Design and Implementation of Multi-Band Folded PIFA for Mobile Communication

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Abstract

In this paper, we proposed a multi-band folded PIFA(Planar Inverted-F Antenna) for mobile communication. The proposed antenna has a small size of 30×10×5.035mm^3, and covers the GSM(Global System for Mobile communications:880-960 MHz), DCS(Digital Communications System:1710-1880 MHz), K-PCS(Korea-Personal Communications Service: 1750-1870 MHz), US-PCS(US Personal Communications Service:1850-1990 MHz), Bluetooth(2400-2483 MHz), Wibro(2300-2390 MHz) and WLAN(Wireless Local Area Network:2400-2483.5 MHz) bands.

Keywords : PIFA Multi-Band Folded

1. Introduction

In recent years, with the development of the mobile communication terminal technology, it's strongly required for the mobile station to cover multi-band with a single internal type antenna. And also there are strong demands for small-sized, lightweight, and compact mobile stations[1]. PIFA(Planar Inverted-F Antenna) being compact and low-profile, offers significant advantages in terms of low SAR(Specific Absorption Rate) due to the reduced backward radiation towards the user's head and less detuning effects caused by the metallic parts located in its vicinity[2]. However, one of many advantages of PIFA structure is that it can be easily incorporated into the electronic equipments due to the flexible structures and compactness. So the PIFA have been widely applied in the mobile phone as internal antennas[3,4].

2. Proposed Antenna

Fig. 1 shows the implemented antenna and Fig. 2 shows antenna parameters. The antenna size of example design is 30×10×5.035 mm^3, and it has folded structure for small size. For the design studied here, the antenna is fabricated on an inexpensive FR4 substrate with the dielectric constant of 4.4 and the substrate thickness of 1.6 mm. Ground size is 80×40mm^2. And Table 1 shows values of the design parameters which were derived through the simulation.

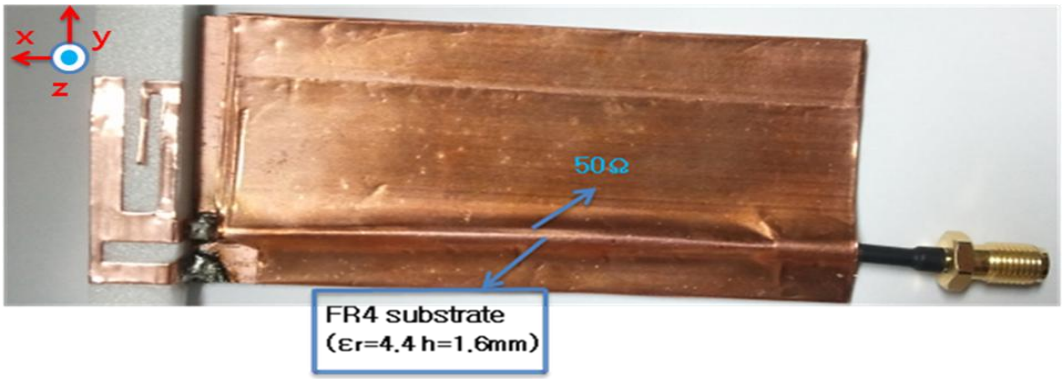

Figure 1: Photo of the implemented antenna.

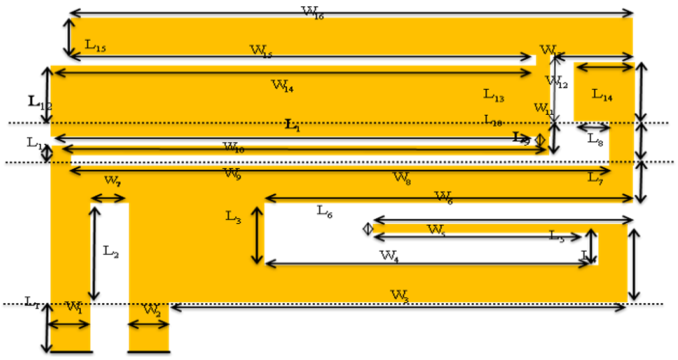

Figure 2: Parameters of the proposed antenna.

