Enhancement of Rectangular Micro strip Patch Antenna Parameters By Using "Slotted Circular Ring" Shaped Meta material Structure

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Abstract- **A patch antenna tested the performance of the magnetic meta material as a substrate and validated that a single substrate can achieve a range of miniaturization values. In this work CST-MWS simulation software is used to compare the return loss and bandwidth of the micro-strip patch antenna at a frequency of 2.29GHz and height of 3.2 mm from the ground plane with the proposed meta material structure. It has been observed that the return loss has improved by 23.50 dB, bandwidth is improved up to 50.7 MHz the directivity increases by 0.4dBi.**

Keywords- **Rectangular Micro strip Patch Antenna (RMPA), Double Negative Left-handed Meta Material, Return Loss (LH-MTM).**

INTRODUCTION

Antennas play a very important role in the field of wireless communications. Some of them are Parabolic Reflectors, Patch Antennas, Slot Antennas, and Folded Dipole Antennas. Each type of antenna is good in their own properties and usage. We can say antennas are the backbone and almost everything in the wireless communication without which the world could have not reached at this age of technology. Major disadvantages of micro strip antennas[1-4] are their low efficiency, low power, high *Q* (sometimes in excess of 100), poor polarization purity, poor scan performance, spurious feed radiation and very narrow frequency bandwidth, which is typically only a fraction of a percent or at most a few percent. In some applications, such as in government security systems, narrow bandwidths[5][6-7] are desirable. However, there are methods, such as increasing the height of the substrate, that can be used to extend the efficiency (to as large as 90 percent if surface waves are not included) and bandwidth (up to about 35 percent) [8]. However, as the height increases, surface waves are introduced which usually are not desirable because they extract power from the total available for direct radiation.

DESIGN SPECIFICATION

The RMPA parameters are calculated from the formulas given below.

Desired Parametric Analysis [9], [10]

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
ε_r = Dielectric constant of substrate
The effective dielectric constant of the RMPA

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

The actual length of the Patch (L)

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

Where

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

Calculation of Length Extension

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

The RMPA is designed using the calculated parameters shown below in Table 1.

TABLE **I**
RMPA Specifications

Parameter	Dimension	Unit
Dielectric Constant	**4.3**	-
Loss Tangent	**0.02**	-
Thickness	**1.6**	mm
Operating Frequency	**2.29**	GHz
Length	**30.96**	mm
Width	**39.88**	mm
Cut Width	**5**	mm
Cut Depth	**10**	mm
Path Length	**29.94**	mm
Feed Width	**3**	mm

Designing and Simulation of RMPA at 2.29GHz A rectangular micro strip patch antenna (RMPA), with a recessed micro strip feed line, backed by a perfect electrical conductor (PEC) ground plane is shown in Figure 1. The antenna was designed to resonate at 2.29GHz.

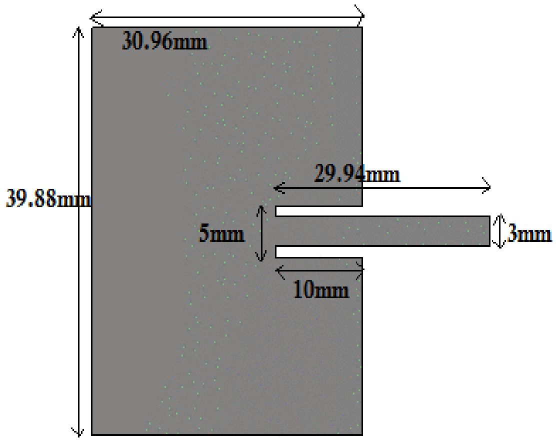


Fig1. Dimensional view of Rectangular Micro strip Patch Antenna at 2.29GHz . (all dimensions in mm)

