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Miniaturized Dual-Band Antenna for 2.4/5.8GHz WLAN Operation in the Notebook Computer

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Abstract: A novel dual-band microstrip antenna for an internal notebook antenna for WLAN operation is presented. The antenna has a simple structure consisting of a spiral strip. The proposed antenna has a low profile and can easily be fed by using a 50 Ω microstrip line. It is believed that the size of the antenna is about the smallest among the existing internal laptop antennas for 2.4/5.8GHz WLAN operation. The antenna occupies a small area of 6mm×7mm on a FR4 substrate. Compact size, low cost, ease of fabrication and good radiation parameters respect to the previous designs are the most important advantages of the proposed antenna.

Key word: Dual-Band, Microstrip Antenna, spiral, WLAN.

INTRODUCTION

The demand for compact size, light weight and low cost antennas has increased in the recent years with the widespread deployment of wireless communications, like the wireless local area networks (WLAN). WLAN's are designed to operate in the 2.4 GHz (2.4–2.48 GHz) and 5.8 GHz (5.725–5.825 GHz) frequency bands.

In (Y.L. Kuo and K.L. Wong, 2003), Printed double-T monopole antenna for 2.4/5.2GHz dual band WLAN operations was introduced. The authors in (Z. Zhang, *et al*., 2005) proposed a dual-band WLAN dipole antenna, which was fabricated on FR4 substrate and using an internal matching circuit to completely cover the WLAN bands. In (Chou and Wong, 2007), a uni-planar dual-band monopole antenna for 2.4/5 GHz WLAN operation in the laptop computers was introduced, which had a simple structure consisting of a driven strip and a coupled strip. In (Mehdi Abioghli, *et al*., 2011) a dual band bow-tie antenna with parasitic elements was proposed for the same applications. The authors in (Chien-Yuan Pan, *et al*., 2007) proposed Dual wideband Printed monopole antenna for WLAN/WiMAX applications. Reference (Wen-Shan Chen and Kuang-Yuan Ku, 2008) reported novel design of the band-rejected function has been proposed by inserting strips on wideband printed open slot antenna by choosing the proper parameters of the strips, to provide, triple bands operation. In (Deepti Das Krishna, *et al*., 2008) a dual wide-band CPW-fed modified Koch fractal Printed slot antenna was proposed for the WLAN and WiMAx applications. The authors in (C.H. See Pan, *et al*., 2008) proposed a dual-frequency planar inverted F-L-antenna (PIFLA) that could provide a compromise between size reduction and attainable bandwidth. Reference (R.K. Raj, M. Jospen and P. Mohanan, 2006) reported a new compact microstrip-fed dual-band coplanar antenna for WLAN applications. This antenna was fabricated on FR4 substrate of dimensions 217mm×217mm. In (Mehdi Abioghli, 2011) new compact triple-band microstrip triangular patch antenna was proposed for WLAN/WiMAX applications.

In this paper, we introduce a novel dual band microstrip spiral antenna. The proposed antenna utilizes a single element antenna with multiple resonant modes to achieve dual-band operations. Hence, it is suitable for practical applications in a WLAN system.

MATERIALS AND METHODS

This paper is consisted of three main parts. In Section I, antenna design procedure is presented. Then, Results and Discussion is given in Section II. Finally, concluding remarks are made in Section Conclusion.

Antenna Design:

Fig.1 shows the geometry of the proposed dual-band antenna for 2.4/5.8GHz WLAN applications. The antenna is printed on a 0.8-mm thick FR4 substrate, and comprises of a spiral strip. For the ground plane, it is selected to be 180mm in length and 140mm in width, which are reasonable dimensions for general laptop computers. For practical applications, the proposed antenna and the ground plane (metal frame) together can also be fabricated from stamping a large metal plate, that is, the proposed antenna becomes an integrated antenna for laptop applications. It should be noted that when the antenna is mounted at the top edge of the laptop display with metal casing, which is generally the case for most laptop computers, as studied here, the use of a large flat metal plate as the ground plane of the system is acceptable for the evaluation of the antenna performance. The detailed dimensions of the antenna are given in Fig. 1. The width of the strip is 1mm and its total length from short point to open end is approximately 28mm. The width of the microstrip feed line was

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calculated to be 1.5mm in order to achieve good impedance matching in both bands. In order to obtain a good matching condition, the feed position is placed close to the shorting point. When the feed position is away from the shorting point, the resonant input resistance quickly increases.

