Designing of RMPA with Modified Metamaterial Structure

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Abstract
In this research paper an unsymmetrical metamaterial structure is used to modify the rectangular patch antenna at 2.59Ghz or in S band Patch antenna alone is not applicable for any wireless communication because the gain,bandwidth and efficiency are not upto the mark so when metamaterial was implemented with patch the salient features of patch get increased and provide better efficiency.

Keywords: *Unsymmetrical metamaterial,Rectangular patch, Bandwidth, Return loss.*

INTRODUCTION

Requirement of antenna in wireless applications, especially in the S bands has waft in recent past years.The need of the small size and efficient antenna has risen tremendously, various researchers came up with new advancement to renovate the antenna features without disturbing the easiness and expansion of shape. By investigatingthe reviewthat was taken out from study the available techniques which can be implemented to retouch the parameters of this proposed antenna. Detailed literature review shows the use of parasitic elements [1], various feeding techniques [2] could also be preferred, hypothetical concept of MTM structure [3] could also be incorporated, and DGS [4] could also be studied, it was found that among them MTM was seen, the by far best technique available. It is not only easy to design[5][6] and cheap in fabrication as well.Satellite applications, military requirements, medical application and telecommunication system[12]are among few in which antenna is required for communication and data transfer. So studying the performance of a rectangular patch when MTM is introduced above the height of 3.276mm from the patch antenna.

DESIGNING AND SIMULATION OFRMPA& IMPLEMENTATION OF METAMATERIAL

A RMPA at frequency of 2.59 GHz is introduced. CST software version 2018 was used for designing antenna, following fig. 1 shows the proposed antenna at the frequency of 2.59GHz and then in corresponding figure 2 simulation result showing radiation pattern is presented of the antenna designed at 2.59GHz.

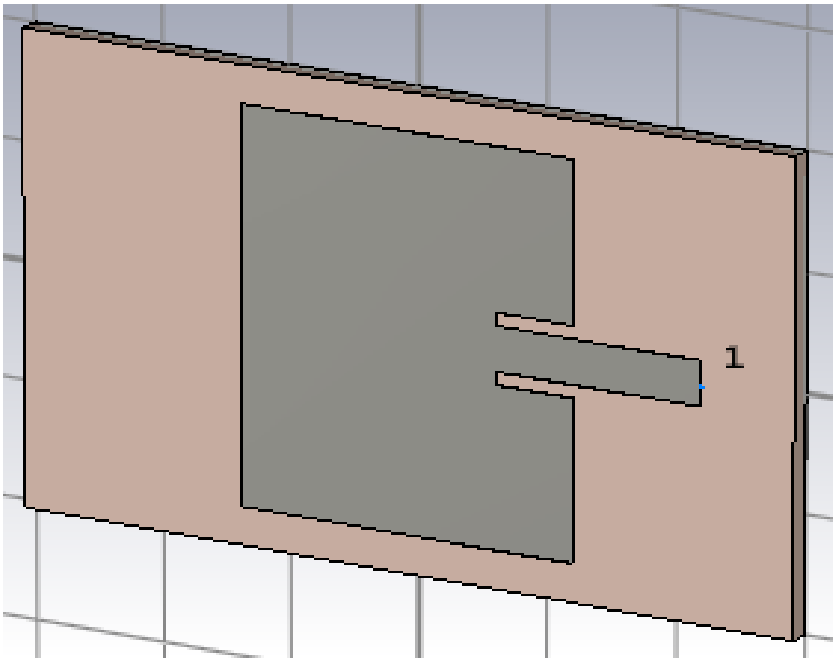

Fig: 1.*Patch at 2.59GHz frequency (Dimensions shown in Table 1).*

Table: 1.*Dimensions of Patch shown in Fig. 1.*

Parameter	Dimensions of Rectangular Patch	Unit
Length (L)	25.9122	Mm
Width (W)	33.507	Mm
Cut Width	6	Mm
Cut Depth	6	Mm
Path Length	15.791	Mm
Width Of Feed	3.80	Mm

