Novel Monopole Antenna for UWB Application

[1]Mr.K.G.Jamkhande[1].Mrs.P.P.Belagli[2]
1Assistant Professor, Electronics and Telecommunication dept.SBGI Miraj.(MH)India
2Associate Professor, Electronics dept. JJM COE Jaysingpur.(MH)India

Abstract

The ultra wideband (UWB) system, one of the core wireless communication technologies has experienced rapid growth in recent years. In ultra wideband systems, the UWB antenna is one of the key components. The capability of antenna size reduction and highly precise performance including enhancement of the band-rejection characteristics, in WLAN-operating bands, have increased the demand for UWB system for commercial and defense applications manifold .The proposed antenna consists of a square radiating patch with two rectangular slots and a ground plane with inverted T-shaped notch, which provides a wide usable fractional bandwidth of 3.12-10.6GHz. The proposed antenna is simple and small in size.

I. Introduction

RF and Microwave Technologies are rapidly finding their way into commercial applications. Industrial applications such as satellite data transfer, vehicle tracking and paging systems have been among the first to be developed. Other applications include mobile telephony, Radio Frequency Identification systems (RFIDs), Direct Broadcast Television (DBS), Wireless Local Area Networks (LANs) and Personal Communications Systems (PCS). The intelligent vehicle highway of the future will guide us through traffic jams and systems using Global Positioning System (GPS) will tell us about our location. From being a technology that had its utilization mainly in Telecommunications and Radar applications, it is today the forefront technology for a myriad of wireless applications.

Owing to the rapid development of modern communication and semiconductor technologies, a wide variety of wireless services have been successfully introduced worldwide in the past few years. Commercial ultrawideband (UWB) systems require small low-cost antennas with omnidirectional radiation patterns and large bandwidth. Such requirements can be fulfilled by monopole antenna which presents really appealing physical features such as simple structure, small size, and low cost. Hence planar monopoles are extremely attractive to be used in emerging UWB applications, and growing research activity is being focused on them.

In UWB communication systems, one of key issues is the design of a compact antenna while providing wideband characteristic over the whole operating band.

Two new small wideband planar monopole antennas with truncated ground plane using an L-shaped notch in the lower corner to achieve the maximum impedance bandwidth were proposed.

This paper focuses on a square monopole antenna, which combines the square-patch approach with a truncated ground plane and achieves a fractional bandwidth of 3.12-10.6GHz. In this paper, we investigate the effects of two rectangular slots for square patch and also insertion of a modified inverted T-shaped notch in the ground plane on the frequency bandwidth and impedance matching.

II. ANTENNA DESIGN

The novel square monopole antenna fed by a 50-Ohm microstrip line is shown in Fig. 1, which is printed on a FR4 substrate of thickness 1.6 mm, permittivity 4.4, and loss tangent 0.0018.The microstrip line width W_f is 2 mm for 50-Ohm impedance. The basic antenna structure consists of a square radiating patch, a feed line, and a ground plane. The square radiating patch has a width W. The patch is connected to a feed line of width W_f and length Lf, as shown in Fig. 1.

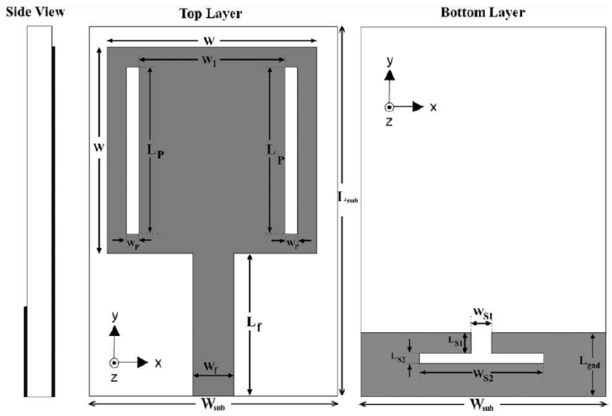

Fig.1. Geometry of proposed antenna with inverted T-shaped notch.

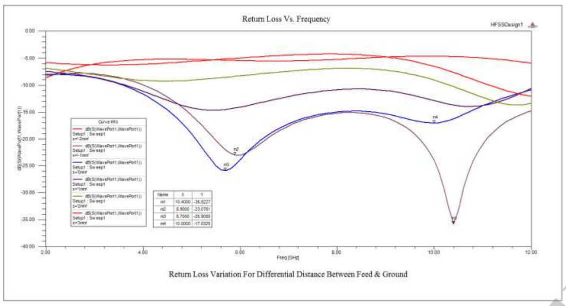

Fig.2. Return loss characteristic between feed & ground plane

On the other side of the substrate, a conducting ground plane of width Wsub and length Lsub is placed. The truncated ground plane plays an important role in the broadband characteristics of this antenna because it helps match the patch with the feed line in a wide range of frequencies. This is because the truncation creates a capacitive load that neutralizes the inductive nature of the patch to produce nearly pure resistive input impedance .The T-shaped notch is used to control the impedance bandwidth and return loss level by modifying the capacitance between the patch and the ground plane. To further enhance the matching, we use two rectangular slots in the antenna's patch. These slots are placed to create additional path for the surface current, which produce an additional resonance, and as a result, increase the bandwidth.

