A Triple-band Planar Inverted-F Antenna for WLAN Application

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Abstract— A novel tri-band PIFA antenna operating at WLAN frequency is proposed. The antenna has a two-layer structure, resembling a capital E. By folding the E-shaped structure down, It can largely reduce the size of the antenna. The antenna is feed by the probe, which extends from the ground plane to connect to the radiating strip. The short-circuit strip connects with the ground plane is realized by the probe or shorting wall. The whole structure is the three-dimension version of the simple inverted-F antenna. Three electric current path consititute three resonant mode, corresponding to 2.4/5.2/5.8 GHz, respectively.

1. INTRODUCTION

Wireless local area network (WLAN) technology have extensively been used in commercial, medical, and industrial applications over the last decade [1]. Various antenna operating in this frequency band have been reported. Planar inverted-F antenna (PIFA) is widely applied in mobile terminal due to its low backward radiation and easily-fabricated structure. And due to the flexibility of PIFA antenna's structure, it can be cover the whole WLAN frequency band conveniently. A variety of designs can be found in the literature [2–5].

In this paper, a novel tri-band E-shaped PIFA antenna for WLAN application is proposed. It can provide three frequency bands for WLAN application, covering 2.4, 5.2 and 5.8 GHz.

2. ANTENNA DESIGN

A Eshaped tri-band PIFA antenna is presented, illustrated in Figure 1. The antenna can be considered as a E-shaped plane folded to reduce the size, the antenna balances the capacitive reactance and the inductive reactance through a short pin with length of 2 mm, which also can be replaced by a short wall, just slightly tuning the parameters. A thickeness of 0.8 mm FR4-exopy substrate place below the metal ground to substain the whole structure. The first current

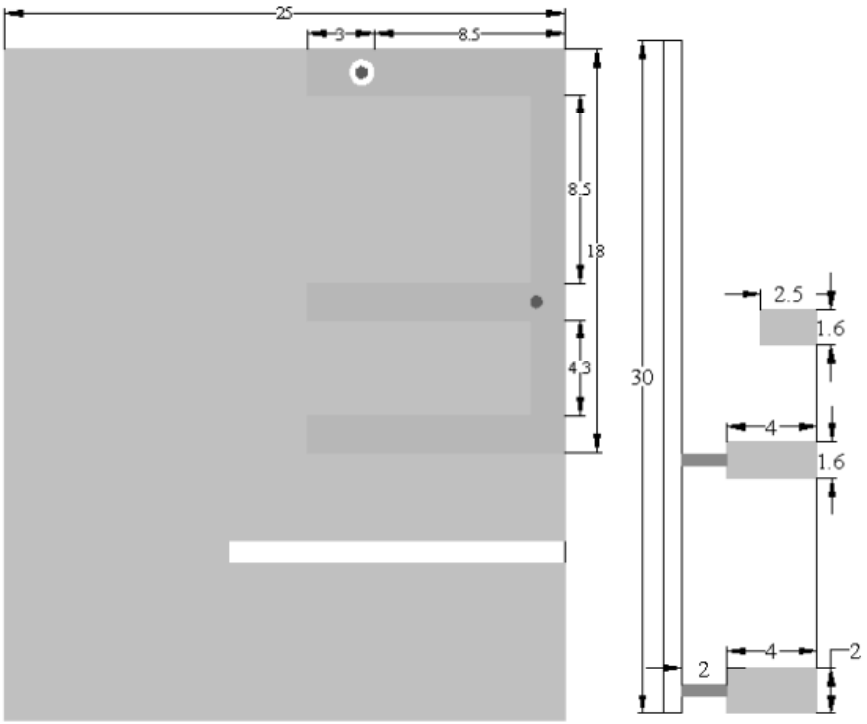

Figure 1: Geometry of the proposed antenna.

path from point A to B is 42 mm, approximately equal to quarter-wavelength in the frequency 2.4 GHz, its current distribution pattern is shown in Figure 2(a), it can be observed that the

