Recent Technique in Design of Band Pass Filter in Microstrip Applications

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ABSTRACT
In this paper, a new approach for the development of planar Metamaterial structures is developed. For this purpose, split-ring resonators (SRRs) coupled to planar transmission lines are investigated. The electromagnetic behavior of these elements, as well as their coupling to the host transmission line, are studied. The proposed analysis is of interest in the design of compact microwave devices based on the Metamaterial concept.

Keywords—*Metamaterial, Microstrip, Conventional Filter, Computational electromagnetic, Q- factor*

I. INTRODUCTION

In recent years, there has been a growing interest for the design of one, two and three-dimensional artificial structure (also called metamaterials) with electromagnetic properties generally not found in nature. Among them, special attention has been devoted to double-negative media. These are artificial periodic structures composed of sub-wavelength constituent elements that make the structure behave as an effective medium with negative values of permittivity and permeability at the frequencies of interest. The properties of such media were already studied by Veselago [4] over 30 years ago.

Metamaterials refer to artificial structures that consist of a periodic array of metal pieces or the like. Technologies called "left-handed Metamaterials" in particular can even produce phenomena that are not available in natural substances and thus it is expected that this will enable the fabrication of electronic devices with functions heretofore unimaginable.

This paper first provides eight pole square split ring resonator are introduces which are nearing practical use, focusing on such applications as telecommunication devices, we will also mention the future evolution of such technologies. Metamaterials are usually composed of periodic sub-wavelength units, which can produce electric or magnetic response under the excitation of external incident waves. Since the characteristic dimensions of the composing units are far smaller than the working wavelength, effective medium theory can be utilized to describe the electromagnetic properties of the periodic structures [1-3]. In this paper, new MTMs comprised of square split ring resonator (SSRR) are constructed and analysed and simulation are done by using IE3D software.

II. METAMATERIAL

Periodically arranged at intervals shorter than the specified wavelength of an electromagnetic wave, small pieces of metal and the like can constitute an artificial medium that has characteristics not found in nature (Figure 1). Such a medium is called metamaterial. Metamaterials can also be made of dielectrics, magnetic substances, semiconductors, and the like, and even electric circuits instead of metal pieces.

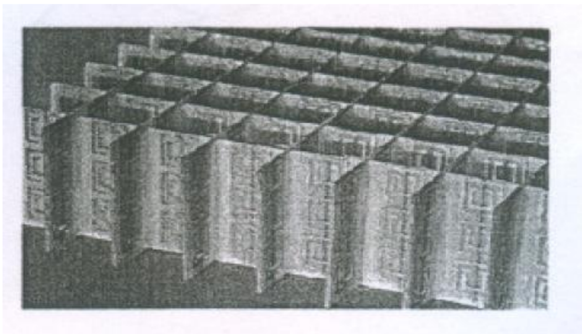

Fig.1 Metamaterial Proposed by D.R. Smit

The word "meta" derives from the Greek word that means "beyond". While conventional materials provide their intended physics properties in terms of design on the atomic or molecular level, metamaterials realize their specified physical properties through the design of an artificial structure that can be regarded as a quasi-uniform medium in a macroscopic view.

Russian scientist V.G.Veslago published about 30 years ago that examined the effects of a "left-handed" material with the simultaneously negative-permittivity and permeability along with a negative refractive index. Having originated from a purely theoretical interest, the study predicted some new phenomena that had never been conceived of. Left-handed materials were supposed to have a negative refractive index and optical applications of their characteristics attracted interest. Since there was no actual material to validate the theory at that time, no further attention was given to left-handed materials.

In 2000, US physicists D.R.Smith et al. Realized a left-handed material by an artificial structure called Metamaterial. A number of discussions and examples of experiments have been reported ever since. The electromagnetic characteristics of electronic material are primarily determined by the basic parameters, i.e. the permittivity, the permeability and the conductivity.

In contrast to such ordinary electronic materials, ones with this simultaneously negative- permittivity and permeability, if any are referred to as left-handed materials since the vectors correspond in direction to the thumb and two figures of the left hand (the third quadrant in Figure 2). There exist no left-handed materials in nature, however. Left-handed materials produce peculiar phenomena among which "negative refractive index" and the generation of a "backward wave" are the properties of particular significance.

