International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 6, June - 2014

Design and Analysis of Microstrip Monopole UWB Antenna

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***Abstract*— The purpose of this work is to design, simulate and fabricate a microstrip patch antenna capable of operating in the 4.15 GHz to 10.07 GHz bandwidth. This bandwidth is synonymous with the Ultra Wideband (UWB) bandwidth. The basic requirement of this antenna is that it should exhibit a return loss of less than 10 dB in the operating frequency range. The rectangular patch antenna is designed on dielectric substrate and fed with 50 Ω microstrip by optimizing the width of partial ground, the width of the feed line to operate in UWB. This antenna consists of a radiating element with a strip, and a partial ground plane and feeding line has been demonstrated. The antenna design is simulated on CAD FEKO simulation software .The proposed antenna has a compact structure . The circuit model had been simulated in CAD FEKO simulator .**

Index Terms – UWB, Patch antenna ,monopole ,microstrip.

I. INTRODUCTION

Ultrawideband (UWB) technology has gained a lot of popularity among researchers and wireless industry after the FCC permitted its marketing within the frequency band of 3.1 GHz to 10.6 GHz [1]. The attractiveness of UWB is in its capability of offering high capacity short-range wireless communication links using low-cost low-energy transceivers. To establish the communication between two nodes, these transceivers require UWB antennas, preferably of small size and low manufacturing cost. Planar monopole antennas of various shapes and feeding structures (coaxial, micrsotrip and coplanar waveguide type) have been found as good candidates to fulfill this requirement.[1]

In recent years, microstrip ultrawideband (UWB) antennas have attracted much attention owing to their advantages such as simple structure, low profile, high data rate, easy integration with monolithic microwave integrated circuits (MMICs), and ease of fabrication. Despite all these advantages, the narrow impedance bandwidth (BW) is one of the main challenges of microstrip antenna design. In recent years, various techniques have been presented to overcome the narrow impedance BW of these antennas. Some of the bandwidth enhancement techniques that are used to design planar antennas have been stated as below: Etching polygon-like slot antennas [2-8], modified elliptical antennas [4], using a fork-like tuning stub [5], and parasitic elements [11]. On the other hand, the frequency range for UWB systems between 3.1–10.6 GHz will cause interference to the existing wireless communication systems, such as WiMAX (3.3–3.7 GHz) and 5150–5350/5725–5825 MHz (specified by IEEE 802.11a) bands. Therefore, design of UWB antennas with multiband filtering functions to avoid potential interference with these frequency bands is necessary. For this purpose, different techniques with single, dual, and multiple notch functions have been recently reported [2]–[11].

In this project, the commercially available CAD FEKO simulation tool is used. This tool is capable of generating radiation patterns of the electric field (E – field) and magnetic field (H – field) for selected frequencies as well as plotting return loss values for the S(1,1) port parameters in the desired operating frequency range. In addition, current flow patterns would also be simulated. The design that exhibits the optimum return loss and radiation pattern will be fabricated and tested .

This project is to design, simulate, fabricate and verify the simulation results of a microstrip patch antenna for UWB use. The rectangular patch would be the basic design for the microstrip patch antenna.

II. ANTENNA CONFIGURATION

The configuration of the planar UWB antenna is illustrated in fig.1and 2. The radiating structure is in the form of rectangle. The ground plane located at the reverse side of the substrate is also in the shape of rectangle. The antenna is fed using a microstrip line whose width is calculated using the well-known microstrip line design equations.

The proposed design of UWB antenna is simple and compact. Fig. 1 and fig.2 illustrated the configuration of the basic antenna, which consists of a rectangular patch with a partial ground plane, and a feed-line. The antenna structure was designed on FR-4 substrate having dielectric constant of 4.4 and thickness of 1.6 mm. The design was simulated using CAD-FEKO Simulation software. The substrate dimension is 25×25mm^2. The design antenna has the following optimized parameters: Wp=14.74 mm, Lp=10.11 mm, Ws=24.32 mm, Ls=19.71 mm, Wf=3 mm, Lf=11.53 mm and h=1.6 mm.

