

A Printed Monopole Antenna with Two Coupled Y-Shaped Strips for WLAN/WiMAX Applications

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Abstract—In this paper, a new design of dual-band monopole antenna with two coupled Y-shaped strips for WLAN/ WiMAX applications is presented. By adjusting the geometries of the two Y-shaped strips, two separated impedance bandwidths of 17.5% (3.31~3.94 GHz) and 18.6% (4.98~5.94 GHz) ($S_{11} \leq -10dB$) can be obtained. The proposed antenna has a low profile and can be easily fed by using a 50 Ω microstrip line. Good radiation characteristics of the antenna can also be obtained. The overall dimension of the proposed antenna can reach 17.7×26×1mm³.

I. INTRODUCTION

Nowadays, the wireless local area net work (WLAN: 2.4-2.48GHz, 5.15-5.35GHz, and 5.72-5.85GHz) and the worldwide interoperability for microwave access (WiMAX: 2.5-2.69GHz, 3.40-3.69GHz, and 5.25-5.85GHz) system are becoming increasingly popular. Thus, many researchers have been paying much attention to design multi-bands, omnidirectional pattern antennas for the mentioned above application, such as [1]-[5]. In [1], the antenna with dual band-notch characteristics can operate at two bands in WLAN system. A coupled dual-U-shaped antenna for WiMAX triple-band operation has been presented in [2]. In [3], by using defected ground structure, the design of triple-frequency antenna for WLAN/WiMAX applications is proposed. In [4], the double-T antenna for the dual-band WLAN operations has been reported, in which two T-shaped strips generate two different resonant frequencies. In [5], a monopole antenna with a shorted parasitic inverted-L wire for WLAN application is studied.

In this letter, a new design of dual-band monopole antenna with two coupled Y-shaped strips for WLAN/WiMAX applications is presented. The operation bands can be determined by the geometries of the two Y-shaped strips, the coupling of the two strips and the ground plane. The overall dimension of the proposed antenna can reach 17.7×26×1 mm³. The simulated and the measured results show that the antenna can effectively cover two separated impedance bandwidths of 630MHz (3.31~3.94 GHz) and 960MHz (4.98~5.94GHz), which satisfy both 5.2/5.8-GHz WLAN bands and 3.6/5.5-GHz WiMAX bands.

II. ANTENNA DESIGN

Figure 1 illustrates the geometry of the presented dual-band antenna with two coupled Y-shaped strips for WLAN/ WiMAX applications. Both of the two coupled Y-shaped strips

and a 50 Ω microstrip line are printed on the same side of the substrate with dielectric constant of 2.65 and a thickness of 1mm. On the other side of the dielectric substrate, a ground plane is printed below the microstrip feed line.

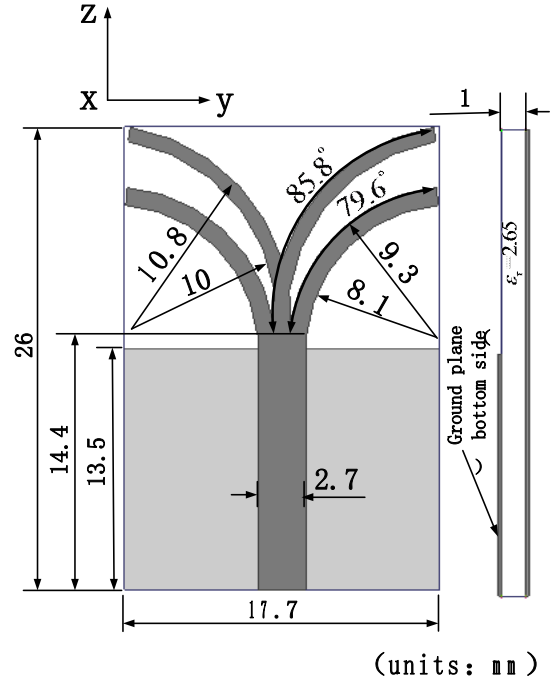


Figure 1. the geometry of the presented dual-band antenna

As shown in Figure 2, the top Y-shaped strip is designed to resonate at 3.56 GHz, whereas the bottom Y-shaped strip provides the high resonance frequency at 4.63 GHz. The length of each strip is about a quarter of the guided wavelength λ_g , which is calculated at the desired resonant frequency. The guided wavelength λ_g is defined as:

$$\lambda_g = \frac{c}{\sqrt{\epsilon_{eff}} f} \quad (1)$$

$$\epsilon_{eff} \approx \frac{(\epsilon_r + 1)}{2} \quad (2)$$

The Equation(1) and (2) are cited from [6]. Where c is the speed of light, f is the resonant frequency, ϵ_{eff} is the effective relative permittivity and ϵ_r is the relative permittivity. Given a resonant resonant frequency, the initial total length of the strip can be determined by (1). After the connection of the two Y-shaped strips, the proposed antenna can cover 3.31~3.94 GHz and 4.98~5.94GHz, which satisfies both bands 5.2/5.8-GHz

WLAN and 3.6/5.5-GHz WiMAX bands. It means that the operation bands can be determined by both the geometries of the two Y-shaped strips and the coupling of the two strips. Figure 3 shows the measured results of the proposed antenna, we can see that the simulated results of the antenna have good agreement with the measured results.

