ELECTRON BEAM COUPLING TO ELECTRICAL METAMATERIAL STRUCTURES

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Many authors over many decades have considered the coupling of electron beams to various microwave structures. These structures range from slow wave structures, such as traveling wave tubes, to dielectrics, such as the dielectric Cherenkov maser. In this presentation, we consider the coupling of relativistic electron beams to electronic metamaterials. In previous treatments, our research focused on linear metamaterials without frequency or spatial dispersion. We now extend this treatment to consider both issues, as well as so-called indefinite medium, in which the dielectric permittivity and magnetic permeability must be treated as a tensor. Further, we investigate in a cylindrical geometry electron beams of finite extent. We treat the electron beam as a cold, non-neutral plasma confined by an infinite magnetic field, confining motion of the electrons to the axial direction. We treat the metamaterial, which loads the cylindrical waveguide along its outer wall, using effective medium theory, considering cases of double positive, single positive, and double negative dielectrics. In particular we study the dispersion and small signal growth rate of this system, the frequency range of applicability, and the Pierce parameter and coupling impedance of such structures.