Printed Square-shape UWB Antenna with Dual Band-Notched Characteristics

Ms. Parul N. Jha
EXTC Engineering
Shree L.R Tiwari College of Engineering
Mumbai, India
Parul.jha1207@gmail.com

Prof. Bharati A. Singh
EXTC Department
K. J. Somaiya college of Engineering
Mumbai, India
bhartisingh@somaiya.edu

Dr. S S Thakur
EXTC department
Vidyalankar Institute of Technology
Mumbai, India
sanjayami@gmail.com

***Abstract*—**Ultra Wideband (UWB) is a new emerging and promising technology as it can accommodate higher data over a large bandwidth. we proposed a Printed Square-shape UWB Antenna With Dual Band-Notched Characteristics. A simple square patch antenna has been fed through a 50 Ω microstrip feedline .A rectangular notch has been etched on the ground plane to reject the interference of WIMAX Band (3GHZ-4.7GHZ) and U-shape slot has been etched on the radiator to reject the interference of WLAN Band(5GHZ-6GHZ).The size of proposed antenna is 66mm(L_{sub}) x 66mm(W_{sub}) x 1.59mm (H) which is quite compact. A large bandwidth from 1.6 GHz to 9.2 GHz with VSWR less than 2, except 3GHz-4.7GHzand 5GHz-6GHz have been achieved by simulating on IE3D software. The proposed antenna is successfully fabricated on the FR4 substrate with ε_r = 4.43.

Keywords*—*Rectangular-shaped notch, U-shape Slot, Dual band-notched characteristics, WiMAX, ultra wideband (UWB) Application.

*****

I. Introduction

The antenna is one of the key areas of research and design as it being the interfacing organ of any electronic communication system. The commercial utilization of UWB which had been approved by FCC, the interest of UWB systems has aroused among many due to its the feasible design and implementation. The UWB technology in wireless system consumes very low pulse energy. This is being proposed for short range and high bandwidth communication systems. since UWB is a low power system, it does not provide any interference with any other system. The presented [1] proposed c-shaped slots to create the band notch characteristics for 3.4 and 5.5 GHz bands. Whereas the created slot provide the band stop filter response characteristics [2]. Even if the various types of slots formed on feed line may create the band notch characteristics [3,4].[5] Integrated three notch elements on a primitive antenna to produce triple band-notch characteristics. [6] Focuses on different feeding techniques, UWB antennas, their geometries and design parameters.[7] Discussed PRMAs with single, dual and triple microstrip line feed to show the effect of feed network to enhance the impedance bandwidth. [8] A new simple compact configuration of a vertex chopped PETMA is proposed for very large bandwidth. Every assigned slot elements creates unique band stop characteristics to cover dual, triple, quadruple band. In order to minimize coupling, the shape and positions of each element are optimized and controlled. The combination of each notch element on the primitive UWB antenna is aimed at providing double band rejection at WiMAX (3.3- 3.7 GHz) & WLAN 2 (5.15-5.825 GHz) to reduce the interference between narrow band and UWB.

Though UWB is allowed to operate over 3.1-10.6 GHz, few othernarrowband services occupy frequencies in that range, such as wireless network WiMAX operating in the 3-4.7 GHz bands and WLAN operating in the 5-6 GHz bands. To suppress dispensable bands UWB antenna uses filters in some applications. However, the complexity of the UWB system increase due to the uses of filters and this increases the cost of the antenna. Therefore, there is a potential risk that these narrow bands will interfere with UWB system. The proposed antenna is desirable to design the compact UWB antenna with dual band notched frequency band which will minimize the potential interferences between UWB system and narrow bands. In this paper, a compact UWB antenna area of 66mm (L_{sub}) x 66mm(W_{sub}) x 1.59mm (H) is first proposed. Simply by etching a rectangular-shaped slot in the ground plane, single band-notched characteristic from 3 to 4.7 GHz can be easily obtained to reduce the potential interferences. The second notched is created on the radiator patch by etching a U-Shape slot to reduce the interference from 5-6 GHz band.Details of the antenna design and simulation are prese nted to demonstrate the performance of the proposed antennas.

