A Novel Antenna Design for WLAN/WIMAX Dual-Mode Notebook

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1. Abstract

This paper proposes a novel multi-band antenna design suitable for WLAN/WIAMX dual-mode notebook application. The proposed antenna is printed on a 0.8 mm FR4 substrate, and consists of a T-shape monopole structure and a loop antenna with a L-shape shorting strip structure which is fed by coupling of the T-shape monopole. Through the adjustment of gap between the T-shape monopole and the shoring strip, a more uniform current distribution in shorting strip can be obtained and it can strongly reduce the antenna dimensions and enhance the antenna bandwidth. The proposed antenna has a compact size of 24 x 7.8 x 0.8 mm^3 and a wide bandwidth in lower band and higher band defined by 2.5:1 VSWR, respectively, which can cover the WLAN 2.4 G band (2400 ~ 2500 MHz), WLAN 5 GHz band (5150 ~ 5850 MHz) and WIMAX bands (2300 ~ 2400 MHz and 2500 ~ 2700 MHz). Due to its compact size and planar structure, the proposed antenna is very suitable for the embedded antenna of notebook, especially in ultra-thin platform. Besides, the good antenna efficiency and radiation performance are obtained. Details of the proposed antenna and experimental results are presented and discussed.

2. Introduction

Recently, the compact embedded antenna design for notebook application is very popular. Also several related designs have been reported in the public literature [1-5]. However, in these designs, usually its bandwidth is limited about 100 MHz (2400 ~ 2500 MHz) in 2.4 GHz band. It is not enough to cover the required bandwidth of WLAN (Wireless Local Area Networks)/WiMAX (Worldwide Interoperability for Microwave Access) system. Besides, they also have the larger antenna dimension such as the high profile of greater than 8% of the wavelength at 2500 MHz or 3-dimension structure occupied the more volume. It makes them less attractive to be applied in notebook which demand a low-profile and compact size embedded antenna.

In this paper, we propose a new design which is different with the general traditional design just included a single antenna structure. The proposed antenna is integrated with a dual-antenna structure which consists of a T-shape monopole antenna and a coupling-fed loop antenna. Through the dual-antenna structure, the antenna bandwidth can be effectively enhanced. And the antenna dimension is also greatly reduced via its coupling structure. Besides, the thickness of the proposed antenna is just 0.8 mm that makes it very attractive to apply in ultra-thin notebook embedded antenna due to its very thin planar structure. In addition, the proposed antenna has a very low profile of 7.8 mm in height (about 6.5% of the wavelength at 2500 MHz) and compact antenna size just of 24 x 7.8 x 0.8 mm^3. Also it is very easy to fabricate due to its simple structure, it will cause the lower cost and higher mass production stability. Details of the dimensions of the proposal antenna are described, and the measured radiation characteristics are presented.

3. Antenna Design

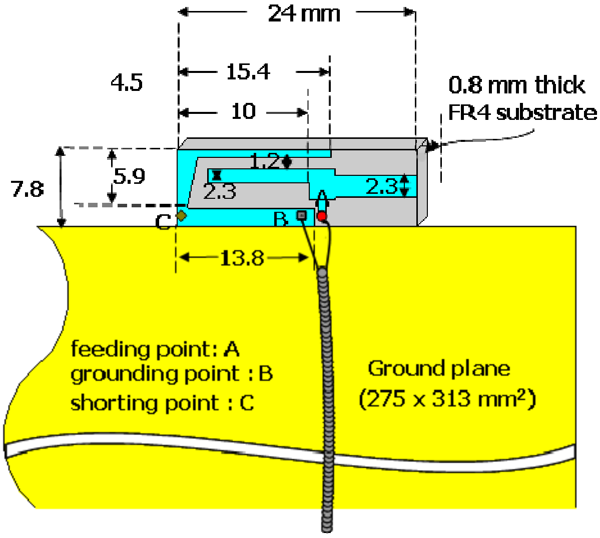

Figure 1: Geometry of the proposed novel antenna design for WLAN/WIMAX dual-mode notebook.

