About this Article

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INDUCTIVELY LOADED DIPOLES

The following material was extracted from earlier editions. Figure and Equation sequence references are those from the 21st edition of *The ARRL Antenna Book*

SHORTENED DIPOLES

As shown in preceding sections, there are a number of ways to load antennas so they may be reduced in size without severe reductions in effectiveness. Loading is always a compromise; the best method is determined by the amount of space available and the band(s) to be worked.

The simplest way to shorten a dipole is shown in **Fig 69**. If you do not have sufficient length between the supports, simply hang as much of the center of the antenna as possible between the supports and let the ends hang down. The ends can be straight down or may be at an angle as indicated but in either case should be secured so that they do not move in the wind. As long as the center portion between the supports is at least ¼, the radiation pattern will be very nearly the same

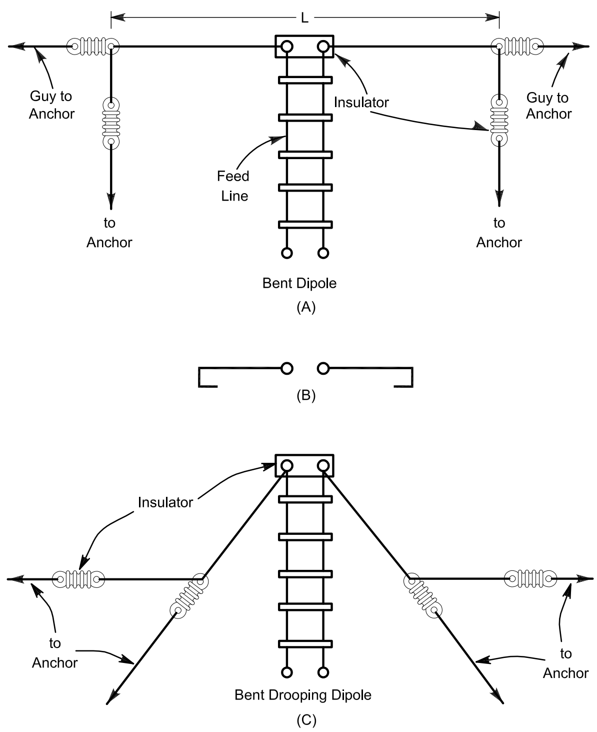


Fig 69—When space is limited, the ends may be bent downward as shown at A, or back on the radiator as shown at B. The bent dipole ends may come straight down or be led off at an angle away from the center of the antenna. An inverted V at C can be erected with the ends bent parallel to the ground when the support structure is not high enough.

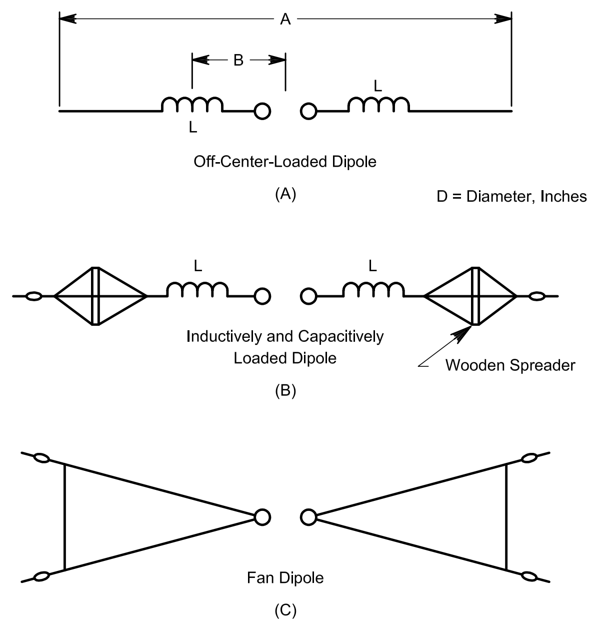


Fig 70—At A is a dipole antenna lengthened electrically with off-center loading coils. For a fixed dimension A, greater efficiency will be realized with greater distance B, but as B is increased, L must be larger in value to maintain resonance. If the two coils are placed at the ends of the antenna, in theory they must be infinite in size to maintain resonance. At B, capacitive loading of the ends, either through proximity of the antenna to other objects or through the addition of capacitance hats, will reduce the required value of the coils. At C, a fan dipole provides some electrical lengthening as well as broadbanding.

as a full-length dipole.

The resonant length of the wire will be somewhat shorter than a full-length dipole and can best be determined by experimentally adjusting the length of ends, which may be conveniently near ground. Keep in mind that there can be very high potentials at the ends of the wires and for safety the ends should be kept out of reach. Letting the ends hang down as shown is a form of capacitive end loading. While it is efficient, it will also reduce the matching bandwidth—as does any form of loading.

The most serious drawback associated with inductive loading is high loss in the coils themselves. It is important that you use inductors made from reasonably large wire or tubing to minimize this problem. Close winding of turns should also be avoided if possible. A good compromise is to use some off-center inductive loading in combination with capacitive end loading, keeping the inductor losses small and the efficiency as high as possible.

Some examples of off-center coil loading and capacitive-end loading are shown in **Fig 70**. This technique was described by Jerry Hall, K1TD in Sep 1974 *QST*. In the equation below, the diameter D is that of the wire used for the antenna, in inches. The frequency f is expressed in MHz.