The optimal dimensions of the designed antenna are as follows:

Wsub=12mm, Lsub=18mm, W=10mm,Lf=7mm, W_f=2mm, W1=6mm, Lp=8mm, Wp=0.5mm, Ls1=1mm, Ws1=1mm, Ls2=.5mm, Ws2=6mm and Lgnd=3.5mm.

III.RESULTS AND DISCUSSIONS

In this section, as per above mentioned parameters the planar monopole antenna is constructed, and the analytical results observed of the input impedance and radiation characteristics are presented and elaborated in brief . Here behavior of the parameters is studied by changing one parameter at a time and keeping all other parameter constant. The simulated results are obtained using the Ansoft simulation software high-frequency structure simulator (HFSS).

Initially, the behavior of feed gap distance over impedance bandwidth is studied by varying it. From the simulation it is observed that as separation distance d changes impedance bandwidth is effectively improved at upper frequency. It is also observed that increasing the feed gap distance causes reduction in the impedance bandwidth at lower frequency. The observed behavior feed gap variation is shown in fig 2. Thus, the electromagnetic coupling between the lower edge of the square patch and the ground plane can be properly controlled. The optimized separation distance is chosen as 3.5 mm.

Fig.3 shows the return loss characteristics with inverted T-shaped notch in the ground of the novel monopole square antennas. As shown in Fig.3, it is seen that the upper and lower frequency bandwidth is sensitive to the inverted T-shaped notch on the ground plane & lower frequency bandwidth is affected by using the rectangular T-shaped notch in the ground plane. With the above fig.3 we observe that we get a notch exactly at 6.4GHz.

Fig.4 shows the structure of various square antennas. Fig.5 shows the current distribution of various antennas at 11.2GHz. It is observed that with plain ground the distributed is minimum of fig.4.a.and by inserting a

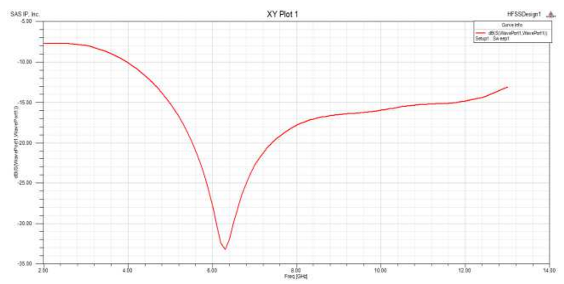

Fig. 3. Return loss characteristic with inverted T-shaped slot with plane ground

rectangular notch in the ground plane the current distribution increases of fig 4.b and by inserting inverted T-shaped notch in the ground plane the current distribution is maximum of fig.4.c. The above simulated results of simulation is shown in fig.5.

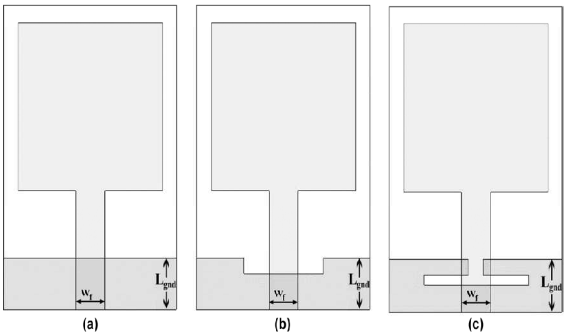

Fig. 4. (a) The ordinary square antenna. (b) The antenna with rectangu-lar notch in the ground plane. (c) The antenna with inverted T-shaped notch in the ground plane.

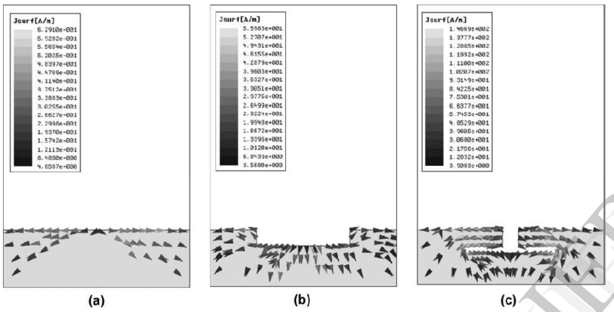

Fig. 5. Simulated surface current distributions on the ground plane for the antennas shown in Fig. 4 at 11.2 GHz.