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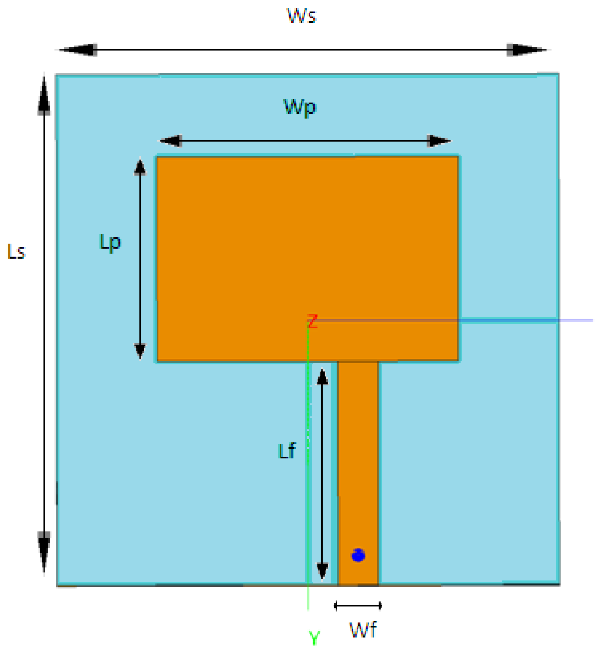


Fig.1 Basic antenna Configuration front view

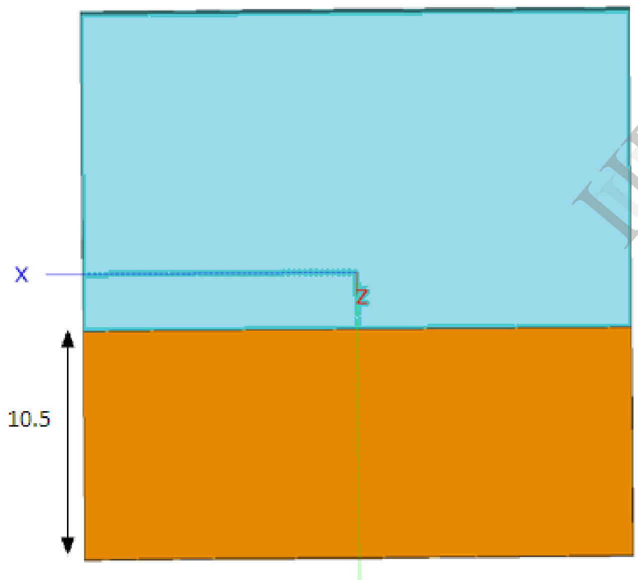


Fig.2 Basic antenna configuration back view

The antenna is fed using a 50Ω microstrip line whose width is calculated using the well-known microstrip line design equations. The rectangular radiating patch antenna with steps, a partial ground plane, feed line parameters was optimized to get desired response. Therefore, the geometric parameters of the proposed structure can be adjusted to tune the return loss and bandwidth over wide range of frequency. This design is designed at lower frequency i.e. at 3.1 GHz frequency to optimise whole UWB range 3.1 to 10.6 GHz.

The gap between the bottom plane and diverging patch is additionally optimized because it acts as an identical network and improves electrical resistance information measure in 2 bands. Additionally, ground plane dimensions also are optimized to attain the required twin band operation because it affects the resonant frequencies and in operation bandwidths in 2 bands. the present distribution on the patch affects the electrical resistance characteristics of the antenna. By cutting the 2 notches of appropriate dimensions at the 2 lower corners of the patch, electrical resistance information measure gets increased as shown in figure3 and 4. This development happens as a result of the 2 notches have an effect on the magnetism coupling between the oblong patch and therefore the ground plane. The patch and therefore the ground plane type a similar dipole. the bottom plane is beveled, leading to a swish transition from one resonant mode to a different and making certain smart electrical resistance match and stable gain over a broad frequency vary. The projected antenna are able to do high gain at low and high frequency with bevel on the bottom plane.

So , for enhancement of bandwidth two slots are cut at the patch and in the third design the patch is cut at the edges and ground is beveled as shown in below fig.5 and 6.

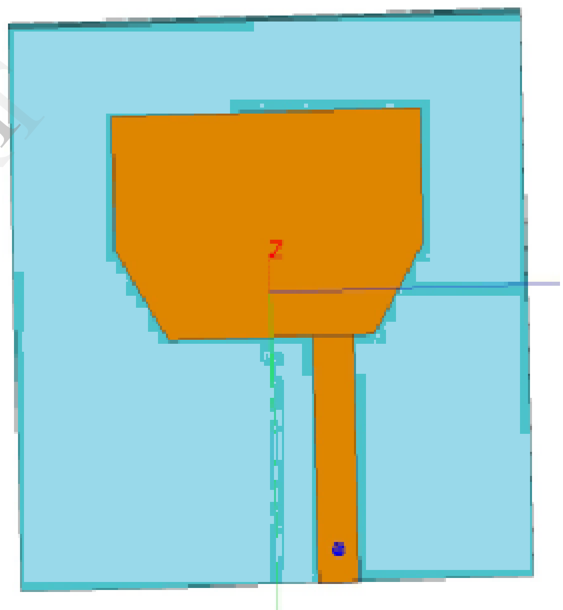


Fig.3 Antenna configuration by cutting two lower corners front view.

