Chapter 5
Metamaterial-Based Absorber

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ABSTRACT

In this chapter, the authors discuss metamaterial absorbers. The need for active absorbers and also different types of active absorbers have been listed in detail such as switchable absorber/reflector, switchable absorber, and tunable absorbers. The recent trends and the work investigated by researchers around the globe have also been mentioned in brief, which can set a benchmark for further research in the field of metamaterial absorbers. The proposed MTM structure is made up of four-square patches. The structure was designed on an FR4 substrate measuring 11 mm by 11 mm with a thickness of 1.60 mm. Other properties of the substrate include relative permittivity of 4.4 and loss tangent of 0.019. The structure has a full ground plane to minimize transmission. The structure's primary resonance for absorber mode configuration is at 8 GHz. The simulations of the proposed structure were carried out using CST.

INTRODUCTION

The high frequency region has been basically quantified into two regions, microwave and optical range. Optical region covers infra-red, visible and ultra-violet region. The microwave range lies between 300 MHz to 300 GHz and in terms of wavelength it lies between 1m to 1mm (Mujawar et al., 2022). For all the conventional users,

DOI: 10.4018/978-1-6684-8287-2.ch005

microwave frequency ranges from 1 to 40 GHz, over which we can also consider the mmwave band from 30 to 300 GHz and the operating wavelength is between 1mm to 10mm or 1 cm. The optical range lies between 30 to 3000 THz. There is a THz gap of 0.3 to 30 THz between microwave and optical range. According to carson's rule, as carrier frequency increases the bandwidth requirement increases by 10% of the carrier frequency. The channel capacity as per shannon's law depends on bandwidth and signal-to-noise ratio. $C = Blog_2(1+SNR)$, As SNR remains constant and bandwidth increases, the channel capacity will increase. Therefore, the number of channels that can be accommodated over a particular medium increases. Hence the researchers have opted for higher frequencies for communication purpose.

Introduction to Metamaterial: The word "Meta" means "beyond". Metamaterials are basically structures which are homogeneous in nature. They are the periodic structures and when their periodicity is excited by external waves or signals. It exhibits unusual electromagnetic properties. There are different type of materials and each material has its own properties. The property of the material never changes at any cost. When the properties of the material are changed artificially, it is called as metamaterial. All natural materials like glass, or diamond have positive electrical permittivity, magnetic permeability and an index of refraction. When the properties of these materials are changed making them negative, it is called metamaterial (Smith et al., 2005). Metamaterial is not a natural material; it is artificial material by changing the character so that they can change the property of the electromagnetic waves. A basic meta-atom consists of unit cell, the size of unit cell is less than $\lambda/4$ (effective homogeneity limit). Meta-surface is the two dimensional analog of the metamaterial. It basically comes from frequency selective surface, where we are having 2 dimensional array, which can be made of metallic patches, slots etc. The thickness of the structure is very thin in nature that is less than $\lambda/10$. When the thickness is less than $\lambda/10$, the structure is ultra-thin in nature. Whenever the periodicity is operating in the sub-wavelength region ($\leq\lambda/4$), the structure is a meta-surface. Ripin et al. (2012) came up with the idea for an MSA that makes use of EBG structures at the ground and incorporates the dielectric from Rogers RO3003. As compared to an antenna that does not have an EBG structure, this model was resonated at 7.3 GHz, which resulted in an increased bandwidth of 39.63% while simultaneously lowering its size by 22.38%. It is put to use in analyzing a wide variety of MSA features. The Nicolson-Ross-Weir (NRW) method was used in order to do research on the metamaterial characteristics of the proposed antenna.

Wearable sensors equipped with antennas that can monitor a person's health, as well as their performance in sports, during exercise, and other activities, are gaining a significant amount of popularity. These types of applications could make use of the ON-body and OFF-body sensors that are a part of Wireless Body Area Networks (WBANs). The ISM band is regarded as the band that is most ideally

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