DESIGN AND ANALYSIS OF CIRCLEHEAD SHAPE MICROSTRIP PATCH ANTENNA

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Abstract -*Microstrip patch antennas are increasing in popularity and get more important 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 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 CIRCLEHEAD-shaped slotted patch antenna. Here bandwidth is obtained 40% 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. Zeland IE3D ver14 software is used to design and simulate the proposed patch antenna.

Key Words: Rectangular microstrip antenna, coaxial probe feeding, slotted patch antenna, CircleHead shape patch antenna.

1. 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 [6].

1.1 Micro strip Patch Antenna

Microstrip Patch Antennas (MPA) is 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. [1]

1.2 Structure

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. [6]

2. ANALYSIS OF MICRO STRIP PATCH ANTENNA

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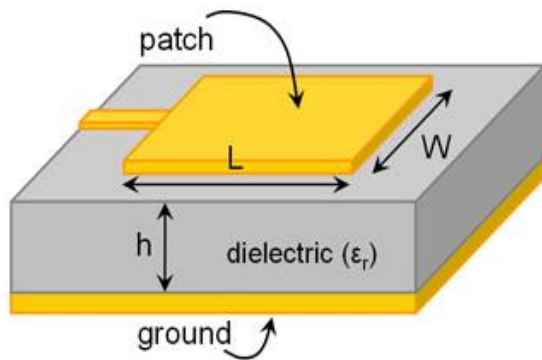

Figure 1: Structure of a Microstrip Patch   Antenna

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

Where m, n = 0, 1, 2 ... K_{mn} = 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:

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

and

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

Where f_r 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. [5]

By using the above equations we can find the values of actual length of the patch as:

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

where ε_{eff} is the effective dielectric constant and Δl is the line extension which is given as

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

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

3. RECTANGULAR MICROSTRIP ANTENNA DESIGN PARAMETERS

In this paper several parameters of Rectangular Microstrip patch Antenna resonating at frequency 1.09GHZ have been investigated using Zealand Ie3d ver14 software. The geometry of patch antenna is shown in figure-1. The design specifications for patch antenna are:
1. Substrate permittivity (εr) = 4.2
2. Substrate thickness (h) = 1.6 mm.
3. Length of patch (L) = 72 mm.
4. Width of patch (W) = 81 mm.
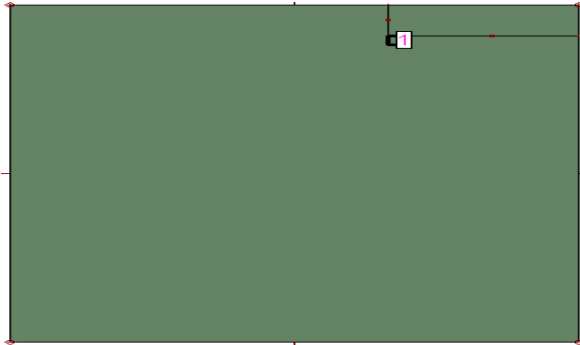5. Feed point location = (13,32).

3.1 SIMULATION RESULT:

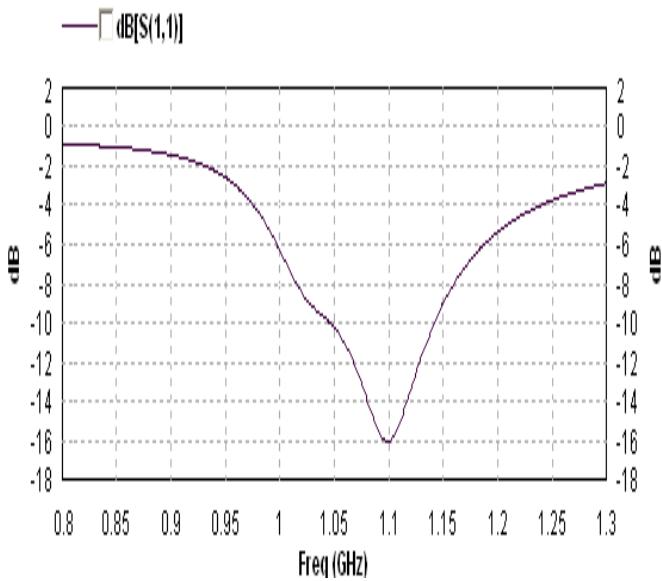Figure 2: Rectangular microstrip patch antenna resonating at 1.09 GHZ.
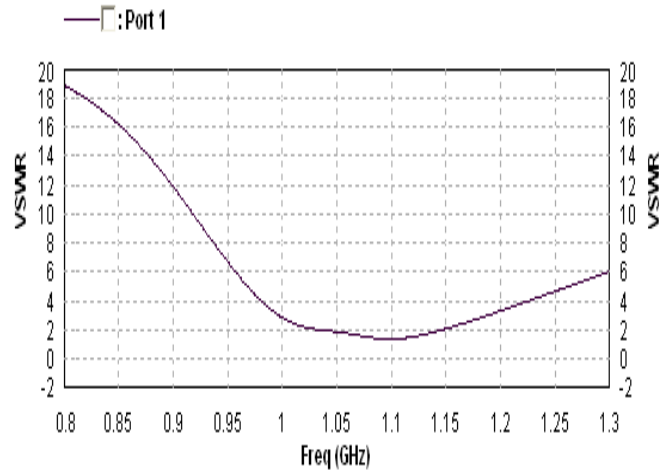
VSWR Display

