A Dual Band U-shaped Slot Antenna for WLAN and WiMAX Applications

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Abstract— A compact dual band antenna with two U-shaped slots is presented. The antenna structure consists of rectangular patch and a ground plane at the same side. By using two U-shaped slots, the dual band characteristics are successfully obtained. Utilizing a CPW (Coplanar Waveguide) feeding line, the overall dimension of the antenna is 34.5 mm × 40 mm, which printed on an FR4 substrate with a dielectric constant of 2.95 and a substrate thickness of 0.8 mm. Simulation and measurement results show that the antenna impedance bandwidth covers the frequency range of 2.15 to 3.72 GHz. With almost omni-directional radiation pattern, the proposed antenna configuration can be applied to WLAN and WiMAX devices.

1. INTRODUCTION

Rapid development of wireless applications has promoted the printed antenna with characteristics of low cost, miniaturization and profiles reduction. Increasing attentions have been attached to wide dual-band and multi-band antennas vary with area or country [1]. Numerous types of popular antennas have been proposed and published for wireless local area network (WLAN) and World wide Inter operability for Microwave Access (WiMAX) applications [2, 3]. Many of them belong to categories such as the circular slot antennas, slot monopole antennas and slot antennas with triangular SRR terminated feedline [4–6]. To enhance the impedance bandwidth, the monopole and the slots with different shapes is used [7, 8]. With outstanding features, CPW-fed antennas have lower radiation losses and less dispersion than microstrip lines [9].

In this letter, a novel CPW-fed dual-band antenna with U-shaped slots is proposed, simple and well suited for WLAN and WiMAX operation. Owing to the two U-shaped slots, dual band resonant modes are brought in. The proposed antenna employs two L-shaped slots in the ground plane to broaden the impedance bandwidth which can easily cover the WLAN and WiMAX bands [10]. The antenna has promising features, including good impedance matching performance over the whole operating frequency band and stable radiation patterns. Good agreement between the measurement and simulation is achieved.

2. ANTENNA DESIGN

Figure 1 shows the configuration of CPW-fed dual-band slot antenna as well as the coordinate axis. The antenna is printed on a FR4 substrate with thickness of 0.8 mm, relative permittivity of 4.3 and loss tangent of 0.02, respectively. A 50-Ω CPW transmission line of a signal strip is used for feeding the antenna. Two U-shaped slots in the rectangular radiating patch generate two resonant modes and L-shape slots help to enhance the impedance bandwidth. Simulation and optimization of the antenna have been conducted with high-frequency structure simulator (HFSS) which is based on the finite element method. As shown in Table 1, the optimal parameters for proposed configuration are obtained.

Table 1: Value of the optimized parameters (unit: mm).

W	L	S	W_1	W_2	W_3	W_4	W_5	W_6
34.5	40.0	0.3	33.6	18.9	16.4	14.9	14.7	16.0
W_7	W_8	L_1	L_2	L_3	L_4	L_5	S_1	h
14.9	1.5	10.5	2.6	6.5	26.7	2.0	0.5	0.8

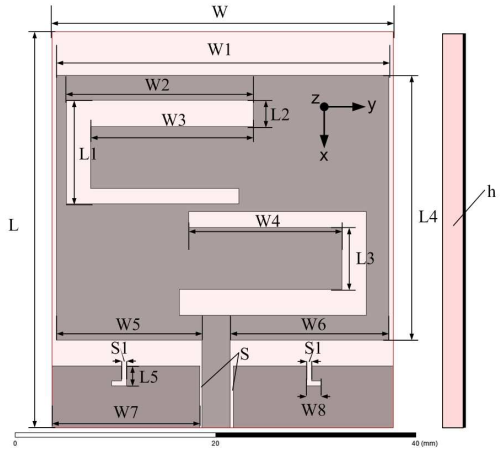
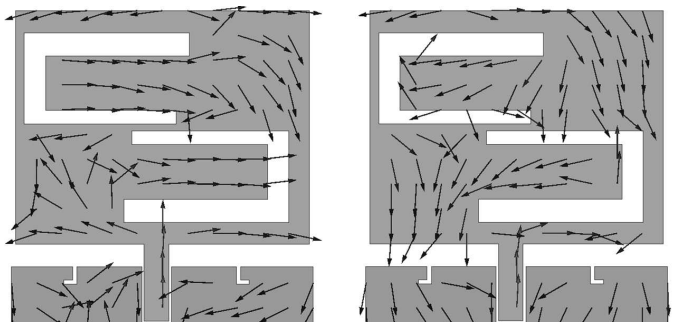


Figure 1: Configuration of the proposed antenna.



(a) 2.45 GHz (b) 3.44GHz

Figure 2: Surface current distributions of the proposed antenna.

3. SIMULATION AND MEASUREMENT

Figures 2(a) and 2(b) plot the current distributions of the proposed dual-band slot antenna at the central frequencies of the first and second resonant bands, respectively. As shown in Figure 2, the U-shaped slots increase the current routes to achieve two resonant bands.

Figure 3 plots the measured and simulated S_{11} curves against frequency. The antenna has two operating bandwidths with the central frequencies of 2.45 GHz and 3.44 GHz and the simulated results agree excellently with measurements.

