International Journal of Engineering Research (ISSN:2319-6890)(online),2347-5013(print)
Volume No.3, Issue No.2, pp : 66-69 01 Feb. 2014

Circular Shape Antenna Embedded with b-Shape Slot for UWB Applications

Kirandeep Randhawa, Davinder Parkash
Department of ECE, HCTM Kaithal
Kirandeep374@gmail.com, Devnitk1@gmail.com

Abstract- ***In this paper, a design and analysis of compact coplanar waveguide-fed ultra wideband slot antenna is presented. The proposed antenna has simple structure consisting of b-shape slot in a circular patch. The overall dimension of the antenna come around 32 mm X 22 mm X 1.6 mm and fed by 50Ω CPW feed. The impedance matching and radiation characteristics of the designed structure are investigated by using IE3D. The simulation results show that the antenna offers excellent performance for UWB application with impedance bandwidth ranging from 4.2 GHz to 10.8 GHz. The simulated peak gain of proposed antenna is 5 dBi. This antenna configuration would be quiet useful for UWB indoor application as it is easy to fabricate.***

Keywords - Coplanar waveguide (CPW), Slot and Ultra Wideband (UWB)

I. Introduction

Traditional Ultra-wideband (UWB) antennas have been unable to combine with the modern integrated system for their complex structures and large volumes, miniaturized ultra-wideband printed antennas being good candidates for their low profile. Recently CPW-fed printed antennas have received considerable attention owing to their attractive merits, such as ultra-wide frequency band, good radiation properties and easy integration with system circuits. However, most previously reported CPW-fed antenna designs are complex [1-4], with poor radiation patterns, unsuitable for practical applications. In general planar slot antennas two parameters affect the impedance bandwidth of the antenna, the slot width and feed structure [5, 6]. The wider slot gives more bandwidth and the feed structure gives the good impedance matching [7,8]. The CPW feed line with various possible patch shapes such as T cross, Circular Slot, arc shape and square is used for wide bandwidth [9, 10].

In this paper, a new circular CPW-fed UWB antenna with b-shape slot is proposed. This slot is used to enhance the impedance bandwidth. It demonstrates that the compact design can achieve an ultra wide bandwidth, the operation bandwidth being 4.2 to 10.8 GHz, covering UWB operating band, with satisfactory radiation patterns and peak gain.

II. Antenna Design

The geometry of the proposed monopole antenna is shown in Fig.1. The total size of the proposed antenna is 32 mm x 22 mm.