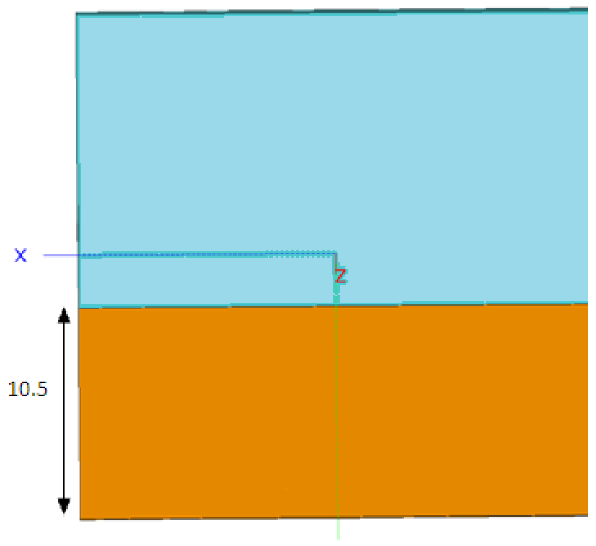


Fig.4 Antenna configuration by cutting two lower corners back view.

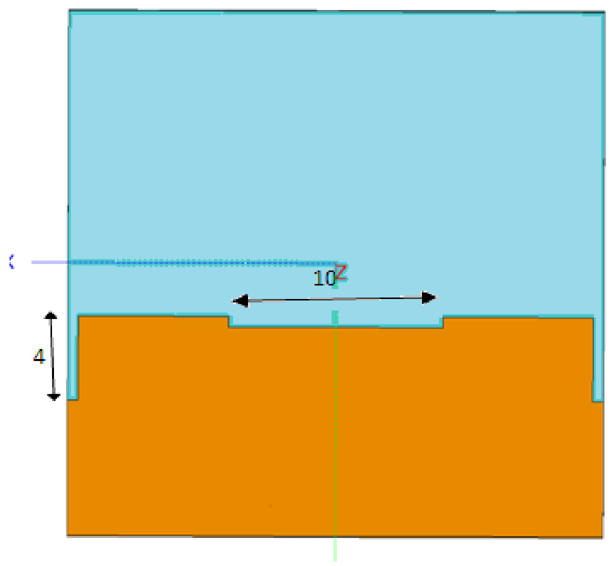


Fig.6 Antenna Configuration back view

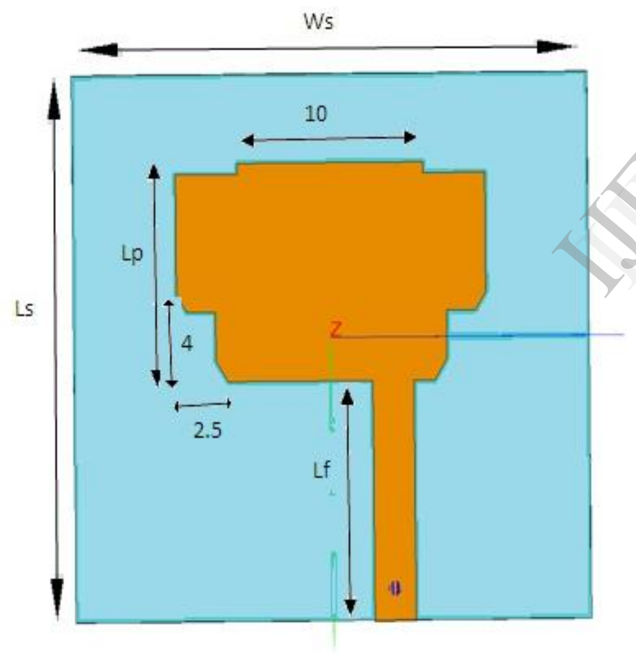


Fig5. Antenna Configuration front view

III. PARAMETRIC STUDY AND DISCUSSION

The proposed antenna is optimized by using CAD-FEKO simulator software. A planar antenna was designed and the return loss was measured. Fig. 7 shows the simulated results for return loss of this antenna and Fig.8 shows simulated result for VSWR. The operating band of any antenna is described by return loss less than -10 dB or VSWR less than 2.The overall goal of the proposed antenna design is to achieve good performance in the return loss i.e. reflection coefficient in dB below -10dB and VSWR< 2. Suitable antenna geometry is needed for this reason. The proposed UWB antenna shows the simulated operating frequency band 3.1-10.6 GHz. The measured impedance bandwidth with 10 dB return loss for the proposed antenna is from 4.15-10.07 GHz.

