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Return loss& Gain Enhancement in RMPA by Rectangle cut Shaped Meta Material Structure Using at 2.097GHz

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Abstract
A Rectangular Micro strip Patch Antenna (RMPA) along with meta material which has design of "Rectangle Cut Shaped'' structure is proposed at height of 3.2 mm from the ground plane. The RMPA with proposed Meta material structure is designed to resonate at 2.097 GHz frequency. In this paper work focused on return loss & gain. The return loss & gain of the parameters of RMPA enhancing the performance of antenna for useful applications such as wireless application & long distance communication. Basically if return loss reduces then the signal is useful for long distance communication. Proposed Meta material structure is significantly reduced the return loss and increased the bandwidth and gain of the antenna with compare to RMPA alone. The gain is increased up to 3.242 in comparison to RMPA alone. The return Loss of proposed antenna is reduced to -41.9db.

***Keywords*-Rectangular micro strip patch antenna (RMPA), Rectangle Cut Shaped Meta material structure.**

1. INTRODUCTION

1.1 RMPA

The Rectangular micro strip patch antenna have been proposed because of its low profile, light weight and low cost [2]. However, antenna inherently has a low gain and a narrow bandwidth. A micro strip antenna in its simplest form consists of a radiating patch on one side of a dielectric substrate and a ground plane on the other side. The top and side views of a rectangular micro strip antenna are shown in as the square, semicircular, sect oral, and annular ring shapes shown in Figure are also used. Radiation from the micro strip antenna can occur from the fringing fields between the periphery of the patch and ground plane.

1.2 DOUBLE NEGATIVE META MATERIAL

Veselago found the existence of unknown materials which has the value of permittivity and permeability are simultaneously negative at the resonate frequency. The concept of Meta material had been discovered by V.G. Veselago [1]. This property shows that material is known as double negative metamaterial.
A Meta material is a structure composite with unique electromagnetic properties such as the backward wave and the negative refraction. Electromagnetic properties such as the backward wave and the negative refraction [3]. Shelby Smith and Schultz invented the first structure to prove the existence of Meta materials was split ring structure in 2000 [4-5].

1.3 DESIGN SPECIFICATION

Formula Used For Designing of RMPA [6, 7]

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 RMPA

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

The actual length of the Patch (L)

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

Where

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

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. ANALYSIS OF RECTANGULAR MICROSTRIP PATCH ANTENNA

Table1: RMPA Specification

Parameter	Dimension	Unit
Dielectric Constant	4.3	-
Loss Tangent	0.02	-
Thickness	1.6	mm
Operating Frequency	2.097	GHz
Length	34.1634	mm
Width	43.9409	mm
Cut Width	5	mm
Cut Depth	10	mm
Path Length	31.9701	mm
Feed Width	3	mm

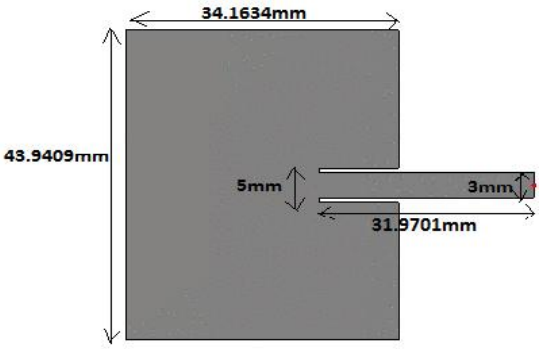

Fig1. Rectangular micro strip patch antenna at 2.097 GHz (all dimensions in mm).

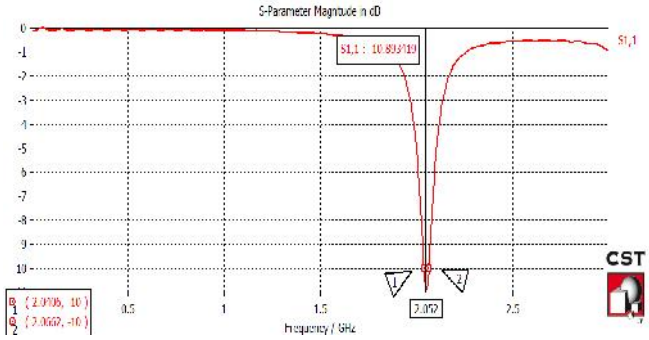

Fig2. Simulated Result of Rectangular micro strip patch antenna showing Return Loss of -10dB and Bandwidth of 25.8MHz

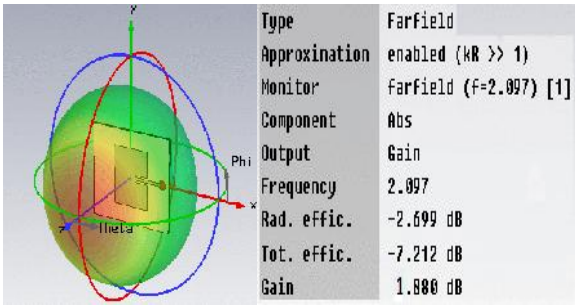

Fig 3. Radiation Pattern of Rectangular micro strip patch antenna showing 1.880dB Gain in Z direction.

