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Design of Slotted Circle Split Ring Micro Strip Patch Antenna Connected with Rectangular Shaped Meta Material Structure to Enhance Parameters at 1.8 GHz

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Abstract

This paper extends for Rectangular Micro strip Patch Antenna (RMPA) along with Meta material which has Design of "Slotted Circle Split Ring with Rectangular" proposed for better improvement in the impedance bandwidth and reduction in the return loss at operating frequency 1.8GHz. The proposed antenna is designed at a height 3.2 mm from the ground plane by using CST-MWS software. At 1.8 GHz the bandwidth is increased up to 30MHz in comparison to RMPA alone. The Return loss of proposed antenna is reduced by-36.95dB. This antenna is small size, cheap, compact and easy to fabricate, and achieve good radiation characteristics with higher return loss. In this paper, return loss basically defined as system becomes stable with reduced return loss.

Keywords: *Rectangular micro strip patch antenna, (RMPA), double negative, left-handed meta material, permittivity and permeability, slotted circle split ring*

INTRODUCTION

A Patch antenna is a type of low profile micro strip antenna, which can be mounted on a flat surface. It consists of a flat rectangular sheet or "patch" of metal, mounted over a larger sheet of metal called a ground plane. Patch antennas are simple to design and easy to modify and customize. Factors of the patch antennas can be improved by integrating Metamaterial structure on it. Metamaterial is an artificial material which has negative permeability and permittivity hence named as double negative Metamaterial. It is not a practically achieved material but by using some specific designs meta material can be verified. This verification can be done by method of Double negation properties. Application of a conventional antenna always limited since they are governed by the 'right hand rule' which determine how electromagnetic wave should behave. Victor Georgievich Veselago, a Russian physicist was the first which proposed the metamaterials theoretically in 1968 [1]. J.B. Pendry had studied further more in the Metamaterial field [2]. After that in 2000, Smith made the first prototype structures of LHM [3–5]. The LHM is a combination of Split Ring Resonator (SRR) and thin wire (TW). Metamaterial is used because it is easy to fabricate.

Desired Parametric Analysis

Calculation of Width (W)

$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r+1}} = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \quad (1)$$

Where,

c = free space velocity of light

ε_r = Dielectric constant of substrate

The effective dielectric constant of the Microstrip antenna to account for fringing field.

Effective dielectric constant is calculated from:

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(\frac{1}{\sqrt{1+\frac{12h}{w}}}\right) \quad (2)$$

The actual length of the Patch (L)

$$L = L_{eff} - 2\Delta L \quad (3)$$

Where

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{eff}}} \quad (4)$$

Calculation of Length Extension

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)} \quad (5)$$

Design and Analysis of Micro strip Patch Antenna

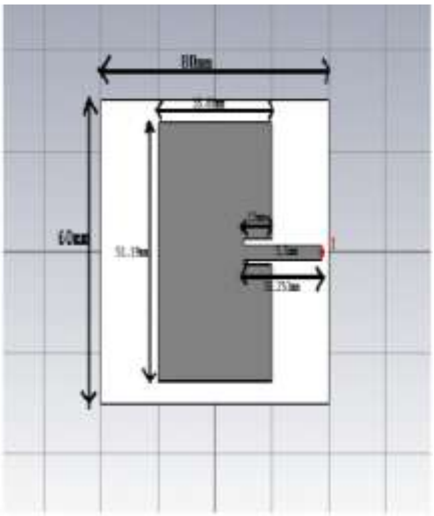

Fig. 1: The Rectangular Micro strip Patch Antenna is shown in Figure Essential Parameters of the Design are shown in Table 1.

***Table 1:** Rectangular Micro Strip Patch Antenna Specifications.*

Parameters	Magnitude	Unit
Dielectric Constant	4.3	-
Loss Tangent	0.02	-
Thickness (h)	1.6	mm
Operating Frequency	1.8	GHz
Length (L)	39.88	mm
Width (W)	51.191	mm
Cut Width	5	mm
Cut Depth	10	mm
Path Length	35.251	mm
Width of Feed	3.5	mm

Then, the Slotted Circle Split Ring Meta Material Structure Micro Strip Patch Antenna At 1.8GHz is placed above the patch antenna at a height of 3.2 mm from ground plane in order to study its influence, and the results are compared with those of the antenna alone. The required specifications of this design are shown in the Figure 4 [6–8].

