Design and Development of Microstrip Patch Antenna for Wireless Communication

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Abstract- In this project, MoM based IE3D software is used to design a Microstrip Patch Antenna with enhanced gain and Bandwidth. Patch antenna is realized as per design requirements. Desired Patch antenna design is simulated by using IE3D simulator. A wideband U and phi-shape Microstrip patch antennas have been designed. The return loss is below −14dB and 9dB gain from 4.5 GHz to 5 GHz with a bandwidth of 14% and 90-97.5%efficiency .The return loss is below −10dB and 8.6dB gain from 5.5 GHz to 7.7 GHz with a bandwidth of 35.8% and 70-92% efficiency respectively. Antennas are thin and compact which makes it easily portable. These antennas can be used for wireless Local Area Network application and Radar applications respectively.

Keywords- Microstrip Patch Antenna, MoM, IE3D software

I. INTRODUCTION

Communication plays the most important role in the worldwide society day todays life nowadays and the communication systems are rapidly switching from “wired to wireless”.Microstrip antennas have several advantages over conventional microwave antenna and therefore are widely used in many practical applications. Microstrip antenna has drawn the maximum attention of the antenna community in recent years. In spite of its various attractive features like, light weight, low cost, easy fabrication, conformability on curved surface and so on, the micro strip element suffers from an inherent limitation of narrow impedance bandwidth. This work will be carried out to design and development of Microstrip patch antenna for wireless communication using Zeeland IE3D software.

The rest of the paper is organized as follows. Proposed method of analysis and designs are explained in section II. Experimental results are presented in section III. Concluding remarks are given in section IV.

II.PROPOSED ALGORITHM:

A .Method of analysis-

Transmission line model: It's a simple yet easiest among all other methods and gives more physical insight. However, it is more suitable for simple structures.

This model represents the Microstrip antenna by two slots of width *W* and height *s*eparated by a transmission line of length L. The Microstrip is essentially a non-homogeneous line of two dielectrics, normally the substrate and air. Hence, most of the electric field lines lies in the substrate and parts of some lines are in air. As a result, this transmission line do not support pure transverse electromagnetic mode of transmission, since the phase velocities would be different in the air and the substrate. Instead, the dominant mode of propagation would be the quasi-TEM mode.

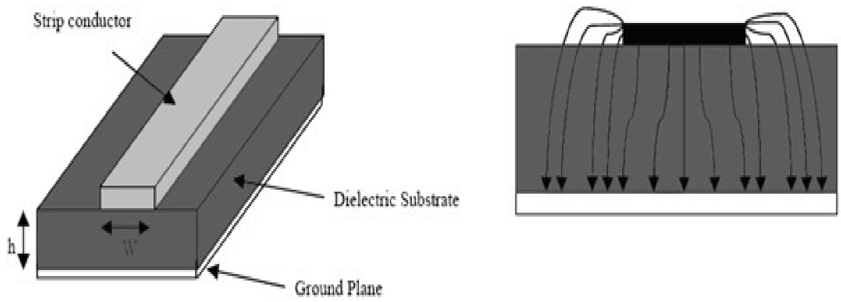

Figure 1.Microstrip Patch Antenna

Microstrip Antenna Feeding Techniques: Coaxial Probe Feed

B .Design method -

This antenna consists of a ground plane, dielectric layer and U and Phi-shaped patch. The three essential Parameters for the design of a rectangular Microstrip Patch Antenna, using Transmission Line Model, are:
Operating Frequency (*f0*)
Dielectric Constant of Substrate (Ɛr)
Height of Dielectric Substrate (*h*)
The length and width of rectangular patch antenna are calculated from below equations. Where c is the Velocity Light, r is the dielectric constant of substrate

1: Calculation of the Width (W_p):

$$W = \frac{c}{2f\sqrt{(\varepsilon_r+1)/2}}$$

2: Calculation of Effective dielectric constant (r_{eff}):

$$\varepsilon_{reff} = \frac{(\varepsilon_r+1)}{2} + \frac{(\varepsilon_r-1)}{2}\left[1+10\frac{h}{W}\right]^{-\frac{1}{2}}$$