Figure 4 shows the results of the proposed antenna's surface current distribution for the two resonant frequencies at 3.60GHz and 5.17GHz. Obviously, from the Figure 4(a), much surface current distributes at the top Y-shaped strip, which means that its resonance mode has been excited at 3.60GHz. What's more, we also should note that there is a little current between the two strips. From the Figure 4(b), much current distributes at the top and bottom Y-shaped strips, which means that its resonance mode has been excited at 5.17GHz. In conclusion, both the two resonance modes has been excited at corresponding positions of the proposed antenna. Each Y-shaped strip and the couplings between the strips provide the contributions for the final two frequency bands.

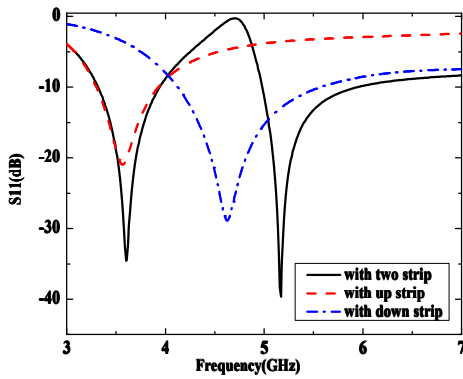


Figure 2. Simulated S-parameters of the proposed antenna without top or bottom strip and with two strip

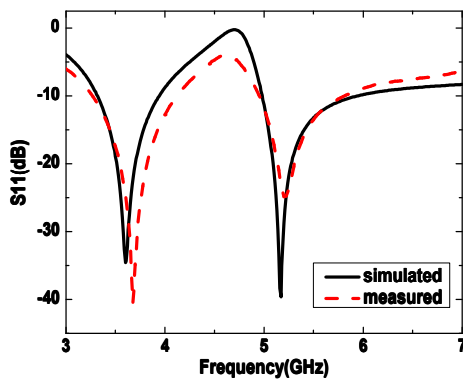


Figure 3. Measured S-parameter results of the presented antenna

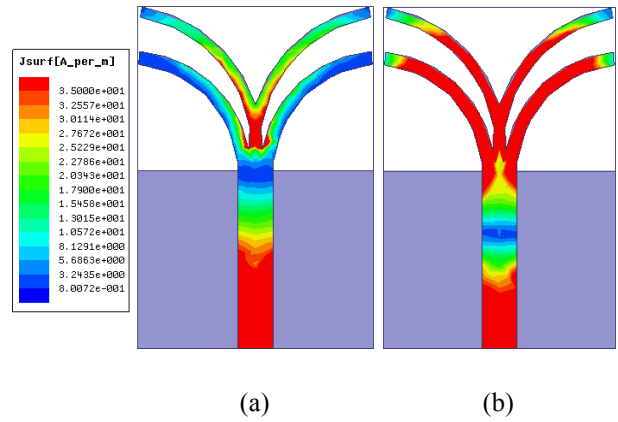
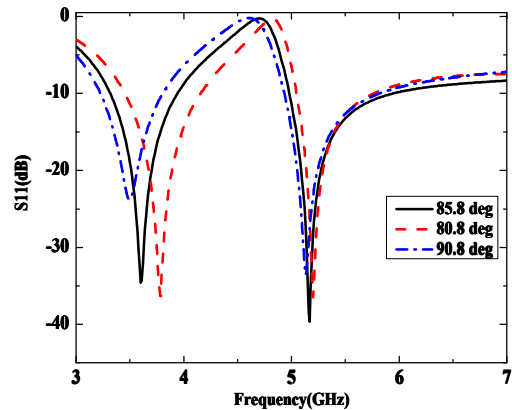


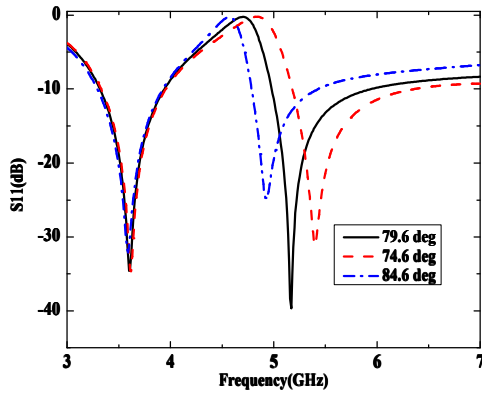
Figure 4. Simulated results of the current distributions for the proposed monopole antenna at different frequencies (a) 3.60GHz (b) 5.17GHz, respectively