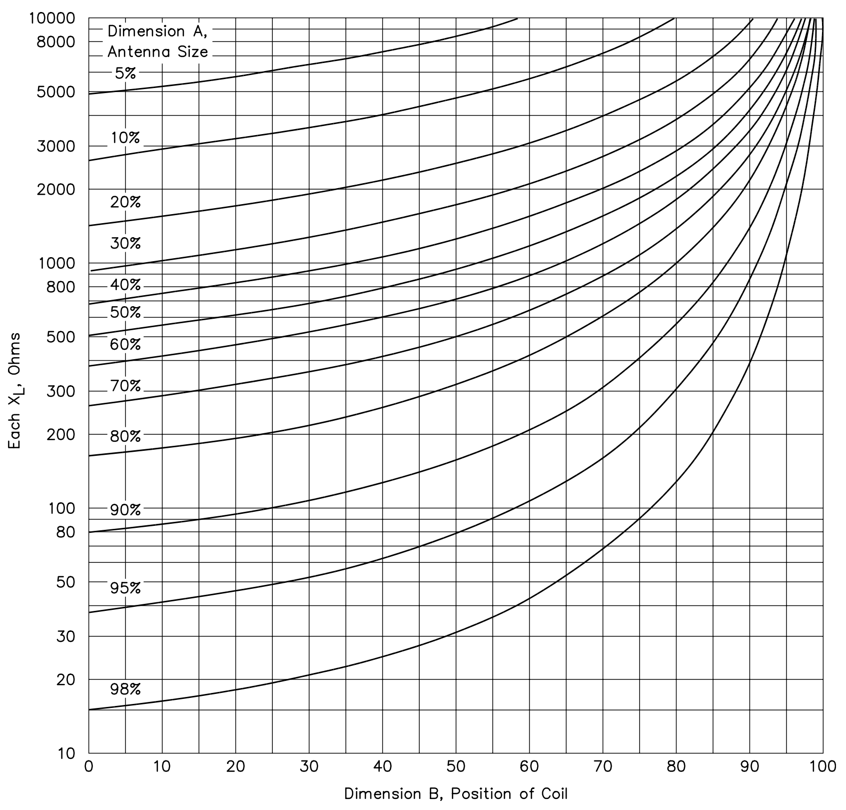
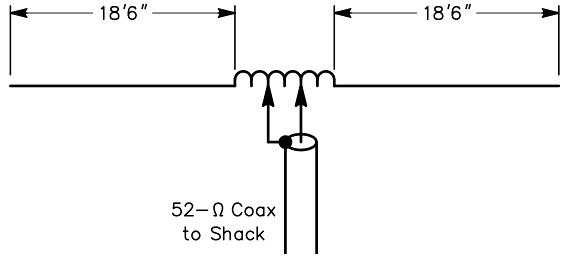


Fig 71—Chart for determining approximate inductance values for off-center-loaded dipoles. See Fig 70A. At the intersection of the appropriate curve from the body of the chart for dimension A and proper value for the coil position from the horizontal scale at the bottom of the chart, read the required inductive reactance for resonance from the scale at the left. Dimension A is expressed as percent length of the shortened antenna with respect to the length of a half-wave dipole of the same conductor material. Dimension B is expressed as the percentage of coil distance from the feed point to the end of the antenna. For example, a shortened antenna, which is 50% or half the size of a half-wave dipole (one-quarter wavelength overall) with loading coils positioned midway between the feed point and each end (50% out), would require coils having an inductive reactance of approximately 950 Ω at the operating frequency for antenna resonance.

Fig 72—The WØSVM "Shorty Forty" center-loaded antenna. Dimensions given are for 7.0 MHz. The loading coil is 5 inches long and 2½ inches diameter. It has a total of 30 turns of #12 wire wound at 6 turns per inch (Miniductor 3029 stock).



For the antennas shown, the longer the overall length (dimension A, Fig 70A, in feet) and the farther the loading coils are from the center of the antenna (dimension B, also in feet), the greater the efficiency of the antenna. As dimension B is increased, however, the inductance required to resonate the antenna at the desired frequency increases.

Approximate inductive reactances for single-band resonance (for the antenna in Fig 70A only) may be determined with the aid of **Fig 71** or from Eq 10 below. The final values will depend on the proximity of surrounding objects in individual installations and must be determined experimentally. The use of high-Q low-loss coils is important for maximum efficiency.

A dip meter or SWR indicator is recommended for use during adjustment of the system. Note that the minimum inductance required is for a center-loaded dipole. If the inductive reactance is read from Fig 66 for a dimension B of zero, one coil having approximately twice this reactance can be used near the center of the dipole. **Fig 72** illustrates this idea. This antenna was conceived by Jack Sobel, WØSVM, who dubbed the 7-MHz version the "Shorty Forty."

$$X_L = \frac{10^6}{34\pi f}\left(\frac{\left(\ln\frac{24\left(\frac{234}{f} - B\right)}{D} - 1 \right)\left(\left(1 - \frac{fB}{234}\right)^2 - 1 \right)}{\frac{234}{f} - B} - \frac{\left(\ln\frac{24\left(\frac{A}{2} - B\right)}{D} - 1 \right)\left(\left(\frac{\frac{fA}{2} - fB}{234}\right)^2 - 1 \right)}{\frac{A}{2} - B} \right) \qquad \text{(Eq 10)}$$