A Compact Tri-Band Printed Antenna Design

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***Abstract*— A compact tri-band printed antenna has been designed which is applied to wireless local area network and worldwide interoperability for microwave access. The antenna is consisted of '3'-shaped and other rectangular radiation patches connected to a strip line directly. Operating frequencies of the antenna are covered at 2.45, 3.5, and 5.8 GHz, and good radiation properties have been obtained at the operating bands. Experiment results have been verified this design available.**

Keywords—compact structure; print antenna; tri-band

I. Introduction

Nowadays, due to developing of modern wireless communication technology and growing requirement of accessing internet by mobile devices, wireless local area network (WLAN) and worldwide interoperability for microwave access (WiMAX) has been widely used. In the field of wireless communication, the useful spectrum resource is limited; antennas with multibands function, compact size, and omnidirectional pattern have become the research focuses. Because advantages of low cost and can easily integrate with electronic and telecommunication equipment, the printed antenna are highly applied in wireless communication system. As a consequence, a large number of printed antennas were designed for WLAN/WiMAX applications [1]-[3]. To obtain multiband features, a compact rectangular microstrip antenna is realized by two different single-slotted single-band rectangular microstrip antennas with slotted ground plane in Ref [4], but it is only applied in dual-band operation. Furthermore, a coplanar waveguide (CPW)-fed planar printed antenna is presented for triple bands operation [5]. However, the interference of the multiband can not be ignored.

In this letter, a compact tri-band printed antenna is designed for WLAN/WiMAX applications. The effects of different parameters and simulated results of the antenna are introduced in subsequent sections.

II. Antenna Geometry Structure

The geometry of the tri-band printed antenna is depicted in Fig. 1. The antenna is printed on an FR4 substrate with overall dimension is 24×21×1.6mm^3. Thus, its structure is very compact. The radiation patches and microstrip 50Ω line are printed on the top of the substrate and the ground plane is printed on the bottom of the substrate. The results of simulation are carried out by the software ANSYS HFSS 13.0, which is based on the commercially available finite element method.

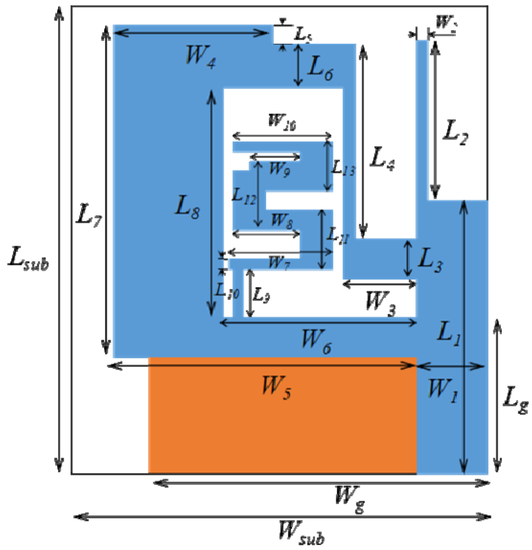

Fig. 1. The geometry of the tri-band antenna.

Evolution processes of designing the presented structure by three prototypes are displayed in Fig. 2. The different reflection coefficients (S_{11}) is shown in Fig. 3. In the structure of A1, it is designed to produce a 6.5GHz band. By designing rectangular ring radiation patch and '3'-shaped radiation patch, A2 is formed to excite frequencies for 2.45 and 5.6 GHz applications. To achieve tri-band function, a rectangular radiation patch is added to A2, by optimizing the parameters of A3, it can produce a tri-band covering the 2.45, 3.5 and 5.8 GHz bands. In the end, the antenna appears a reasonable performance due to further optimizing the dimension parameters, which is based on the structure of A3. The size of antenna designing is shown in TABLE I.

III. Antenna Simulation and Measurement Results

To check the effect of variation dimension parameters of the antenna, simulation works were done on its performance.

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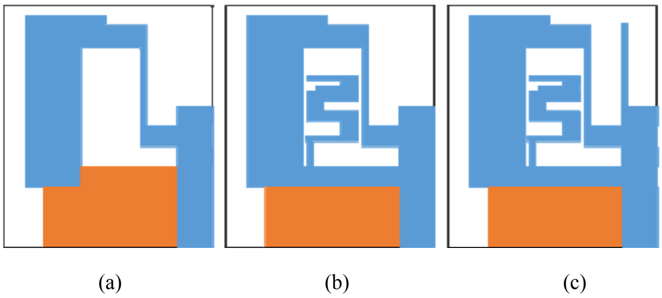


Fig. 2. Evolution processes of printed antenna, (a) A1, (b) A2, (c) A3.