The first design concerns a UWB antenna without any slots on patch and plane ground(Basic geometry). The design parameters are shown in fig.7 and 8.

The next design concerns a UWB antenna with a two slots at the edges of the patch having dimensions 4mm x 2.5mm and plane ground to enhance the bandwidth of antenna(Modified geometry(A)) fig.3 and 4.

The third design concerns a UWB antenna with slots at the edges of the patch and beveled ground as shown in fig. 5 and 6 (Modified geometry(B)). And in this design the bandwidth is increased compared to other two designs as shown in fig.7 and 8.

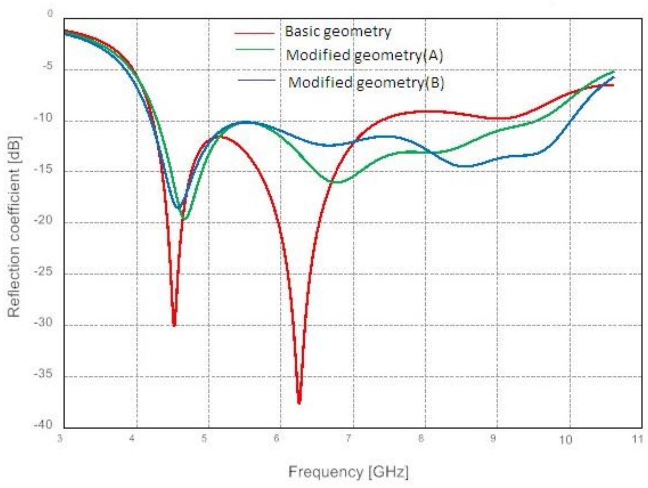


Fig.7 Simulated reflection coefficient vs frequency for given antenna

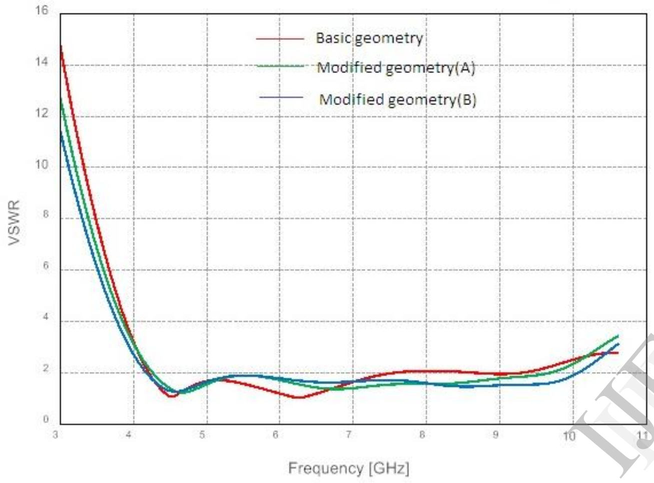


Fig.8 Simulated VSWR vs. frequency for proposed antenna

Fig.9 shows the simulated normalised far field radiation patterns in the H and E-planes at sampling frequencies 5.5 GHz and 8 GHz. It is found that the antenna has nearly good omnidirectional radiation patterns in the H-plane and dipole like radiation patterns in the E-plane.

