Printed Monopole UWB Antenna with Dual Notch Bands

E. Kusuma Kumari, Sekhar M

Abstract— ***A UWB antenna with simple semi circular monopole antenna fed by a microstrip line with a semi circular ground plane is presented in this paper to achieve a operating bandwidth from 3.1GHz to 10.6GHz. Low cost FR4 glass epoxy material with a dimesnion of 30mm×32mm×1.6mm has been used to design the antenna. Proposed antenna is incorporated with two complimentary rectangular ring slots with discontinuities. The rectangular slots are placed such that the discontinuities face opposite to each other and it will generate a static resonance which is the reason for the dual notch bands covering the frequency ranges of WiMAX and WLAN.***

Keywords— ***Monopole, Complimentary slots, partial ground, Dual Notch.***

I. INTRODUCTION

Ultra Wideband Antennas play a key role in the development of the applications in the unlicensed frequency band covering the frequency region of 3.1GHz to 10.6GHz. but care has to be taken in the transmitted circuit design to design filters to eliminate the licensed frequency bands of WiMAX and WLAN which will make the transmitted circuit complex and huge. The best way is to design an antenna which will not receive the signals from these licensed bands instead of filtering them after reception which will cause a lot of problems of interference also[1].

In order to have dual notch band characteristics a radiating patch with slots at the center and a partial V shaped ground plane is presented in [2]. To introduce a dual notch band a rectangular patch with a inverted T slot with a stub in it is proposed in [3] here the ground plane is partial ground with rectangular truncations. A pentagon patch with a pentagon ring slot fed by a coplanar wave guide feeding is proposed in [4]. In [5] a circular patch with a tapered ground plane and slits in the circular patch are considered to achieve the dual notch band characteristics.

Proposed antenna is a simple semi circular monopole antenna fed by a microstrip line with a semi circular ground plane. Two complimentary rectangular ring slots with discontinuities are etched in the patch to achieve dual notch band characteristics. Different antenna parameters of the proposed antenna were studied and presented in this paper.

II. DEVELOPMENT OF PROPOSED ANTENNA

Antenna Design

A simple semi circular monopole antenna fed by a microstrip line with a semi circular ground plane are been used to achieve a UWB antenna operating from 3.1GHz to 10.6GHz. Low cost FR4 glass epoxy material with a dimesnion of 30mm×32mm×1.6mm has been used to design the antenna. Proposed antenna with UWB Characteristics can be seen in the figure 1 below.

(a) Front View

(b) Rare View

Fig. 1. Proposed UWB antenna

The cumulative effect of the semi circular radiating element and the ground plane will give the necessary UWB Characteristics to the antenna. The Radius of the ground plane is considered such that the ground plane ends just at the beginning of the patch on the other side of the substrate

Revised Manuscript Received on February 11, 2019.

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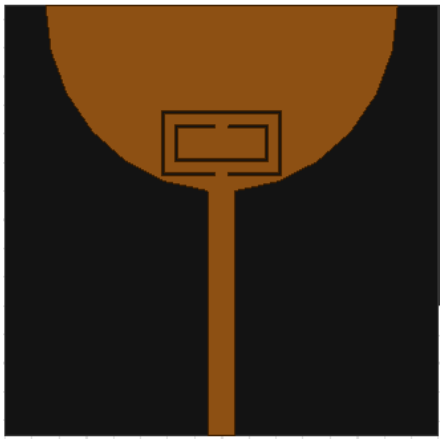
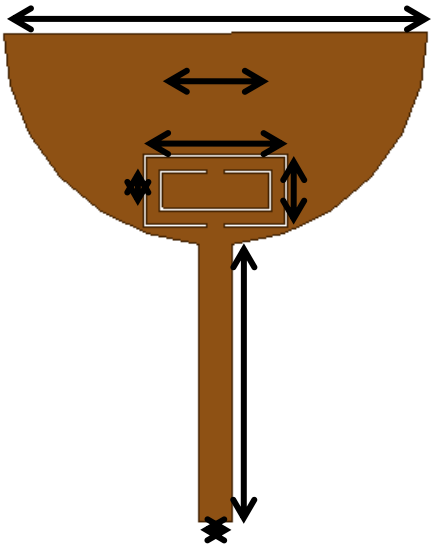
Figure 2 below shows the proposed antenna with two complimentary rectangular ring slots with discontinuities. The rectangular slots are placed such that the discontinuities face opposite to each other and it will generate a static resonance. The resonance of the complimentary slots depends upon the length of the slot and it will be determined depending upon the frequency at which the notch band is required. The length will be taken as the value which is equal to the fifty percentage of the wavelength at which the notch band is required. Since we require two notch band two slots were taken. The optimized final dimensions of the dual notch band antenna are depicted in the figure 2b.



