ISSN: 2321-8169
2299 – 2302

Design of 3-side Truncated Patch Antenna for UWB Applications

Jashandeep Singh, Amrik Singh
Electronics & Communication Engg. Deptt.
Bhai Gurdas Institute of Engineering &Technology
Sangrur, India
e-mail; jsdeol1989@gmail.com , amrik3011@gmail.com

Sushil Kakkar
Electronics & Communication Engg. Deptt.
Bhai Gurdas Institute of Engineering &Technology
Sangrur, India
e-mail: sushil.kakkar@bgiet.ac.in

Abstract- A 3-sided truncated microstrip patch antenna for ultra wideband (UWB) applications has been presented in this paper. The proposed antenna is compact in size and design on FR4 substrate. In order to validate the antenna performance, simulated results have been reported using HFSS EM solver. The proposed antenna is feasible for WLAN, WIMAX, Wi-Fi and other various wireless applications.

Keywords*- Patch Antenna, Retun Loss, UWB*

*****

I. INTRODUCTION

An antenna is a transducer designed to transmit or receive electromagnetic waves. A microstrip antenna consists of a radiating patch on one side of dielectric substrate ($\varepsilon_r \leq 10$) and ground plane on the other side [1]. A large number of microstrip patch antennas have been studied till date. The rectangular and circular patches are the basic and most commonly used microstrip antennas. Rectangular geometries are separable in nature and their analysis is also simple.

The circular patch antenna has the advantage of their radiation pattern being symmetric [2]. Microstrip patch antennas radiate mainly because of the fringing fields between the ground plane and edges of the patch. In order to achieve good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation [3, 4]. Low dielectric constant substrates are generally preferred for maximum radiation.

Due to low cost, compact size and ease of fabrication slot antennas are attractive for broadband and UWB applications. Slot antennas fed by microstrip-line were investigated for UWB applications [5]. Because the microstrip-line-fed slot antennas have wide impedance bandwidth, simple structure, easy manufacture and low cost, it can suitable for apply to wireless local area network (WLAN) or Blue-tooth applications communication products [6]. The UWB system covers the frequency range from 3.1-10.6 GHz, which based on narrow pulses to transmit data at extremely low power, and looks like random noise to most conventional radio systems [7, 8]. There is a huge range of applications for UWB technology, which consists of wireless communication systems, radar, sensing and imaging, position and tracking, etc. [9, 10]. In the presented work, a truncated antenna structure has been employed for UWB applications.

II. DESIGN AND STRUCTURE

Figure 1 shows the geometry of the antenna with a corner-truncated rectangular patch fabricated on the FR4 Substrate. The dielectric constant of substrate ε_r= 4.4 and a loss tangent of 0.02 and thickness of the substrate h= 0.8mm have been used to design microstrip patch antenna. The dimensional parameters of the proposed antenna are detailed in Table.1. In this work a corner truncation scheme is used to enhance the bandwidth for UWB applications. On the ground a non symmetric $\lambda/4$ L-shaped slot has been used for producing miniaturization and a wide operating bandwidth. The rectangular patch is fed by microstrip-line has been truncated three corners, simultaneously. The three corners are investigated to understand their effects on the enhanced operation banwidth. The proposed antenna is simulated using Ansoft High Frequency Structure Simulator (HFSS), which is full wave electromagnetic simulation software for the microwave and millimeter wave integrated circuits. Ansoft HFSS employs the Finite Element Method (FEM), adaptive meshing, and brilliant graphics to give an unparalleled performance and insight to all of the 3D EM problems [11, 12]. The 3D model of proposed antenna generated in the HFSS is shown in Figure 2. By varying the values of Corner A, Corner B and Corner C a good impedance match over the UWB frequency range can be excited well.

TABLE.1 ANTENNA DIMENSIONS

Length of Patch (Lp)	6 mm
Width of Patch (Wp)	9 mm
Thickness of Substrate	0.8 mm
Length of Substrate (L)	35 mm
Width of Substrate (W)	30 mm
Width of Feed (x)	1.53 mm
Length of Feed (Lf)	14.55 mm

