Progress In Electromagnetics Research Letters, Vol. 6, 149–156, 2009

PLANAR MONOPOLE ANTENNA WITH BAND-NOTCH CHARACTERIZATION FOR UWB APPLICATIONS

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Abstract—A novel CPW-fed antenna having a frequency band-notched function for UWB applications is proposed and studied. By inserting a pair of inverted-T-shaped slots on the radiation element, the narrow frequency band notch has been created to cover the desired frequency varying from 3.4 to 3.69 GHz and the required UWB bandwidth is also acquainted. Good monopole-like radiation patterns and antenna gains have also been obtained.

1. INTRODUCTION

Recently, ultra wideband communication systems have been developed widely and rapidly, which lead to a great demand in designing wideband microwave components, such as antennas, filters and so on [1–9]. Several antenna configurations including planar monopoles and dipoles have been studied for ultra broadband applications [10–15]. Also, UWB transmitters should not cause any electromagnetic (EM) interference on nearby communication systems such as WiMAX and WLAN systems. The use of the 3.4–3.69 GHz band is limited by WiMAX. Therefore, a band-rejection filter is necessary in UWB RF front-ends, and this will provide complications for UWB systems.

In this paper, a novel UWB CPW-fed monopole antenna with band-notched characteristic is studied. The proposed antenna is designed to reject the limited band from 3.4 to 3.69 GHz. This antenna not only satisfies all UWB bands but also rejects the limited band in order to avoid possible interference with the existing WiMAX band. Details of the antenna design are described, and experimental results of the proposed antenna are presented and discussed.

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2. ANTENNA DESIGN

Figure 1 shows the proposed antenna with the inverted-T-shaped slots having a frequency band-notched function. The total size of the antenna including the ground plane is only $38 \times 50\,\text{mm}^2$, which is printed on FR4 substrate with thickness of 1 mm and relative permittivity of 4.4. The radiation element is a multilateral circular patch making it possible to have broadband impedance matching. A 50-Ω CPW transmission line, which consists of a signal strip width of 4.2 mm and a gap distance of 1 mm between the single strip and the coplanar ground plane, is used for feeding the antenna. By varying the shape and the size of the monopole, the wideband operation of the proposed antenna can be excited with good impedance matching. Also, bandwidth is increased by inserting two symmetry square slots on the ground plane. By inserting a pair of inverted-T-shaped slots on the radiating element, an additional surface current path along the slots is created which contributes to the band notch. The prototype of the antenna as shown in Fig. 2 has been fabricated and tested.

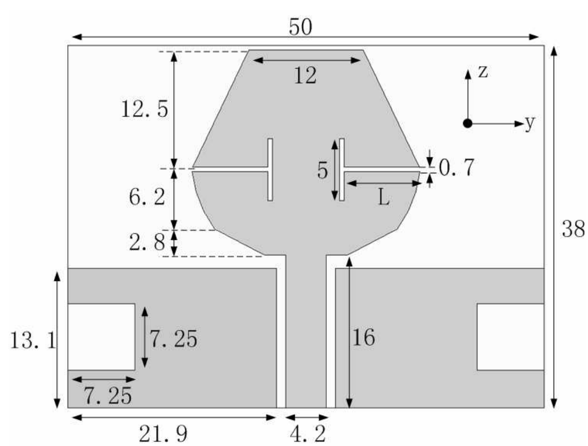


Figure 1. Geometry of the proposed UWB antenna.

3. RESULTS AND DISCUSSION

The simulated and measured VSWR obtained using HFSS 11 and WILTRON37269A vector network analyzer are presented in Fig. 3, respectively. It can be seen that the measured VSWR reasonably agrees with the simulated results with an acceptable frequency discrepancy, which may be because of the difference between the

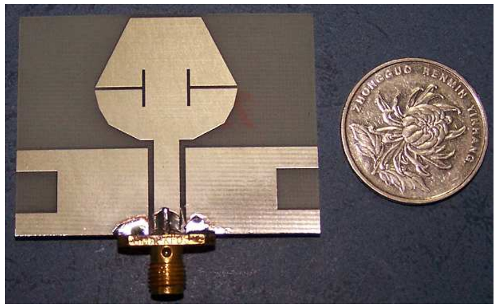


Figure 2. Prototype of the proposed UWB antenna.

