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Design and Analysis Single H Shaped Metamaterial Embedded RMPA

Shivani Jain
Research Scholar
Shree Ram Institute of Technology
Jabalpur (M.P.), [INDIA]
Email: shivani.jain1491@gmail.com

Divyanshu Rao
Assistant Professor,
Department of Electronics And Communication Engg.
Shree Ram Institute of Technology
Jabalpur (M.P.), [INDIA]
Email:divyanshu3@gmail.com

Ravi Mohan
Professor
Department of Electronics And Communication Engg.
Shree Ram Institute of Technology
Jabalpur (M.P.), [INDIA]
Email: ravimohan7677@yahoo.co.in

ABSTRACT

In this paper present microstrip patch antenna incorporated with left-handed metamaterial at 5.2 GHz. The proposed antenna utilizes metamaterial structure in the height of 1.5 mm from the ground plane. This paper shows the comparison between the microstrip patch antennas using alone and loaded with metamaterial structure with the improvement in antenna Reflection loss between all ports (S Parameters) and reduction in return loss at the same resonant frequency. By use of this combination it has been seen that there is an Improvement of return loss of around 3 dB. These structures are simulated using IE3d Electromagnetic simulator of Zeeland Software incorporation.

Keywords: *— Patch Antenna, Metamaterial, Single H-Shaped Structure, Feeding Point, Return Loss.*

I. INTRODUCTION

All communication devices which use free space as the medium of communication need antenna. Antenna is a transducer which coverts electrical energy into electromagnetic waves and radiate into space when used as a transmitter and receives electromagnetic waves and converts into electrical energy when used as receiver[1-2].In microwave range microstrip patch antennas are used. They are very useful in satellite communication as well. Microstrip patch antenna is one of the most preferred antenna structures due to their low profile and ease of fabrication [3]. They have many applications, especially in wireless communication. However, the major disadvantage of the microstrip patch antenna is its narrow bandwidth. Lots of research work has been done in recent years to develop bandwidth enhancement techniques. RMPA have different geometries such as rectangular, triangular, circular, etc [4]. In modern wireless communication meta material versatile used to reconfigure antenna characteristics, by using different dielectric substrates on a fixed resonant frequency of 5.2 GHz and height of 1.5 mm. Different parameters such as Return Loss, Antenna Reflection loss between all ports (S parameters) is analyzed. Micro strip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side [6]. The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate. In order to simplify analysis and performance prediction, the patch is generally square, rectangular, circular, triangular, and elliptical or some other common shape Broad band Microstrip patch antenna is widely used in microwave range for transmitting and receiving signals due to their small and conformal size ease of fabrication and planar geometry [7-8].

II. Design Analysis

A. Design Specification

The three essential parameters for the design of a rectangular Microstrip Patch Antenna are:

• ***Frequency of Operation:***

The resonant frequency of the antenna must be selected appropriately. The resonant frequency selected for my design is 5.2 GHz.

• ***Dielectric constant of the substrate (εr):***

The dielectric material selected for my design is Fr 4

epoxy substrate having dielectric constant of 4.3 and loss

tangent =0.0025.which has a dielectric constant of 4.3.

• ***Height of dielectric substrate (h):***

Height of dielectric substrate is 1.5 mm. So, the essential parameters for the design are:

• f_0 : 5.2 GHz

• ε_r: 4.3

• *h s:* 1.5 mm

B. Design Procedure

Step 1: Calculation of the Width (W):

$$W = \frac{c}{2f_0\sqrt{\frac{\varepsilon_r+1}{2}}}$$

Substituting c = 3.00e+008 m/s, ε_r= 4.3 and fo = 5.2 GHz, we get:

W = 22mm

Step 2: Calculation of Effective dielectric constant (ε_{reff}):

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{w}\right]^{\frac{1}{2}}$$

Substituting εr= 4.3, h = 1.5mm and W = 22mm, we get:

$\varepsilon_{reff} =$ 1.2.