II. ANTENNA DESIGN

The shape, structure and dimensions of the proposed antenna is shown in Figure1, an inexpensive FR4 substrate is use for fabrication with the dielectric constant of εr =4 .43 and the substrate thickness of h =1 .59mm. The simple square patch antenna was first designed and then modified using the IE3D Software. For achieving UWB bandwidth, the lower band edge frequency (fL) is the main design parameter. Since referred [7] for the formula to achieve fL=1.6GHz.

fL=7.2/ { L+ p + 0.159W} k GHz (1)

where k=1.15 for FR4 substrate 'k' is the correction factor with εr = 4.43 and feeder length p=1mm

This lower band edge frequency is calculated from experimental adjustment, the optimal dimensions were determined. The dimensions of the designed antenna, including the substrate are (Lsub) x (Wsub) = 66mm× 66mm, radiating patch isL1 x w1 = 40mmx40mm and the feedline is 23mm. To reduce the interference from the IEEE802.16 (WiMAX) systems, it is desirable to create the band-notched function in the UWB system. Fig. 1 also shows the geometry and dimensions with filtering property of the UWB antenna operating in the 3–4.7 GHz band and 5-6GHz band. By etching a dual side rectangular -shaped notch (Ln1xWn2) on the ground plane of antenna, a frequency band notch is created and U-shape slot on radiating patch for rejecting 5-6GHz band.The design concept of the notch function is done by adjusting the total length of therectangular-shaped notch .The total length of the rectangular-shaped notch (Ln1) can be obtained approximately from the following formula [3]:

$$L = \frac{c}{4f\sqrt{\frac{\varepsilon r+1}{2}}} \qquad (2)$$

Where εr ,c and f are dielectric constant, the velocity of light in free space, and the center frequency of the desired bands, respectively.

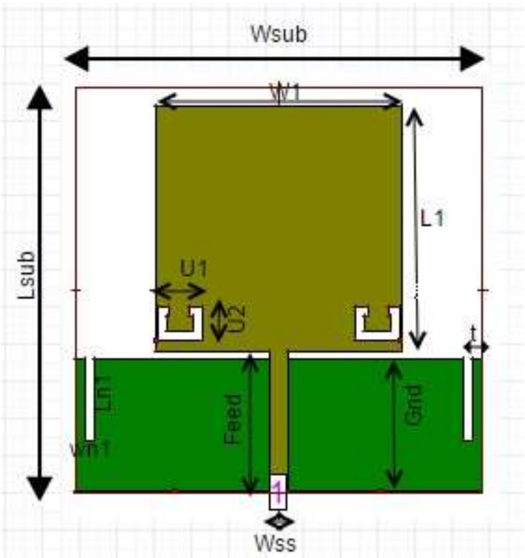

Fig1: Structure and configuration for 3-4.7GHz Notch

III. RESULTS AND PARAMETRIC STUDIES

To have good impedance matching in UWB, the dual rectangular notch is created on the ground plane which reject band 3-4.7 GHz WiMAX. Fig. 1 shows the complete structure of the proposed antenna with the rectangular and U-shape notch. The important parameters of proposed antenna are Ln1 and t of rectangular notch and U1 and U2 of U-shape slot is described below.

A) Parametric studies

1) Effect of Ln1 Variation: By varying length Ln1 of rectangular-shape notch, the frequency for WiMAX band can be rejected. The effects of Ln1 variation on notch frequencyare shown in Fig. 2. It can be observed from Fig. 2 and Table1,as the Ln1 increases from 10 mm to 13 mm and keeping Wn2=1.6mm ,the notch frequency decreases from 4.1 GHz to 3.6 GHz.

Table 1: effect of variation in Ln1

Length(mm)	Width	Notch Frequency(GHz)
Ln1=10	Wn2=1.6	4.1
Ln1=12	Wn2=1.6	3.89
Ln1=13	Wn2=1.6	3.6

The simulated VSWR of Table 1 is plotted in Fig. 2.

2) Effect of t Variation: The effect of gap t variation on notch frequency is shown in Fig. 3. It can be observed from Fig.3 as the gap t increases from 0.5 mm to 1.5 mm, the impedance matching of an antenna can be improved. Hence impedance bandwidth is effectively increased to from 1.6 GHz to 9.2 GHz except 3GHz to 4.7GHz.The final design parameters of the rectangular-shape notch are Ln1=13mm and Wn1=1.6.

