RMPA using Meta Material Structure on 3.2 Layer at 2.787 GHz for Performance Specification

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Abstract— In this paper Authors analyzed and explored a significant concept of micro-strip patch using metamaterials structure Basic aim of this paper is to explain the general properties of rectangular micro-strip patch antenna with meta material structure like return loss, bandwidth, directivity and gain In this paper authors have compared the return loss, bandwidth & gain of the micro-strip patch antenna at frequency of 2.787 GHz and height of 3.2 mm from the ground plane with loaded meta material structure.

Key words: Patch, Return-Loss, Bandwidth, Printed Antenna

I. INTRODUCTION

Communication plays an important role in the worldwide society now days and the communication systems are rapidly switching from “wired to wireless”. Wireless technology provides less expensive alternative and a flexible way for communication. Antenna is one of the important elements of the wireless communications systems. Thus, antenna design has become one of the most active fields in the communication studies. One of the types of antenna is the micro strip patch antenna The unusual properties of the meta materials are utilized here in a Micro strip Patch Antenna at a Frequency of 2.787GHz in order to achieve a more efficient Antenna, Meta materials were first introduced by Veselago [1] The IEEE standard defines an antenna as a part of a transmitting or receiving system that is designed to radiate or to receive electromagnetic waves [2–3] A patch antenna is a low-profile antenna consisting of a metal layer over a dielectric substrate and ground plane. Typically, a patch antenna is fed by a micro strip transmission line, but other feed lines such as coaxial can be used. The advantages of patch antennas are that they radiate with moderately high gain in a direction perpendicular to the substrate and can be fabricated in a low cost FR-4 substrate. Micro-strip antennas have unique features and attractive properties such as low profile, light weight, compactness and Conformability in structure [4]. With those advantages, the antennas can be easily fabricated and integrated in solid-state devices. Micro-strip antennas are widely applied in radio frequency devices with single-ended signal operation. This has recently been used in microwave design with a combination of meta-materials, either as a cover or a substrate [5]. In modern wireless communication systems, the micro-strip 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 [6].

II. METHODOLOGY

The Rectangular Resonant Micro strip Patch Antenna is etched on FR4 (Lossy) substrate of Thickness h = 1.6mm, and dielectric constant εr =4.3 by using PEC [4] (Perfect Electric conductor) as the conducting plane. The proposed design is based on “B” shaped meta material structure. The Rectangular Micro strip Patch Antenna (RMPA) parameters are calculated from the formulas given below.

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Desired Parametric Analysis [2], [3]

A. *Calculation of Width (W):*

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

- Where
- c = free space velocity of light
- εr = Dielectric constant of substrate

B. *The Effective Dielectric Constant of the Rectangular Microstrip Patch Antenna:*

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

C. *The Actual Length of the Patch (L):*

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

D. *Calculation of Length Extension:*

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

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

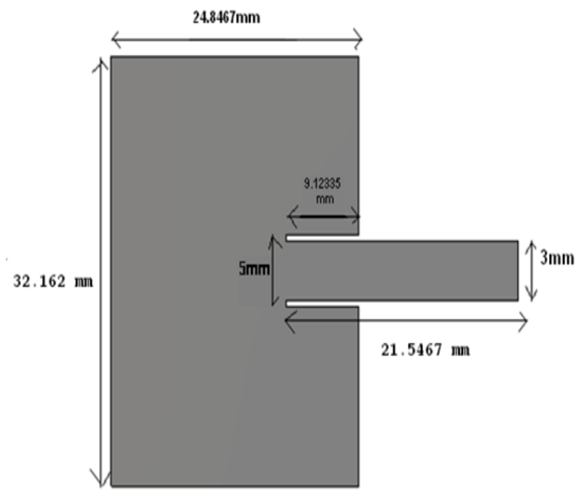

Fig. 1: Rectangular patch antenna at 2.787 GHz.

