna is shown in **fig. 2**. I suggested in my October column that a matching coil might be required at the antenna feedpoint to bring the impedance closer to 50 ohms.

Shortly after publication, I received a note from K4MT stating, in part, "Your statement that the antenna impedance is quite low and that a matching coil across the feedpoint is needed is not correct. With the stagger-tuned dipoles, each dipole acts as the network for the other. . .Nothing more is needed!"

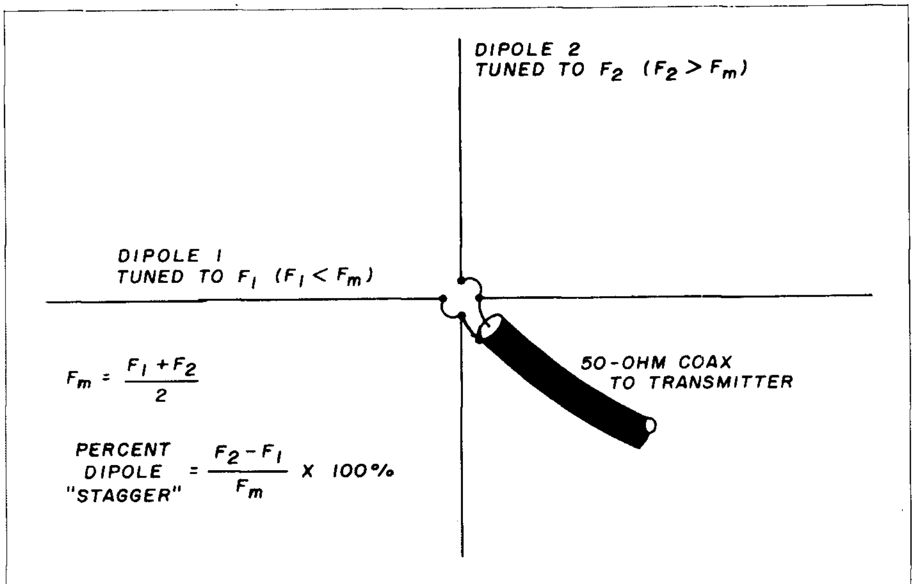


fig. 1. Top view of broadband stagger-tuned, crossed-dipole antenna.

Logan is correct and I am wrong, as his letter proves. He goes on to say that for the stagger-tuned dipoles, between the two chosen resonant frequencies, the reactances of the dipoles have opposite signs, forming a lossy, antiresonant circuit which can have an impedance maximum near the center frequency where the reactances are equal in magnitude. Near the band edges, at the resonant frequencies of the dipoles, the impedance is somewhat less than that of each dipole alone. Hence the W-shaped curve for the impedance as well as the SWR.

Mason goes on to say that height of the antenna above ground has a significant impedance effect and that when the resonant points are properly chosen, a satisfactory SWR curve can be achieved for heights of one-quarter wave or less. Great news for the "top-band" operator!

Paul Scholz, W6PYK, has worked with Mason to develop a computer program that determines the best design frequencies for the crossed-dipole antenna and provides im-

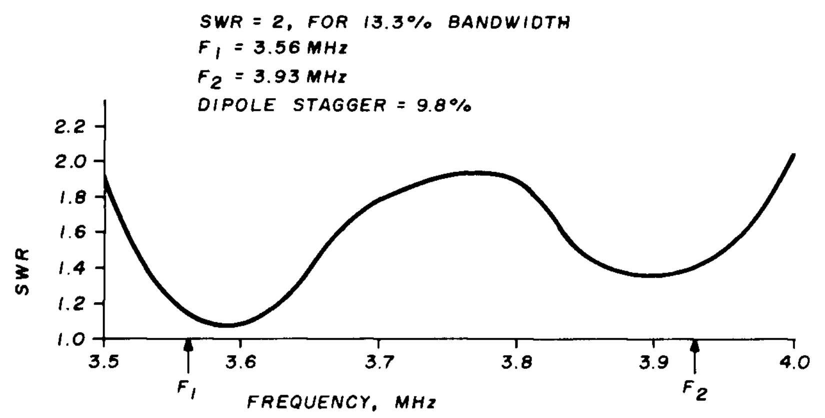


fig. 2. Measured SWR of broadband 80-meter stagger-tuned antenna using inverted Vs.

