

A Printed Miniature Dual-Band Antenna with Folded Meander-line Dipole type for 2.4/5GHz WLAN Bands

Young Jun Cho, Soon Ho Hwang, and Seong Ook Park
School of Engineering, Information and Communications University
103-6, Munjiro, Yuseong-gu, Daejeon, 305-714, Korea
E-mail: linus11@icu.ac.kr

1. Introduction

Recently, the applications of mobile wireless communication such as notebook computers with wireless local area networks (WLANs) are rapidly developed [1],[2]. In particular, such devices are required toward more miniaturization, and a small size of internal antenna is more demanding. The printed dipole antenna has inherently a narrow width, but it can be easily placed along the perimeter or at the corners of the display panel of the notebook computer [2].

This paper presents the printed dual-band meander-line dipole antenna for WLAN devices. Two separate dipoles with asymmetric arm lengths are printed on a FR4 dielectric substrate and fed by a 50Ω coaxial cable. A non-uniform meander-line arm is designed to resonate at the frequencies of 2.4 GHz and 5 GHz bands [3]. WLAN operation bands of the proposed antenna consist of 2.4 GHz band (2.4 GHz - 2.53 GHz for IEEE 802.11b), and 5GHz bands (5 GHz - 6.5 GHz for IEEE 802.11a in the US and HIPERLAN/2 (High PERformance LAN – Type 2) in Europe). The radiation pattern is approximately omni-directional at each associated frequency band. The proposed antenna has a compact and small size to be easily placed in a notebook computer, and it can provide a sufficient bandwidth for the applications of IEEE 802.11a/b and HIPERLAN/2 bands.

2. Antenna Design

Fig. 1 shows the structure of the proposed dual-band antenna with non-uniform folded meander-line dipole type. A 50Ω coaxial cable is used as the feeding structure on a single layer of FR4 substrate with relative permittivity, ϵ_r , 4.6 and an outer ground conductor of one is connected directly to the small ground patch. The total size of the proposed antenna has the volume of $7 \times 22 \times 1 \text{ mm}^3$. The main radiating element is folded composed of a meander-line strip able to reduce the size. It is a non-uniform shape to resonate at dual frequencies [3]. The conductor plane of the opposite side of the PCB is removed. This structure minimizes the effect of WLAN devices when the proposed antenna is adhered to them. In order to determine the dual resonant frequencies, Fig. 2. shows the variation of VSWR values in terms of the different slot lengths a and b. Fig. 2(a). indicates the each associated VSWR graphs with the three different values of a with the fixed length of $b = 5.5 \text{ mm}$. As the length of

slot A gets shorter, the total current path of the meander-line radiator also becomes shorter. This results the resonant frequency into shifting up the higher frequency of a 2.4 GHz band. Similarly, Fig 2(b). shows the variation of VSWR in terms of three different value of b with the fixed length of a = 2.0 mm. As the length of slot B is shorter, the current path of the end of the meander-line, which plays a dominant role in resonating at the upper frequency of a 5 GHz band, is shorter. The resonant frequency is shifted into higher one. Each slot of A and B has dominant roles of the each associated frequency, respectively. The optimized values of a and b covering the dual frequency WLAN bands are 2.0 mm and 5.5 mm, respectively. Fig. 3. represents the simulated current distributions at 2.44 GHz and 5.8 GHz. As shown in Fig. 3.(a) and (b), there are dominant current distributions in the vicinity of slot A at 2.4 GHz and slot B at 5.8 GHz, respectively. This confirms again that slot A significantly influences the 2.4 GHz frequency band and slot B the 5 GHz band. In order to optimize the antenna performance, Ansoft HFSS (High Frequency Structure Simulator) and CST MWS (Microwave Studio) are utilized for tuning each associated parameter of the antenna structure. The measured results are performed with Agilent 8722ES network analyzer

3. Result

The measured and simulated VSWR in terms of frequency are compared in Fig. 4. There is a good agreement with each other. The measured impedance bandwidth ($VSWR \leq 2$) at the lower frequency band is about 130 MHz, or 5.3%, from 2.4 GHz to 2.53 GHz, with respect to 2.44 GHz which meets the bandwidth requirement (2.4 - 2.484 GHz) for IEEE 802.11b applications [4]. As for the upper band, the impedance bandwidth is about 1500 MHz or 27.6% from 5 GHz to 6.5 GHz with respect to 5.432 GHz which also covers the required bandwidth for IEEE 802.11a (5.15 - 5.35 GHz, 5.725 - 5.825 GHz) and HIPERLAN/2 (5.15 - 5.35 GHz, 5.47 to 5.725) devices [4]. Fig. 5 and 6 show the measured and simulated radiation patterns at 2.44 GHz and 5.8 GHz, respectively. Dipole-like omni-directional radiation patterns can be seen at each frequency. The measured and simulated results agree well with each other at both the 2.4 GHz and 5 GHz bands. The maximum measured and simulated radiation gains are 1.65 dBi and 1.89 dBi at 2.44 GHz and 2.64 dBi and 2.79 dBi at 5.8 GHz, respectively.