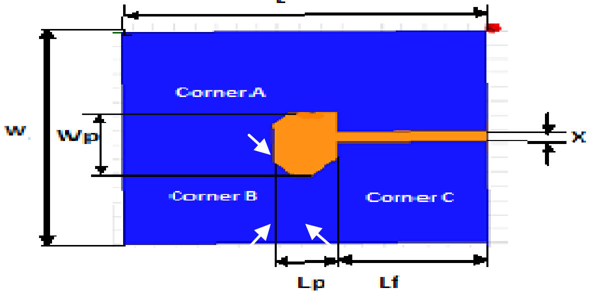

Figure 1. Geometry of proposed antenna showing patch and substrate

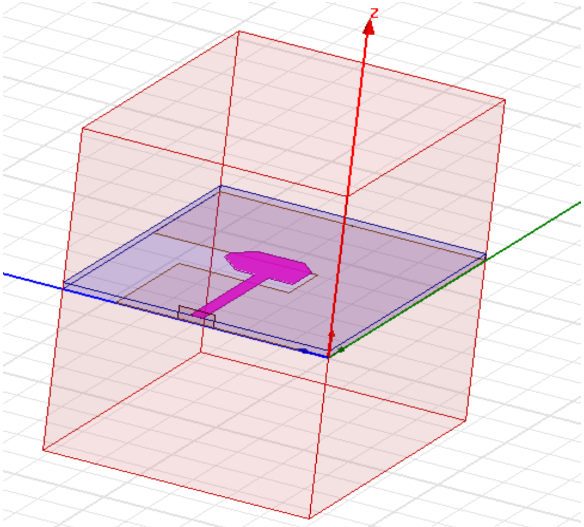

Figure 2. 3D Ansoft HFSS generated model of proposed antenna

III. RESULTS AND DISCUSSIONS

A. Return Loss

Return loss is the loss of signal power resulting from the reflection caused at a discontinuity in transmission line. This discontinuity can be a mismatch with the terminating load or with a device inserted in the line. A return loss of -42.18 dB at 3.9 GHz and -25.6dB at 8.3 GHz is obtained for the proposed antenna, as shown in Figure 3.The presented result shows that designed antenna possesses broad bandwidth from 2.8 GHz to 12 GHz covering entire UWB allocated by FCC.

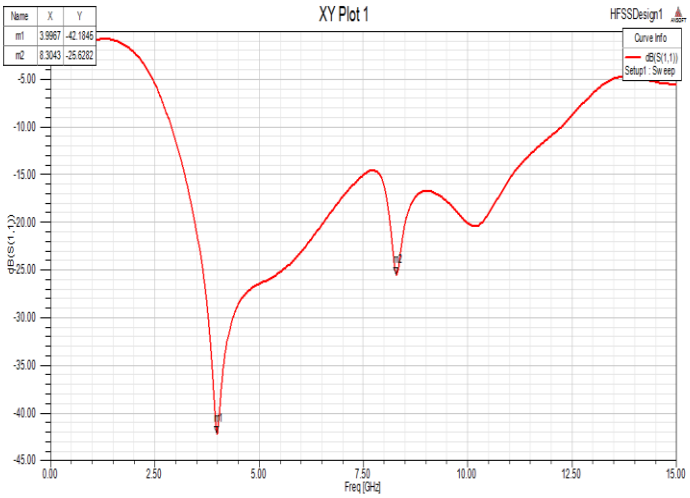

Figure 3. Return Loss of the Proposed Antenna

B. VSWR

VSWR stands for Voltage Standing Wave Ratio, and is also referred to as Standing Wave Ratio (SWR). VSWR may be express in terms of the reflection coefficient, which describes the power reflected from the antenna. The VSWR is always a real and positive number for antennas. The smaller the VSWR is, the better the antenna is matched to the transmission line and the more power is delivered to the antenna. The minimum VSWR is 1.0. The presented results shown in Figure 4 reveals that VSWR value for the proposed antenna is less than two for the entire frequency band.

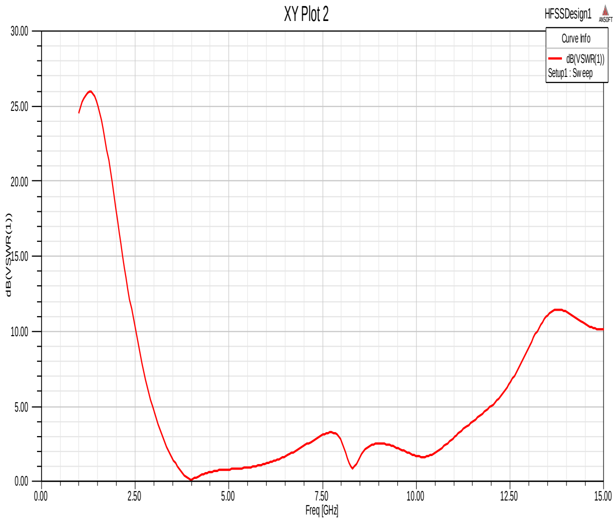

Figure 4. VSWR of the proposed antenna

C. Radiation Pattern

The Radiation pattern or antenna pattern can be defined as the representation of the angular distribution of radiated power density in the far field, as shown in Figure 5. The radiation pattern is the graphical representation of the radiation properties of the antenna as a function of space. The antenna's pattern explains how the antenna radiates energy out into space. It is important to state that an antenna radiates energy in all directions, at least to some extent, so the antenna pattern is actually three-dimensional as shown in Figure 6.

