A New Compact Planar ultra-wideband Microstrip Patch antenna

Pritam Singh Bakariya[1]
Department of Electronics Engineering
Indian school of mines, Dhanbad
Jharkhand- 826004, India
E-mail: [1]pritam.gs@gmail.com

Santanu Dwari[2]
Department of Electronics Engineering
Indian school of mines, Dhanbad
Jharkhand- 826004, India
E-mail: [2]santanu_dwari@rediffmail.com

Abstract- **In this paper, a compact ultra-wideband (UWB) printed monopole antenna is presented, which is suitable for wide-band communication access systems, is proposed. A special-shaped radiation patch is used in having a yagi-uda like shape-slot. It occupies a compact volume of 40 x 35 x 0.8 (1120 mm^3) including the ground plane. The 10 dB impedance bandwidth of the proposed antenna is from 2.81 GHz to 21.41GHz. The design and optimization has been carried out using the commercial software ANSYS HFSS version 14. The antenna has been designed on a FR-4 substrate having thickness 0.8 mm and dielectric constant 4.4. Good radiation patterns and gains within the operating band have been obtained.**

Keyword- ultra-wideband, printed, monopole antenna

I. INTRODUCTION

MONOPOLE antennas have been widely used in wireless ultra wideband (UWB) communication systems because of their simple structure, low costs, and omnidirectional radiation pattern. The ultrawideband (UWB) technology employs broadband antennas for communication, imaging, and radar applications. Due to its application in most of wireless communication system ultra-wideband (UWB) technology has gained a lot of popularity among researchers. As ultra-wideband (UWB) technology becomes the possible solution for short-range, low-power indoor data communication applications, it offers simultaneously high data rate communication and high accuracy positioning capabilities.

The outcome of previous years of development in wideband printed antennas has produced a variety of different designs. The various type of technique is used to get the wideband while maintaining the small size of antenna. A stepped-patch in combination with multiple resonating elements [1] can be used to achieve ultrawide bandwidth, more than 150%. An EBG structure [2] can be used to obtain a super ultrawideband using semicircular microstrip monopole antenna with circular modified ground plane. While, A super wideband Fractal microstrip antenna is presented in [3]. Several other antenna has been designed and reported to improve bandwidth of microstrip patch antenna which include different regular shape of metal plate such as circular [4], elliptical [5, 6], trapezoidal [7]. An another technique has been used in [8], in which a 2x2 Microstrip patch array has been used to achieve ultrawide bandwidth using Electromagnetic Band-Gap Structure (EBG).

The commercial and military telecommunication systems require ultrawideband antennas. The small physical size and ultra-wide capability are very important in the design of ultrawideband antennas. A printed ultrawide band monopole antenna with smaller size is presented in this paper. The bandwidth of the antenna presented in this paper is from 2.81 to 21.41 GHz for return loss S_{11} less than -10 dB, which has too far wide bandwidth than earlier antennas. It also displays desirable characteristics such as compact size, low cost, and good radiation pattern like omnidirectional and dipole like pattern in both E-plane and H-plane respectively having low cross polarization less than -30 dB. This antenna has very good radiation efficiency over entire impedance bandwidth.

The detailed design and simulated results are discussed in this article. In section 2 the design of antenna and its dimension has been disused. The different parameter like return loss, radiation pattern, co-pol and cross polarization, and antenna efficiency are discussed in section 3. In section 4 conclusions have been drawn. This antenna would be very beneficial for UWB wireless communications in the future.

II. ANTENNA GEOMETRY

The geometry of proposed antenna is depicted in figure.1. The optimization was performed using the commercial software Ansoft HFSS version 14. The design of proposed antenna was optimized taking several aspects into consideration of ultra-wide bandwidth of the antenna. The antenna has a compact volume of 40 x 35 x 0.8 (1120 mm^3) and it is designed on FR-4 substrate with a dielectric constant of 4.4 and loss tangent of 0.02. The thickness of substrate (T) taken here is 0.8 mm. It is composed of a 50-microstrip feed line having length L_S = 12.85 mm and microstrip width W_S = 1.529 mm, a rectangular

978-0-7695-4941-5/13 $26.00 © 2013 IEEE
DOI 10.1109/ACCT.2013.36

radiation patch having L_1= 15 mm and width W = 30 mm, with a partially circular edge in feed side having circular radius R = 14 mm and a moderately adjusted ground plane having length L_g=12.85. A yagi-uda shape like-slot has been introduced on upper patch of antenna to enhance wideband of proposed antenna. All dimension of designed antenna are shown in Table 1.