Figure 1 shows the geometry of the proposed antenna mounted on top of a ground plane of dimensions 275 x 313 mm^2, which can be considered as the LCD panel with the metal housing of a practical notebook. The proposed antenna is printed on a 0.8 mm FR4 substrate (relative permittivity 4.4) of dimensions 24 x 7.8 mm^2, and it consists of a T-shape monopole structure and a loop antenna structure which design dimensions are given in the figure. For the T-shape monopole antenna, it has a feed point A which is connected to a 50-Ω micro coaxial cable and it mainly controls the higher band excitation for the WLAN 5 GHz band. The total path length of the monopole structure is about 16 mm, which is close to one-quarter wavelength of the frequency at 5000 MHz. In addition, the monopole structure is also treated as the coupling feed of the proposed loop antenna. There are two parts in the proposed loop antenna: one L-shape shorting strip and one grounding strip and they are connected in the shorting point C. Besides, the grounding strip is connected to the LCD ground plane and has a point B which is connected to the outer ground shielding of the micro coaxial cable. The proposed loop antenna is fed by the coupling of the T-shape monopole and it is designed for operating at lower band about 2.5 GHz for WLAN 2.4 GHz band and WiMAX band. From the coupling T-shape monopole to the L-shape shorting strip and the grounding strip, the total path length of loop antenna is about 50 mm which is close to the half wavelength of the frequency at 2.5 GHz. Besides, it was found that, by fine tuning the coupling gap between the T-shape monopole and the L-shape shorting strip, the good impedance matching of the lower band can be obtained. And the 1.2 mm gap is the optimal distance in this study.

4. Results and Discussion

With the designed dimensions shown in Figure 1, the proposed antenna was constructed. Figure 2 shows the measured return loss of the proposed antenna. It is observed that some ripples in the return loss curve owing to the long cable length of 500 mm which is similar to the pratical notebook antenna cable length. From the obtained impedance bandwidths, determined from 2 : 1 VSWR, the lower band has a bandwidth of 4000 MHz (2300 MHz ~ 2700 MHz), covering the repuired WLAN 2.4 GHz band (2400 ~2500 MHz) and WiMAX bands (2300 ~ 2400 MHz and 2500 ~ 2700 MHz). For the higher band, a bandwidth of 890 MHz (4110 MHz ~ 6000 MHz) is obtained, which covers the repuired WLAN 5 GHz band (5150 ~ 5850 MHz).

Radiation characteristics have also been studied. Measured radiation patterns for the proposed antenna at 2450 MHz and 5350 MHz are presented in Figure 3 and 4, respectively. The radiation patterns at 2450 MHz and 5350 MHz are close to those of a simple monopole antenna. Other operating frequencies within the lower and higher band were also measured and showed similar patterns as presented in Figure 3 and 4.

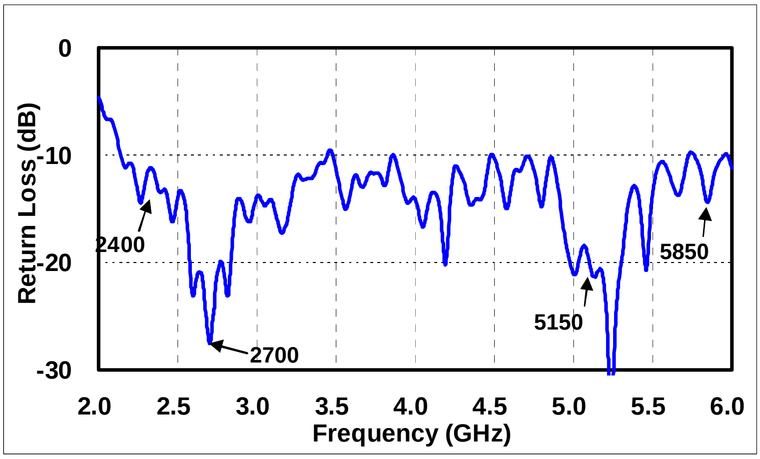

Figure 2: Measured return loss for the proposed antenna.

