

Chapter 53

A Trident Shape CPW Antenna for UWB Applications

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Abstract This article presents a coplanar waveguide (CPW) antenna with a trident shape for ultra-wideband (UWB) applications. First, a basic shape of trident CPW antenna is proposed to excite three resonant modes. The three resonances create a wide operating band but cannot cover the entire UWB band. To increase the impedance matching, the parameters of the proposed antenna are modified, which include adding two strips on the two outer arms and truncating two slots on the bottom of the middle arm. The ground plane of the proposed design is also modified to obtain better impedance matching. Finally, the 10 dB return loss that covers the UWB applications is accomplished. Besides, the dimensions of the proposed design occupy a small area of 32 mm × 17 mm × 0.8 mm with planar structure, which is convenient to apply in wireless devices. This article will provide the experimental measurements of return loss, radiation patterns.

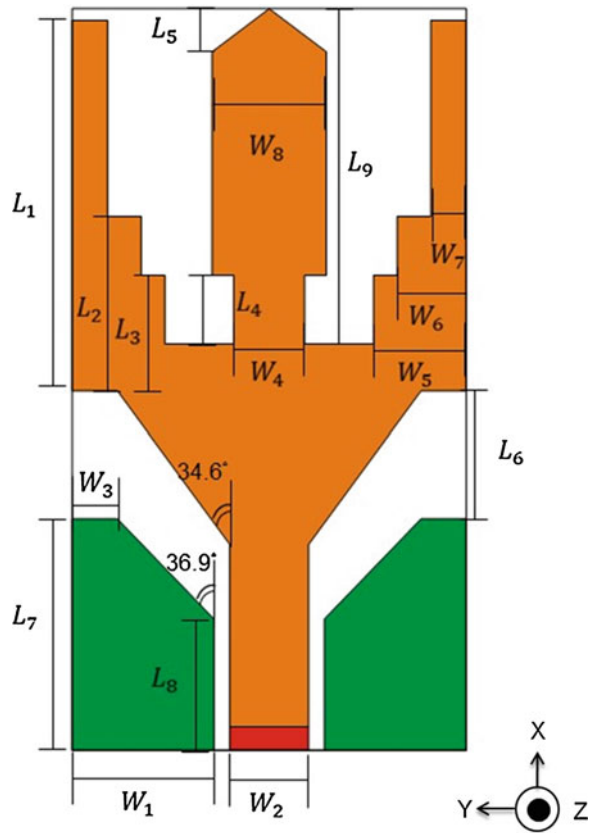
Keywords CPW antenna · UWB · Trident shape · 2-D structure

53.1 Introduction

In recent years, many wireless products for ultra-wideband (UWB) applications are investigated for the advantages of high-speed transmission, low power consumption, and simple hardware configuration. Antenna, the most important component for wireless system, is developed in various configurations and substrate materials in the previous publications. Coplanar waveguide (CPW) feeding having the benefits of 2-D planar structure, small dimensions, and wide impedance bandwidth becomes an optimal design mechanism in designing wideband

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Fig. 53.1 Geometry of the proposed antenna



microwave communication elements. In [1–6], the CPW antennas use circular shape or bevel edge on both antenna portion and ground plane, which reduce the impedance variations to obtain wider impedance bandwidth and meet the UWB application bands. The reference antennas use the popular monopole type or slot type antenna as their main structures. In the proposed design, a trident CPW antenna which excites three fundamental modes and two higher modes to achieve wider impedance bandwidth (2.4–10.6 GHz), is proposed for UWB applications. The proposed design not only performs a wide operating bandwidth but also has a compact dimension of 32 mm × 17 mm × 0.8 mm.

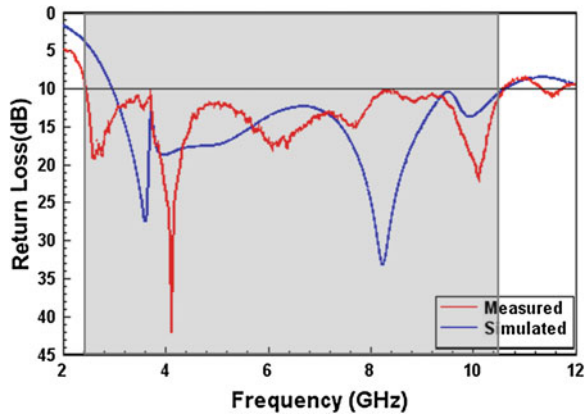
53.2 Antenna Design and Results

The proposed trident shape antenna shown in Fig. 53.1 is fabricated on an FR4 substrate with thickness of 0.8 mm, area of 32 mm × 17 mm, permittivity constant of 4.4, and loss tangent of 0.0245 S/m. The main structure of the trident

