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Designing of S Shaped Microstrip Patch Antenna for Broadband Application Using Slotting Technique

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Abstract— Microstrip patch antennas get more and more important in these days. This is mostly due to their versatility in terms of possible geometries that makes them applicable for many different situations. The light weight construction and the suitability for integration with microwave integrated circuits are two more of their numerous advantages. Additionally the simplicity of the structures makes this type of antennas suitable for low cost manufacturing. And this is also one key feature of microstrip patch antennas are used in mobile communications applications. Thus the size reduction and bandwidth enhancement are becoming major design considerations for practical application of microstrip antennas. The purpose of this paper is to design a dielectric substrate,fr4 substrate for high bandwidth microstrip patch antenna and to compare with the former patch antennas and then proposed the better one. In this research work, we have designed the S-shaped slotted patch antenna. Here bandwidth is obtained 38% of the center frequency which is the extremely large than the parasitic patch antenna. Microstrip Patch Antennas (MPA) are extremely attractive candidates for use in many applications due to their interesting features such as low cost, light weight, thin profile and conformability. A 3D field solver is used to simulate the performance of the proposed antenna by inputting the sizes of the physical structure. Coaxial probe feeding technique is used to feed the antenna. ADS(advanced desidn system) software simulator software are used to design and simulate the proposed patch antenna.
Keywords— Rectangular microstrip antenna, fr4(frame resistive) substrate ,coaxial probe feeding, slotted patch antenna, S shape patch antenna.

I. INTRODUCTION

Communication can be broadly defined as the transfer of information from one point to another. A communication system is usually required when the information is to be conveyed over a distance. The transfer of information within the communication system is commonly achieved by superimposing or modulating the information onto an electromagnetic wave which acts as a carrier for the information signal. At the required destination, the modulated carrier is then received and the original information signal can be recovered by demodulation. Over the years, sophisticated techniques have been developed for this process using electromagnetic carrier waves operating at radio frequencies as well as microwave and millimeter wave frequencies. In today's modern communication industry, antennas are the most important components required to create a communication link. Through the years, microstrip patch antenna structures are the most common option used to realize millimeter wave monolithic integrated circuits for microwave, radar and communication purposes. The shape and operating mode of the patch are selected, designs become very versatile in terms of operating frequency, polarization, pattern and impedance [1].

A. Microstrip Patch Antenna

Microstrip Patch Antennas (MPA) are extremely attractive candidates for use in many applications due to their interesting features such as low cost, light weight, thin profile and conformability. On the other side, the greatest disadvantage of MPA is its low bandwidth which can be as low as 1%. These antennas can be integrated with printed strip-line feed networks and active devices.

Rectangular and circular micro strip resonant patches have been used extensively in a variety of array configurations. A development in large scale integration which is the result of electronic circuit miniaturization is the apex factor contributed for the recent advances of microstrip antennas. Conventional antennas being sizeable and high-cost part of an electronic system, micro strip antennas based on photolithographic technology are considered as quantum leap. [4]

A Microstrip Patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side in its most fundamental form as shown in Figure 1. The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate. [1]

II. ANALYSIS OF MICROSTRIP PATCH ANTENNA

A. Resonance Frequency

The resonance frequency depends on the patch size, cavity dimensions, and the filling material dielectric constant. It is expressed as follows;

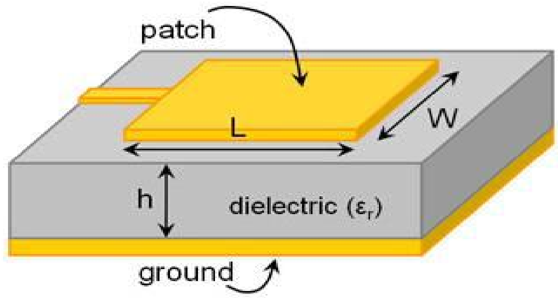

Fig1. Structure of a Microstrip Patch Antenna

$$f_{mn} = \frac{K_{mn} c}{2\pi\sqrt{\varepsilon_r}}$$

Where m, n = 0, 1, 2… Kmn = wave number at m, n mode, c is the velocity of light, is the dielectric constant of the substrate, and

$$K_{mn} = \sqrt{\left(\frac{m\pi}{W}\right)^2 + \left(\frac{n\pi}{L}\right)^2}$$

Length and width of non radiating rectangular patch's edge at a certain resonance frequency and dielectric constant are given by:

$$L = \frac{c}{2f_r\sqrt{\varepsilon_r}}$$

and

$$W = \frac{c}{f_r}\sqrt{\frac{2}{\varepsilon_r+1}}$$

Where fr is the resonance frequency at which the rectangular microstrip antenna is to be designed. The radiating edge W, patch width is usually kept such that it lies within the range L<W>2L for efficient radiation.

