A Compact UWB Antenna With Dual Band-Notched Characteristics

Abu F.N.Rashid, Shabana Huda , Sanghamitra Chatterjee
ECE Department, Camellia Institute Of Technology,Kolkata,West Bengal,India.

Abstract—We propose a compact planar ultra wideband (UWB) antenna with 5.5/7.4 GHz dual band-notched characteristics. The antenna consists of a circular metal patch and a 50 ohm coplanar waveguide (CPW) transmission line. Two types of simple slots, semicircular and L shaped are cut in the radiating patch to create dual band-notched characteristics at 5.15–5.825 GHz for WLAN and 7.25 - 7.75 GHz for downlink of Xband satellite communication systems. The antenna has a small size of length by width of 40x37 mm^2, a stable gain, and a nearly omnidirectional radiation pattern in the entire bandwidth. The proposed antenna is successfully simulated showing broadband matched impedance, stable radiation patterns and constant gain.

Index Terms—Coplanar waveguide (CPW), dual band-notched characteristics, ultra wideband (UWB) antennas

1 INTRODUCTION

SINCE the Federal Communications Commission (FCC) first approved rules for the commercial use of ultra wideband (UWB) in 2002 [1], the feasible design and implementation of UWB system has become a highly competitive topic in both academy and industry communities of telecommunications. In particular, as a key component of the UWB system, an extremely broadband antenna will be launched in the frequency range from 3.1–10.6 GHz, which has attracted significant research power in the recent years [2-3]. It is desirable to design the UWB antenna with dual notched frequency bands both in 5.15–5.825 GHz and 7.25 - 7.75 GHz to minimize the potential interferences between UWB system and narrowband systems. So far, several design methods and structures have been reported. These UWB antennas with filtering property have been proposed not only to mitigate the potential interferences but also to remove the requirement of an extra band stop filter in the system [4-11].

In this article, a coplanar-waveguide-fed (CPW-fed) planar monopole UWB antenna with a small size and dual band notched characteristics is proposed. By using two types of simple slots etched in the radiating patch, L-shaped and semicircular, two notched bands are achieved. The antenna covers the entire allocated UWB frequency band except for the two notched bands and also satisfies other UWB antenna requirements.

2 ANTENNA DESIGN

Through simulations with the software CST™, the final optimized design of the proposed antenna with a compact size of $L_{sub}xW_{sub}$ (40x37mm^2) is obtained as shown in Figure 1. This antenna is printed on the FR4 substrate with height of 1.59mm and a relative dielectric constant $\acute{\varepsilon}_r$ of 4.4 and a loss tangent of 0.002. The antenna consists of a 50ohm CPW feed line and a planar circular radiating patch with radius 9mm. The single-layered CPW-fed structures with ground plane length 18mm and width 16.5 mm of the antenna make it easy to integrate with a RF front-end. The gap (g_p) between patch and ground plane is optimized to 0.75mm and gap between ground and central conductor(g_f) is optimized to 0.4mm for proper impedance matching.

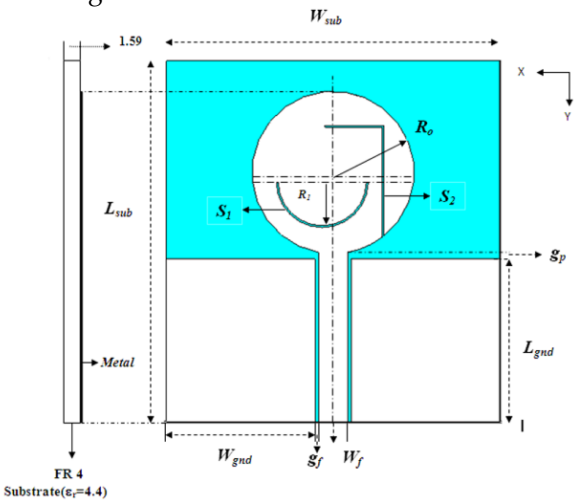


Fig.1: Geometry of the proposed antenna (units in mm)

Two types of slots with the same line width of 0.2 mm, L shaped (S_2) and semicircular (S_1), are cut in the radiating patch to generate the band notches in 7.25 - 7.75 GHz for downlink of Xband satellite communication systems and 5.15–5.825 GHz for WLAN band. The total length of the slot S_2(L_{s2}=18.74mm) is about a quarter of the guided wavelength calculated at the center frequency of the Xband, whereas that of the slot S_1(L_{s1}=15.7mm) is about a half of the guided wavelength calculated at the center frequency of the WLAN band.

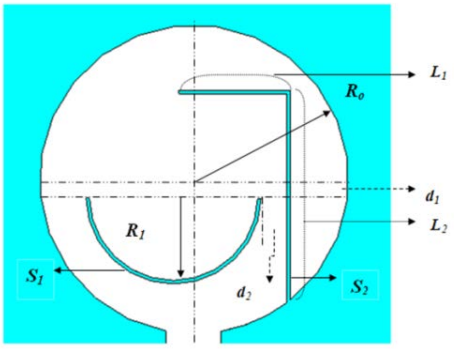


Fig.2: Geometry of the proposed notch structures of the antenna and design parameters (units in mm).

