Dual band meandered PIFA for Bluetooth Communication

°정민석, 이범선
경희대학교 전파공학과

°Minseok Jung, Bomson Lee
Department of Radiowave Engineering, Kyunghee University
1 Seochun, Kihung, Yongin, Kyungki-do, South Korea

Tel : +82-31-201-2924, FAX : +82-31-202-2924
E-mail: jfdtd@cvs2.khu.ac.kr, bomson@khu.ac.kr

ABSTRACT

The dual band meandered PIFA has been designed, fabricated, and measured. The measured impedance bandwidth is 9.24% @2.45GHz (2.27-2.49GHz) and 16.33% @5.75GHz (4.95-5.83GHz), repectively. The radiation patterns are similar to those of a typical PIFA. The antenna gains of each resonant frequencies are 5.06(@2.38GHz), 5.95(@5.39GHz) dBi respectively.

Key words : meandered PIFA, Bluetooth, WLAN

I . Introduction

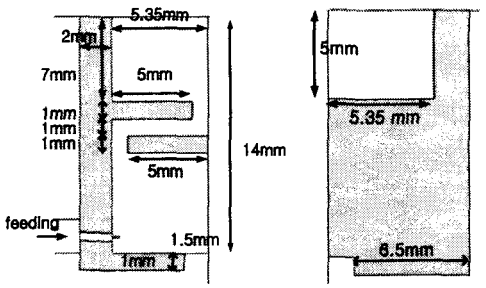
The whip/helical antennas have been widely used for mobile communication. These antennas usually increase the volume of handsets and are gradually being replaced by built-in antennas. One of the most promising built-in antennas is the planar inverted F antenna (PIFA), the size of which is typically $\lambda/4$, but using a capacitive loading technique it can be reduced to $\lambda/8$[1]. It can be top-mounted, side-mounted, or back-mounted but its structure must be designed together with that of the handset body. The location of the PIFA on the handset affects the specific absorption rate(SAR) inside the head[2]. These effects will most probably be considered for the design of upcoming or next generation antennas.

Recently, the development of embedded antennas for mobile communication handsets has become a hot issue. Internal chip antennas have not only structural merit, but also the economical advantage of mass production. Murata Manufacturing Co. Ltd. has developed several types of chip antennas, which are being applied to some mobile communication services[3, 4]. Various complex structures embedding line conductors in various material have been designed and fabricated. The typical dimensions of Murata's chip antennas are 10×4×2 mm and impedance bandwidth is about 100-150MHz at 2GHz. The typical antenna gain is <0 dBi

In this paper, a novel planar inverted F antenna using meander conductor lines directly coated on the edge of the rectangular FR-4 substrate of size 80×42×1.6mm and relative permittivity ε_r=4.7 is

presented. The FR-4 substrates are very cheap and widely available. The meander line PIFA has been designed based on a vast amount of parameter study, using a high frequency structure simulator (Microwave studio). Despite the proposed simple structure, which can be realized quite easily and cheaply, the performance of the designed and fabricated antenna is better than those commercially available at present.

II. Design and Fabrication of a meandered PIFA



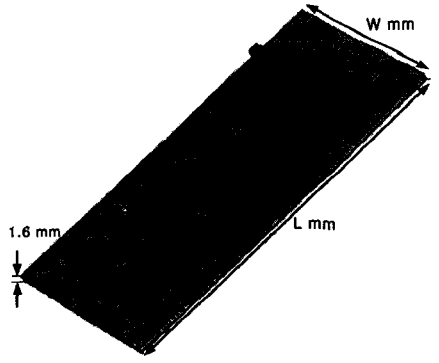


Fig. 1 Geometry of meander line PIFA

Consider the meandered PIFA with the new feeding structure shown in Fig. 1. The coaxial feed line is connected to the meandered part, which is the edge of the FR-4 substrate with relative permittivity ε_r=4.7 and height h=1.6mm. The overall size of the proposed meandered PIFA is 20.6×5.35×1.6 mm. The antenna size of front side is 14×5.35 mm and the size of the back side is 5×5.35 mm. The impedance matching is obtained mainly by optimizing the structure of the meandered part and position of feeding point.

Fig. 2 shows the simulated S_{11}'s of meandered PIFA for different ground sizes (L×W mm). We can see that the return losses for each case are in good agreement. They show a double resonance characteristic. The first resonance occurs at 2.47 GHz (2.39~2.59) and second resonance occurs at 5.75 GHz (5.57~5.89). The proposed antenna structure can be one of the good choices when a variety of ground size is expected to be used.

