Enhancement of Microstrip Patch Antenna by Using"Blade-Pipette Shaped Hexagonal SRR"

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Abstract

The compact patch antennas (CPA) are mandate and size is little and solid design. These antennas are source created to accomplish the ongoing necessities. These antennas are wanted to be had less return loss, better directivity, and higher transmission capacity and minimized size at the working at recurrence when utilized in any imparting activity. This offered configuration is considered at the reverberating recurrence of 2.5GHz. The coupling of fix and ground alongside the metamaterial execution over the Microstrip Patch Antenna upgraded the transmission capacity and gain.

Keywords: *Metamaterial, Hexagonal Shaped, bandwidth, Microstrip Patch, CPA, LHM, Ground Plane, Dielectric Substrate.*

INTRODUCTION

The MPA is a printed kind of receiving wire comprising of a DS with εr and μr (as a rule μr = 1) when sandwiched in the middle of GP and a patch. MPA has a limited point of interest when contrasted with other ordinary MPA like a Low manufacture cost, its light weight, low volume and low profile design that is the reason MPA can be effectively mounted on the rockets and satellite without major modification [2]. Inspite of preferred standpoint there arelimited downsides, as limited transmission capacity and low gain. A typical strategy to beat these disadvantages is utilizing exhibit of MPA be that as it may, this strategy has downsides which are high feed networklosses and create common coupling another technique to conquer this deficits by utilizing LH metamaterial. In this paper, MTM is utilized for improve the factors of MPA. MTM's are synthetic materials which are not producing in environment. They are worked by periodicallyarranged unit cells and these unit cells are not made of physical particle and atoms but rather, contain little metallic resonator which interface with outer electromagnetic wave. Metamaterial is additionally known as twofold negative metamaterial on the grounds that it demonstrate negative permittivity εr<<<<0, and negative permeability [6]μr<<<<0. Metamaterial was first presented by Victor Vesalago in 1967[1] [8], yet as just a hypothetical idea. Later in the time of 2001 Dr. Smith [10], manufactured a structure with SRR and TW and it's named as LHM [15]. This paper demonstrates the change of gain and BW by putting metamaterial on the highest point of MPA with air hole. This marvelous can be categorized by the NRI and the anti-parallel phase velocity (PV) which is also known as backward wave.

DESIGNING AND SIMULATION OF PA & IMPLEMENTATION OF METAMATERIAL

Another antenna has been proposed for the working recurrence of 2.5 GHz. Parameters were calculated by formulas which is listed in [8] and outlining (structure) and recreation of this offered antenna was done on the CST MWS 2018. Organized antenna is appears in recorded fig. 1 and afterward in comparing figure 2 reproduction results demonstrates the radiation design is exhibited of the reception apparatus composed at 2.5GHz.

