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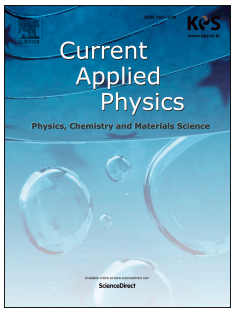

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Design and analysis of a new composite double negative metamaterial for multi-band communication

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Abstract: In this paper, a double C-shaped structure of double negative composite metamaterial is designed and depicts in configurations that can capable in a multi-band microwave frequency band. The design has achieved relative negative permeability, relative negative permittivity and relative negative refractive index. Analysis and comparison were done by using four configurations of composite metamaterial such as horizontal 1×1 array and vertical 1×1 array structures and the horizontal 1×1 and vertical 1×1 unit-cell configurations. Multi-band operating frequencies namely, S-band, C-band and X-band have been achieved using all configurations. The proposed metamaterial size is 1.2 cm × 1.2 cm × 0.16 cm which includes all geometrical parameters to fit the design inside the substrate area. Computer Simulation Technology (CST) is adopted to investigate this design where an incident electromagnetic wave travelling along the positive z-axis with an E-field polarized along the y-axis. The results of the proposed metamaterial depict multi-band metamaterial response over the frequency span from 1 to 15 GHz. The effective medium ratio of the metamaterial unit-cell is 7.44. Moreover, the results clearly seen that the single-negative and double-negative metamaterial characteristics of the unit-cell and arrays over the multi-band. The dimensions and scattering parameters of the proposed double C-shaped metamaterial are suitable for the S -band, C-band and X-band applications.

Keywords: C-shaped unit-cell; DNG metamaterial; Multi-band;

1. Introduction

Metamaterials have some exotic electromagnetic properties that cannot meet the properties of natural materials. It is man-made electromagnetic materials which are not found available in nature. The exotic electromagnetic properties of these composite materials can be achieved from their different structure rather than chemical arrangements. Materials with relative negative permittivity (ε less than 0) and permeability (μ less than 0) was some various properties compared to conventional materials has been depicted by Victor Veselago in 1968. Till 1999, due to the non-appearance of the properties of the regular materials, this matter was less important. Negative permittivity properties of the materials could be found, but make engineered material with negative permeability was challenging work. Smith et al. achieved success to develop a new engineered material with unusual properties such as negative permeability and permittivity practically in 2000 [1]. Three types of metamaterials were discussed in various papers such as μ or ε negative metamaterial, μ and ε negative metamaterial and zero-index metamaterial. A metamaterial will be single negative material (SNG) whether it has negative permittivity or negative permeability properties of the material [2]. Double-negative (DNG) material is a type of material which has μ and ε both negative [3]. On the contrary, zero-index material is a