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Hybrid Shaped Band-Notched Ultra-Wideband Patch Antenna

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1. Introduction

Recently, planar monopole antennas, which feature broad bandwidth and small size, have received intensive attention in ultra-wideband (UWB) application [1,2] due to the merits of wide impedance bandwidth and omnidirectional radiation pattern. The broad operating frequency range of 3.1-10.6 GHz differentiate UWB systems from conventional systems [3]. However, due to the overlap of the currently allocated UWB frequency band with the existing wireless local area network (WLAN), special characteristics such as band notch is much desired for UWB antennas to reduce the interference between those two communication systems. In view of this, different shapes of antennas have been proposed, such as adding a U-shape or V-shape [4,5] slot into the planar monopoles. As such, a notched band can be realized.

In contrast to previous studies, we first present, in this paper, a hybrid shape adopted for the planar monopole antenna, which has UWB operating bandwidth and band-notch feature. At the center notch frequency, the disturbance of surface current distribution in this hybrid patch will be smaller compared to the conventional rectangular or square patch, thus causing a smaller mismatch of the antenna's input impedance. Hence, the performance of the UWB antenna is improved. Details of the proposed antenna are described and the results of the prototype are presented.

2. Antenna Design

The configuration of the proposed planar ultra-wideband monopole antenna with a band-notch feature is shown in Fig. 1. The antenna was fabricated on a Rogers substrate having 20mil thickness and relative dielectric constant of 3.46. The area occupied by the antenna aperture is only 35mm×35mm. Antenna part is formed by two ellipses with a rectangle to smooth out the discontinuity of the overlap parts. On the backside of the substrate, the finite ground plane of length L2 = 12 mm is printed to cover only the microstrip feed line. By inserting a rotated E-shape slot into the planar monopoles, a notched band can be achieved. The notched frequency can be adjusted by tuning the length of E-shape slot and the notched depth can be slightly adjusted by optimizing the length of middle slot. The detail dimensions (mm) of the antenna are obtained in Table I.

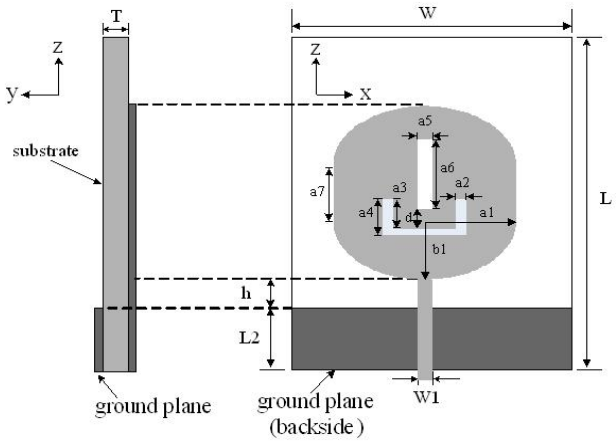

Fig. 1. Geometry of the proposed band-notched monopole antenna.

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Table I

h	L	W	L2	W1	a1	a2
0.25	35	35	12	1.16	9.6	0.7
a3	a4	a5	a6	a7	b1	d
3.55	3.75	1	6	6	6	3.8

3. Simulation and Experimental Results

The antenna prototype is shown in Fig. 2. The proposed monopole antenna is simulated and optimized using the commercial simulation software CST Microwave Studio simulator.

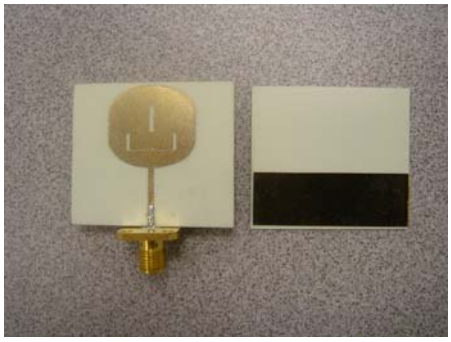


Fig. 2. Photograph of the proposed UWB antenna.

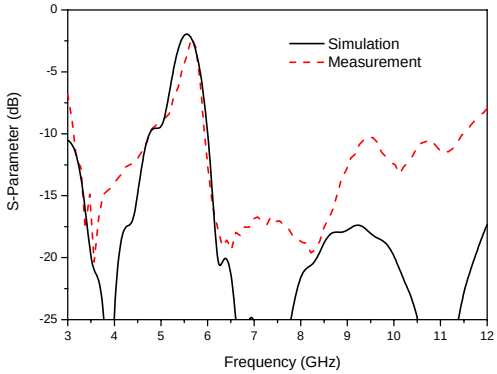
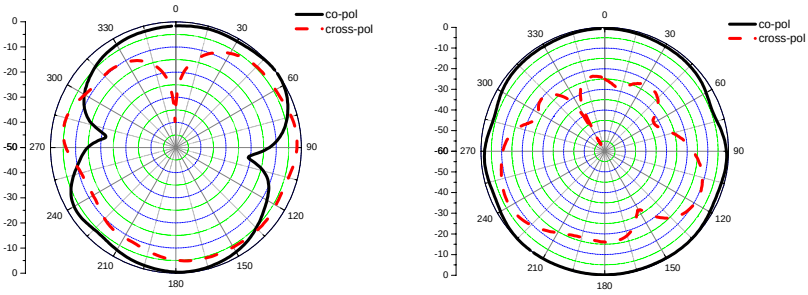
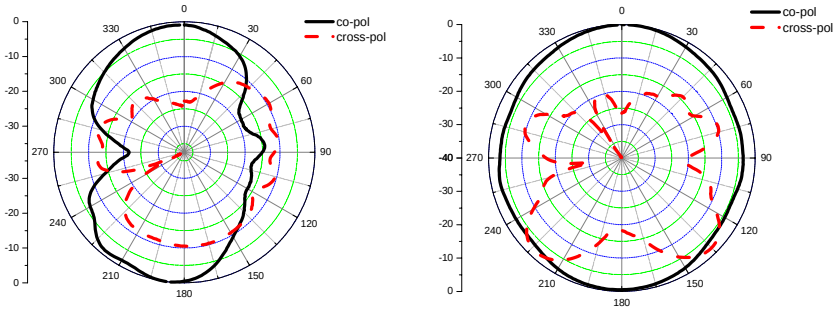