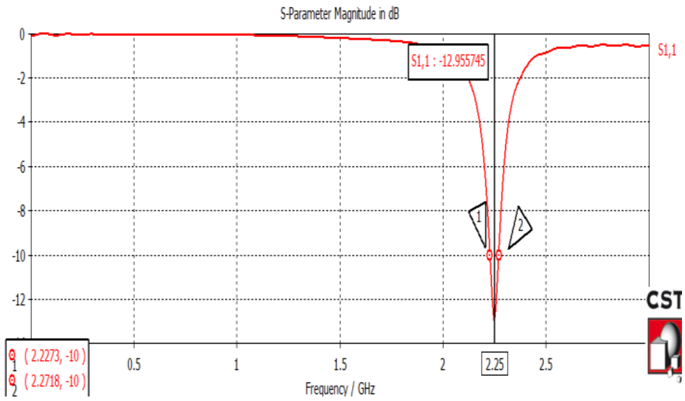
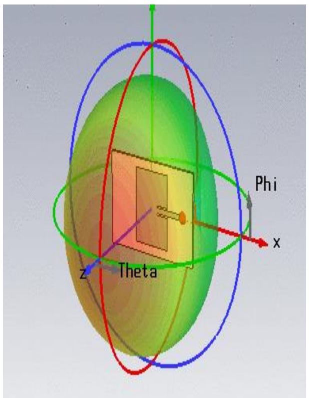


Fig 2. Simulated Result of Rectangular micro strip patch antenna showing Return Loss of -12.92dB and Bandwidth of 44.7 MHz.



Type	Farfield
Approximation	enabled (kR >> 1)
Monitor	farfield (f=2.31) [1]
Component	Abs
Output	Directivity
Frequency	2.31
Rad. effic.	-2.029 dB
Tot. effic.	-3.936 dB
Dir.	6.182 dBi

Fig3. Radiation Pattern of Rectangular micro strip patch antenna showing 6.182dBi directivity in Z direction.

Designing and Simulation of "SLOTTED CIRCULAR RINGS" double negative meta material structure

When the proposed structure is incorporated with the RMPA, it shows the improved impedance bandwidth [9] [16] of 50.7MHz & Return Loss of -36.50dB as shown in Figure 8. The simulation range is used 0-3GHz, because to show the resonant at only in operating frequency. The Double-Negative meta material properties of the proposed structure are also verified above. Dimensions of the meta material structure is however quite larger than the conventional rectangular micro strip patch antenna, but its obtained from NRW method at designing frequency 2.29GHz and gives comparatively good results to patch antenna alone.

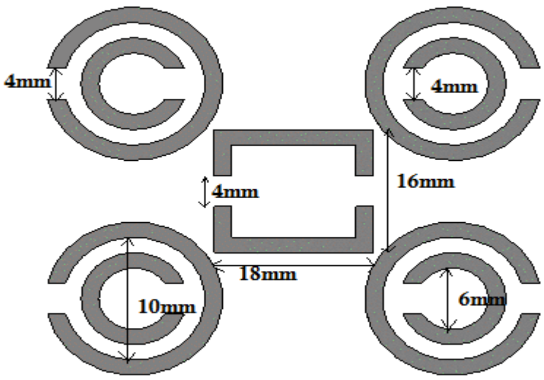


Fig4. Rectangular Micro strip Patch Antenna loaded with "Slotted Circular Ring" Shaped Meta material Structure.

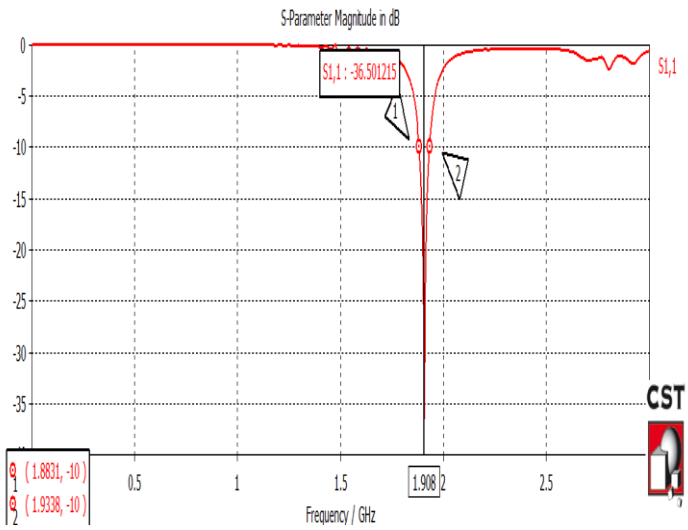


Fig5. Simulated result of proposed meta material structure showing Return Loss of -36.50dB and Bandwidth of 50.7MHz.