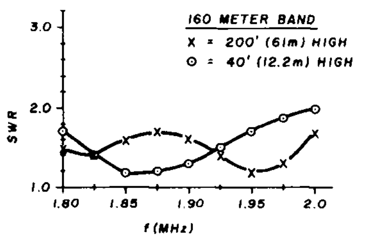


fig. 3. Computer-derived SWR curves for K4MT crossed-dipole antenna for 160-meter band. (Computer program by Paul Scholz, W6PYK.)

pedance and SWR readout. Two examples, given in **fig. 3** and **4**, show that even at low height, both the 80 and 160-meter designs exhibit a good match to a 50-ohm line; a better match, in fact, than if the antenna were suspended higher in the air.

The 160-meter design is summarized in **fig. 3**. The dipoles were cut by formula to 1.75 MHz and 2.1 MHz (outside both ends of the 160-meter band) in the case of the 40-foot high antenna, and to 1.8 MHz and 1.975 MHz in the case of the 200-foot high antenna.

In each case, the resonant frequencies were chosen to provide a satisfactory value of SWR across the band (less than 2 to 1). The 40-foot high configuration is of most interest because it is a practical situation that can be duplicated by the average Amateur.

Only a portion of the "W" shape shows in the curve, as the higher design point was chosen outside the high frequency end of the band. Compare this curve with your ordinary 160-meter dipole located at a 40-foot elevation!

The "W" shape shows up in the 200-foot high antenna as the design points are closer together. But who can place an antenna at the 200-foot level? Not me.

Fig. 4 shows two crossed-dipole SWR curves for the 80-meter band. One antenna is 100 feet high and the design points are 3.55 MHz and 3.9 MHz. Note that the minimum SWR points do not correspond exactly to the design frequencies. The design points of the 40-foot high dipoles are 3.525 MHz and 3.975 MHz. Both of these antennas provide good SWR curves, with the lower antenna especially attractive for everyday operation across the band.

In summary, the K4MT crossed-dipole, broadband antennas do not exhibit critical design requirements and should be trimmed at the specific location for best match.

For those who want to write their own computer program for this antenna, the necessary information is given in **fig. 4** of K4MT's orignial article. (Thanks to K4MT and W6PYK for forwarding the computer data and additional design information to me.)

the K2GNC Y-doublet for 80 meters

Other hams have been experimenting with broadband antennas for 80 and 160 meters: Bill Pfaff, K2GNC, has come up with the interesting concept shown in **fig. 5**. He's had his Y-doublet up for over three years and it's worked quite well. The antenna is supported by a pole in the center, similar to that of an inverted-V. When properly constructed, it covers the entire 80-meter band (3.5 MHz to 4.0 MHz) with a SWR less than 1.5 to 1. This requires proper length and orientation of the three unequal-length elements.

The drawing shows connection of the three antenna wires to the feedline. Two wires (radials?) are attached to the shield of the line and a third antenna wire is attached to the center con-

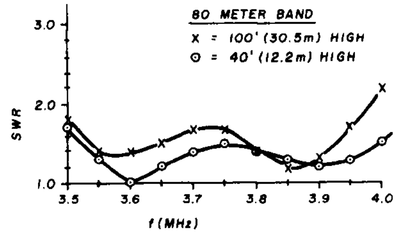


fig. 4. Computer-derived SWR curves for K4MT crossed-dipole antenna for 80-meter band. (Computer program by Paul Scholz, W6PYK.)

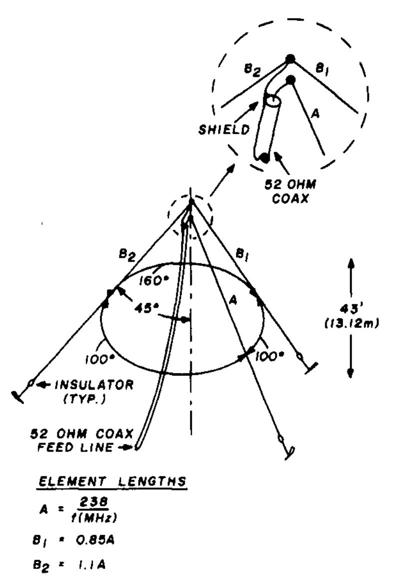


fig. 5. The K2GNC "Y-doublet" antenna for 80 meters. Antenna covers complete band with low SWR. It is supported from a single pole.

ductor. The wires form an angle of 45 degrees with respect to the 45-foot wooden support. The antenna wires also help guy the pole.

