# Compact CPW-Fed Triple Band-Notched UWB Antenna with Rectangular Slots

Athira Kaladharan
Dept. of Electronics and Communication
Amal Jyothi College of Engineering
Kanjirappally, India

Ria Maria George
Dept. of Electronics and Communication
Amal Jyothi College of Engineering
Kanjirappally, India

***Abstract*—A simple coplanar waveguide (CPW)-fed printed planar triband notched monopole antenna for WLAN/WiMAX/downlink of satellite communication systems is presented. The antenna is printed on rectangular substrate and three slots are etched on the radiator to achieve three radiating elements for notching operation. The radiator is very compact in size and simple in structure. The proposed antenna not only achieves three bands to notch 3.3–3.7 GHz for WiMAX, 5.15–5.825 GHz for WLAN, and 7.25–7.75 GHz for downlink of X-band satellite communication systems but also exhibits good radiation characteristics. The effect of each radiating element is analyzed in detail. The current distribution, VSWR, radiation pattern, peak gain and return loss characteristics are analyzed.**

***Keywords*— Coplanar waveguide (CPW)-fed, rectangular slot, monopole antenna, notch, WiMAX, WLAN.**

## I. INTRODUCTION

Federal Communication Commission (FCC) allocated band from 3.1 to 10.6 GHz as Ultra Wideband (UWB)[1]. Ultra wideband communication has many advantages such as low power, low emission level, non-dispersion. The FCC limits put on UWB antenna design additional challenges compared to conventional narrow band antenna design. The impedance matching, radiation efficiency and group delay are among the parameters that must be considered with great care during design. These parameters are usually almost constant in the narrow band antenna but in ultra wideband frequency range they vary significantly. Modern antenna has multiband operations covering a whole frequency range such as UWB. An extremely broadband antenna, which is one of the essential components in the UWB communication system, will be considered in the frequency range from 3.1 to 10.6 GHz. Until now, various structures have been studied to achieve wideband antennas. However, in practical applications, antenna design for UWB applications is still facing many challenges. The main challenge in designing this type of antenna is the interference issues. UWB antennas are also necessary for the rejection of unwanted signals from existing technologies such as IEEE 802.11a in the U.S. (5.15–5.35 GHz, 5.725–5.825 GHz) and HIPERLAN/2 in Europe (5.15–5.35 GHz, 5.47–5.725 GHz) and downlink of satellite communication (7.25–7.75 GHz). For generating band notched characteristics, different monopole antenna has been proposed [2]-[8].

The objective of this letter is to present a simple and compact radiator with stable radiation performance of a triple band-notched planar antenna suitable for UWB applications. It will be shown that the proposed antenna in Fig. 1 possesses the desirable feature of compactness while achieving an acceptable impedance bandwidth performance.

In the proposed structure, based on defected ground structure (DGS), by cutting three rectangular slots on the radiator provide band notched function for WLAN, WiMAX and downlink of satellite communication systems. The proposed antenna which not only cover the UWB range but also reject interference from other co-existing systems and having good omnidirectional characteristics. The antenna has a compact radiator and simple structure leads to reduced size.

The paper is frame worked as follows. Section II discusses related work giving a brief review of various existing antennas with notching capability. Section III describes antenna design giving the concept behind the design of antenna. Simulation results and analysis are covered in Section IV. Section V concludes the paper with a brief summary of the main results and findings.

## II. RELATED WORK

In order to generate the frequency band-notch function, modified planar monopoles have been recently proposed. In [2], to avoid frequency-band interference, a reconfigurable structure is used. It is desirable to design the UWB antenna with a reconfigurable notch band which leads to effectively and full utilization of the UWB spectrum. Antenna has a bandwidth from 3.04 to over 10.87 GHz with a band-rejection performance in the frequency band of 5.03-5.94 GHz. However, the elements were developed on the same layer within the antenna radiator for generating single-frequency band-notched antennas. Therefore, due to space limitation, it is difficult to generate dual/multiple notches.

In [3], dual band-notch characteristic is achieved by using a U-slot defected ground structure in the ground of the feeding line and an E-slot in the radiating patch. By adjusting the length of the dimension of the U-slot DGS properly, a notched band at 3.8 GHz can be obtained. By choosing the dimensions of the E-slot properly, another notched band can be achieved at 5.8 GHz. Moreover, the two notched bands can be controlled by adjusting the length of the corresponding slot. However, the size of the antenna is very large and hence not applicable to practical uses.

