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Enhancement in RMPA Parameters by Rhombus Cut Shaped Meta Material Structure Using at High Frequency 6.65GHz

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Abstract

A Rectangular micro strip patch antenna loaded with "Enhancement in RMPA parameters by Rhombus Cut Shaped Meta material high frequency using at 6.65GHz" As a rectangular microstrip patch antenna is designed at a height of 1.6mm & Left handed Meta material structure is designed at a height of 3.2mm from the ground plane by using CST-MWS software. The resonance frequency 6.65GHz of the designed antenna is using as a high frequency. We knew that frequency is increases as a bandwidth is also increases. Therefore in this paper work used at high frequency. The 10 dB impedance bandwidth of proposed antenna is 438.4MHz. The Return loss of the proposed antenna reduced to -34dB. This antenna is small size, cheap, compact and easy to fabricate, and achieve good radiation characteristics with higher return loss.

Keywords-Rectangular Micro strip Patch Antenna, Metamaterial, Bandwidth, Return Loss.

1. INTRODUCTION

1.1 RMPA

An antenna is defined as a part of a transmitting or receiving system which is designed to radiate or to receive electromagnetic waves [1]. Rectangular Microstrip Patch antennas have attractive properties including the low profile, light weight, compact and conformable in structure, and easy to be integrated with solid-state devices [2]. Application of a conventional antenna always limited since they are governed by the 'right hand rule' which determine how electromagnetic wave should be have. However, a Metamaterial substrate offers an alternative solution to a wireless antenna applications using the left hand rule [3].

1.2 LEFT HANDED META MATERIAL

Left Handed Metamaterials are composite materials with unique electromagnetic properties due to the interaction of electromagnetic waves with the finest scale periodicity of conventional materials [4]. The person who is responsible in discovering the concept of metamaterials is Veselago in 1967 [4]. He assumes an unknown material that has a negative permeability and permittivity in the same frequency range and it shows the abnormal of electromagnetic properties when the uniform plane-wave propagation [4] was studied. As a result, the left-handed material (LHM) has a reverse basic feature of light, such as negative refractive index (NRI) [5-6].

2. DESIGN AND SIMULATED RESULTS OF RMPA AND PROPOSED ANTENNA

The Rectangular micro strip patch antenna parameters [7, 8] are calculated from the formulas given below:
Calculation of Width (W)

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

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

The effective dielectric constant 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)

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

Where

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{eff}}} \qquad (4)$$

Calculation of Length Extension

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

3. ANALYSIS OF RECTANGULAR MICRO STRIP PATCH ANTENNA

TABLE I: RMPA SPECIFICATIONS

Parameter	Dimension	Unit
Dielectric Constant	4.3	-
Loss Tangent	0.02	-
Thickness	1.6	mm
Operating Frequency	6.65	GHz
Length	10.5802	mm
Width	13.8502	mm
Cut Width	3	mm
Cut Depth	4	mm

Path Length	9.8502	mm
Feed Width	2	mm

The physical parameters of rectangular micro strip patch antenna are W=13.8502 mm, L=10.5803mm, length of transmission line feed= 9.8502mm, with width of the feed= 3mm. The rectangular micro strip patch antenna designed on one side of glass/epoxy structure with $\varepsilon_r = 4.3$ and height from the ground plane d= 1.6mm.

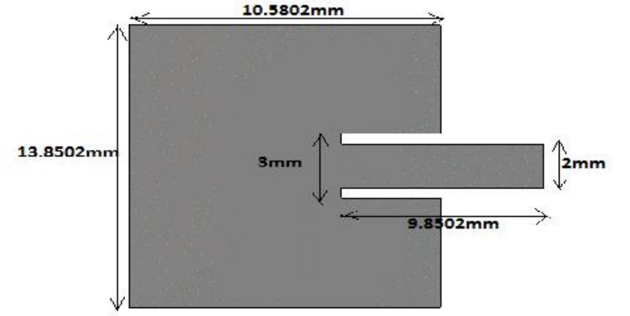

Fig1: Rectangular micro strip patch antenna at 6.65 GHz (all dimensions in mm).