3: Calculation of the Effective length (L_{eff}):

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{reff}}}$$

4: Calculation of the length extension (L):

$$\frac{\Delta l}{h} = 0.412\frac{(\varepsilon_{reff}+0.300)\left(\frac{W}{h}+0.262\right)}{(\varepsilon_{reff}-0.258)\left(\frac{W}{h}+0.813\right)}$$

5: Calculation of actual length of patch (L_p):

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

6. Calculation of Gain:

$$Gain = 4\pi\left(\frac{U(\theta,\phi)}{Pin}\right) \qquad \text{Dimensionless Units.}$$

C .*Antenna structure-*

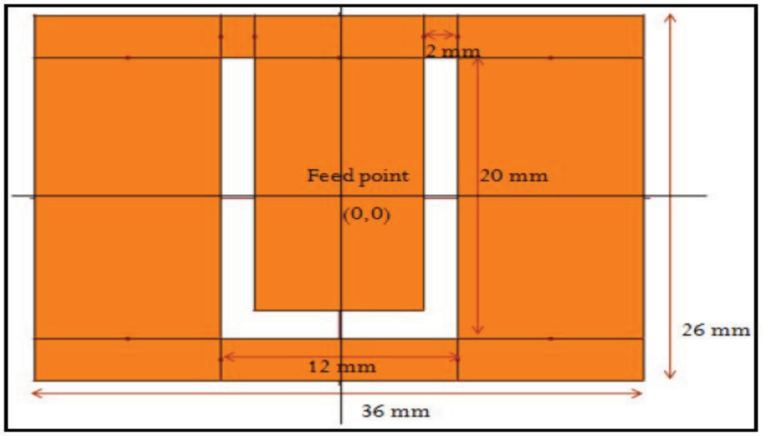

Figure 2. U-slotted patch antenna

Other essential parameters for the design are:

εr = 1.03
h = 5mm
tanδ = 0.0005

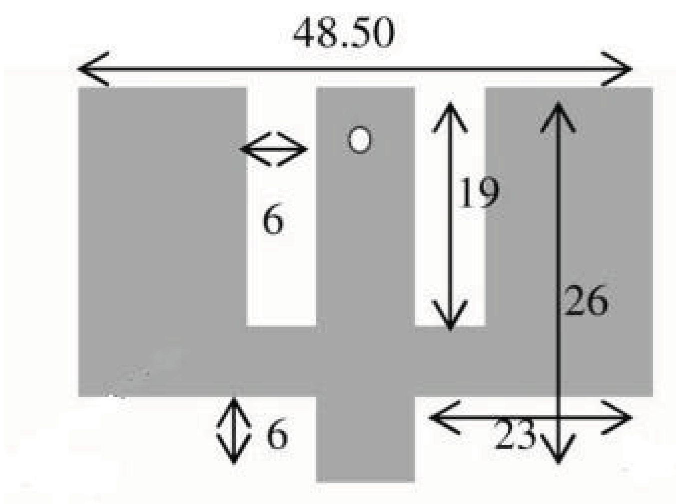

Figure 3. Phi-shaped patch antenna

Other essential parameters for the design are:

εr = 1.03
h = 5mm
tanδ = 0.0005
Feed point = (0, 6.7)
Radius of the probe = 0.7127