Now let us see the simulated current distribution of the proposed antenna at 5GHz & 10 GHz is shown in fig.6a &6b. The red part in the fig.5 indicates radiation. At 5Ghz we get radiation at lower part of the proposed antenna with the edges of the patch & the current distribution at 10GHz we get maximum radiation as the red part is maximum as compared to 5GHz. Thus we can say that maximum radiation is obtained at higher frequency.

Fig.7 shows the simulated return loss characteristics with front slot with ground plane. By varying the position of the slot we get different return loss characteristics .when the distance between two front strip is 4mm we get good result that is we get return loss less than -10 db and we get two notches at 5.8 and 10.5 GHz. The simulated return loss characteristics for different values of Ls_1 with Ws_1 fixed at 6mm are shown in fig 8.a. It is observed that lower frequency is insensitive to Ls_1 and upper frequency is affected by variation in notch length Ls_1. It is seen that variation in the size of lower notch lengths Ls_1 causes effective change in the impedance matching.

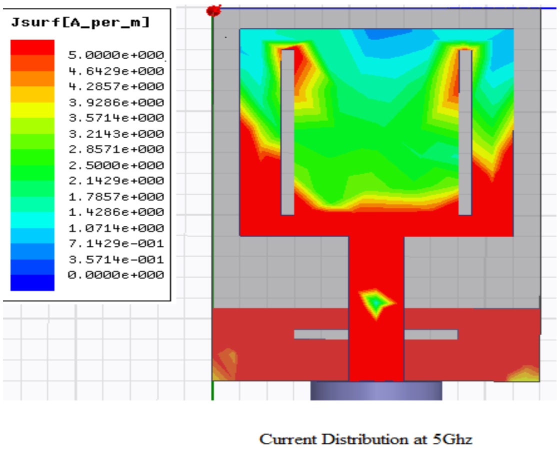

Fig.6a Current distribution of the proposed antenna at 5GHz

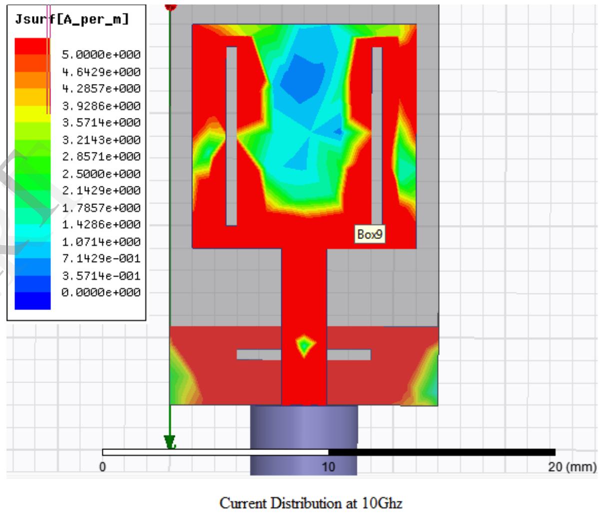

Fig.6b Current distribution of the proposed antenna at 10GHz

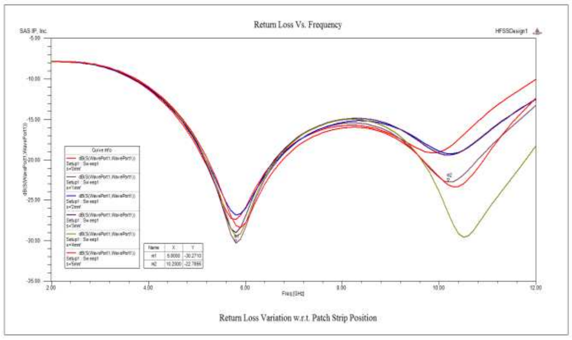

Fig.7. Return loss characteristic with front slot with plane ground

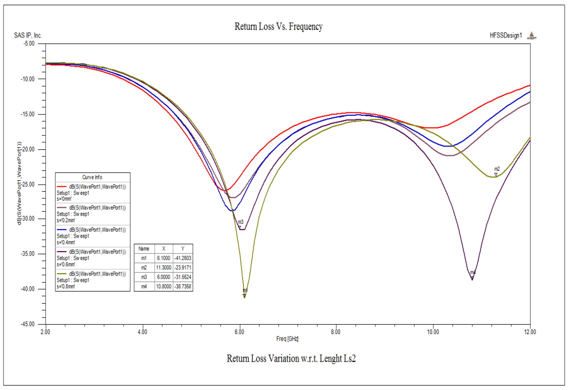

Fig.8 (a) Simulated return loss characteristics of the proposed antenna with different values of Ls2 (Ws2 is fixed at 6 mm)

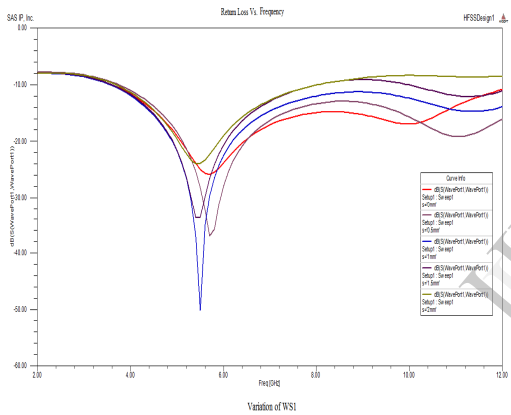

Fig.8b Simulated return loss characteristics of the proposed antenna with different values of Ws1 (Ls1_ is fixed at 1 mm).

