A Novel Coplanar Waveguide Fed Ultra-Wideband Antenna With Dual Band-notched Characteristics

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Abstract: A novel ultra-wideband (UWB) antenna is proposed in this paper ,which has a band-notched characteristic for the interference between the UWB applications and the IEEE802.11a wireless local area network (WLAN) and the WiMAX /C-band with combination of notched structures. The proposed antenna fed by coplanar waveguide (CPW) ,with modified U-slots and general U-slot in echelon patch which can be used to reject the frequency 5.15 to 5.825 GHz, 3.3 to 3.6GHz ,and 3.7 to 4.2GHz. The simulation results show that the antenna has obvious band-notched characteristics in the notched band which can effectively prevent the interference of these narrow-band communication systems, and also has well radiation characteristics in the whole band .

1. Introduction

The Ultra-Wideband standard was approved for commercial use in 2002 by the US Federal Communications Commission (FCC) with range of 3.1 ~ 10.6GHz. For UWB antenna system, the frequency range of its coverage is very wide, however, these of the 5.15 to 5.825 GHz frequency band , 3.7-4.2GHz frequency band, and 3.3-3.6GHz have been limited by IEEE 802.11a for wireless local area network (WLAN) systems, C-band, and worldwide interoperability for microwave access(Wimax) systems. To avoid the interference between the UWB and these narrow-band systems, band-notched filter in UWB systems is necessary. Several antennas with band-notch characteristic have been reported.[1-6]. Jia-Yi Sze and Jen-Yi Shui, proposed wideband planar monopole antennas with a band-notched characteristics[7], a rejected frequency band within the UWB was produced by embedding a pair of U-slot lines in the back-patch. Qing-Xin Chu and Ying-Ying Yang , proposed a simple antenna to achieve dual band-notched characteristic by using compylementary split ring resonator structure[8], the radiating patch using the gradient structure which can expand the bandwidth of antenna. As we all have known the fact that the U-slot can realize the notched characteristic, M. Mahmoud had made an investigation of changing the angle of U-slot's arms can expand the bandwidth[9]. In this paper, a CPW-fed UWB antenna with dual band-notched characteristic is investigated numerically and experimentally. We proposed a antenna by using the combination of a pair of modified U-slots and general U-slot. The modified U-slot effecting high frequency's band-notch function, and the radiating patch using a gradient structure. The miniaturized monopole antenna of size 31.5*26.7*0.508 mm^3 has achieved two notched bands covering 3.20-4.2GHz and 5.05-5.97GHz.

2. Antenna Design

The design and the parameters of the CPW-fed monopole antenna with U-slots embedded on the structure for achieving dual-band rejected functions are presented in Fig.1. Rogers RO4350 (tm) with a small size of 31.5*26.7*0.508mm^3, relative permittivity εr= 3.48 and loss tangent tan δ= 0.0037 is used as dielectric substrate. A CPW feed line of W_f strip width and G_f gap between the strip and the coplanar ground plane is printed to achieve 50 ohms impedance. We use echelon patch to improve the bandwidth of antenna for it's gradually structure.

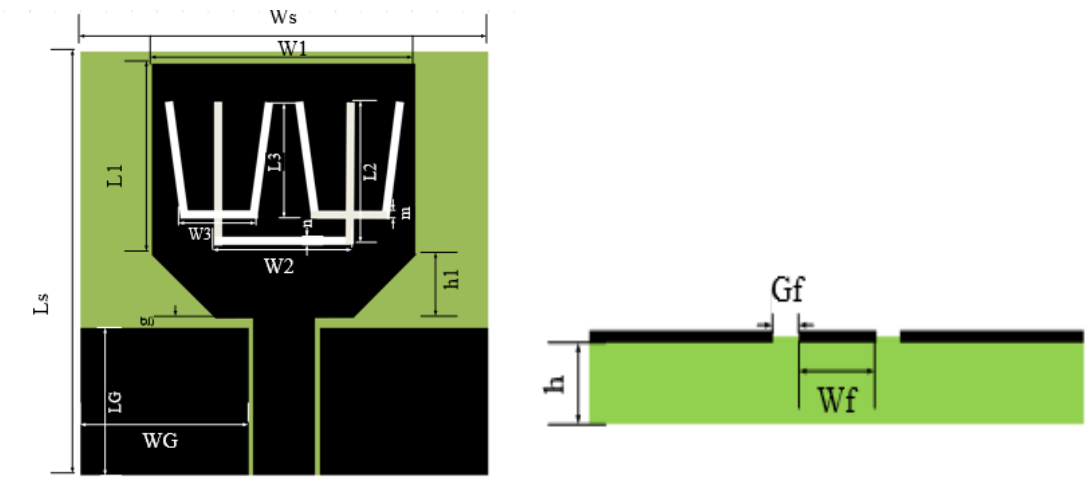

Fig.1 Top view and side view of the model

We can get frequency parameters of antenna by making a rough calculation with this formula:

$$f_{notch}=c/(2*L*\sqrt{\varepsilon_{eff}}) \quad (1)$$

Ansoft HFSS 13.0[10] is used to analyze features and optimize the design parameters for the proposed antenna. The table1 shows some parameters of proposed antenna :

