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A COMPACT CPW-FED UWB ANTENNA WITH WIMAX-BAND NOTCHED CHARACTERISTICS

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Abstract—This paper presents a novel CPW-fed band-notched UWB antenna for the 3.5 GHz wireless local area network (WiMAX) applications. The prototype consists of planar diamond shaped monopole and ground plane. By inserting a novel coupling band-notched filter, which consists of an isosceles trapezoid slot in the radiation patch and a same sized isosceles trapezoid patch on the back of the substrate, with the slot connecting to the patch below through shorting hole, band-rejected filtering property in the WiMAX band is achieved. The proposed antenna is successfully designed with broadband matched impedance, good radiation patterns and constant group delay.

1. INTRODUCTION

Owing to its high data transmission rate, large bandwidth, short-range characteristics and feasible design, UWB system has become a highly competitive topic in both academy and industry communities of telecommunications. Ever since the Federal Communications Commission (FCC) in the United States released unlicensed frequency band of 3.1–10.6 GHz for commercial communication applications [1], the need of high data rates wireless communication becomes more and more urgent. However over the inherently operating bandwidth, the IEEE 802.16 WiMAX system (3.3–3.6 GHz) is overlapped with this allocated spectrum. Previous literatures [2–4] have provided several designs to avoid the potential interference and enhance the band-notched properties at the WiMAX band.

In the above mentioned design considerations, the behavior of the antenna with band-notched characteristic in target band is achieved

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by embedding L-shaped, U-shaped, arc-shaped, C-shaped, and other special-shaped slots or branches on the radiation patch or on the ground plane [5–8], introducing symmetrical parasitic patches around the radiation patch [9], etc. In addition to traditional band-rejected filtering methods, some new methods [10, 11] have been presented. In this Letter, we present a band-notched monopole antenna using these new methods [10, 11]. The center frequency of the notched band can be finely tuned by changing the number and the position of the shorting hole. The simulated results are carried out using a commercially available software package HFSS. Also the measured data are presented and discussed.

2. ANTENNA DESCRIPTION

Figure 1 shows the geometry and dimensions of the proposed antenna, which is a CPW-fed monopole printed on a FR4 substrate with size of 20 mm × 30 mm, thickness $h = 1.6$ mm, relative permittivity = 4.4, dielectric loss tangent = 0.02. The width of the feed line and the gap are 1.2 mm and 0.7 mm, respectively. The feed dimensions are fine designed to obtain 50 Ω impendence. In this structure, the band-rejected filtering property in the WiMAX band is accomplished by using simple shorting hole with radius of 0.2 mm between the top slot and the isosceles trapezoid patch below. The two isosceles trapezoid structure play a role of capacitance at the 3–4 GHz notched band, and the two shorting holes is equivalent to the inductance at the notched band. By simply introducing cavity below the radiating patch of the antenna, the notched band can be created. Moreover, this structure

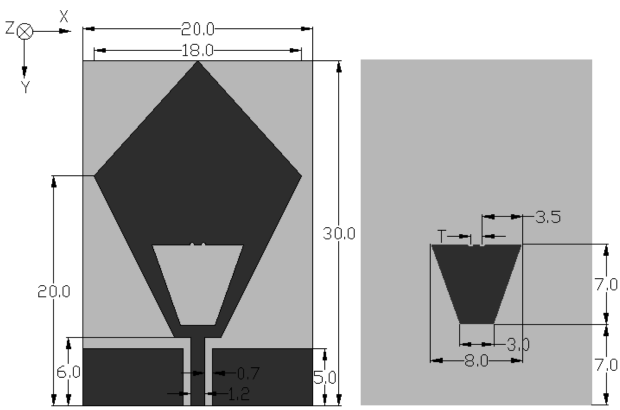
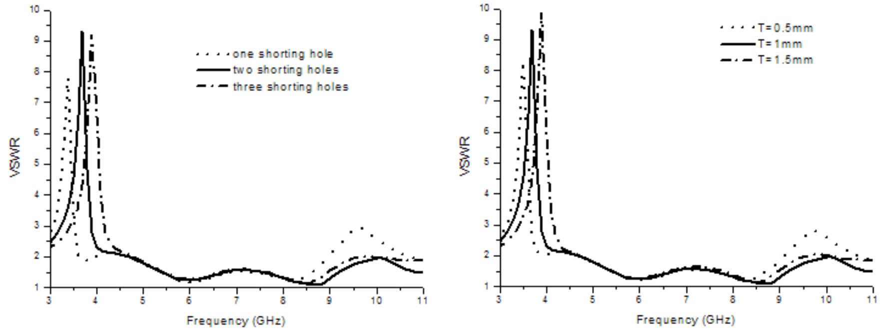


Figure 1. Geometry and dimensions of proposed antenna (mm).