In [4], printed monopole antenna that uses a vertical coupling strip to flexibly control the rejection frequency band for UWB system operation is presented. The antenna can

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 08, August-2016

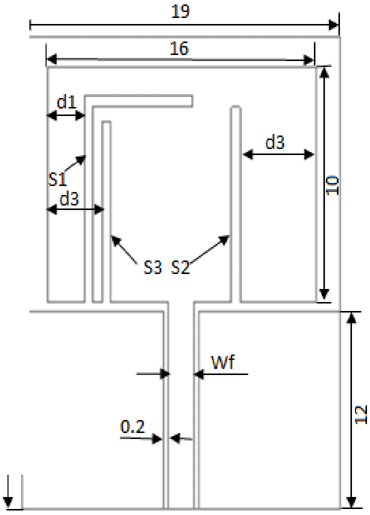


Fig.1. Geometry of the proposed antenna.

easily adjust its stopband property so that better radiation performance can be achieved. The effect caused by frequency interference from other systems is avoided with the help of tunable stopband. However, return loss of the antenna is comparatively small.

In [5], based on electromagnetic coupling, the modified V-shaped protruded strip acts as an impedance-matching element to control the impedance bandwidth of the proposed antenna because it can create additional surface current paths in the antenna. The single band-notch function is provided by cutting a pair of L-shaped slits in the corners of a square radiating patch, and dual band notch characteristics obtained by cutting an E-shaped slot in the radiating patch. But the design has complicated structure that lead to an increase in fabrication costs, antenna size, and difficulty in integration with microwave integrated circuits.

## III. ANTENNA DESIGN

The proposed monopole antenna fed by a CPW feed line as shown in Fig. 1, which is printed on an FR4 substrate of thickness 1.2 mm and having dielectric constant, $\varepsilon_r$ of 4.4. This simple structure only occupies an area of 19×24 mm$^2$.

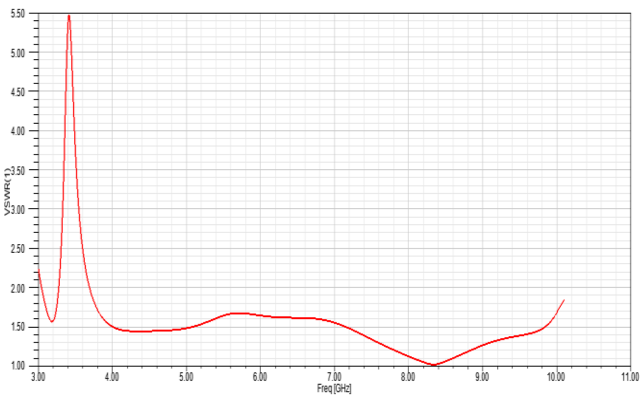


Fig.2. VSWR of the antenna with slot S1.

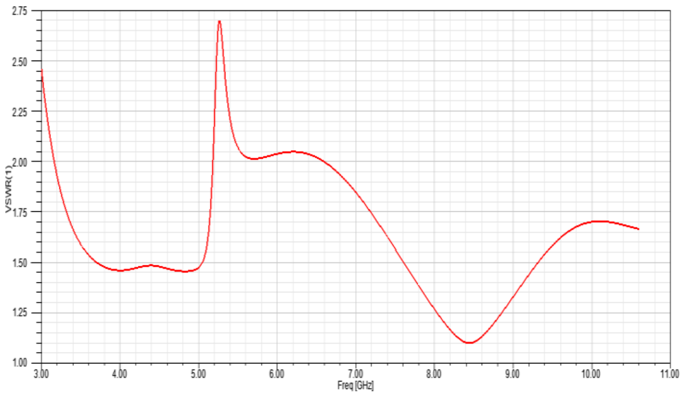


Fig.3. VSWR of the antenna with slot S2.

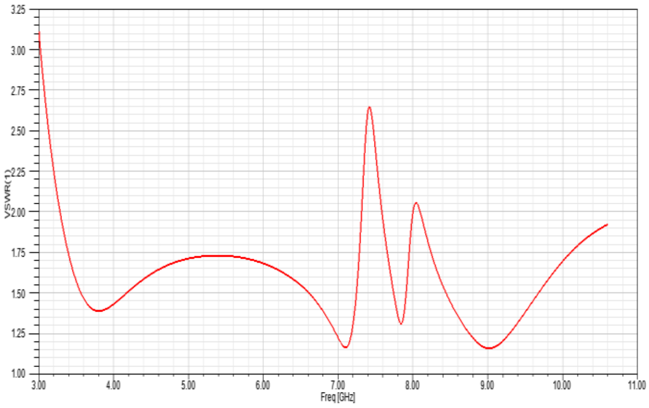


Fig.4. VSWR of the antenna with slot S3.

The proposed antenna consists of a rectangular radiating patch with three rectangular slots and defected ground plane at two sides of radiator. The square patch is connected to a feed-line with the width of $W_f$ and the length of $L_f$, as shown in Fig. 1. Triple-frequency band notches are achieved by vertically aligning three rectangular slots on radiator. Here, each slot is responsible for creating a frequency band notch.