III. SIMULATED RESULTS

Figures 5(a) and (b) show the simulated reflection coefficients changing with the central angle parameters of the proposed antenna for dual-band performance. Here, the central angle of the strip can be considered as one optimized parameter to obtain the two frequencies we need. From Figure 5(a), the low frequency band can be effectively adapted as the central angle of top Y-shaped strip is changed from 80.8 deg. to 90.8 deg. Clearly, from Fig.5 (b), we also know that as the central angle of bottom Y-shaped strip is changed from 74.6 deg. to 84.6 deg., the high frequency band is also tuned lower and lower. So we should also note that both the two operation bands can be determined by not only the geometries of the two Y-shaped strips but also the coupling of the two strips and the ground. Therefore, the final design needs the consideration of the two strips and the ground together.



(a)



(b)

Figure 5. Simulated reflection coefficients of the proposed antenna with the central angle parameters: (a) central angle of the top Y-shaped strip (b) central angle of the bottom Y-shaped strip

According to Figure 6, we can see the simulated peak gains of the proposed antenna for WLAN/WiMAX bands. At the desired frequencies, their peak gain are about 3.51 dBi, 3.77 dBi, 3.58 dBi and 3.41 dBi at 3.6 GHz, 5.2 GHz, 5.5 GHz and 5.8 GHz, respectively. The far-field radiation patterns for the proposed antenna at 3.60 and 5.17 GHz are given in Figure 7(a) and (b). It can be observed that the antenna gives nearly omnidirectional and stable radiation patterns in the H-plane at the two working frequency bands.

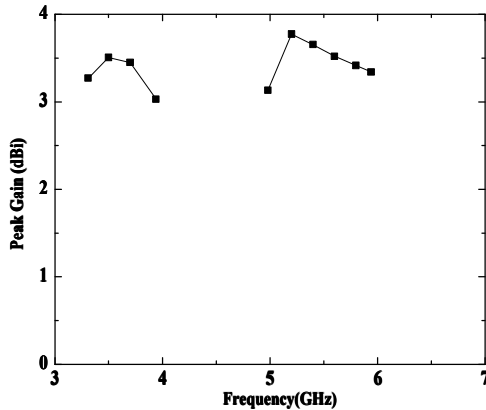
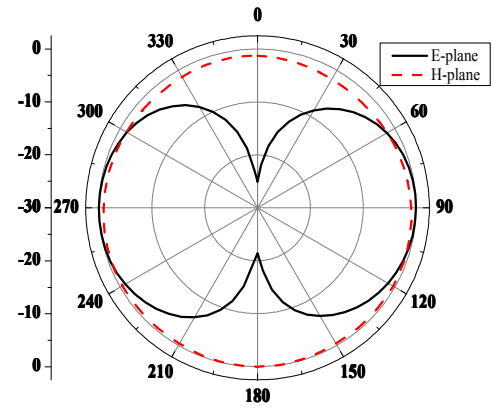
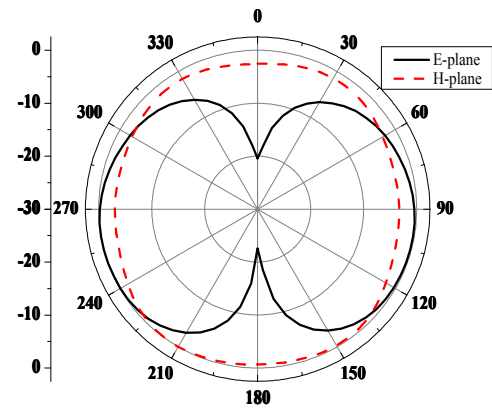


Figure 6. The peak gains of proposed antenna for the desired bands



(a)



(b)

Figure 7. Simulated radiation patterns of the proposed antenna at (a) 3.60GHz E-plane and H-plane (b) 5.17GHz E-plane and H-plane

IV. CONCLUSION

This paper presents a new design of dual-band monopole antenna with two coupled Y-shaped strips for WLAN/WiMAX applications. By properly adjusting the geometries of the two Y-shaped strips, two separated impedance bandwidths can be obtained. The proposed antenna has good radiation characteristics for 5.2/5.8-GHz WLAN bands and 3.6/5.5-GHz WiMAX bands, as well. The overall dimension of the proposed antenna can reach $17.7 \times 26 \times 1$ mm³. Therefore this novel simple antenna could be a better candidate for a WiMAX/WLAN dual-mode system.

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