Middle-East Journal of Scientific Research 25 (2): 268-273, 2017
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2017.268.273

CPW Fed Polygonal Stub loaded Antenna for UWB with Dual Band Notch Characterstics

K.A. Ansal, S.G. Jinsa, T. Nimmymol, R. Praseeda and S.M. Riyanka

Department of Electronics and Communication,
Saintgits College of Engineering, Kottayam 686532, India

Abstract: In this article, presented a compact CPW fed slotted antenna with polygonal conducting stub for ultra wide band (UWB) applications. The notched band functions achieved by adding parasitic strip on the ground plane and etching a C-shaped slot on the radiating stub. The proposed prototype is designed on FR4 epoxy substrate with dielectric constant 4.4 has dimension 29x31x0.8 mm^3 and it covers a frequency range of 3.1 -10.6 GHz for (VSWR<2). The fundamental parameters of the antenna such as return loss, VSWR, 2D radiation patterns, gain and bandwidth are obtained and all meets of the acceptable antenna standards. The simulation results of this antenna are analyzed by using Mentor Graphics IE3D version 15.10 electromagnetic solver which is based on Method of moments (MoM).

Key words: Coplanar waveguide(CPW) · Ultrawide Band(UWB) · Return Loss · VSWR · Gain

INTRODUCTION

Ultra-wideband (UWB) antennas are becoming very attractive in modern wireless communication systems, mainly because of properties such as high data rate, low power consumption and low cost. The wireless portable device need antenna operated in different frequencies for various wireless transmission functions, which may result in challenges in antenna design, such as antenna space limitation, multi antennas interference and etc. One UWB antenna can be used to replace multi narrow-band antennas, which may effectively reduce the antenna number.

Since Federal Communication Commission (FCC) released a frequency band of 3.1-10.6 GHz for commercial UWB applications, UWB technology has gained attention in both industry and academia. UWB antenna is one of the key elements in UWB systems. Hence, design of UWB antenna has gained importance in the wireless research field. Since small antennas are required for portable systems, miniaturization of antenna has become one of the major research attention. The Planar slot antennas have become popular among recently proposed antennas due to their miniaturized profile, wide bandwidth and ease of integration with RF front ends. The conventional microstrip based design has disadvantage of narrow impedance bandwidth. Various techniques reported in the literature to improve the impedance bandwidth of microstrip antennas such as E-shaped patch [1], defected ground structure (DGS) [2], stacked patches [3], insertion of parasitic elements [4], deployment of different shaped feed geometries and slots [5-6]. However, they cannot provide much wider bandwidth to mitigate the various wireless application functions together. This can be rectified by using coplanar waveguide (CPW) feed with different radiating patches like elliptical [7], circular patch [8] etc. for ultra-wide bandwidth. Ultra wideband antenna has various applications such as target identification, location tracking, radio frequency identification etc. The design and characterisation of UWB antenna have several bottlenecks. firstly UWB antenna has pulse based transmission, phase should be constant over entire operating band to avoid pulse distortion in wireless communications. Secondly, the return loss of the antenna should be maintained below -10dB throughout operating band. Thirdly, the antenna should also be miniaturized so that it can be easily integrated with modern communication terminals. The gain of antenna is a function of frequency and radiation pattern. Hence, the antenna should receive signals in all directions. The characteristics such as vswr, return loss, gain and

Corresponding Author: Dr. K.A. Ansal, Department of Electronics and Communication, Saintgits College of Engineering, Kottayam 686532, India.

radiation pattern are discussed in this article. Several methods have been proposed in the literature to design UWB antennas with band-notched functions, including etching C-shaped, L-shaped, T-shaped, H-shaped, U-shaped, E-shaped and half-circle slots on the radiating patch or on the ground plane [9-13], or by employing T-shaped, L-shaped and spiral parasitic strips or open circuit stubs to the antennas [14-17].

In this paper, a novel CPW-fed antenna with dual notched characteristics is discussed for UWB applications. The antenna has better impedance matching and stable radiation patterns over the UWB incorporating pair of parasitic strips on the ground plane and C-Shaped slot loaded on the polygonal radiator. The antenna can be operated in IEEE802.16 WiMAX band (3.3-3.7GHz) and IEEE 802.11 WLAN band (5.2-5.5GHz). The optimized geometry of the proposed CPW-fed slot antenna is Polygonal shaped. The parametric analysis is done to optimize the design and to achieve the ultra wideband performance and notch band characteristics. The radiation characteristics of antenna in both E-plane and H-plane are simulated and presented. The current distribution, gain and efficiency of antenna are also discussed.

