A Compact CPW-Fed UWB Antenna with Quadruple Band-Notched Characteristics

Zeng-Pei Zhong,[1] Mo-Lin Fan,[2] Guan-Long Huang,[1] Tao Yuan[1]*
[1]College of Information Engineering Shenzhen University
Shenzhen 518060, China
[2]Kunshan Innowave Communication Technology Co. Ltd.
Kunshan 215300, China

***Abstract*—A compact CPW-Fed UWB antenna with quadruple band-notched characteristics is proposed. The antenna consists of a flower-shaped radiator, a ground plane and a coplanar waveguide (CPW) feed-line. The UWB antenna can efficiently operate in the frequency band of 2.7-10.6 GHz. To obtain four rejected bands, four Meander-line slots are etched on the radiator and ground plane. Rejected frequency bands of C-band (3.60-4.32 GHz), WLAN (5.17-5.32 GHz), WLAN (5.80-5.93 GHz), and X-band (7.13-7.88 GHz) are obtained by the four slots. Both design and analysis of the proposed antenna are detailed in the paper.**

***Keywords*—UWB, compact, CPW, quadruple notched bands**

I. INTRODUCTION

The great enthusiasm of designing UWB antennas was aroused since the unlicensed frequency band 3.1-10.6 GHz was allocated for commercial UWB systems by the Federal Communications Commission (FCC) in 2002 [1].

However, there are many challenges in designing an UWB antenna with high performance. Among these challenges, the most important one is to avoid potential interference between UWB systems and some narrow band wireless communication systems, including WiMAX (3.3-3.69 GHz), C-band for satellite communication (3.7-4.2 GHz), WLAN (5.15-5.35 GHz and 5.725-5.825 GHz), downlink of X-band satellite communication (7.25-7.75 GHz) and ITU service (8.025-8.4 GHz).

In the last decade, much work have been done to get band-notched characteristics of UWB antennas. Some UWB antennas were designed with one rejected band [2], [3], two [4], [5], three [6], [7] or four rejected bands [8], [9]. Among these antennas, band-notched functions can be obtained by utilizing various slots etched on the radiating patch or ground plane, including Taper-shaped, C-shaped, U-shaped, L-shaped, Ω-shaped, π-shaped and ring-shaped slots. To make good use of the UWB spectrum, it is necessary to realize an UWB antenna with multiple band-notched characteristics.

In this paper, a compact CPW-fed UWB antenna with size of 23×26×0.8 mm^3 and quadruple notched bands is proposed. There are four different slots on the antenna, which contribute to reject frequency bands of C-band (3.60-4.32 GHz), WLAN (5.17-5.32 GHz), WLAN (5.80-5.93 GHz), and X-band (7.13-7.88 GHz).

II. ANTENNA DESIGN

The geometry of the proposed antenna is shown in Fig. 1. The antenna is printed on Duroid 5870 substrate with relative permittivity of 2.33 and loss tangent of 0.0012. Overall dimension of the antenna is 23×26×0.8 mm^3. As shown in Fig. 1, the proposed antenna consists of a fork-shaped radiator with three meander-line slots, and a ground plane with one meander-line slot. The antenna is finally fed by a 50 Ω coplanar waveguide (CPW) feed-line. The proposed antenna is designed and analyzed in the high frequency structure simulator (HFSS). The optimized parameters are shown in TABLE I.

