ANALYSIS OF PATCH ANTENNA FOR PARAMETER ENHANCEMENT AT 1.911GHZ

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ABSTRACT

In this paper work, A patch antenna and our proposed metamaterial patch antenna are simulated and compared. A rectangular microstrip patch antenna along with the innovative metamaterial structure is proposed at a height of 3.2mm from the ground plane. This work is mainly focused on increasing the potential parameters of microstrip patch antennas and analyzing the dual band operation of proposed antenna.This structure produces a better performance compared to simple RMPA. The implementation of the metamaterial as the substrate in a rectangular microstrip patch antenna produces high value of return loss.

Rectangular Microstrip Patch antenna loaded with metamaterial (MTM) is proposed for better improvement in the impedance bandwidth and reduction in the return loss at operating frequency 1.911 GHz. The proposed antenna is designed at a height 3.2 mm from the ground plane. At 1.911 GHz, the bandwidth is increased up to 27.2 MHz in comparison to RMPA alone of bandwidth 6.5 MHz. The Return loss of proposed antenna is reduced by -19.15dB. Microstrip Patch antenna has advantages than other antenna is lightweight, inexpensive, easy to fabricate and achieve radiation characteristics with higher return loss. CST MICROWAVE STUDIO is used to design the metamaterial based rectangular microstrip patch antenna.

Keywords- Rectangular microstrip patch antenna (RMPA), Metamaterial (MTM) Impedance Bandwidth, Return loss.

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I. INTRODUCTION

In modern wireless communication systems, the microstrip patch antennas are commonly used in the wireless devices. Therefore, the miniaturization of the antenna has become an important issue in reducing the volume of entire communication system [1].

Microstrip antennas are largely used in many wireless communication systems because of their low profile and light weight [2].

The "patch" is a low-profile, low –gain, narrow – bandwidth antenna. Aerodynamic considerations require low-profile antenna on aircraft and many kinds of vehicles. Typically a patch consists of thin conducting sheet about 1 by 1/2λ0 mounted on Substrate. Radiation from the patch is like radiation from two slots, at the left and right edges of the patch. The "slot" is the narrow gap between the patch and the ground plane. The patch –to-ground-plane spacing is equal to the thickness t of the substrate and is typically about λ0/100. Advantage of patch antenna than several antenna is lightweight and inexpensive. The electric field is zero at the center of patch, maximum at one side, minimum on the opposite side. The important parameters of any type antenna are impedance bandwidth and return loss. The impedance bandwidth depends on parameters related to the patch antenna element itself and feed used. The bandwidth is typically limited to a few percent. This is a disadvantage of basic patch antenna. Metamaterial based rectangular microstrip patch antenna improves the bandwidth and return loss in significant way. CST MICROWAVE STUDIO is a software package for the electromagnetic analysis and design, use to design the metamaterial based rectangular microstrip patch antenna. The software contains four different simulation techniques like transient solver, frequency domain solver, integral equation solver, Eigen mode solver and most flexible is transient solver.

V.G. Veselago in 1968 provided a theoretical report on the concept of metamaterial (MTM) [3]. A Left- Handed metamaterial or double-Negative Metamaterial exhibits negative permittivity and permeability [4]. The currently popular antenna designs suitable for the applications of wireless local area network (WLAN) and world- wide interoperability for microwave access (WiMAX) have been reported [5].

II. DESIGN SPECIFICATIONS

The RMPA parameters are calculated from the following formulas. Desired Parametric Analysis [6][7].