Table 2: effect of variation in t

Length(mm)	Width	Gap t (mm)	Frequency(GHz)
Ln1=13	Wn2=1.6	t=0.5	2.7-4.7
Ln1=13	Wn2=1.6	t=1	2.9-4.8
Ln1=13	Wn2=1.6	t=1.5	3-4.7

The simulated VSWR of Table 2 is plotted in Fig. 3.

3) Effect of U1 and U2: The effect of U1 and U2 is shown in Fig.4.It can be observed that due to length of U1 and U2 the impedance matching improved and the other band 5-6ghz has been rejected.

Table 3: effect of U1 and U2

U1(mm)	U2(mm)	Gap(mm)	Frequency(GHz)
7.3	5.5	1.5	5-6.2

B) Results

1) Simulated VSWR

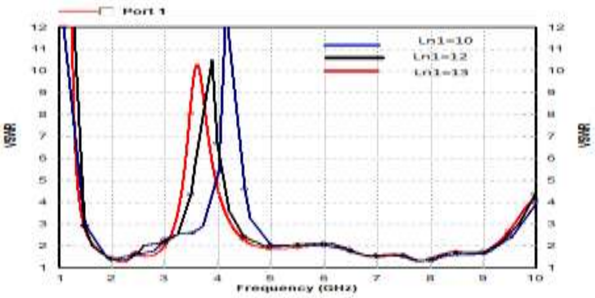

Fig2: Simulated VSWR characteristics with different values of Ln1 for 3GHz notch

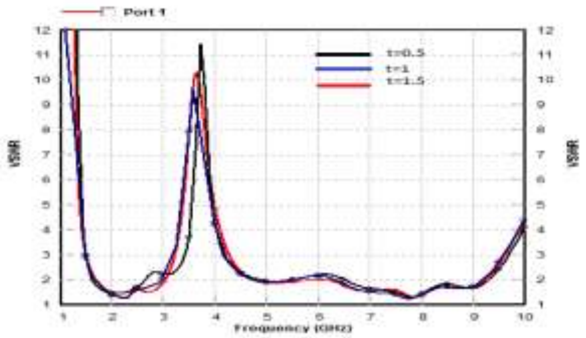

Fig3: Simulated VSWR withdifferent values of gap t for 3GHz notch

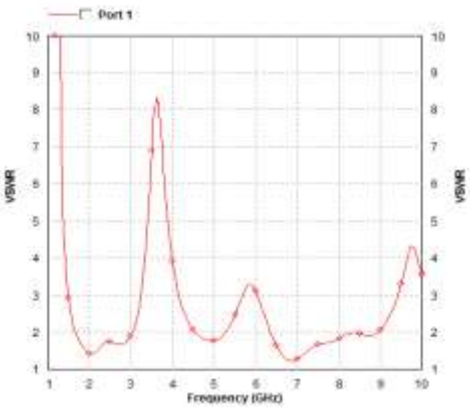

Fig4: Simulated VSWR for Dual notch

Table 3. Optimized parameters (mm).

Length Ln1	Width Wn1	Gap t	Notch Frequency band	Notch frequency fnotch
13mm	1.6mm	1.5mm	3-4.6GHz	3.6GHZ