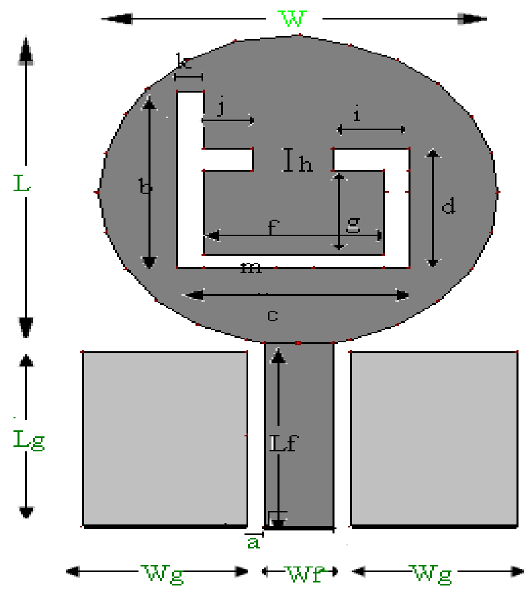

Figure 1: Diagram of proposed antenna

As shown in the fig. 1, the antenna consists of circular patch consisting of b-shape slots in it. The b shape slot is embedded in centre of the proposed antenna. The antenna is constructed with the above described patch and fed by Coplanar Waveguide Feed (CPW) feeding. The patch is printed on a 1.6mm thick FR4 substrate with relative permittivity of 4.4.The ground size of the proposed antenna is 11.6 mm x 8.4 mm. The ground plane is symmetrical at the base line of the feeding strip line. To obtain the optimal parameters of the proposed antenna for UWB application, IE3D, full-wave commercial EM software that can simulate a finite substrate and a finite ground structure, is used. Thus, the proposed antenna design can provide a wide bandwidth while retaining stable performance via the optimized geometrical parameters. The parameters of proposed antenna are shown in Table 1**.** The distance between patch and ground is 0.6 mm and between feed and ground is 0.87 mm. The rectangular strip feed line has dimensions of 12.2 mm × 3.5 mm. The slot b-shape dimension 11.7 mm × 11.8 mm is embedded on patch. The slot is cut from centre to enhance the impedance bandwidth of antenna. This antenna covers impedance bandwidth range from 4.2 GHz to 10.8 GHz.

International Journal of Engineering Research (ISSN:2319-6890)(online),2347-5013(print)
Volume No.3, Issue No.2, pp : 66-69 01 Feb. 2014

Table 1: Parameters of proposed circular antenna

Parameters	Values (mm)	Parameters	Values (mm)
L	20	c	11.8
W	20	d	8
Lg	11.6	f	9
Wg	8.4	g	5.58
Lf	12.2	h	1.5
Wf	3.5	i	3.9
a	.87	j	2.5
b	11.7	k	1.4
m	0.9		

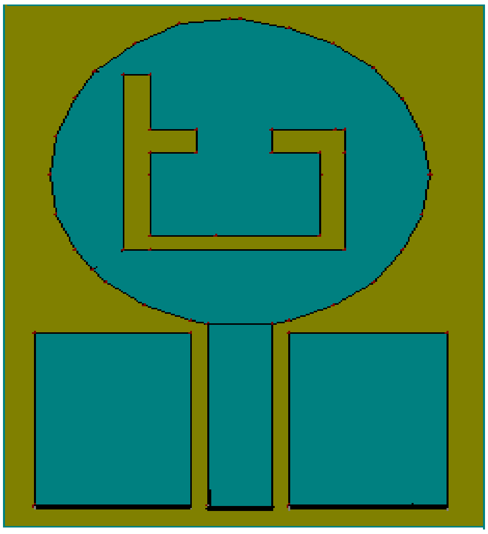

Figure 2: Fabricated circular patch with b-slot

III. Simulated Results And Discussions

The design evolution of the proposed UWB antenna and its corresponding simulated return losses are presented in fig.3.

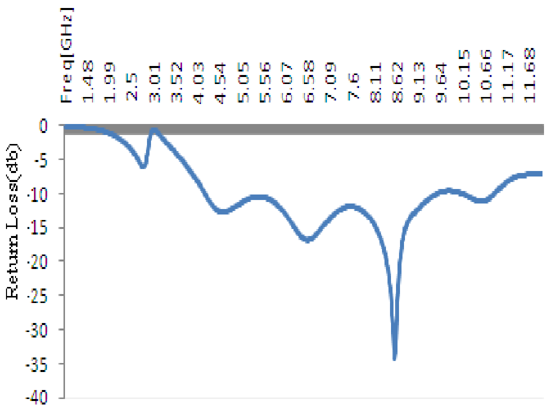

Figure 3: Return loss of proposed antenna

This antenna provides better impedance matching which creates impedance bandwidth of 6 GHz for the working bands of 4.2 to 10.8 GHz centered at 8.5 GHz. The peak value of return loss at 8.5 GHz is -33 db.

3.1 Parametric study

Parametric comparison in this design is done by removing slot from patch, decreasing ground length and by cutting the slot from centre. Fig. 4 shows the graph of return losses when there was no slot in patch. Peak value of return loss decreased to -22 db. Peak value of return losses is increased by inserting slot in a circular patch.

