ISSN 2320 2599
Volume 3, No.5, September - October 2014
International Journal of Microwaves Applications
Available Online at http://warse.org/pdfs/2014/ijma01352014.pdf

A Simple Compact UWB antenna with Band Notched Characteristics

Trupti N.Pawase[1], Prof.R.P.Labade[2]

[1]Dept. Of Electronics & Telecommunication, Amrutvahini College Of Engineering, Maharashtra, India, tpawase@gmail.com
[2]Dept. Of Electronics & Telecommunication, Amrutvahini College Of Engineering, Maharashtra, India, rplabade@gmail.com

ABSTRACT

A compact monopole, small sizes, low profile and planar micro strip rectangular patch ultra-wideband (3.1-10.6GHz) antenna with band notched for Wi-max (3.1-4.7GHz) is presented in this paper. To prevent possible interference between UWB and other wireless system such as Wi-max two notching structures designed on radiating patch. The obtained Reflection Coefficient and VSWR results are good in ultra wideband region (3.1-3.9GHz) except in band notch Wi-max region (3.1-4.7 GHz).The proposed antenna has been designed on a FR4 substrate with dielectric constant (ε_r) = 4.4, loss tangent (tan δ)= 0.02.The antenna is simulated using CAD FEKO 6.3 suit electromagnetic simulator using MOM (Method of moment)

Key words: UWB, CAD FEKO, Wi-max, Band Notched

1. INTRODUCTION

Ultra wideband (UWB) system has gained a lot of attention in the wireless world because of their advantages including high speed data rate, low spectral power density, high precision, low complexity and low cost. The Federal Communication Commission (FCC) allowed the 3.1 -10.6 GHz unlicensed band for UWB communication in February 2002[1]. However over the designated frequency band, there exist some narrow bands for communication systems, such as Wi-MAX (3.3-3.7 GHz) ,WLAN (5.15-5.825 GHz) and satellite communication systems at 7.2 GHz[11].They may cause communication interference with UWB system[11]. This problem is solved by notching the existing frequency band from UWB frequency spectrum so that interference does not occur which is shown in various papers. Recently various academic and industrial fields also showed their interest to explore various UWB antennas and notching technique [9]-[10].

2. ANTENNA DESIGN

Figure 1 shows the geometry of the proposed UWB antenna with notch bands, which is printed on FR4 substrate with relative dielectric constant of 4.4, thickness of 1.6mm and loss tangent of 0.02. The proposed antenna has dimension of 30mm x 33mm (W_{sub} X L_{sub}).The width of feed line is fixed at 2.8mm to achieve the characteristic impedance of 50Ω. On the upper surface of substrate rectangular patch with the size of W_p X L_p is printed. On the other side of the substrate, the conducting ground plane with a length of L_g. The gap distance between the radiating patch and ground plane (d=Lf-Lg) is another effective parameter on the impedance matching[5]. By adjusting it, the electromagnetic coupling between the lower
edge of the patch and ground plane can be properly controlled [6].In this design gap distance is fixed at 1mm.

The optimized dimensions of proposed antenna are as follows: W_{sub}=30mm, L_{sub}=33, W_p=13mm, L_p=19, W_f=2.8mm ,L_f=10.5mm, L_g=9.5mm.Using these dimensions the antenna satisfies the requirement of UWB antenna from 3.1GHz -10.6GHz .

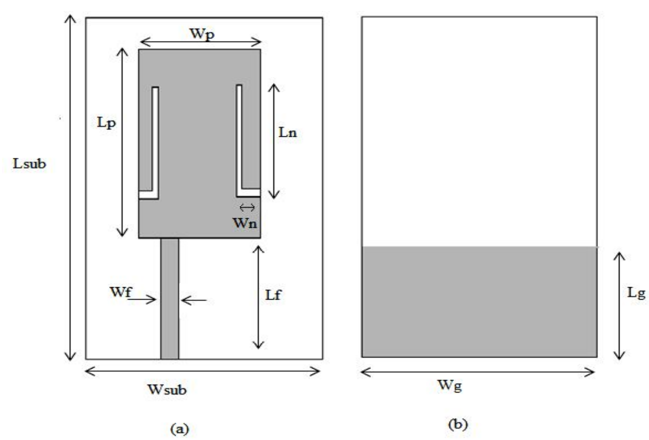

Figure 1: Configuration of proposed antenna
(a) Top View (b) Bottom View

To reduce the interferences from the Wi-MAX system, the band notched function is desirable in the UWB system[4].
By etching a pair of two symmetrical L- shaped slots in the of for Wi-MAX is created. This configuration is shown in Figure 1.