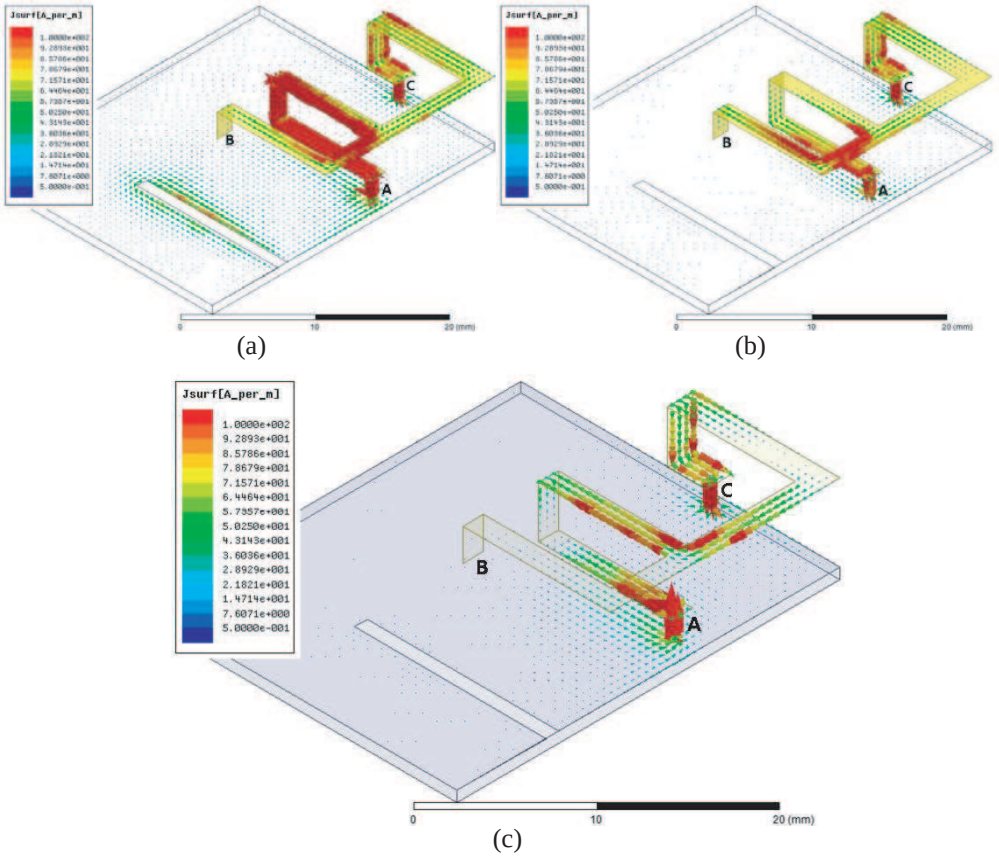

Figure 2: Simulated current distribution of the proposed PIFA antenna, (a) 2.45, (b) 5.28, (c) 5.86 G.

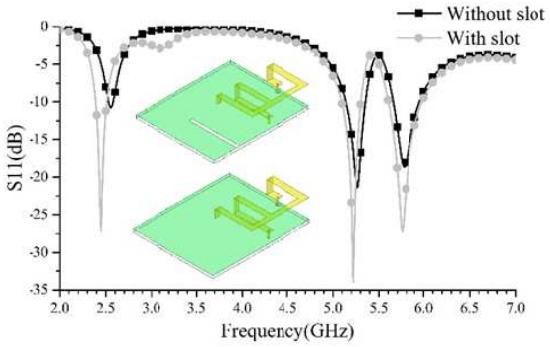

Figure 3: Comparison of the return loss for proposed antenna with/without slot.

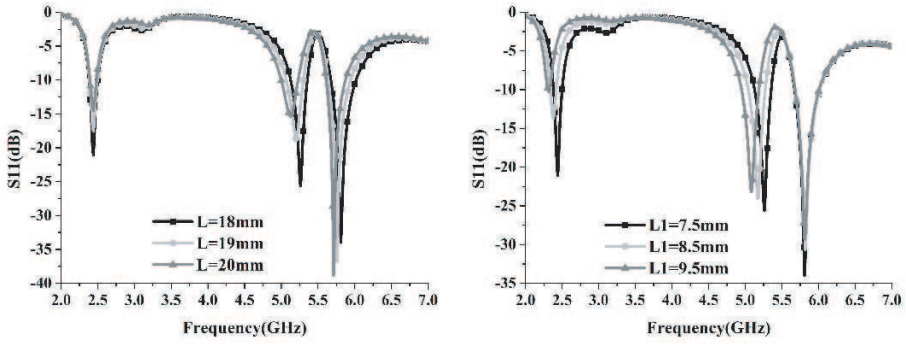

Figure 4: Return loss against frequency with different parameters. (a) L and (b) L_1.

majority of the current is concentrated on AB at frequency 2.4 GHz, the slot extend the current path, plays a role in enhancing the impedance matching at lower frequency. The second current path composed of AC and BC parts is about 48 mm close to three quarter-wavelength at 5.28 GHz, the current distribution in Figure 2(b) verify it well. The third current path BC is about 53 mm, one-wavelength, two current nulls also verify it, at 5.86 GHz, as shown in Figure 2(c).

