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Rectangular Patch Antenna Using "ARRAY OF HEXAGONAL RINGS" Structure in L-band

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***Abstract*—In this work, a Rectangular microstrip patch antenna loaded with rectangular patch antenna using "array of hexagonal rings" structure in L-band metamaterial structure is designed at a height 3.2 mm from the ground plane by using CST-MWS software. It improves gain due to its negative refractive property. The resonance frequency that we have used here is 1.95GHz. There are many parameters which we have considered return loss and bandwidth of antenna The Return loss of the proposed antenna is reduced by 21.32dB. Bandwidth of this antenna has also increased up to 27MHZ that shows improvement in antenna property by proposed design. This antenna can have any applications in communication at L-band.**

Keywords - Rectangular Microstrip Patch Antenna, Metamaterials, Bandwidth, Return Loss..

I. INTRODUCTION

An antenna is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. A transmitter supplies an oscillating radio frequency electric current to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves).
A patch antenna is a type of radio antenna with a low profile, which can be mounted on a flat surface[3]. It consists of a flat rectangular sheet or "patch" of metal, mounted over a larger sheet of metal called a ground plane. The assembly is usually contained inside a plastic radome, which protects the antenna structure from damage. Patch antennas are simple to fabricate and easy to modify and customize.An antenna is a form of tuned circuit consisting of inductance and capacitance, and as a result it has a resonant frequency. This is the frequency where the capacitive and inductive reactances cancel each other out. At this point the antenna appears purely resistive, the resistance being a combination of the loss resistance and the radiation resistance**.**.The radiation mechanism arises from discontinuities at each truncated edge of the microstrip transmission line. The radiation at the edges causes the antenna to act slightly larger electrically than its physical dimensions, so in order for the antenna to be resonant, a length of microstrip transmission line slightly shorter than one-half a wavelength at the frequency is used. A patch antenna is usually constructed on a dielectric substrate[1,2,4].

A metamaterial is a structural composite with unique electromagnetic properties due to the interaction of waves with the finer-scale periodicity of conventional materials. This could be accomplished by surrounding an antenna with a shell of double negative (DNG) material. At the time this was investigated both analytically and numerically. When the electric dipole is embedded in a homogeneous DNG medium, the analysis shows that the antenna acts inductively rather than capacitively, as it would in free space without the interaction of the DNG material. In addition, the dipole-DNG shell combination increases the real power radiated by more than an order of magnitude over a free space antenna. A notable decrease in the reactance of the dipole antenna corresponds to the increase in radiated power. The person responsible for discovering the concept of metamaterials in 1967 was Veselago . Veselago assumed the existence of unknown materials with negative permeability and permittivity in the same frequency range[7,11].

The introduction of the so-called metamaterials (MTMs), artificial materials which have engineered electromagnetic responses that are not readily available in nature, has provided an alternate design approach to obtain efficient electrically-small antenna (EESA)systems[6,8].

2. ANTENNA PARAMETERS

The Rectangular microstrip patch antenna parameters are calculated from the formulas given below [8, 9].

The resonance frequency is given by

$$f_0 = \frac{C}{2Le\sqrt{\varepsilon_r}} \qquad (1)$$

Where c is the speed of light in vacuum.

To account for the fringing of the cavity fields at the edges of the patch, the length, the effective length *Le* is chosen as

Le= L + 2ΔL

Calculation of Width (W):

$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r+1}} = \frac{C}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \qquad (2)$$

Where,
c = free space velocity of light
ε_r = Dielectric constant of substrate

Effective dielectric constant is calculated from**:**

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(\frac{1}{\sqrt{1+\frac{12h}{w}}}\right) \qquad (3)$$

The actual length of the Patch (L)

$$L = L_{eff} - 2\Delta L \qquad (4)$$

Where

$$\text{Leff} = \frac{C}{2f_r\sqrt{\varepsilon_{eff}}}$$

Calculation of Length Extension

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

TABLE 1: RECTANGULAR MICROSTRIPPATCH ANTENNA SPECIFICATIONS

	Dimensions	Unit
Dielectric Constant (εr)	4.3	-
Loss Tangent (tan ∂)	0.02	-
Thickness (h)	1.6	Mm
Operating Frequency	1.95	GHz
Length (L)	35.44	Mm
Width (W)	45.64	Mm
Cut Width	5	Mm
Cut Depth	10	Mm
Path Length	32.50	Mm
Width Of Feed	3.009	Mm