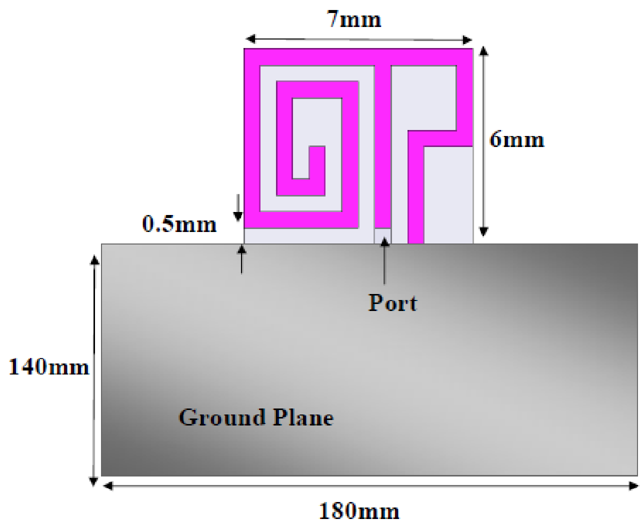

Fig. 1: The proposed printed dual-band antenna structure.

RESULT AND DISCUSSION

The proposed antenna was simulated by both Ansoft HFSS and Microwave Studio CST softwares. The numerical method bases of these packages are different, namely finite element method (FEM) for HFSS and integral equation method for CST. Therefore, comparing the simulation results of these softwares may validate our initial design operation.

The antenna of Fig. 1 was simulated and simulated return loss results are shown in fig. 2. The simulated VSWR 2:1 bandwidth is 100 and 600MHz at 2.4 and 5.8GHz frequency bands, respectively.

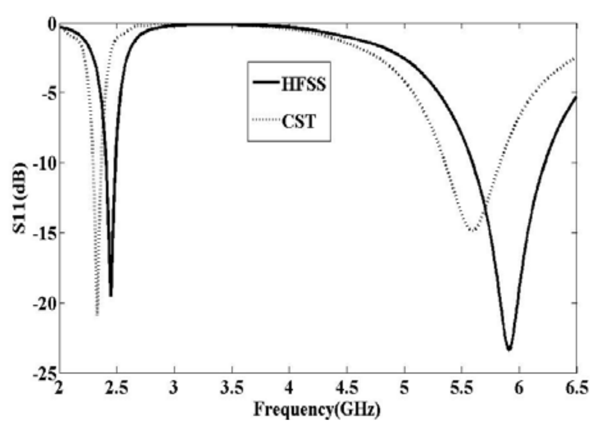

Fig. 2: Simulated return loss of the proposed antenna.

Fig. 3(a), (b) presents the simulated surface current distributions on the proposed antenna of fig. 1, at 2.45GHz and 5.5GHz frequencies. It is seen that strong current density flow is through the spiral strip at the frequency of 2.45GHz, while at 5.8GHz, the terminal of the spiral strip has the strong current density. It is obvious that the length of the resonant path in 2.45GHz is longer than the length of the resonant path in 5.8GHz. Fig. 4. Shows the pick gain of the propose antenna. As illustrated the antenna gains changes between -6.7dB and 5.4dB in the operating frequency bands. The principal plane normalized radiation patterns of the proposed WLAN antenna at 2.4/5.8GHz are shown in Figs. 5. As it can be observed nearly omnidirectional radiation patterns are achieved at two operating frequency bands.

Parametric Study:

Simulated return loss of the antenna of Fig. 1for various widths of the ground-plane was also studied. Small effects on the 2.4GHz band are seen. This is probably because the operating frequencies in the 2.4GHz band have wavelengths which are more comparable to the dimensions of the ground plane and thus a small effect is expected. Finally, from the obtained results, the ground plane should also be treated as part of the radiation structure. Which means that placement of additional circuitry on the ground plane will also affect the antenna's performance. This should be considered in practical applications.