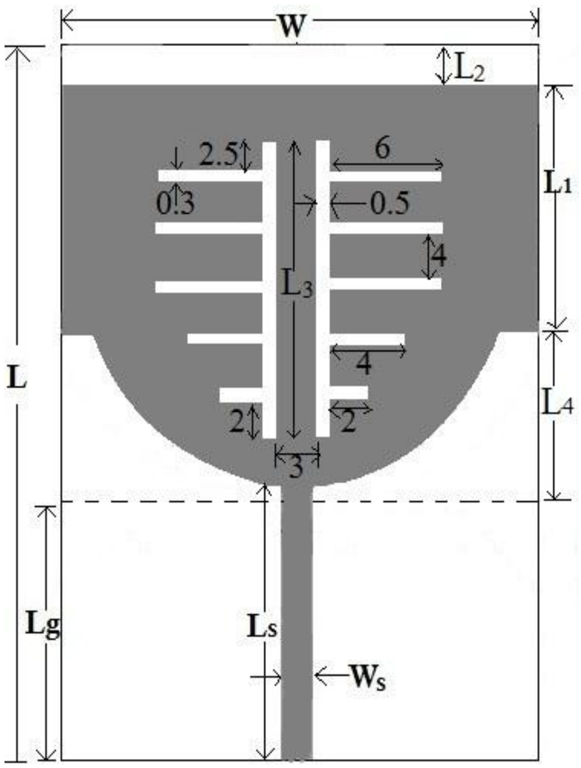

Fig.1- Geometry of proposed

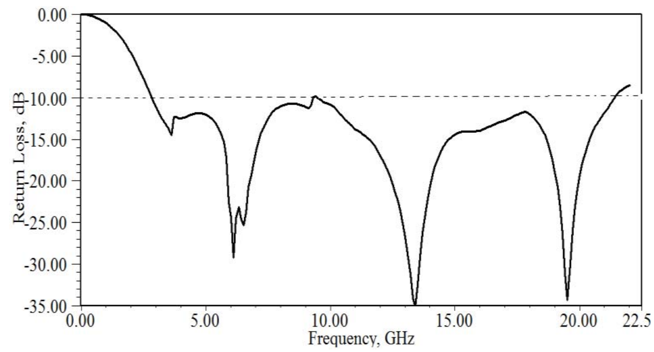

Fig.2- Simulated return losses against frequency

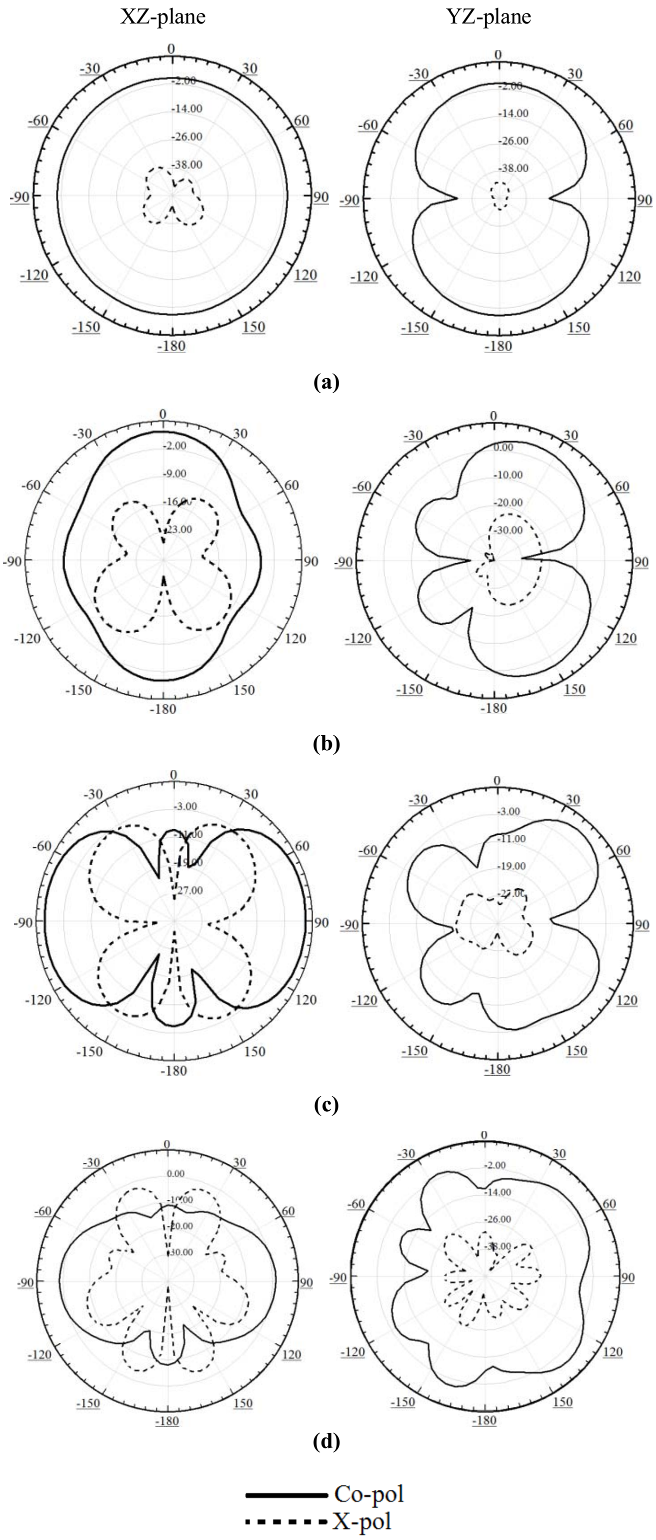

Fig.3 Radiation pattern at different frequency. (a) 3 GHz (b) 7 GHz (c) 10 GHz (d) 15 GHz

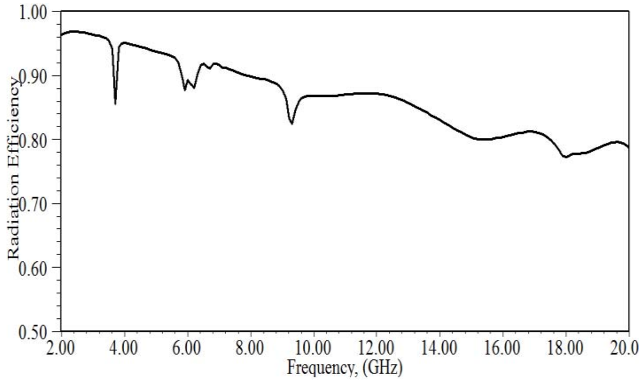

Fig-4 Radiation Efficiency of proposed antenna

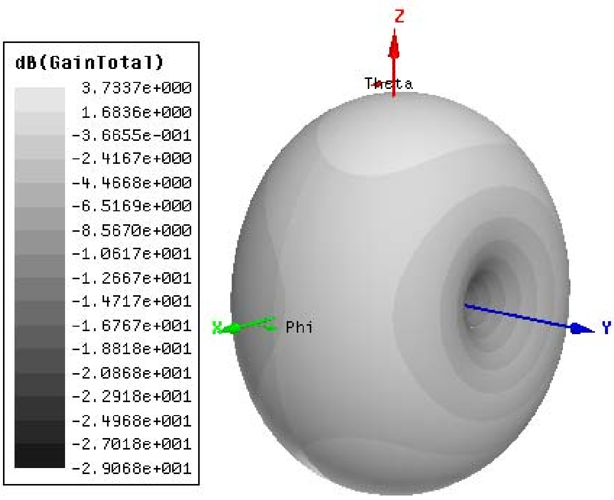

Fig.5-3D plot of Radiation Pattern at 4.5 GHz

III. RESULTS AND DISCUSSION

The impedance bandwidth and radiation behavior of the proposed antenna are examined using the commercial software high-frequency structure simulation (HFSS). Fig. 2 shows the simulated return loss against frequency for the designed UWB antenna. The resulted impedance bandwidth shows a very wide band in between 2.81 to 21.41 GHz.

