

Element Length Correction for Solid Yagi Elements

Steve Kavanagh, VE3SMA

Most Yagi modelling software does not take into account the capacitance of the end surfaces of solid elements as are typically used at 144 MHz and above. In the VHF range this is of very little consequence as the elements are customarily of quite small diameter with respect to their length and so have negligible end-surface area. However as the frequency goes up it is customary to retain similar element diameter, for mechanical reasons primarily, which makes the end surface area more significant.

If we optimize an antenna using typical modelling software and then build it using solid element material, there will be an extra capacitance at each end of the element due to the end surface area, which will tend to detune the element downwards compared to the theoretical model. Therefore, in order to retain the same element resonance as in the theoretical model, it will be necessary to reduce the length of the element slightly. As a first approximation the amount of length reduction should be that which reduces the area of the cylindrical surface by the same area as that of the two end surfaces. The area of each end surface is

$$A_{\text{end}} = \pi D^2/4 ,$$

where D is the element diameter. The area of the cylindrical surface of the element over a short length δ is

$$A_{\text{cyl}} = \pi D \delta .$$

We must shorten each end of the actual element with respect to the theoretical length by an amount δ such that A_{cyl} is equal to A_{end} . Thus

$$\begin{aligned} \pi D \delta &= \pi D^2/4 , \text{ and so} \\ \delta &= D/4 . \end{aligned}$$

The total length correction for a dipole element (to correct for the capacitance of both ends) is then just 2δ , or $D/2$.

For example, a 1296 MHz design may call for a theoretical element length of 4.00 inches and diameter D of 1/8 inch. The element length should be shortened by half the diameter, or 1/16 inch to correct for the software not taking into account the end surface capacitances. The antenna should be built with a corrected element length of 3.94 inches.