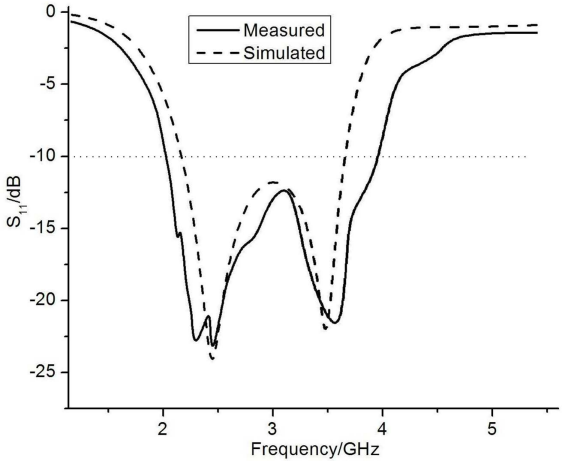
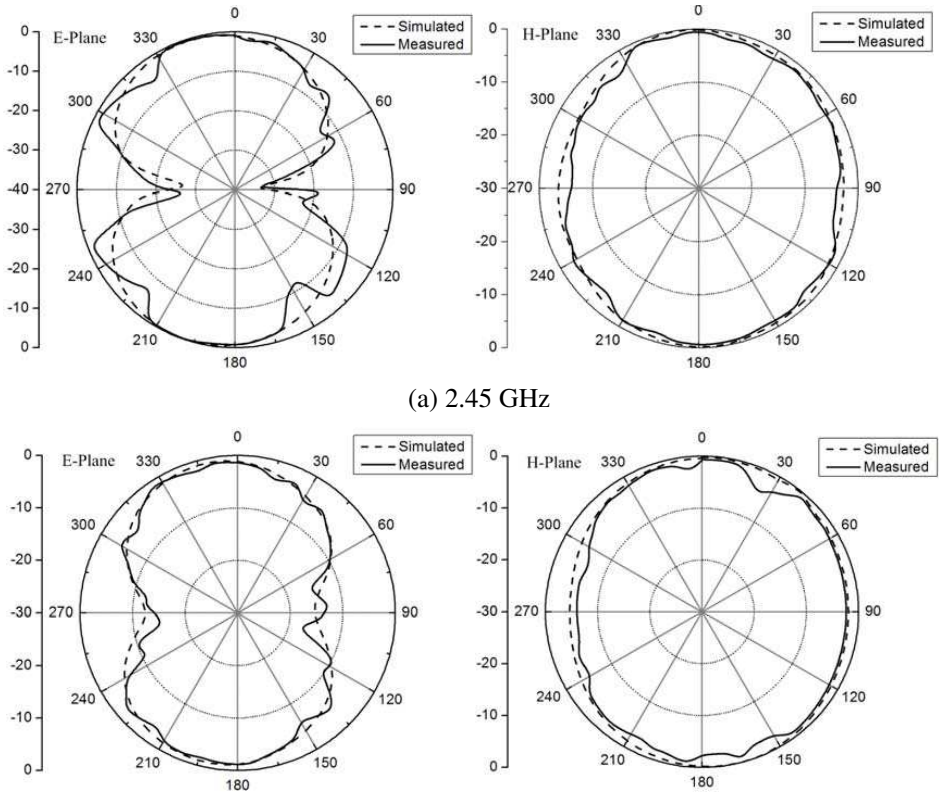


Figure 3: Measured and simulated S_{11} of the prototypes.

Figure 4 demonstrates the measured radiation pattern at 2.45 and 3.44 GHz. At low band, a figure-eight radiation pattern is obtained in the E-plane, and a nearly omni-directional radiation pattern in the H-plane. Although the obtained patterns are not as good as a conventional simple monopole antenna, they are close to the monopole-like patterns.

In Figure 5, the measured gain at low band varies in a range of $3.44 \sim 5.23$ dBi and varies in a range of about $3.12 \sim 4.09$ dBi at the high band. For bandwidth frequencies associated with dual impedance, acceptable broadside radiation patterns and favorable cross-polarization characteristics are obtained. However, the gain variations reach more than 1.0 dBi across the operating bandwidths from 2.40 to 2.60 GHz. As the antenna gain is a function of its electrical dimensions relative to the wavelength of interest, current distribution, and radiation pattern, the proposed antenna has larger gain in the lower band. Photograph of the fabricated antenna is shown in Figure 6.



(a) 2.45 GHz

(b) 3.44 GHz

Figure 4: Radiation patterns of the presented antenna.

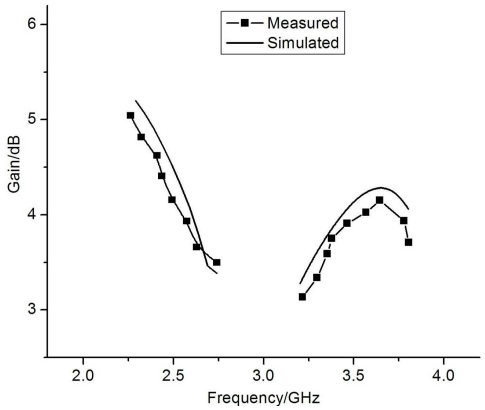


Figure 5: Simulated and measured gain against frequency for the proposed antenna.

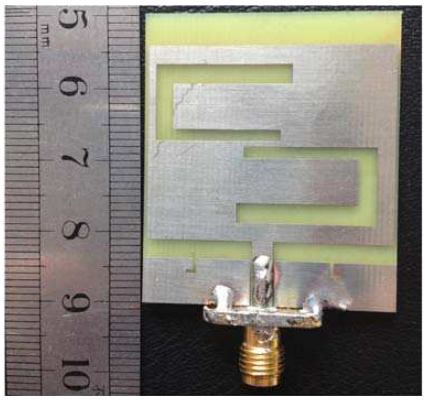


Figure 6: Photograph of the fabricated antenna.

4. CONCLUSION

A novel CPW-fed U-shaped slot antenna is proposed for WLAN and WiMAX applications. Two resonant operating bands are introduced by the U-shaped slots. Owing to the L-shaped DGS, the bandwidths of the proposed antenna are enhanced. Simulations and measurements have indicated that the proposed antenna can be effectively used for WLAN and WiMAX applications.

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