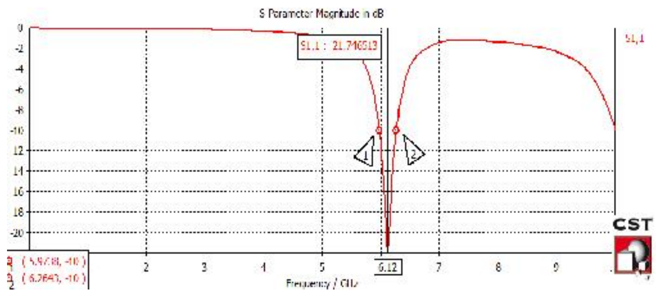

Fig2: Simulated Result of Rectangular micro strip patch antenna showing Return Loss of -21dB and Bandwidth [8] of 290.5MHz.

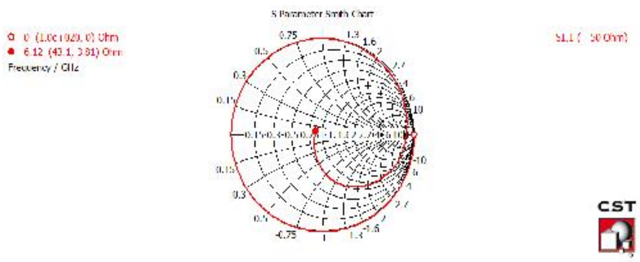

Fig3: Smith chart [9] of the rectangular micro strip patch antenna at 6.65GHz

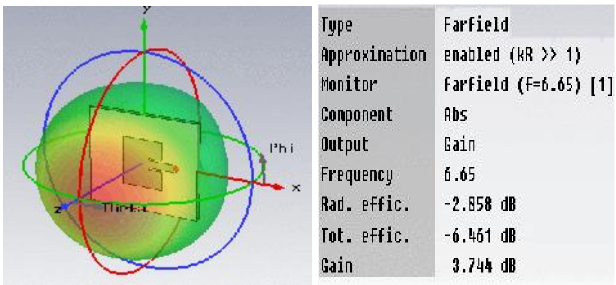

Fig4: Gain of the rectangular micro strip patch antenna at 6.65GHz

4. LEFT HANDED META MATERIAL STRUCTURE

In this Meta material design, "Rhombus Cut Shaped Meta material" are loaded on the patch antenna. Rhombus is distributed equally with each other and cut vertically with 2 mm width. This design gives the better improvement in impedance bandwidth and reduction in return loss.

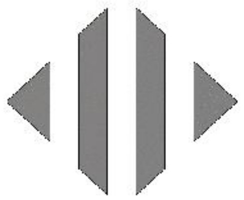

Fig: 5 Design of proposed Meta material structure at the height of 3.2 mm from ground plane.

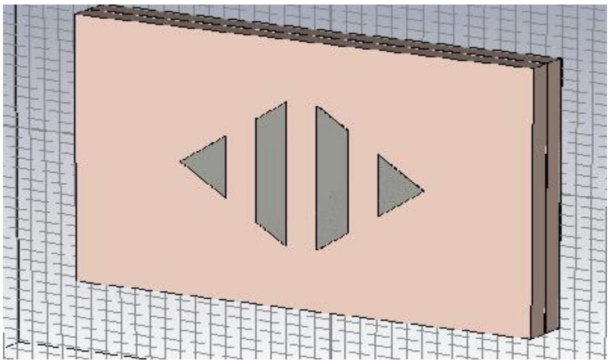

Fig6: Rectangular micro strip patch antenna with proposed Meta material structure.