Table 53.1 Detailed dimensions of the proposed antenna

Antenna parameters								unit: mm
L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	
16	7.5	5	3	1.9	5.5	10	5.6	
W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	
6.1	3.4	2	3	4	3	1.5	5	

Fig. 53.2 Simulated and measured return losses of the proposed antenna

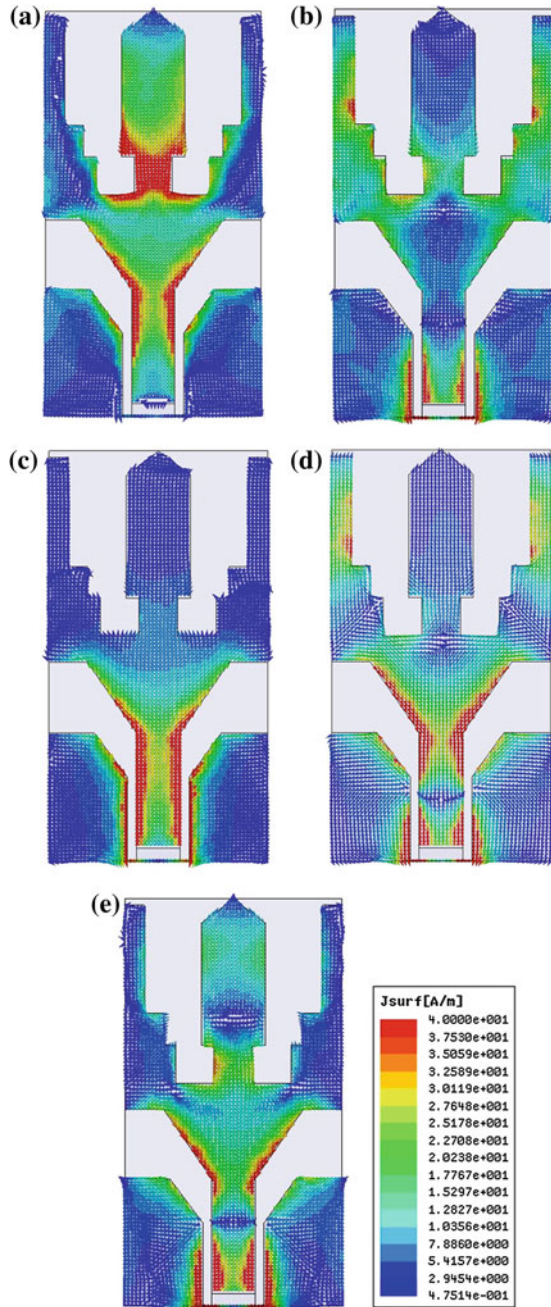


antenna consists of two outer arms on both sides and a middle arm. To increase the impedance matching, the two outer arms is added two strips (L_2 and L_3) to smooth the guiding current and the middle arm is truncated two slots (L_4) to match the impedance. In addition, the angle of the bevel edge in antenna geometry is 34.6° while that of antenna ground is 36.9° . The antenna ground is fabricated on both ends of the substrate and a 50-ohm CPW-fed line with width of 3.4 mm (W_2) is printed through the ground plane. Detailed dimensions of the proposed antenna are listed in Table 53.1.

To confirm the antenna’s application bands, the measured and simulated return losses of the proposed antenna are shown in Fig. 53.2. The simulated results of this paper are obtained through high frequency simulation software (HFSS). From the results, the agreements of the measured and simulated return losses can be seen although small variations of resonances and impedance matching are existing, which are occurred by the fabrication errors. The measured result based on 10 dB return loss (2.4–10.6 GHz) covers the UWB application.

The surface current distributions of the proposed antenna at the five resonant frequencies (3.6, 3.9, 5, 8.2 and 9.9 GHz) are plotted in Fig. 53.3. From Fig. 53.3a, b, c, the surface current distributions at 3.6, 3.9, and 5 GHz are concentrated on the middle arm, the two outer arms, and the 34.6° bevel edge, respectively. The results indicate that the three resonances are obtained from their fundamental modes. The higher operating bands at 8.2 and 9.9 GHz are achieved from higher modes of the two outer arms and the middle arm as shown in

Fig. 53.3 Simulated current distributions at different frequencies **a** 3.6 GHz, **b** 3.9 GHz, **c** 5 GHz, **d** 8.2 GHz, **e** 9.9 GHz



