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Design and Simulation of Rectangular and U Shape Microstrip Patch Antenna Using IE3D Software

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Abstract: The aim of this paper is to design a rectangular Microstrip Patch Antenna with enhanced gain and bandwidth and study the effect of antenna dimensions Length (L), Width (W) and substrate parameters relative Dielectric constant (ε_r),substrate thickness on antenna gain and bandwidth. In this paper a proposed structure of Rectangular and U shape micro strip patch antenna for high frequency application is design and simulated. The antenna is designed for operating frequency 6 GHz and dielectric constant 4.4 by using IE3D simulation software. Proposed antenna is designed for wireless communication.

Keywords: IE3D, Micro strip Patch, Return Loss, U-shaped patch antenna, VSWR, Wireless application.

I. INTRODUCTION

In this paper, the design parameters and results for a rectangular and U-slotted microstrip patch antenna in IE3D software is explained and the results obtained from the simulations . The microstrip patch design is achieved by using Micro strip Line Feed technique. The increased bandwidth is compare bandwidth of normal patch antenna and bandwidth of U shape micro strip patch antenna. We will analyse that there is increase in bandwidth using propose antenna and using Micro strip Line Feed at position where maximum matching is obtain. The proposed antenna is designed and simulated using IE3D full wave electromagnetic simulation software from Zeland Inc. To increase antenna efficiency and gain a low loss material should be used to fabricate the patch.

II. ANTENNA DESIGN PROCEDURE

The geometry of rectangular microstrip patch antenna and u shape microstrip patch antenna with different finite ground. The antenna is designed and fabricated on a substrate with a dielectric constant (ε_r) 4.4, a thickness(h) of 1.6 mm, and loss tangent (tanδ) = 0.01 and the microstrip feed line is realized on the same substrate layer. The dielectric material which is used here is bakelite material because of its low value of tangent loss and dielectric constant. The properties which are considered are dielectric constant, loss tangent, and their variation with temperature, frequency, dimensions,stability, thickness, resistance to chemicals, flexibility etc.

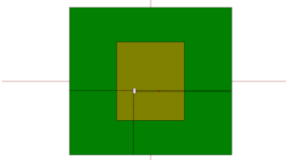

Fig.1 proposed antenna geometry with Micro strip Line Feed at x,y(-3.075,-1.975)

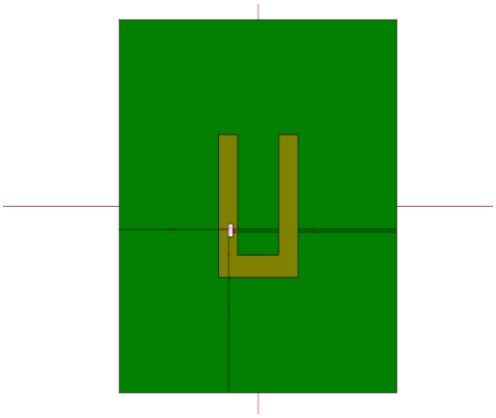

Fig.2 Proposed antenna geometry with Micro strip Line Feed at x,y(-3.075,-1.975)

III. DIMENSION OF ANTENNA

The calculated values of the antenna geometry:

Width of the patch w	16 mm
Length of the patch L	12.5 mm
Height of the substrate h	1.6mm
Dielectric constant ϵ_r	4.4
Width of the ground plane W_g	30mm
Length of the ground plane L_g	30mm
Tangent loss $\frac{\sigma}{\omega\epsilon}$	0.01

Width of the patch:

$$W = \frac{c}{2f\sqrt{\frac{\epsilon_r+1}{2}}} \quad (1)$$

Effective dielectric constant:

$$\epsilon_{reff} = \frac{\epsilon_r+1}{2} + \frac{\epsilon_r-1}{2}\left(1+12\frac{h}{w}\right)^{-1/2} \quad (2)$$

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Effective length of the patch:

$$L_{eff} = \frac{c}{2 f \sqrt{\epsilon_{reff}}} \quad (3)$$

Delta length or length extension:

$$\Delta L = 0.412 \times h \times \frac{(\epsilon_{reff} + 0.3)\left(\frac{w}{h} + 0.264\right)}{(\epsilon_{reff} - 0.258)\left(\frac{w}{h} + 0.8\right)} \quad (4)$$

Actual length of patch :

$$L = L_{eff} - 2\,\Delta L \quad (5)$$

Where parameter:

$c = 3\times10^8\ m/s$

h = thickness of the substrate characteristic impedance in terms of height and width of the substrate:

$$Z_0 = \frac{120\pi h}{w\sqrt{\epsilon_{reff}}} \quad (6)$$

IV. SIMULATED RESULT

The feature of the proposed antenna is analyzed using the Zeland IE3D software. The IE3D is an integrated full wave electromagnetic simulator and optimization package for the analysis and design of the patch antenna. The simulated results are shown in the figures below.

4.1 Rectangular microstrip patch antenna

The VSWR is 1.6 at the frequency5.24 GHz which is in the C band. The ideal value of the VSWR is 1. The value of VSWR is under the acceptance level and can be used in various applications.