(a) Front View of Simulated Notch band antenna

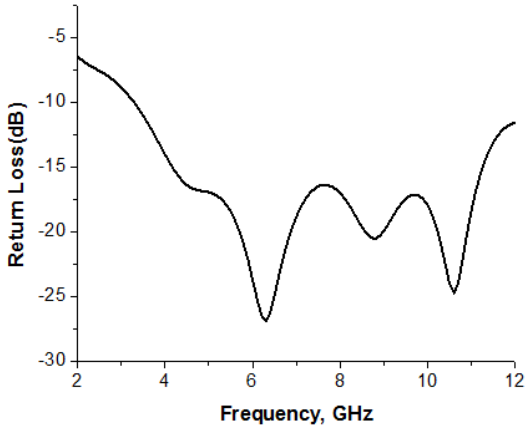


(b) Schematic Model of Patch

Fig. 2. Proposed Notch band antenna

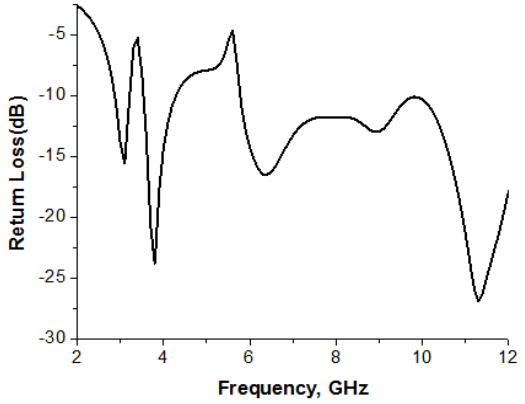
III. RESULTS

Performance of the printed monopole antenna with and without slots is analyzed using Ansys HFSS software. Antenna parameters such as impedance matching, near field and far field characteristics, current distribution were studied. All the above mentioned parameters were studied and depicted below. Figure 3(a) below depicts the impedance matching plot of the proposed antenna without slots, here we can observe that the value of the impedance matching curve for the entire frequency of operation 3.1GHz to 10.6GHz is below -10dB without notch bands.



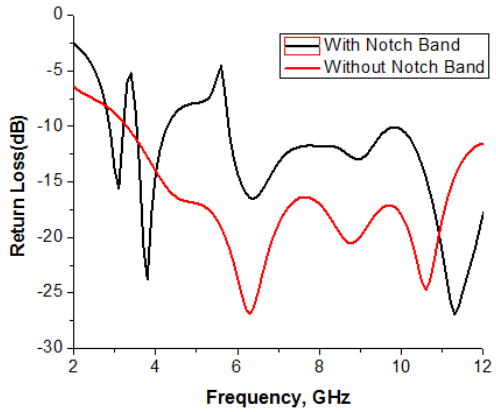
(a) No Notch bands

In Figure 3(b) return loss plot of the antenna with slots has been presented and it can be observed that with the introduction of slots in the patch two notch bands appeared covering the frequencies 3.21GHz to 3.53GHz and 4.3GHz to 5.7GHz.



(b) Dual Notch bands

Figure 3(c) below presents a comparative study of the return loss plot with and without notch bands. It can be clearly observed that the static resonance generated by the complimentary ring slots has made significant effect on the impedance characteristics of the antenna



(c) Comparison of Return Loss characteristics

Fig. 3. Return loss plots

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Figure 4 below depicts the VSWR plot of the proposed dual notch band antenna. Observed a VSWR value of less than 2dB across entire operating bandwidth except at the frequencies covering the two notch bands.