***Desired Parametric Analysis** [8]:*

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,

ε_r = Substrate's Dielectric constant

Effective dielectric constant will be calculated by**:**

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

Actual length of the Patch (L)

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

LengthExtension will be Calculate by

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{eff}+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{w}{h}+0.8\right)}(4)$$

The reflection coefficient (S11) of this antenna is depicted inFig. 2. The antenna is working at 2.59GHz or S band. But the outputof the antenna are not up to the mark. Following fig 2 is showing the return loss which is merely at-11 dB and bandwidth is also 49MHz only. In order to get the antenna effective and more directive theconcept of MTM needs to be introduced in the design. MTM[13] structures are used toproduce resonating bands, which raises the gain and a well BWand also help in miniaturization of an antenna. Keeping thisbelief in mind, modify the initial design by applyingMTM above the patch.

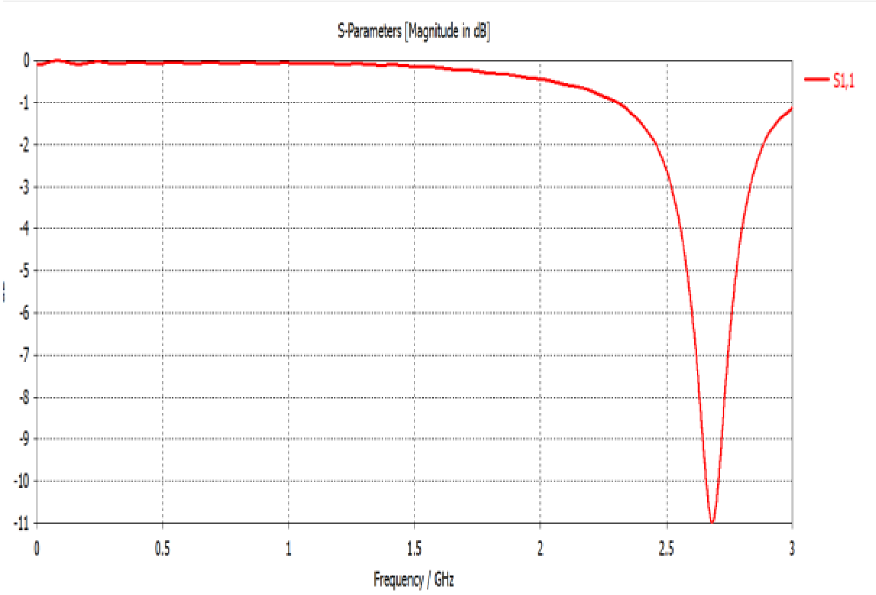

Fig: 2.*Simulated result of rectangular patch shown in fig 1.*

After analyzing the simulated results of patch in the above fig2 ,the MTM structure with dimension in fig3 which is implemented in a ground plane shown in fig4.