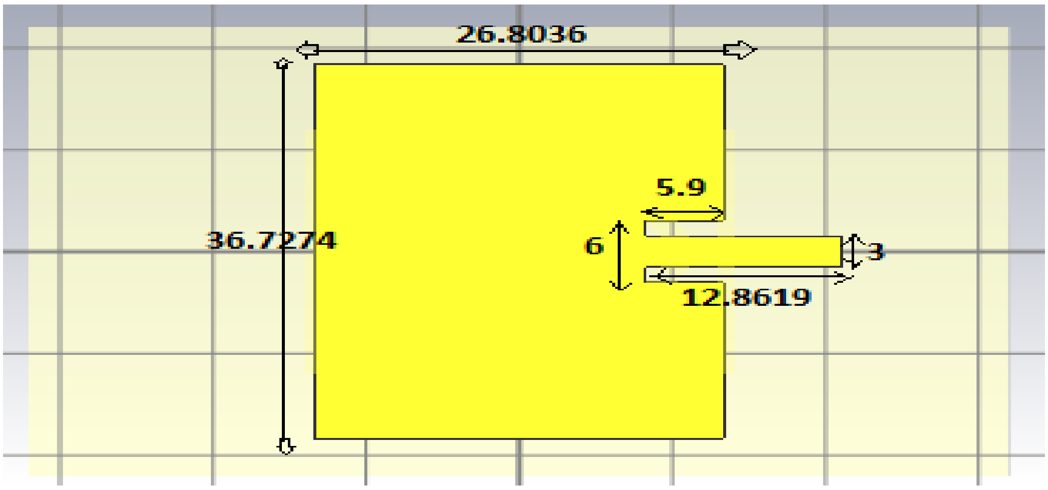


Fig: 1.*Designed antenna at 2.5GHz frequency (all dimensions are in mm).*

Antenna appears in recorded figure 1 is planned, ascertained and reproduced in MW studio device of CST MWS. Simulated consequence of this composed antenna or transducer is appears in figure underneath indicating RL of - 14dB and BW of 62MHz. RMPA can be calculated by the formula:-

$$W= \frac{1}{2fr\sqrt{\mu\epsilon}}\sqrt{\frac{2}{\varepsilon r+1}}=\frac{c}{2fr}\sqrt{\frac{2}{\varepsilon r+1}} \qquad \ldots (1)$$

Where,
c = speed of light in vacuum
ε_r= Dielectric constant (DC) of substrate
The effective dielectric constant (ε_r) 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)

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

$$L_{eff}=\frac{c}{2fr\sqrt{\varepsilon eff}} \qquad \ldots (4)$$

Calculation of Length Extension

$$\frac{\Delta L}{h} = 0.412\,\frac{(\varepsilon eff+.3)(\frac{w}{h}+.0264)}{(\varepsilon eff-0.258)(\frac{w}{h}+0.8)} \qquad \ldots (5)$$

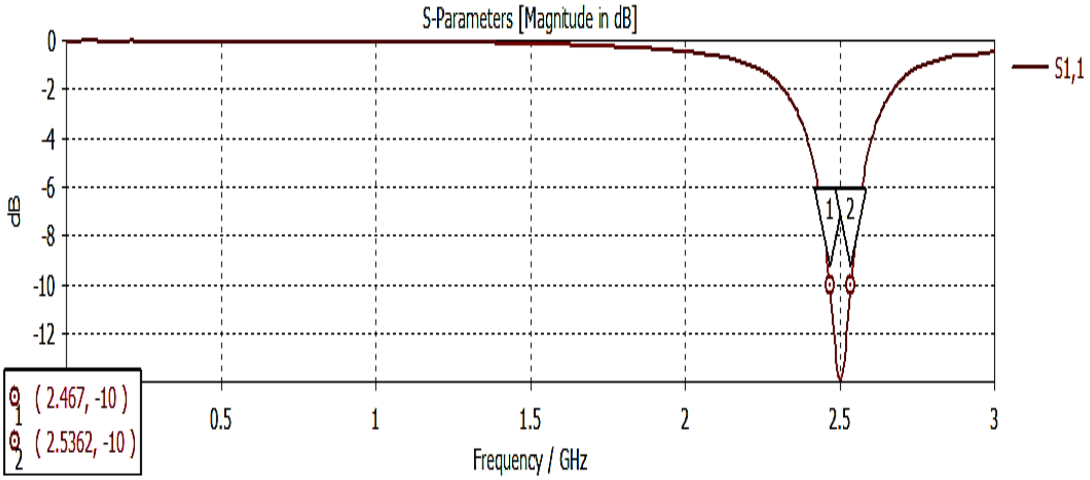


Fig: 2. *Return loss of patch antenna at 2.5 GHz*

Composed RMPA was reproduced and its outcome was exhibited in the figure 2. Simulated or watched result demonstrates return loss (RL) of - 14 dB and the data transmission was around 62MHz. These outcomes are not up to the necessities so parameter change is attractive. To satisfy the interest of metamaterial cover was actualized, metamaterial outline or structure in fig. 3 and following figure demonstrates its simulated outcomes. In this proposed plan, one hexagon molded ring with cuts, pipette shaped circle and two parallel bars with blade shaped are utilized in the structure and this was utilized to adjust or change the antenna includes, the metamaterial will bring up in the bordering fields and improving the radiations.