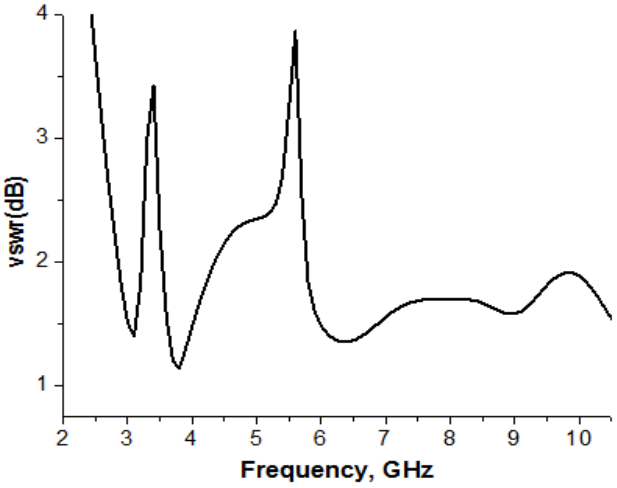
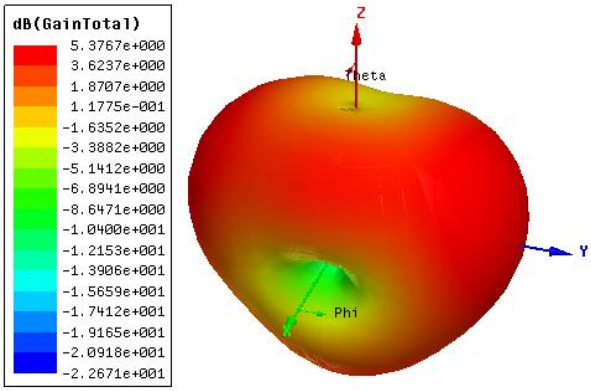


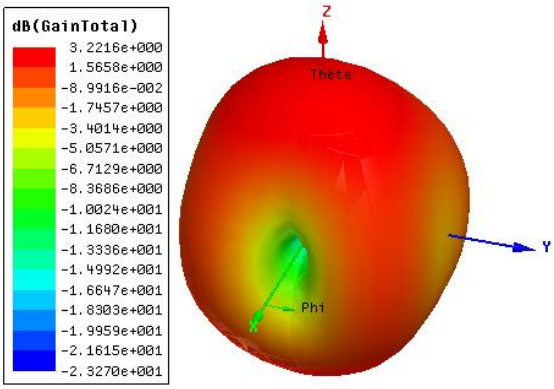
Fig. 4. VSWR

Figure 5 below depicts the Gain of the dual notch antenna at three intermediate frequencies of 3.8GHz, 6.4GHz and 9GHz in the operating bandwidth. Observed a gain of 5.37dB, 3.22dB and 2.60 dB for the frequencies of 3.8GHz, 6.4GHz and 9GHz respectively

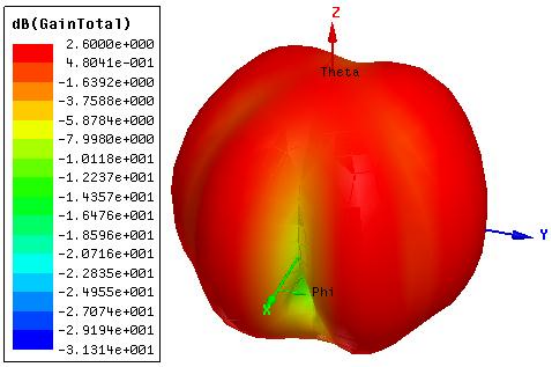
Figure 6 below depicts the directivity of the dual notch antenna at three intermediate frequencies of 3.8GHz, 6.4GHz and 9GHz in the operating bandwidth. Observed a directivity of 3.58dB, 3.68dB and 2.66dB for the frequencies of 3.8GHz, 6.4GHz and 9GHz respectively