U1(mm)	U2(mm)	Gap(mm)	Frequency(GHz)
7.3	5.5	1.5	5-6.2

2) Measured VSWR

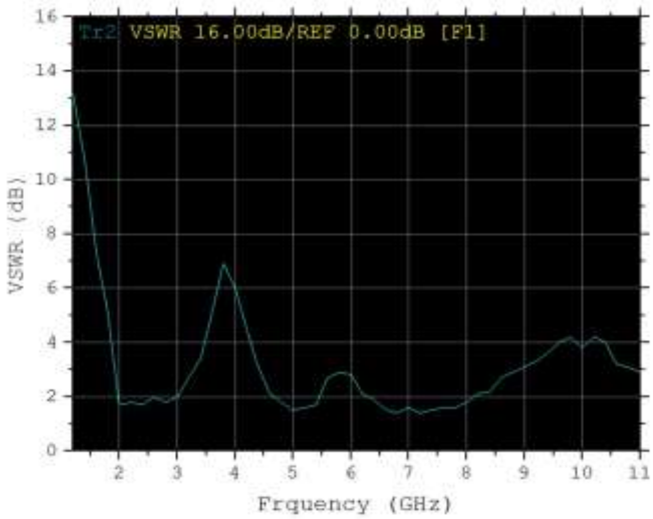

Fig5: Measured VSWR for optimized parameters for 3ghz notch

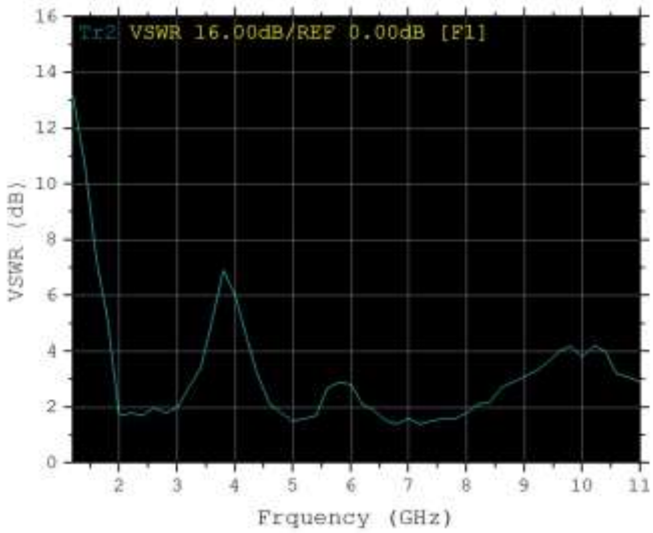

Fig6: Measured VSWR for optimized parameters for dual notch

IV. CONCLUSION

The antenna presented in this paper is a simple, low cost and compact printed square patch antenna, which is designed for 1.6–9.2GHz application. Then notch band has been designed by adding a rectangular notch to the ground plane and U-slot to the radiator patch for filtering the WiMAX (3-4.6GHz) and WLAN(5-6.2GHz) frequencies, to minimize the interference with UWB. The proposed antenna provides more than 95% antenna efficiency.The proposed antenna, has simple construction, outstanding performance and easy to fabricate, which is suitable for various UWB application.

REFERENCES

[1] Qing-Xin Chu and Ying-Ying Yang, “A Compact Ultra wideband Antenna With 3.4/5.5 GHz Dual Band-Notched Characteristics”,IEEE Trans. Antennas and Propag.,vol.56,pp.3637-3644, Dec. 2008.

[2] L. Xiong and P. Gao Research Institute of Electronic Science and Technology, University of Electronic Science and Technology of China “Compact dual band printed diversity antenna for WIMAX/WLAN Application”Progress In Electromagnetic Research C, Vol. 32, 151-165, Sep 2012

[3] S. K. Mishra and J. Mukherjee, Indian Institute of Technology (IIT), Bombay,“Compact printed dual band notched U-shape UWB antenna”Progress In Electromagnetic Research C, Vol. 27, 169-181, Feb. 2012

[4] R. Azim and M. T. Islam Institute of Space Science (ANGKASA) “Compact planar UWB antenna with band notch characteristics for WLAN and DSRC”Progress In Electromagnetic Research, Vol. 133, 39-406, Nov 2013

[5] D.O. Kim and C.Y. Kim, “CPW-fed ultra-wideband antenna with triple-band notch functions”, Electron. Lett. vol.46, pp.1246-1248, Sept.2010.

[6] Kiran Raheel, Shahid Bashir, Nayyer Fazal, “Review of techniques for designing printed antennas for UWB application” International Journal of Engineering Sciences & Emerging Technologies, ISSN: 2231 – 6604 Volume 1, Issue 2, pp: 48-60, Feb 2012.

[7] K. P. Ray, S. S. Thakur & S. S. Kakatkar “Bandwidth Enhancement Techniques for PrintedRectangular Monopole Antenna”, IETE Journal of Research, 60:3, 249-256 June 2014

[8] K.P. Ray and Y. Ranga ,SAMEER, IIT Campus, Powai,“Ultra-wideband printed modified triangularmonopole antenna” The Institution of Engineering And Technology Electronics Letters online no: 20061913 doi: 10.1049/el:20061913,3 July 2006.