The notch frequency given the dimension of the band notched feature can be postulated as:

$$f_{notch} = \frac{c}{4L\sqrt{\varepsilon_{eff}}} \quad (1)$$

where 'L' is total length of the notching element, ε_{eff} is the effective dielectric constant and c is speed of light[4]. We take equation (1) into account in obtaining the total length of two symmetrical L shape slots and then adjusted geometry for the final design. Geometry of two elements with length Ln and width Wn is shown in the Figure 2. The dimensions of notching element are: L_n=10mm and W_n=4mm with the thickness of 0.5mm.Hence the total length of Wi-MAX notch structure is $L_{total}= L_n+W_n$.

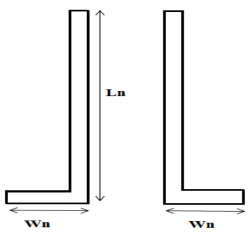

Figure 2: Symmetrical two L-shape element

3. SIMULATION RESULTS AND DISCUSSION

In this section ,UWB antenna with two symmetrical L-shape notches designed and simulated by using CAD-FEKO simulation software version 6.2.[8]

To obtain Wi-MAX notch (3.3 -3.7GHz) in UWB antenna we designed rectangular Patch antenna and simulated to observe different standard results of antenna. Figure 3 shows Geometry of antenna designed on CAD FEKO version 6.2 with parameters calculated and different results are analyzed.

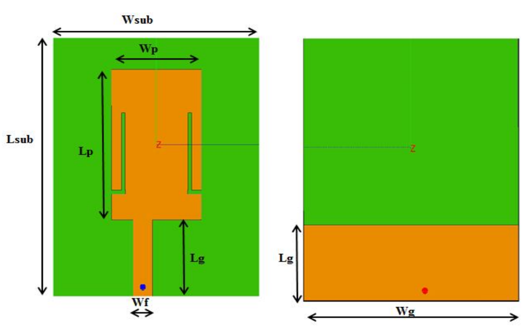

Figure 3: Geometry of Antenna on CAD FEKO

Figure 4 shows simulated VSWR characteristics for UWB band notched structure which should be less than or equal to 2 for entire UWB range except 3.1-4.7 GHz which is Wi-MAX band.

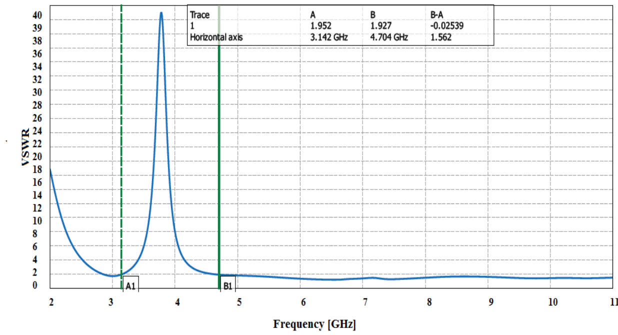

Figure 4: Simulated VSWR of the proposed antenna

The obtained reflection coefficient is below -10dB for UWB range except Wi-Max notch band as shown below figure. VSWR and Reflection Coefficient graph shows antenna is giving good band notch characteristic with the center frequency 3.5 GHz.