Antenna Structure and Design: The theoretical values of Wand L are obtained from Equation. 1 for the lowest resonant frequency f_l = 3.1 GHz and dielectric constant ε_r = 4.4. The optimized values of W and L are obtained using IE3D electromagnetic solver. These values are shown in the Table 1.

The geometry of antenna is shown in Figure.1. The antenna is printed on FR4 dielectric substrate with dielectric constant ε_r =4.4and loss tangent tanä =0.002. The antenna has compact size of 28 ×31×0.8 mm^3.The antenna is fed by CPW with the thickness h =0.8mm.The gap 'g' between center conductor and ground plane of CPW is 0.45mm. The CPW feed has 50 characteristic impedance and it is terminated by subminiature version A (SMA) connector. Since the patch and feed structure are constructed on the same plane, one metallic layer only is present. Hence, the antenna can be easily fabricated and it has low cost. The antenna has novel tuning stub in polygonal shape. The antenna is optimized with Mentor Graphics IE3D electromagnetic solver. The total width 'W'and length 'L' of planar antenna are given by the Equation.1,where dielectric constant ε_r of substrate is greater than 4.

$$W = L = \frac{c}{2f_l\sqrt{\varepsilon_{eff}}} \quad (1)$$

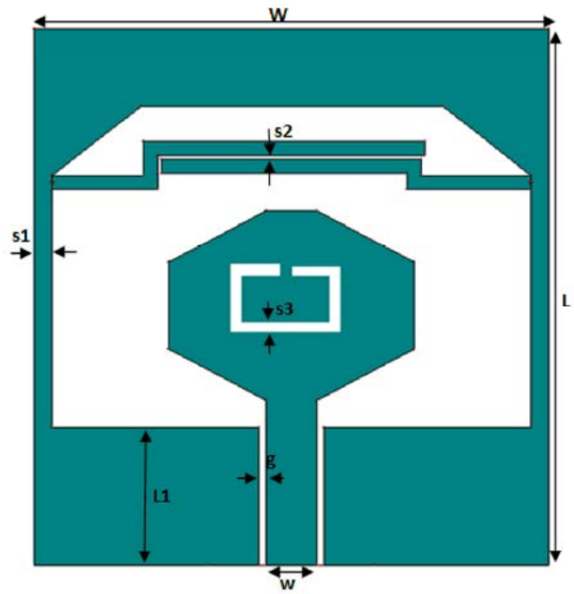

Fig. 1: Geometry of the proposed antenna

Table 1: Parameters of the proposed antenna

Parameter	L	W	w	s1	s2	s3	L1	g
Value(mm)	31	29	2.8	1	0.2	0.5	8	0.45

here c is velocity of light in free space and fl is the lowest operating frequency corresponding to free space wavelenth λo.

$$\lambda_0 = \frac{c}{f_l}$$

and

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2}$$

RESULTS AND DISCUSSIONS

The design evolution of the proposed antenna with notch band function from the parent polygonal shaped antenna (i) shown in Figure. 2. The notch band characteristics at (3.3-3.7GHz) WiMaX band obtained by adding L shaped closed ended parasitic tuning stub on the ground plane shown in antenna (ii). The notch band at the (5.1-5.4GHz) WLAN band obtained by loading a C- Shaped slot on the polygonal radiating stub shown in antenna (iii). This notched design does not affect the gain and radiation performance of the proposed antenna in other frequencies so that, we can avoid interference due to other proximity devices in the specified notched band of frequencies. The return loss characteristics of