The far-field radiation patterns of proposed monopole antenna at different frequencies 3 GHz, 7 GHZ, 10 GHZ, and 15 GHz respectively are shown in fig. 3. The results include co-polarization and cross polarization in the E-plane and the H-plane. From the result it is seen that this antenna has the nearly omnidirectional radiation characteristics. The cross polarization of simulated result is less than -30 dB for lower frequency and the cross-polarization level rises with frequency increase. The antenna has good radiation efficiency throughout the whole 2.81-21.41 GHz band which is shown in fig. 4.The 3D plot of radiation pattern is shown in fig. 5 at 4.5 GHz. The antenna has a good gain response over entire band of frequency with an average gain 3.73 dBi.

IV. CONCLUSION

A simple and compact super ultra-wideband micro strip-fed printed monopole antenna is presented which will be very useful for ultra-wideband wireless technology. The antenna has a very wide impedance bandwidth ranging from 2.81–21.41 GHz for S_{11} less than -10 dB, which is too far wider than earlier antennas. This antenna occupies compact volume of 1120 mm^3. The results show that the antenna not only has a ultra-wide bandwidth but it also has good radiation efficiency. The antenna gives good far-field radiation characteristics in both E-plane and H-plane across the whole band with an average gain of 3.73 dBi which makes the proposed antenna suitable for ultra-wideband application.

REFERENCES

[1] K. Rambabu, H. A. Thiart, et. al. “Ultrawideband Printed-Circuit Antenna,” IEEE Transactions On Antennas And Propagation, Vol. 54, NO. 12, December 2006

[2] D. N. Elsheakh, H. A. Elsadek, et. al. “Enhancement of Microstrip Monopole Antenna Bandwidth by Using EBG Structures,” IEEE Antennas and Wireless Propagation Letters, Vol. 8, 2009

[3] Abolfazl Azari, “A New Super Wideband Fractal Microstrip Antenna,” IEEE Transactions on Antennas and Propagation, Vol. 59, NO. 5, may 2011

[4] J. Sosa-Pedroza, E. Gardu~no-Nolasco, et. al., “Design and Construction of UWB Antennas,” PIERS Proceedings, Suzhou, China, September 12-16, 2011

[5] Ntsanderh C. Azenui and H. Y. D. Yang, “A Printed Crescent Patch Antenna for Ultrawideband Applications”, IEEE Antennas And Wireless Propagation Letters, Vol. 6, 2007.

[6] Nikolay Telzhensky and Yehuda Leviatan, “Planar Differential Elliptical UWB Antenna Optimization,” IEEE Transactions on Antennas and Propagation, vol. 54, NO. 11, november 2006

[7] X.-S. Yang and J.-H. Dou, “Planar Multi-Trapezoidal Ultra-Widebandantenna And Its Parametric Analysis,” Progress In Electromagnetics Research Letters, Vol. 12, 49{58, 2009

[8] Dalia Nashaat, Hala A. Elsade, et.al., “Ultrawide Bandwidth 2x2 Microstrip Patch Array Antenna Using Electromagnetic Band-Gap Structure (EBG),” IEEE Transactions on Antennas and Propagation, Vol. 59, NO. 5, May 2011

Table-1. Antenna Dimension

L (mm)	W (mm)	L_1 (mm)	L_2 (mm)	L_3 (mm)	L_4 (mm)	L_g (mm)	W_S (mm)	L_S (mm)	sub	T (mm)	ε_r	tanδ
40	30	15	2.5	21	9.7	12.8	1.529	12.85	FR4	0.87	4.4	0.02