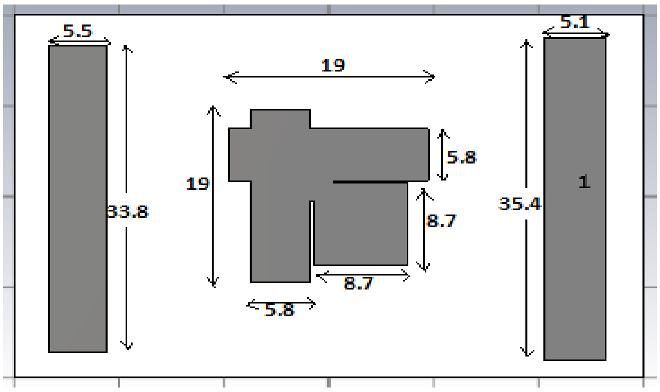

Fig: 3.*Dimensions of MTM Structure(mm)*

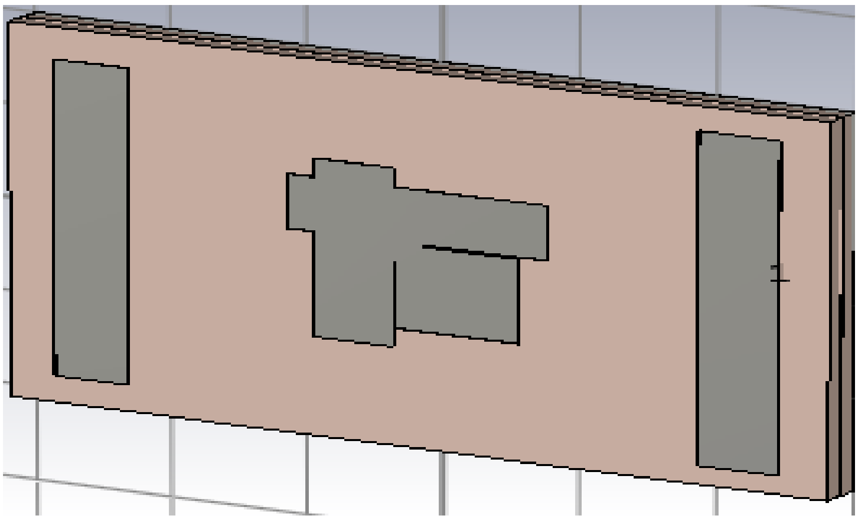

Fig: 4.*MTM Design Plot in Groundplane of Patch*

After implementing MTM[11][14],the symptoms of the antenna have improved significantly and start resonating at 2.59GHzand shows the return loss of -15dB instead of -11 previously whereas the BW extalted to 72MHz from 49MHz.

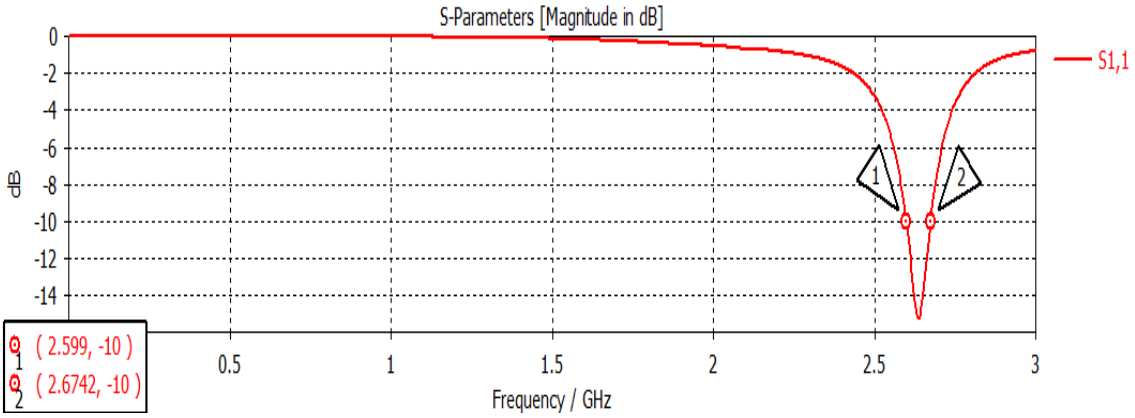

Fig: 5.*Return loss of RMPA with MTM*

After simulation there is need to prove that used MTM has DNG property in fig7&8so it has been plot between two waveguide ports which lay on left and right ofthe X-Axis in order to calculate the Sll & S21 [7][8].So by using theNRW approach[9][10]. The μ and ε can be found and directly exported to Excel software in table 2&3.

$$\mu_r = \frac{2.c(1-v2)}{\omega.d.i(1+v2)} \quad (5)$$

$$\varepsilon_r = \mu_r + \frac{2.S11.c.i}{\omega.d} \quad (6)$$

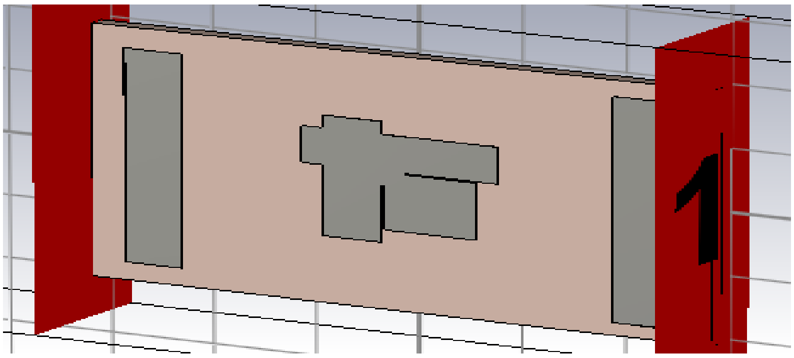

Fig: 6. *MTM structure placed between two waveguide ports and under boundary conditions.*

