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Low pass filter using metamaterial

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Abstract

From last many years metamaterials have great inquisitiveness for research by designers, many antenna and filter designers used these materials for their research and gets good results. These materials are special because they are artificial material having the property of negative permeability or negative refractive index so that it has the ability to support backward waves. The proposed filter in this paper is physically implemented on top of a FR-4 substrate using usual fabrication process the comparison plots for transmission coefficient and reflection coefficient of both simulate and measured results. The mid frequency is taken as 1.8GHz. The dielectric permittivity is 4.2 with a depth of 1.6mm, and the loss tangent considered is 0.02 are the essential design parameters for the low pass filter. Full wave EM simulations were used to take out the appropriate coupling coefficient and external quality parameters, which were then used to estimate the physical dimensions of the microstrip filter. The purpose of this study is to demonstrate that the equivalent circuit elements (capacitance and inductance) are affected by the surface current distribution.

Introduction

Metamaterials are known to have unusual characteristic with their unnatural built properties with easy definition which said metamaterials are made with characteristics of negative permeability and permittivity with negative refraction index which is defined firstly in 1968 by the physicist Victor-Veselgo. Metamaterials have these characteristic from the predefined structures in place of their creation [1]. Metamaterials have broad function area in different fields of science and engineering for researchers to demonstrate special electromagnetic characteristic that are not create by nature. These characteristics are found by the period structure of this material which enhances the future of this material in microwave field [2]. Pendry [3] was proposed a new structure of split ring resonator (SRR) as two structure of rings together in form of loops of opposite facing and developed on a dielectric substrate. SRR structure is designed very simple in the form of concentric circle or concentric square loops with the property of negative refractive index at required frequency range [[5], [6], [7], [4]]. The working principle of these rings is to placed them in time varying magnetic field and these rings are induces a rotating current which produce a magnetic field, by this it opposes the incident field. By the break open in the ring it act as a capacitor and form a LC tuned circuit at particular resonant frequency and the negative refractive index prevents the wave propagation at that particular resonant frequency [8].

The demand of microstrip low pass filter increases day by day because of its compact size and ease of fabrication also the compatibility with other planner devices. To accomplish the goal of getting these type of filters different techniques are applied and mateamaterials are the best one of them [9], [10], [11]. In this paper a low pass filter is planned to design with square split ring resonator Section 2 contains the design of SRR and Section 3 follows it with mathematical derivation, at last Section 4 concludes it with result.