Calculation of Width (W):

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

(1)

Where

C = free space velocity of light,

r =Dielectric constant of substrate

The effective dielectric constant of the rectangular microstrip patch antenn (2)

Actual length of the patch (L):

$$L = L_{eff} - 2\Delta L$$

(3)

Calculation of length extension:

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

(4)

III. ANALYSIS OF RECTANGULAR MICROSTRIP PATCH ANTENNA AND METAMATERIAL STRUCTURE WITH SIMULATED RESULTS

The Rectangular Microstrip Patch Antenna is designed on FR-4 (Lossy) substrate at 50Ω matching impedance dielectric constant εr = 4.3 and height from the ground plane d=1.6mm.The parameter of rectangular microstrip patch antenna are L= 35.8462 mm, W= 46.0721 mm, Cut Width= 5mm, Cut Depth= 10mm, length of transmission line feed= 35.58mm, with width of the feed= 3mm shown in figure1.

The simple RMPA is inspired by metamaterial structure at 1.794 GHz.

Table1.Rectangular Microstrip Patch Antenna Specifications

parametrs	Dimension	Unit
Dielectric con-stant	4.3	-
Loss tangent (tan)	.02	-
Thickness (h)	1.6	Mm
Operating frequency	1.794	GHz
Length L	35.85	Mm
Width W	46.07	Mm
Cut width	6	Mm
Cut depth	10	Mm
Path length	35.57	Mm

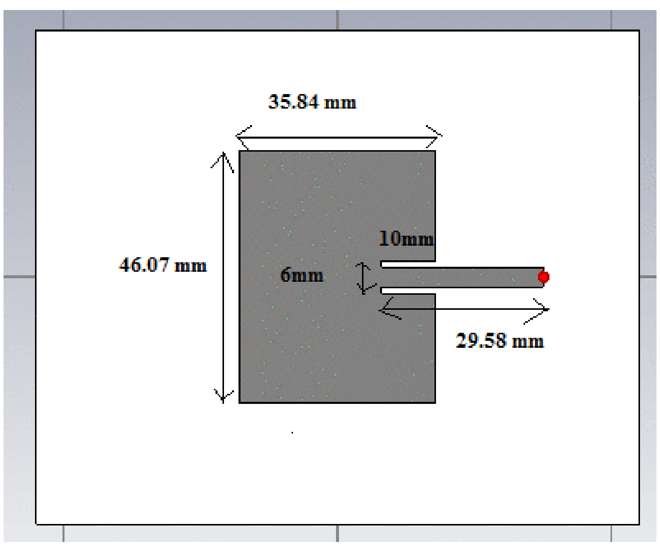

Figure1. Rectangular microstrip patch antenna at 1.911 GHz.

CST-software is used to design the Rectangular microstrip patch antenna (RMPA) at oprating frequency 1.794 GHz.

However, their employment raises some problems, such as, difficulty impedance matching or increasing of surface waves in the Substrate that could decline the radiation efficiency and the radiation pattern. Bandwidth of the antenna may be considerably becomes worse [8].

Simulated result of Return loss and bandwidth of Rectangular Microstrip Patch antenna(RMPA) is shown in fig 2.

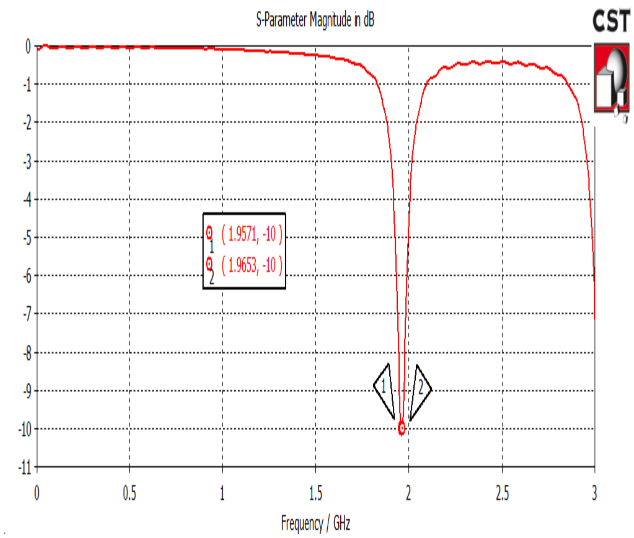

Figure 2. Simulation of return loss and bandwidth of RMPA.