DESIGN OF RECTANGULAR MICRO STRIP PATCH ANTENNA AT HEIGHT OF 1.6MM FROM GROUND PLANE

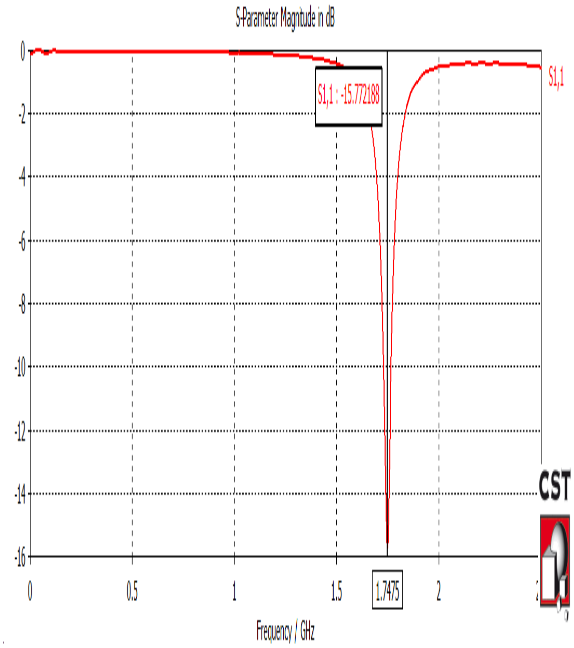

***Fig. 2:** Rectangular Micro Strip Patch Antenna at 1.8GHz.*

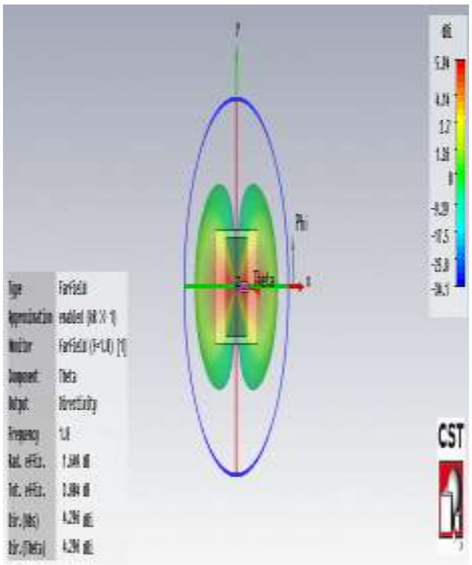

***Fig. 3:** Radiation Pattern of RMPA showing Directivity of 4.296dBi.*

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Designing and Simulation of "SLOTTED CIRCLE" Double Negative Meta Material Structure

When the proposed structure is incorporated with the RMPA, it shows the improved impedance bandwidth of 30MHz and Return Loss of -36.95dB as shown in Figure 8 [9–16].

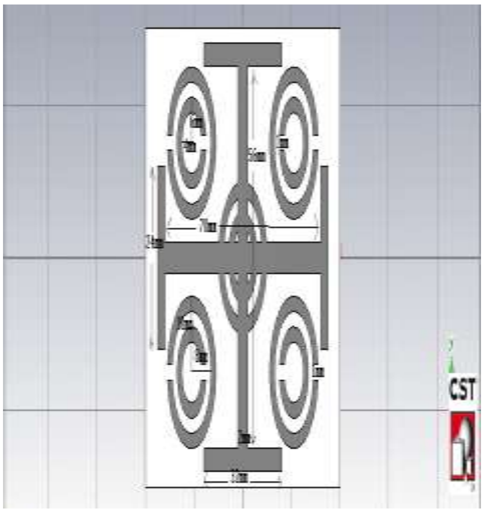

Fig. 4: *Rectangular Micro Strip Patch Antenna Loaded with "Slotted Circle Split Ring" Shaped Meta Material Structure at the Height of 3.2mm from the Ground Plane (all Dimensions in mm).*

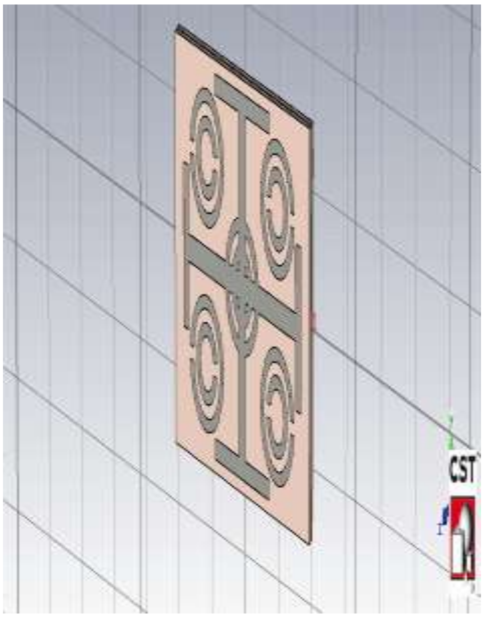

Fig. 5: *Rectangular Micro Strip Patch Antenna with Proposed Meta Material Structure.*