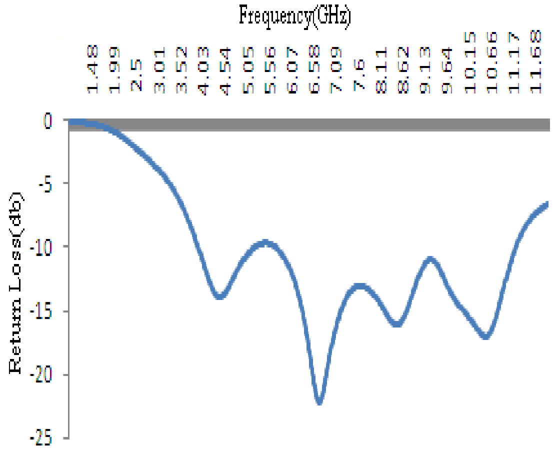

Figure 4: Return loss of proposed antenna without slot

Fig. 5 shows the parametric study of the proposed antenna. It shows the comparison graph of return losses when there was no cut at the centre of slot; when the length of ground plane is decreased. The slot is cut from centre to enhance the impedance bandwidth as without cut, there was no impedance bandwidth in working bands from 4.2 to 5.9 GHz. By decreasing the length of ground, impedance bandwidth decreases.

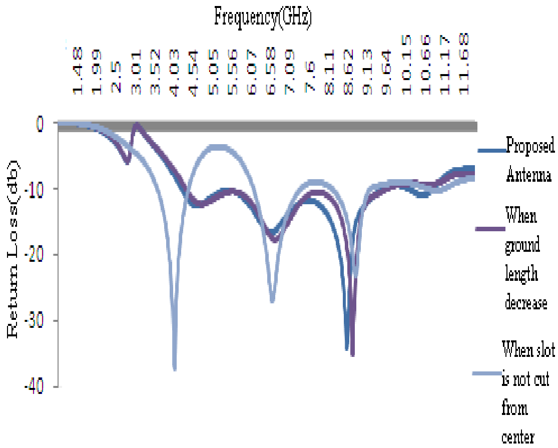

Figure 5: Comparison graph of return loss of (a) Proposed Antenna (b) Antenna when ground length decreased (c) Antenna when no cut was there in a slot

Fig. 6 represents the gain versus frequency curve of the proposed UWB antenna**.** The gain versus frequency curve shows that it has maximum gain at the desired resonant frequency. For the working band 4.2 GHz to 10.8 GHz, the maximum gain is 5 dBi. As a result, the gain of proposed

International Journal of Engineering Research (ISSN:2319-6890)(online),2347-5013(print)
Volume No.3, Issue No.2, pp : 66-69 01 Feb. 2014

antenna satisfies the requirement of ultra-wide band applications.

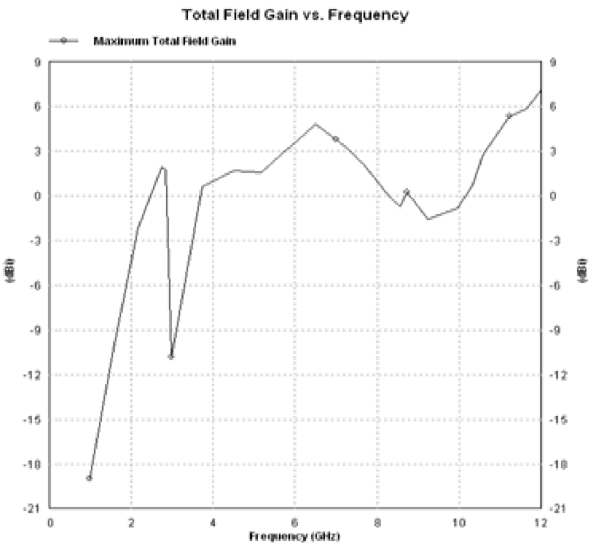

Figure 6: Gain of proposed Antenna

In Fig. 7 and 8, simulated 2D radiation pattern for elevation and azimuthal plane at 1 GHz is shown and Fig. 9 and 10, shows 2D radiation pattern for elevation and azimuthal plane at 8.7 GHz. Fig. 11 and 12, shows 3D radiation pattern. E-plane pattern at 90 degree in figure 7 and 9, presents a figure of eight like structure which satisfies the condition of radiation pattern of a UWB antenna. . Similarly H-plane pattern for 0 degree forms an omni -directional pattern is shown in Figure 8. Radiation pattern presents the graphical representation of radiation properties of antenna as a function of space co-ordinates. These patterns are desirable for UWB applications.