The ratio W/L= 1.5 gives good performance according to the side lobe appearances. [6] By using the above equations we can find the values of actual length of the patch as:

$$L = \frac{c}{2f_r\sqrt{\varepsilon_{eff}}} - 2\Delta l$$

Where ξeff is the effective dielectric constant and Δl is the line extension which is given as

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

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

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III. DESIGN PARAMETERS

In this paper several parameters of Rectangular Microstrip patch Antenna resonating at frequency 4.5GHZ have been investigated using ADS(advanced design system) software. And using the fr4 substrate .The geometry of patch antenna is shown in figure-1. The design specifications for patch antenna are:

- Substrate permittivity (ξr) = 4.2
- Substrate thickness (h) = 1.6 mm.
- Length of patch (L) = 20.67 mm.
- Width of patch (W) = 15.35 mm.
- Feed point location = (10.5, 11.5).

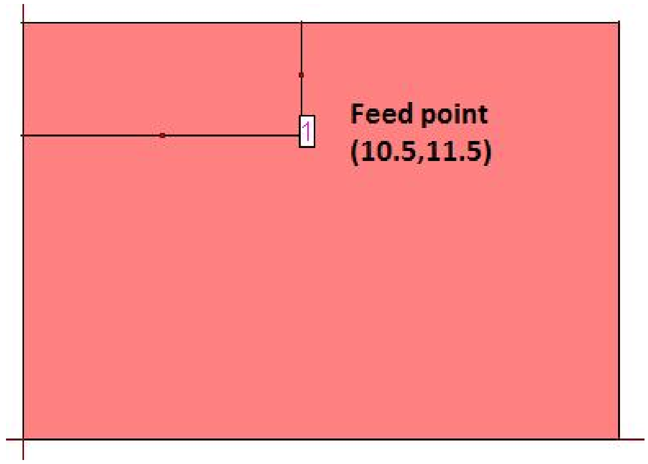

Figure 2 Rectangular microstrip patch antenna resonating at 4.5 GHZ.

IV. S - SLOTTED ANTENNA

The base of S shaped antenna structure designed is a simple rectangular microstrip patch antenna. The antenna structure is designed by cutting two rectangular slots in the rectangular microstrip patch antenna. The designed antenna structure along with its dimensions is shown in fig 3. The design parameters are same as in case rectangular microstrip patch antenna.

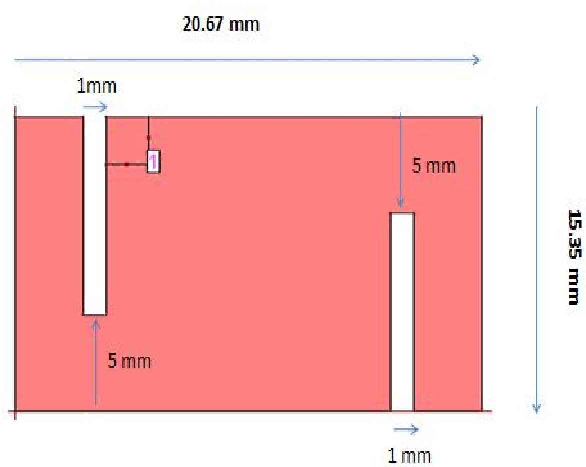

Figure.3. S- Slotted Microstrip Patch Antenna.

V. SIMULATION RESULT DISCUSSION

ADS simulation software V.14 was chosen to simulate the structures shown in the Figures. The S-parameter was obtained from simulation. The simulated result of Rectangular Microstrip Patch Antenna and Slotted S shape Microstrip Patch Antenna Structure

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are shown in figure 4 and 5.