(a) Gain at 3.8GHz

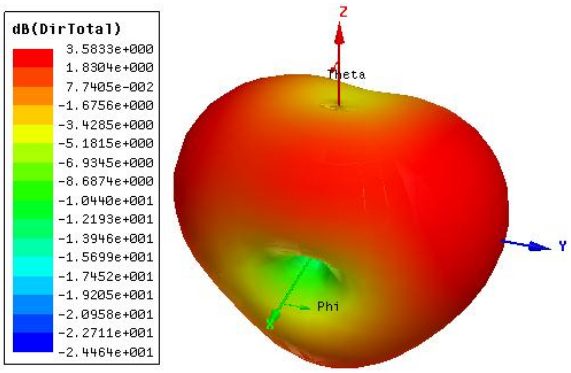


(b) Gain at 6.4GHz

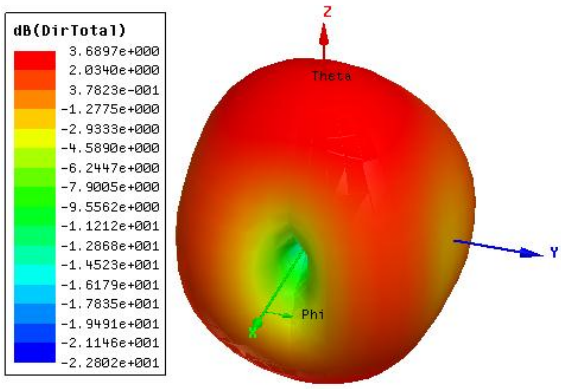


(c) Gain at 9GHz

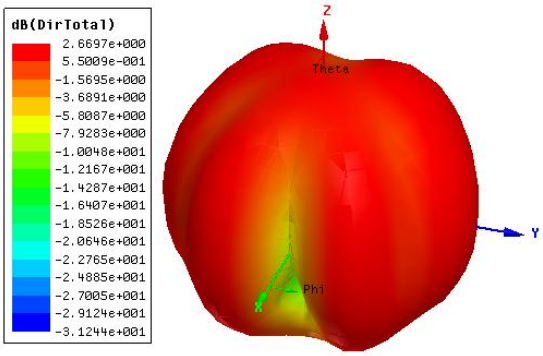
Fig. 5 Gain of Dual Notch band antenna



(a) Directivity at 3.8GHz



(b) Directivity at 6.4GHz



(c) Directivity at 9GHz

Fig. 6 Directivity of Dual Notch band antenna

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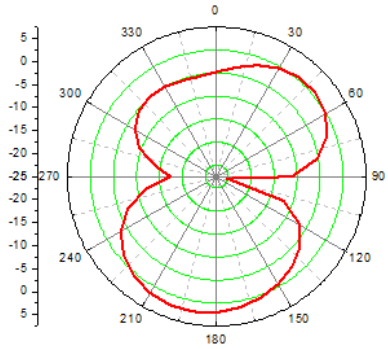
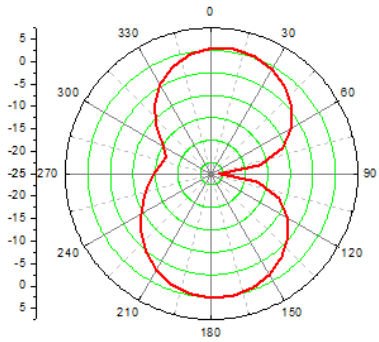
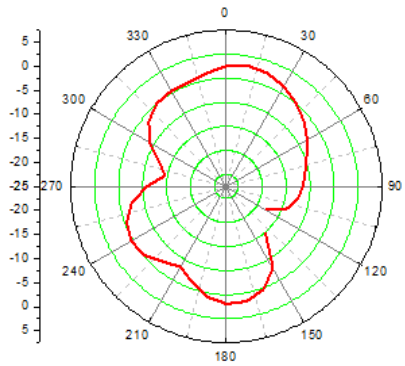
Figures 7, 8 below depicts the elevation plane and azimuthal plan patterns of the antenna with dual notch characteristics. Observed a uniform radiation pattern without any nulls at all the three intermediate operating frequencies.



