Small Printed Antennas with Folded Shorted-Strip for Dual-Band WLAN

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Abstract - Small printed antennas with folded shorted-strip for dual-band WLAN are presented. The proposed antennas are based on the stacked shorted-patch structure, which is a popular approach for further reducing the antenna size of a typical planar inverted-F antenna. According to our simulation results, two prototype antennas are manufactured and measured. The obtained antennas operate in IEEE802.11a/b/g bands (2.4-2.484GHz and 5.15-5.35GHz bands) and can be adopted for various potable applications.

Introduction: There has been a great deal of interest in developing multi-band antennas in wireless communication systems. With the revolution of wireless communication, studies and development efforts have been focused on smaller size and better performance antennas. In the previous studies pertaining to the IEEE 802.11a/b/g standard operating frequency 2.4GHz and 5GHz, various types of antennas have been developed in the personal wireless units [1-3]. 802.11b/g has been dominant market choice in commercial wireless applications. In recent years, the demand for further expansion of wireless systems has been shifting from existing standard to dual band covering frequency range of 2.4GHz and 5GHz. Owing to the rapid progress in WLAN communication the antenna developments have also demanded multi-band operations in the 2.4GHz and 5GHz. As an example, most of portable units will incorporate 802.11a and 802.11b/g technology, which can provide data rates up to 54Mbps and 11Mbps, respectively. In the 5GHz, there are other operation bands depending on the countries so our future antenna design will be focusing on expanding the covering frequency range up to 5.85GHz. Previous efforts for developing dual-band antennas are limited in typical planar inverted-F antennas (PIFA) [4], [5]. Recently, various printed antenna structures have been proposed to meet the requirements such as compact size, low cost and simple manufacture in wireless system applications [6], [7]. In this study, we propose small printed antennas supporting IEEE802.11a/b/g. The geometry is basically a folded shorted-patch antenna [4]. Simulation and measured results are presented and compared.

Antenna design and measurement: Figure 1 shows the proposed antenna configuration and the coordinate system used here. Figure 1(a) shows an inverted-F antenna with folded shorted-strip. The driven radiating plate is a typical inverted-F antenna structure and a shorted parasitic strip is used to reduce the overall antenna size to $\lambda_o/8$ [4]. It is clear that the physical length can be reduced by 50% because the shorted parasitic strip makes the total resonant length of the antenna to be $\sim\lambda_o/4$. In order to get the dual band operation, the optimum length of each plate and the gap between two plates are determined based on the simulation result shown in figure 2. In addition to the plate length and gap, the size of ground plane also affects to the electrical performance. The feeding point is on the driven plate and 3mm apart from the ground post and other parameters are shown in figure 2. The lower radiating plate is 17mm in length and 1.5mm in width and normally generates the resonance of 5.3GHz band. And the shorted parasitic strip produces the other resonance in 2.4GHz. All of the dimensions mentioned above are not optimised in the specific unit.

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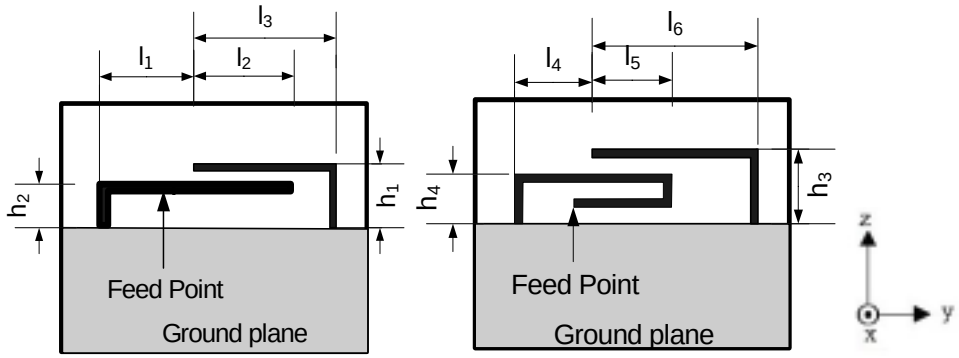


(a) (b)

Fig. 1 Antenna configuration and the coordinate system
(l_1=8mm, l_2=9mm, l_3= 13mm, l_4=7mm, l_5=8mm, l_6=15mm, h_1=4mm, h_2=2.5mm, h_3=5mm, h_4=3mm)