The optimized dimensions are given in table1.

Table 1:Optimized dimensions of the proposed antenna:

Slot parameter	**Value (in mm)**
Slot (S_1)	
Radius(R_1)	4.9
Distance from center of patch (d_1)	1
Distance second slot S_2 (d_2)	1.5
Length (L_{s1})	15.7
Slot (S_2)	
L_1	6.5
L_2	12.246
Length (L_{s2})	18.746

3 RESULTS

Performance of the simulated S_{11} characteristics of antenna is shown in Fig. 3. From the figure, it is evident that bandwidth of the antenna extends from 3GHz to 12GHz and the desired filtering property is introduced by the slots as expected. This dual band-notched UWB antenna successfully blocks out the 5–6 GHz band and 7.16 - 7.857 GHz and still performs good impedance-matching at other frequencies in the UWB band.

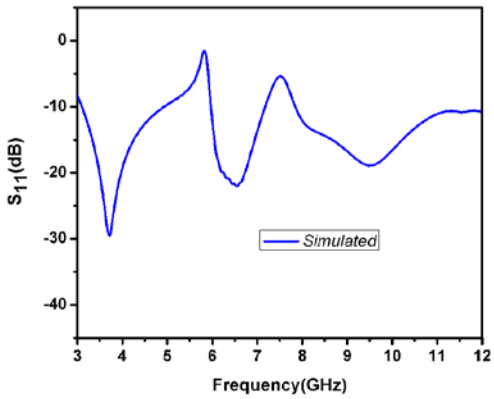
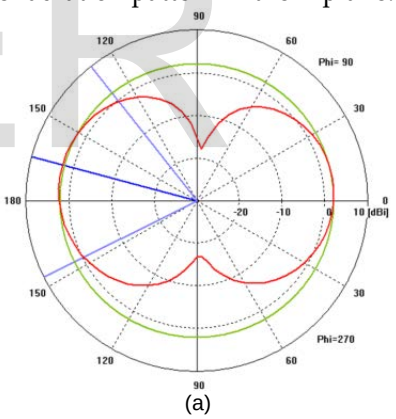
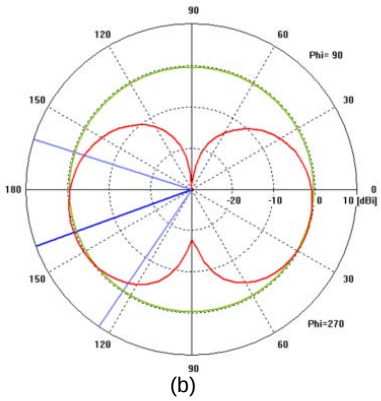


Fig.3: Simulated S_{11} characteristics of the proposed antenna.

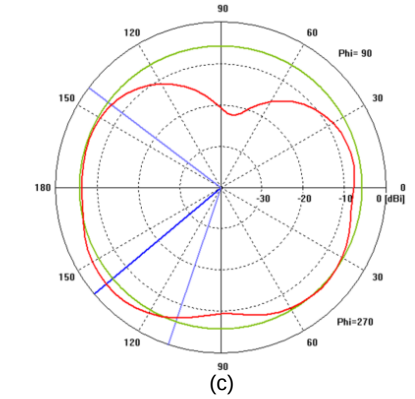
The simulated radiation patterns in the E (y–z) and the H (x– z) planes at 3.72GHz, 6.55GHz, and 9.35GHz are shown in Figure 4. The antenna displays a nearly omnidirectional radiation pattern in the H-plane and a dipole-like radiation pattern in the E-plane.



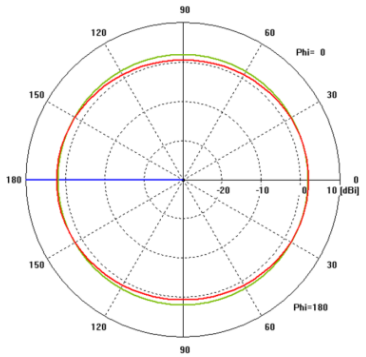
(a)



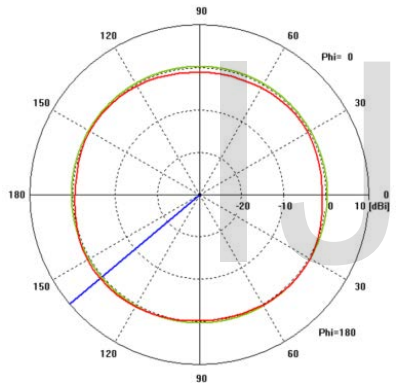
(b)



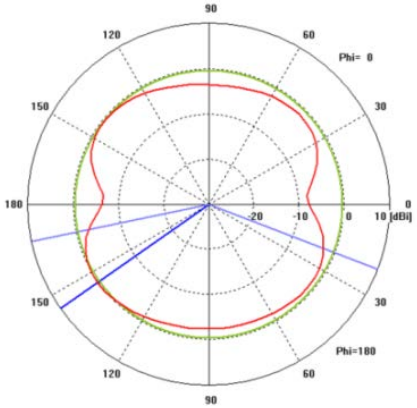
(c)
E plane patterns



(a)



(b)



(c)
H plane patterns

Fig.4: Simulated radiation patterns in the E- and the H- planes at (a) 3.72 GHz, (b) 6.55 GHz, and (c) 9.53 GHz.

