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A Band Notched Monopole Antenna for UWB Applications

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ABSTRACT: This study presents a new design of a single band notched UWB antenna. The design is based on elliptical radiating patch, a microstrip feed line on the front, partial ground and an inverted U-shaped slot on the partial ground. The antenna has a structure with a compact size of 18x13mm^2. The antenna operates in UWB range except the rejected band from 4.85 GHz to 6 GHz. The presented return loss and radiation pattern results show that the antenna offers excellent performance with reduced interference having a simple design and compact size.

KEYWORDS: UWB, compact size, rejected band, reduced interference.

I.INTRODUCTION

A wireless communication technology that produces signals with bandwidth wider than 500 MHz is referred as the Ultra-wideband (UWB). It occupies the frequency band of 3.1 GHz to 10.6 GHz that has been approved by the Federal Communications Commission (FCC) 2002 [1].UWB antennas have become popular due to its high bandwidth range, high data rate, increase in the spectral efficiency, simple configuration, small size and low cost. A number of microstrip antennas have been designed to meet the UWB requirements. There are a set of interference frequency bands such as WiMAX (Worldwide Interoperability for Microwave Access),WLAN (Wireless Local Area Network) and ITU (International Telecommunication Union) having centre frequencies of 5.2 GHz, 5.8 GHz for WLAN; 3.5 GHz, 5.5 GHz bands for WiMAX and 8 GHz for ITU. To address this drawback, it is acceptable to design an antenna having single band stop characteristics to minimize potential interference [2]-[9].The proposed paper provides a compact size and low cost microstrip antenna that operates in the UWB range, 4 GHz to 12.2 GHz with a notch frequency from 4.85 GHz to 6 GHz. For impedance matching, an inverted U-shaped slot is introduced in the partial ground. The paper suggests a new structure of antenna with a radiating elliptical patch, a microstrip feed-line extended and partial ground. Furthermore, by etching inverted U- shaped slot in the partial ground will provide impedance matching.

II.ANTENNA DESIGN

The structure of the proposed antenna consists of a compact size of 18x13mm^2 with thickness of 1mm on a cheap FR4 substrate having relative permittivity ε_r = 4.4. Antenna includes a radiating elliptical patch, a microstrip feed-line extended and an inverted U-shaped etched slot in partial ground. As shown in Fig.1, in order to achieve an acceptable impedance matching, an inverted U-shaped slot is etched off the ground structure. The stop band at a centre frequency of 5.5 GHz is achieved by making use of elliptical radiating patch and an extended microstrip feed-line with a width of 2mm. The antenna is being optimized by using computer simulation technology (CST) with three dimensional EM simulator. The effect of various parameters such as voltage standing wave ratio (VSWR), S parameter, etc. will be discussed in the next section.

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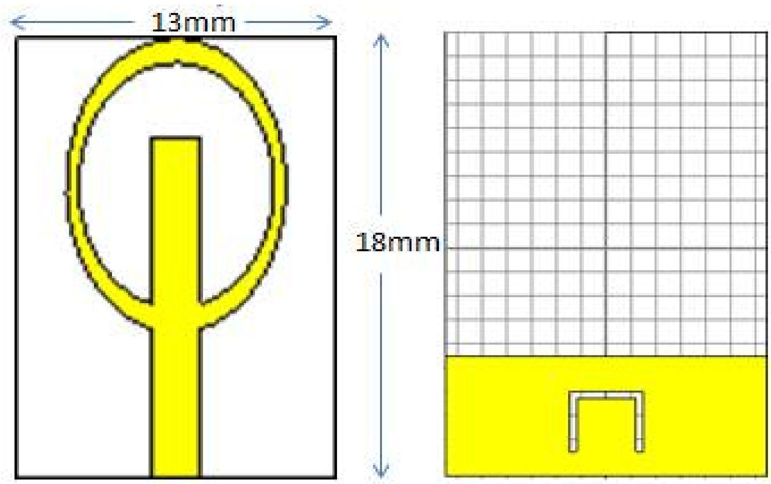

Fig1: Geometry of antenna (left: front view, right: back view)

III. RESULT AND DISCUSSION

Parametric analysis deals with the results obtained due to variations in parameters of antenna. This is done by varying one parameter and fixing the others. This analysis leads to the optimum values which are explained in the following stages.