III. EXPERIMENT AND RESULT

A. Analysis for U-Slotted patch antenna -

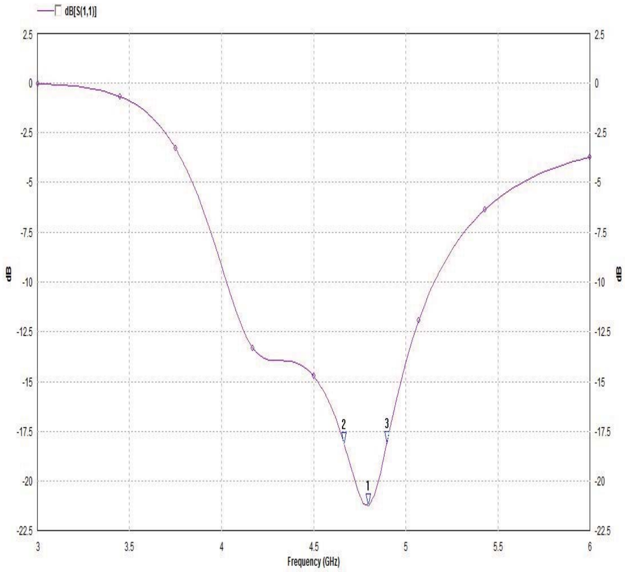

Figure 4. Return loss

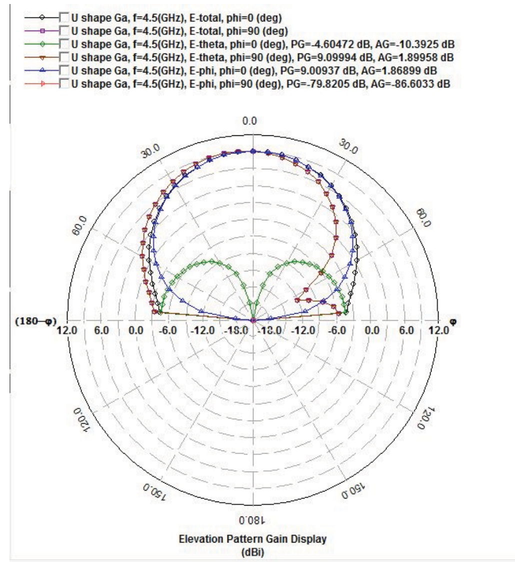

Figure 5. Gain

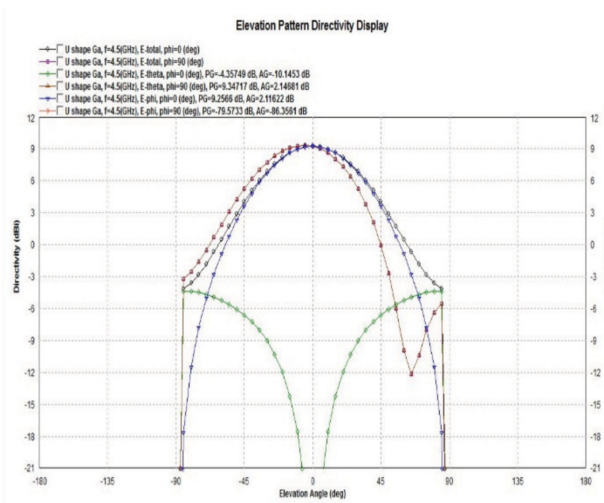

Figure 6. Directivity

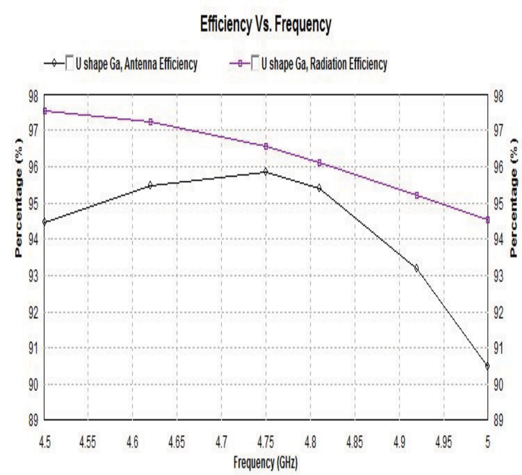

Figure 7 .Efficiency

U slotted Microstrip patch antenna design is simulated by using IE3D simulator with the frequency ranges from 3 GHz to 6 GHz. The return loss is below −14dB and 9dB gain from 4.5 GHz to 5 GHz. Maximum return loss is obtained at 4.8 GHz of -21.24dB with a bandwidth of 14% and having 90-97.5%efficiency.