Table 1: Parameters of proposed antenna

name	Ws	Ls	W1	L1	WG	LG	Wf	L2	W2
Value(mm)	31.5	26.7	15.5	13.8	10.25	12.5	5.7	9	6.6
h	Gf	W3	L3	T	g	m	n	d	h1
0.508	0.25	5.8	8	1	0.5	0.4	0.4	6.35	2.5

3. Simulation Results and Analysis

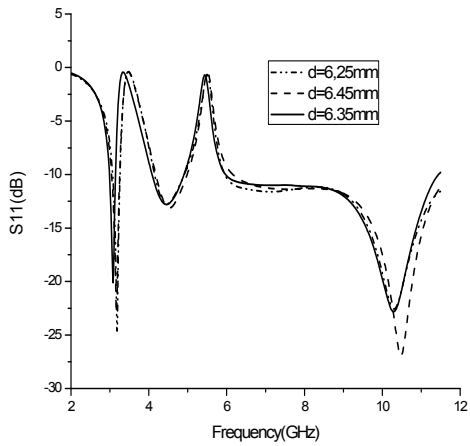

Fig.2 The return loss of proposed antenna

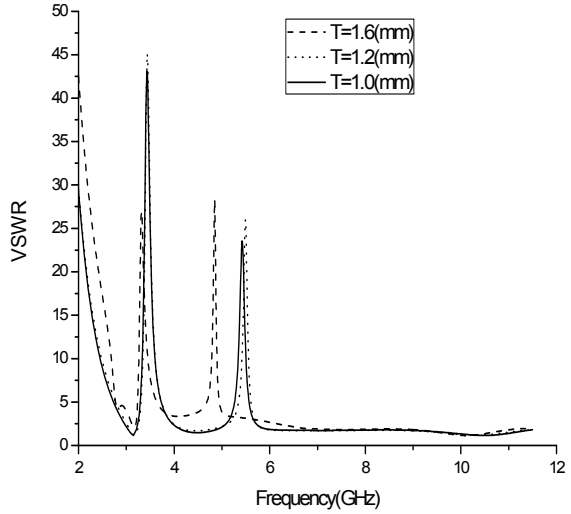

Fig.3 The VSWR of antenna with different distance(T)between U-slots

From the figure2,we can see the proposed antenna shows S11 ≦ 10dB , frequency range from 2.95-11.50 GHz, which consists with the UWB (3.1-10.6 GHz) operation, and the location of slots on the patch has certain influence on the performance of the antenna.

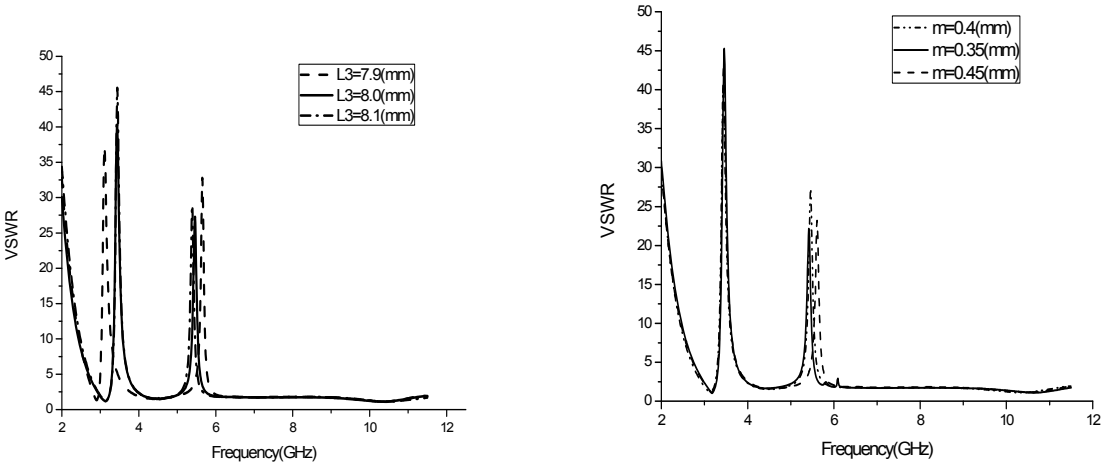

Fig.4 VSWR in difierent dimensions of the modified U-slots

Figure3-4 show, the distance(T) between the slots has a significant effect on the notch characteristics of antenna, and the band-notch in high frequency(5.05-5.97GHz) of proposed antenna changes by changing the modified U-slots structure (the length of L3) ,we can also see that the notch center frequency was decreasing as the L3 increasing because of the angle of U-slots'arms have changed, so we get a fact that the modified U-slots structure can be adjusted to achieve a WLAN frequency band-notch. In the figure5, we achieve a rejected frequency band with 3.20-4.21GHz by adjusting the length of the general U-slots, the simulation results conform to the requirements.