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

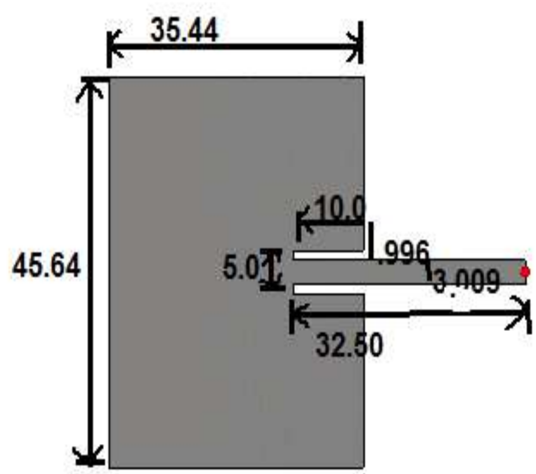

Figure 1: Rectangular patch antenna designed at 1.95 GHz (All dimensions in mm).

The results of simulation of this antenna are shown in figure 2 and 3.The CST-MWS (computer simulation Technology) was opted to simulate the structures shown in the figures below.

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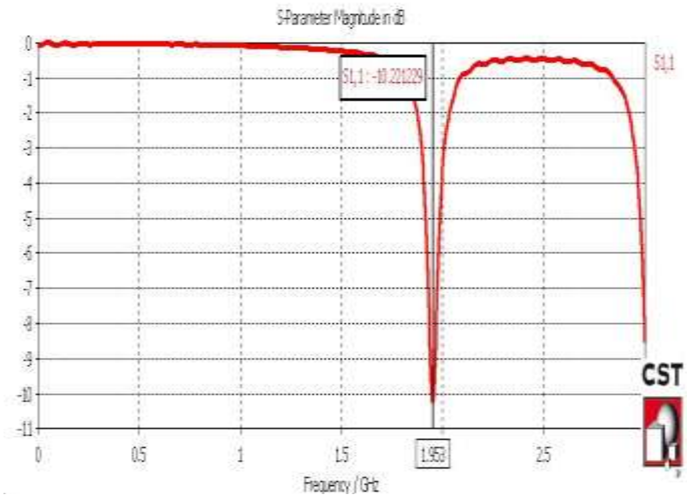

Figure 2: Simulated Result of Rectangular microstrip patch antenna showing return loss of -10.22 dB and 9.6MHz Bandwidth.

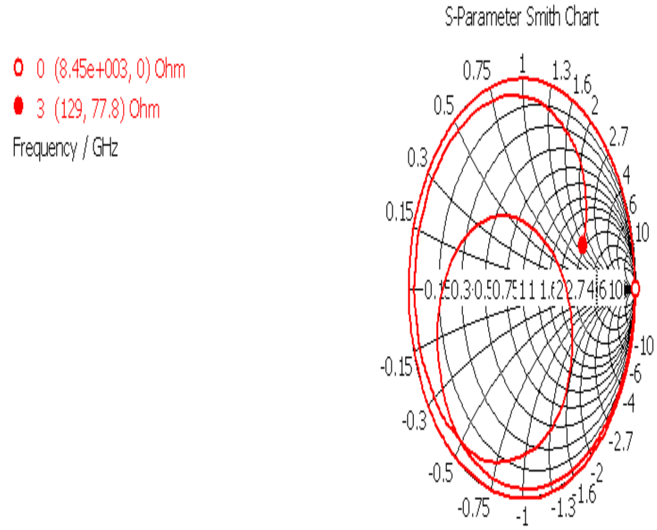

Figure 4: Smith chart of Rectangular microstrip patch antenna at 1.95 GHZ

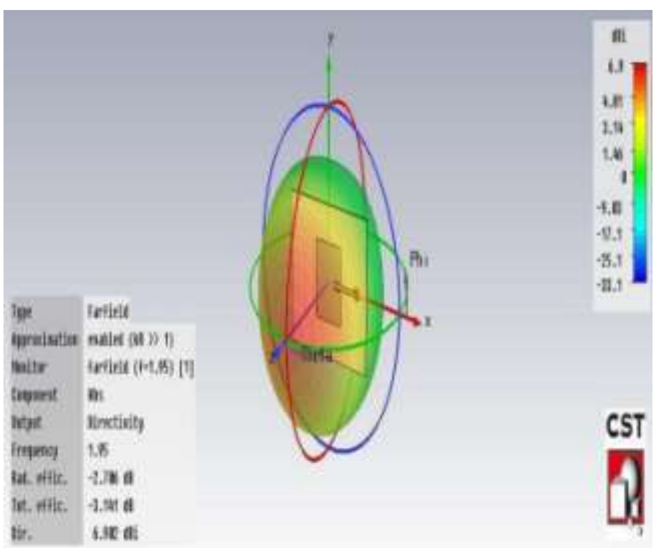

Figure 3: Radiation Pattern of Rectangular microstrip patch antenna with directivity 6.982dBi.

