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

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ABSTRACT: Microstrip patch antenna is used in many wireless communication system. In this paper a proposed structure of U-shape microstrip patch antenna for high frequency application is designed and simulated. The antenna is designed for operating frequency 5.937 GHz and dielectric constant 4.5 by using IE3D simulation software. Proposed antenna is designed for wireless communication.

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

1 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 narrowBandwidth 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 methods such as increasing the thickness of substrate with low dielectric constant, cutting slot and different shapeof antenna. By microstrip line feeding moving thedifferent 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 increased in bandwidth using propose antenna and using microstrip line feeding at position where maximum matching is obtained. 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.

2 ANTENNA DESIGNING PROCESS

The geometry of a single patch antenna is used u-slot with different finite ground and dimension is feeded by microstrip line feed. The patch antenna is constructed on same dielectric substrate. The patch antenna having a relative permittivity ($\varepsilon \boldsymbol{r}$) = 4.5, substrate of thickness (h) = 1.6 mm, loss tangent (tanδ) = 0.002 and the microstrip feed line is realized on the same substrate layer. The dielectric material which is used this antenna is bakelite material because of it'slow value of tangent loss and dielectric constant. The properties which are considered as dielectric constant , loss tangent and their variation with temperature, frequency, dimensions, stability, thickness, resistance to chemicals, flexibility etc.

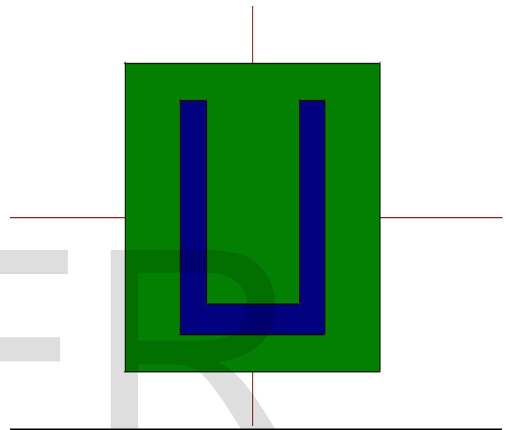

Figure 1. Normal U shape micro strip patch antenna
(Before using Feed)

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.

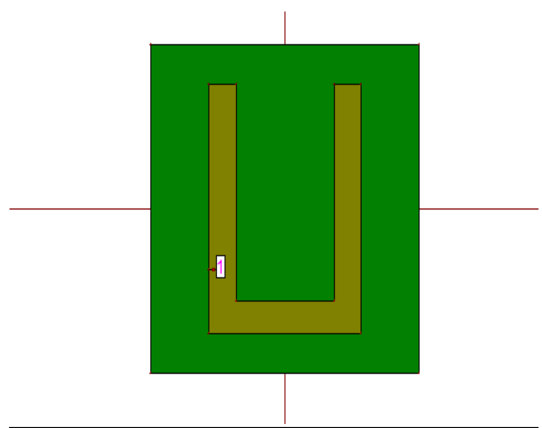

Figure 2. Proposed antenna geometry with probe feed at x,y(-4.775,-3.750)

3 VALUE DETERMINATION OF ANTENNA

The calculated values of the antenna:

Width of the patch, w	15.22mm
Length of the patch, L	11.32mm
Height of the substrate, h	1.6mm
Dielectric constant, ε_r	4.5
Width of the ground plane, W_g	20mm
Length of the ground plane, L_g	20mm
Tangent loss, (tanδ)	0.002

The width of the patch is calculated using the following equation,

$$W = \frac{C_0}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}} \qquad (1)$$

Where,
W = Width of the patch
C_o= Speed of light
ε_r= value of the dielectric substrate

Effective refractive index,

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2}, W/h > 1 \qquad (2)$$

Effective length of the patch,

$$L = \frac{C_0}{2f_r\sqrt{\varepsilon_{reff}}} - 2\Delta L \qquad (3)$$

Due to fringing, electrically the size of the antenna is increased by an amount of (ΔL). Therefore, the actual increase in length (ΔL) of the patch is to be calculated using the following equation,

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)} \qquad (4)$$

The length (L) of the patch is now to be calculated using the below mentioned equation,

$$L = \frac{C_0}{2f_r\sqrt{\varepsilon_{reff}}} - 2\Delta L \qquad (5)$$

Where parameter,
c = 3×10^8
h = thickness of the substrate
characteristic impedance in terms of height and width of the substrate:

$$Zo = \frac{120\pi h}{w\sqrt{\varepsilon reff}} \qquad (6)$$

4 RESULT OF SIMULATION

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 1.06522 at the frequency 2.61814 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.

$$VSWR = \frac{1+|\Gamma|}{1-|\Gamma|} \qquad (7)$$

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.