Figure 4: VSWR Display of rectangular microstrip patch antenna.

In that figure, the operating frequency is 10 MHZ from 1.04 GHz to 1.14 **GHz, where VSWR≤2 is. The** resonance frequency of that region is 1.09 GHz where maximum return loss -16.00dB.

S-Parameters Display

Figure 3: S parameter Display of rectangular microstrip patch antenna
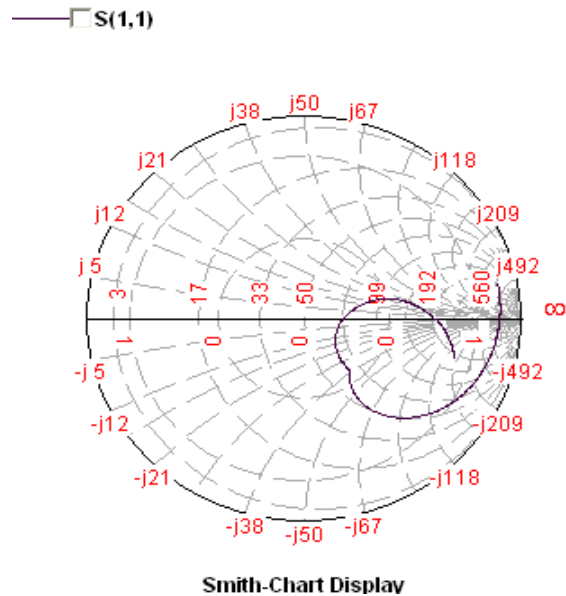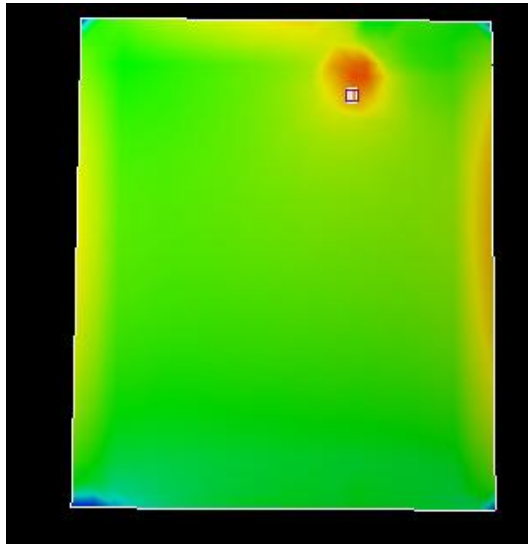

Smith-Chart Display

Figure 5: Smith chart

Figure 6: Current distribution

4. CIRCLEHEAD-SHAPE SLOTTED ANTENNA

The base of CircleHead 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 7. The design parameters are same as in case rectangular microstrip patch antenna.
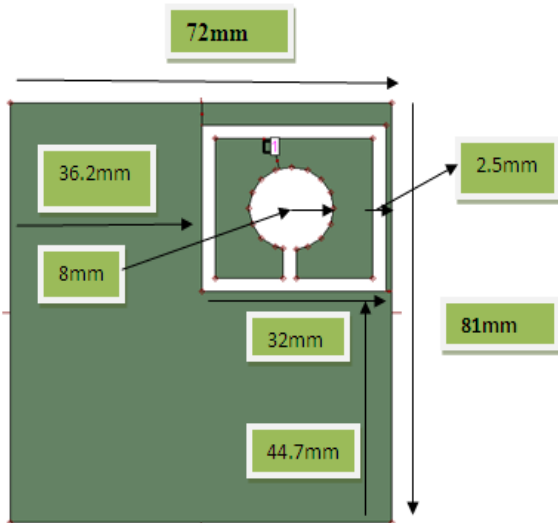

