Internal PIFA for 2.4/5 GHz WLAN applications

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An internal planar inverted-F antenna (PIFA) for 2.4 GHz Bluetooth and 5 GHz WLAN applications is presented. The proposed antenna has an impedance bandwidth of 110 MHz in Bluetooth band and 900 MHz near 5 GHz in WLAN band within 2.1 VSWR, and an approximately omnidirectional radiation pattern can be obtained. These features are suitable for 2.4/5 GHz WLAN applications.

Introduction: Notebook computers are increasingly being equipped with wireless local area networks (WLAN) for IEEE 802.11b (2.4–2.48 GHz), 802.11a (5.15–5.35, 5.725–5.825 GHz) protocols in Europe [1, 2], and HIPERLAN/2 (5.15–5.35, 5.47–5.725 GHz) in the US, respectively. PIFAs are very suitable in WLAN applications since they are compact and easy to manufacture [3]. This letter investigates the internal PIFA with small size of ground plane for covering 802.11a/b and HIPERLAN/2 band. It can be easily placed at the corners of the display panel of a notebook computer [2], and is designed to resonate at 2.4 and 5 GHz bands by adjusting the location of the shorting pin and length of the radiation element.

Antenna design and performance: Fig. 1 shows the structure of the proposed antenna. It consists of a radiation element with a volume of 27.5 × 11 × 7 mm³ and a rectangular ground plate of 47.5 × 20 mm². A 50 Ω coaxial cable directly feeds to a radiation patch. For achieving the resonant mode at 2.4 GHz band, the resonant length marked in path A is chosen to be about 32 mm, corresponding approximately to a quarter wavelength of 2.4 GHz, as shown in Fig. 1. The length between the feeding and shorting point marked in path B is about 12 mm, a quarter of the wavelength of 5.5 GHz. To determine the dual resonant frequencies, Fig. 2 shows the variations of VSWR values according to the different position of the short pin and the length of the radiation element. Fig. 2a indicates each associated VSWR graph with three different values of O from a reference line (ra) to the shorting point with the fixed length of 12 mm. The variations of the shorting position make the length of path A and B change, simultaneously. When the length of a is shorter, the lower resonant band shifts to the left and the higher one to the right at the same time. This is because the shorter the length of a, the longer the length of path A regarding the Bluetooth band and the shorter the length of path B related to the WLAN band. Fig. 2b shows the variation of VSWR in terms of three different values of ≡ from a reference line (rb) to the folded radiation element with a fixed length of 12 mm. When the length of b is shorter, the lower resonant band shifts to the right. However, the higher one shifts only a small variation. This is because the shorter the length of b, the shorter the length of path A while retaining the constant length of path B. However, the length of path B is constant. The length of path A and path B has dominant roles in each associated frequency, 2.4 and 5 GHz band, respectively. The optimised values of a and b are 12 and 16 mm. To optimise antenna performance, SEM CAD (Simulator Platform for Electromagnetic Compatibility Antenna Design and Dosimetry, SPEAG) is utilised for tuning each associated parameter of the antenna structure. The optimised sizes of the antenna structure are shown in Fig. 1. The measured results are performed with an Agilent 8722ES network analyser.

Results: The measured and simulated VSWR results in terms of frequency are compared in Fig. 3. The measured impedance bandwidth (VSWR ≤ 2) at the lower frequency band is about 110 MHz from 2.38 to 2.49 GHz. As for the upper band, it is about 900 MHz from 5.1 to 6.0 GHz. The radiation patterns are approximately omnidirectional. There exists some vulnerability to measurement error owing to the positioning effect of the feeding cable. Although there are slight discrepancies between the simulated results and the measured ones, it can be seen that they show a similar tendency. The maximum measured and simulated radiation gains are 2.39 and 2.29 dBi at 2.44 GHz, and 3.7 and 4.03 dBi at 5.8 GHz, respectively.
Conclusion: A dual-band antenna with a simple structure for Bluetooth and WLAN bands has been proposed and investigated. To cover the dual band, the position of the shorting pin and length of the radiation element are adjusted. The proposed antenna has relatively broader impedance bandwidths covering the Bluetooth and WLAN bands with approximately omnidirectional radiation patterns and high gain. These structural and electrical properties are very attractive for dual-band WLAN applications.

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References