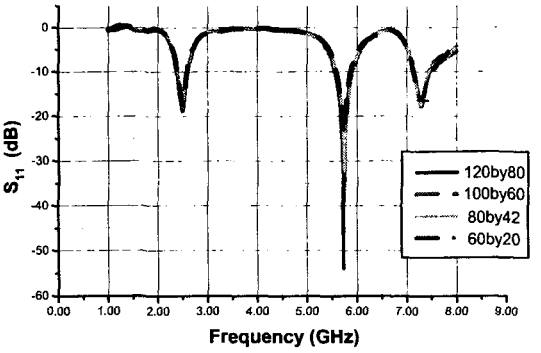


Fig. 2 S_{11} of meandered PIFA for different ground sizes (L×W mm)

Fig. 3 shows the S_{11}'s of meandered PIFA for different feeding points. In fig. 3, coaxial feed is connected with the meandered part and is assumed to be located 1mm away from the bottom of the meandered part. In case A, the feeding point is located 2 mm away from the bottom of the meandered part and case B, C, D are 3, 4, 5 mm away form the bottom of the radiation plate respectively. In Fig. 3, the resonant frequencies become larger, and return loses become smaller as the poison of the feeding point toward the bottom of the antenna become longer.

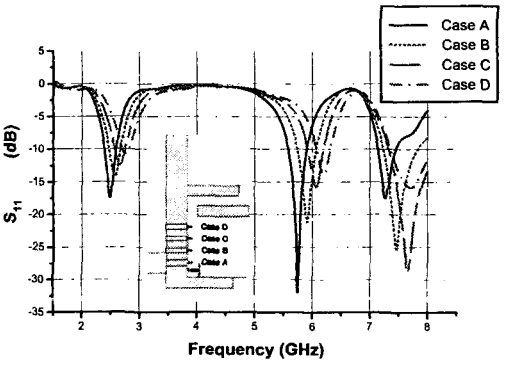


Fig. 3 Return loss of meandered PIFA for different feeding positions

Ⅲ. Measurement of a meandered PIFA

The designed meandered PIFA has been fabricated and measured. The measured and simulated S_{11}'s are compared in Fig. 4. Based on a return loss of 10dB, the band width of the simulated S_{11}'s are 8.03% (2.39~2.59GHz) and 5.58% (5.57~5.89GHz), respectively. The measured ones are 9.24% (2.27~2.49GHz) and 16.33% (4.95~5.83GHz), respectively. They are shown to be in good agreement in terms of resonant frequencies. The measured return loss bandwidth of the fabricated antenna is wide enough to cover the frequency band for bluetooth communication services used at 2.45 GHz and 5.75 GHz.

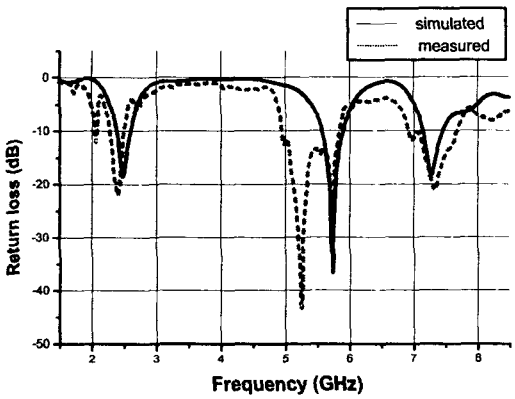
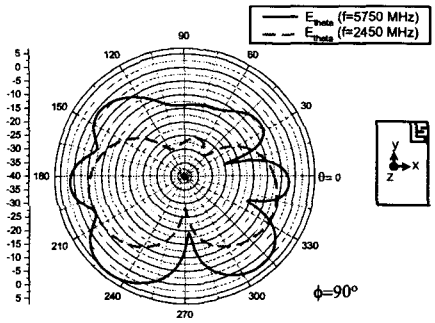
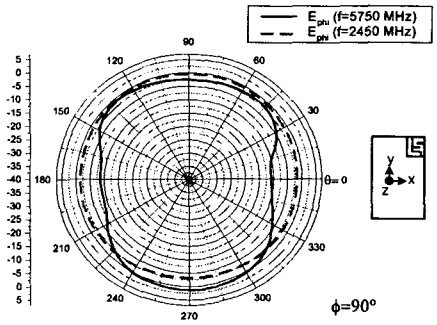


Fig. 4 Simulated and measured return loss of meander type PIFA

The simulated radiation patterns of the meandered PIFA are shown in Fig. 5 through 7. The simulations have been performed in the xz (Fig. 5), yz (Fig. 6), and xy (Fig. 7) plane. For each plane, the Co- and Cross-Pol patterns have been simulated at the center frequencies of 2.45 and 5.75 GHz, respectively. We can see that the radiation patterns at the frequencies of 2.45 GHz and 5.75GHz resemble each other and are similar to those of a typical PIFA. For the frequencies of 2.45 and 5.75 GHz, the antenna gains are 1.4 and 2.4 dBi, respectively.