STAGE 1

The Fig.3 depicts the VSWR curve for the partial ground having a length of 3.7mm on the FR4 substrate. The length of partial ground is determined by performing the parametric analysis and it was found to be 3.7mm. Impedance matching does not happen throughout the UWB range in this stage. Next stage resolves this issue.

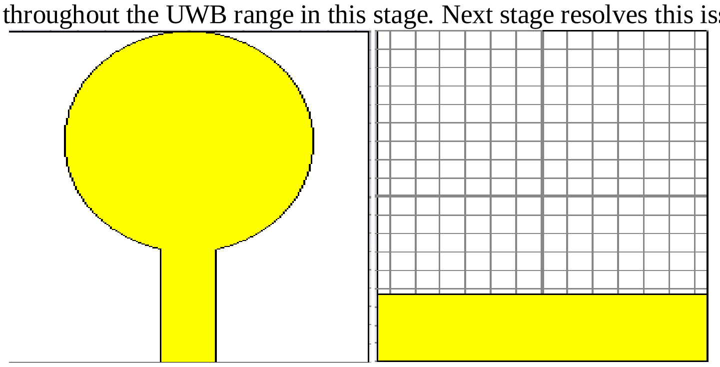

Fig.2: Antenna design stage 1

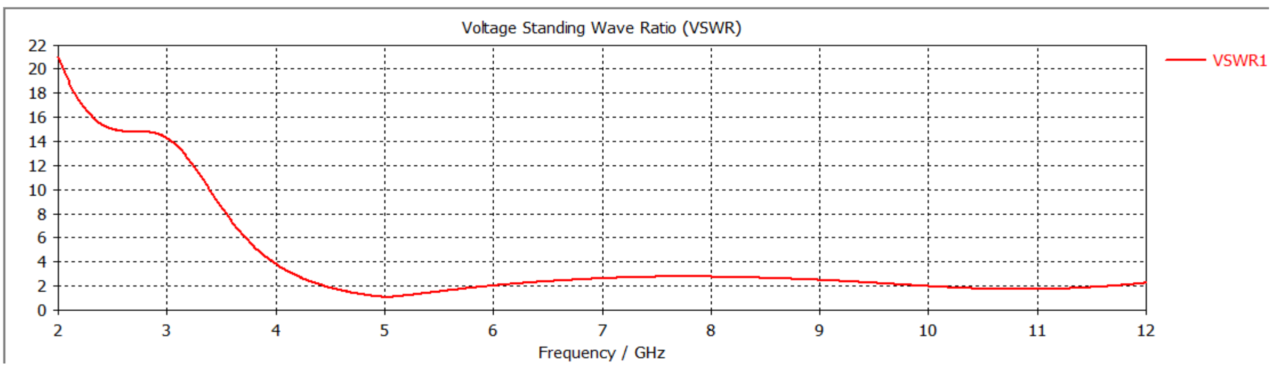

Fig. 3: VSWR stage 1

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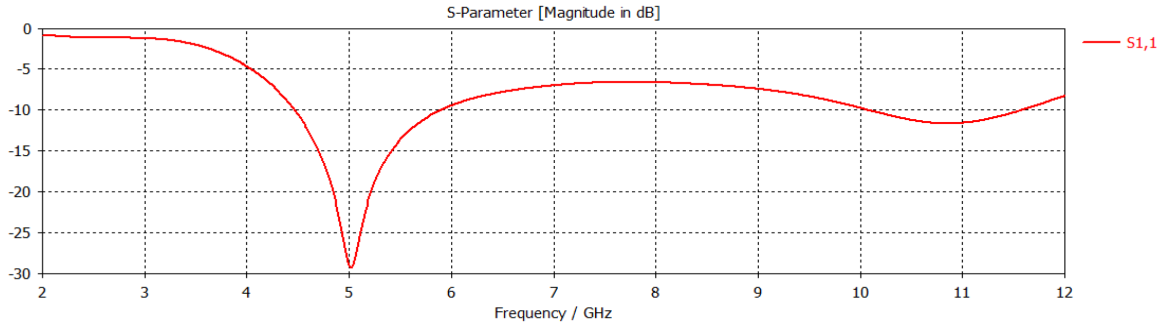

