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

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ABSTRACT

Microstrip patch antenna is use in many wireless communication system. In this paper a proposed structure of 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, Return Loss, U-shaped patch antenna, VSWR, Wireless application.

I. INTRODUCTION

An antenna is defined by the IEEE as a “transmitting or receiving system that is designed to radiate or receive electromagnetic waves”. An antenna can be any shape or size. It has many advantages such as low profile, compactness, easy to fabricate on chips, easy installation and low cost etc but it has some disadvantage of narrow bandwidth which proved to be a challenge for engineers to meet high data rate for various broadband application. The bandwidth of antenna can be increased by various method such as increasing the thickness of substrate with low dielectric constant,cutting slot and different shape of antenna. By microstrip line feeding moving the different location of feeding point we get optimized bandwidth. 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 microstrip line feeding at position where maximum matching is obtain. The proposed antenna is designed and simulated using IE3D full wave electromagnetic simulation software from Zeland IE3D. To increase antenna efficiency and gain a low loss material should be used to fabricate the patch.

II. ANTENNA DESIGN PROCEDURE

The geometry of a single patch antenna using u-slot with different finite ground dimension feed by microstrip line feed. The patch antenna is constructed on same dielectric substrate. The patch antenna having a relative permittivity (ε_r) = 4.4, substrate of thickness (h) = 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.

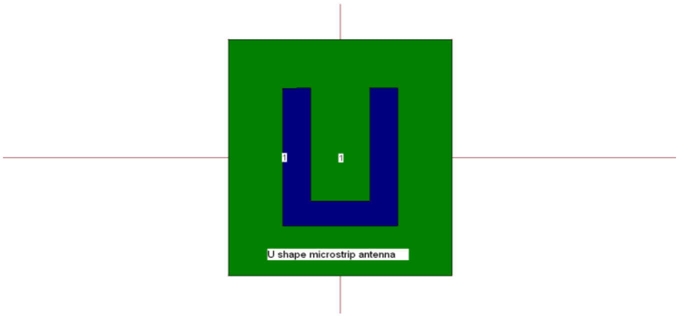

Figure 1. Normal U shape micro strip patch antenna

Dielectric constant is defined as the measure of degree to which an EM wave is slowed down as it travels through the material. So, a low value of dielectric constant material is chosen to avoid the storage of charge in the substrate, EM wave should be reflected by the substrate and not absorbed.

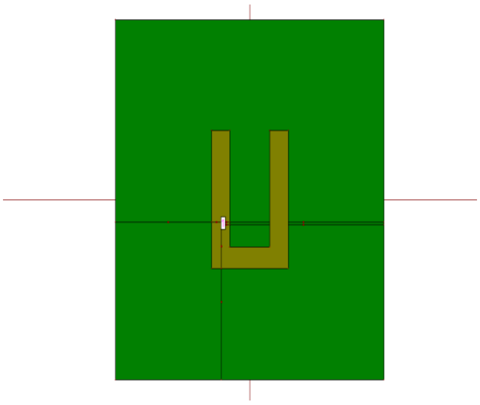

Figure 2. Proposed antenna geometry with probe feed at x,y(-3.075,-1.975)

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 = 1.6 mm
Dielectric constant ϵ_r = 4.4
Width of the ground plane W_g = 30 mm
Length of the ground plane L_g = 30 mm
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:

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

Effective length of the patch:

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

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 :

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

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. 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. It shows that how much the transmission line is matched. If the source impedance and load impedance are equal i.e. $Z_L = Z_s$. Then the total power will be absorbed by the load.

$$\Gamma = \frac{Z_l - Z_s}{Z_l + Z_s}$$

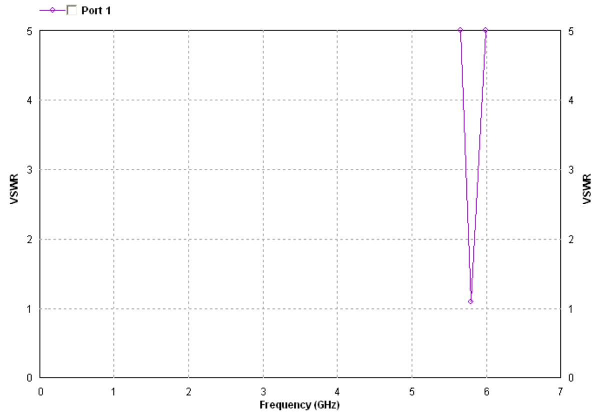

Fig.3 Simulated VSWR Curve

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.

$$RL = -20 \log_{10} |\Gamma|$$

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

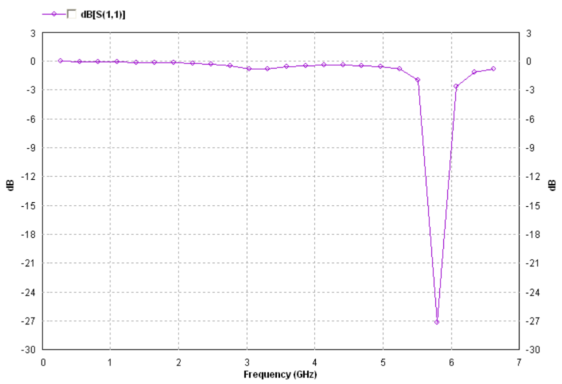

Fig.4 Proposed antenna geometry with probe feed at x,y(-3.075,-1.975)

V. CONCLUSION

The antenna proposed in this paper has the circular polarization radiation. The value of the axial ratio is about 1 dB in the band of our consideration which shows that the wave is circularly polarized. Circular polarization of an antenna is observed from its axial ratio graph , if it is below 3dB then it is said that the antenna is the good circularly polarized. The quality factor of the antenna is low as I have used the low value of dielectric constant. The antenna shows good directivity, and the gain of 7dBi. The value of the VSWR is less than 2:1 and the return loss is -27.13 db Which are applicable in the C-band application such as in radar and other wireless communication applications . In this antenna bandwidth is improved i.e. 6.64% and the efficiency of antenna is also good .

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