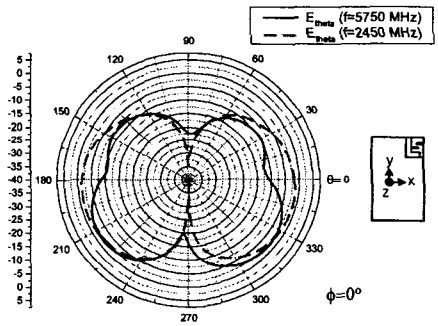


a. Co-Pol

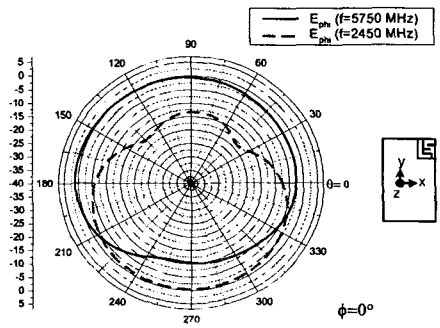


b. Cross-Pol

Fig. 5 Simulated radiation patterns of meandered PIFA in yz plane

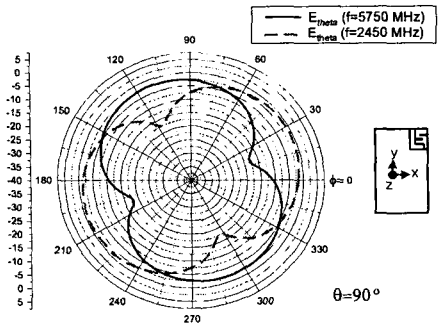


a. Co-Pol

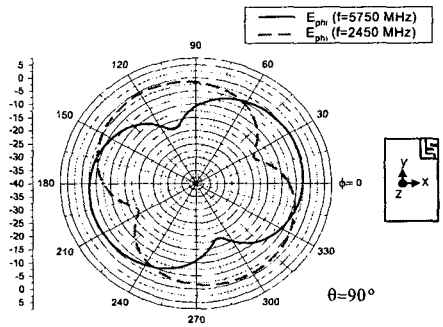


b. Cross-Pol

Fig. 6 Simulated radiation patterns of meandered PIFA in xz plane



a. Co-Pol



b. Cross-Pol

Fig. 7 Simulated radiation patterns of meandered PIFA in xy plane

Ⅳ. CONCLUTION

The dual band meandered PIFA has been designed, fabricated, and measured. The measured impedance bandwidth is 9.24% @2.38 GHz and 16.33% @5.39 GHz. The antenna gain is 1.065 @2.45GHz and 6.069 @5.7GHz respectively. The proposed antenna structure can be used for bluetooth and WLAN applications.

This work was supported by grant R11-2002-103 from Korea Science & Engineering Foundation.

Reference

[1] Rowell, C.R., and Murch, R. D, "A capacitively loaded PIFA for compact mobile telephone handsets," *IEEE Trans.*, Antennas Propag., vol. 45, no. 5, pp. 837-842, 1997.

[2] Iskander, M.F., and YUN, Z., "Polarization and human body effects on the microwave absorption in a human head exposed to radiation from handheld devices," *IEEE Trans.*, Antennas Propa., vol. 48, no. 11, pp. 1979-1987, 2000.

[3] Dakeya, Y., Suesada, T., Asakura, K., Naka jima, N., and Mandai, H, "Chip multiplayer antenna for 2.45GHz-band application using LTCC technology," *IEEE MTT-S Int.* Microwave Symp. Dig., vol. 3, pp. 1693-1696, 2000.

[4] Fujimoto, K., and James, J.R., *Mobile antenna systems handbook*, Boston/London: Artech House, 2000.

[5] G. L. Matthaei, L. Young, and E. M. T. Jones, *Microwave Filters, Impedance-Matching Networks and Coupling Structures*, New York: McGraw-Hill, 1964.