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PATCH ANTENNA IMPROVEMENT USING METAMATERIAL

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***Abstract* – Author in this research manuscript improve the antenna by using metamaterial. Not only return loss but other parameters like directivity and efficiency were also improved after introducing metamaterial as a cover over the patch with the gap of substrate. Two octal split ring shaped were used as a new design to modify the antenna parameters, return loss was improved from -10dB to -28dB whereas the directivity has been improved from 5dBi to above 6dBi and efficiency is also increased.**

Keywords* – *Negative Media, RMPA, return loss, multiband, directivity.

I. INTRODUCTION

Metamaterials are artificial materials that allow the occurrence of simultaneously negative permeability and permittivity, hence sometimes called double negative (DNG) [1]. The effect of metamaterials in wireless communications has already been investigated in several publications. The effect on the power radiated by an electrically small antenna placed in a DNG shell has been analyzed in [2], and using metamaterials in power dividers has been investigated in [3]. Microstrip antennas are versatile, conformal, and light weight antennas that have served a lot of applications in the field of wireless communication. Regardless of their low power handling capacity and the narrow bandwidth, microstrip antennas are used in a large number of applications. Several methods of analysis have been used in the past to analyze different geometries of microstrip antennas for a variety of applications.

Aycan Erentok published a model of an idealized radiating system composed of an electrically small electric dipole antenna enclosed in an electrically small multilayered metamaterial shell system is developed analytically [4]. Lucio Vegni proposed design of innovative microwave components based on metamaterials, such as patch and leaky wave radiators, absorbers, and directional couplers [5]. Cheng Jung Lee presented two examples of compact quad band antennas which are designed based on MTM technology [6]. These multi-band antennas not only occupy smaller volume than conventional antennas such as monopole and PIFA, but also provide equal or better performances. Cheng Chi Yu carried out a compact antenna with metamaterial for WiMAX [8]. The use of metamaterial has reduced the size of antenna remarkably. The bandwidth of the antenna sufficiently covers 3.45-3.75 GHz WiMAX bands. Prathaban Mookiah proposed rectangular patch antenna array for MIMO communications was simulated on a magnetic permeability enhanced metamaterial [7]. The analysis was performed with respect to performance metrics such as degree of mutual coupling for different element spacing, achievable channel capacity, bandwidth and efficiency. Along with them numerous research paper were published on patch antenna and metamaterial, in this paper a new metamaterial design is proposed to enhance the parameters of patch.

II. METHODOLOGY

Design process was carried out with the starting of calculating parameters of patch and then designing and simulation and analyzing its parameters. After analyzing its parameters the designed patch and its simulated results are presented in following figures. Patch dimensions are, Patch length= 33.3078mm, patch width= 42.8577mm, feed length= 31.428mm.

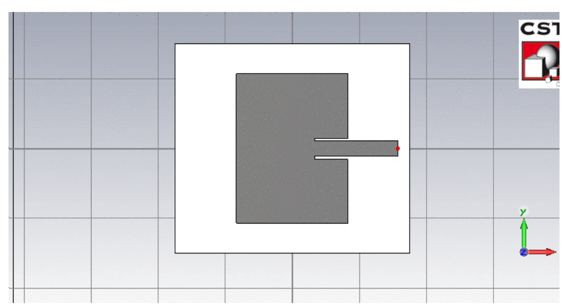

Fig. 1. Patch antenna at 2.15 GHz.

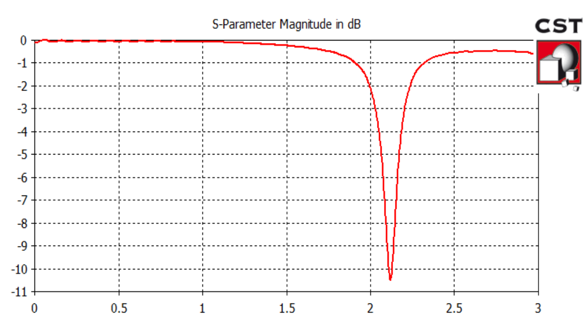

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Fig. 2. Simulated result of patch antenna.