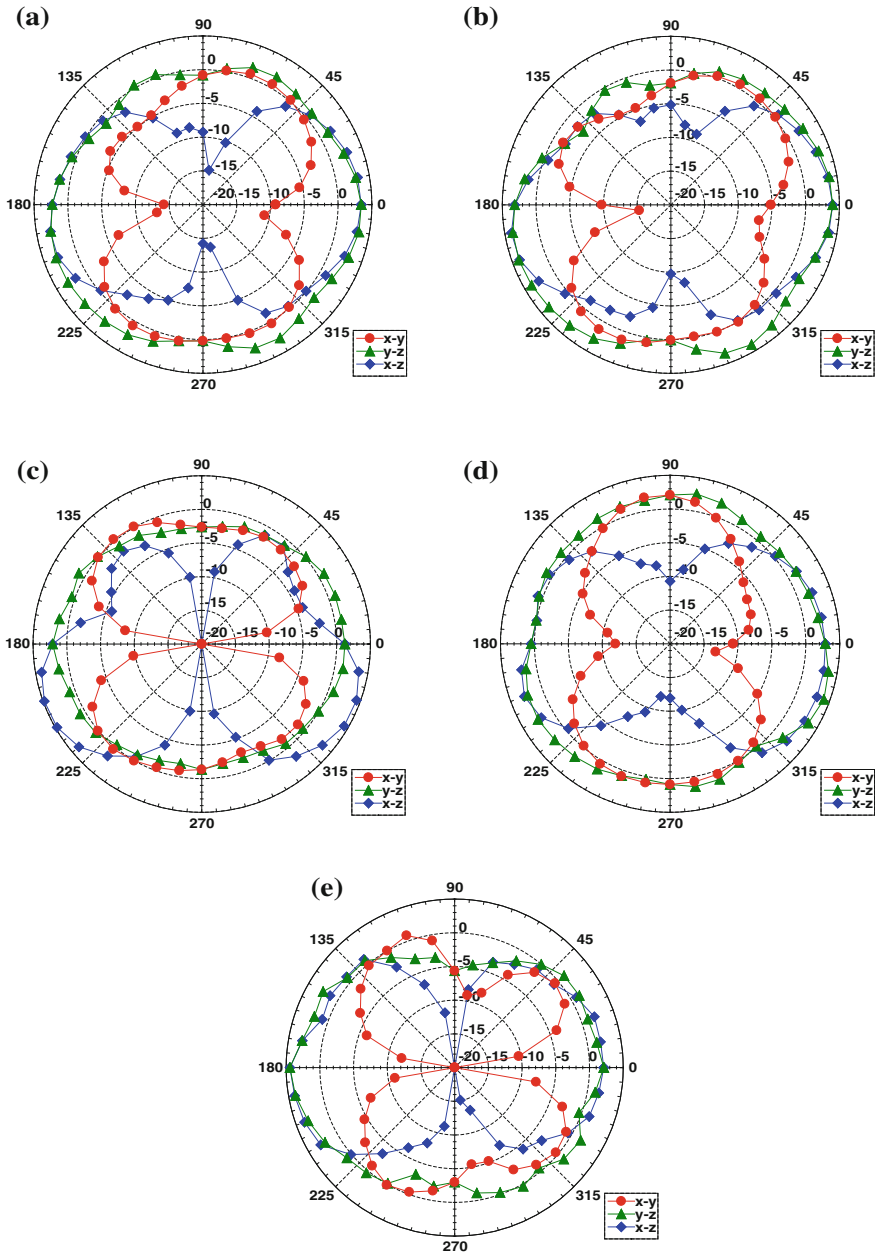


Fig. 53.4 Simulated radiation patterns at **a** 3.6 GHz, **b** 3.9375 GHz, **c** 5.05 GHz, **d** 8.23125 GHz, **e** 9.94375 GHz

Fig. 53.3d, e. In Fig. 53.4, the simulated radiation patterns at 3.6, 3.9, 5, 8.2 and 9.9 GHz are presented. From the results, the patterns in the Y–Z plane perform an omni-directional characteristic and that in the X–Y and X–Z plane have the shape of number 8. Because the 8.2 and 9.9 GHz bands are higher modes, the patterns are slightly twisted. Besides, the patterns are similar to the conventional dipole antennas that have a benefit of stable reception.

53.3 Conclusion

The trident CPW antenna for UWB applications is proposed and verified. Three fundamental modes and two higher modes obtained by the middle arm, the two outer arms, and the 34.6° bevel edge produce a wide operating band. The measured bandwidth based on 10 dB return loss is from 2.4 to 10.6 GHz that covers the UWB application bands (3.1–10.6 GHz). The proposed design not only operates broad operating band but also occupies a compact dimensions of $32 \text{ mm} \times 17 \text{ mm} \times 0.8 \text{ mm}$. The compact and 2-D planar structure has advantages of easy fabrication and applying in the wireless devices. Beside, the radiation patterns perform an omni-directional characteristic in the Y–Z plane and the shape of number 8 in the X–Y and X–Z plane.

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