(a) (b)

Figure 2. (a) Simulated VSWR of proposed antenna with different shorting hole numbers; (b) Simulated VSWR of proposed antenna with different T values.

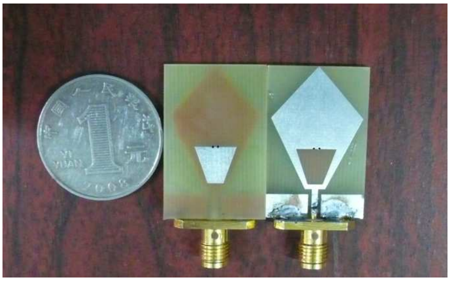


Figure 3. Photograph of the manufactured band-notched antenna.

changes the inductance and capacitance of the input impedance, which in turn leads to change the bandwidth. The simulation software HFSS is used in the design and simulation processes of the proposed antenna. By properly varying the number and the position of the shorting hole, a wider impedance matching is achieved. The distance between the two shorting holes is also optimized by simulating.

Figure 2(a) shows the effect of different shorting hole numbers on antenna performance, the center frequency of notched band moves to a higher frequency with the numbers of shorting hole increasing. It can be seen from Figure 1 that the letter "T" stands for the distance between two shorting holes. As shown in Figure 2(b), upon increasing T from 0.5 mm to 1.5 mm, the center frequency of notched band also moves to a higher frequency. The photograph of manufactured band-notched antenna is shown in Figure 3.

3. ANTENNA PERFORMANCES

The proposed band-notched antenna is measured by a Wiltron-37269A network analyser. The measured and simulated VSWR are shown in Figure 4, and the VSWR of the reference antenna without notched characteristics is also presented for comparison. At the frequency from 3 to 4 GHz, the proposed antenna has notched band characteristic. The measured data reasonably agrees with the simulated result with an acceptable frequency discrepancy, which may be referred to the difference between the measured and the simulated environments.

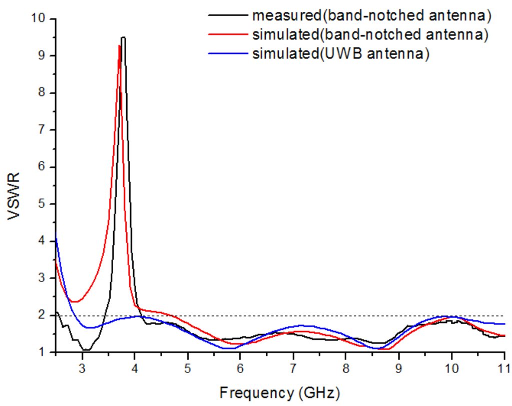
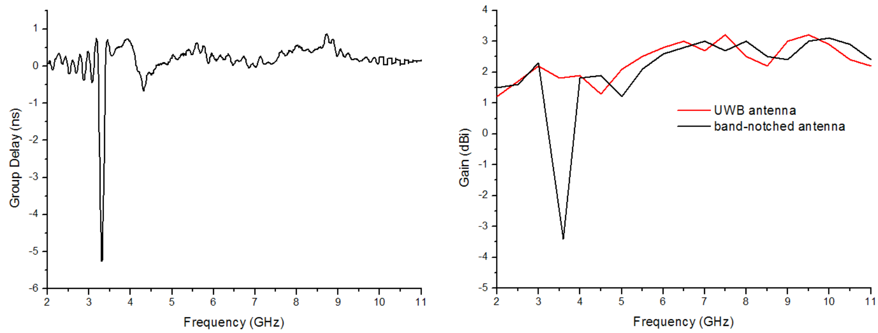


Figure 4. Simulated and measured VSWR of the band-notched antenna.



(a) (b)

Figure 5. (a) Measured group delay for the proposed antenna; (b) Measured peak gain of the proposed antenna.