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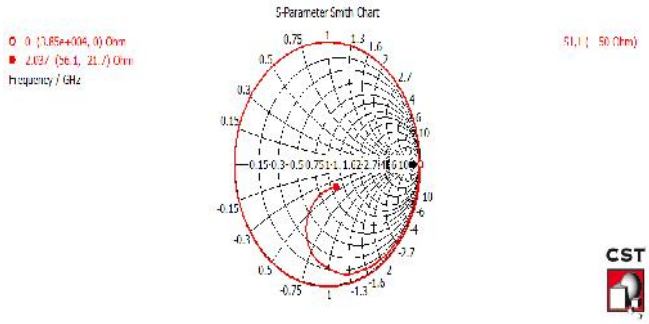

Fig4. Shows the smith chart [10] of the RMPA.

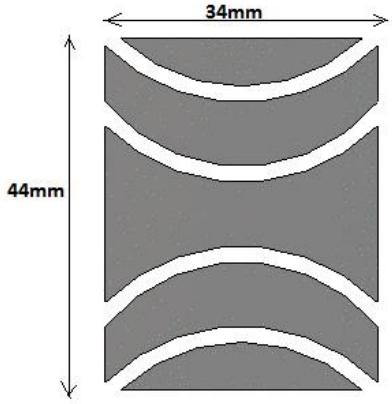

Fig5. Design of proposed Meta material structure at the height of 3.2 mm from ground plane.

3. ANALYSIS OF METAMATERIAL STRUCTURE

In this Meta material design rectangle cut shaped structure is proposed at height of 3.2 mm from the ground plane .in design the dimensions are L=34mm & W=44mm. The gap is 2mm.This design gives the better improvement in impedance bandwidth and reduction in return loss.

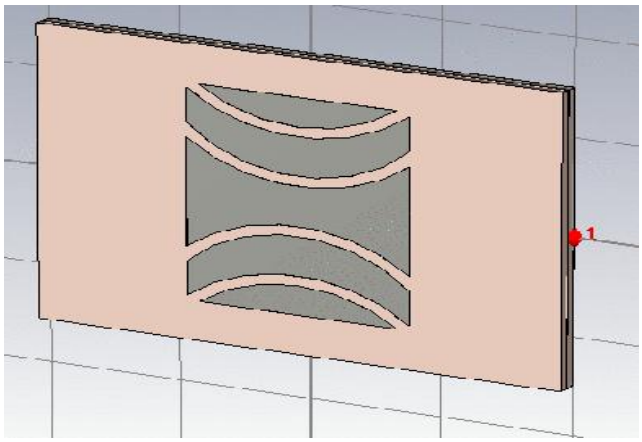

Fig 6. Rectangular micro strip patch antenna with proposed Meta material structure.

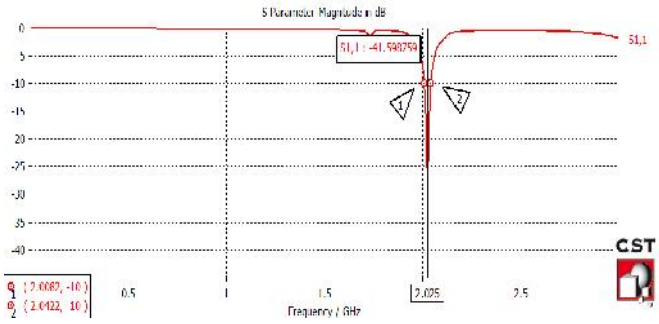

Fig7. Simulated result of the RMPA along with proposed Meta material cover showing Return Loss of -41.9dB & Bandwidth[11] of 34MHz.

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 [8][9] (gain, 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 to -41.9 dB 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 that the fig 8 shown below the radiation pattern of proposed antenna showing directivity of 6.286 dBi.

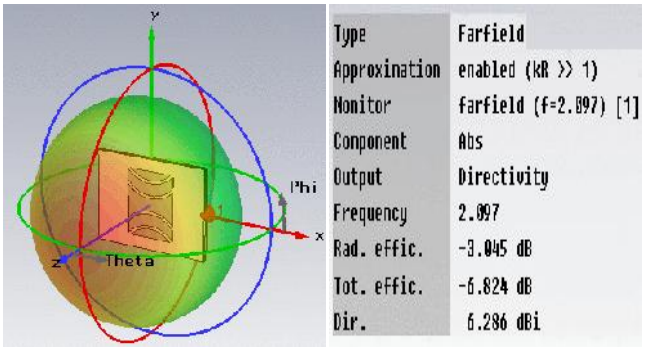

Fig8. Radiation pattern of proposed antenna showing Directivity of 6.286dBi.