4. Conclusion

A printed miniature dual-band antenna with the folded meander-line dipole type for 2.4/5GHz WLAN bands has been proposed and investigated. The proposed antenna occupies a small volume of $7 \times 22 \times 1 \text{ mm}^3$ in order to be easily placed on WLAN notebook applications. It has relatively broader impedance bandwidths covering the 2.4 GHz (2.4 GHz – 2.53 GHz) and 5 GHz (5 GHz – 6.5 GHz) bands. To cover the dual band, the method of non-uniform folded meander-line structure is applied. Good radiation characteristics for the proposed antenna have also been observed. These structural feature and electrical properties are very attractive for WLAN applications.

Acknowledgment: This work was supported by the National Research Lab. (NRL) of the Ministry of Science and Technology, Korea, under contract No. M1-0203-0015.

Reference

- [1] SUN, Y.H., and CHANG, K.: ‘Low cost microstrip-fed dual frequency printed dipole antenna for wireless communications’, *Electron. Lett.*, 2000, 36,(14), pp.1177 – 1179
- [2] TSAI, S. N.: ‘Antenna module for portable computer’, *US Patent No. 6297779*, 2001
- [3] Egorov, I., Zhinong, Y.: ‘A non-uniform helical antenna for dual-band cellular phones’, *AP-S Int. Symp.*, 2000, IEEE , Vol. 2 , pp. 16-21
- [4] Ciais, P., Staraj, R., Kossiavas, G., Luxey, C.: ‘Compact internal multiband antenna for mobile phone and WLAN standards’, *Electron. Lett.*, 2004, 36,(14), pp.920 - 921

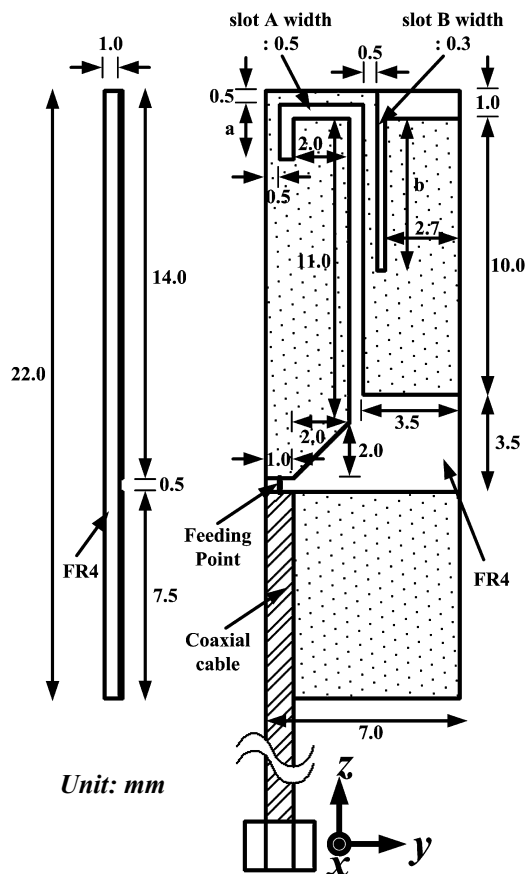
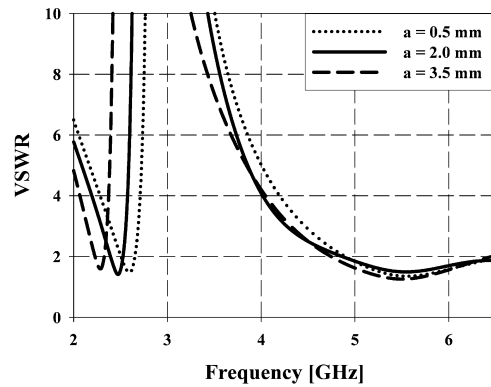
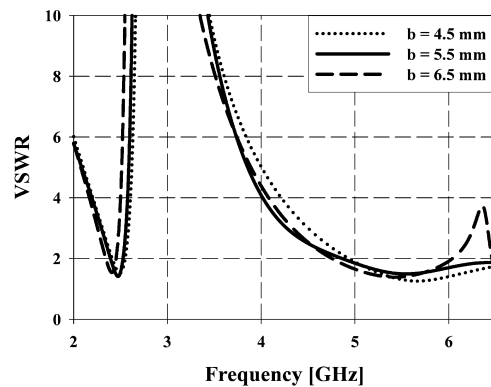