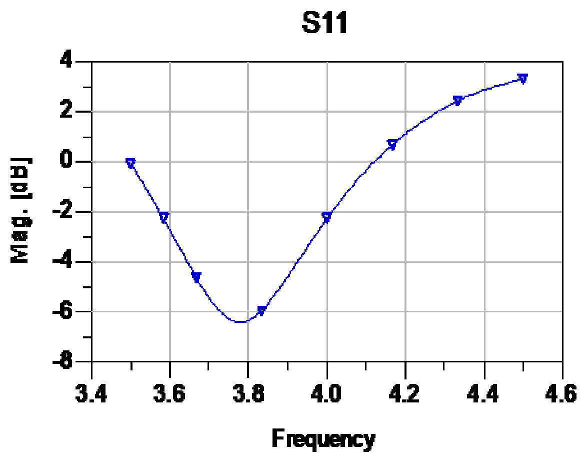


Figure.4. Reflection Coefficient of rectangular microstrip patch antenna

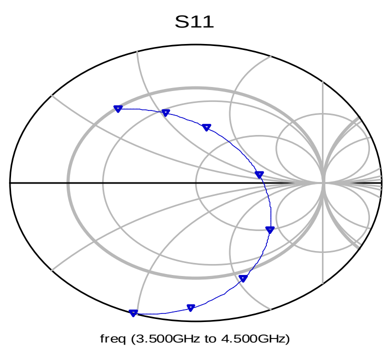
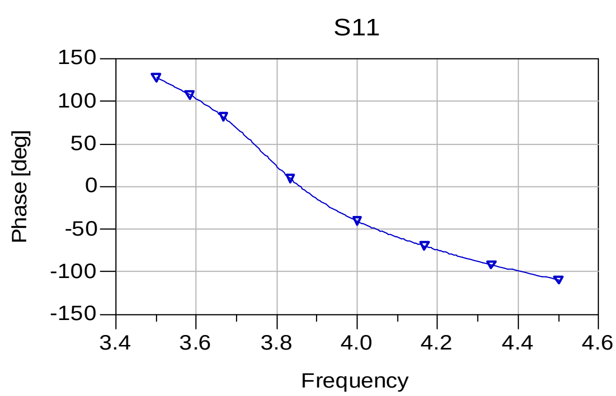


Figure. 5. Smith Chart

Figure. 6. S parameter Display of S shape slotted microstrip patch antenna.



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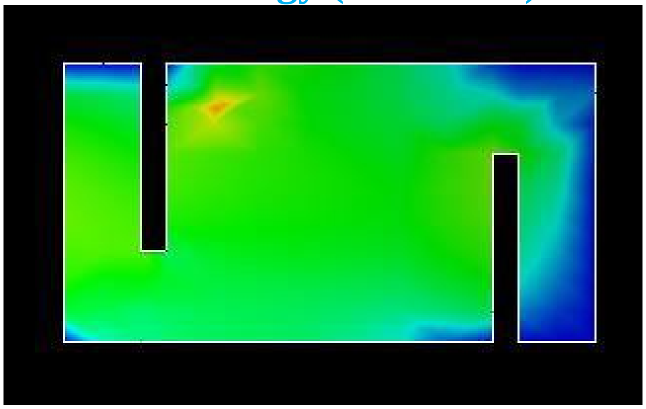

Figure.7. Current Distribution of S Shape Slotted Microstrip Patch Antenna.

