Extremely Low Profile Wideband UHF Antenna

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This research analyzes the properties of anisotropic magnetic media used to reduce the profile of a radiating rectangular cavity at low UHF. Traditionally, air-filled rectangular waveguides achieve broadband performance via a coaxial line-to-waveguide transition which terminates in a tuning element. The waveguide is terminated in a short below the tuning element. Usually the electrical height between the tuning element and the short is approximately one quarter the guide wavelength. We propose loading this portion of a waveguide with high index anisotropic media to reduce this height. Furthermore, we explore the concept of a low profile radiating waveguide at low UHF by also minimizing the distance between the tuning element and the radiating aperture. The aperture is the opening of our cavity surrounded by a one inch flange. At this point, the structure is more accurately described as a cavity rather than a waveguide due to its being a very small fraction of wavelength. We use a transverse resonance condition established between the walls of the cavity and the anisotropic medium to suppress the introduction of high order resonances introduced by the high refractive index of the medium. We derive this transverse resonance condition for the anisotropic case and apply the results to the design of our cavity.

The fields inside the cavity are stimulated using a variation on a traditional coaxial-line-to-waveguide transition. We terminate the inner conductor of the coaxial line to two symmetric rectangular probes fed 180 degrees out of phase. These probes are thin, serving to help minimize the cavity profile, while the width and length of the probes serve to tune out the reactance within the cavity and provide a wideband impedance match at the coaxial inputs. The symmetric feed creates a potential difference between the two probes providing a continuous path for the current. This eliminates the fringing fields associated with the potential difference created between the probe and the walls of the cavity which act as common ground.

The resulting antenna design yields a $0.06\lambda_{max}$ (3.2") cavity depth with a VSWR better than 3:1 from 225 to 500 MHz with no external matching circuitry needed. We define λ_{MAX} as the lowest frequency which achieves a 3:1 VSWR. The antenna also shows a very good realized gain of 4.0 to 7.9 dB across the band. This means that even though the aperture is close to the short below the tuning element, we are not shorting out the antenna. These high realized gain values coupled with a 124% bandwidth make this type of low-profile anisotropic cavity design very appealing.