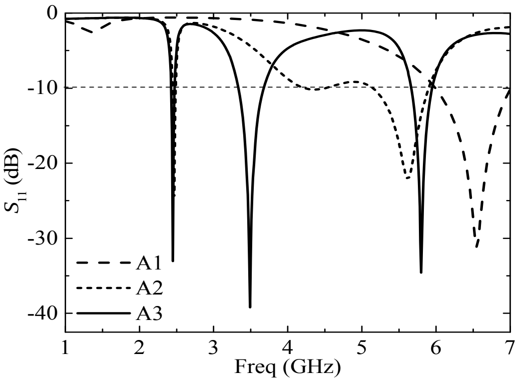


Fig. 3. Simulated reflection coefficients of A1, A2, A3.

TABLE I. DIFFERENT DIMENSION PARAMETERS (UNIT: MM)

L_{sub}	W_{sub}	L_g	W_g	L_1	L_2	L_3
24	21	8	17	14	8.2	2
L_4	L_5	L_6	L_7	L_8	L_9	L_{10}
10	1	2.1	17	11.9	2.5	0.5
L_{11}	L_{12}	L_{13}	W_1	W_2	W_3	W_4
3	3.5	2.5	3.5	0.6	3.9	8
W_5	W_6	W_7	W_8	W_9	W_{10}	
15.5	10	5.2	3.4	2.55	5.1	

The effect of variation dimensions of L_9 is exhibited in Fig. 4. It is clear from figure that the size of L_9 mainly effecting 2.45 GHz, L_9 =2.5 mm, the antenna works well. Similarly, the effect of variation dimensions of L_2 is illustrated in Fig. 5. It shows that the size of L_9 mainly effecting 3.5 GHz by the means of the resonant frequency becoming smaller with L_2 increases gradually. Furthermore, in order to test the effect of the ground plane, some simulations were carried out. Increasing L_g of the ground plane, the resonant frequency of 5.8GHz will change along with L_g, as shown in Fig. 6.

Changing certain dimension parameters will cause effects on the function of the antenna. After optimizing step by step, it is easy to realize the desirable function. Based on the detailed dimensions presented in TABLE I, the reflection coefficient is below -10dB over the bands 2.425-2.476, 3.33-3.68, 5.66-5.95 GHz.

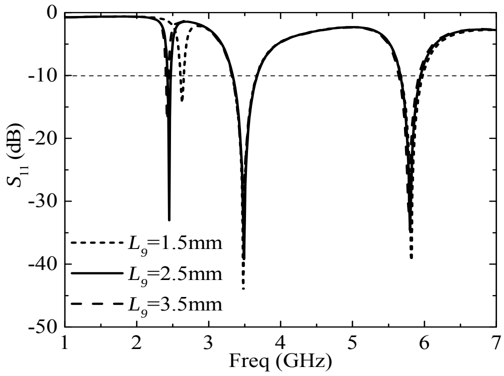


Fig. 4. Reflection coefficients for different length of L_9.

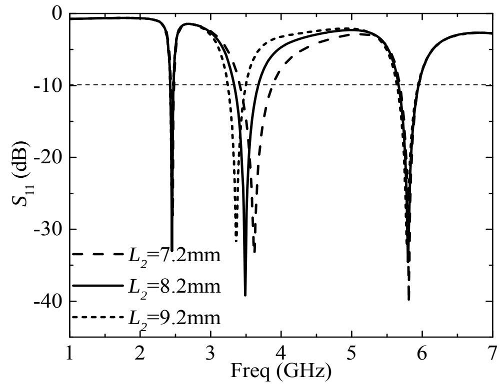


Fig. 5. Reflection coefficients for different length of L_2.

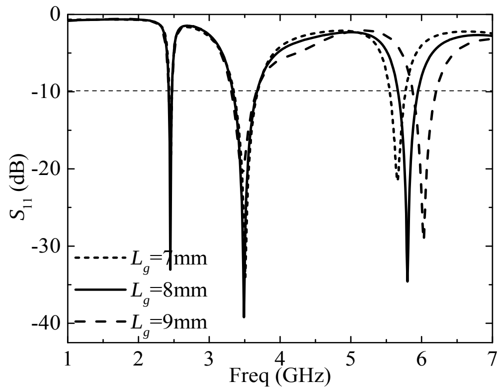
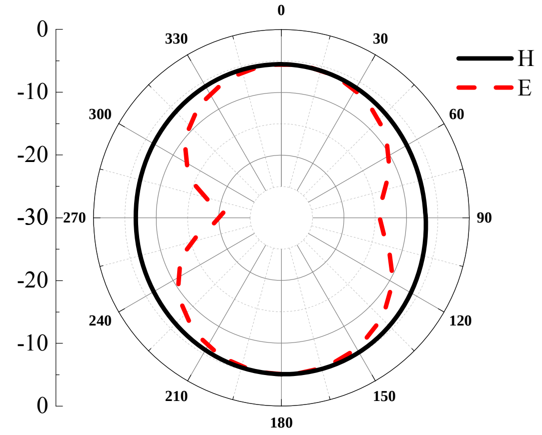