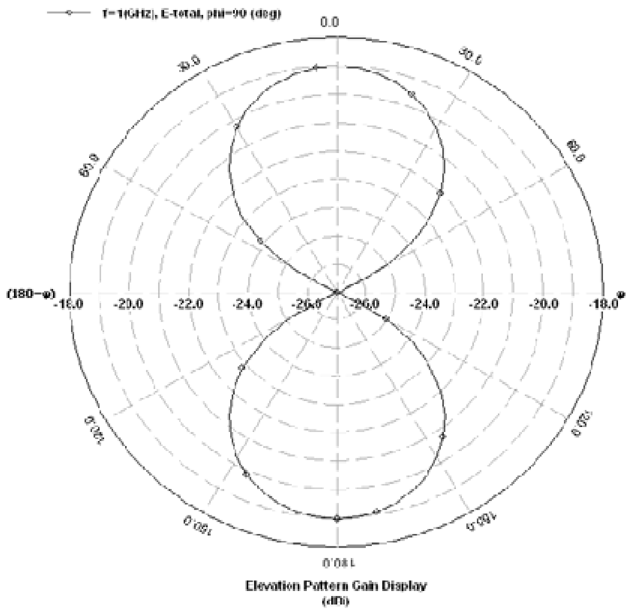

Figure 7: Elevation radiation pattern at 90^0at 1GHz

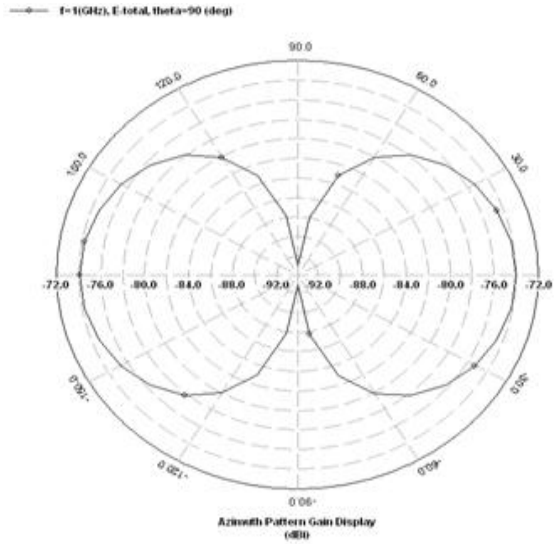

Figure 8: Azimuthal radiation pattern at 0^o

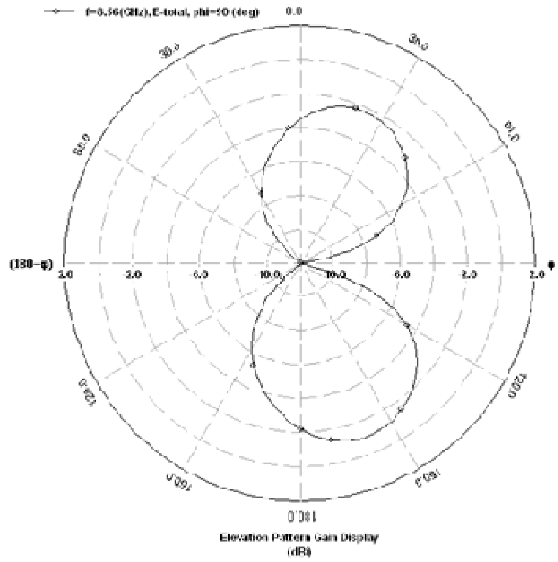

Figure 9: Elevation radiation pattern at 90^0 at 8.7 GHz

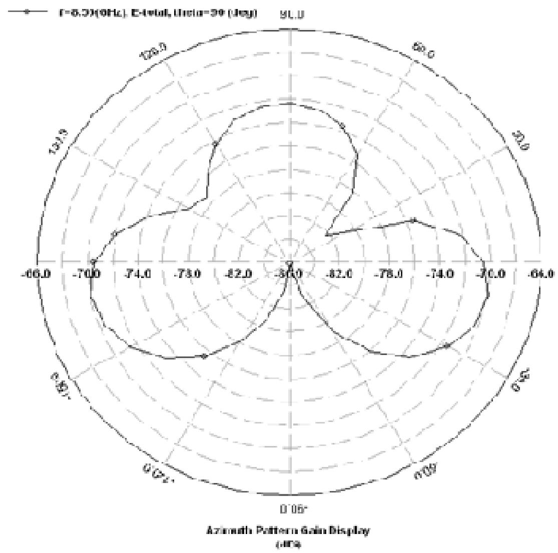

Figure 10: Azimuthal radiation pattern at 0^o at 8.7 GHz

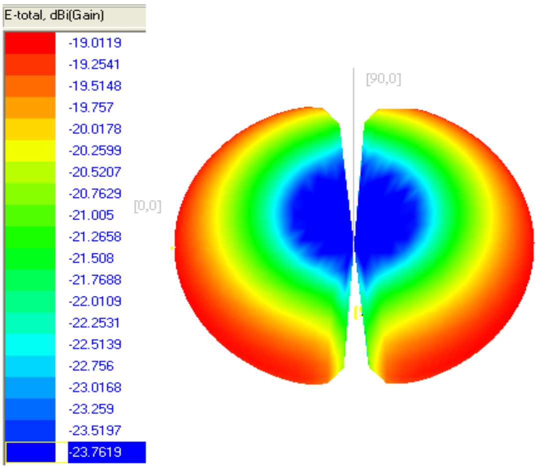

Figure 11: 3D pattern at 1 GHz

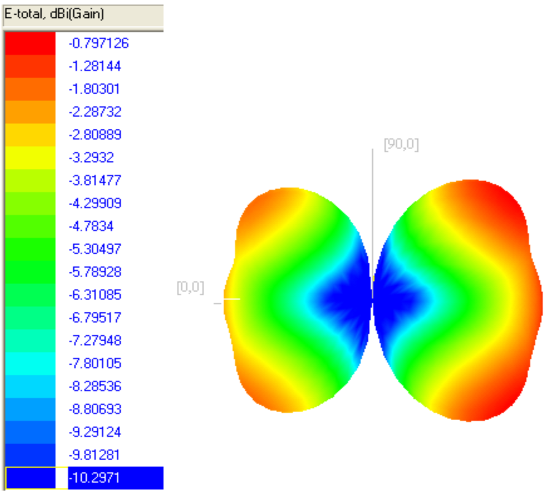

Figure 12: 3D radiation pattern at 8.7 GHz

The formation of the lower and upper resonant frequency resonance can be explained by observing the surface currents on the conductors of the antenna at 1 GHz. As shown in fig. 13 , the maximum current is present at the top of patch and in between slot. The value of maximum current is 11.2 amperes.

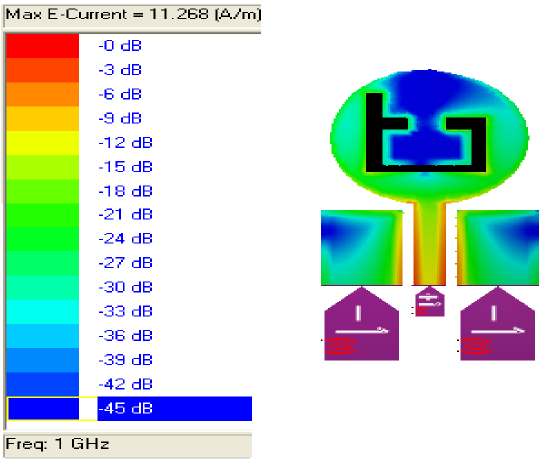

Figure13: Current distribution of proposed antenna

Figure 14 shows the efficiency curve of proposed UWB antenna. Proposed antenna has maximum efficiency of 77%.