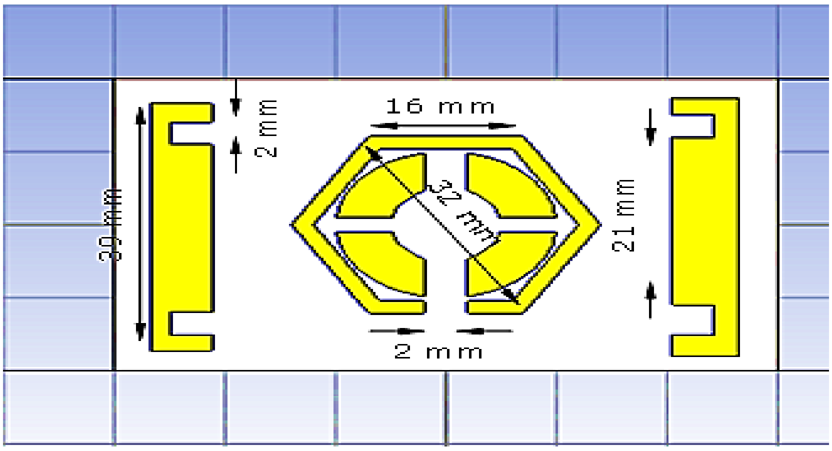


***Fig: 3.** Experimental view of metamaterial structure*

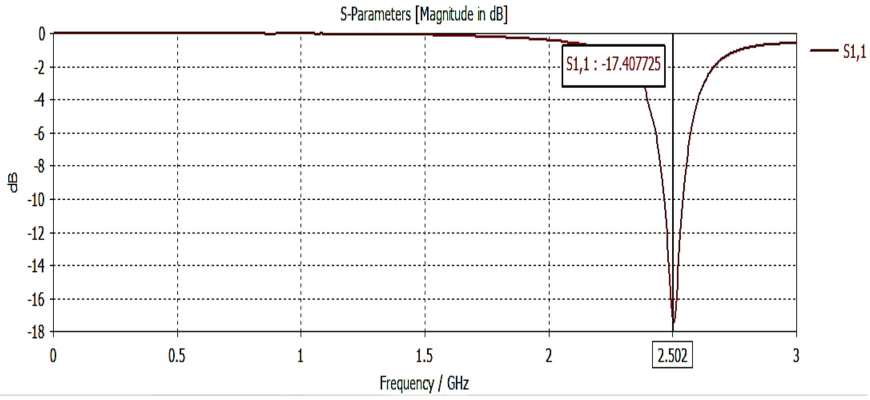
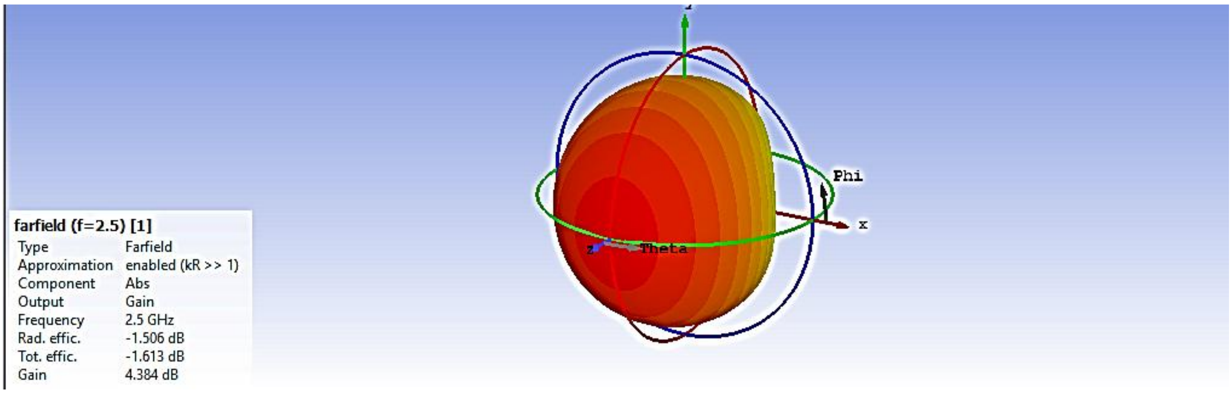


