

“Three-dimensional CRLH metamaterials for microwave applications”, pp. 151-162

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Abstract – Left-handed Metamaterials are artificial electromagnetic structures exhibiting special properties like negative permeability, negative permittivity and negative refractive index. The name left-handed (LH) metamaterials is due to the circumstance that the vectors of the electric field, the magnetic field and phase velocities form a left-hand oriented trihedron. The wave equation and the electrodynamics of an ideal metamaterials are investigated. It is shown that a real metamaterial can exhibit negative refractive index only in a limited frequency range and is essentially inhomogeneous. Such materials therefore are composite right/left-handed (CRLH). The Maxwell's equations and extended analytic models considering negative and positive refractive index regions are introduced and discussed. The transmission line matrix (TLM) scheme provides a fundamental theoretical framework for the finding and exploration of three-dimensional metamaterial structures. CRLH 3D metamaterial cells can be realized on the basis of the TLM topology. Structure and dispersion properties of the balanced 3D metamaterials based on such cells as well their possible planare realizations are discussed.