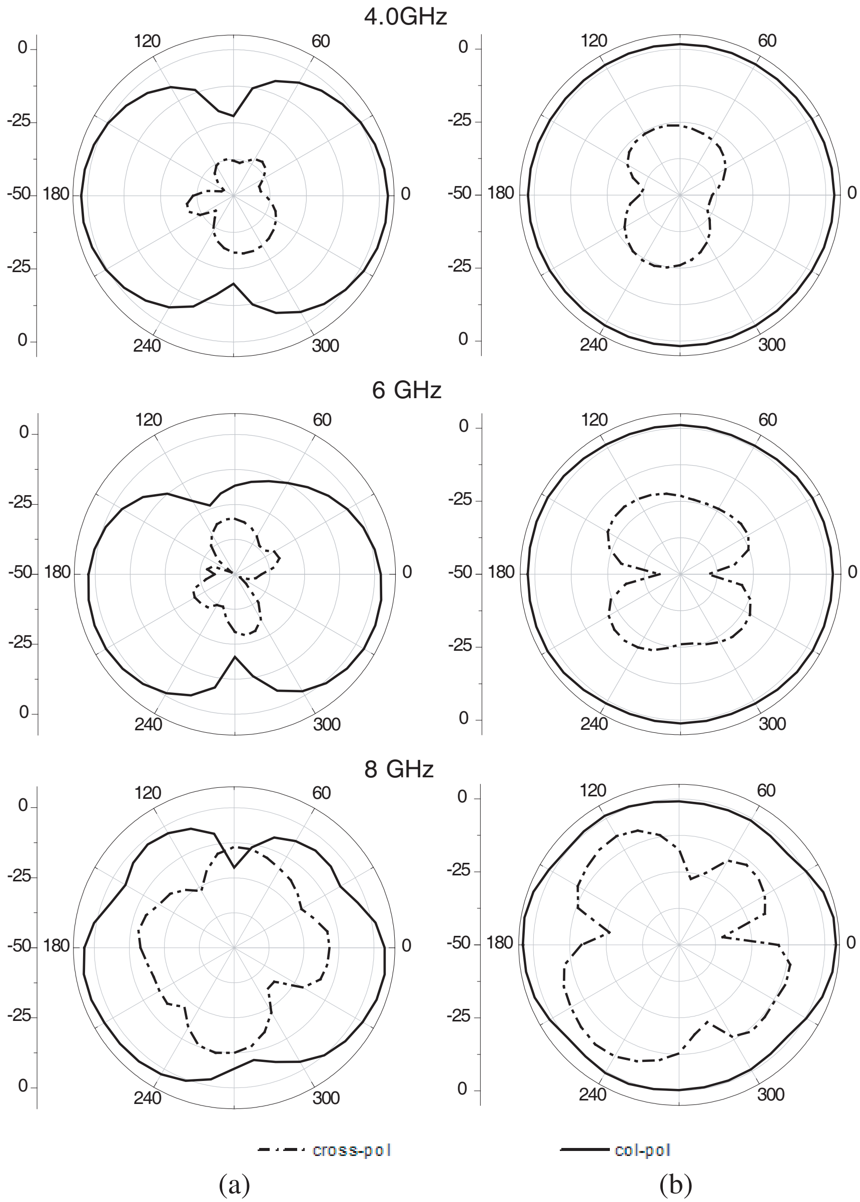


Figure 6. The (a) *E*- and (b) *H*-plane radiation patterns of the proposed antenna.

Figure 5(a) shows the experimental results on the antenna group delay between a pair of uniform band-notched antennas. They are mounted on the two ports of the network analyzer face to face with a distance [11] of 30 cm. The group delay variations of the proposed antenna highly exceed 5 ns in the vicinity of notch-bands, which can deteriorate phase linearity. However, in the un-notched frequency part, the group delay variations are small showing good characteristics. Figure 5(b) illustrates the measured gain of the fabricated antenna in the frequency range of 2 to 11 GHz. The gain in the notched band is expected to be sharply reduced as low as −3.6 dBi. For other frequencies outside the rejected bands, the gains remain good and stable in performance. The radiation characteristics of the frequencies across the band have been studied

The radiation characteristics of the proposed antenna at three pass band frequencies of 4, 6, and 8 GHz are shown in Figure 6. It can be observed that the H-plane radiation patterns are almost omnidirectional and the E-plane patterns are monopole-like. The results show that there is an increase in the cross-polarized pattern in both planes for higher frequency of operation. Figure 6 also shows that the radiation patterns of the antenna are almost stable in both planes.

4. CONCLUSION

A compact and ultra-wideband CPW-fed antenna with wide band frequency characteristic has been proposed, and the results are discussed. By introducing simple shorting hole between an isosceles trapezoid slot in the metallic radiation patch and a same sized isosceles trapezoid patch on the back of the substrate, the band-notched properties at the WiMAX band is achieved. The measured data confirm the simulated results. Due to its electrical characteristics such as very small volume, wide impedance bandwidth, WiMAX band rejection, omnidirectional radiation pattern, and small group delay, the proposed antenna is expected to be a good candidate in various UWB systems.

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