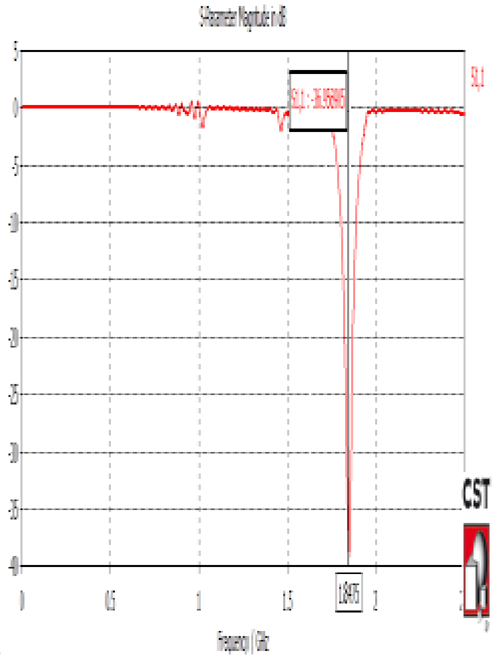

Fig. 6: *Simulated Result of Proposed Metamaterial Structure showing Return Loss of -36.95dB and Bandwidth of 30MHz.*

Simulation result of Return loss and bandwidth of Rectangular micro strip patch antenna loaded with metamaterial structure is shown in Figure 6 [17, 18].

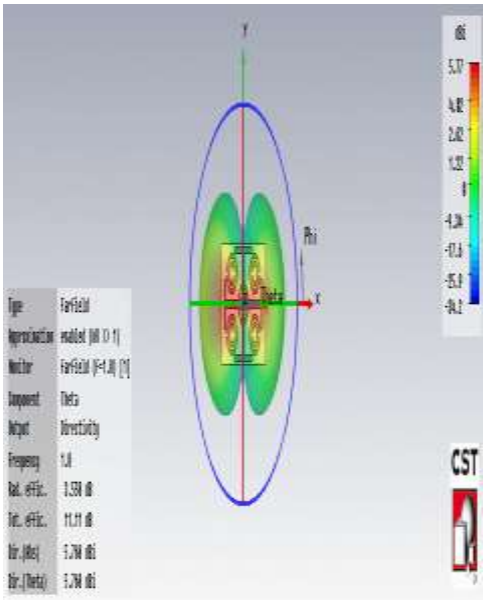

Fig. 7: *Shows the Improved Directivity in Z Direction with Respect to the Proposed Metamaterial Antenna [12–14].*

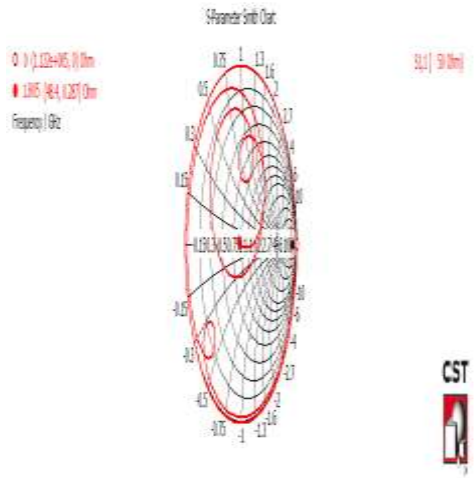

Fig. 8: *Smith Chart of the Proposed Metamaterial Structure at 1.805GHz.*

The smith chart is very useful when solving transmission problems. The real utility of the Smith chart, it can be used to convert from reflection coefficients to normalized impedances (or admittances), and vice versa.

SIMULATION RESULTS

In this paper, Rectangular micro strip patch antenna loaded with Slotted Circle Split Ring Meta Material Structure is simulated using CST-MWS software. The proposed design in comparison to RMPA alone, found that the potential parameters of the proposed antenna is increased. This is clear from Figures 2 and 5 that the return loss is reduced by -15.77 dB and bandwidth, Directivity, Gain is increased.

CONCLUSION

In this work, the behavior of a Rectangular Micro strip Patch Antenna loaded with “Slotted Circle Split Ring Micro strip Patch Antenna Connected with Rectangular” shaped double negative Meta material structure at a height of 3.2mm from the ground plane is examined. It is revealed that integrating the proposed Meta material structure with the patch antenna at a height of 3.2mm from the ground plane.

The microstrip antenna is simple to fabricate, easy to replacement, low profile and highly efficient. The use of this type of antenna is highly preferred into satellite communication and wireless communication. This antenna gives high gain due to huge reduction in return-loss. The use of Metamaterial provides a large advancement into the parameters of RMPA. By using CST simulation software the proposed antenna could be used in several microwave applications that requires improved bandwidth and reduced return loss at the operating frequency the simulated results provide that, improvement in the bandwidth is 30 MHz and the Return loss of proposed antenna is reduced by -36.95 dB. It is clear that we can easily overcome the drawbacks of RMPA by using the properties of Meta material (MTM).

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