The bandwidth of simple RMPA is 10.1MHz and Return loss is -10.3 dB.

The Rectangular microstrip patch antenna has 3D Radiation pattern at 1.794 GHz as shown in figure3. The radiation pattern shows the directivity of simple RMPA is 6.832 dB.

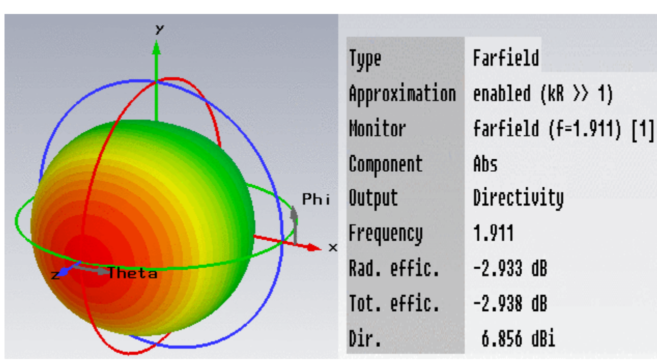

Figure 3. Radiation pattern of RMPA at 1.911 GHz.

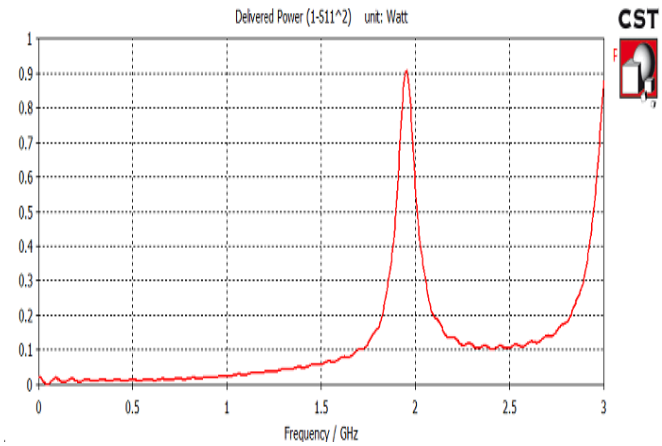

Figure 4. Delivered power to RMPA. The maximum power deliver to patch antenna is above 0.90 watt.

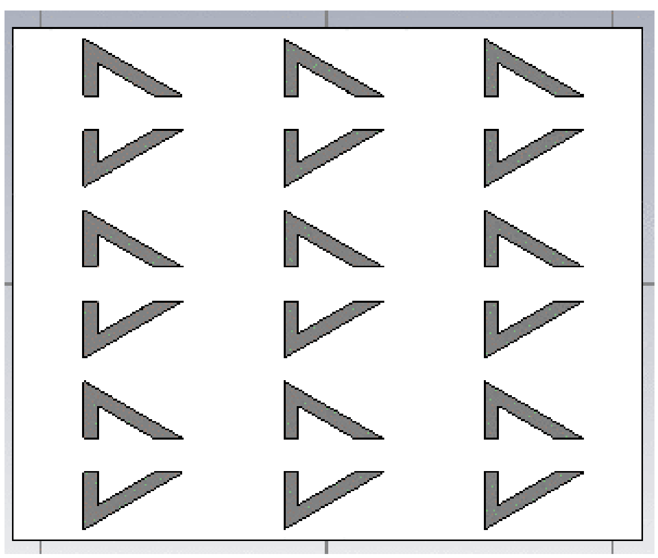

Figure 5. Design of proposed metamaterial structure at the height of 3.2 mm from ground plane.

In this metamaterial design, symmetrically cut H and five hexagonals are loaded on the patch antenna. Hexagonals is distributed equally with each other and cut horizontally with 6 mm width. This design gives the better improvement in impedance bandwidth and reduction in return loss.

