Low Profile Wide Band VHF/UHF Antenna

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Many applications in communications and radar require antennas that conform to the surface of the supporting structure. Whenever applicable, the antenna aperture is approximated by a plane with the requirement that the dimension normal to the aperture ("profile") be minimized. Low profile antennas are of special importance within the VHF/UHF bands where they are used as communications antennas on airborne platforms. In addition to low profiles, these antennas also require wide bandwidths. Meeting both requirements at the long wavelengths involved poses special difficulties. Although the subject of profile reduction for flush mounted antennas is not new, the number of papers dealing specifically with VHF/UHF band designs is surprisingly small. Two recently proposed designs employ variants of a discone antenna.

The availability of high index metamaterials has widened the range of possible design approaches. Of particular interest are high index magnetic ($\mu_r \geq 10$) materials that exhibit low loss in the UHF/VHF band. This paper presents preliminary simulation results of an antenna model where the profile reduction is achieved with high index metamaterials. The antenna is a flanged rectangular aperture backed by a tapered cavity terminated by a short circuit. An appropriately shaped high index magnetic/dielectric material within the cavity establishes local resonance conditions with the inner conducting walls along the taper. The band of interest is 200 – 500 MHz.

Simulations show that for an antenna profile of less than 1% of the wavelength at the lower band edge, a uniaxial anisotropic high index magnetic material gives a positive realized gain over of the entire band. Specific guidelines for the orientation of the material anisotropy are presented based on the realized gain of the antenna. Furthermore, a transverse resonance technique is developed to optimize the shape of the material with an emphasis on maintaining a constant cutoff frequency throughout the cavity. All materials are assumed lossless, and the figure of merit used is the far field realized gain of the radiating structure. All simulations have been run using the time domain solver of CST Studio Suite 2013, and adaptive meshing has been used to verify convergence in the far field results.