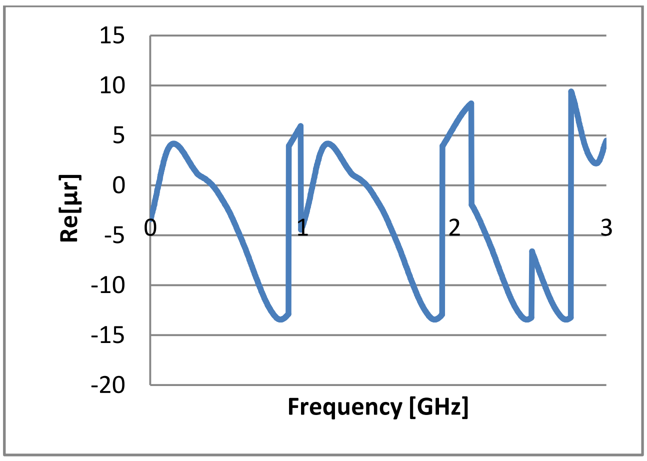

***Fig: 7.**Permeability vs. Frequency Graph*

***Table:2.** Value of Permeability at operating frequency*

Frequency[GHz]	Permeability[μ_r]	Re[μ_r]
2.579	-9.4432056091421-43.5638744424317i	-9.44305609
2.582	-9.5616289907819-43.4851380711555i	-9.56168991
2.585	-9.6795749032553-43.4046063927037i	-9.67957403
2.588	-9.7970466376625-43.3220236867363i	-9.79746638
2.592	-9.9140394700083-43.2371079457366i	-9.91403947

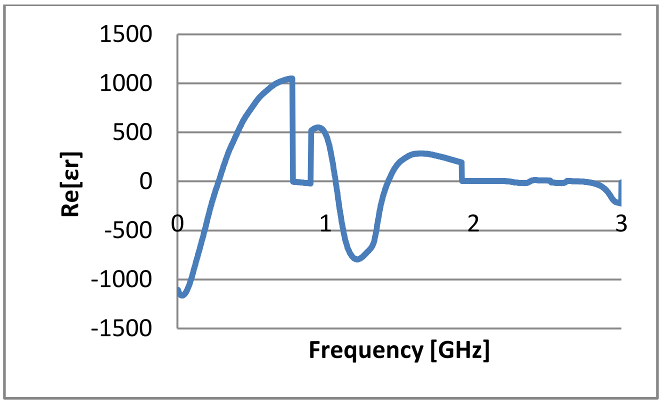

***Fig:8.**Permittivity vs. Frequency Graph*

***Table:3.** Value of Permittivity at operating frequency*

Frequency[GHz]	Permittivity[ε_r]	Re[ε_r]
2.5799999	-17.1275773489181-72.075019338489i	-17.12757735
2.5829999	-17.3341218882299-71.8708780027334i	-17.33412189
2.5859995	-17.5194310269606-71.6691627170821i	-17.51943103
2.5889995	-17.675392587701-71.4698662084193i	-17.67539259
2.592	-17.7904831761175-71.2735247493642i	-17.79048318

CONCLUSION

In this paper an unsymmetrical MTM design was proposed to improve the features of RMPA. Initially when rectangular antenna was designed and simulated it was seen that this particular antenna was not having sufficient parameter to be used in any wireless applications[15]. Later when MTM was implemented over this antenna a significant achievement was recorded when analyzed and gets an efficiency upto 80%.

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