Step 3: Calculation of the length extension (ΔL):

$$\Delta L = \frac{0.412h(\varepsilon_{reff}+0.3)(\frac{w}{h}+0.264)}{(\varepsilon_{reff}-0.258)(\frac{w}{h}+0.8)}$$

Substituting ε_{reff} = 1.2, h = 3mm and W = 800mil, we get:

ΔL = 0.00130 mm.

Step 4: Calculation of the Effective length (L_{eff}):

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}}$$

Substituting ε_{reff}= 5.046, c = 3.00e+008 m/s and f = 5.2GHz, we get:

Step 6: Calculation of actual length of patch (L):

$$L = L_{eff} - 2\Delta L$$

Substituting L_{eff} and ΔL, we get: L = 17 mm.

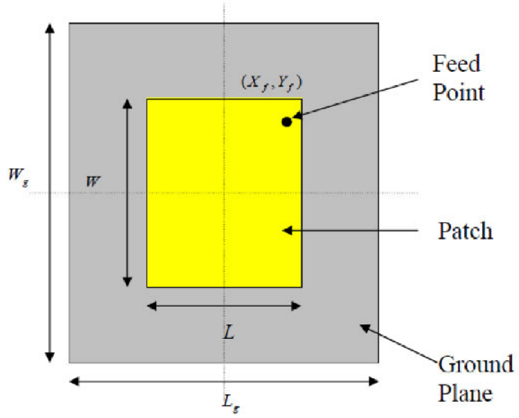


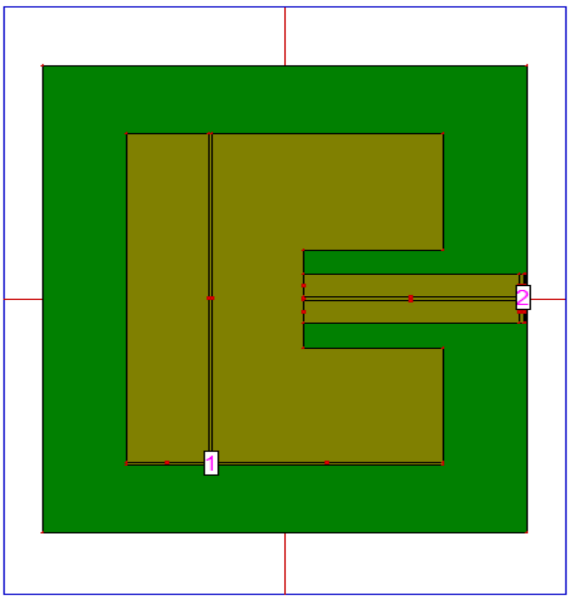
Figure 1: Top View of Design Procedure

C. Design Configurations

Compact broad band antenna design in two configuration in first design theoretical antenna an in second design antenna 1 using Round H-Shape META material, analyzed and validated all two geometry in IE3D Simulator, the geometry of all two configure is shown.

THEORETICAL ANTENNA

Micro strip feeding



Lg= 26mm

Figure 2: Theoretical Antenna

PROPOSE ANTENNA 1

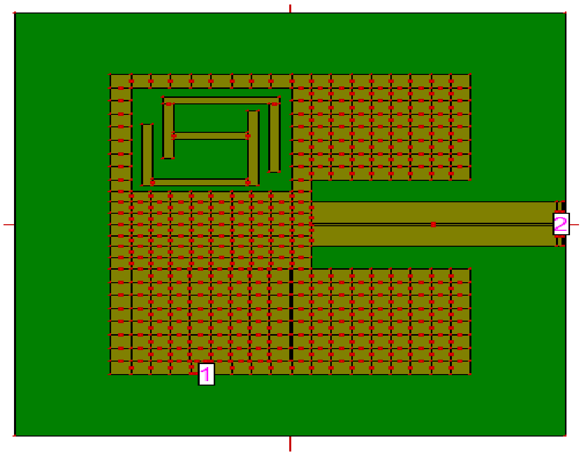


Figure 3: Proposed Antenna 1

Design METAmaterial in round H-Shape is used in left top corner of patch to reconfigure properties of antenna, due to using META material reconfigure permeability and permittivity of design antenna, single H-Shape META material proposed antenna shown in figure-3.