Fig. 3. Measured and simulated return loss of the antenna

Fig. 3 shows return loss of the proposed antenna which a notched frequency band centered at 5.55 GHz is observed.



(a) (b)



(c) (d)

Fig. 4. Measured radiation patterns of the antenna: (a) E-plane at 4 GHz; (b) H-plane at 4 GHz; (c) E-plane at 7 GHz; (d) H-plane at 7 GHz.

In Fig. 4, the measured antenna radiation patterns at 4 and 7 GHz are presented. Co-polarization and cross-polarization are plotted in black and red, respectively. At the low frequency, E-plane radiation pattern is similar to that of the traditional monopole antenna. For the H-plane radiation patterns, it is still remain nearly omnidirectional across the operation bandwidth.

Also the measured gain in the boresight is shown in Fig. 5 which is over the entire UWB frequency band, and a sharp antenna-gain decrease in the notched frequency band is shown.

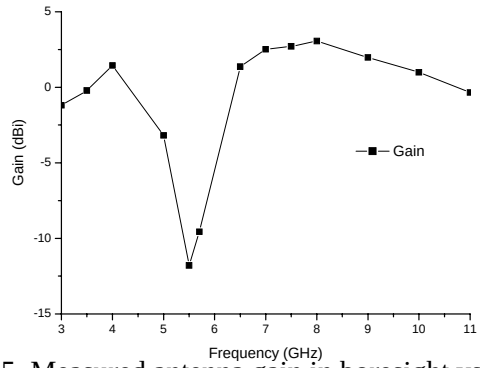
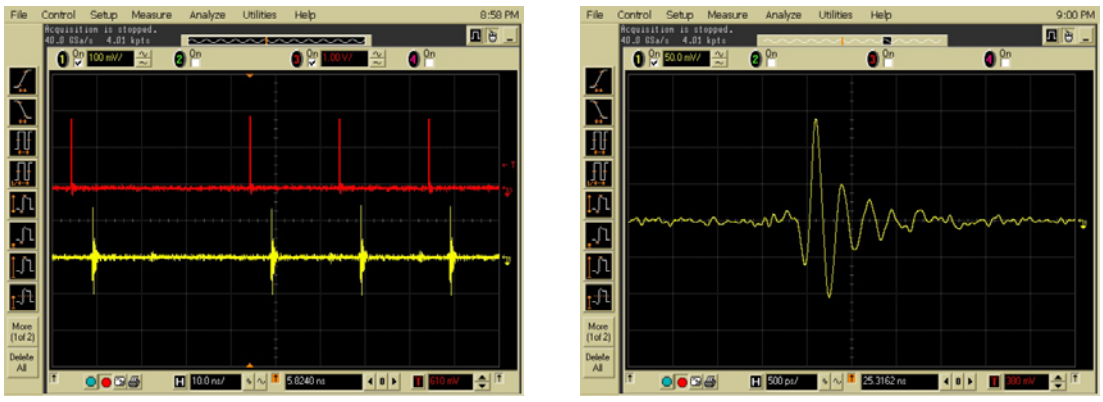


Fig. 5. Measured antenna gain in boresight vs. frequency

Fig. 6 shows measured signal of the antenna impulse response. From the Fig. 6 (b), a well behaved pulse is demonstrated. Fig. 7 shows a measured spectrum of the antenna emitted pulse sequence. It can be seen that the pulse has been shaped such that its major spectrum energy occupies the FCC UWB band (3.1-10.6GHz). Also at the frequency band with the existing wireless local area network (WLAN), the proposed UWB antenna with band-notch characteristic is behaved.



(a) (b)

Fig. 6. Measured signal of impulse response of the proposed antenna. (a) Input signal and received waveforms. (b) Waveform of the received signal.

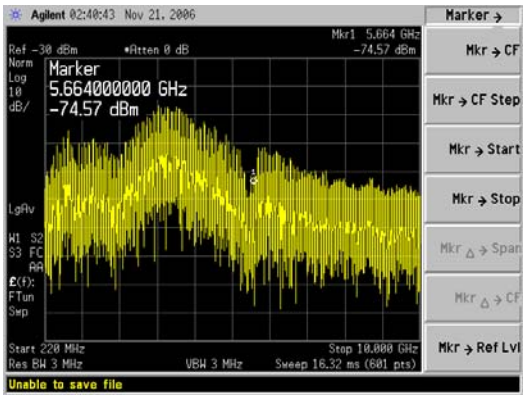


Fig. 7. Measured spectrum of the receive signal.

4. Conclusion

In this paper, a hybrid shape is adopted for the planar monopole antenna, which has UWB operating bandwidth and band-notch feature. The measured S-parameter and radiation patterns show that the antenna can be used effectively for UWB communication. By inserting a rotated E-shape slot into the planar monopoles, a notched band can be achieved. Measured waveforms and spectrum of the receive signal demonstrate that the proposed antenna is suitable for UWB applications.

Acknowledgments

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