Full-wave EM simulations are performed using ANSYS HFSS leading to the following optimal dimensions for the proposed antenna. $W_f$ = 1.5 mm, d1 = 2.5 mm, d2 = 4 mm, d3 = 3.6 mm.

## IV. RESULTS AND DISCUSSION

The configuration of the slots is shown in Fig. 1. In this design, length of the slot is calculated as the quarter of the guided wavelength at the respective notch frequency. The influence of each slot on the characteristics of antenna is studied first.

Fig. 2 shows the VSWR of the antenna with slot S1 only. As shown in Fig. 2, antenna has a band notch from 3.3 to 3.7 GHz for the WiMAX application. Hence slot S1 is responsible for first band-notch.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 08, August-2016

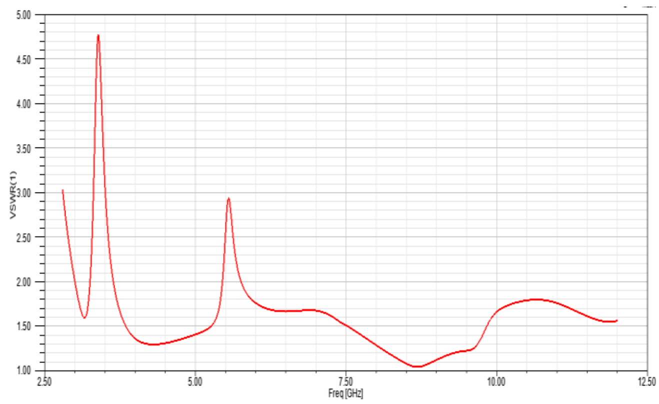


Fig.5. VSWR of dual band notch antenna.

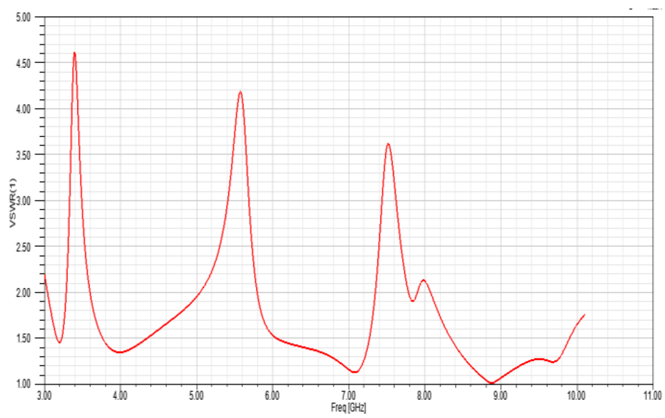


Fig.6. VSWR of proposed antenna.

Fig. 3 shows the effect on VSWR of the antenna with slot S2 only. Proposed antenna has a band notch from 5.15 to 5.825 GHz for the WLAN application. Hence slot S2 is responsible for second band-notch. Fig. 4 shows the influence of slot S3 on VSWR of the antenna. Proposed antenna has a band notch from 7.25 to 7.75 GHz for the downlink of satellite communication. Hence slot S3 is responsible for third band-notch.

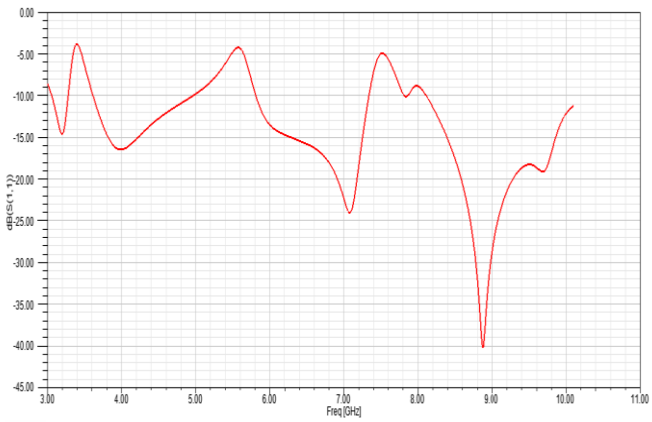


Fig.7. Return loss of proposed antenna.

Fig. 5 shows the VSWR of dual band notch antenna. When slot S1 and S2 is loaded into the radiating patch, antenna act as a dual band notch for notching 3.3–3.7 GHz for WiMAX, 5.15–5.825 GHz for WLAN. Fig. 6 shows the VSWR of the proposed antenna loaded with three rectangular slots. Proposed antenna covering the ultra wideband with a bandwidth from 3.1 to 10.6 GHz. It providing triband notched characteristics in 3.3–3.7 GHz for WiMAX, 5.15–5.825 GHz for WLAN, and 7.25–7.75 GHz for downlink of X-band satellite communication systems. Fig. 7 shows the return loss of the proposed antenna. It is evident from the obtained reflection loss graph, for required bandwidth the reflection loss is below -10dB, which means transmission of signal will takes place at this frequency and for notched bandwidth, reflection loss is above -10 dB.