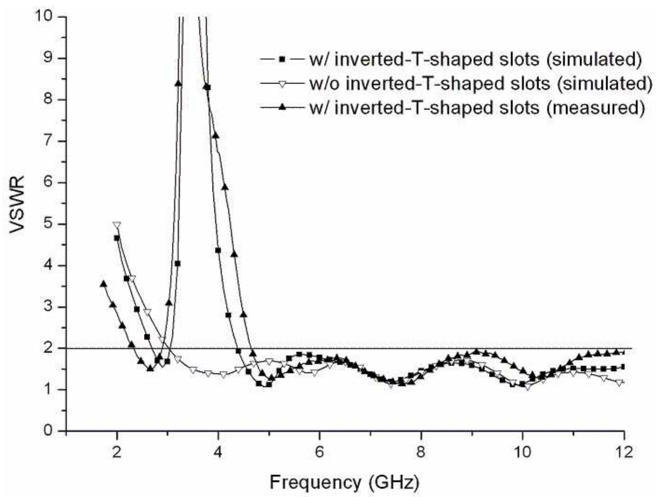


Figure 3. Simulated and measured VSWR for the proposed antenna with and without the band-notch structure.

simulated and the measured environments. In addition, the simulated VSWR for the proposed antenna without the inverted-T-shaped slots on the radiating element is also plotted in Fig. 3. Without the inverted-T-shaped slots on the radiating element, the impedance bandwidth of the proposed antenna defined by VSWR < 2 is from 3.08 to 12.7 GHz which satisfies the UWB bandwidth. By introducing the inverted-T-shaped slots on the radiating element, the sharp frequency band-notch characteristic is obtained very close to the desired frequency from 3.4 to 3.69 GHz. The simulated VSWR characteristic of the proposed antenna with various L is shown in Fig. 4. By varying the L length from 5 mm to 7 mm, the center frequency of stop band varies from 3.5

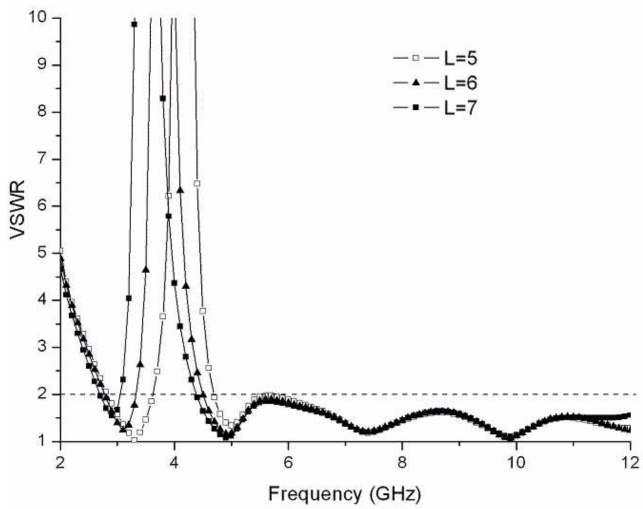
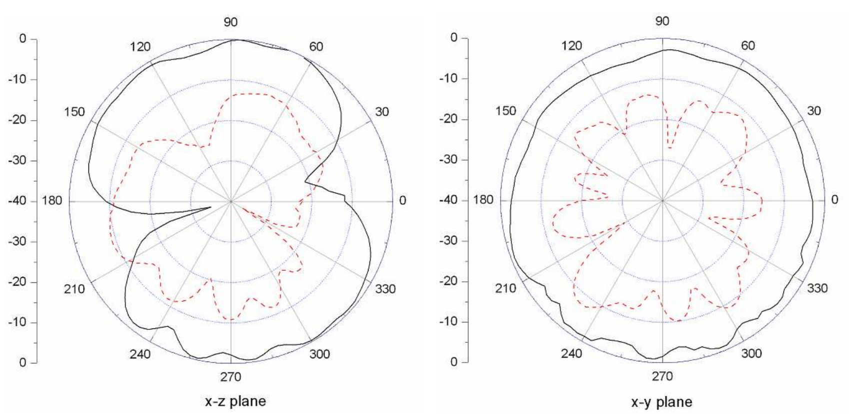