Fig. 4: Return loss stage 1

STAGE 2

As shown in the Fig.5, an inverted U-shaped slot is introduced in the partial ground which enhances the impedance matching characteristics. The inverted U-shaped slot of width 0.3mm and length 2.5mm is etched off the partial ground. The notched frequency band for removing interference is obtained in next stage.

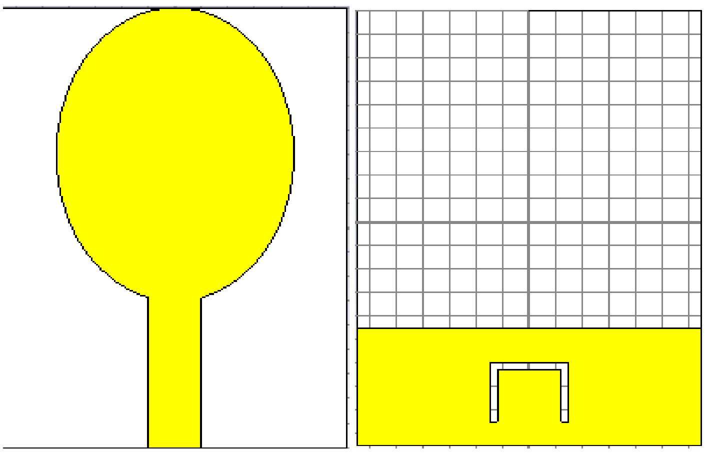

Fig5: Antenna design stage 2

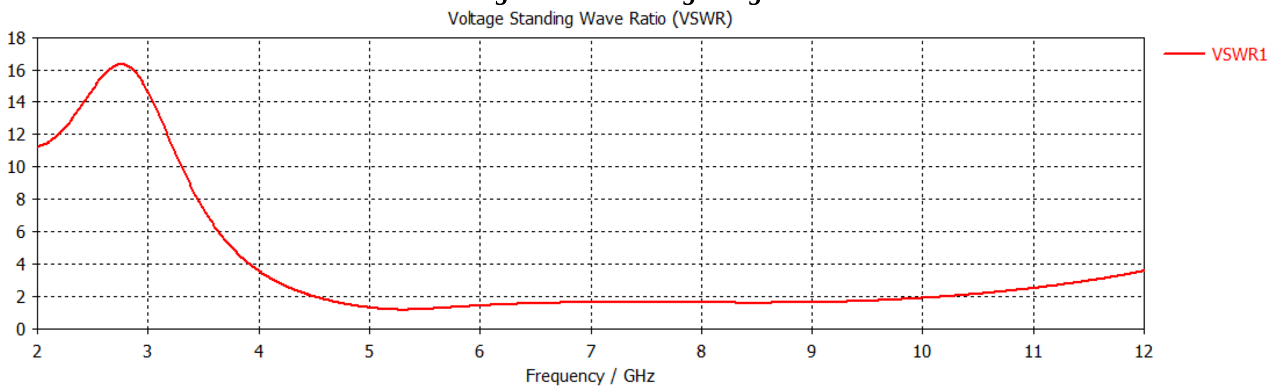

Fig6: VSWR stage 2

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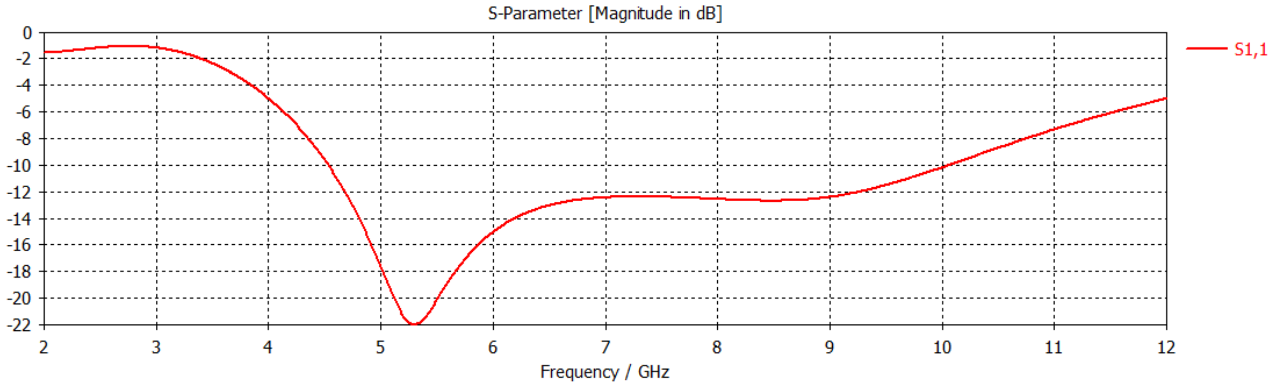

Fig7: Return loss stage 2

STAGE 3

This stage deals with the production of notch of the WLAN band. The Fig.8 and Fig.9 depicts the final design and VSWR of the antenna. The main aim of the paper is to reduce the interference by notching the interfering WLAN with UWB. VSWR graph shows the significant value over the complete UWB range except the notched band. Return loss is also less than -10dB for the operating region.The results for different radius of ellipse have been tested and the optimum value is found to be 12mm major axis length and 9mm minor axis length with elliptical patch thickness of 1mm across major axis and 0.5mm across minor axis of ellipse.It is seen that the microstrip feed line is extended with a length of 6.9mm projecting inside the elliptical patch. This elliptical patch and the feed-line together exhibit the band filtering feature giving rise to the notch band in the WLAN region.The VSWR and the return loss graphs show the notched band in WLAN region from 4.85 GHz to 6 GHz with a centre frequency of 5.5 GHz.It is also observed that by varying the length of the feed-line, the notched band shifts, indicating that the notched band is controllable.

RADIATION CHARACTERISTICS

Fig.11-16 shows the normalized far field radiation patterns in the two principal planes i.e. H-plane (x-z plane) and E-plane (y-z plane) at frequency 5.5 GHz. The structures of the radiation patterns are irregular because of the compact antenna size (18x13mm^2).