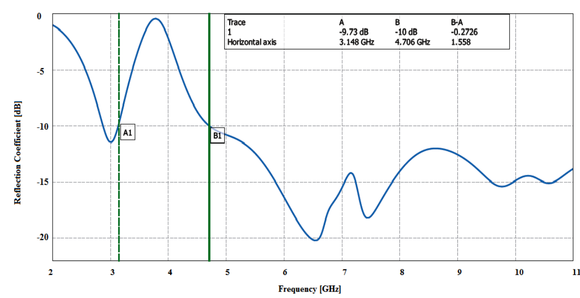

Figure 5: Simulated Reflection Coefficient of proposed antenna

The performance of UWB response with Wi-MAX notched characteristics depends on a number of parameters such as gap between radiating patch (g), width(W_n) and length(L_n) of notching element, thickness of notching element(t_ notch) and feed width(f_w) variation. The parameters which have significant effect on UWB response with Wi-MAX band notched characteristics are discussed and their parametric studies are mentioned in this section.

The gap between radiating patch and ground plane 'g' affects impedance bandwidth[4].The optimum UWB impedance bandwidth with single band notched characteristic is obtained at g=1mm. Simulated VSWR at different gap (g) is shown in Figure 6.

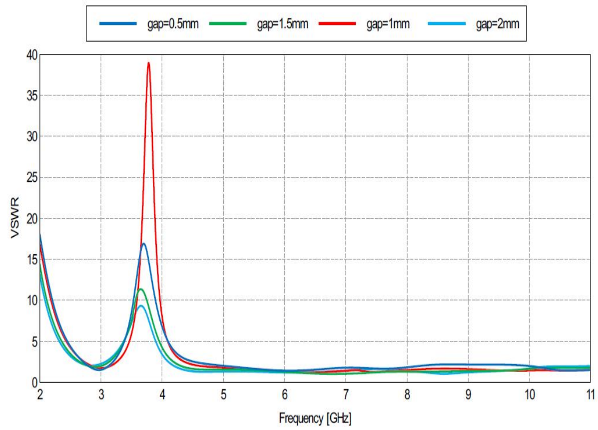

Figure 6: Simulated VSWR vs frequency at different gap ‘g’ (i) 0.5mm (ii) 1mm (iii) 1.5 (iv)2mm

For same gap distance Reflection coefficient simulated results are shown in Figure 6. By observing both Figure 5 and Figure 6 it is obtained that for gap distance=1mm good VSWR and reflection coefficient obtained in UWB region except Wi-MAX band notched region. To reject the interference of the Wi-MAX system from UWB we designed this structure and it showing good impedance matching.

The simulated Reflection Coefficient at different gap distance ‘g’ is shown in Figure 7.

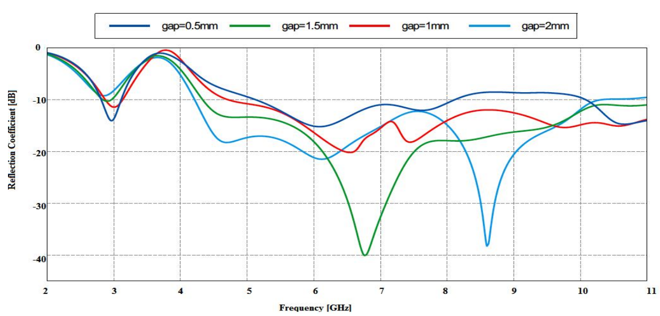

Figure 7: Simulated Reflection Coefficient vs frequency at different gap ‘g’ (i) 0.5mm (ii) 1mm (iii) 1.5 (iv)2mm

Feed line is also main parameter to analyze antenna characteristics. For the impedance matching we simulated for different feed width ‘fw’ and taken VSWR ,Reflection Coefficient results as shown in Figure 8 and figure 9 respectively.

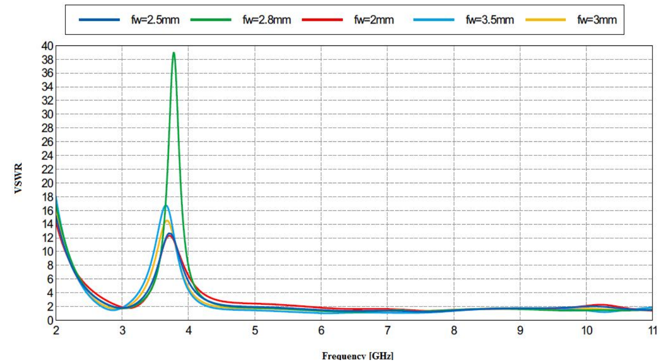

Figure 8: Simulated VSWR for various Feedline width(f_w) (i)2mm (ii)2.5mm (iii)2.8mm (iv)3mm (v)3.5mm