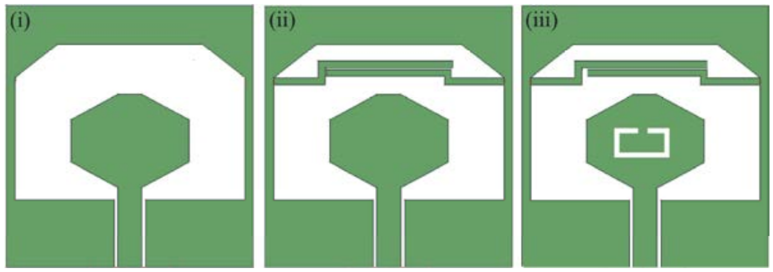

Fig. 2: Design iteration of the proposed antenna

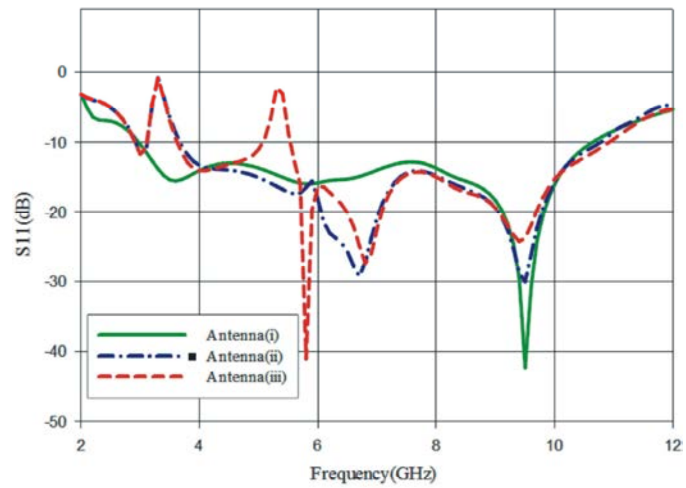

Fig. 3: Return Loss characteristics of the proposed antenna for various design iteration

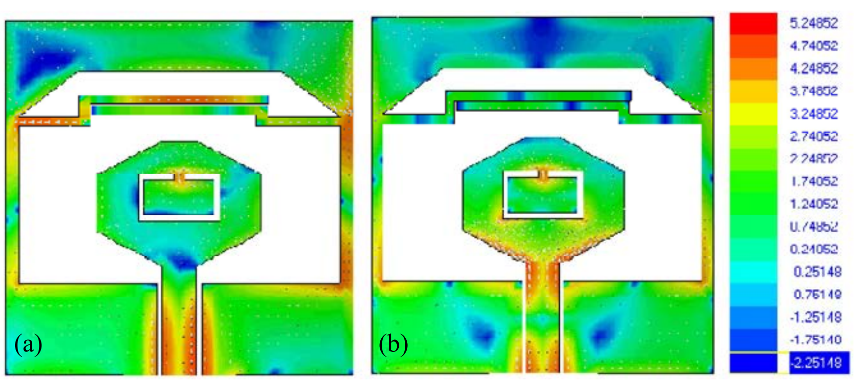

Fig. 4: Current distribution of the proposed antenna (a) 6.5GHz (b) 9.4GHz

proposed geometries for the design iteration shown in Figure. 3, from which it is clear that proposed design performed well in the ultra wide band range.

The current distribution for the proposed design shown in Figure.4. in the 6.5GHz current perturbed across the ground plane and notch band tuning parasitic stubs which is attached on the ground plane. In the 9.4GHz the current is more perturbed across the polygonal radiating stub and notched band C-shaped slot which is loaded on the radiator. From the figure we can see that the proposed design yield average gain of 5dBi. The photograph of the fabricated prototype and its measurement set up shown in Figure 5.

The comparison between measured and simulated return loss characteristics of the proposed prototype shown in figure.6 reveals that the measured characteristics closely match with simulated. In simulation the design yield a matching of -42dB, but in measurement the antenna give average return loss of -30dB

Figure 7 shows the simulated 2D radiation patterns with Elevation and azimuthal plane at resonant frequencies by using Mentor Graphics IE3D