***Fig: 4.** Return loss (RL) of RMPA with loaded MTM at 2.5 GHz*



farfield (f=2.5) [1]

Type	Farfield
Approximation	enabled (kR >> 1)
Component	Abs
Output	Gain
Frequency	2.5 GHz
Rad. effic.	-1.506 dB
Tot. effic.	-1.613 dB
Gain	4.384 dB

***Fig: 5.**Showing radiation pattern with efficiency and gain*

After the examination, it has been go along that the proposed MTM structure adjusted the parameters up, as it were, [9], the proposed MTM technique enhances the arrival loss and raise the BW when contrasted with BW of (fix) patch.

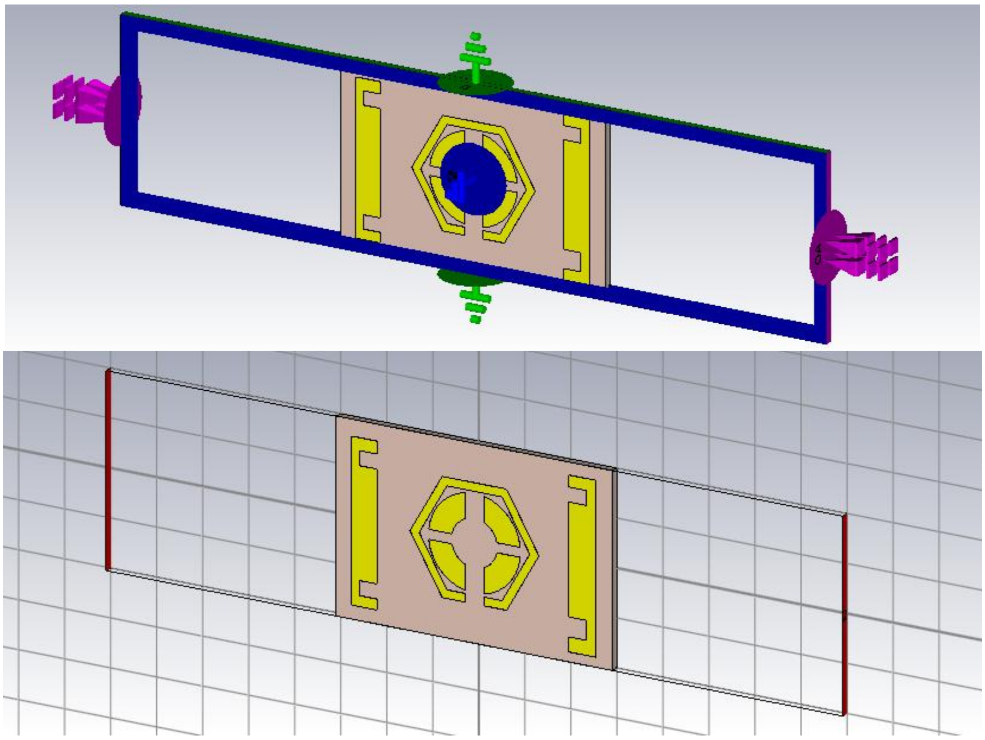


***Fig: 6.** Proposed Waveguide Ports& Boundaries of applied metamaterial structure*

Two waveguide ports and boundaries were characterized at the left and right of the X-Axis as appeared in above figure 6 with the end goal to compute the Sll and S21 [7] parameters. The acquired S-parameters are sent out to MS Excel Software for finding the estimation of the μr , εr of the presented MTM structure, utilizing the Nicolson-Ross-Weir Approach[9][10][12]. Fig 7 is the graph of ε versus frequency, by computing the NRW approach from the MS-Excel Software and also getting permeability versus frequency graph which is cited in fig. 8. The got parameters from MS-Excel Software recorded in underneath in table I of permeability at working frequency and permittivity at working frequency is appeared in beneath table II.