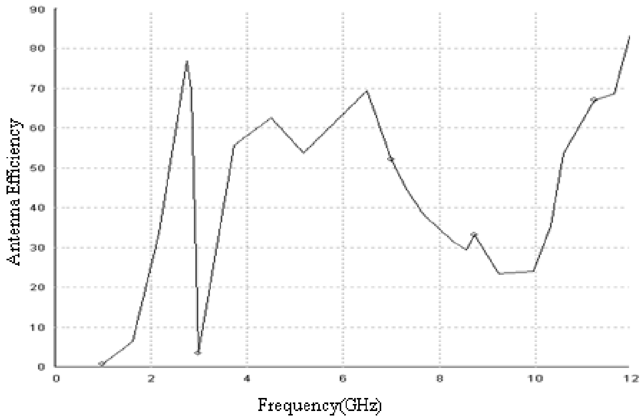

Figure 14 Simulated Efficiency versus Frequency

IV. Conclusion

A circular antenna suitable for UWB applications is proposed. Effects of varying dimensions of key structure parameters on the antenna and various parameters like length of ground, dimensions of slot and their performance are also studied. Moreover, the proposed antenna has several advantages, such as small size, excellent radiation patterns, and higher gains and good efficiency. These characteristics are very attractive for some wireless communication systems for a variety of applications. This antenna covers frequency band from 4.2 to 10.8 GHz.

References:

i. *W. Zhou, Y. S. Li and C. Y. Liu, "Research on a CPW- Fed Ultra-Wideband Antenna," Microwaves, Vol. 26, No. 8, 2010, pp. 234-237.*

ii. *Y. J. Ren and K. Chang, "An Annual Ring Antenna for UWB Communications," IEEE Antennas Wireless Pro- pagation Letters, Vol. 5, No. 1, 2006, pp. 274-276.*

iii. *C. Zhou, H. L. Cao and L. S. Yang, "An Improved Cop- lanar Waveguide-Fed Ultra-Wideband Antenna Design," Chongqing University of Posts and Telecommunications (Natural Science), Vol. 20, No. 1, 2008, pp. 39-41.*

iv. *Y. Q. Wu, S. W. Hu, K. M. Liao, H. L. Zhou and M. Tang, "An Improved U-shaped Slot Ultra-Wideband Mic- rostrip Antenna," Electronic Components and Materials, Vol. 09, 2012, pp. 55-58.*

v. *X.Qing, Z.N.chen "CWB-fed UWB monopole –like slot antenna", IET Antenna Propagation Feb. 2008, pp 889-899.*

vi. *Z.Li, C-X, Zhang, "Design CPW-fed Aperture antenna for UWB Application", Progress in Electromagnetic Research Vol.2, 2008.*

vii. *G.M.Yang, R.H.Jin, G.B.Xiao, "UWB Antenna with Multi Resonator Split-Ring Loops" IEEE Trans. Antennas Propagation vol. 57, 2009, pp256-260.*

viii. *Shun-Yun Lin, "A Novel Compact Slot Antenna for Ultra Wideband Communication," IEEE International Symposium. PP.5123-5126.June 2007.*

ix. *T.A Denidni and M.A.Habib. "Broandband printed CPW-fed circular slot antenna," Electronics Letters, Vol.42, Feb 2006.*

x. *S.W.Qu, C.Ruan and B.Z.Wang, "Bandwidth enhancement of wide slot antenna fed by CPW and microstrip line," IEEE antennas and Wireless Propagation Letters. Vol.5. PP15-17,2006.*