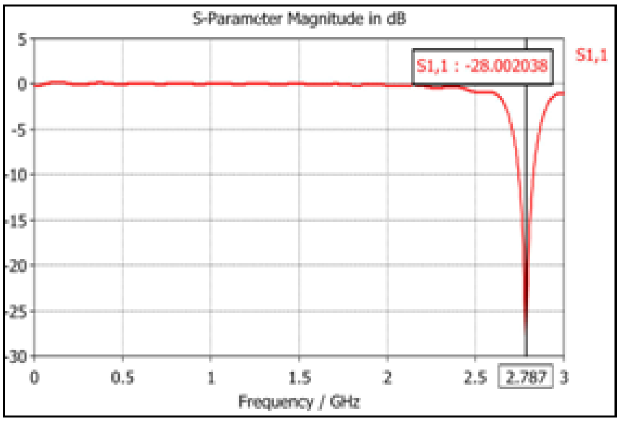

Fig. 2: Return loss S1, 1 of Rectangular Microstrip Patch Antenna

The Rectangular Micro strip Patch Antenna is designed on FR-4 (Lossy) substrate. The parameter specifications of rectangular micro strip patch antenna are mentioned in table 1. These are calculated from the above discussed formulae.

Sr. No.	Parameters of patch antenna		
	Parameters	**Dimension**	**Unit**
1.	Dielectric constant	4.3	-
2.	Loss tangent (tan)	.02	-
3.	Thickness (h)	1.6	mm
4.	Operating frequency	2.787	GHZ
5.	Length L	24.8467	mm
6.	Width W	32.162	mm
7.	Cut width	5	mm
8.	Cut depth	9.1235	mm
9.	Patch length	21.5467	mm
10	Width of feed	3	mm

Table 1: Rectangular Micro strip Patch Antenna Specifications

The structure of the proposed antenna and the. The antenna is modeled and simulated using method of moment based electromagnetic simulation software CST, version 10, between 0 to 3GHz.