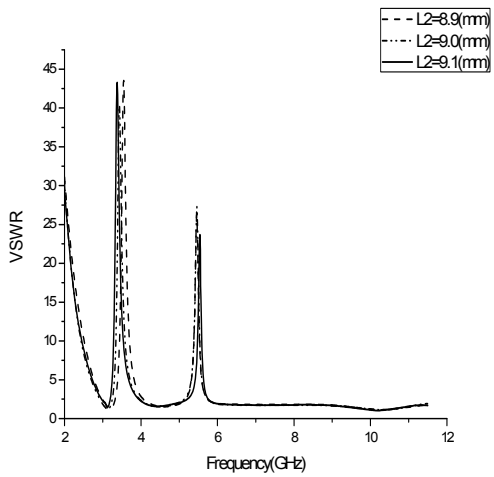

Fig.5 The influence with different general U-slot's length

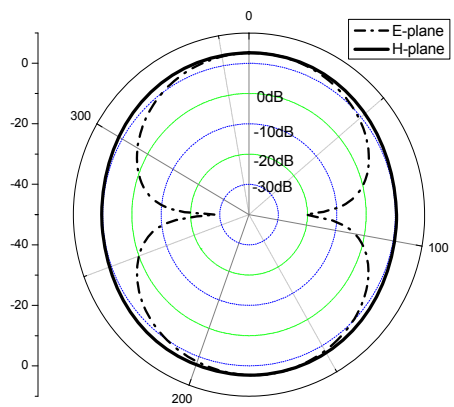

Fig.6 Radiation patten of proposed antenna at the frequency to 5GHz

The figures(fig6,fig7) show that the E surface normalized pattern show "8" shape at 5GHz and 7GHz, and the H surface normalized pattern has approximately omnidirectional and symmetry in the whole band.

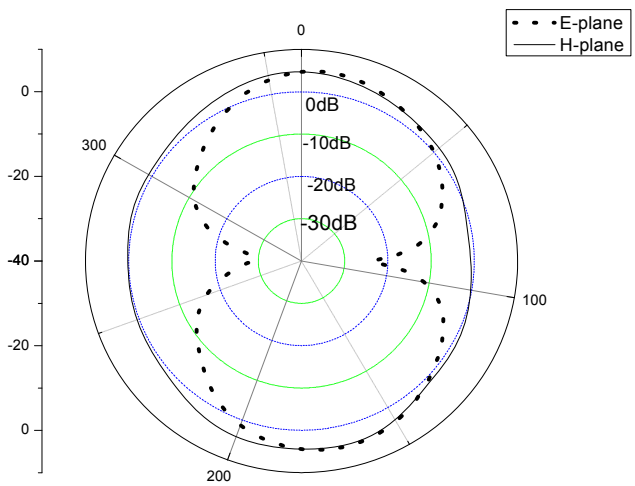

Fig7 Radiation patten of proposed antenna at the frequency to 7GHz

4. Conclusion

A novel dual band-notched CPW-fed monopole antenna has been presented. The echelon radiating patch satisfies the UWB operation and the U-shaped slots group achieve dual

band-rejected functions to prevent interference from WIMAX, C-band, and WLAN systems, we can also see the proposed antenna has well radiation characteristics in the whole band. Depending on this simple technique, the proposed antenna can relax the filtering spectrum in RF front-ends and can be easily integrated, and aslo has good pratical value for many advantages,such as thickness, miniaturised size and low cost .

Acknowledgments

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References

[1] . M. J. Ammann and Z. N. Chen, “A wide-band shorted planar monopole antenna with bevel,” IEEE Trans. Antennas Prop., vol. 51, no. 4, pp.901–903, Apr. 2003.

[2] . E. Lee, P. S. Hall, and P. Gardner, “Compact wideband planar monopole antenna,” Electron. Lett., vol. 35, no. 25, pp. 2157–2158, Dec. 1999.

[3]. Kyungho, Chung, Jaemoung, Kim,“Wideband Microstrip-Fed Monopole Antenna Having Frequency Band-Notch Function”IEEE Microwave and wireless components letters, vol. 15, no. 11, November 2005.

[4] . H.W.Liu,C.H.Ku,and C. F. Yang, “Novel CPW-fed planar monopole antenna for WIMAX/WLAN application,”IEEE Antennas Wireless Propagation Letter, vol.9, pp. 240-243, 2010.

[5] . Y. Kim and D. H. Kim, “CPW-fed planar ultra wideband antenna having a frequency band notch function,” Electron. Lett., vol. 40, no. 7, pp.403–405, Apr. 2004.

[6] . Jia-Yi Sze and Jen-Yi Shiu,“Design of band-notched ultrawideband square aperture antenna with a hat-shaped back-patch”IEEE transactions on antenna and propagation, vol. 56, no. 10, October 2008.

[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 transactions on antenna and propagation, vol. 56, no. 12, December 2008.

[8] . M. Mahmoud,“ Improving the bandwidth of U-slot microstrip antenna using a new technique (trough-slot patch)”IEEE region 5 conference, 17-20 April 2008 .

[9] . Ansoft HFSS, from Ansoft Corporation, Four Station Square Suite 200, Pittsburgh, PA 15219.