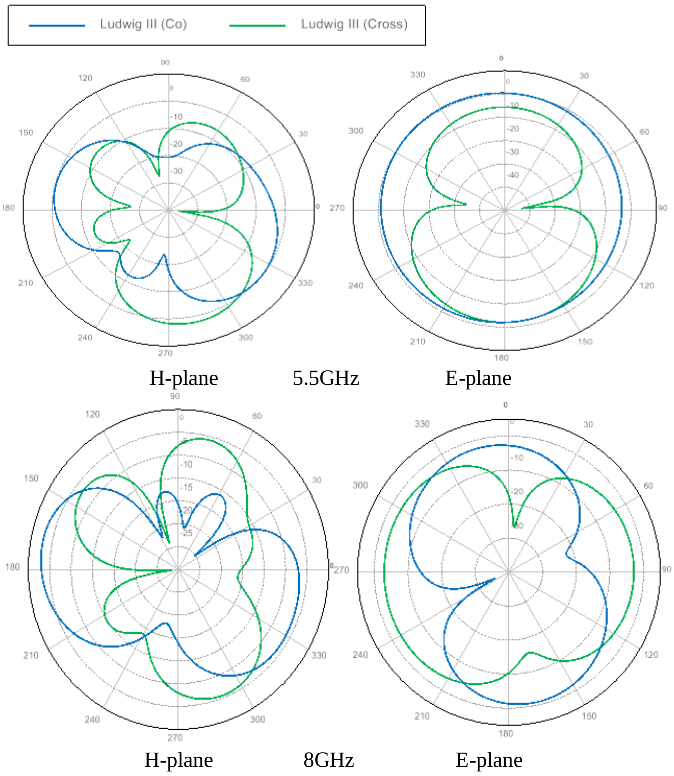
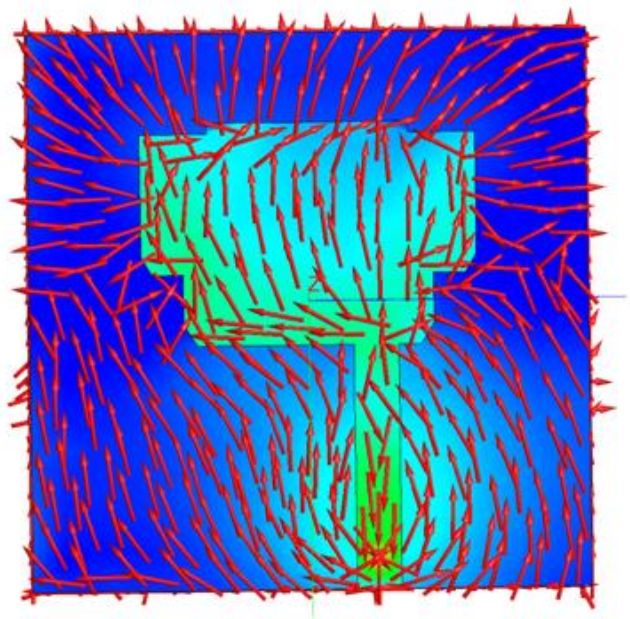
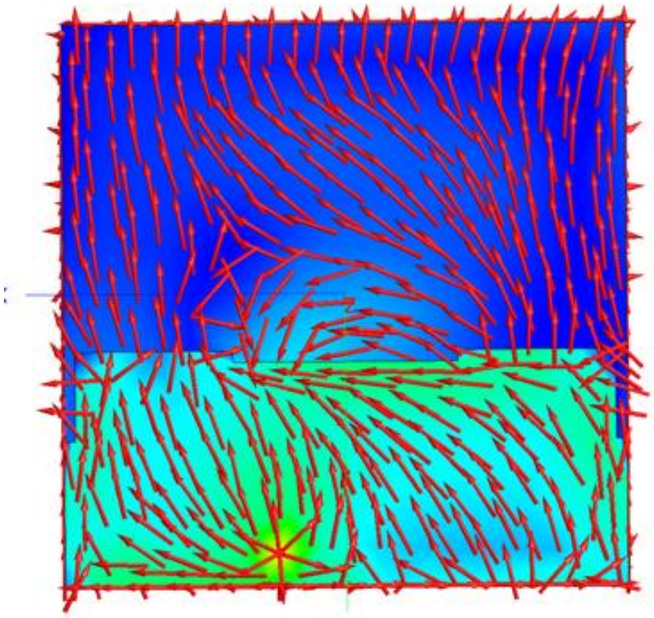


Fig.9 Simulated H-plane and E-plane radiation patterns of the given antenna configuration

In fig.10 current distribution is shown which is used to analyze the optimization in the radiating patch.



(a)



(b)
Fig.10 Surface Current Distribution

IV. CONCLUSION

This paper proposed a simple rectangular microstrip antenna design for UWB applications. The antenna is capable of achieving an input impedance bandwidth from 4.15 to 10.17 GHz. The simulated results of the proposed antenna satisfy the 10-dB return loss requirement for UWB as defined by the FCC. The proposed UWB antenna structure can be used in future UWB systems. It can tackle the frequency interference from WLAN and WIMAX. The antenna structure is a flat, and its design is a simple and straightforward geometrically small, hence embedded easily in wireless communication systems. In the future work the optimization of whole UWB i.e. 3.1 GHz to 10.6 GHZ and notch the Wimax frequency will be done.

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