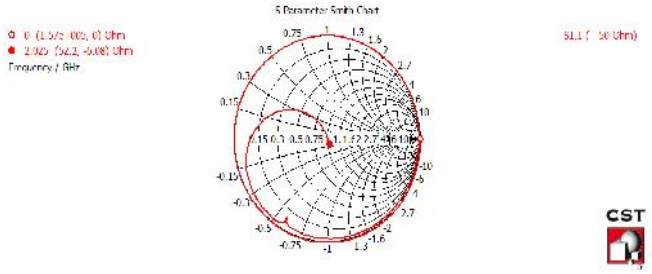

Fig9. Shows the smith chart of the RMPA along with proposed meta material cover, it is clear from the figure that the impedance of the antenna is matched with the co-axial cable i.e. 50Ω.

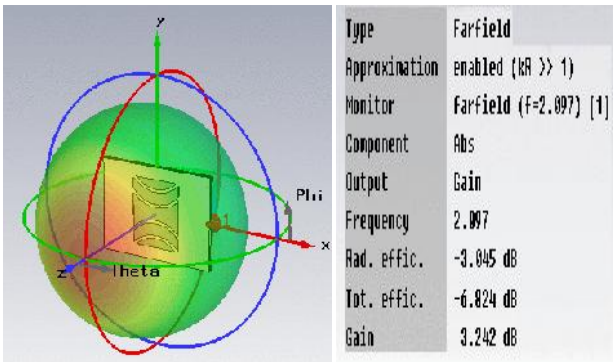

Fig10. Radiation Pattern of Proposed Antenna Showing Gain Of 3.242 dB

Table -2. Comparison of designed antenna

Parameter	RMPA alone	RMPA With Meta material
Bandwidth	25.8 MHz	34MHz
Return loss	-10 dB	-42.9dB
Directivity	5.182 dB	6.286dB
Gain	1.880Db	3.242dB
Frequency	2.097 GHz	2.097GHz

4. 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 mainly focused on return loss & gain. The simulated rectangular micro strip patch antenna results in Return Loss of -10 dB & 1.880dB Gain while when it is designed with “Rectangle Cut Shaped ” Meta material structure at 3.2mm from the ground plane, it shows Return Loss of -41.9 dB& 3.242dB which shows improvement Return loss & Gain and significant reduction in return loss.

5. REFERENCE

[1]. V.G. Veselago “The electrodynamics of substances with simultaneously negative value ε and μ” Sov Phys. Uspekekhy.10 (4), 509-5, 1968

[2]. Y. P. Zhang and J. J. Wang, "Theory and analysis of differentially-driven microstrip antennas,"Antennas and Propagation, IEEE Transactions, vol. 54, pp. 1092-1099, 2006.

[3]. D.R. Smith, W.J. Padilla, D.C. Vier, S. C. Nemat-Nasser, and S. Schultz, Composite medium with simultaneously negative permeability and permittivity, Phys Rev Lett 84, 4184–4187,May 2000.

[4]. B. Szentpali, "Metamaterials: a new concept in the microwave technique," in TELSIKS 2003. 6th International Conference on Telecommunications in Modern Satellite, Cable and Broadcasting Service, 2003., 2003, pp. 127-132 vol.1.

[5]. L. Ran, J. Huangfu, H. Chen, X. Zhang, K. Cheng, T. M. Grzegorczyk, and J. A. Kong, "Experimental study on several left-handed metamaterials," Progress In Electromagnetics Research, vol. 51, pp. 249-279, 2005.

[6] Constantine A.Balanis, Antenna Theory and Design. John Wiley & Sons, Inc., 1997.

[7] W.L. Stutsman, G.A. Thiele, Antenna Theory and design, John Wiley & Sons, 2nd Ed., New York, 1998.

[8]. BimalGarg, Nitin Agrawal, “Gain Enhancement of Rectangular Resonant Microstrip Patch Antenna Incorporated With “Wired SRR” Double Negative Left Handed Metamaterial in C-Band”, National Conference on Innovations in Micro-electronics, Signal Processing and Communication Technologies, V-IMPACT 2012, organized in V.I.T., Jaipur on February 18th& 19th 2012.

[9].Prashant Dubey, Vijay Sharma, “Design of Interconnected Rectangular Rings” Double Negative Left-handed Inspired Metamaterial Structure for Improving Antenna Parameter”, National Conference on Innovations in Micro-electronics, Signal Processing and Communication Technologies, V-IMPACT 2012, organized in V.I.T., Jaipur on February 18th&19th 2012.

[10]. David M. Polar, “Microwave Engineering”, 3rd Edition, John Wiley & Sons, 2004.

[11]. A. D. Yaghjian and S. R. Best, "Impedance, Bandwidth, and Q of Antennas," IEEE Trans. On Antennas and Propagation, Vol. 53, No. 4, pp. 1298 1324, 2005.