3. Testing And Results

S11 (return loss) Vs Frequency

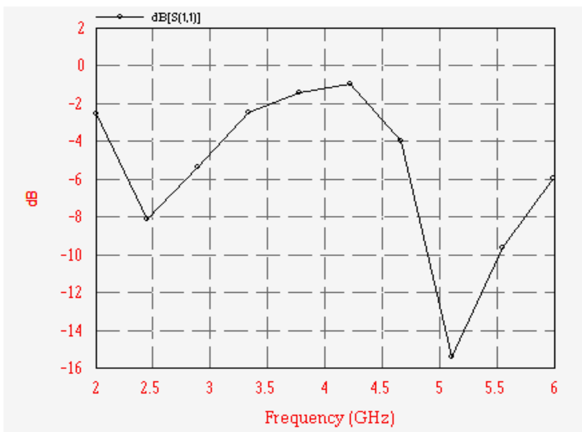


Figure 4: S11 Vs Frequency

Figure 4 shows a S11(return loss) Vs Frequency in which frequency increases return loss have firstly decreases than increases after that fall down to frequency 5.2GHz and again increases, by all these surface current increases due to fringing field**.** This designing gives

13.5% of C-Band from 4.8 to 5.5GHz, return losses at 5.2 GHz is -15.7Db.

S12 Vs Frequency

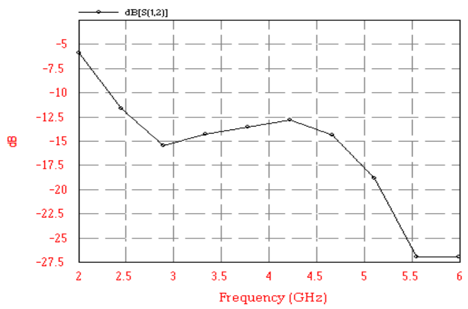


Figure 5: S12 Vs Frequency

Figure 5 shows a S12 (reflection loss) Vs Frequency in which Reflection between port 1 and 2 port S12 obtained maximum value of S12 is -26dB.

S21 Vs Frequency

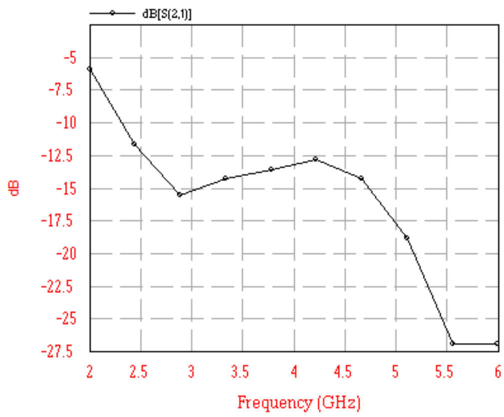


Figure 6: S21 Vs Frequency

Reflection between port 2 and 1 port S21 Shown in fig 6, obtained maximum value of S21 is -27dB.

Proposed Antenna 1

This antenna design METAmaterial in round H-Shape is used in left top corner of patch to reconfigure properties of antenna, due to using META material reconfigure permeability and permittivity of design antenna, single H-Shape META material proposed antenna shown in Figure-3, all results of this antenna discusses here.