Table 1: Design parameters of the proposed antenna.
(L, W : Parameter / unit : mm)

L_1	5.035	L_9	3.800	W_1	3.000	W_9	26.900
L_2	8.500	L_{10}	1.000	W_2	3.000	W_{10}	23.900
L_3	4.000	L_{11}	2.500	W_3	20.500	W_{11}	2.000
L_4	4.570	L_{12}	4.535	W_4	17.000	W_{12}	4.000
L_5	1.500	L_{13}	6.535	W_5	10.500	W_{13}	5.000
L_6	1.000	L_{14}	5.500	W_6	12.500	W_{14}	23.900
L_7	3.965	L_{15}	3.600	W_7	3.000	W_{15}	23.000
L_8	5.000			W_8	19.500	W_{16}	29.100

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3. Simulation and Measurement

The commercial program HFSS (High Frequency Structure Simulator) based on the FEM (Finite Element Method) is used to obtain suitable values of parameters and analyze the behavior of the proposed antenna.

Fig. 3 shows measurement and simulation results on the S_{11} of the proposed antenna. We use the high-frequency program HFSS(High Frequency Structure Simulation) to process numerical simulation. Through Fig. 3 we can know that three operating bandwidths are obtained

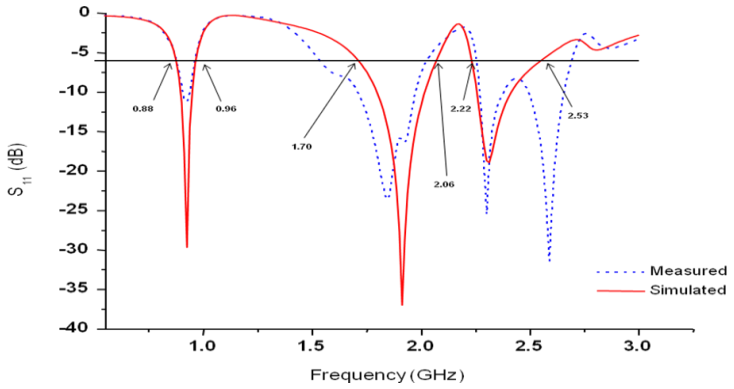
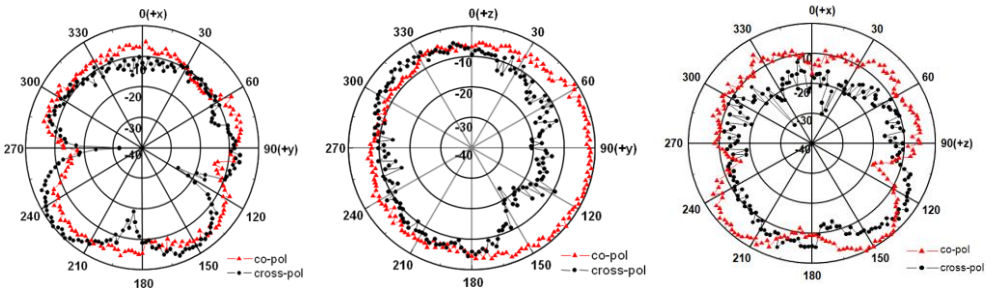


Figure 3: Simulated and measured S_{11}.

