Compact CPW-fed ultra-wide band antenna with band-notched characteristic

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Abstract

A novel compact wide band monopole antenna with notched band for wireless UWB communication system is proposed in this paper. The structure with two rectangular slots are adopted to broaden the impedance band, the improved band-notched performance is obtained by the band rejection element of an unclosed quadrilateral slot on the radiation patch. The dimension of this antenna is as small as 20mm×14mm×1.6mm which makes it more suitable for portable UWB devices. Besides, the frequency band of the proposed antenna is ranging from 2.8GHz to 11.9GHz that meets the requirement of UWB which allocated by FCC. Both simulated and measured results are analyzed and discussed to validate the design.

Keywords

Compact; CPW-fed; Antenna.

1. Introduction

Since 2002, the Federal Communication Commission (FCC) released 3.1GHz to 10.6GHz as the band used for ultra-wide band system, much attentions have been obtained to UWB antenna in the literature and industries. However, the requirement of wide impedance matching band with constrained volume and the interference bands such as WiMAX(3.3-3.6GHz) and WLAN (5.15-5.35GHz and 5.725-5.825GHz) within the UWB band have becoming the challenge that antenna designers must face on the design process. In response to the increasing demand for compact and broadband antennas, different methods have been introduced in the articles. For instance, two asymmetric structure with U-shaped strips and staircase-shaped strip which for wider band are introduced in [1, 2]. To avoid the effects of other frequency bands that are active in the UWB range, some antennas with filtering characteristics have been studied. And the most popular way is removing notches with various shapes like rectangular complementary split ring resonators [3,4], arc strips[5], and U-shaped slots[6].

In this letter, a compact CPW-fed antenna with band notched characteristic is proposed. Two rectangular notches are etched on the ground plane to broaden the impedance bandwidth, the unclosed quadrilateral slot is applied to achieve band rejection. The simulated and experimental results of the proposed structure are obtained, which cover the frequency of 2.8GHz to 11.9GHz with good impedance matching excepted the rejected band 5.15GHz to 6GHz. The whole dimension of this design is 20mm×14mm×1.6mm which is much smaller than most of the antennas in the literature.

2. Antenna Design

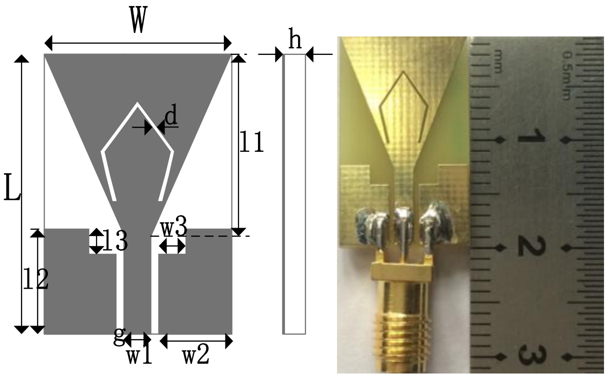

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Fig. 1 Geometry and photograph of the proposed antenna(a.Geometry, a.Geometry).

The geometry and dimension of this design is shown in Fig. 1 which is printed on a substrate with a relative permittivity of 4.4 and a thickness of h. Fig. 2 depicts the process of the antenna design. It is clear from them the antenna is composed of a funnel-shaped radiation patch, an unclosed quadrilateral slot and two rectangular notches. By cutting the unclosed quadrilateral on the radiation patch the bandstop function is achieved while the rectangular notches make the impedance band wider.

Fig. 2 Process of the antenna design.

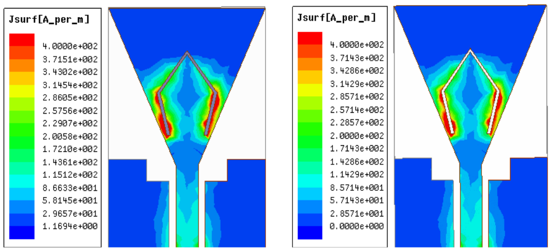

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Fig. 3 Current distribution at 5.4GHz (a. 0^0 ,b. 180^0)

The notch frequency and impedance band would be effected by the change of the key parameters like ‘g’, ‘l3’, and ‘w3’. When increases ‘l3’ and decreases ‘w3’ simultaneously, there would be a great influence at higher frequency which with a poor impedance matching. On the other hand, as ‘g’ gets smaller, the impedance matching at lower frequencies is poor and the rejected band moves toward to lower frequency. Then the current distribution of the notched band at 0^0 and 180^0 is shown in Fig. 3. It can be observed that the current strength around the unclosed quadrilateral slot at corresponding frequency is very strong. The optimal dimensions of the proposed antenna are as follows: W=14mm, L=20mm, d=0.3mm, l1=13mm, l2=2.5mm, l3=1.8mm, w1=2mm, w2=5.4mm, g=0.6mm, h=1.6mm.