B. Analysis for Phi-shaped patch antenna -

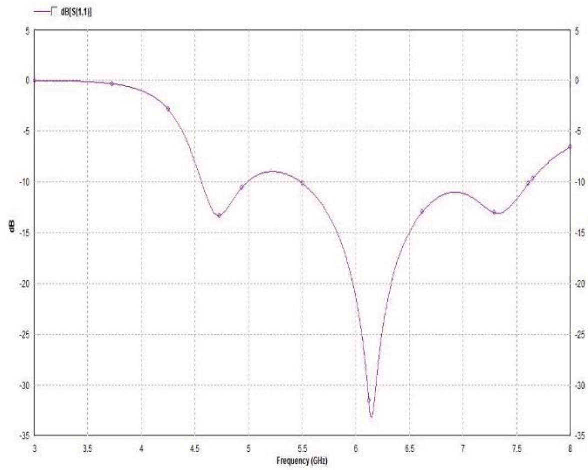

Figure 8. Return loss

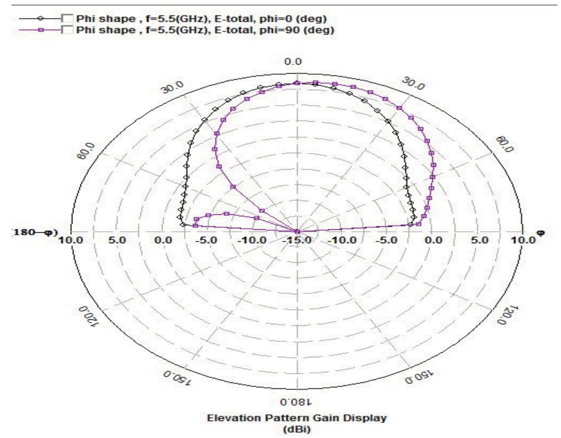

Figure 9.Gain

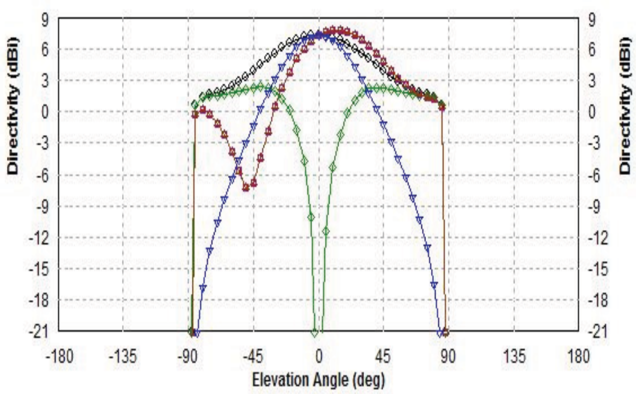

Figure 10.Directivity

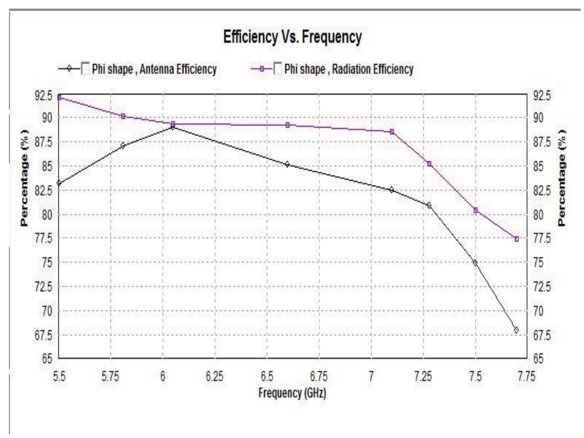

Figure 11.Efficiency

Phi- Shaped Microstrip patch antenna design is simulated by using IE3D simulator with the frequency ranges from 3 GHz to 8 GHz The return loss is below −10dB and 8.6dB gain from 5.5 GHz to 7.7 GHz.Maximum return loss is obtained at 6.2 GHz of -33dB with a bandwidth of 35.8% and 70-92% efficiency.

IV. CONCLUSION

We have designed two different wideband Microstrip patch antennas. The characteristics of proposed antennas have been investigated through different parametric studies using IE3D simulation software. The proposed antennas have achieved good impedance matching, stable radiation patterns, and high gain. The U-slotted and Phi-shaped antenna can be used for Wireless LAN application and Radar applications respectively. Fabrication and Verification of simulated results can be carried out in future.

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