$$\Gamma = \frac{ZL-ZS}{ZL+ZS} \qquad (8)$$

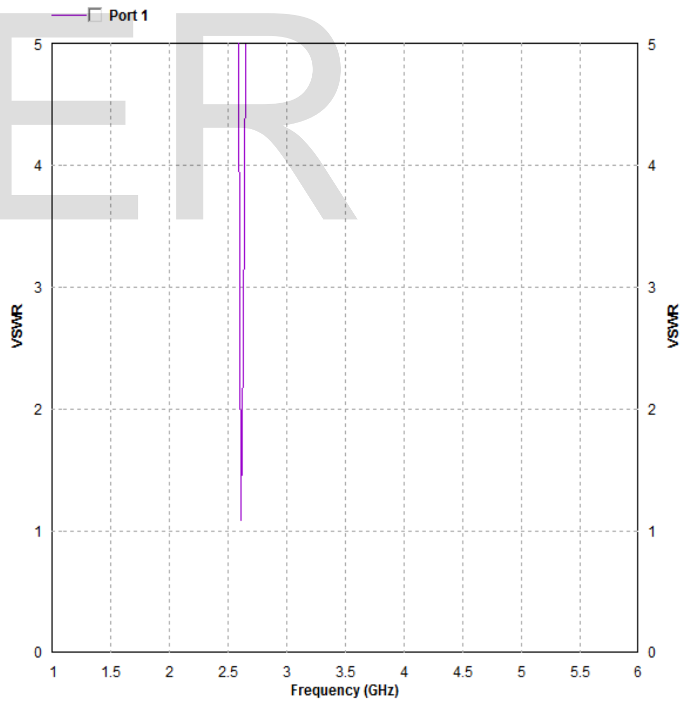

Fig.3 Simulated VSWR Curve

The VSWR is obtained in this design is 1.06522 at the frequency of 2.61814. 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 -28.3696 dB at 2.61814GHz.

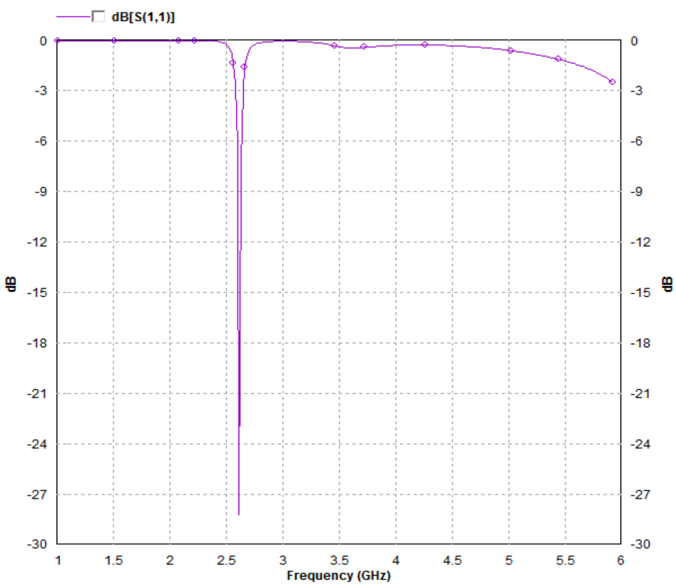

Fig.4: Proposed antenna geometry with probe feed at x,y(-4.775,-3.750)

5CONCLUSION

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 6.93 dBi. The value of the VSWR is less than 2:1 and the return loss is -28.3696 dbWhich are applicable in the C-band application such as in radar and other wireless communication applications.Inthis antenna bandwidth is improved i.e. 7.1% and the efficiency of antenna is also good.

6 FUTURE WORK

Further enhancement in the antenna gain and bandwidth can be done by doing more research such as by using different antenna shapes, using different feeding methods, by changing the feed locations etc.Some more methods which can be implemented are using antenna array, using stacked configurationetc.

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REFERENCES

[1] Liton Chandra Paul, Nahid Sultan ''Design, Simulation and Perfomanc Analysis of a Line Feed Rectangular Micro-Strip Patch Antenna'', Volume 4, Issue 2, pp: 117-126, Feb. 2013.
[2] Vijay shanker, Anil Kumar, A. K. Jaiswal and Ekta Singh Chauhan "Frequency Reconfigurable Microstrip Patch Antenna for Wireless Applications" , Accepted 30 May 2016, Available online 03 June 2016, Vol.6, No.3 (June 2016)
[3] UjwalPrakash .AJ, S.Merlin Gilbert Raj,Pristin.K.Mathew, "Performance Analysis ofU-Slot And V-Slot Patch Antenna For Wireless Applications",
[4] Ahmed FatthiAlsager "Design and Analysis of Microstrip Patch Antenna Arrays" page 08
[5] James j., and P.S. Hall (Eds), Handbook of microstrip antenna, Peter Peregrinus, London, UK, 1989
[6] Ramesh Garg, PrakashBartia, InderBahl, ApisakIttipiboon, ''*Microstrip Antenna Design Handbook*'', *2001*, pp 1-68, 253-316 Artech House Inc. Norwood, MA.
[7] J. D. Kraus, R. J. Marhefka, "*Antenna for all applications*" 3rd Ed., McGraw- Hill, 2002.
[8] Robert A. Sainati, CAD of Microstrip Antennas for Wireless Applications, Artech House Inc, Norwood, MA, 1996
[9] Y T Lo and S W Lee, editors, ''*Antenna Handbook Theory, Applications & Design*'', Van Nostrand Rein Company, NY, 1988.

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