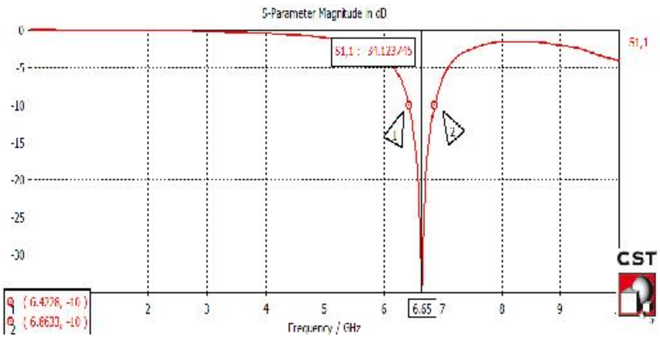

Fig7: Simulated result of the RMPA along with proposed Meta material cover showing Return Loss of -34dB & Bandwidth of 438.4MHz.

The simulated results of the RMPA along with proposed meta material cover are shown in figure 7 & 8, it has been found that the potential parameters like [10][11] (gain, total efficiency, & directivity) of the proposed antenna increases significantly in comparison to RMPA alone. The return loss of the RMPA along with proposed Meta material cover is reduced by 34dB Radiation pattern is defined as the power radiated (transmitted) or received by an antenna in a function of the angular position and radial distance from the antenna. It describes how an antenna directs the energy it radiates and it is determined in the far field region.

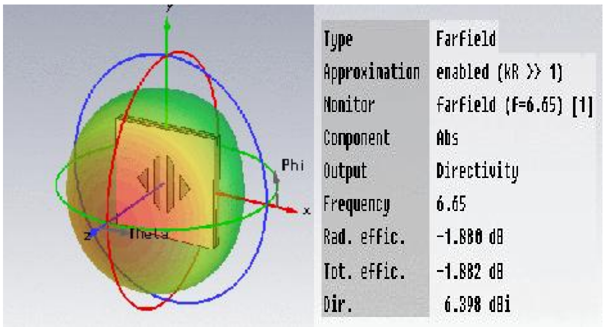

Fig8: Radiation pattern of proposed antenna showing Directivity of6.398dBi.

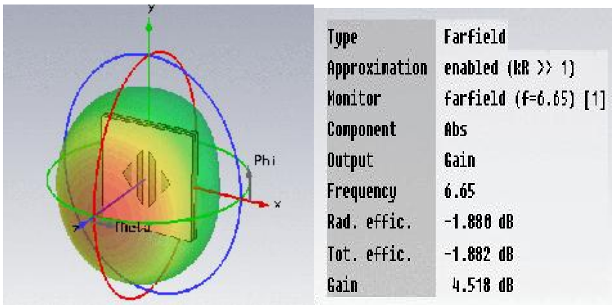

Fig9: Gain of RMPA with proposed meta material structure.

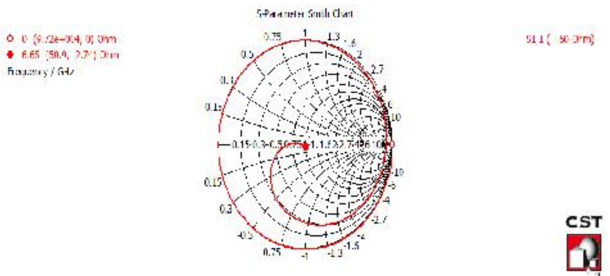

Fig10: Smith chart of RMPA with proposed meta material structure.

5. CONCLUSION

We can see that RMPA structure having certain specification can be enhanced by using LH-MTM. So that its bandwidth, efficiency, return loss and gain could be ameliorated. Hence this work could be further amended by using variant patterns of Meta material structures. Further in future this work could be shifted in higher frequencies so that micro antennas could be used for the WLAN technologies. the simulated rectangular micro strip patch antenna results in Return Loss of -21 dB & 290.5MHz Bandwidth while when it is designed with “Rhombus cut shaped structure” Meta material structure at 3.2mm from the ground plane, it shows Return Loss of -34 dB & 438.4MHz Bandwidth which shows improvement of bandwidth and significant reduction in return loss.

6. REFERENCE

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