Fig. 1. Geometry of Proposed antenna

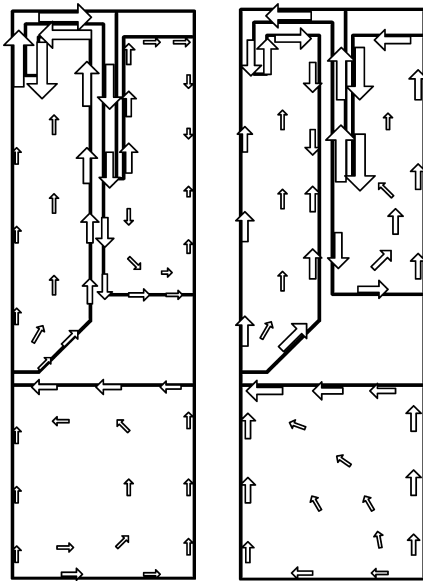


(a) The variations of slot length a



(b) The variations of slot length b

Fig. 2. Simulated VSWR according to each slot lengths



(a) at 2.44 GHz (b) at 5.8 GHz

Fig. 3. Current Distributions

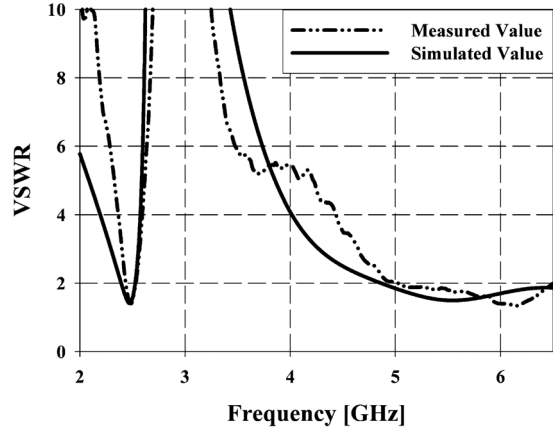


Fig. 4. Measured and simulated result of VSWR

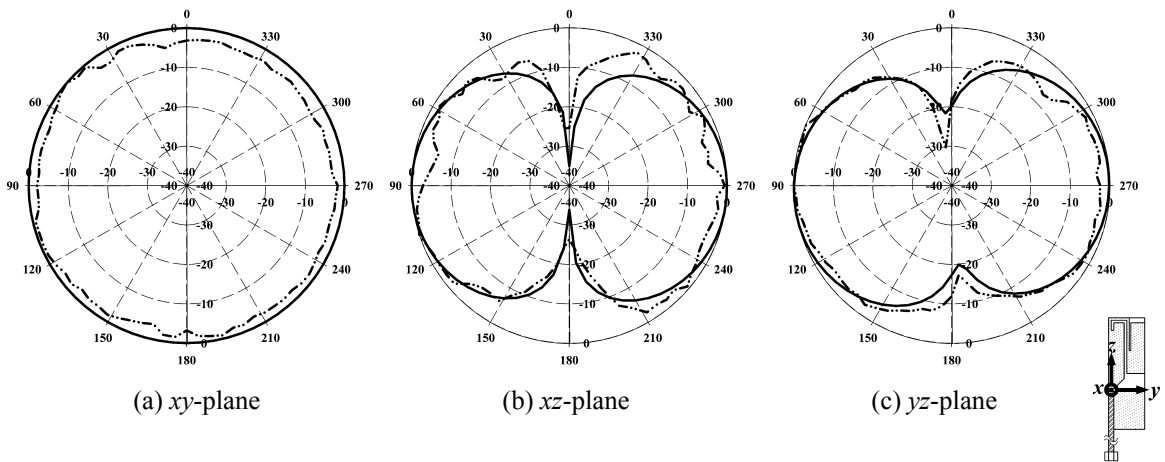


Fig. 5. Measured and simulated radiation patterns at 2.44 GHz

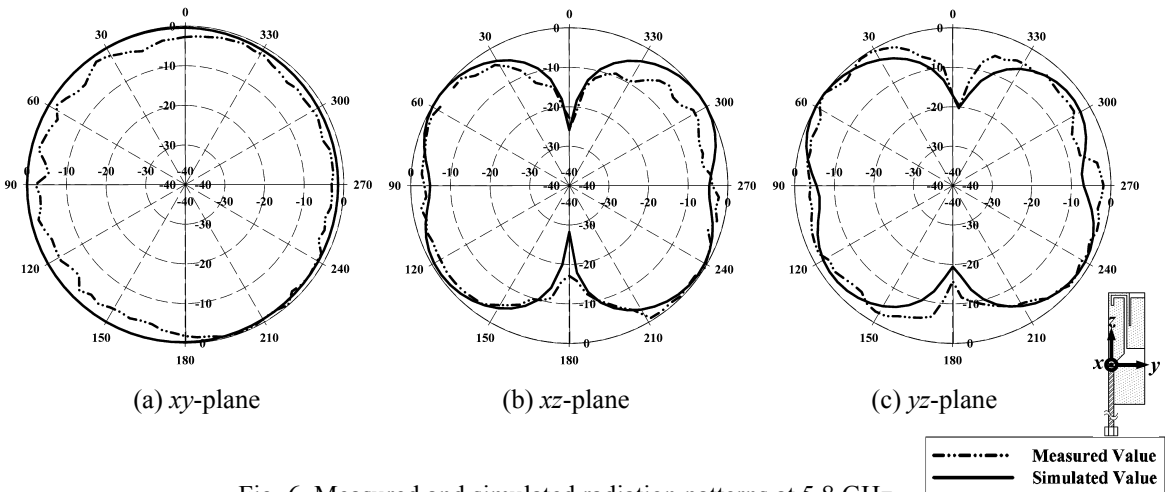


Fig. 6. Measured and simulated radiation patterns at 5.8 GHz