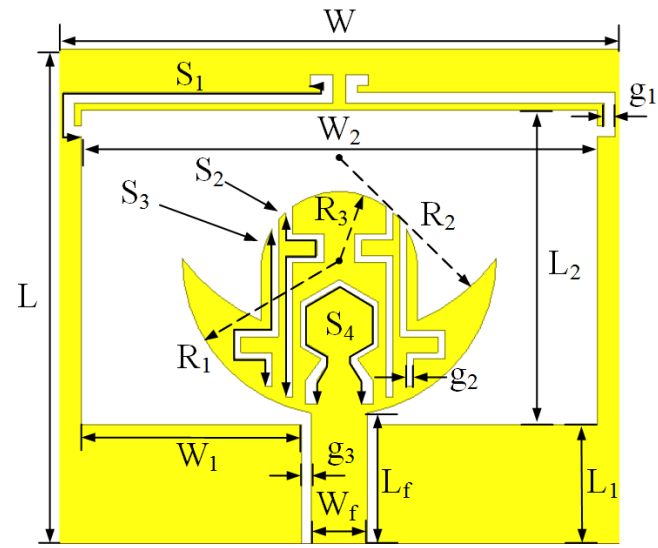

Fig. 1. Geometry of the proposed antenna

TABLE I. OPTIMIZED PARAMETERS OF THE PROPOSED ANTENNA

Parameter	Value (mm)	Parameter	Value (mm)
L	23	S_2	11.1
W	26	S_3	10.1
L_1	5.3	S_4	13.6
W_1	9.8	R_1	7
L_2	16	R_2	8.75
W_2	23	R_3	3.5
L_f	2.5	g_1	0.5
W_f	5.8	g_2	0.3
S_1	15.1	g_3	0.45

III. RESULT AND DISCUSSIONS

Simulated VSWR curves of the proposed antenna are shown in Fig. 2. Result of the UWB antenna is also included for comparison, which can cover the entire UWB band (2.7-10.6 GHz). After the band notched design, the proposed antenna is able to realize four rejected frequency bands: C-band (3.60-4.32 GHz), WLAN (5.17-5.32 GHz), WLAN (5.80-5.93 GHz), and X-band (7.13-7.88 GHz). The result shows that the rejected bands have good matching characteristic within the target frequency bands. By changing the size and location of the slots, four rejected bands can be adjusted effectively.

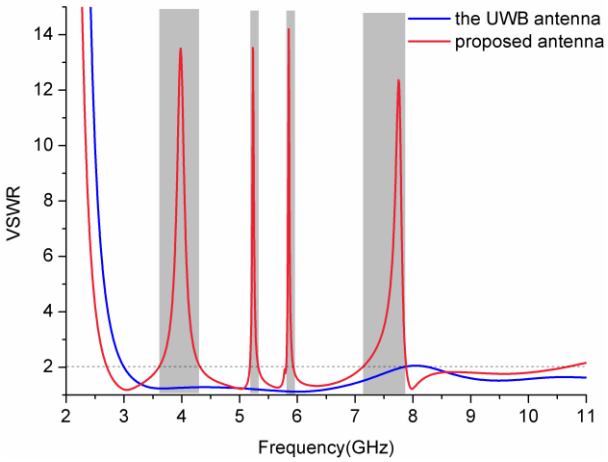

Fig. 2. Simulated VSWR of the proposed antenna.

In Fig. 3, the simulated far field radiation patterns in *E*-plane (*phi = 0 deg*) and *H*-plane (*phi = 90 deg*) at 6 GHz shows the omnidirectional characteristic of the proposed antenna.

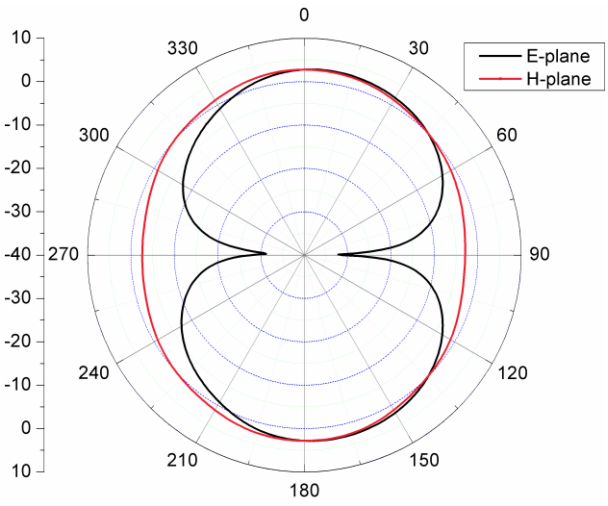

Fig. 3. Simulated radiation pattern at 6.0 GHz.

At last, in order to prominent the advantages of this proposed antenna, a comparison of the proposed antenna and other reported ones is shown in Table II.