(a) at 3.8GHz

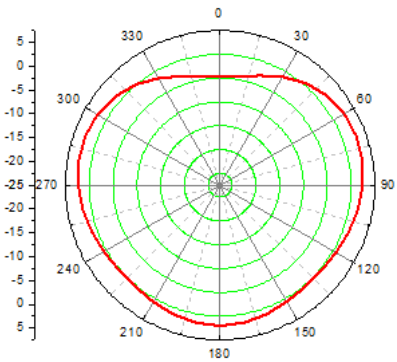


(b) at 6.4GHz

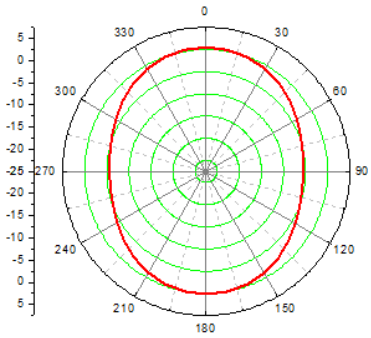


(c) at 9GHz

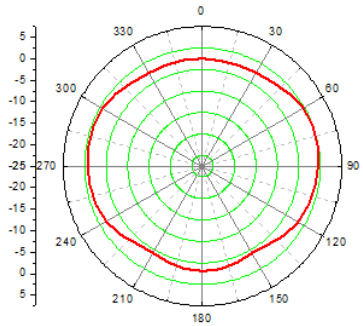
Fig. 7. Elevation Plane Patterns



(a) at 3.8GHz



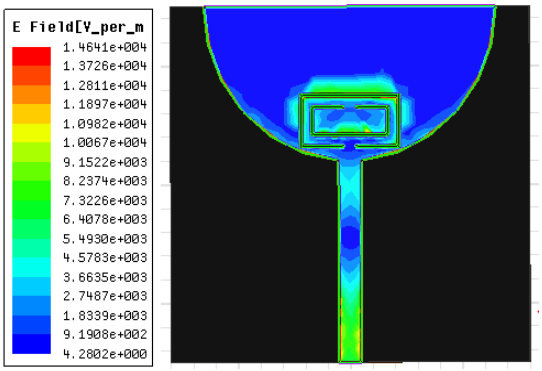
(b) at 6.4GHz



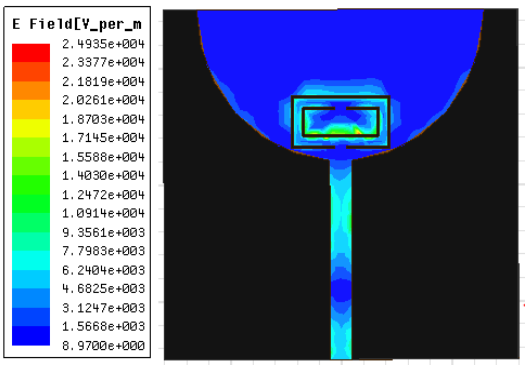
(c) at 9GHz

Fig. 8. Azimuthal Plane Patterns

Figures 9, below depicts the current distribution in the proposed dual notch band antenna for different intermediate operating frequencies. From the plots we can observe that for the resonance at different frequencies different regions of the antenna are responsible.



(a) at 3.8GHz



(b) at 6.4GHz

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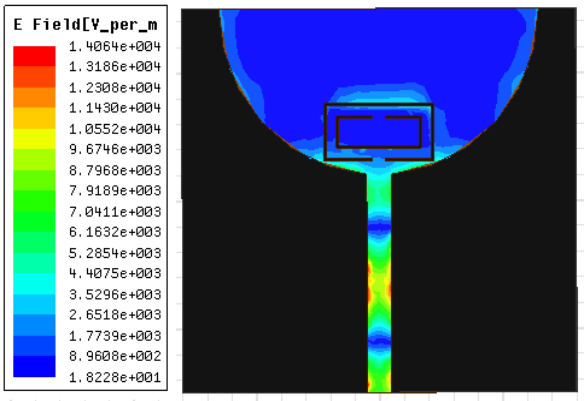

(c) at 9GHz

Fig. 9. Current distribution plots

IV. CONCLUSION

A printed Monopole UWB antenna with dual notch bands has been designed and investigated in this paper. FR4 material has been used to design the antenna. For UWB characteristics a semi circular patch with line feed and a semi circular ground plane are been considered. To incorporate notch bands two complimentary rectangular ring slots with discontinuities are been places in the patch. It can be observed that with the introduction of slots in the patch two notch bands appeared covering the frequency bands of 3.21GHz to 3.53GHz and 4.3GHz to 5.7GHz which will eliminate the interference of the WiMax and WLAN frequency bands.

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