Figure 7: CircleHead shape slotted Microstrip patch Antenna.
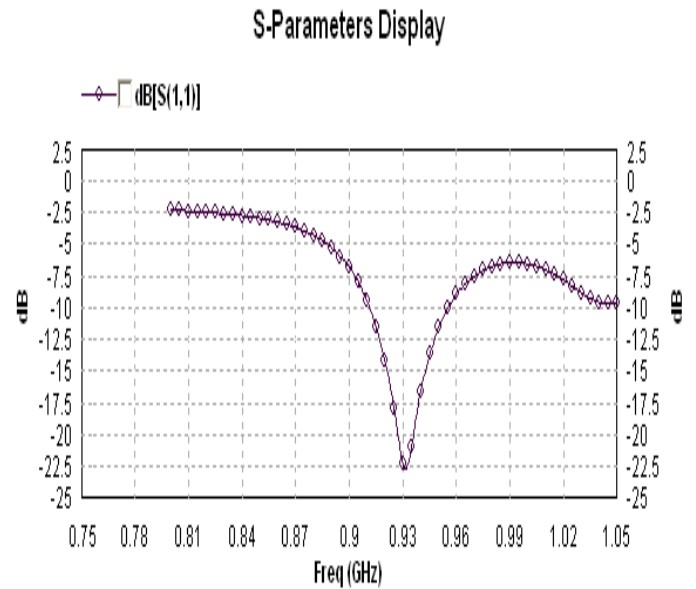
4.1 SIMULATION RESULTS :

Figure 8: S parameter Display of CircleHead shape slotted microstrip patch antenna.

In figure 8, 9 the operating frequency is 46 MHZ from 0.911 GHz to 0.957 **GHz, where VSWR≤2 is. The resonance** frequency of that region is 4.607 GHz where maximum return loss -22.71dB.
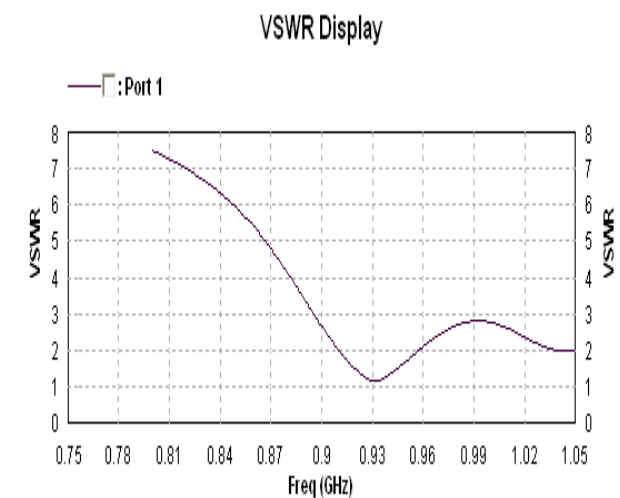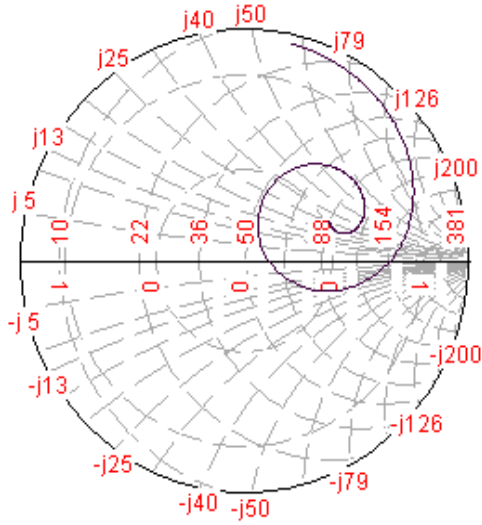

Figure 9: VSWR Display of CircleHead shape slotted antenna.