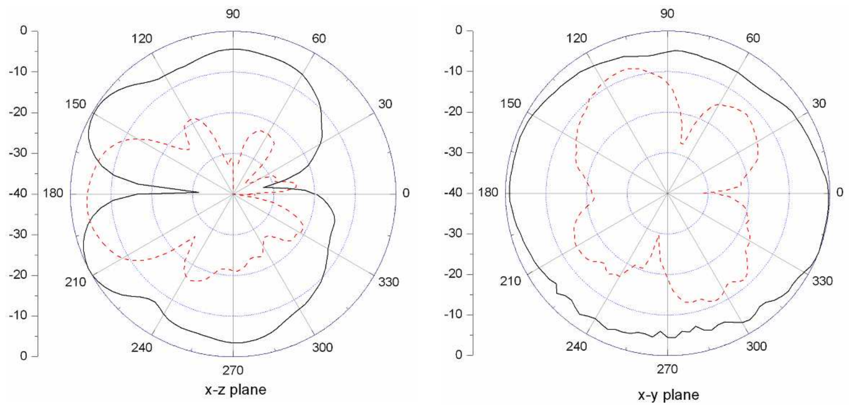
Figure 4. Simulated VSWR characteristic of the proposed antenna for various L lengths.

to 4.2 GHz.

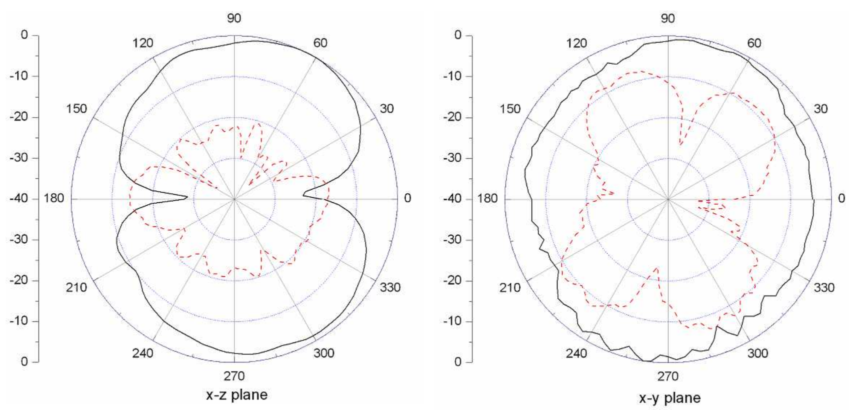
Figure 5 shows the measured radiation patterns of the prototype antenna at sampling frequencies of 3, 5 and 7 GHz, respectively. Nearly omnidirectional radiation patterns in the x-y plane and dipole-like radiation patterns in the x-z plane are obtained at these frequencies. Fig. 6 presents the measured peak gains of the proposed UWB monopole antenna with and without the inverted-T-shaped slots on



(a)



(b)



(c)

Figure 5. Measured radiation patterns for the proposed antenna at (a) 3 GHz; (b) 5 GHz; (c) 7 GHz. ($-E\theta$ $\text{---}E\phi$).

the radiating element within its working frequency band. As shown in Fig. 6, gain decreases drastically at the notched frequency band of 3.5 GHz.

Figure 7 and Fig. 8 exhibit the magnitude and group delay of the antenna system transfer function of a band-notched antenna pair which is composed of two identical band-notched antenna prototypes and positioned face to face with a separation of 0.3 meter.