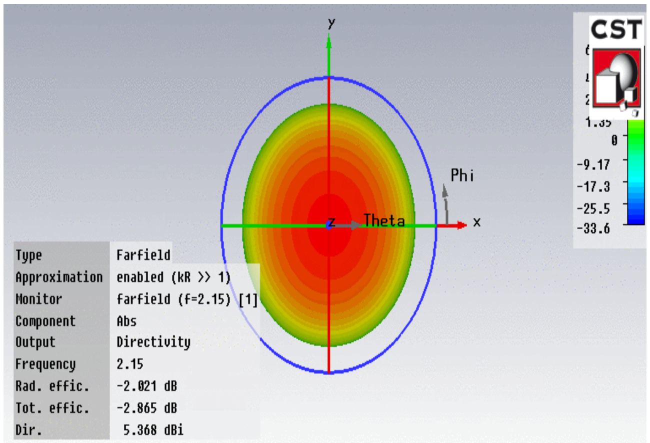

Fig. 3. Simulation result shows directivity, efficiency and radiation pattern.

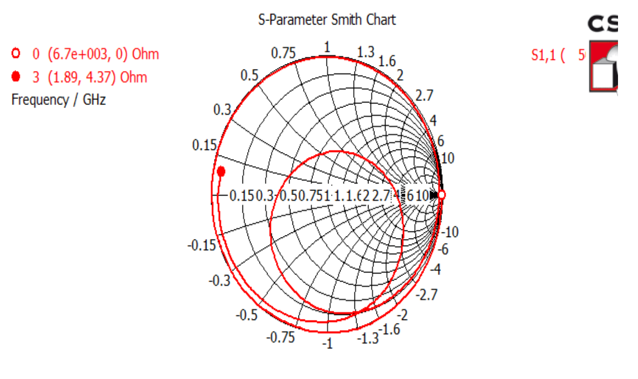

Fig. 4. Smith Chart of the proposed patch

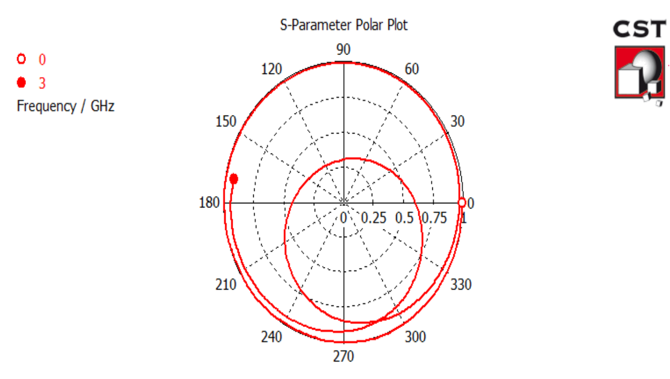

Fig. 5. Polar plot of simulated patch

Simulated results shows that the designed antenna at 2.15GHz is showing return loss of -10.2dB, directivity 5.368dBi and radiation efficiency of -2.02dB, which can be written as 62 in terms of percentage.

After antenna simulation metamaterial concept was introduced and after the substrate implication metamaterial cover was implemented, proposed design is shown in figure below and the simulated results after implementing this cover are also presented in subsequent figures. The outer radius of bigger octal shape is 15mm and inner radius is 12mm whereas the outer and inner radius of smaller octal shaped split ring are 5 and 3mm. Cut made in these rings are of 10mm and 3mm respectively for outer and inner rings.

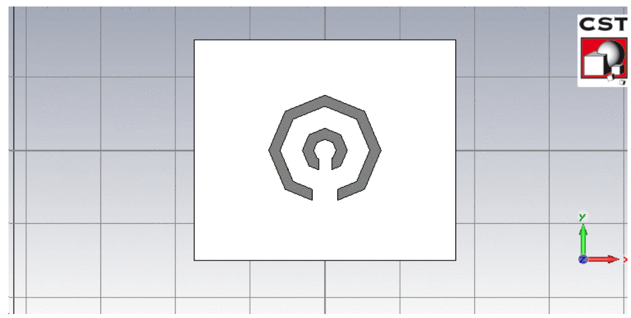

Fig. 6. Proposed design of metamaterial

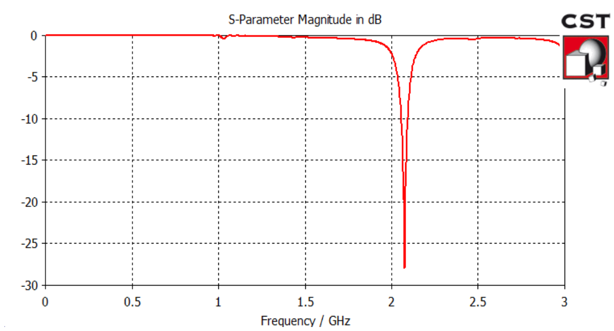

Fig. 7. Simulated result of patch after metamaterial implementation

After introduction of metamaterial the parameters of patch modified, return loss has been increased from -10.2dB to -28dB. Other simulated results are as follows.