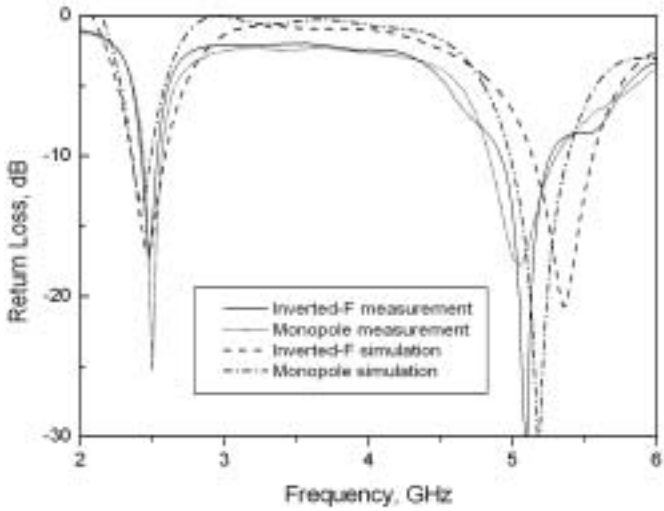
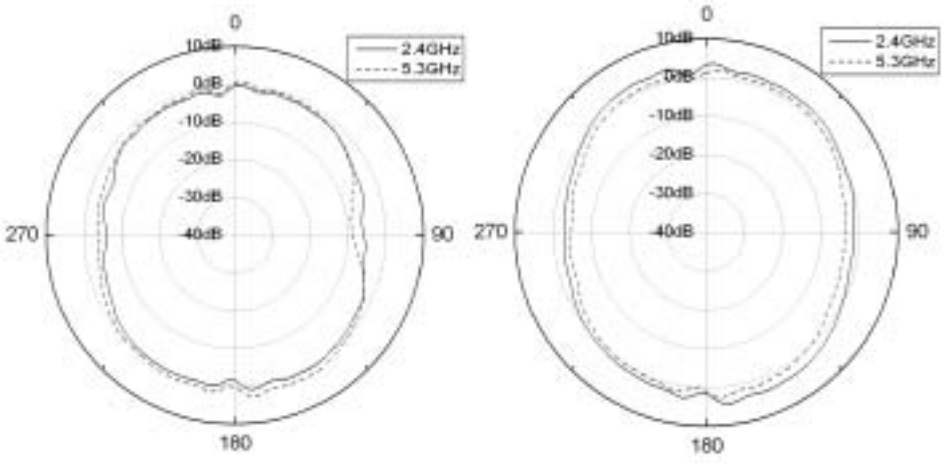


Fig. 2 Predicted and measured return loss

Figure 1(b) shows a folded monopole antenna with folded shorted-strip. In recent years, a monopole antenna has been the most promising candidate for mobile communications. However, due to the compact mobile devices, a protuberant element is not a possible solution anymore. The folded monopole shown in figure 1(b) could be the answer to satisfy both size and performance issues. Figure 2 presents the return loss of the simulation and measurement and shows fairly good performance in both frequency bands. Figure 3 shows the radiation patterns of the measurement in x-y plane. The measured average gain in the 2.4GHz and 5GHz band have a level of ~ -3dBi for the inverted-F and ~ -2dBi for the folded monopole, respectively. This meets the typical specifications to most of the wireless applications. It should be emphasized that the main reason why we present the folded monopole type here is to get the uniform radiation pattern in x-y plane. As shown in figure 3(a), the inverted-F type has poor directivity gain in the y direction ($\phi = 90^{o}$). The measured data in y-z plane is not shown here but it could be estimated from the x-y plane data.



(a) (b)

Fig. 3 Measurement results for the radiation pattern
(a) Inverted-F type, (b) Monopole type

Conclusions: A novel small antennas with folded shorted-strip for dual-band WLAN are presented. The proposed antenna has good characteristics in the 2.4GHz and 5GHz bands and manufacturing is very simple and easy. It is also easy to tune the antenna in lower and higher bands by controlling two plates. In the future study, we will investigate the coupling effects in the gap between two plates and more detailed theoretical calculation of the length of plates as well as the effects by ground plane.

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