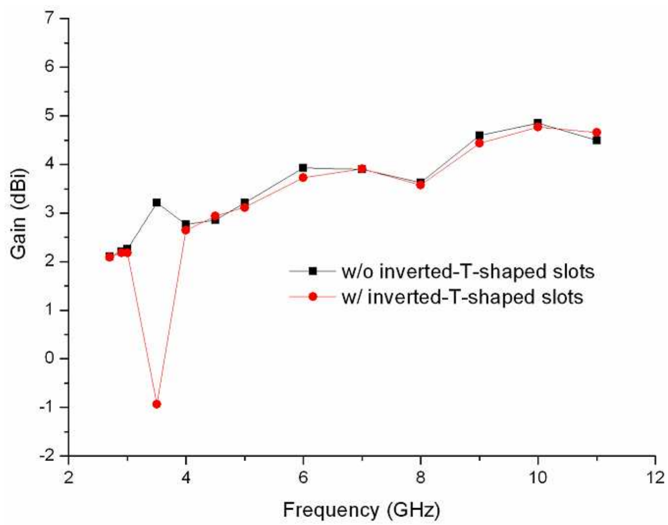


Figure 6. Measured peak antenna gains of the proposed antenna for UWB applications.

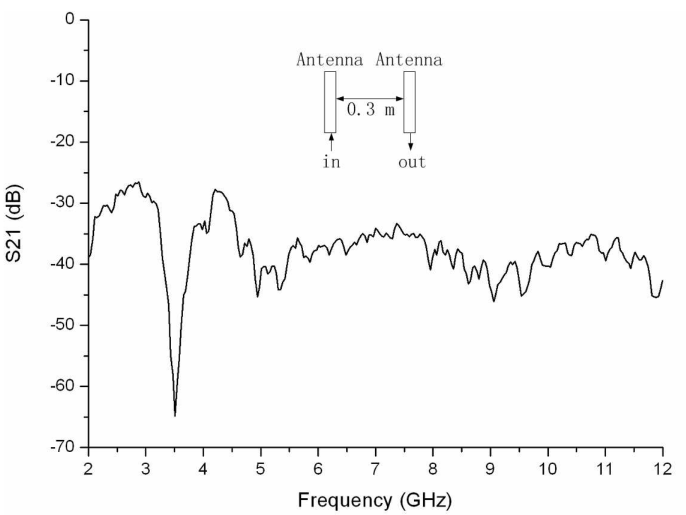


Figure 7. Measured magnitude of transfer function.

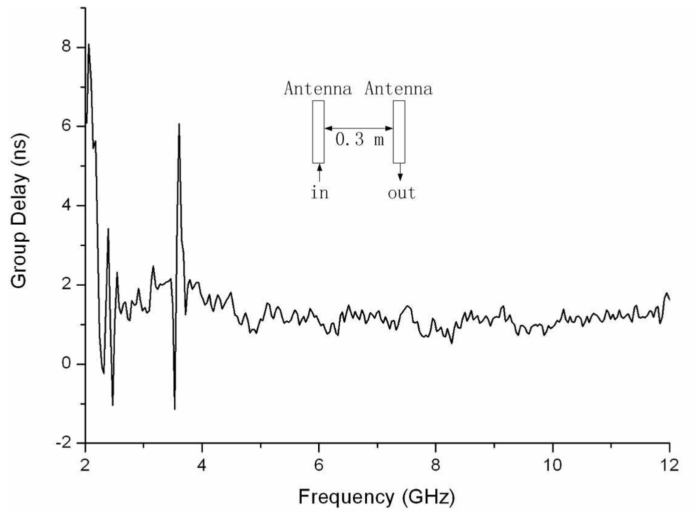


Figure 8. Measured group delay.

4. CONCLUSION

A novel UWB printed antenna with a modified ground has been designed and manufactured. A band-notched characteristic at 3.5 GHz is achieved by incorporating a pair of inverted-T-shaped slots on the radiating element. The proposed antenna has the frequency band from 2.3 GHz to over 12.7 GHz for VSWR less than 2.0 with a rejection band between 3.05 GHz and 4.55 GHz. The proposed antenna having a frequency band-notched function and good electrical characters is promising for wireless communication applications.

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