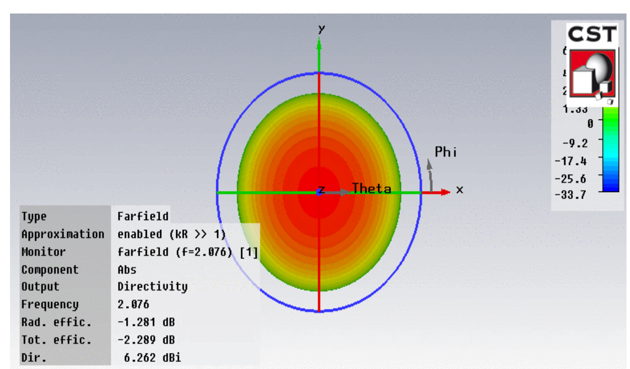

Fig. 8. Radiation pattern with directivity and efficiency

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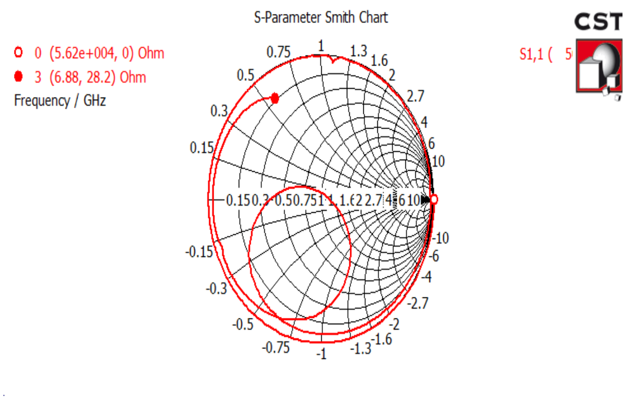

Fig. 9. Smith Chart.

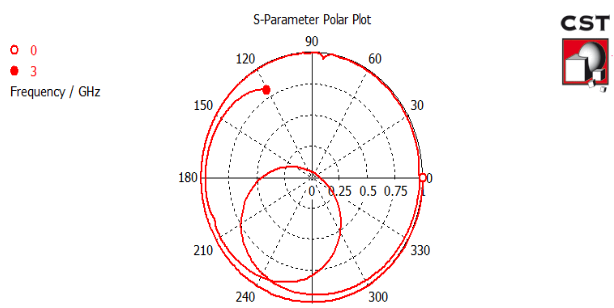

Fig. 9. Polar plot.

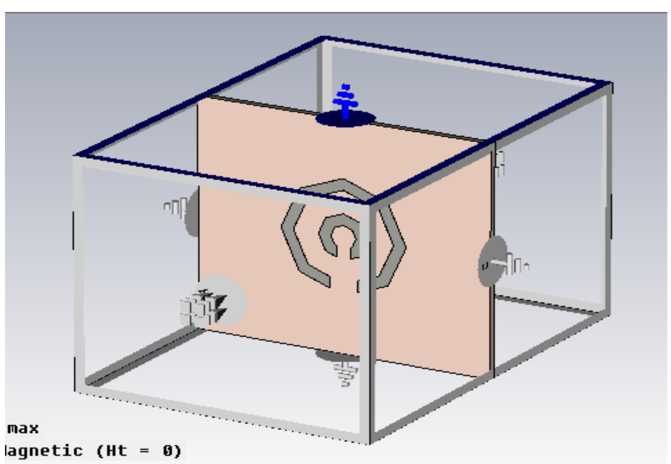

Fig. 10. Applied boundary condition for NRW approach

III. RESULT

After simulating and analyzing the modified parameters of the patch it was necessary to prove the design is a metamaterial, NRW approach was used. In NRW approach boundary condition was applied on metamaterial structure and after that excitation was done and permittivity and permeability was calculated. Both permittivity and permeability was found negative hence it was proved that used design was metamaterial. Comparative chart is shown below in table 1.

TABLE I: COMPARISON CHART

S. no.	Parameters	Parameters of RMPA alone at 2.15 GHz	After metamaterial introduction At 2.076 GHz
1	Return loss	-10.5 Db	-29dB
2	Bandwidth	32 MHz	49 MHz
3	Directivity	5.368 dBi	6.262 dBi
4	Efficiency	62.79 %	74 %

After the comparison it has been observed that the proposed metamterial structure modified the antenna as per the requirement.

IV. CONCLUSION

The antenna was proposed to work for the S band applications and so was the result showing. Antenna is operating on the frequency of 2.07GHz with high return loss better directivity and improved efficiency. The split ring resonators modified the patch as per the requirement for the wireless application of the S band. This proposed design could be useful when more directive antenna is required.

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