Equations Used for Calculating (ε_r) and (μ_r) NRW Approach:-

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

$$\varepsilon_r = \frac{2c(1-v1)}{\omega.d.i(1+v1)}$$

$$V\,1 = S11 + S21$$

$$V2 = S21 - S11$$

Where,

ε_r = Permittivity
μ_r = Permeability
d = Thickness of the Substrate
i = Imaginary coefficient
$V1$ = Voltage Maxima
$V2$ = Voltage Minima
c = Speed of Light
ω = Frequency in Radian

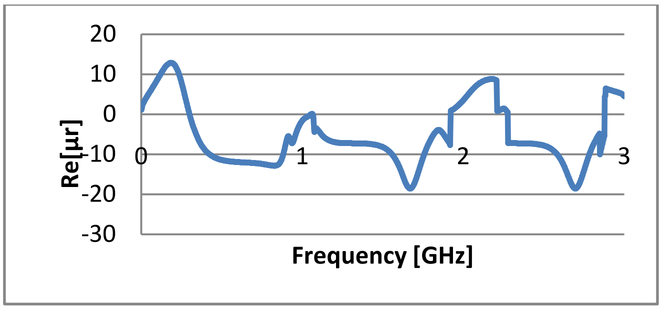


Fig: 7. *Permeability vs Frequency Graph*

Table I: *Value of Permeability at operating frequency*

Frequency [GHz]	Permeability[μr]	Re[μr]
2.4959996	-6.75342158048483-30.517310708274i	-7.75084380
2.4990001	-6.7477098866490-31.4251238271278i	-7.78231626
2.5020001	-6.8688093138976-31.3322068876919i	-7.81572584
2.5049999	-6.8439075169084-31.2223570964554i	-7.85122459
2.5079999	-6.8889725069065-31.1441856222509i	-7.88897250

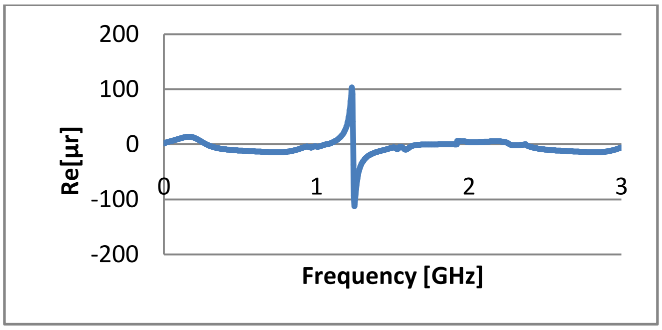


Fig: 8. *Permeability vs Frequency Graph*

Table: II *Value of ε (Permittivity) at operating frequency*

Frequency [GHz]	Permittivity[εr]	Re[εr]
2.4959	-24.30876416706429-46.589964150976328i	-24.68805319
2.4990	-25.1496974642529-47.9150764629728i	-24.6905541367
2.5020	-25.077676701592-48.3475725790192i	-24.46996318
2.5049	-24.9943797048388-48.7789553516057i	-23.59521670
2.5079	-24.9004009256111-49.2086197448464i	-23.87065393

RESULT

The detectedresults of above two figures (fig. 2 and fig. 4) by relating the simulated results displays in fig. 2 (simulated result of PA before DGS implementation) & in fig. 4 & 5 (simulated result after incorporating DGS) that there is major improvements is achieved in Return loss, gain, Bandwidth. Efficiency is merely gets affected. When these results had been compared w.r.t the parameter variation. Comparative chart is shown below in table

Table: III*Comparison chart is shown below in table.*

SNO.	PARAMETERS	RMPA ANTENNA AT 2.5 GHz	RMPA WITH MTM AT 2.5 GHz
1.	Return Loss	-14 dB	-17.40 dB
2.	B.W.	62MHz	94MHz
3.	Directivity	5.891dBi	6.111dBi
4.	Gain	4.384dB	4.553dB

CONCLUSION

This proposed RMPA was organized for the uses of S band [10]. At first configurations of fix PA were analyzed and they were not expressively fulfilling or satisfying the necessity of the focused on applications yet when hexagonal or blade-pipet shaped formed Metamaterial structure is executed over the PA, a remarkable change is accomplished. BW and (RL) return loss both at the sameperiod demonstrates a remarkable change. Changed PAcanbemaking use of in S band applications like WLAN and Satellite applications [15].