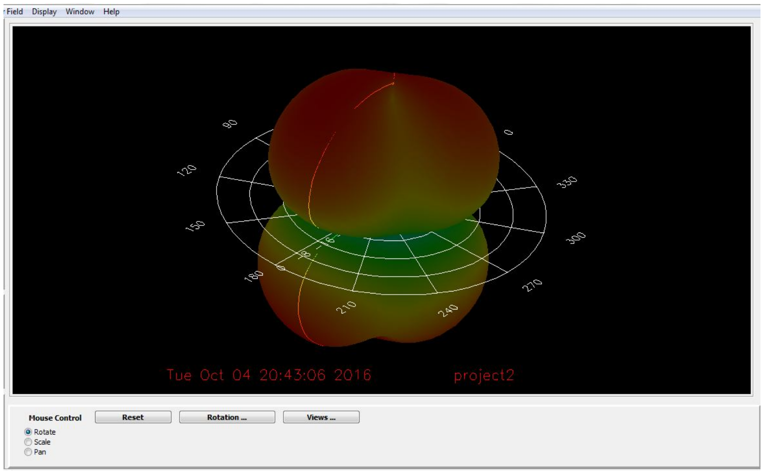

Figure.7.radiation pattern for S Shape Slotted Microstrip Patch Antenna

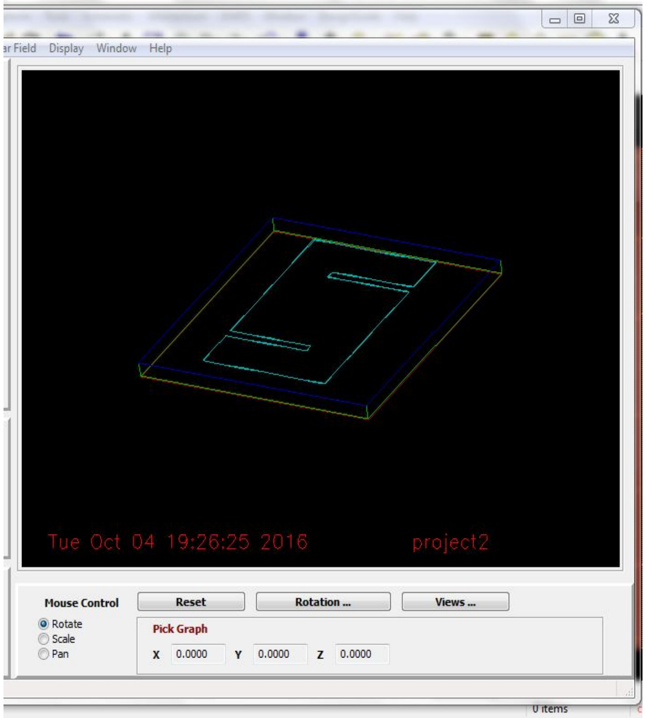

Figure.8.3D view for S Shape Slotted Microstrip Patch Antenna.

VI. MEASURED RESULT DISCUSSION

Table1. Shows result comparison between rectangular microstrip patch antenna and S shape slotted microstrip patch antenna

Geometry	Rectangular MS Antenna	S Slotted MS Antenna
Resonating Frequency	4.491 GHz	4.580 GHz
Max Return Losses	-20.470 Db	-22.124 Db
FL	4.426 GHz	4.475 GHz
FH	4.556 GHz	4.685 GHz
Bandwidth (S Parameter)	130 MHz	210 MHz
Feed point Impedance	44.14 Ohm	48.814 Ohm
VSWR at FL	4.395 GHz	4.445 GHz
VSWR at FH	4.505 GHz	4.655 GHz
Bandwidth	130 Mhz (2.89 %)	210 Mhz (4.585%)

Vector Network Analyzer (VNA) who's Range of measurement of frequency is 10 MHZ To 40 GHZ was chosen to simulate the Antenna hardware shown in the Figure 12 and 16. The S-parameter was obtained from simulation. The simulated result of Rectangular Microstrip Patch Antenna and Slotted S shape Microstrip Patch Antenna Structure are shown in figure 13 and 17. At 4.491 GHz frequency simulated Rectangular Microstrip Patch Antenna alone exhibits the Return Loss of -20.470 dB and Bandwidth about 130 MHz while when it is incorporated with Rectangular S Slot structure. It resonates at 4.580 GHZ frequency and shows Return Loss around -22.124 dB and Bandwidth 210 MHz .The enhancement in Bandwidth near about 70 MHZ was achieved.

VII.CONCLUSION

It always has been the paramount matter of concern to put vigorous attempts to vanquish almost all the limitations of conventional microstrip patch antenna characteristics, which is depicted clearly in this paper and could be understood vividly. Few evident adverse and critical issues like broad banding using slotting technique are taken care in this research work. In spite of that, handy and proficient solutions are now outnumbered and few in number and encounter many other problems and complications like distortion of radiation patterns, reduction of gain, complexity of structure etc. Hence, more distant research is earnestly needed in this area of research work.