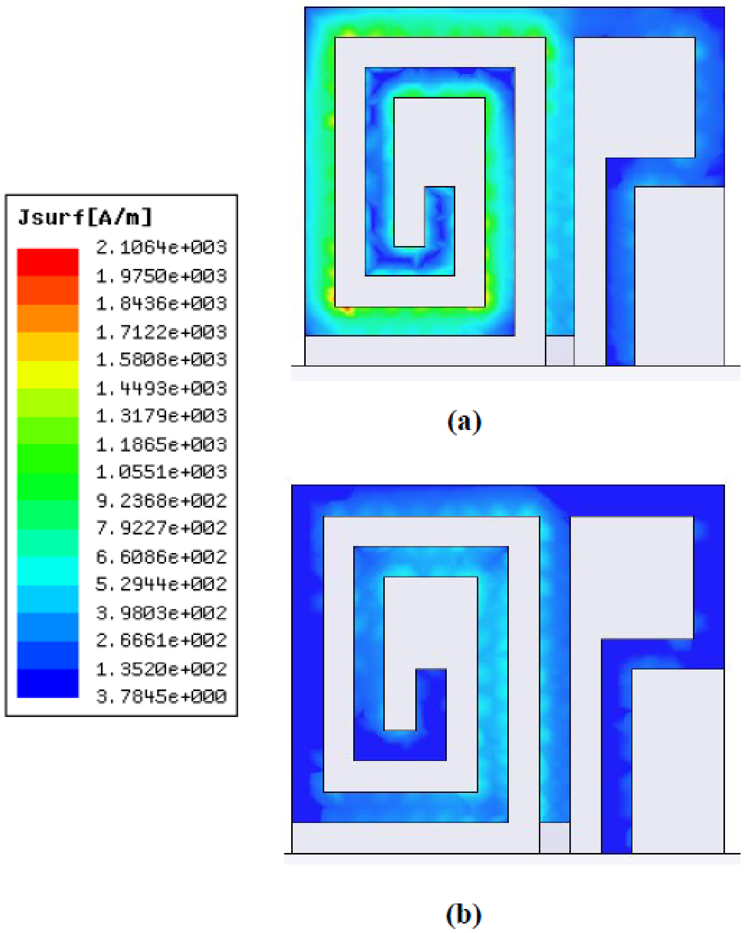

Fig. 3: The simulated surface current distributions at (a) 2450MHz and (b) 5800MHz on the proposed antenna.

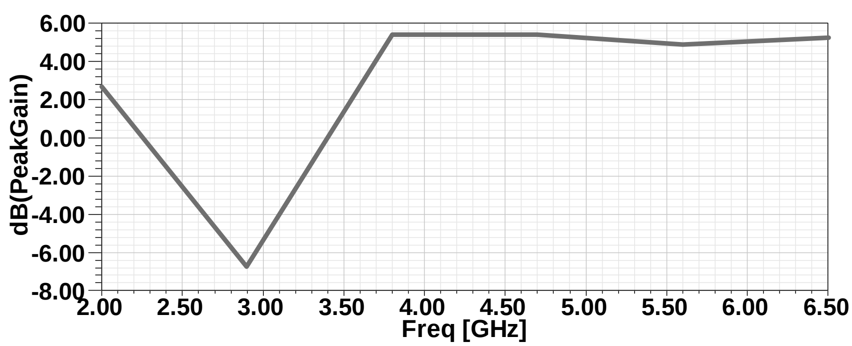

Fig. 4: Peak gain of the proposed antenna.

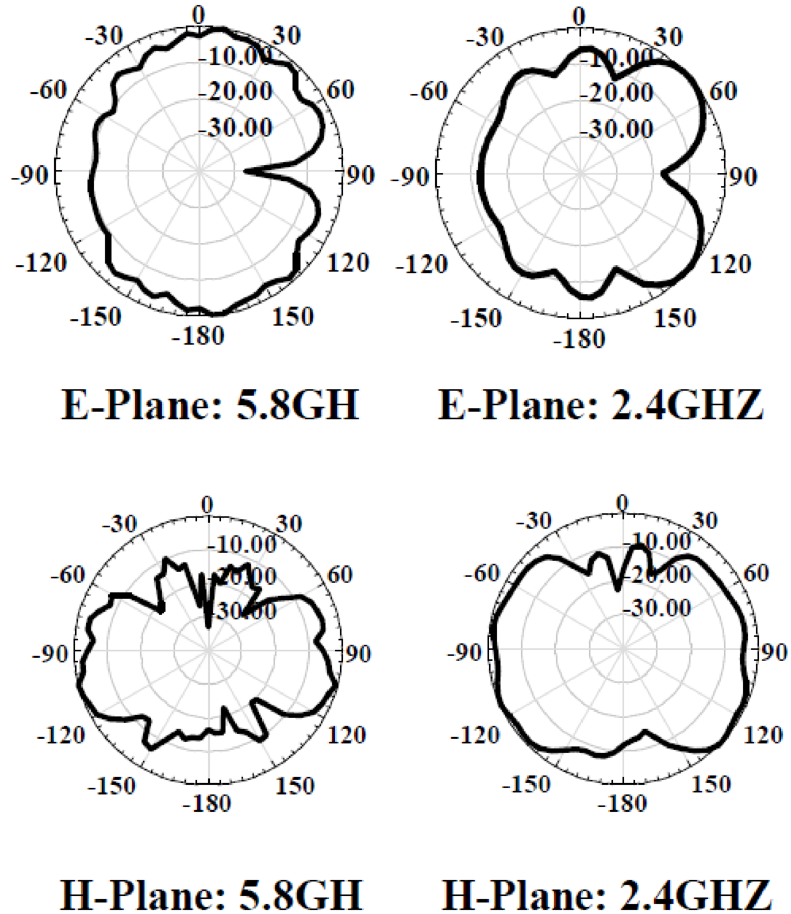

Fig. 5: Normalized radiation patterns of the proposed antenna.

Conclusion:

Dual-band operations of a novel microstrip spiral antenna have been demonstrated. That is suitable for WLAN operations in the 2.4/5.8GHz bands. The VSWR 2:1 bandwidth in the 2.4GHz band was 100MHz, while the VSWR 2:1 bandwidth in the 5.8GHz was 600MHz. These bandwidths exceed the requirements of any WLAN applications. It is believed that the size of the antenna is about the smallest among the existing internal laptop antennas for 2.4/5.8GHz WLAN operation. The nearly omnidirectional radiation patterns are achieved over the interested operating frequency bands.

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