REFERENCES

1. BimalGarg, DauoodSaleem,“A highly efficient & directive rectangular microstrip patch transceiver using circular SRR based metamaterial structure for microwave and wireless communication applications,” has been published for the publication “Innovative Trends in Information Technologies and Computing Sciencesfor Competitive world order” JNU, New Delhi, February 2013
2. Jun-Won Kim, Tae-Hwan Jung, Hong-KyunRyu, Jong-Myung Woo, "Compact Multiband Microstrip Antenna Using Inverted L and T-Shaped Parasitic Elements." IEEE Antennas and Wireless Propagation Letters, vol. 12, 2013, pp. 1299-1302.
3. BimalGarg, AnkitSamadhiya, Rahul DevVerma, “Design of Double-F Metamaterial Structure for Enhancing Bandwidth of Patch Antenna With Negative μ And ε”. International Conference on Communication Systems and Network Technologies (CSNT-2012), Rajkot (Gujrat), 11-13 May 2012
4. BimalGarg, Rahul Tiwari, Ashish Kumar and TilakChitransh, “Design of factored ‘X’ shaped metamaterial structure for enhancement of patch antenna gain”, International Conference onCommunication Systems and Network Technologies 2011.
5. BimalGarg, DauoodSaleem,“Analysis and design of innovative double H metamaterial structure for amelioration in patch antenna parameters,” STM journals, Volume 2, Issue3, December2012.
6. BimalGarg, Vijay Sharma, NitinAgrawal, “Enhancement of Gain and Directivity of Rectangular Resonant Microstrip Patch Antenna Loaded with “SYMMETRIC W” shaped Double Negative Left-Handed inspired metamaterial”, National Conference on Recent Advances in Microwave Engineering, 2011.
7. Emad S. Ahmed "Multiband CPW-Fed Rectangular Ring Microstrip Antenna Design for Wireless Communications." IEEE Jordan Conference, AEECT, 2011.
8. PradeepPaswan, Vivekanand Mishra, P. N. Patel, SurabhiDwivedi "Performance Enhancement of Coaxial Feed Microstrip Patch Antenna Using Left-Handed Metamaterial Cover," IEEE conference, SCEECS, 2014.
9. J.B. Pendry, A.J. Holden, D.J. Robbins, W.J. Stewart,“magnetism from conductors and enhanced nonlinearphenomena” IEEE Trans.

Micro Tech. vol.47 no.11, pp.2075-2081, Nov.1999.
10. D.R. Smith, W.J. Padilla, D.C. Vier, et al, Compositemedium with simultaneously negative permeability andpermittivity, Phys Rev Lett 84, 4184–4187,May 2000.
11. J.B. Pendry, Negative refraction males a prefect lens, PhysRevLett, 85, 3966–396,2000.
12. Y.J. Sung, M. Kinand Y.S. Kin, “Harmonics Reduction with Defected Ground Structure for Micro-Strip Patch Radiator”, IEEE Radiator and Wireless Propagation Letters, Vol. 2, 2003.
13. C. A. Balanis, “Microstrip Antenna” in Antenna Theory and Design, Vol 3, John Wiley & Sons, Inc., 1997, pp. 811-882.
14. D. R. Jackson and N. G. Alex6poulos, "Gain enhancement methods forprinted circuit antennas," IEEE Trans, Antennas Propag, vol. AP-33, no. 9,Sep, 1985.
15. H. Nakano, M. Ikeda, K.,Hitosugi, and 1. Yamauchi, "A spiral antennasandwiched by dielectric layers," IEEE Trans. Antennas Propag., vo1.52, no. 6,Jun. 2004,

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