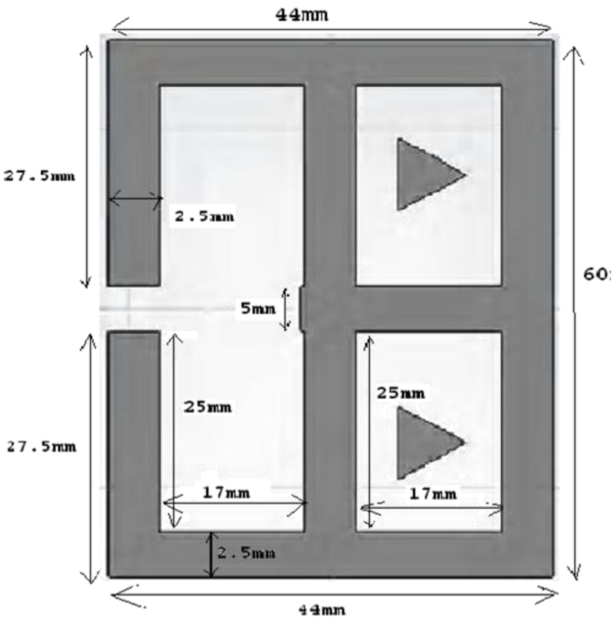

Fig. 3: structure of the proposed antenna dimensional view

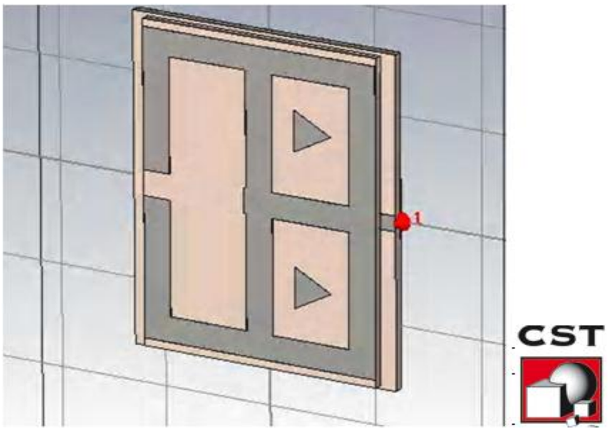

Fig. 4: Structure of the Proposed Antenna

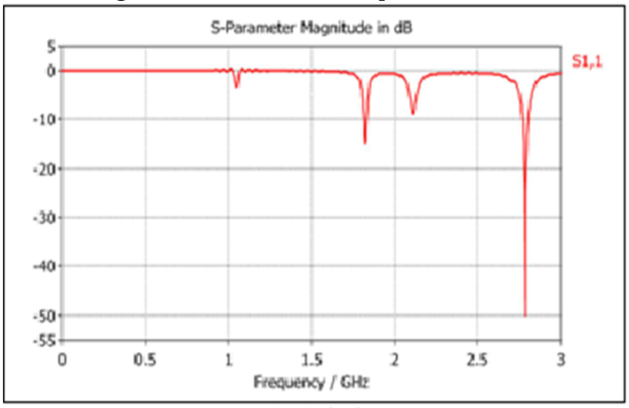

Fig. 5: Simulation of Return Loss S1, 1 RMPA with proposed metamaterial structure

This Return loss pattern within the simulated frequency range has been obtained from CST-MWS software, for verifying this result, hardware has been fabricated on PCB. After the fabrication of proposed antenna the antenna parameters like return loss and bandwidth are measured on the spectrum analyzer.

IV. SIMULATION RESULTS

Fig. 2 and 5 shows the graph of return loss V/s frequency, and impedance variations V/s. frequency respectively. The graph of return loss shows that antenna is resonating at 2.787GHz frequency with return loss of -50.012228 dB and bandwidth of proposed antenna is increased up 33 MHz and directivity is also increased

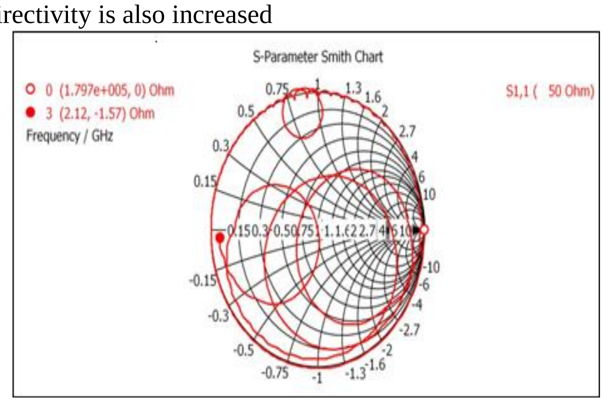

Fig. 6: Smith chart of PMPA loaded with metamaterial.

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.

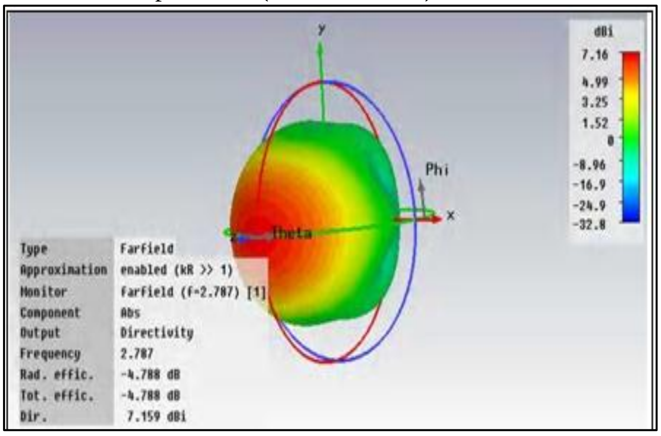

Fig. 7: Directivity graph

V. CONCLUSION

The proposed antenna provides the better improvement in the impedance bandwidth and reduction in the return loss at2.787 GHz. The drawback of Patch Antenna was impedance bandwidth. For this purpose, Rectangular micro strip patch antenna loaded with meta material structure has been proposed for improving the return loss by using CST MICROWAVE STUDIO in this paper.

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