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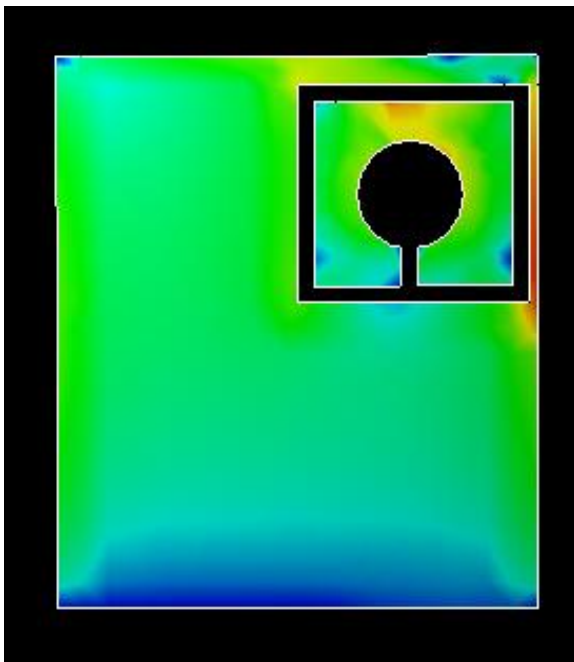**Smith-Chart Display**

Figure 10: Smith chart

Figure 11: Current distribution of CircleHead shape slotted microstrip patch antenna.

5. RESULT COMPARISION

Table 1: Shows result comparion between rectangular microstrip patch antenna and CircleHead shape slotted microstrip patch antenna.

	Rectangular antenna	CircleHead shape antenna
Resonating frequency	1.09 GHZ	0.93 GHZ
Max Return loss	-16.00 dB	-22.71 dB
Z parameter	66.68 Ohm	57.76 Ohm
Starting frequency	1.04 GHZ	0.911 GHZ
End frequency	1.14 GHZ	0.957 GHZ
Bandwidth	10 MHZ	46 MHZ

5.1 Simulation Result discussion

 IE3D 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 CircleHead shape Microstrip Patch Antenna Structure are shown in figure 3 and 8. At 1.09 GHz frequency simulated Rectangular Microstrip Patch Antenna alone exhibits the Return Loss of -16.00 dB and Bandwidth about 10 MHz while when it is incorporated with Rectangular CircleHead Slot structure. It shows Return Loss around-22.71dB and Bandwidth improvement 46 MHz. The enhancement in Bandwidth near about 36 MHZ was achieved and Antenna was used for wide band applications.

6. DESIGNED RECTANGULAR MICROSTRIP ANTENN HARDWARE

Figure 12: Rectangular microstrip patch antenna resonating at 1.09 GHZ.

7. DESIGNED S SHAPE SLOTTED ANTENNA HARDWARE

Figure 13: CircleHead shape slotted Microstrip Patch Antenna.
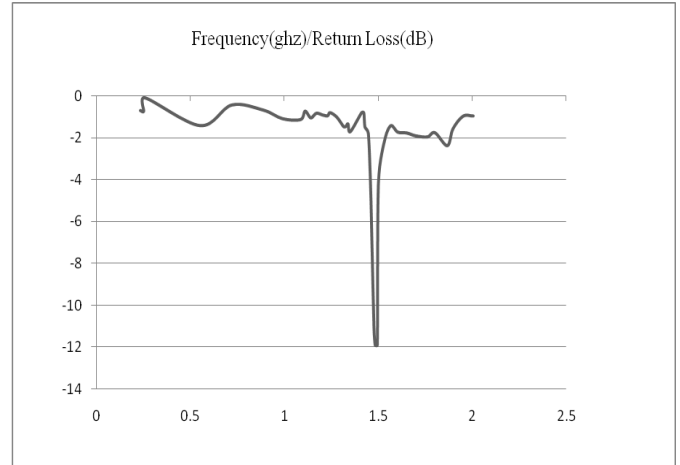
7.1 MEASURED RESULTS

Figure 14: S parameter Display of CircleHead shape slotted microstrip patch antenna.

Figure15: Connection of CircleHead MSA through SWR Bridge to Spectrum analyzer.

8. RESULT COMPARISON

Table2: Shows comparison between simulated and tested results.

Antenna Parameters	Simulated Results	Measured Results
Length	72	72
Width	81	81
Return Loss	-22.71	-11.9
Bandwidth	46MHZ	18MHZ

8.1 Simulation Result Discussion

Spectrum Analyser (SA) whose Range of measurement of frequency is 9 KHZ To 3 GHZ was chosen to simulate the Antenna hardware shown in the Figure 12 and 13. The S-parameter was obtained from simulation. The simulated result of CircleHead shape Microstrip Patch Antenna Structure are shown in figure 14. At 1.14 GHz frequency simulated CircleHead Microstrip Patch Antenna alone exhibits the Return Loss of -11.99 dB and Bandwidth about 18 MHz while when it is incorporated with was achieved.

9. 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 came out in our research work:

- In our project we studied different aspects related to microstrip antenna and we have made a microstrip antenna at 1.14 GHz.
- Thus we can say that we have obtained our aim successfully.

10. REFERENCES

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BIOGRAPHIES

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