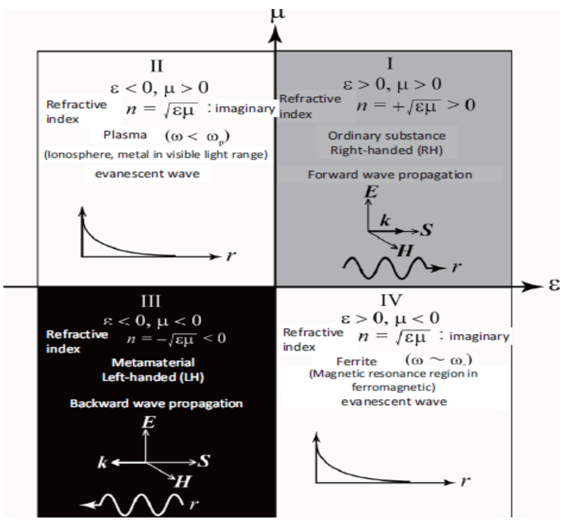

Fig.2 Classification of Materials by Permittivity ε and Permeability μ

III. CLASSES OF METAMATERIALS

Metamaterials have the potential of an enormous impact, because with the capability to direct wave propagation at the electromagnetic level, whole system can be refined. In orther words, "significant decreases in the size and weight of component devices and system" while at the same time enhancing or increasing performance can be achieved. Metamaterials allow for a flexibility of design,which means the capability to the fit desired applicatons. Composite Metamaterials, is an alternate term that is used to expresses these developments. As development of Metamaterials continues, and uses are found, it is necessary to focus on how to integrate metamaterials with other sturdier materials. In light of these developments metamaterials are represented by different classes, Split-ring resonator originally proposed by pendry have attract great intrest among microwave engineer due to their potential application to the synthesis of artificial materials.

IV. DESIGN PROCEDURE

In this paper eight pole asymmetric band pass filter is design and simulated. This filter structure is able to produce two finite frequency attenuation poles one on the lower side and other on the higher side of pass band. The element value of low pass prototype filter of this design are

$g_1 = 1.02761$, $g_2 = 1.46561$, $g_3 = 1.99184$, $g_4 = 1.86441$
$M_{1,2} = M_{7,8} = 0.08441$, $M_{4,5} = 0.0723$, $M_{3,6} = -0.01752$,
$M_{2,3} = M_{6,7} = 0.06063$, $M_{3,4} = M_{5,6} = 0.05375$
$J_3 = -0.33681$, $J_4 = 1.3013$
$Q_{ei} = Q_{eo} = 9.9199$

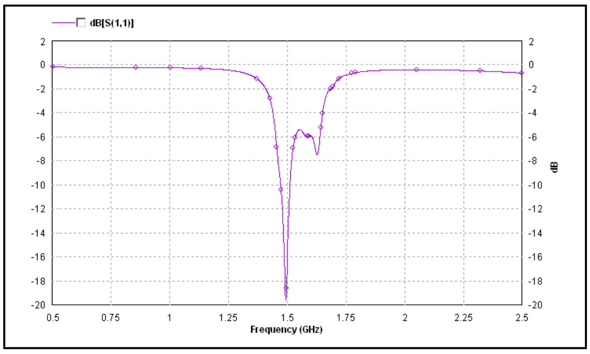

Fig.3 Full-wave EM simulated return loss response of the filter for $\varepsilon_r = 4.4$ and h =1.6.

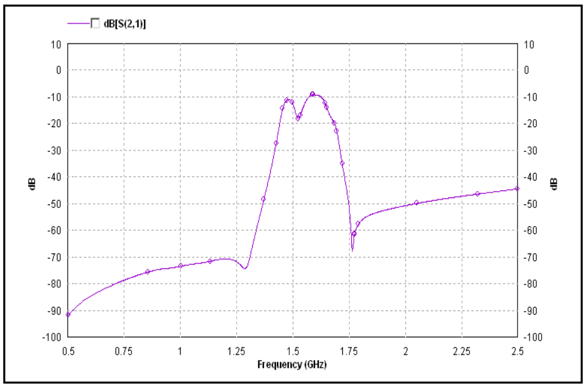

Fig.4 Full-wave EM simulated insetion loss response of the filter for $\varepsilon_r = 4.4$ and h =1.6.

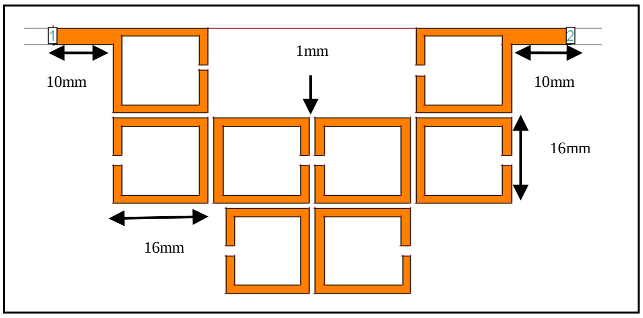

Fig.5 Layout of the eight-pole microstrip band-pass filter on $\varepsilon_r = 4.4$ and h = 1.6 mm.

VI. RESULT & CONCLUSION

Fig.5 shows the final layout of the design asymmetric split ring resonator band pass filter. The simulated result of fig.5 are shown in fig.3 and fig.4. The filter having return loss of – 20 dB at 1.5 GHz. The filter having split ring resonator have large fractional bandwidth (FBW) = 10.359% and the rejection in the lower pass band is 40dB at 125.5MHz. The filter is design on the top of FR/4 'Glass/Epoxy' substrate having the dielectric permittivity of 4.4 with the thickness 1.6mm the loss tangent of the substrate is 0.02. the simulated result shows that by using square split ring resonator the fractional bandwidth within increase and the return loss in the pass band is also increase and the rejection in the lower side of the pass band is also increases.

If practical applications to exploit the advantageous properties of left-handed metamaterials for the market requirements are proposed by industry without being blinded by the linear model of research and development and if academic societies work cooperatively with the proposals, there will be then technical advances promoting its practical use and even another step forward. With the globalization of research activities and worldwide competition, the speed of development has grown intense.

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