Fig.5 shows the simulated gain of the antenna. Sharp gain decreases occur both in 5.15–5.825 GHz and 7.25-7.75 GHz bands. However, for other frequencies outside the rejected bands, the antenna gain is nearly constant in the entire UWB band.

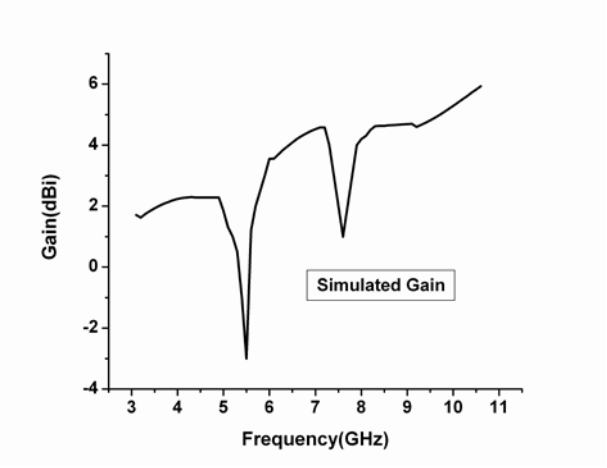


Fig.5: Simulated gain of the proposed antenna

4 CONCLUSION

A small CPW-fed planar monopole UWB antenna with dual band-notched characteristics is proposed and discussed. The two designed notched bands are realized by etching two types of simple slots in the radiating patch, L-shaped and semicircular. These notched bands can significantly suppress potential electromagnetic interference with existing systems in the UWB bands, i.e., WLAN and Xband. The proposed antenna shows very good simulation results with a wide bandwidth from 3 to >12 GHz with two intended notched bands. Accordingly, the proposed antenna is expected to be a good candidate in various UWB systems.

ACKNOWLEDGMENT

Authors like to acknowledge Camellia Institute of Technology, Madhyamgram, Kolkata, WB, India, for providing academic and administrative help.

REFERENCES

[1] First Report and Order, "Revision of Part 15 of the Commission's Rule Regarding Ultra-Wideband Transmission System FCC 02–48," Federal Communications Commission, 2002.

[2] T. G. Ma and S. K. Jeng, "Planar miniature tapered-slot-fed annular slot antennas for ultra-wideband radios," *IEEE Trans. Antennas Propag.*, vol. 53, pp. 1194–1202, Mar. 2005.

[3] Y. C. Lin and K. J. Hung, "Compact ultrawideband rectangular aperture antenna and band-notched designs," *IEEE Trans. Antennas Propag.*, vol. 54, pp. 3075–3081, Nov. 2006.

[4] T. P. Vuong, A. Ghiotto, Y. Duroc, and S. Tedjini, "Design and characteristics of a small U-slotted planar antenna for IR-UWB," *Microw. Opt. Technol. Lett.*, vol. 49, pp. 1727–1731, Jul. 2007.

[5] Y. -J. Cho, K. -H. Kim, D. -H. Choi, S. -S. Lee, and S. -O. Park, "A miniature UWB planar monopole antenna with 5-GHz band-rejection filter and the time-domain characteristics," *IEEE Trans. Antennas Propag.*, vol. 54, pp. 1453–1460, May 2006.

[6] V. J. Lui, C. H. Cheng, Y. Cheng and H. Zhu, "Frequency Notched Ultra-Wideband Microstrip Slot Antenna with Fractal Tuning Stub," *Electronics Letters*, Vol. 41, No. 24, 2005, pp. 294-296.

[7] W. J. Lui, C. H. Cheng and H. B. Zhu, "Compact Frequency Notched Ultra-Wideband Fractal Printed Slot Antenna," *IEEE Microwave and Wireless Components Letters,*vol. 16, No. 4, 2006, pp. 224-226.

[8] A. Azari, J. Rowhani "Ultra Wideband Fractal Microstrip Antenna Design" *Progress In Electromagnetics Research C,* vol. 2, 7–12, 2008.

[9] A. M. Abbosh and M. E. Bialkowski, "Design of UWB planar band-notched antenna using parasitic elements," *IEEE Trans. Antennas Propag.*, vol. 57, no. 3, pp. 796–799, Mar. 2009.

[10] L. Peng, C. L. Ruan, Y. L. Chen, and G. M. Zhang, "A novel bandnotched elliptical ring monopole antenna with a coplanar parasitic elliptical patch for UWB applications," *J. Electromagn.Waves Appl.*, vol. 22, no. 4, pp. 517–528, Apr. 2008.

[11] W. S. Lee, D. Z. Kim, K. J. Kim, and J. W. Yu, "Wideband planar monopole antennas with dual band-notched characteristics," *IEEE Trans. Microw. Theory Tech.*, vol. 54, no. 6, pp. 2800–2806, Jun. 2006.