The simulation result shows in fig.8b return loss curve with L_{s1} over various notch widths W_{s1}. As the notch width simulation results are observed with optimal 1mm, the lower frequency is slightly lowered and upper frequency is markedly increases.

Fig.8 shows the return loss characteristics of the proposed antenna which satisfies the 10-dB return loss requirement from 3.12 to 10.63 GHz.

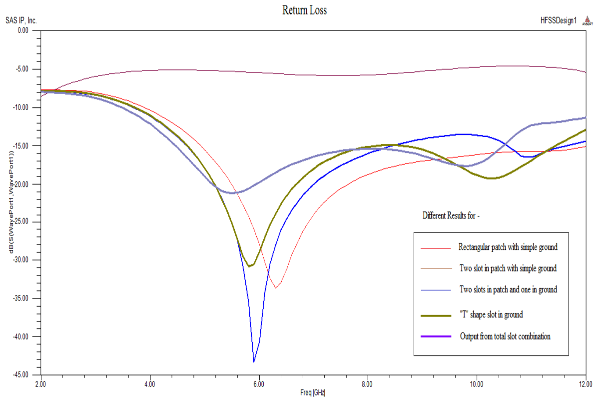

Fig.8 All the return characteristics of the proposed antenna

VI. CONCLUSION

A novel, compact printed monopole antenna has been proposed for UWB applications. The fabricated antenna satisfies the 10-dB return loss requirement from 3.12 to 10.63 GHz. The feed-gap distance, the sizes of T-shaped notch, and the sizes of two rectangular slots in the antenna's patch to obtain the wide bandwidth have been optimized by parametric analysis.

V.List of References:

[1]Hans Gregory Schantz, “A Brief History of UWB” Antennas Proceedings of the 2003, IEEE UWBST Conference, 2003.

[2]Seok H. Choi, Jong K. Park, Sun K. Kim and Jae Y. Park,” A New UWB Antenna For UWB Applications”, Microwave and Optical Technology Letters, Vol. 40, No. 5, March 5 2004.

[3]D. D. Sandu, O. G. Avadanei, A. Ioachima, D. Ionesi, ”Contribution to the cavity model for analysis of microstrip patch antennas”, Journal Of Optoelectronics And Advanced Material, Vol. 8, No.1, February 2006 , p. 339 – 344.

[4]Sarah Kitchen, “Fractal Geometry”, Nov.19, 2008. Yale University, China.

[5] Anupam Tiwari and Raj Kumar, “On the Design of CPW-fed Appollian Gasket Fractal Antenna”, Progress In Electromagnetics Research Symposiu Proceedings, Moscow, Russia, August 18{21, 2009.}

[6]Ikbal Zammouri and Bechir Ayeb, “Fractal Shapes Description with Parametric L-systems and Turtle Algebra”, World Academy Of Scienc Engineering and Technology 34,2007.

[7]Z. H. Qian and R. S. Chen, K. W. Leung, H. W. Yang, “FDTD Analysis Of Microstrip Patch Antenna Covered By Plasma Sheath”, Progress In Electromagnetics Research, PIER 52, 173–183, 2005.

[8]Bharat Bhushan Agrawal, Vibha Rani Gupta, ”Improvement of Impedance Matching of a Rectangular Printed Monopole Antenna”, Microwave Review, September 2008.

[9]Yashar Zehforoosh, Dr. Changiz Ghobadi, Dr. Javad Nourinia, “A Novel Multilayer Microstrip Antenna for Ultra Wideband Applications”, Proceedings of the 5th WSEAS International Conference on Tlecomemunications and Informatics, Istanbul, Turkey, May 27-29, 2006 (pp239-242).

[10] S. Maci and P. Piazzesi, “Dual-band slot-loaded patch antenna,” Proc. Antenna Propag., vol. 142, no. 3, pp. 225–232, Jun. 1995.

[11] Ansoft High Frequency Structure Simulation (HFSS). ver. 11, Ansoft Corp., 2005.

[12] J. P. Lee, S. O. Park, and S. K. Lee, “Bow-tie wideband monopole antenna with the novel impedance-matching technique,” Microw. Opt.