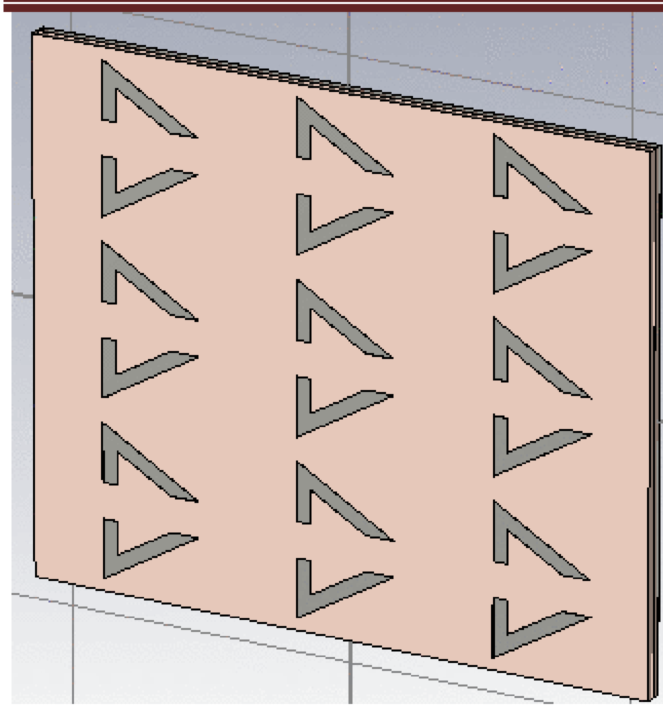

Figure 6. Rectangular microstrip patch antenna with proposed metamaterial structure.

Simulation result of Return loss and bandwidth of Rectangular microstrip patch antenna loaded with metamaterial structure is shown in Fig 7.

The proposed metamaterial structure reduces the return loss by 20.7dB and increases the band-width up to 16.9 MHz.

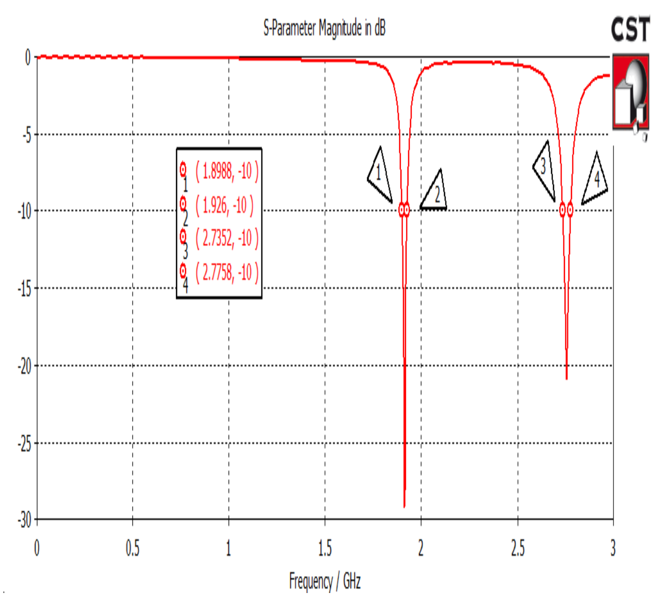

Figure 7. Simulation of Return loss and impedance bandwidth of RMPA with proposed metematerial structure at operating frequency 1.794 GHz.

The Simulated result of RMPA loaded with hexagonal shaped metamaterial is showing return loss of -30.1dB and Bandwidth of 27 MHz.

It is clear that the Directivity of proposed antenna is almost unaffected in comparison to simple RMPA alone.

