

The Radio Hotel- Dissecting Series #2

A look inside those encased, potted, sealed, multi-layered, "things" we use on a daily basis.

Inside the Cushcraft R-Series Vertical and its' Black Box

by Rick Hiller -- W5RH



One of the more popular antennas over the past many years is the Cushcraft R-series verticals. Starting out as the R3 for 20, 15 and 10 meters, then adding bands to get the R4, R5, R6 and R7 (the most popular, a 7 band version). Currently they have the R-8000 and most recently the R9000. The benefit of this antenna system (at left) is that it is a self-contained, self-resonant vertical system requiring none of the traditional vertical $\frac{1}{4}$ wl counterpoise/radials. How this all works is that it is an electrical $\frac{1}{2}$ wl vertical dipole on each band and fed off-center thru a matching network (literally -- the "Black Box"- see right). So the system is designed to have an unbalanced input feed Z of 50 ohms on all of the bands. In order to get the higher off-center feed Z from a 50 ohm input, Cushcraft designed a matching network and placed it inside "the black box" .

The network, inside the black box, has a 1:1 Guanella balun (black core) for choking RF destined for the feed coax shield outside, followed by a 1:1.2 ratio toroid transformer (red core) to give the impedance transformation.....there are coupling capacitors that help with the matching and DC isolation along with a 50 uH coil that provides a high impedance path to ground for bleeding off static charges when they get too high. So really nothing special, just basic antenna and feedline magic put together in a unique configuration.

Modeling -- When I modeled a 10 meter version of this antenna -- the easiest band to model -- you end up with an off-center-fed dipole. The feedpoint is further out the antenna length from the center high current loop making the feed impedance greater than 50 ohms (See TRH BVARC Newsletter May 2015 -- The Antenna Pt.3)

For reference, if you calculate a full $\frac{1}{2}$ wl on 28.500 you get 196 inches. The vertical portion of the R7 on 10 meters is 137" or 135 electrical degrees. The remaining 45 degrees (dipole has 180 degrees) will be handled by the end loading -- the seven radials spread out at the bottom. The feed Z at the bottom of the 135 degree vertical section is nominally 60 ohms, due to these seven 49" horizontal radials. (Note: Modeling a full length vertical dipole and feeding it in the same spot -- calculates to about a 110 ohm feed Z, which is more typical for an OCF dipole.) With each band addition you get a longer vertical element (with a constant end loading radial structure) and that moves the feedpoint further and further out from the antenna's electrical center. The coils in the higher band traps add cumulatively to the total antenna loading, making, for example, the 40 meter loaded antenna length about 23 feet (certainly short for 40 meters).

R-Series Vertical Performance -- Cushcraft instructs you to place the antenna base at 10 feet off the ground. This height provides a main lobe launch angle of about 17 degrees -- nice for DX. Even when mounting the antenna at increased heights, the launch angle remains around 17 degrees. The benefit of mounting it higher, if you can, is that it is above the surrounding buildings and trees and away from most of the locally generated noise. Some folks swear by a top of the tower vertical to receive (and transmit) in all directions. In that situation it might just tie into being a second antenna for the beneficial purpose of diversity (see TRH January 2017 BVARC Newsletter).



Enjoy your hobby. GL ES

73 DE W5RH

Next time.... The Other Antenna Attributes