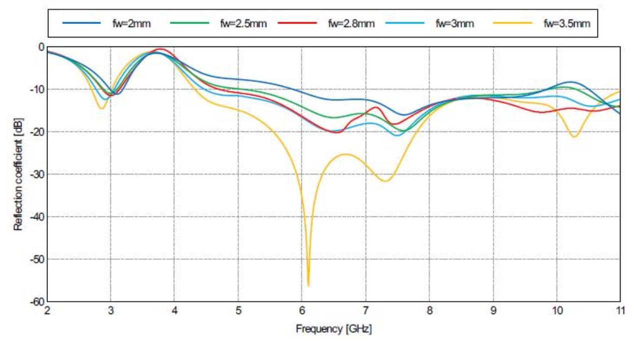

Figure 9: Simulated Reflection Coefficient for various Feed line width (f_w) (i)2mm (ii)2.5mm (iii)2.8mm (iv)3mm (v)3.5mm

For Feed width of 2.8mm it is observed that we obtained VSWR <2 for entire UWB except notched region. Same analysis done for varying thickness of notching L shape element and obtained VSWR is shown in Figure 10.

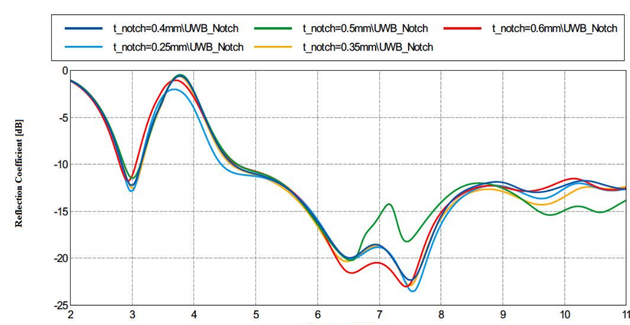

Figure 10: Simulated VSWR at different thickness of two L-shape notching element (t_notch) (i) 0.25mm (ii) 0.35mm (iii) 0.4mm (iv) 0.5mm (v) 0.6mm

Figure 11. shows the comparison of the simulated current distribution on the notched antenna at 3.2, 3.5 and 5.5 GHz. It can be observed that at (i) 3.2 GHz the majority of the surface current is concentrated around where notch was cut and on feed line. Whereas current is weak outside of the patch. At the center frequency of notch band that is 3.5 GHz

surface current distribution increased than the 3.2 GHz and current concentrated on the edges of interior and exterior of the notched structures. The outer current distribution also improved and current direction changes as shown in the figure 10. Simulation at 5.5 GHz shows that antenna is UWB antenna which having current distribution on all the geometry.

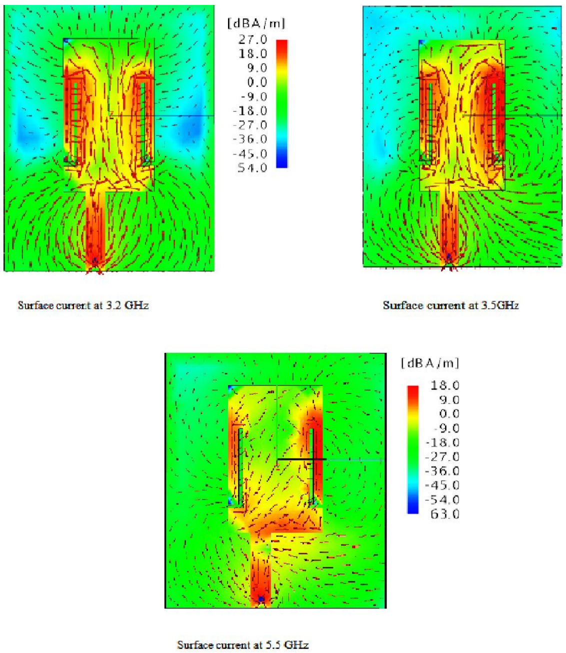

Figure 11: Simulated Surface current distribution (i) 3.2 GHz (ii) 3.5GHz (iii) 5.5GHz