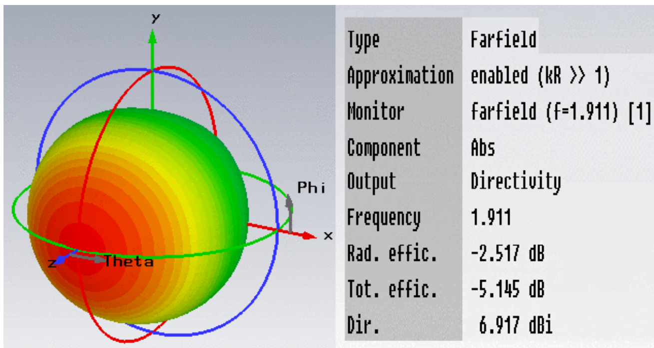

Figure 8. Radiation pattern of proposed antenna showing Directivity of 6.856 dBi.

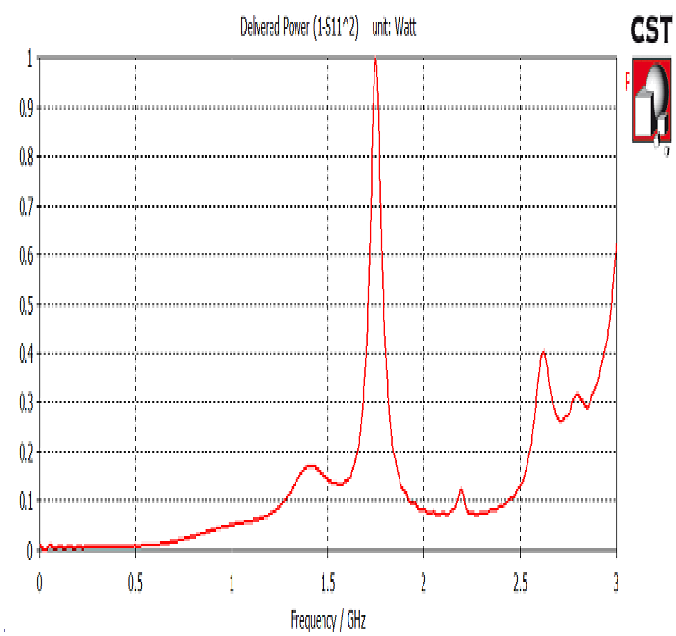

Figure12. Delivered power to reduced size RMPA loaded with metamaterial structure.

The maximum power deliver to proposed rectangular microstrip patch antenna is 1 watt in figure 12.

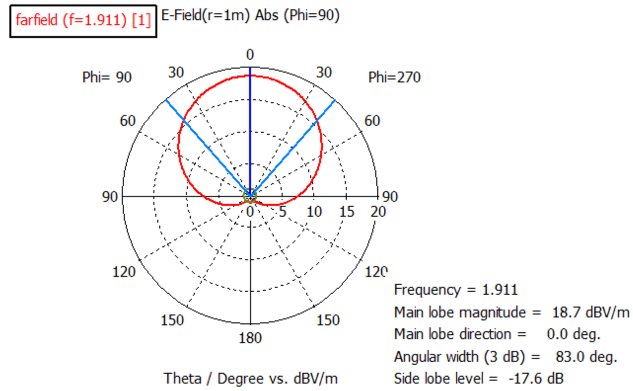

Figure13. E Field of the reduced size RMPA loaded with Metamaterial

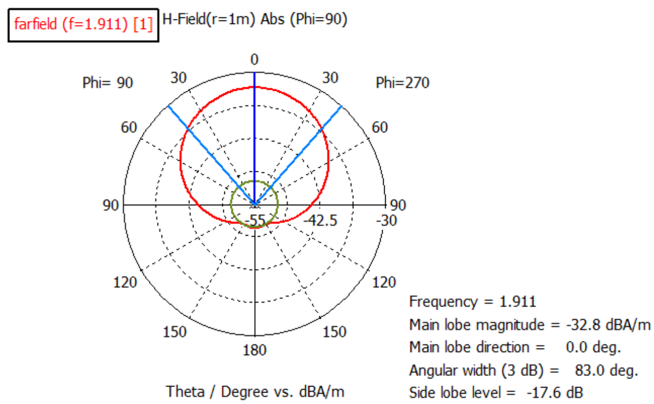

Figure14. H Field of the reduced size RMPA loaded with Metamaterial.