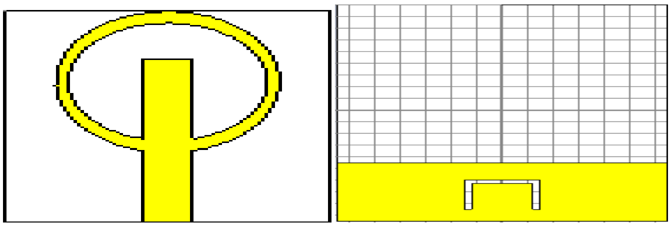

Fig. 8: Antenna design stage 3

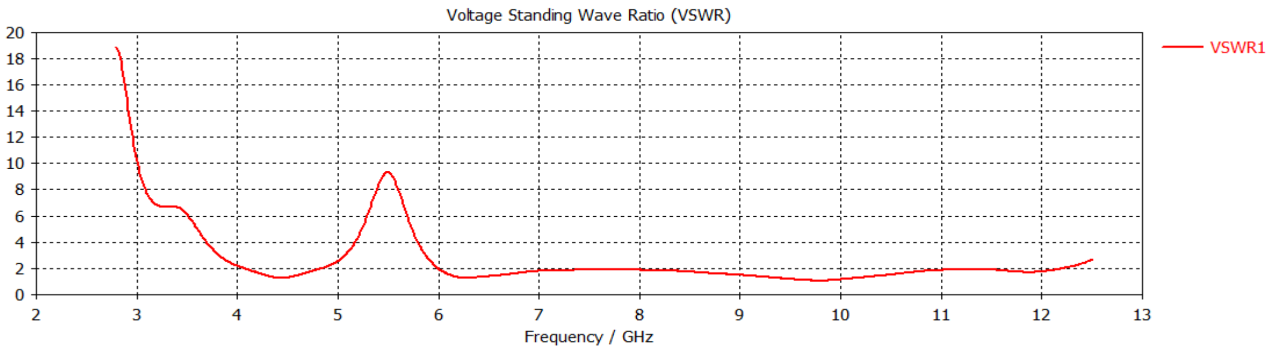

Fig. 9: VSWR stage 3

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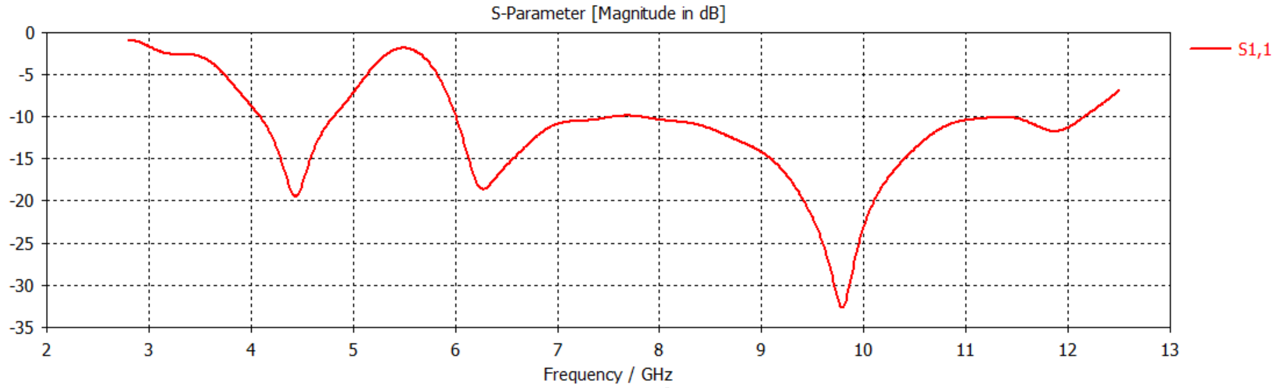

