Tech Notes

Phased Arrays of Short Vertical Antennas

It is possible to devise an array of two or more vertical antennas to provide useful gain and directivity over a single vertical element, but proper design and adjustment may be a more complicated matter than one might think because gain depends on such factors as spacing between elements, phase difference, etc., and these will change from one band to the next. About the most one can hope to do is to work out a compromise design that will be truly effective on two adjacent bands.

Probably the simplest system would involve two vertical antennas spaced from 1/2 to 3/4 wavelengths apart at the highest frequency of operation and fed with equal in-phase currents. Such an array would be bi-directional and provide up to four decibels of "broadside" gain. At half the design frequency the broadside gain would be less than two decibels. Thus, an array of the two elements for 40 meters (spacing between elements approximately 35 ft.) would provide a fair amount of gain on that band and perhaps a few decibels less on 80 meters. The same array could no doubt be operated on the higher-frequency bands, but the directivity pattern (if any) would change considerably, for the great spacing (in terms of wavelength) would cause the production of "end-fire" as well as broadside radiation.

In the case of close-spaced elements (1/8 to 1/4 wave) it is possible to produce a unidirectional end fire pattern by feeding the two elements with a phase difference of 90 degrees by means of an electrical 1/4 wavelength "delay" line. This arrangement produces a rather broad single lobe (cardioid pattern) in the direction of the element with the lagging current, and very good front-to-back radiation are possible with such an array. However, both the radiation resistance and the feedpoint impedance will be much lower than for a single vertical element, making the system more critical with respect to operating bandwidth and impedance matching, especially if each element is physically shorter than 1/4 wavelength at the operating frequency and if the spacing between elements is less than 1/4 wavelength. Close-spaced out-of-phase short elements should have the best possible radial system under each element so that the earth loss resistance doesn't account for the major part of the overall feedpoint impedance. If this precaution isn't observed the earth loss may wipe out all or most of the theoretical gain of the array.

Still another problem with close-spaced arrays using physically short elements is that the power-handling capability may be less than for a single element because the mutual impedance between the elements will raise overall circuit Q while reducing the radiation resistance of the array.

As with the relatively wide-spaced in-phase arrays, the close-spaced out-of-phase types may be operated on other bands where the spacing and phase difference will not be optimum and where the directive pattern can be expected to change from band to band.

In general, the Butternut HF6V-X and HF2V will be under less of a disadvantage in phased arrays than conventional multi-trap designs that use a progressively smaller portion of the available radiator at 7 MHz and above, but the problems of devising an effective array on more than one band will remain the same. Wide-spaced in-phase arrays are generally better behaved than the close-spaced out-of-phase types and show higher values of radiation resistance. This makes the ground/radial situation somewhat less critical, but more real estate is required for effective broadside arrays, especially on 80 and 160 meters.

For further information on vertical arrays one should consult a recent edition of the ARRL Antenna Book.

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