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Enhancement in RMPA Parameters by Rhombus Connected With Circle Meta Material Structure Using at 1.9 GHz

Vijay Dandotiya
M.Tech Scholar, Dept. of Electronics & Comm.
Rustamji Institute of Technology, Tekanpur, Gwalior, India
vijay33339@gmail.com

Chetan Pathak
Asst. Prof.ar, Dept. of Electronics & Comm.
Rustamji Institute of Technology, Tekanpur, Gwalior, India
cp_rjit@yahoo.co.in

Abstract - Author proposed a new design of meta-material to provide advancement into the factors of the rectangular microstrip patch antenna (RMPA) "Enhancement in RMPA parameters Rhombus Connected With Circle Meta material structure high using at 1.9GHz" As a rectangular microstrip patch antenna is designed at a height of 1.6mm & Left handed Meta material structure is designed at a height of 3.2mm from the ground plane by using CST-MWS software. The resonance frequency 1.9GHz of the designed antenna is using as a high frequency. This paper mainly worked on return loss. The Return loss of the proposed antenna reduced to -31,16dB & bandwidth is increased up to 41.9MHz. 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- RMPA (Rectangular Microstrip Patch Antenna), CST (Computer Simulation Technique), Bandwidth, Return loss.

1. INTRODUCTION

1.1 RMPA: An antenna is defined as a part of a transmitting or receiving system which is designed to radiate or to receive electromagnetic waves [1]. Rectangular Microstrip Patch antennas have attractive properties including the low profile, light weight, compact and conformable in structure, and easy to be integrated with solid-state devices [2]. Application of a conventional antenna always limited since they are governed by the 'right hand rule' which determine how electromagnetic wave should behave. However, a metamaterial substrate offers an alternative solution to a wireless antenna applications using the left hand rule [3].

1.2 Left handed Meta material: A Patch antenna is a type of low profile microstrip 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 & permittivity hence named as double negative metamaterial. It is not a practically achieved material but by using some specific designs metamaterial can be verified. This verification can be done by NRW method of double negation properties.

Victor Georgievich Veselago [4] [6], a Russian physicist was the first which proposed the metamaterials theoretically in 1967. J.B. Pendry had studied further more in the metamaterial field. After that in 2001, Smith made the first prototype structures of LHM [5]. The LHM is a combination of Split Ring Resonator (SRR) and thin wire (TW). Metamaterial is used because it is easy to fabricate

2. DESIGN AND SIMULATED RESULTS OF RMPA AND PROPOSED ANTENNA

The Rectangular micro strip patch antenna parameters [7, 8] are calculated from the formulas given below:

Calculation of Width (W)

$$w = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r+1}} = \frac{C}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \qquad (1)$$

Where, c = free space velocity of light
εr = Dielectric constant of substrate

The effective dielectric constant of the RMPA

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

The actual length of the Patch (L)

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

Where

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

Calculation of Length Extension

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

2.1 Analysis of rectangular micro strip patch antenna

TABLE I: RMPA Specifications

Parameter	Dimension	Unit
Dielectric Constant	4.3	-
Loss Tangent	0.02	-
Thickness	1.6	mm
Operating Frequency	1.9	GHz
Length	45.64	mm
Width	35.44	mm
Cut Width	5	mm
Cut Depth	10	mm
Path Length	32.82	mm
Feed Width	3	mm

The physical parameters of rectangular micro strip patch antenna are W=35.44 mm, L=45.64mm, length of transmission line feed= 25.995mm, with width of the feed= 3mm. The rectangular micro strip patch antenna designed on one side of glass/epoxy structure with ε_r = 4.3 and height from the ground plane d= 1.6mm.

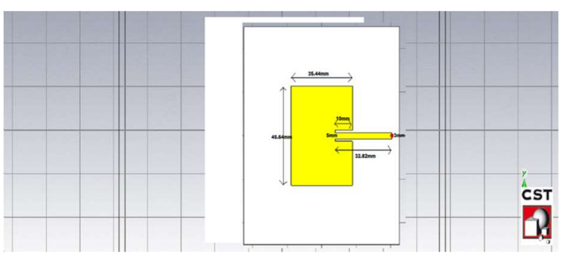

Fig1: Rectangular micro strip patch antenna at 1.9 GHz (all dimensions in mm)

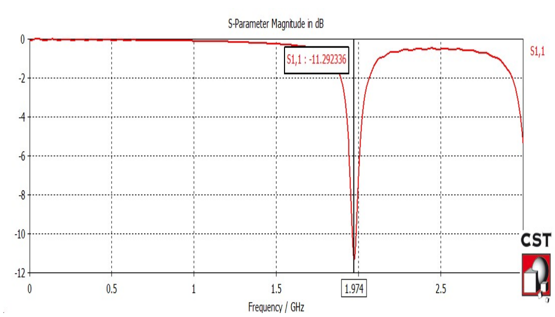

Fig2: Simulated Result of Rectangular micro strip patch antenna showing Return Loss of -11dB and Bandwidth [9] of 23.2MHz