3. Simulation and results of proposed design **(**ARRAY OF HEXAGONAL RINGS)

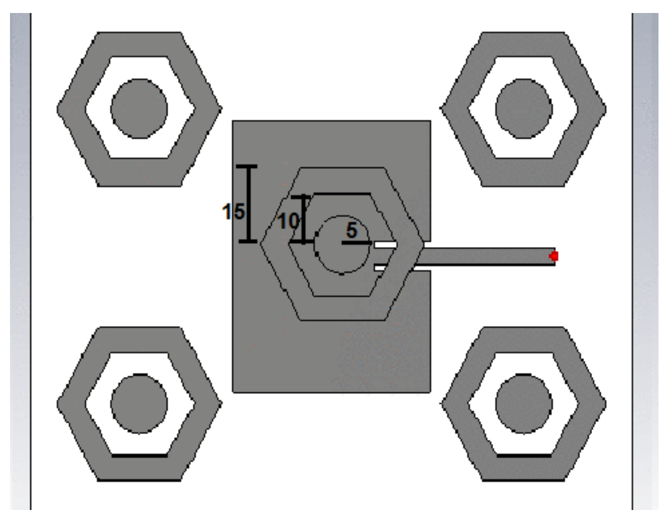

Figure 5: Rectangular Microstrip patch antenna with "ARRAY OF HEXAGONAL RINGS" shaped metamaterial structure

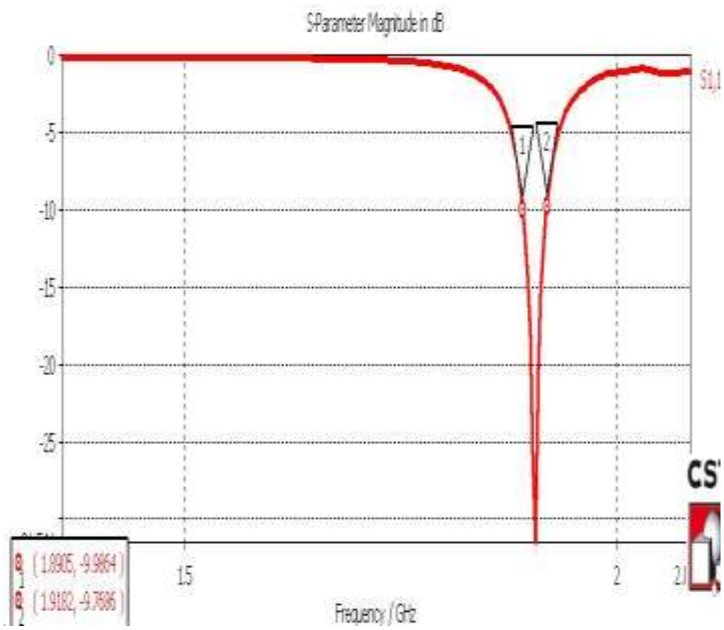

Figure 6: Simulated result of proposed antenna showing Return Loss of -31.54dB and Bandwidth of 27.6 MHz

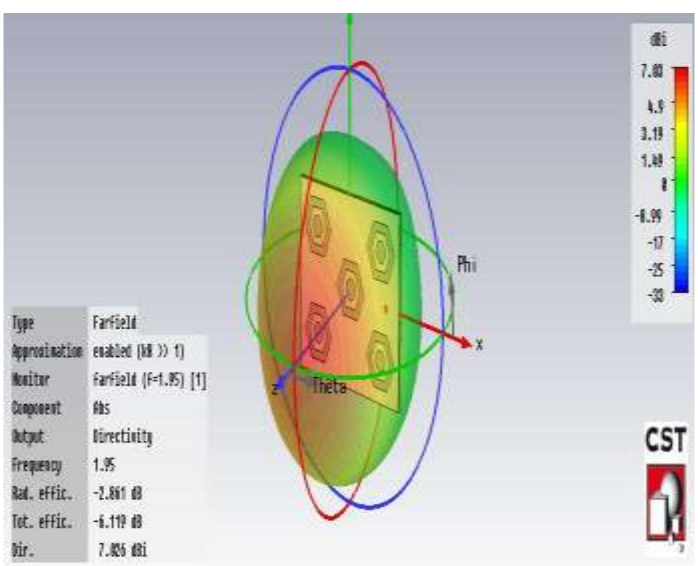

Figure 7: Radiation Pattern of proposed antenna showing 7.826dBi directivity.