This radiation pattern shows that the antenna radiates more power in a certain direction than another direction. This is commonly expressed in dB. Figure 5 shows that radiation pattern of proposed antenna is nearly omni-directional in azimuth plane and nearly bidirectional in elevation plane. The 3D-polar plot of the presented antenna is shown in Figure 6.

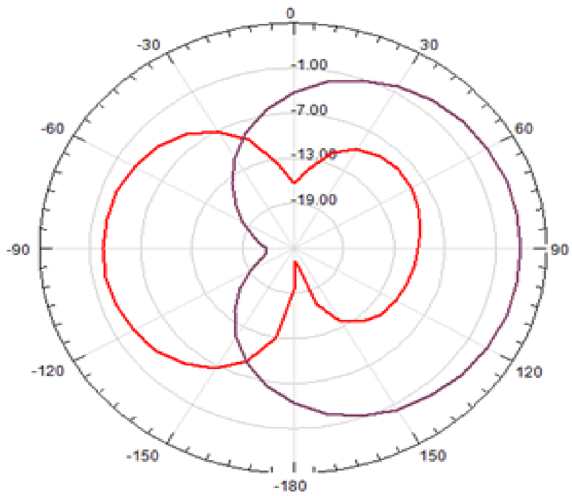

Figure 5. Radiation Pattern of prposed antenna at Phi= 0 and 90 degree

ISSN: 2321-8169
2299 – 2302

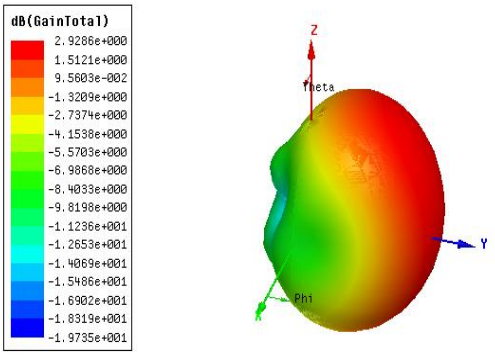

Figure 6. 3-D Polar Plot Showing Total Gain (in dB)

D. Axial Ratio

The ratio of major axis to the minor axis of the polarization ellipse is termed as axial ratio, where the resulting pattern is an oscillating pattern [13,14]. The simulated axial ratio of the proposed antenna is obtained using HFSS EM simulator and shown in Figure.7

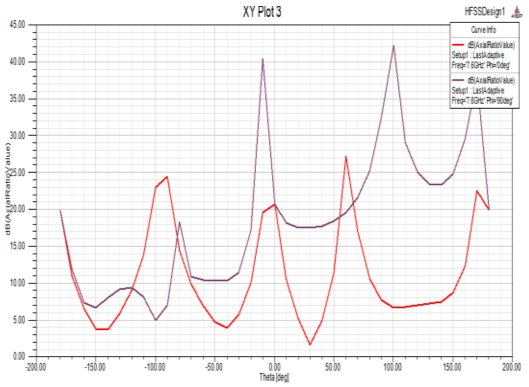

Figure 7. Axial Ratio

E. H-Field Distribution

It is the plane containing the magnetic field vector and the direction of maximum radiation. The magnetic field or "H" plane lies perpendicular to the "E" plane. The H-plane usually concides with the horizontal/azimuth plane in case of vertically polarized antenna and in case of horizontally-polarized antenna, it usually concides with the vertical/elevation plane [13,14]. The H-field of proposed antenna is shown in Figure 8.

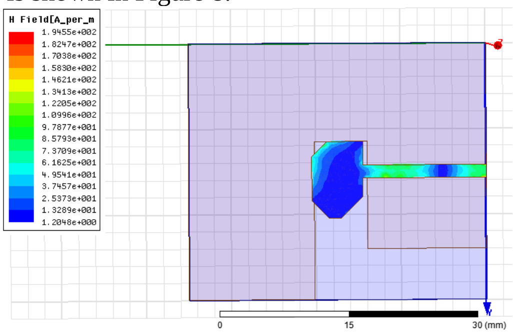

Figure 8. H-field Distribution

F. E-Field Distribution

An electric field can be visualized by drawing field lines which indicates the direction and magnitude of the field. The E-plane containing the electric field vector and the direction of maximun radiation [13,14]. Field lines start on positive charge and end on negative charge. The E-Field of the proposed antenna is shown in Figure 9.