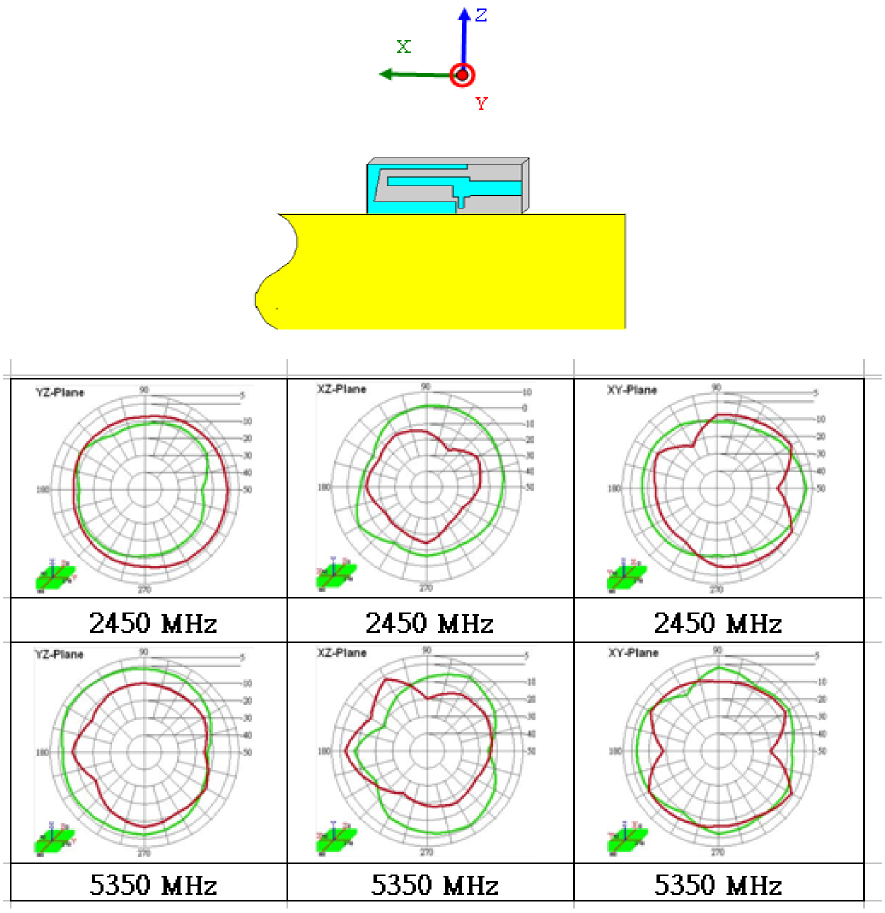

Figure 3: Measured radiation patterns for the proposed antenna at 2450 MHz and 5350 MHz.

References

[1] F.R. Hsiao, H.T. Chen, T.W. Chiou, G.Y. Lee, and K.L. Wong, "A dual-band planar inverted-F patch antenna with a branch-line slit," Microwave Opt. Technol. Lett., vol. 32, pp. 310-312, Feb. 20, 2002.

[2] Y.L. Kuo and K.L. Wong, "Coplanar waveguide-fed folded inverted-F antenna for UMTS application," Microwave Opt. Technol. Lett., vol. 32, pp. 364-366, March 5, 2002.

[3] S.H. Yeh and K.L. Wong, "Integrated F-shaped monopole antenna for 2.4/5 GHz dual-band operation," Microwave Opt. Technol. Lett., vol. 34, pp. 24-26, July 5, 2002.

[4] H.S. Shin, K.S. Band and E.B. Kim, "Multi-band antenna and notebook computer with built-in multiband antenna," U.S. Patent Publication No. 2003/0124985 A1, 2003.

[5] S.W. Su and K.L. Wong, "Wideband antenna integrated in a system in package for WLAN/WiMAX operation in a mobile device," Microwave Opt. Technol. Lett., vol. 48, pp. 2048-2053, Oct. 2006.