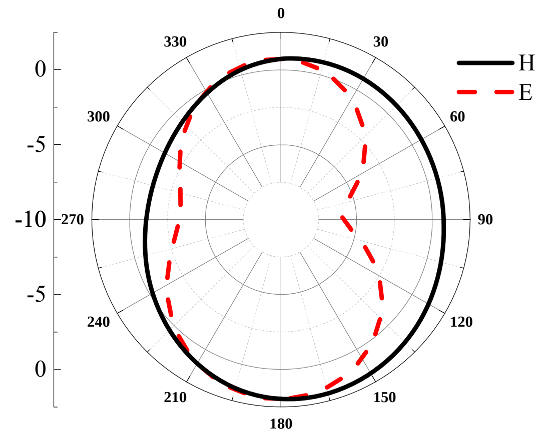
Fig. 6. Reflection coefficients for different length of L_g.

Radiation patterns in H-plane and E-plane of the proposed antenna is simulated at 2.45, 3.5, and 5.8 GHz, respectively. The simulated results are shown in Fig. 7 (a)–(c). It can be seen from the picture that the proposed printed antenna presents desirable omnidirectional H-plane patterns and bidirectional E-plane patterns in the requirement frequency bands.

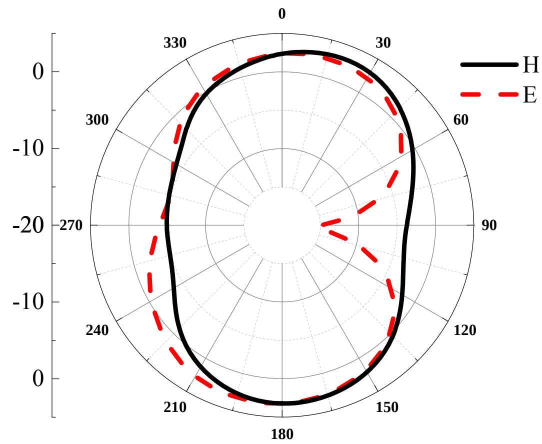
The photo of fabricated sample antenna is depicted in Fig. 8. Reflection coefficient of the printed antenna is tested by using vector network analyzer in our laboratory. Results are illustrated in Fig. 9. Contracting between simulated and measured results, it reveals that the printed antenna has a reasonable performance. Some mismatch between measured and simulated reflection coefficients are mainly because of experimental environment constraints and fabrication tolerance.



(a)



(b)



(c)

Fig. 7. Radiation patterns of the proposed antenna at requirement frequencies, (a) f =2.4GHz, (b) f =3.5GHz, and (c) f =5.8GHz.

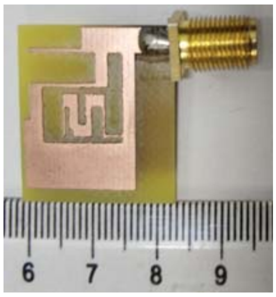


Fig. 8. Photo of fabricated antenna.

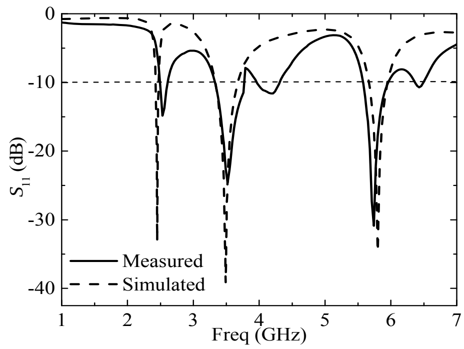


Fig. 9. Measured and simulated reflection coefficients of the antenna.

IV. Conclusion

A tri-band printed antenna for WLAN/WiMAX applications is proposed, which is not only compact in size, but low cost as well. However, the structure of the antenna is complex. The simulated and measured results indicated that the printed antenna matches the requirement of WLAN and WiMAX communication systems, and reflection coefficient is realized below -10dB over the bands 2.425-2.476, 3.33-3.68, 5.66-5.95 GHz. Meanwhile, almost radiation patterns are reasonable at the useful bands.

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