Fig. 5: Photograph of the fabricated prototype and its measurement set up

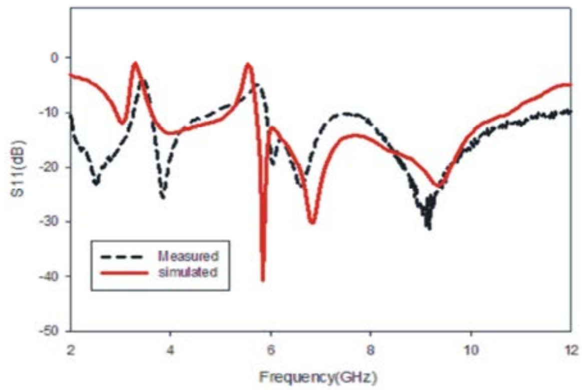

Fig. 6: Comparison between simulated and measured return loss characteristics

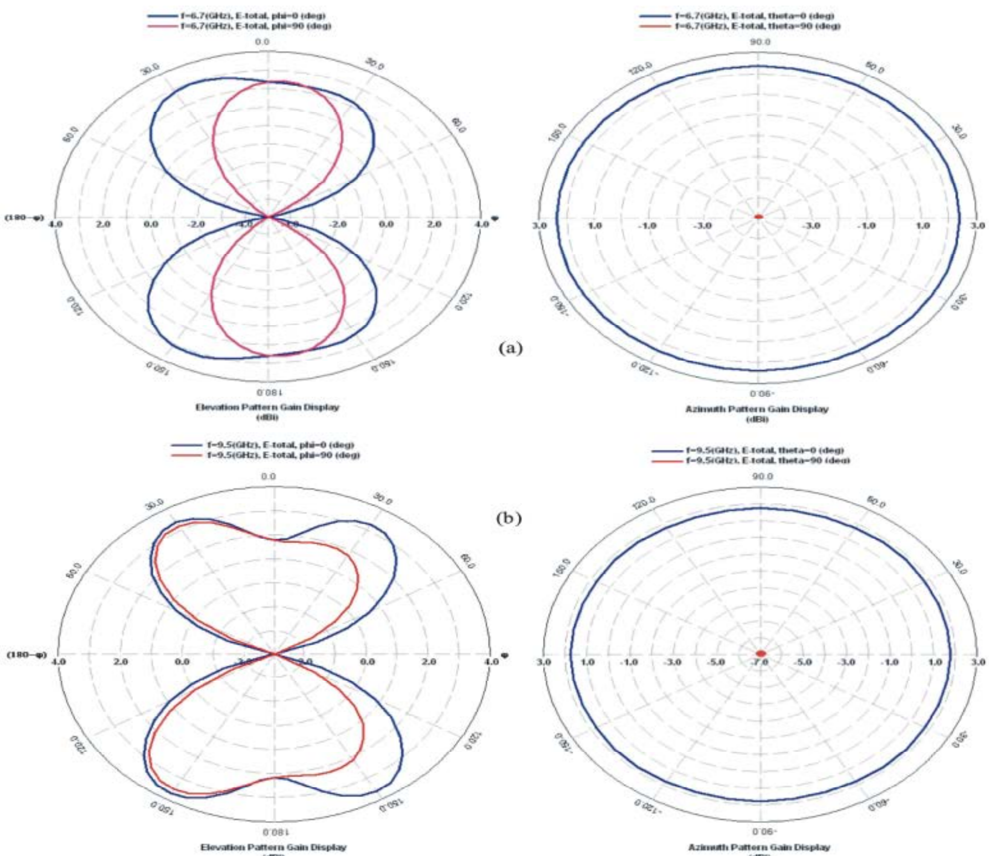

Fig. 7: Simulated Elevation and Azimuthal radiation patterns(a) 6.7GHz (b) 9.5GHz

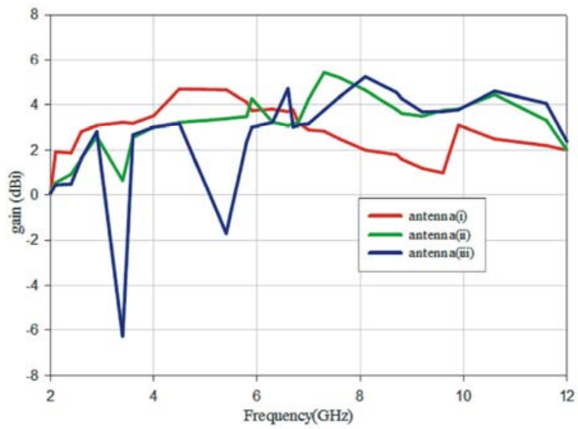

Fig. 8: Simulated gain of the proposed antenna and its varients

electromagnetic solver. The simulated radiation patterns of antenna in the E-plane (XZ-plane) and H-plane (YZ-plane) for two different frequencies 6.7 GHz and 9.5GHz. The patterns and other curves are obtained at the time of simulation. We observed good radiation patterns by taking 20 cells per wavelength. From the figure we can clear that E- plane patterns are bidirectional and H-plane patterns are ominidirectional in nature.

Finally the antenna gain is simulated and displayed in figure 8. The proposed prototype has a average gain of 4dBi in the entire operating range except notch band frequencies. In the notch frequencies ie, 3.5 GHz and 5.2GHz the gain drop down to 0dBi. From which it evident that those frequencies the demonstrated prototype yield less interference. The peak gain of the antenna is 5.2 dBi observed at 8.1GHz which is sufficient for present and future wireless communication standards.