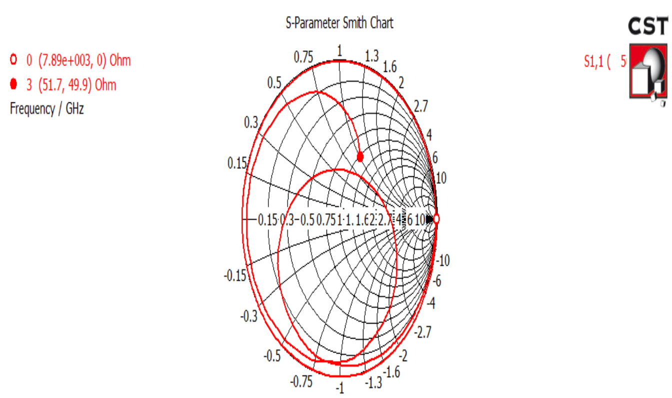

Figure 15. Smith chart of simple Rectangular microstrip patch antenna.

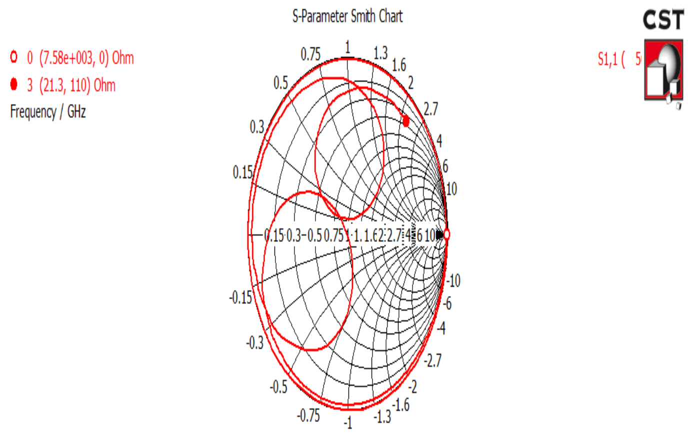

Figure 16. Smith chart of PMPA loaded with metamaterial.

The smith chart is very useful when solving transmission problems. The real utility of the Smith chart, it can be used to convert from reflection coefficients to normalized impedances (or admittances), and vice versa.

Smith chart of RMPA loaded with symmetrically cut H and hexagonal shaped metamaterial structure at 1.794 GHz. Above Fig. shows the impedance variation in the simulated frequency range and received impedance matching for proposed antenna at characteristic impedance.

IV. SIMULATION RESULTS

In this paper, Rectangular microstrip patch antenna loaded with symmetrically cut H and hexagonal shaped metamaterial structure is simulated using CST-MWS software. The proposed design in comparison to RMPA alone, found that the potential parameters of the proposed antenna is increased. This is clear from Fig.2 & Fig.7 that the return loss is reduced by 20.7 dB and bandwidth is increased by 16.7MHz. From the Fig.9, it is clear that the Directivity of proposed antenna design is almost unaffected. The maximum power deliver to proposed rectangular microstrip patch antenna is 1 watt.

V. CONCLUSION

The main drawback of Patch Antenna was impedance bandwidth. For this purpose, Rectangular microstrip patch antenna loaded with symmetrically cut H and Hexagonal shaped metamaterial structure has been proposed and analyzed in this paper. The simulated results provide that, improvement in the bandwidth is 16.9 MHz and the Return loss of proposed antenna is reduced by 20.7 dB. It is clear that we can easily overcome the drawbacks of RMPA by using the properties of Metamaterial (MTM). By using Metamaterial, the maximum power delivered to proposed antenna is 1 watt as compared to the RMPA delivered power of 0.9 watt.

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VII. REFERENCES

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