The two "radials" (marked B1 and B2 in the drawing) are located 100 degrees away from the radiator (marked A), as viewed in the horizontal plane. Minimum SWR frequencies are controlled by the B1 and B2 wire lengths. K2GNC has adjusted his wires so that the SWR of the antenna is below 1.5 to 1 from 3530 kHz and 3980 kHz. Outside these limits, the SWR rises sharply. SWR at the band edges can be reduced, but at the expense of high mid-band SWR.

design example

Choosing a design frequency of 3800 kHz generates the following element lengths:

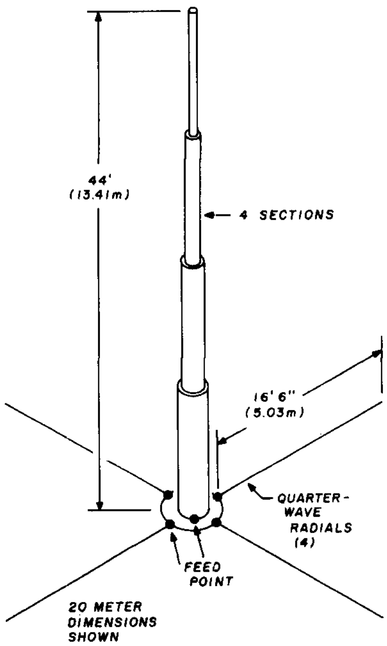
A: 62.63 feet or 62 feet 7 inches (=238/3.8)
B: 53.24 feet or 52 feet 3 inches (=0.85 × 62.63)
C: 68.89 feet or 68 feet 10 inches (=1.1 × 62.63)

The length and height of B1 and B2 can be varied.

A 10-meter model was assembled and placed on a rotator. Field strength measurements revealed a nearly-omnidirectional pattern, with narrow, deep nulls on each side of wires B1 and B2. K2GNC suggests these nulls may be due to the presence of nearby objects.

The feedline should come straight down to the ground underneath the antenna. The use of a balun did not affect measured SWR, nor antenna operation.

I spoke to Bill Pfaff on the phone about this interesting antenna and mentioned the K4MT crossed-dipoles. I asked him if he thought his antenna was a relative of K4MT's, and what would happen if he added a second wire to the A wire, running away from it, making it a four-wire configuration. Bill said he'd tried this idea and found that it didn't work as well as the present designs. So perhaps the K4MT and K2GNC antennas don't have that much in common, after all.



FREQUENCY (MHz)	WHIP	RADIAL
7.0	89' 0" (27.13m)	33' 5" (10.19m)
10.1	61' 9" (18.82m)	23' 2" (7.06m)
14.17	44' 0" (13.41m)	16' 6" (5.03m)
18.11	34' 5" (10.49m)	12' 10" (3.91m)
21.22	29' 4" (8.94m)	11' 0" (3.35m)
24.94	25' 0" (7.62m)	9' 4" (2.84m)
28.6	21' 9" (6.63m)	8' 2" (2.49m)

fig. 6. The 5/8-wave HF vertical antenna. "Whip" is made of four 12-foot telescoping sections of aluminum tubing. Taper ratio from bottom to top is 2:1.

the extended ground plane for HF operation

One of the long-standing jokes about the ground plane antenna is that because it's omnidirectional, it's equally poor in all directions! Maybe so, but an examination of DX QSLs reveals that a large percentage of overseas stations uses ground plane antennas, and some of these signals are quite powerful.

VHF operators have popularized a 5/8-wavelength vertical whip antenna which provides 3 dB gain over a simple 1/4-wave ground plane. It is possible to adapt such an antenna to a lower frequency just as it is done at VHF.

Originally, the 5/8-wave vertical antenna was designed some decades ago for use as an "anti-fade" antenna for the broadcast band.

