HIGH FREQUENCY ANTENNAS

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1. Long Wire Antennas:

a. The fundamental wire-type antenna is the horizontal half-wave center-fed antenna. The nominal impedance of this type of antenna is about 73 ohms, which will give a 1.5:1 standing wave ratio (SWR) for a 50 ohm transmitter/receiver. Various matching networks (delta and gamma types for example) can be used for 1:1 ratio, but the power loss with a 1.5:1 is minimal, and the value of messing around with matching networks is questionable. Like all balanced antennas, the dipole should be fed through a 1:1 balun (balanced to unbalanced transformer). The problem with half-wave dipoles for 75 meter frequencies (3.9-4.0 Mhz) is that the antenna is approximately 120 feet long. The antenna should be erected horizontally as high as possible. In most cases, the antenna will not be at least a 1/4 wavelength above ground (at 75 meters that equates to 55 to 60 feet). This means the directional effect of the dipole is virtually non-existant, so any geographical orientation can be used for omni-directional use. Dipoles are sometimes referred to as "long wire" antennas, an erroneous term since a true long-wire is at least one wavelength long. Variations of the half-wave dipole in use includes the commonly called "coaxial" dipole, which uses coaxial cable for part of the radiating element. The coaxial dipole seems to have a better bandwidth, probably due to the diameter of the coax used as a radiating element versus the number 14 or 12 wire diameter used with a regular dipole. The half-wave dipole provides a good match only at the frequency for which it is "cut" and it has a high angle of radiation (60-80 degrees) which is correct for the 100-500 mile operating range.

b. The trap dipole is a variation of the half-wave horizontal dipole which provides multi-band operation. Wave-trap networks are inserted along the length of the dipole and act to disconnect part of the antenna on higher bands to permit matching at different frequencies. The characteristic impedance of the trap dipole is also about 73 ohms, the same as the basic dipole. The length of the antenna is still the same on the lowest band, so a large amount of space is still required. The traps are frequency-dependent networks, and thus provide a relatively narrow bandwidth of matched operation. These antennas are also non-directional at the heights normally used.

c. The inverted "V" dipole is a variation of the half-wave dipole that can be used in restricted space. The center-fed portion of the antenna is supported at a height of 40-50 feet, and the radiating elements are ruin diagonally down to the ground. The angle between the elements should be about 100 degrees for a good match to 50 ohms. The element lengths are approximately the same as a regular dipole. The angle of radiation is about 50 to 70 degrees which is suitable for operation in the 100-500 mile range.

d. The rotatable dipole is a center-loaded dipole about 40 feet long with aluminum conduit elements. When mounted about 50 feet high, where the directional effect becomes apparent, it can be rotated and permits desired signals to be peaked, or undesired signals to be suppressed. Initial testing of such an antenna has indicated no real advantage over a dipole or inverted "V" that would make it worth the time and effort.

e. True long-wire antennas are at least one wave-length long. Such antennas are directional off the ends of the antenna. If one end of the long-wire is terminated in its characteristic impedance (500-600 ohms), the antenna can be made uni-directional, obviously, a good sized backyard is needed for a 75 meter long-wire antenna (it's at least 220 feet long!!).

2. Parasitic Arrays:

a. The "beam" antenna commonly used is a three-element parasitic array - reflector, driven element, and director. The antenna is directional and will give 3-5 DB gain. The elements are half-wave in length, which means they are practical for 10, 15, and 20 meters -- get a little unwieldy for 40 meters -- and just about impractical for 80 meters!! The characteristic impedance is about 73 ohms, with most antennas having a gamma or delta matching network for operation at 50 ohms.

b. The YAGI antenna is the "pure" form of the beam antenna. YAGIs usually have 5 to 10 elements. The driven element in a YAGI is a folded dipole, making the characteristic impedance about 300 ohms. A 6:1 balun is normally used with YAGIs for a match to 50 ohms. A ten element YAGI will have a gain of about 10 DB, with a narrow bandwidth. Again, the physical size of the antenna with half-wave elements is the limiting factor in low-frequency usage.

c. The Quad or delta-loop antenna has become popular in recent years. the biggest advantage of Quad antennas is their ability to provide gain with broad bandwidths. The gain of a Quad is similar to that of a beam or YAGI (with an equal amount of elements). The quad is a directional antenna with an impedance of about 200 ohms (very approximate) and thus requires a matching network for 50 ohm operation. Again, the limitation in use for HF work is the physical size, since the Quad is a square-shaped antenna with each side 1/4 wave length long, while the delta-loop is triangular with each side 1/3 wave length long. Needless to say, there are not many 80 meter Quads around.

3. Vertical antennas:

a. The most common vertical for fixed-station use is the trap vertical, such as made by Hustler and Cushcraft. As with the trap dipole, this antenna uses frequency dependent networks to isolate portions of the antenna for proper resonating on different bands. Although the antenna can be mounted at ground level, greatly improved performance will result from installation on top of a 20-30 foot high mast. The efficiency of the antenna is dependent upon installation of adequate radials. At least four, cut to 1/4 wave length, should be installed for each band.