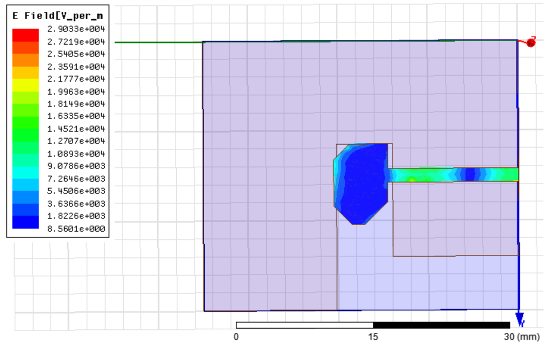

Figure 9. E- Field Distribution of proposed antenna

G. Current Distribution

The triangles shows the current distribution. Here the number of triangles inside the patch are more than those on the substrate i.e the current distribution in the patch is more when compared to that inside the substrate in Figure 12.

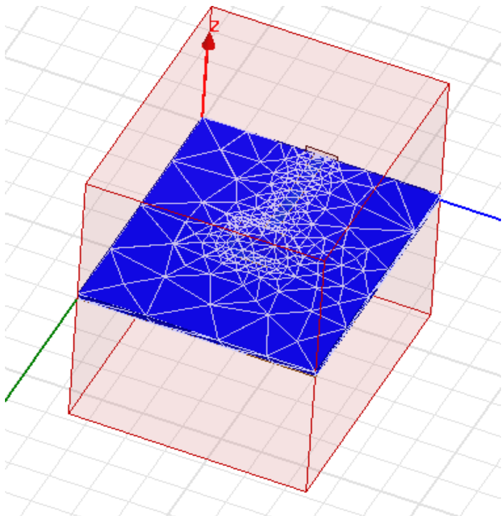

Figure 12. Mesh Pattern

IV. CONCLUSION

In this paper a design of an UWB antenna printed on magnetic FR4 substrate has been described. The simulation results of the antenna show that enhanced impedance bandwidth can be achieved by using L-shaped slot and 3-side truncated corners. It is seen that the proposed antenna achieved good performance and compact size, which well meets the requirements of UWB applications.

ISSN: 2321-8169
2299 – 2302

REFERENCES

[1] I.Singh and V.S Tripathi, "Microstrip Patch Antenna and its Applications" *International Journal of Computer Technical Applications*, Vol.-2, pp 1595-1599, 2011

[2] S.R Vhora and M.D Amipara, "A Noval Design of Rectangular Patch Antenna For Broadband Applications" *International Journal of Engineering Resarch and technology*, Vol.-2, No.-1, 2013

[3] H.Hashemi Isfahani, "A Slit-Loaded Notch-Cut Patch Antenna for Broadband Applications" *International Journal of Engineering Science and Advanced Technology*, Vol.-2, No.-2, pp 380-387, 2012

[4] R.K Prajapati, P.K Singhal and H.K Gupta, "Improvement of Rectangular Microstrip Patch Antenna Parameters for Cellular and Mobile Communication" *Current Resarch In Engineering , Science and Technology*, Vol.-1 , No.-4, pp. 91-97, 2013

[5] A.Singh, R.Kumar and H.S.Dadhwak, "Design of Edge Fed Rectangular Microstrip Patch Antenna for WLAN Applications" *VSRD International Journal of Electrical, Electronics and Communications Engineering* Vol.-2, No.-4, pp.160-167, 2012

[6] Y.Rajput, T.S Rawat and L.Varshney, "CPW Feed Patch Antenna for GPS Applications" *International Journal of computational Engineering Resarch*, Vol.2 , No.-6, 2012

[7] S.Kakkar, S.Rani and A.P Singh, "On the Resonant Behavior Analysis of Small-Size Slot Antenna with Different Substrates", *International Journal of Computer Applications*, pp. 10-12, 2012.

[8] S.Singh, B.Gupta and A.Kumar, "Truncated Rectangular Microstrip Antenna for Wide Band" *International Journal of Science and Engineering*, Vol.-1, pp.34-40, 2013

[9] S.Rani and A. P. Singh, "On the Design and Optimization of New Fractal Antenna Using PSO" International *Journal of Electronics*, vol. 100, No.-10, pp. 1383-1397, 2012

[10] K.Song ,Y.Z .Yin,H.H.Xie and S.Zuo, "A Corner Truncated Patch Scheme of Bandwidth Enhancement for open Slot Antenna" Proceedings of International Symposium on Signals, Systems and Electronics, 2010

[11] A.Agarwal, N.Naushad and P.K.Singhal, "Trucated Gap Coupled Wideband Rectangular Microstrip Patch Antenna" International Journal of Computr Science and Communication Engineering, Vol.-2, No.-1, 2013

[12] I.B Pauria, S.Kumar and S.Sharma, "Design and Simulation of E-Shape Microstrip Patch Antenna for Wideband Applications" International Journal of Soft Computing and Engineering, Vol.2, No.-3, 2012

[13] Balanis, C. A., Antenna Theory: Analysis and Design, John Wiley & Sons, Inc, USA, 2005.

[14] www.antennatheory.com