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Impact of Metamaterial in Antenna Design: A Review

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Abstract

In this paper it is observed that how metamaterials can be used to improve the design parameters of antenna. Metamaterials are kind of structures through which negative permittivity and negative permeability can be obtained. This special property will improve some vital properties of antenna such as return loss, efficiency, size, bandwidth, multiband behavior, directivity, gain and specific absorption rate (SAR). In this paper some popular structures of metamaterial are highlighted after review.

Key Words: Metamaterial, Antenna parameters, Negative permittivity, Negative permeability

I. INTRODUCTION

In recent days people are concentrating more about metamaterial based antenna design as it has lot of advantages. The metamaterial based antenna can be designed with improved antenna parameters.

i) Return loss (RL): Return loss is the loss of power in the signal returned/reflected by a discontinuity in a transmission line. It is usually expressed as a ratio in decibels (dB). The metamaterial structure can decrease the return loss and make antenna to work with a better efficiency.

ii) Efficiency: Antenna efficiency is radiation efficiency. It is a measure of the efficiency with which a radio antenna converts the radio-frequency power accepted at its terminals into radiated power. Efficiency can be increased with the metamaterial defect introduced in the antenna design.

iii) Size: Physical size of the antenna can be decreased by using metamaterial structure as substrate, superstrate or any other position.

iv) Band Width (BW): Bandwidth describes the range of frequencies over which the antenna can properly radiate or receive energy. Often, the desired bandwidth is one of the determining parameters used to decide upon an antenna. For instance, many antenna types have very narrow bandwidths and cannot be used for wideband operation. Bandwidth is typically quoted in terms of VSWR (Voltage Standing Wave Ratio). It can actually measure the transmission line imperfection which indirectly gives the measurement of band width. The use of metamaterial can increase the bandwidth.

v) Multi Band behavior: Multiband structure with lesser size can be designed with the help of metamaterial structure antenna design. Single antenna can cover multiple frequency ranges which in turn improve the overall performance of the antenna.

vi) Directivity: Directivity is a figure of merit for an antenna. It measures the power density the antenna radiates in the direction of its strongest emission, versus the power density radiated by an ideal isotropic radiator (which emits uniformly in all directions) radiating the same total power. Metamaterial antenna can improve the directivity of an antenna.

vii) Gain: A relative measure of an antenna's ability to direct or concentrate radio frequency energy in a particular direction or pattern. The measurement is typically measured in dBi. Metamaterial antenna can improve the gain of the antenna.

II. DIFFERENT METAMATERIAL STRUCTURE REVIEW

A narrow band microstrip patch antenna with "Pentagonal Rings" shaped metamaterial cover is proposed and analyzed at a height of 3.2mm from the ground plane [2]. The antenna is designed with a frequency of 2.31 GHz S band frequency. In this paper decreased Return Loss and increased efficiency is obtained.

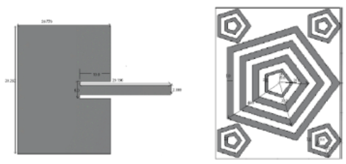

Fig.1. Microstrip Pentagonal patch antenna with Pentagonal ring metamaterial

Microstrip patch antenna filled with split ring resonator array with a S-Shape patch [3] is designed for 1.73 Hz frequency L Band. In this antenna it is reviewed that introduction of metamaterial increase the bandwidth and decrease the return loss.

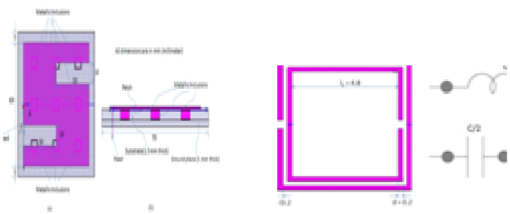

Fig.2. Microstrip S shaped patch antenna with Split Ring Resonator array metamaterial

Rectangular microstrip patch Antenna with Circular Complementary Split Ring Resonator (CSRR) [1] is designed for 1.1 GHz, 1.4 GHz, and 2.25 GHz. In this paper it is reviewed that the use of metamaterial reduces the antenna size with the introduction of Multiband behavior.

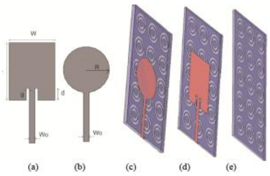

Fig.3. (a) rectangular patch, (b) circular patch, (c) circular patch with a CSRR array in the ground plane, and (d) rectangular patch antenna with a CSRR array in the ground plane (GP), and (e) superstrate with a CSSR array.

Rectangular microstrip inset feed patch antenna with H shaped metamaterial structure is designed for 4.3 GHz. In this work return loss is reduced, antenna size reduced and band width increased.[4]

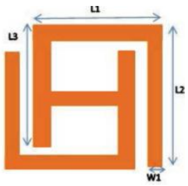

Fig.4. Geometric structure of double H shaped resonator

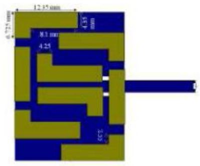

Fig.5. C shaped metamaterial structure

2.4 GHz Rectangular Microstrip Patch Antenna is designed with reduced return loss. The metamaterial is.C-shaped [5].

III. CONCLUSION

After reviewing all the papers, it is concluded that the implementation of metamaterial can decrease the return loss, increase the efficiency, decrease the size, increase the band width, can introduce the multiband behavior, improve directivity and increase gain.

IV. REFERENCES

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