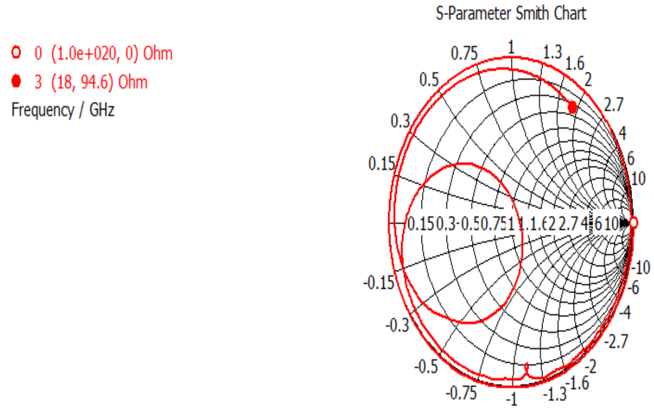

Figure 8: Smith chart of proposed antenna at 1.95 GHZ

4. RESULTS AND DISCUSSIONS

The simulated results of rectangular microstrip patch antenna with “ARRAY OF HEXAGONAL RINGS” shaped structure have shown in the figures 6, 7, and 8. The CST-MWS simulation software has been used to simulate the antenna. By simulating the proposed metamaterial structure with the rectangular microstrip antenna, improvement of 21.32dB in return loss & 18MHz improvement in bandwidth has been found, while the directivity also got improved. At 1.95 GHz frequency the simulated rectangular microstrip patch antenna shows (figure 1) return loss of -10.22dB & bandwidth (figure2) of 9.6MHz while the same when designed with “ARRAY OF HEXAGONAL RINGS” shaped metamaterial structure at 3.2 mm from the ground plane shows (figure 6) return loss of -31.54 dB & 27.6MHz.Respective smith chart of RMPA and proposed designed also shown in figure4 and firgure8.Here normalized impedence has been taken.

5. CONCLUSION

The “Rectangular patch antenna using array of hexagonal rings” structure with Rectangular microstrip patch antenna has been proposed in this paper. The simulated results provide gain, bandwidth and directivity improvement. Gain of a antenna can be further improved by using some variation these variation can be in length, width, frequency and material .But some practical limitation should be taken care while fabricating the structure on CST-MWS software.

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6. REFERENCES:

[1] V.G. Veselago "The electrodynamics of substances with simultaneously negative value ε and μ" Sov. Phys. Uspekekhy.10 (4), 509-514,1968.

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

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

[4] J.B. Pendry, A.J. Holden, D.J. Robbins, W.J. Stewart, "magnetism from conductors and enhanced nonlinear phenomena" IEEE Trans. Micro Tech. vol.47 no.11, pp.2075-2081, Nov.1999.

[5]. D.R. Smith, W.J. Padilla, D.C. Vier, et al, Composite medium with simultaneously negative permeability and permittivity, Phys Rev Lett 84, 4184–4187,May 2000.

[6]. J.B. Pendry, Negative refraction index a prefect lens, Phys Rev Lett, 85 , 3966–396,2000.

[7]. David M. Pozar, "Microwave Engineering", 3rd Edition, John Wiley & Sons, 2004.

[8]. Wu, B-I, W. Wang, J. Pacheco, X. Chen, T. Grzegorczyk, and J.A. Kong, "A study of using metamaterials as antenna substrate to enhance gain," Progress in Electromagnetic Research, PIER 51, 295-328, 2005.

[9].H.A. Majid, M.K.A. Rahim and T. Marsi, Microstrip Antenna gain enhancement using left-handed metamaterial structure, progress in Electromagnetic Research M. Vol.8, 235-247, 2009.

[10]. Silvio Hrabar, JurajBartolic, "Backward Wave Propagation in Waveguide Filled with Negative Permeability Meta Material", 2003.

[11] The Basics of Patch Antennas By D. Orban and G.J.K. Moernaut Orban Microwave Products 2009.

[12]. S. Pyo, S. –M. Han, J. –W. Baik, W. –S. Yoon, and Y.-S. Kim, "Offset-fed metamaterial antenna for radiation mode generation with efficiency improvement", IET Microw. Antennas Propag. 4, 1481 (2010).