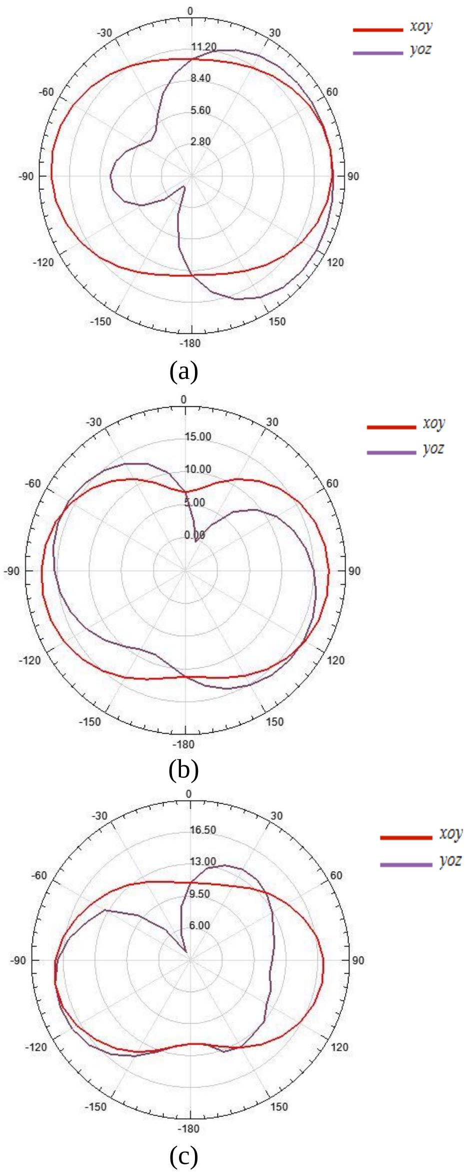


Fig.8. Simulated radiation patterns in the *xoy* and the *yoz* planes at (a) 3.5, (b) 5.5, and (c) 7.5 GHz.

The far field radiation pattern of the antenna are simulated. Simulated radiation patterns in the *xoy* and the *yoz* planes at 3.5, 5.5 and 7.5 GHz are shown in Fig. 8(a)-(c), respectively. The proposed antenna has good radiation characteristics.

## V. CONCLUSION

A very compact CPW-fed UWB antenna with triple band notched characteristics was proposed. Three rectangular slots are used in the radiator to achieve triband notching characteristics. The influence of each slot in getting the specific notch band is discussed. Proposed antenna has simple structure and small size make it easy to integrate with microwave circuits. Antenna having good radiation characteristics and three notch bands for WiMAX, WLAN and downlink of satellite communication.

## REFERENCES

[1] Federal Communications Commission (FCC), Washington, DC, "First report and order in the matter of revision of Part 15 of the commission's rules regarding ultra-wideband transmission systems," ET-Docket 98-153, 2002.

[2] A.Valizade, J. Nourinia, C.Ghobadi, and M. Ojaroudi, "A novel design of reconfigurable slot antenna with switchable band notch and multiresonance functions for UWB applications," *IEEE Antenna Wireless Propag. Lett.*, vol. 11, pp. 1166-1169, 2012.

[3] Kim, K.H., Cho, Y.J., Hwang, "Compact printed ultra wideband monopole antenna with dual band-notch characteristic," *Electron. Lett.*, vol. 60, pp. 783-785, 2008.

[4] H.W. Liu, C.H.Ku, T.S.Wang, and C.F. Yang, "Compact monopole antenna with band-notched characteristics for UWB applications," *IEEE Antenna Wireless Propag. Lett.*, vol. 9, pp. 240-243, 2010.

[5] M. Mehranpour, J. Nourinia, C. Ghobadi, and M. Ojaroudi, "Dual band-notched square monopole antenna for ultrawideband applications," *IEEE Trans. Antennas Propag.*, vol. 11, pp. 172-175, 2012.

[6] M. Rostamzade, S. Mohamadi, C. Ghobadi, J. Nourinia, and M. Ojaroudi, "Square monopole antenna for UWB applications with novel rod shaped parasitic structures and novel V-shaped slots in the ground plane," *IEEE Trans. Antennas Propag.*, vol. 11, pp. 446-449, 2012.

[7] L. Luo, Z. Cui, J.-P. Xiong, X.-M. Zhang and Y.-C. Jiao, "Compact printed ultra wide- band monopole antenna with dual band-notch characteristic," *Electron. Lett.*, vol. 44, pp. 783-785, 2008.

[8] Q. X. Chu and Y. Y. Yang, "3.5/5.5 GHz dual band-notch ultra-wideband antenna," *Electron. Lett.*, vol. 44, no. 3, pp. 172–174, 2008.