Antenna efficiency of antenna is above 70% and it decreases drastically in Wi MAX notch band (3.1-4.7 GHz).Antenna efficiency shown in Figure 12

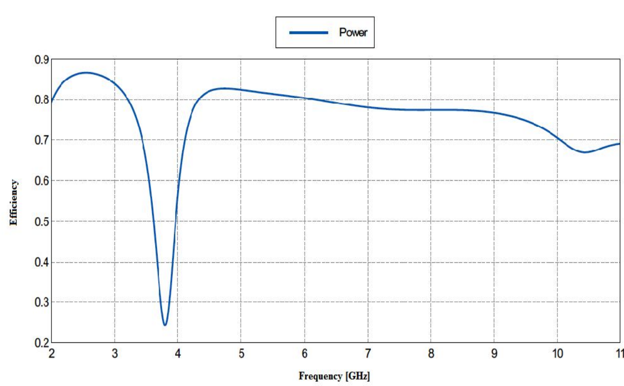

Figure 12: Antenna efficiency over frequency for single notch antenna

4. CONCLUSION

A compact printed, low cost, simple monopole antenna with single notch characteristics is proposed and investigated. Designed antenna minimizes the potential interferences between UWB and Wi-MAX frequency band. Antenna operates satisfactorily from 3.1 to 10.6GHz for VSWR< 2 except for Wi-MAX band (3.1 -4.7GHz).Efficiency of proposed antenna is 70% for entire UWB range except at notch band. The results and discussion proves that the designed antenna is excellent in performance and provides desired band notch characteristics.

REFERENCES

1. FCC, **First Report and order on Ultra-Wideband Technology**,*Tech.Rep.,2002.*
2. C. A. Balanis, **"Antenna theory analysis and design, 2nd edition"** *john Wiley & sons, Inc, 1997.*
3. C. Y. Lin, M. Wu, J. A. Bloom, I. J. Cox, and M. Miller. **Rotation, scale, and translation resilient public watermarking for images**, *IEEE Trans. Image Process.*, vol. 10, no. 5, pp. 767-782, May 2001.
4. S.K.Mishra and J.Mukherjee. **Compact Printed Dual Band-Notched U-Shaped UWB Antenna**, *Progress In Electromagnetics Research C*,Vol.27,169-181,2012
5. A.Nouri and G.R.Dadashzadeh. **A Compact UWB Band-Notched Printed Monopole Antenna With Defected Ground Structure**, *IEEE ANTENNAS AND WIRELESS PROPOGATION LETTERS*,VOL.10,2011.
6. M.J.Ammann and Z.N.Chen. **Wideband monopole antennas for multi-band wireless systems,** *IEEE AntennasPropag.Mag.*,vol.45,no.2,pp.146-150,Apr.2003
7. Qing-Xin Chu, Member IEEE, and Ying-Ying Yang. **A Compact Ultra wideband Antenna With 3.4/5.5 GHz Dual Band-Notched Characteristics**, *IEEE TRANSACTION ON ANTENNAS AND PROPOGATION ,VOL. 56, NO.12 ,DECEMBER 2008*.
8. **CAD-FEKO Simulation Software,** Version 6.2 User Mannual.
9. Symeon Nikolaou, Boyon Kim, Y.-S. Kim, John Papapolymerou, and Manos M. Tentzeris, **CPW-fed Ultra Wideband (UWB) Monopoles with Band Rejection Characteristic on Ultra-Thin Organic Substrate**, *Proceedings of Asia-Pacific Microwave Conference 2006.*
10. Keyvan Bahadori and Yahya Rahmat-Samii, **A Miniaturized Elliptic-Card UWB Antenna With WLAN Band Rejection for Wireless Communications**, *IEEE Trans. Antennas and Propagation. Vol. 55, no. 11, Nov 2007.*
11. Ahmed Shaker, Saber Helmyb Zainud–Deen, Kurany Ragb Mahmoud and Sabry Mohamed Ibrahem, **"Compact Blutooth /UWB Antenna with Multi-Band NotchedCharacteristics"** *Journal of Electromagnetics Analysis and Applications, 2011, 3,512-518, December 2011.*