VHF and UHF antenna fundamentals

Almost all of the fundamentals we have discussed so far are equally true for all the HF bands and VHF up to about 70 mHz. The higher the frequencies become, the more physical characteristics diverge. For instance, a length of wire of one wavelength at 1.2 gHz is extremely small compared to even 6 meters. The impedance of a length of wire is also significantly different. At these ultra-high frequencies, the physical characteristics of antenna and matching components become somewhat bizarre in form. It becomes impractical, for instance, to wind a matching coil of proper characteristic size with wire on a conventional form. At UHF and SHF (frequencies above 800 MHz) frequencies, inductive components are often made using printed circuit techniques. The illustration provided depicts a printed circuit



Printed Circuit RLC Pattern

equivalence of an RLC type circuit to be used at SHF frequencies. It should be obvious from the illustration that this circuit is dramatically different from conventional components used in HF and VHF circuits. It is included to illustrate how frequency affects the physical size and form of the reactive elements we have been discussing so far.

The difference is no less dramatic for VHF and UHF over HF antenna types when considering construction materials. Because of the physical difference in size of fractional wavelength components, the use of wire is seldom chosen for antenna element construction above about 1.5 meters. At 2 meters and 70 cm, the use of heavy gauge wire as an antenna element is quite common in homebrew antennas. As illustrated, #4 wire would be equivalent at

VHF and UHF frequencies to the use of 2 inch or larger pipe at any HF frequency. When thinking in terms of construction of antennas for the higher frequencies, this phenomenon must be considered. It is pointless to consider, for example, the use of #14 wire for a UHF or SHF antenna. It is just as pointless to think in terms of using 1.5 inch aluminum for elements in a 2 meter VHF Yagi.

With the size difference in mind, we can still apply the same principals used when considering the theoretical antenna for VHF and UHF. The computer model will be very similar. However, the physical components used to construct the antenna may take a significantly different form than those used in HF. Let's take a look at a case in point – the Quad Beam.

The quad beam we discussed in an earlier chapter constructed for HF frequencies used #14 wire strung between long supports to construct a square of dimensions measured in meters. A similar quad beam for VHF should use heavy gage wire (#10, #12 AWG sometimes #14) supported by short lengths of wood or plastic pipe measured in inches. The illustration below is of a quad beam using this



construction technique. The total beam length is only a few feet compared to tens of feet at HF frequencies. The significantly more manageable size and construction techniques required for VHF and UHF antennas, at least partially accounts for the popularity of these bands. A similar size differential will be noticed when constructing Yagi style antennas. The basic theory of operation and expected results will remain roughly the same as before,

accounting for the difference in physical size and construction techniques.

The smaller size of elemental components also makes construction of more complex and larger physical designs possible. Consider for a moment the basic Yagi design in a much larger configuration. One commercial 10 element 2

meter Yagi design can be purchased that has less than 12 feet overall boom length. A similar HF Yagi for even 10 meters would be multiple dozens of feet long if the size could even be accommodated with appropriate construction materials. One military grade log-periodic dipole array (often called LPDA) for the HF bands has a boom length of 55.8 feet and covers 7.2 to 30 MHz.

These dramatic comparisons are made to provide a mindset for the VHF/UHF and above frequencies and the construction techniques employed to implement the basic theoretical designs



Military Grade Log Periodic Dipole Array

available to amateurs. This size differential and simpler, cheaper construction and easily obtained high gain design is the reason that array type antennas are more often used in the higher frequencies rather than a simple dipole.

One place the difference is not as easily detected is in mobile antenna design. Even at the VHF and UHF frequencies, the antenna of choice is the vertically mounted mobile antenna. Obviously of shorter length and smaller component size, the VHF vertical is designed strikingly similar in nature to its' HF equivalence. Especially where fiberglass whip type antennas are concerned.

The component size difference affords an opportunity for VHF not afforded to HF without considerable cost and size. Vertical antennas that have significant gain (7 to 10 dBi) are possible on VHF with only modest cost and very little difference in size over similar HF designs. For instance, a four element collinear antenna for 2 meters has a design gain of 10 db in less than 12 feet of length. There is no collinear mobile design for HF frequencies due to the extremely large components necessarily that make a mobile design impractical.

Among the simplest of mobile antennas for VHF is the quarter wave vertical whip (often called a "stinger"). Using theory learned from earlier chapters we can estimate a 2 meter quarter wave vertical to be about 18 inches. If we apply the theoretical information obtained from earlier chapters we find that impedances become similar in nature to the HF equivalence as is the current distribution, radiation pattern, and other factors discussed already.

As mentioned, because of component size difference, we can also construct a dual band, vertically mounted, mobile antenna for both VHF 2 meter and 70 cm UHF on a single monopole (one single vertical element). To do this we insert a inductor coil in-line in the antenna at the approximate $\frac{1}{4}$ wave point for 70 cm. The choice of the value of the inductance is chosen to be a very high impedance at the UHF frequencies and merely a center loading coil for the entire length of the antenna making it a 5/8 wavelength at the 2 meter frequencies. This clever combination approach is used in dozens of commercially available ham radio mobile antennas from multiple manufacturers. It is not beyond the ability of the amateur radio antenna experimenter to construct a multi-band mobile or stationary vertical for a variety of frequency combinations. Higher UHF and SHF frequencies may make physical construction techniques change in a significant way. A good example of this idea is the GPS antenna. Some are no more than a printed circuit coil and vary widely even to the obscure printed circuit "patch" antenna. None even bare a resemblance to the picture shown of a dual band VHF antenna.



Dual Band VHF/UHF Mobile Antenna