3. Results and Discussion

To validate the proposed design, simulated and experimental results of this antenna have been measured and discussed with High Frequency Structure Simulator (HFSS) and Agilent 8722ES vector network analyzer. Fig. 4 is the curves of VSWR(Voltage Standing Wave Ratio) under different situations, which depict the proposed antenna has a good impedance matching between 2.8GHz to 11.9GHz with VSWR<1.5 except the notched band from 5.15GHz to 6GHz. Thanks to the manufacturing error and SMA connector, it can be seen from Fig 4. There is a slight discrepancies between the measured and simulated VSWR curves.

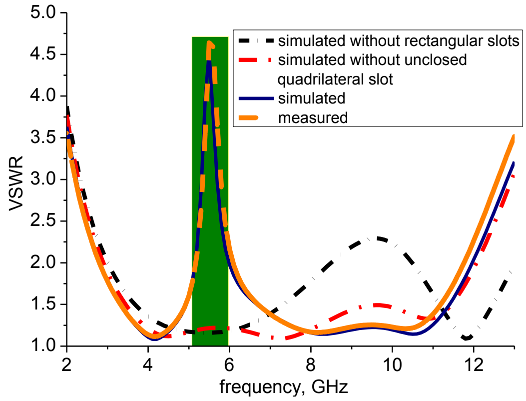

Fig. 4 Simulated and measured VSWR curves.

The radiation patterns in E-plane and H-plane of the resonant frequencies at 4GHz, 7GHz, and 10GHz are plotted in Fig. 5. From the measured results it is clear that the antenna has omnidirectional patterns in H-plane while bidirectional patterns in E-plane. The radiation patterns are nearly stable but the performance in both planes is going to deteriorate as the frequency grows. Fig. 6 demonstrates the simulated and measured gain curves of the proposed antenna alongside the one without unclosed quadrilateral slot. It can be seen that there is a sudden reduction at the frequency of 5.6GHz owing to the unclosed quadrilateral slot. Good agreement is observed between the simulated and measurement results.

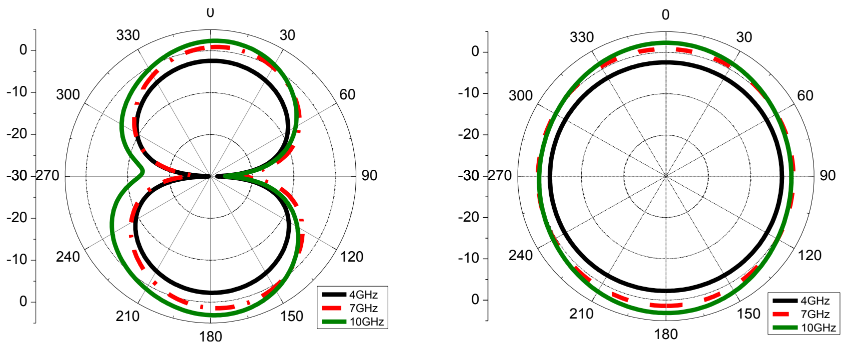

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Fig. 5 Measured radiation patterns at 4, 7, 10GHz at E-plane and H-Plane.(a. E-plane, b. H-plane)

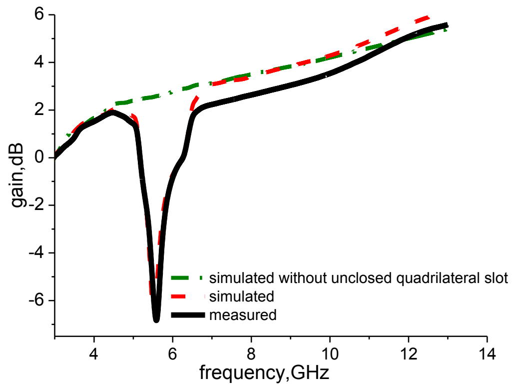

Fig. 6 Simulated and measured gain curves

4. Conclusion

A novel CPW-fed with two rectangular slots and an unclosed quadrilateral slot has been presented and investigated with simulated and experimental results. It has successfully avoiding the interference of other wireless communication systems which operating in the WLAN band. With simple structure and compact size, and in terms of the good impedance matching, omnidirectional patterns, and stable gain, this antenna can be a prefer choice for UWB system.

Acknowledgements

ChongQing postgraduate scientific research and innovation projects (CYS16169)

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