S11 Vs Frequency

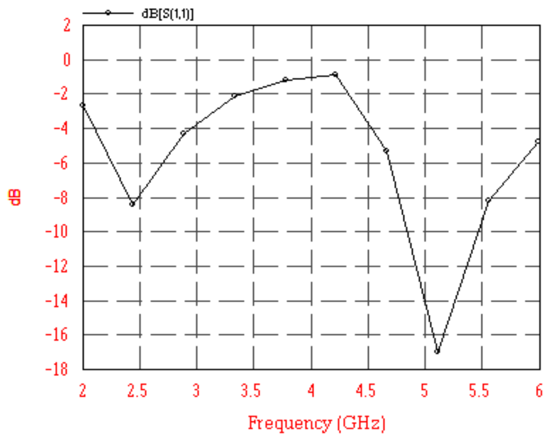


Figure 7: S11 Vs Frequency

Figure 7 shows a S11 (return loss) Vs Frequency in which leads the impedance mismatching. Reflection of port itself S11 Shown in fig 7, this designing gives 13.8% of C-Band from 4.7 to 5.5GHz, return losses at 5.2 GHz is -17db**.**

S12 Vs Frequency

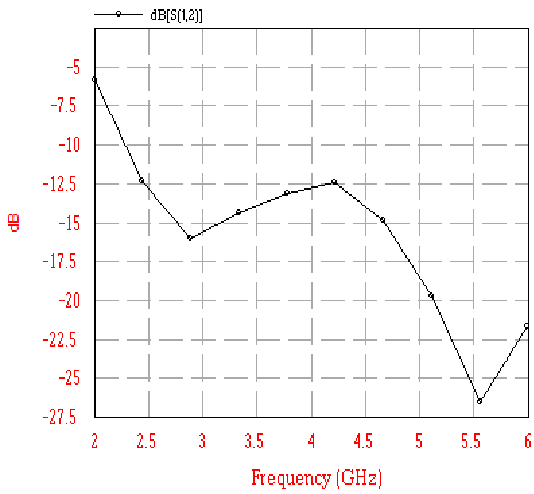


Figure 8: S12 Vs Frequency

Figure 8 shows a S12 (reflection loss) Vs Frequency in which Reflection between port 1 and 2 port S12 obtained maximum value of S21 is -26.2dB.

S21 Vs Frequency

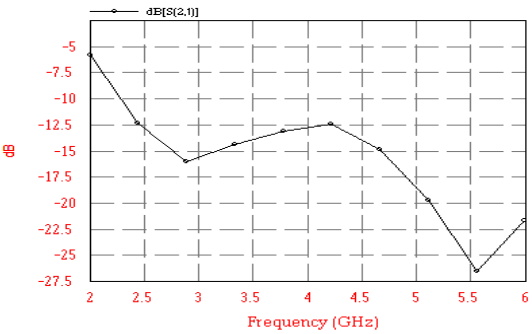


Figure 9:S21 Vs Frequency

Figure 9 shows a S12 (reflection loss) Vs Frequency in which Reflection between port 2 and 1 port S21 obtained maximum value of S21 is -27dB.

S22 Vs Frequency

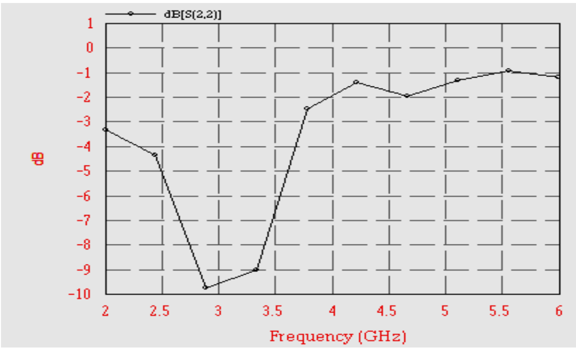


Figure 10: S22 Vs Frequency

Figure 10 shows a S12 (reflection loss) Vs Frequency in which Reflection between port 2 and 1 port S21obtained maximum value of S21 is -9.8dB

IV. CONCLUSIONS

In this paper, we have investigated the enhancement of the Rectangular Microstrip Patch Antenna performances using new H Shaped Metamaterial Structure. We have shown that left handed Metamaterial reduces return loss of this Patch Antenna and S parameters. On making some variations in antenna parameters, simulation the structure on IE3D.

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