TABLE II.
COMPARISON OF THE PROPOSED ANTENNA OVER OTHER REPORTED ONES

#	Size (mm^2)	Bandwidth (GHz)	VSWR
[2]	28×30	5-6	15
[3]	41×45	5.01-5.96	6.5
[4]	24×25	2-4, 4.4-4.8	4, 6
[5]	25×30	3.4-3.69, 5.15-5.85	5, 7
[6]	30×30	3.3-3.8, 5.15-5.85, 7.9-8.4	3, 2.4, 2.4
[7]	28×30	3.3-3.6, 5.47-5.85, 7.2-7.75	3, 4, 3
[8]	31×31	3.3-3.6, 5.0-5.4, 5.7-6.0, 7.6-8.6	9.5, 7, 5.5, 8.5
[9]	26×30	3.3-3.6, 5.15-5.35, 5.725-5.825, 7-7.3	5.8, 8.7, 4.4, 8.7
Proposed antenna	23×26	3.60-4.32, 5.17-5.32, 5.80-5.93, 7.13-7.88	13, 13, 14, 12

IV. CONCLUSION

In this paper, a compact CPW-fed UWB antenna with size of 23×26×0.8 mm^3 and quadruple notched bands has been designed and analyzed. Four rejected bands, 3.60-4.32 GHz, 5.17-5.32 GHz, 5.80-5.93 GHz and 7.13-7.88 GHz, are obtained by the four meander-line slots. Thus, the proposed antenna is able to weaken narrow band interference from C-band (3.7-4.2 GHz), WLAN (5.15-5.35 GHz and 5.725-5.825 GHz), and X-band (7.13-7.88 GHz) effectively. Considering the sizes and band-notched characteristics, the proposed antenna with compact size and quadruple notched bands can be a good choice for UWB communication systems.

REFERENCES

[1] "Federal Communications Commission Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission System from 3.1 to 10.6 GHz," *FEDERAL Communications Commission, Washington, DC: ET-Docket*, pp. 98-153, FCC, 2002.

[2] Zhi-hong Tu, Wen-Ao Li, Qing-Xin Chu, "Single-Layer Differential CPW-Fed Notch-Band Tapered-Slot UWB Antenna," *IEEE Antennas and Wireless Propagation Letters*, pp. 1296-1299, 2014.

[3] K. Srivastava, A. Kumar, R. Kumar, and A. K. Verma, "Reverse G-shape antenna for UWB with notch," *3rd IEEE International Advance Computing Conference (IACC)*, pp. 263-266, Ghaziabad, India, 22-23 Feb. 2013.

[4] S. S. Nagre and A. S. Shirsat, "Design of compact CPW-Fed printed monopole UWB antenna for band notched applications," *International Conference on Automatic Control and Dynamic Optimization Techniques (ICACDOT)*, pp. 394-397, Pune, India, 9-10 Sept. 2016.

[5] S. Kalraiya, H. S. Singh, G. K. Pandey, A. K. Singh, and M. K. Meshram, "CPW-fed fork shaped slotted antenna with dual-band notch characteristics," *2014 Students Conference on Engineering and Systems*, pp. 1-5, Allahabad, India, 28-30 May 2014.

[6] V. K. Dhanesh and P. R. Anurenjan, "Trapezoidal antenna with triple band-notched for UWB applications," *2016 IEEE Annual India Conference (INDICON)*, pp. 1-5, Bangalore, India, 16-18 Dec. 2016.

[7] Peizhe Chen, Zhiyuan Huang, and Qi Fu, "Design of an ultra-wideband monopole antenna with multiple band-rejected characteristic," *2014 IEEE International Conference on Communiction Problem-solving*, pp. 343-346, Beijing, China, 5-7 Dec. 2014.

[8] Y. Cao, J. Wu, and H. Yang, "Design of CPW-fed monopole antenna with quadruple band-notched function for UWB application," *2011 International Conference on Computational Problem-Solving (ICCP)*, pp. 353-356, Chengdu, China, 21-23 Oct. 2011.

[9] M. Darvish, H. R. Hassani, and B. Rahmati, "Compact CPW-fed ultra wideband printed monopole antenna with multi notch bands," *20th Iranian Conference on Electrical Engineering (ICEE2012)*, pp. 1114-1119, Tehran, Iran, 15-17 May 2012.