A representative HF design is shown in **fig. 6**. Dimensions are shown for a center frequency of 14.17 MHz, using tubing for the element. Because the tubing is telescoping, there's a slight taper effect which must be taken into account. The final installation uses a 44-foot vertical section, and many quarter-wave radial wires beneath it. The general formula is:

$$\textit{length (feet)} = 623.5/f \text{ (MHz)}$$

The antenna must be tuned to resonance, and the easiest way to do this is to add enough inductance at the base to make the overall system resonant at an odd quarter-wavelength mode (three-quarter waves).

Three-quarter wave resonance is determined by adjusting the number of turns in the base coil until a dip meter coupled to the coil-antenna system indicates 14.17 MHz. The bottom end of the coil is attached to the radial wires, which fan out in a horizontal plane.

Once the antenna is resonant, the transmission line is tapped on a few turns above the bottom end of the coil and the tap varied until lowest SWR is achieved (**fig. 7**). It may be necessary to adjust the coil a fraction of a turn to drop the SWR to its lowest possible value.

Amateurs accustomed to the performance of a simple ground plane antenna will find this extended version to be a vastly improved design for both receivng and transmitting.

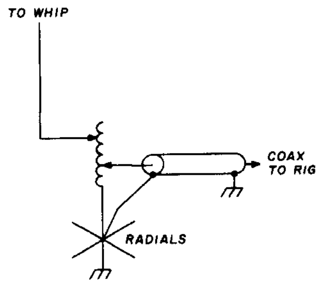


fig. 7. Single coil resonates whip to 3/4-wave mode and also permits match to coaxial line. For 14 MHz, coil is 12 turns of No. 12 wire, spaced twice wire diameter, wound on a ceramic form 2 inches in diameter. Adjust taps for best match as described in text.

table 1. Comparison of Belden 9913 cable with RG-8/U, RG-8A/U and RG-213/U.

f(MHz)	nominal attenuation RG-8/U, RG-8A/U, RG-213/U	(dB/100 feet) 9913
50	1.6	0.9
100	2.2	1.4
200	3.2	1.8
400	4.7	2.6
700	6.9	3.6
900	8.0	4.2
1000	8.9	4.5
4000	21.5	11.0

a coax "sleeper"

Reid Brandon, W6MTF, has pointed out an interesting coaxial cable listed in the new Belden wire and cable catalog. It may be 1984's replacement for the old RG-8/U, RG-8A/U, and RG-213/U. The cable is RG-8/U size, so the fittings for the old cable will work with the new one. It has a solid (not braided) center conductor and 61 percent coverage of the outer braid, plus a conductive, 100 percent coverage solid flexible metallic sheath beneath the braid. The dielectric is called "semi-solid polyethylene," which is not to be confused with foam dielectric. Instead, the new dielectric looks as if it is shaped to provide small air spaces (instead of foam bubbles) along the line. The velocity of propagation is 84 percent as opposed to 66 percent for the RG-8/U type line.

The attenuation of the Belden 9913 cable compared to some of the older varieties is listed in **table 1**. While the virtues of the cable are not apparent below 50 MHz, there's a big payoff in the VHF/UHF region. (Just check the 400 MHz figures!) And the newer cable is a lot less expensive than a power amplifier. For those interested in even less loss in the VHF/UHF region, Belden *9913* is suggested over the readily available forms of RG-8.

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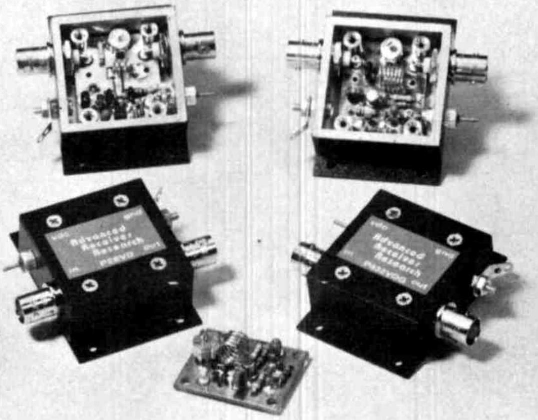

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P220VDG	220-225	‹0.5	20	+ 12	GaAsFET	$79.95
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P432VDA	420-450	‹1.1	17	− 20	Bipolar	$49.95
P432VDG	420-450	‹0.5	16	+ 12	GaAsFET	$79.95

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