3. RESULT AND DISCUSSION

The return loss with/without slot are shown in Figure 3, it can be observed that the slot has slight influence on highfrequency, namely, the length of the ground is enough to excite the resonance of high-frequency. However the slot improve the impedance match of low-frequency and reduce the lowest operating frequency.

To further comprehend the working mechanism, the effect of several parameters on the proposed antenna are studied and displayed in Figure 4. Figure 4(a) implies that the variation of L barely affect the lower resonant frequency, while Figure 4(b) shows that the increment of L_1 has little impact on the upper resonant frequency.

Figure 5 display the radiation pattern of the antenna at the frequency of 2.44, 5.26 and 5.81 GHz in the *xoz* and *yoz* planes. At the frequency of 2.44 GHz and 5.81 GHz, their omnidirectional characteristic have an advantage over that of 5.26 GHz, which may be related with the current

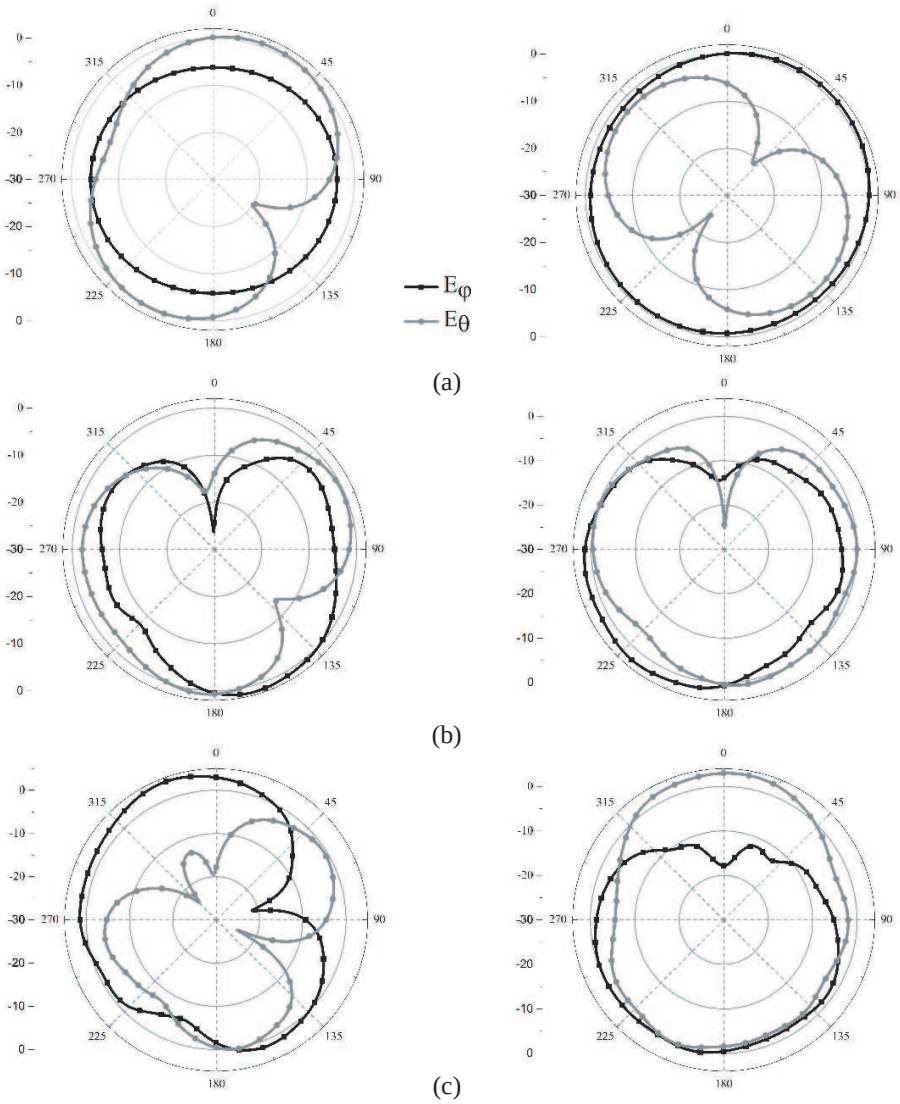

Figure 5: Radiation pattern XOZ_plane(left) and YOZ_plane(right) for (a) 2.44 GHz, (b) 5.26 GHz, (c) 5.81 GHz.

distributed along two path. The inclination of radiation pattern is related with three-dimensional structure.

4. CONCLUSION

A novel tri-band PIFA antenna operating at WLAN frequency is proposed. The tri-band PIFA only occupies $30 \times 25 \times 6\,\mathrm{mm}^3$. Its working mechanism and radiation characteristic are studied.

ACKNOWLEDGMENT

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