Fig. 6 show the improved directivity in Z direction with respect to the proposed meta material antenna.

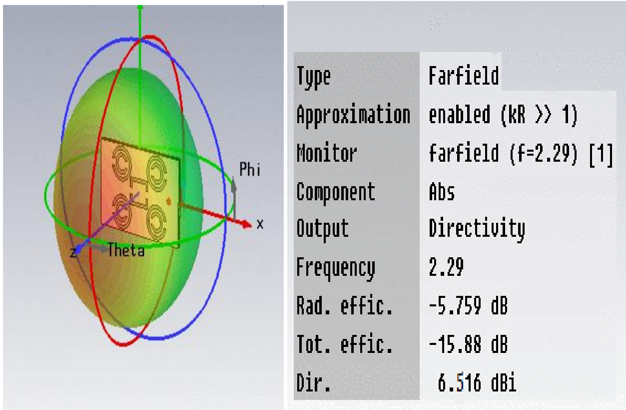


Fig6. Radiation Pattern of proposed meta material structure showing 6.516dBi directivity in Z direction.

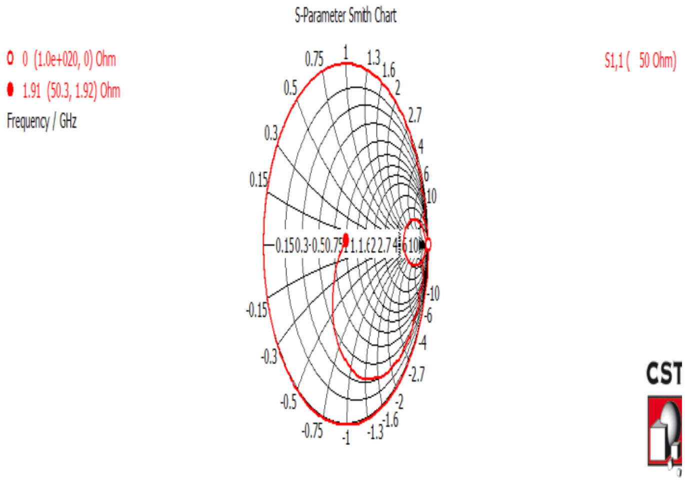


Fig 7. Smith chart of the proposed meta material structure at 1.91GHz

Smith Chart [7] in Figure8 shows that the Proposed "Slotted Circular Ring" Shaped Meta Material Structure is Matched at 2.29 GHz Frequency.

CONCLUSION

In this work, the behavior of a Rectangular Micro strip Patch Antenna loaded with "Slotted Circular Ring" 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, significantly improves the potential characteristics of the antenna. The proposed "Slotted Circular Ring" meta material structure is electrically small and suitable to handle easily. The proposed antenna could be used in several microwave applications that requires improved bandwidth & reduced return loss at the operating frequency. The proposed structure could be considered as a novel approach for improving antenna's potential characteristics. In case of single element it has been observed that the antenna gain, bandwidth, directivity and total efficiency is quite low. But, while deploying it with the Meta material structure, all the potential parameters increases significantly.

PARAMETERS	REFERENCE PAPER META RESULT[13]	THIS PAPER META IMPROVED RESULT
Bandwidth	33MHz	50.7MHz
Return Loss	-29.98 dB	-36.50 dB
Frequency	1.9GHz	2.29GHz
Directivity	-	6.516 dBi
Impedance Matching	51.3 Ohm	50.3 Ohm

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