These radials can also be used as the top guy wires for the mast. These antennas can be adjusted for a very low SWR at 50 ohms, but have a narrow bandwidth. The radiation angle is 30-40 degrees, making them perform well for long-distance operation (1500 mile range) while still usable for short-distance (500 mile range). These are omni-directional antennas.

b. The single band vertical for 75 meter operation is usually a loaded type, either with a coil at the bottom for base-loading or a coil in the center of the mast for center loading. While top-loading would be preferred, the size and weight of the coil required would make for an unwieldy mechanical structure. Center-loading is preferred to base-loading since a large portion of the radiation is performed by the coil itself, and the elevated coil will provide better performance and efficiency. The antenna can be resonated for a 50 ohm impedance. Being frequency-dependent, due to the loading coil, the bandwidth is relatively narrow. Again, the efficiency of the antenna is highly dependent upon the ground radial system. There should be a minimum of four (1/4 wave) radials, with the more, the better. The antenna can be elevated on a mast for better performance. The radiation angle is similar to the trap vertical.

c. Towers utilized to elevate VHF antennas or beams can be loaded and resonated as vertical antennas. The base of the antenna can be grounded or insulated. Adequate ground radials are required for proper operation. The radio amateur's handbook shows several methods of feeding and matching towers for use as vertical antennas, even for 160 meters. A common use for towers is as a counterpoise for "half sloper" antennas. This is a form of inverted-antenna with the tower acting as one of the radiating elements. The antenna is fed at the top of the tower with the coax shield connected to the tower, and the center conductor connected to the sloping element. A "slope" of approximately 45 degrees will permit matching to 50 ohms.

d. Due to mechanical problems involved, the only practical antenna for mobile HF operation is a vertical whip antenna. These can be base-loaded, center-loaded, or trap verticals with the body of the car acting as the counterpoise. The efficiency of such an antenna, though, is only about 5 to 10 percent (working DX from a car usually means driving to the top of Pike's Peak!!). For local (100 mile) operation, the mobile vertical whip does a good job. Two important considerations apply to safety in mobile antenna operation -- one, the antenna must be mechanically suitable to withstand the whipping and shaking involved in traveling -- two, the antenna height must be considered in clearing overhead obstructions, PARTICULARLY power lines.

4. Examples of simple design antennas:

\ctr\G5RV MULTIBANDER ANTENNA

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                I  I          51 FEET
                I  I
                I  I
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```
                I  I
                I  I   --------  300 OHM LINE
                I  I         L = 36 FT FOR
                I  I         HORIZONTAL DIPOLES
                I  I
                I  I         L = 29 FEET FOR
                I  I         INVERTED VEE DIPOLES
                I  I
                I  I
                I  I
            --------------
            |          |      ----------1:1 50 OHM
            |          |                  BALUN
            --------------
                 I
                 I
                 I -------------------50 OHM COAX
                 I                    (RG8) ANY
                 I                    LENGTH
             XMTR/RCVR
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The impedance   at the lower end of the 300 ohm line is 50 to 60 ohms. A 1:1 balun is recommended for RFI or   TVI suppression. The antenna is slightly "short" on 80 meters and the 300 ohm line section acts as a sort of matching stub on that band and acts as an impedance transformer on the other bands.   Trim the 300 ohm line for best SWR on 15 or 20 meters (most critical bands).   SWR should   be 2:1 or better across any band.   SWR of 1.3:1 can be obtained for the most resonant frequency in each band.   Antenna is good for about 400 watts.   For higher power, use regular amateur transmitting open-wire line (300 ohm).   Shielded twin-lead can be used, but length will be different due   to cable propagation factor. You will have to cut and try.

\ctr\DJ4BQ DOUBLE-DIPOLE

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        (55 feet)               (55 feet)
------------------------------O    O-----------------------------
       -----------------------O    O-----------------------
        (40.5 feet)           I    I        (40.5 feet)
                        I    I
                        I    I   --------200 OHM OPEN-WIRE
                        I    I             LINE, ANY LENGTH
                        I    I
                        I    I
                     ------------
                     I        I   -------- 4:1 BALUN
                     I        I        (50:200 OHMS)
                     ------------
                         I
                         I
                         I    ------------- 50 OHM COAX
                         I             (RG8) ANY LENGTH
                         I
                         I
                       XMTR/RCVR
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This antenna operates from 80 to 10 meters. The longer dipole operates on 80, 20, and 15 meter while the shorter dipole operates on 40 and 10 meters. SWR of 1.2:1 to 1.5:1 are typical on each band. This is a 200 ohm antenna and a 4:1 balun must be used to match it to 50 ohm coax. Dipole wires should be spaced at least six inches apart to eliminate interaction of dipoles. Heavy-duty twin lead can be utilized for the dipoles (forming both dipoles at the same time) but the length of the dipoles will be different from the standard dimensions, and you will have to "cut and try" for the lowest SWR. Amateur transmitting 200 ohm open-wire line with plastic spacers should be used, with about a six inch separation from tower legs or mast. Inverted Vee operation may require shortening of the dipole lengths due to extra capacity to ground.
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