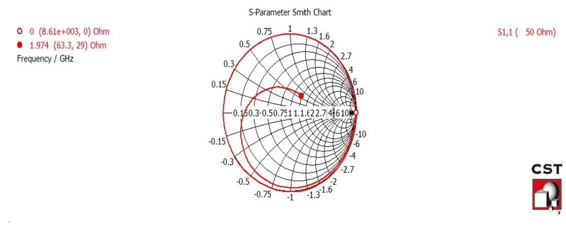

Fig3: Smith chart [10] of the rectangular micro strip patch antenna at 1.9GHz

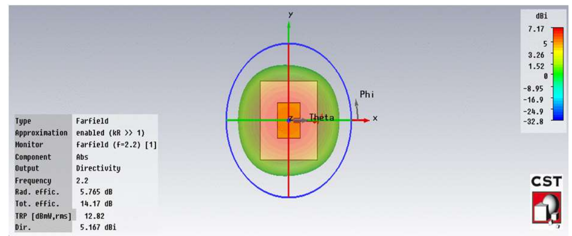

Fig4: Directivity of the rectangular micro strip patch antenna at 1.9GHz

2.2 Left handed Meta material structure

In this Meta material design, "Rhombus Connected with Circle Meta material" are loaded on the patch antenna. This Meta material Structure is distributed equally with each other and cut vertically with 2 mm width. This design gives the better improvement in impedance bandwidth and reduction in return loss.

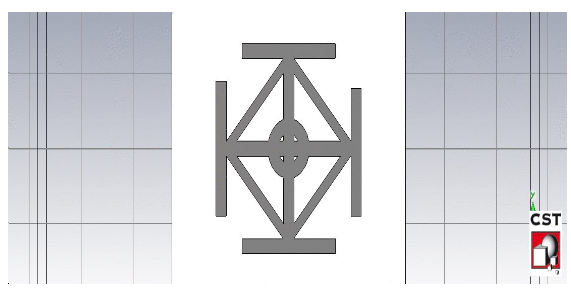

Fig5: Design of proposed Meta material structure at the height of 3.2 mm from ground plane

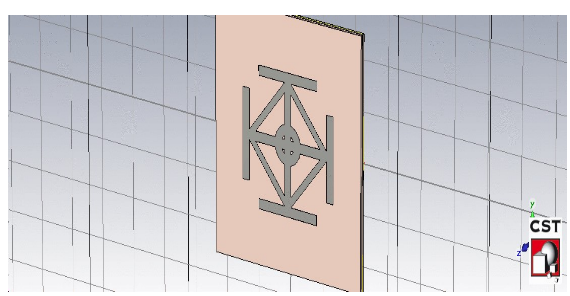

Fig6: Rectangular micro strip patch antenna with proposed Meta material structure

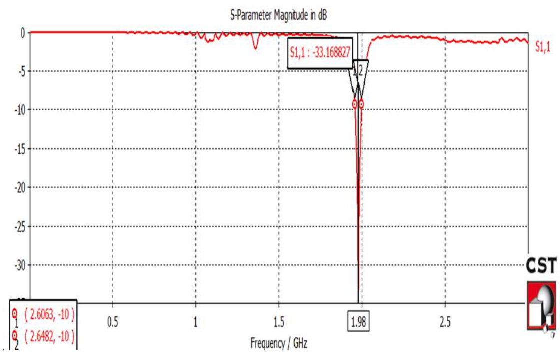

Fig7: Simulated result of the RMPA along with proposed Meta material cover showing Return Loss of -33.16dB & Bandwidth of 41.9MHz

The simulated results of the RMPA along with proposed meta material cover are shown in figure 7 & 8, it has been found that the potential parameters like [11][12] (Total efficiency, & directivity) of the proposed antenna increases significantly in comparison to RMPA alone. The return loss of the RMPA along with proposed Meta material cover is reduced by -33.16dB Radiation pattern is defined as the power radiated (transmitted) or received by an antenna in a function of the angular position and radial distance from the antenna. It describes how an antenna directs the energy it radiates and it is determined in the far field region.

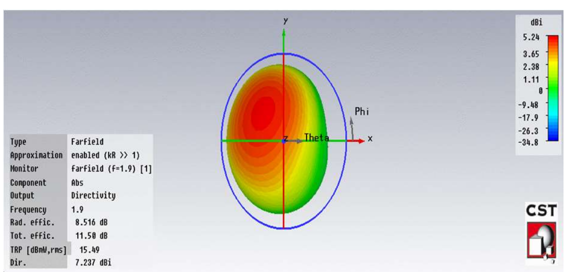

Fig8: Radiation pattern of proposed antenna showing Directivity of7.237dBi.

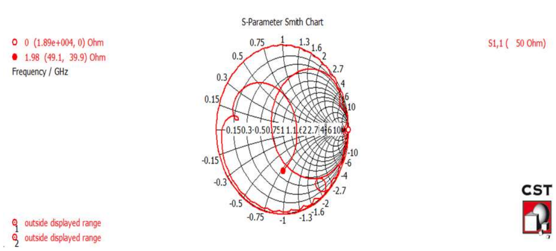

Fig9: Smith chart of RMPA with proposed Meta material structure.

3. CONCLUSION

We can see that RMPA structure having certain specification can be enhanced by using LH-MTM. So that its bandwidth, efficiency, return loss and gain could be ameliorated. Hence this work could be further amended by using variant patterns of Meta material structures. Additional in future this work may be shifted in higher frequencies so small antennas may be used for the local area network technologies. the simulated rectangular micro strip patch antenna results in Return Loss of -11 dB & 23.2MHz Bandwidth while when it is designed with “Two opposite hexagon cut shaped structure” Meta material structure at 3.2mm from the ground plane, it shows Return Loss of -33.16 dB & 41.9MHz Bandwidth which shows improvement of bandwidth and significant reduction in return loss.

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