Finally the following conclusion is come out in our research work that we studied different aspects related to microstrip antenna and we have made a microstrip antenna at 4.5 GHz frequency with 4.485 % bandwidth, which is 1.595 % more as compared to our reference antenna. Thus we can say that we have obtained our aim successfully.

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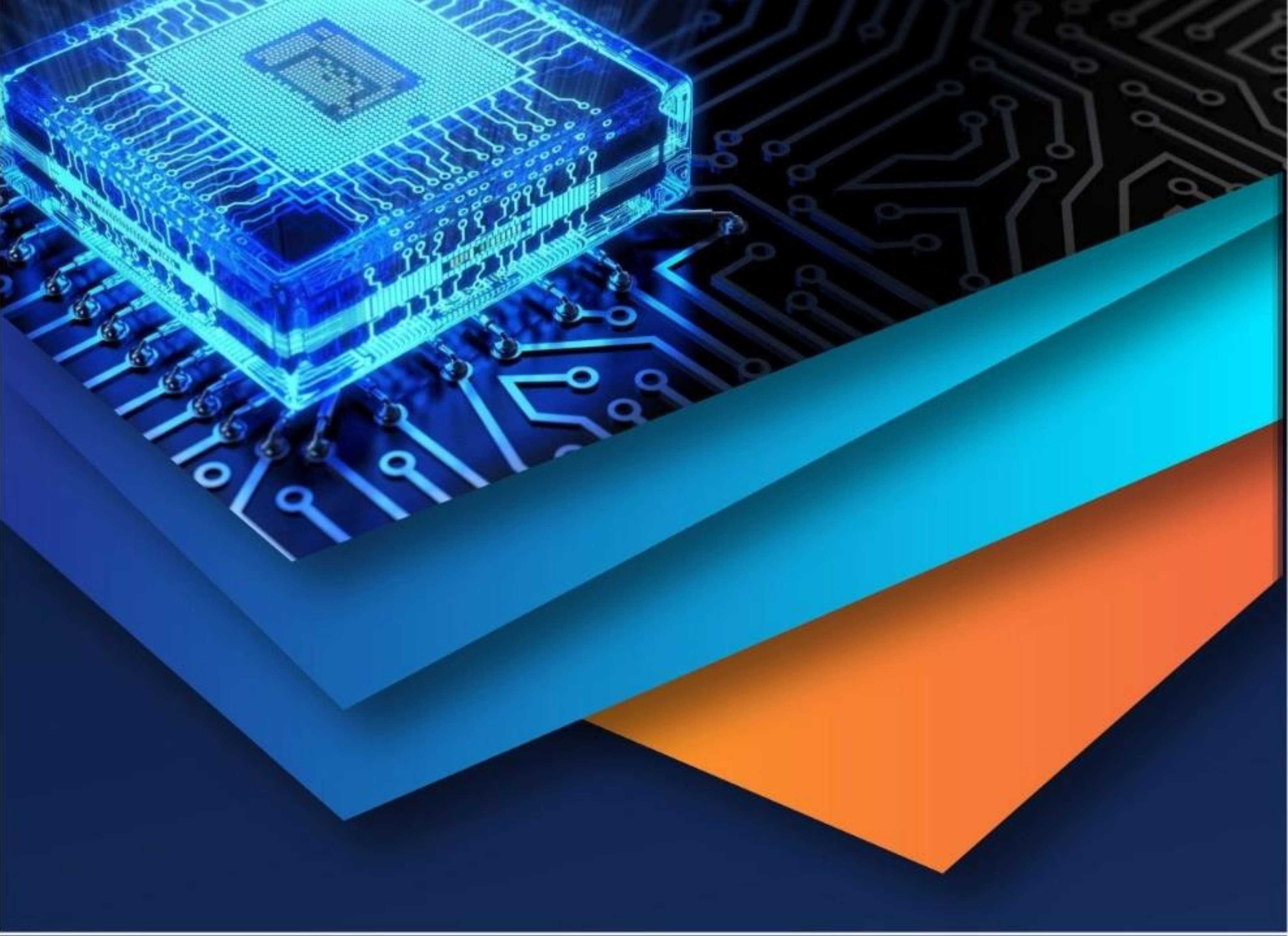

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