J. of Electromagn. Waves and Appl., Vol. 23, 1957–1968, 2009

SOME ASPECTS OF RADIO WAVE PROPAGATION IN DOUBLE ZERO METAMATERIALS HAVING THE REAL PARTS OF EPSILON AND MU EQUAL TO ZERO

H. Oraizi and A. Abdolali

Department of Electrical Engineering
Iran University of Science and Technology
Tehran 1684613114, Iran

Abstract—Recently, various uncommon materials such as metamaterials have been the subject of intensive research. In this paper, we introduce a new class of materials called double zero materials (DZR) having the real parts of both its epsilon and mu equal to zero and investigate the electromagnetic wave propagation in them, particularly the propagation constant k and intrinsic impedance η. We investigate the reflection and transmission coefficients from multilayer structures made of DZR material located in various media. It is shown that the DZR constants namely k and η and also the reflection and transmission coefficients from the multilayer structures are all real quantities. Several numerical examples are provided for both dispersive and nondispersive DZR materials.

1. INTRODUCTION

Common materials are called double positive (DPS) because the real parts of their permittivity and permeability parameters are positive. In 1967, Veselago [1] postulated metamaterials [2–5] which had negative real parts of permittivity and/or permeability denoted as double negative [DNG, $\mathrm{Re}(\varepsilon) < 0$ and $\mathrm{Re}(\mu) < 0$], epsilon negative [ENG $\mathrm{Re}(\varepsilon) < 0$ and $\mathrm{Re}(\mu) > 0$] and mu negative [MNG, $\mathrm{Re}(\varepsilon) > 0$ and $\mathrm{Re}(\mu) < 0$]. In 2000, Smith and Pendry [5–8] proposed several methods for the fabrication of metamaterials, namely thin wires (TW) for ENG metamaterials and split ring resonators (SRR) for MNG metamaterials. Planar metallic configurations and various other types of elements, such as omega (Ω) and S shapes embedded inside material

Corresponding author: H. Oraizi (h_oraizi@iust.ac.ir).