Fig. 10: Return loss stage 3

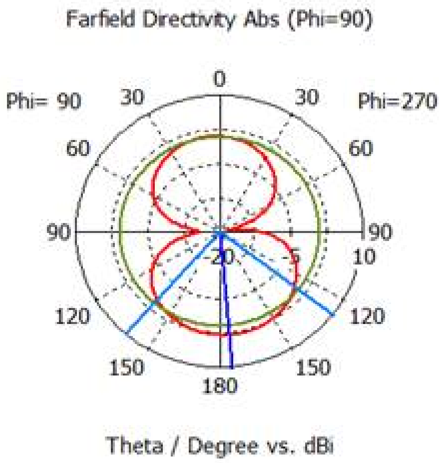

Fig. 11: Radiation pattern H-plane at 2.8 GHz

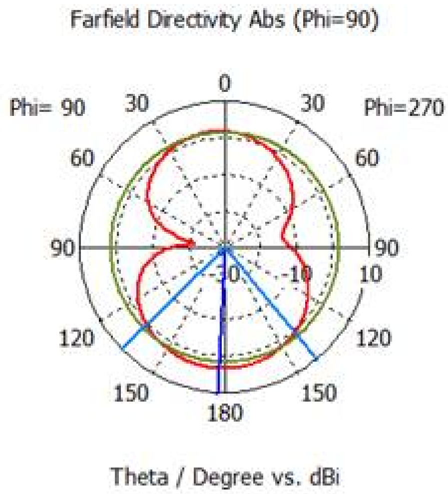

Fig. 12: Radiation pattern H-plane at 7.65 GHz

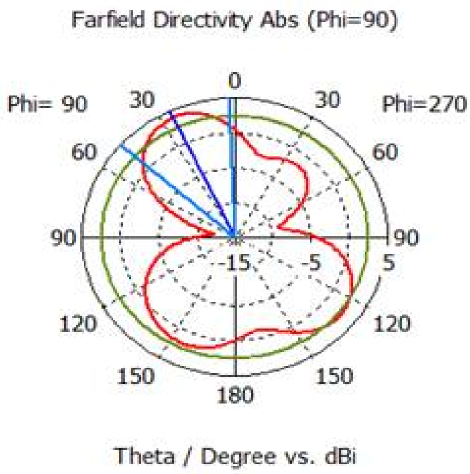

Fig. 13: Radiation pattern H-plane at 12.5 GHz

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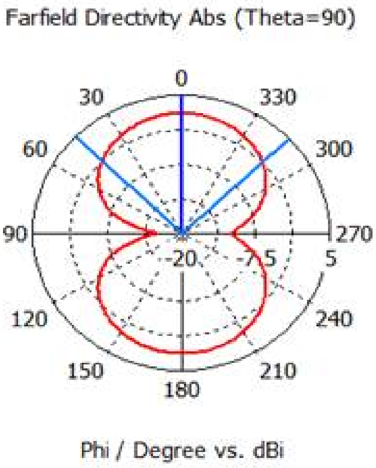

Fig14: Radiation pattern E-plane at 2.8 GHz

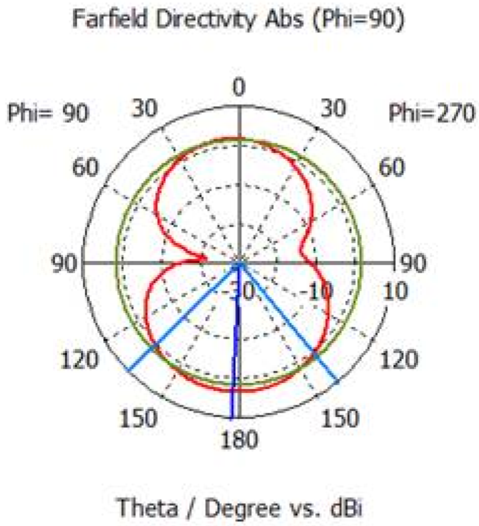

Fig15: Radiation pattern E-plane at 7.65 GHz

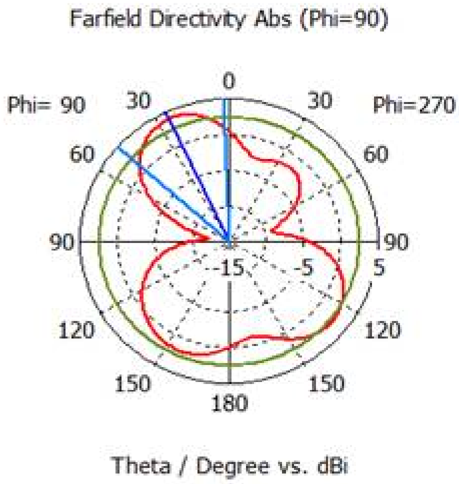

Fig. 16: Radiation pattern E-plane at 12.5 GHz

IV.CONCLUSION

In this paper a controllable single band notched UWB monopole antenna was presented. This antenna can cover a broad impedance bandwidth from 4 GHz to 12.2 GHz with the single notched band of about 4.85 GHz to 6 GHz from the interference band WLAN.The proposed antenna has a small configuration with compact size of $18x13x1mm^3$ and simple geometry. This antenna can therefore be used for the desired UWB communication systems.

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