CONCLUSION

A novel compact CPW-fed planar UWB antenna with dual band-notched charactrstics is proposed and investigated. The primitive UWB antenna is fed by a simple polygonal shaped patch, with a compact size of 31mm × 29mm × 0.8mm. The proposed antenna impedance bandwidth could cover the full UWB spectrum except for the two notched bands for WiMAX and WLAN applications, respectively. A C-shaped slot is etched on the patch and two parasitic strips are added to the ground plane to achieve 5.2GHz and 3.5GHz dual band-notched functions.The ultra wideband width with dual band-notched characteristics,the compact size,and the simple structure of the proposed antenna make it an excellent candidate forUWB applications.

REFERENCES

1. Ang, B.K. and B.K. Chung, 2007. A wide band E shaped patch antenna for 5-6 GHz wireless commutation, Progress In Electromagnetics Research, PIER, 75: 397-407.
2. Mukesh Kumar Khandelwal *et al*, 2017. Defected Ground Structure: Fundamentals, Analysis and Applications in Modern Wireless Trends. International journal of antennas and propagation, Hindawi, Volume 2017.
3. Long, S.A. and M.D. Walton, 1987. A Dual-frequency stacked circular Disc antenna, IEEE Trans. Antennas Propagat. Vol. AP-27, 2:270-273.
4. Aanandan, C.K., P. Mohanan and K.G. Nair, 1990. Broad band gap coupled microstrip antenna, IEEE Transactions on Antennas and Propagation, 38(10): 1581-158.
5. Mridula, S., Sreedevi K. Menon, B. Lethakumary, Binu Paul, C.K. Aanandan and P. Mohanan, 2002. Planar L-strip fed broadband microstrip antenna, Microwave and Optical Technology Letters, 34(2): 115-117.
6. Lethakumary, B., Sreedevi K. Menon, C.K. Aanandan and P. Mohanan, 2003. A wide band rectangular microstrip antenna using an asymmetric T-shaped feed, Microwave and optical technology letters, 37(1): 31-32.
7. Huang, C.Y. and W.C. Hsia, 2005. Planar elliptical antenna for ultra-wide band communications. IEEE Electronics Letters, 6: 296-297.
8. Melo, D.R., M.N. Kawakatsu, D.C. Nascimento and V. Dmitriev, 2012. Planar monopole UWB antennas with rounded patch and ground plane possessing improved impedance matching. Microwave and Optical Technology Letters, 54(2): 335-338.
9. Zhu, X.F. and D.L. Su, 2010. Symmetric E-shaped slot for UWB antenna with band-notched characteristic. Microwave and Optical Technology Letters, 52(7): 1594-1597.
10. Habib, M.A., A. Bostani, A. Djaiz, M. Nedil, M.C.E. Yagoub and T.A. Denidni, 2010. Ultra wide band CPW-fed aperture antenna with wlan band rejection, Progress in Electromagnetics Research, 106: 17-31.
11. Barbarino, S. and F. Consoli, 2010. UWB circular slot antenna provided with an inverted-L notch filter for the 5GHz WLAN band. Progress in Electromagnetics Research, 104: 1-13.

12. Lin, Y.C. and K.J. Hung, 2006. Compact ultra wideband rectangular aperture antenna and band-notched designs, IEEE Transactions on Antennas and Propagation, 54(11): 3075- 3081.
13. Pouyanfar, N., 2013. CPW-FED UWB antenna with band-stop properties, Microwave and Optical Technology Letters, 55(7): 1533-1537.
14. Xu, J., D.Y. Shen, G.T. Wang, X.H. Zhang, X.P. Zhang and K. Wu, 2012. A small UWB antenna with dual band-notched characteristics, International Journal of Antennas and Propagation, vol. 2012.
15. Chu, Q.X. and Y.Y. Yang, 2008. A compact ultra wide band antenna with 3.4/5.5GHz dual band-notched characteristics, IEEE Transactions on Antennas and Propagation, 56(12): 3637- 3644.
16. Liu, J., S. Gong, Y. Xu, X. Zhang, C. Feng and N. Qi, 2008. Compact printed ultra-wideband monopole antenna with dual band notched characteristics, Electronics Letters, 44(12): 710-711.
17. Zhai, H., J. Ou, T. Li, G. Li, L. Li and C. Liang, 2013. A compact ultra wideband antenna with two band-notches, Microwave and Optical Technology Letters, 55(3): 583-586.