Metallic Ogival Resonators Partially Filled with DNG Metamaterial

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A metallic ogival resonator is defined as a closed cylindrical volume with flat top and bottom bases, and whose side walls consist of two portions of parabolic cylinders having the same focal length, a common focal axis, and facing each other. All surfaces of the resonator are assumed to be PEC. The focal axis is the z-axis of a rectangular coordinate system, and is perpendicular to the resonator bases. In any plane z = constant, the x-axis lies in the symmetry plane of the parabolic-cylinder surfaces, while the y-axis passes through the intersecting lines of such surfaces. Thus, the x = 0 plane and the y – 0 plane are symmetry planes that divide the resonator into two equal parts, leading to two different configurations. In either structure, one part is filled with a DPS material and the other with a DNG anti-isorefractive metamaterial. The DPS material is characterized by a real positive wavenumber that is the opposite of the real negative wavenumber of the DNG metamaterial, whereas the two materials have the same real positive intrinsic impedance.

The properties of electromagnetic fields inside the resonator are examined when the electric field is perpendicular to the bases of the cylinder. Hence, the height of the resonator does not play a role in the analysis, that is conducted in the phasor domain with the time-dependence factor *exp(+jωt)* omitted throughout. A rigorous, full-wave analysis of the boundary-value problem is performed utilizing a known methodology (see P.L.E. Uslenghi, *IEEE Antennas Wireless Propag. Lett.,* vol.11, pp.419-422, 2012). All field components are expressed as linear combinations of plane waves and products of plane waves times Fresnel integrals. It is concluded that modes exist inside the resonator that are independent of its dimensions in terms of wavelength. Hence, the resonator can be miniaturized at those frequencies for which the DNG metamaterial behaves as postulated.