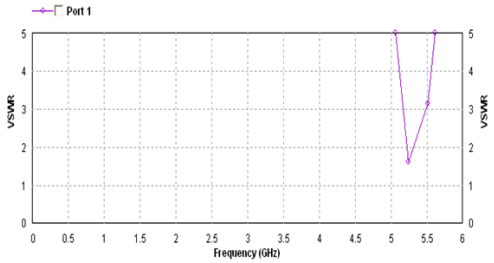

Fig.3 Simulated VSWR Curve

Return loss is related to both standing wave ratio and reflection coefficient. Increasing return loss corresponds to lower VSWR.

RL=-20 log_{10} |Γ|

For Rectangular microstrip patch antenna the value of return loss is - 12.13db

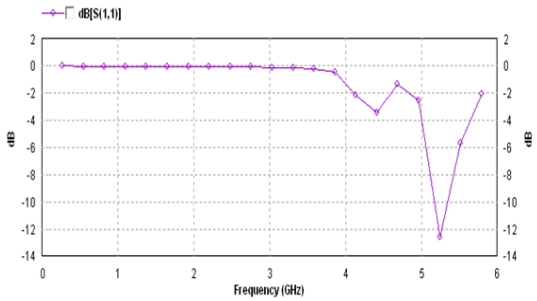

Fig. 4 S-parameter plot for Return loss v/s frequency 12.13 db

4.2 U- shape microstrip patch antenna

The VSWR is 1.11 at the frequency 5.992 GHz which is in the X band. The ideal value of the VSWR is 1. My simulated VSWR is under the acceptance level and can be used in various applications in the X-band region such as for weather monitoring , air traffic control , maritime vessel traffic control , defense tracking and for the vehicle speed detection.

$$VSWR = \frac{1+|\Gamma|}{1-|\Gamma|}$$

Where Γ is reflection coefficient and its value depends on the load and source impedance.

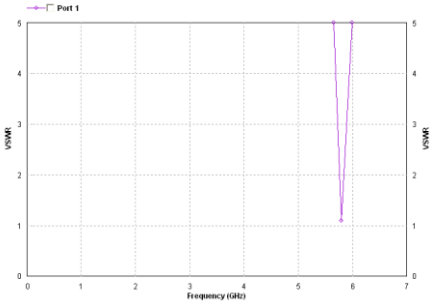

Fig.5 Simulated VSWR Curve

The VSWR is obtained in this design is 1.11 at the frequency of 5.992. Return loss is related to both standing wave ratio and reflection coefficient. Increasing return loss corresponds to lower VSWR. Return loss is a measure of how well devices or lines are matched . A match is good if the return loss is high.

RL=-20 log_{10} |Γ|

The value of return loss is -27.12dB at 5.992GHz.

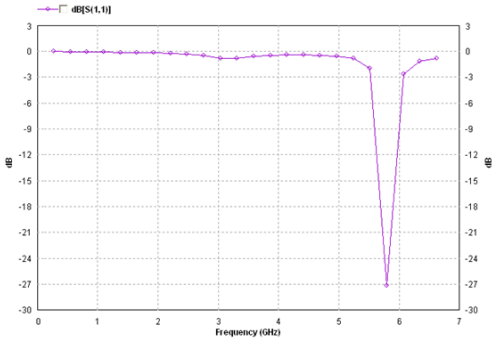

Fig.6 Proposed antenna geometry with Micro strip Line Feed at x,y(-3.075,-1.975)

V. CONCLUSION AND RESULT

Using a microstrip line feed technique design for rectangular & U shape microstrip patch antenna. Analysed the rectangular microstrip patch antenna with return loss is -12.13 dB & bandwidth is 3.61%.The bandwidth of the antenna can be said to be those range of frequencies over which the RL is greater than -9.5 dB.The return loss of the rectangular microstrip patch antenna is -12.13 dB that is good for analysed the different properties of rectangular microstrip patch antenna. Analysed U shape microstrip patch antenna with return loss is -27.13 dB & bandwidth is 6.64%.The bandwidth of the antenna can be said to be those range of frequencies over which the RL is greater than -9.5 dB.The return loss of the U shape microstrip patch antenna is -27.13 dB that is good for analysed the different properties of rectangular microstrip patch antenna.

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Using of U shape Microstrip patch antenna,The size of antenna is reduced compare then Rectangular microstrip patch antenna.The Micro strip patch antennas in terms of pattern, directivity, gain, and electric field determined by using IE3D software.

Return loss (Rectangular microstrip & u shape microstrip patch antenna)

Feed point position (mm,mm)	Frequency (GH_z)	RL (DB)
(-3.075,-1.975)	5.24	-12.13 db
(-3.075,-1.975)	5.992	-27.13 db

Table 1 Comparison of Return loss

Bandwidth (Rectangular microstrip & u shape microstrip patch antenna)

Feed point (mm,mm)	Frequency (F1) (GH_z)	Frequency (F2) (GH_z)	Bandwidth(%)
(-3.075,-1.975)	5.16	5.35	3.61%
(-3.075,-1.975)	5.6	5.8	6.64%

Table 2 Comparison of Bandwith

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