The proposed antenna satisfied with the sufficient bandwidths to cover GSM(Global System for Mobile communications:880-960 MHz), DCS(Digital Communications System:1710-1880 MHz), K-PCS(Korea-Personal Communications Service: 1750-1870 MHz), US-PCS(US Personal Communications Service:1850-1990 MHz), Bluetooth(2400-2483 MHz),Wibro(2300-2390 MHz) and WLAN (Wireless Local Area Network:2400-2483.5 MHz) bands.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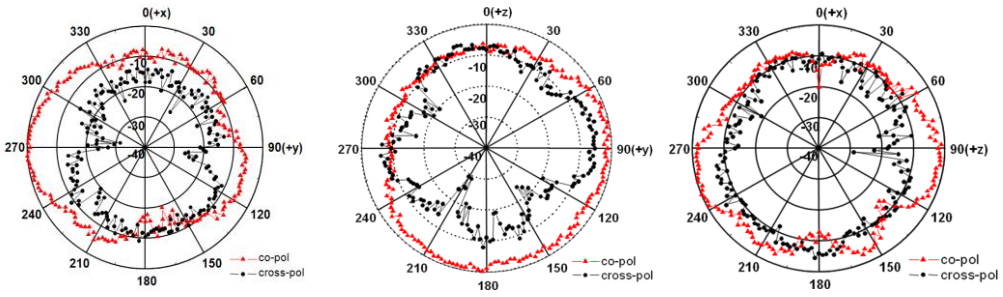
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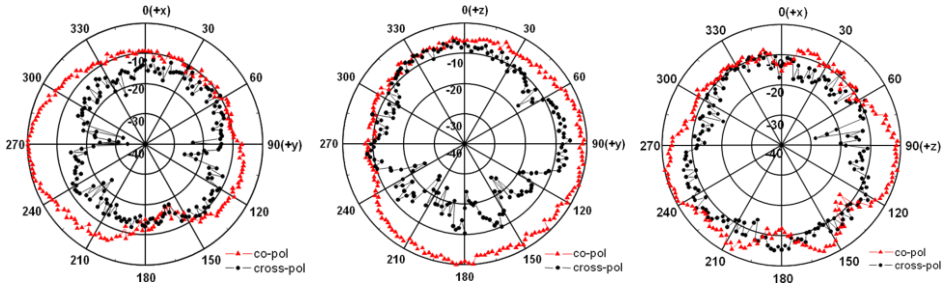
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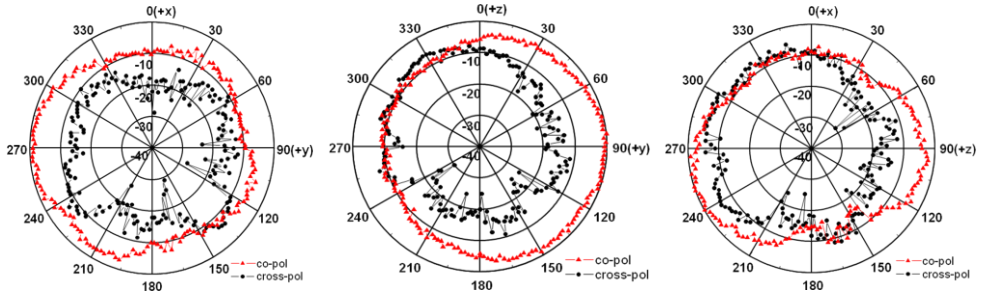
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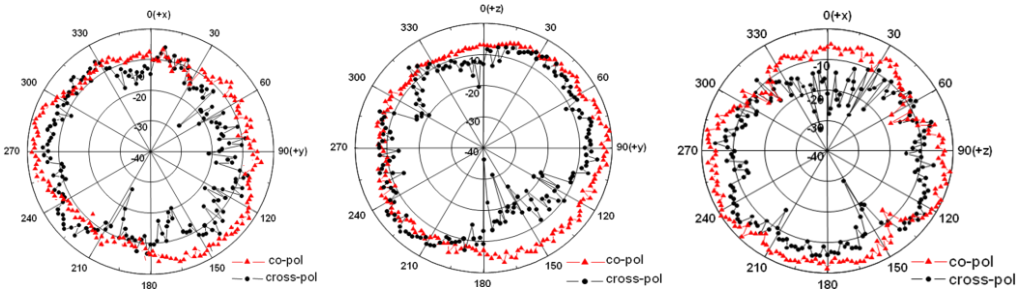
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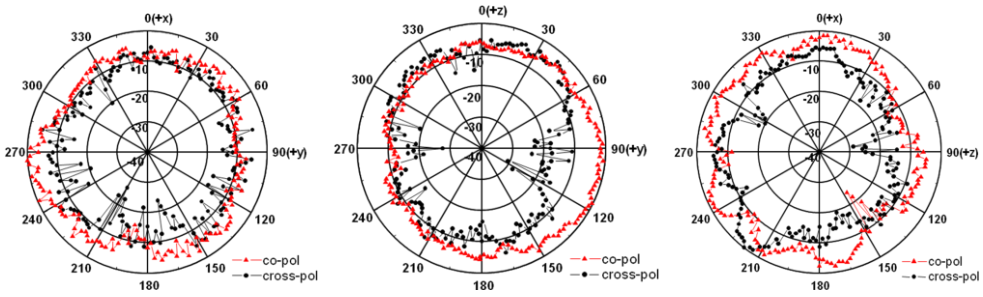

(f)

Figure 4: Measured radiation patterns of the implemented antenna.
(a) at 920MHz, (b) at 1975MHz, (c) at 1810MHz,
(d) at 1920MHz, (e) at 2345MHz, (f) at 2441MHz.

Fig. 4 is the measured co-polarization and cross-polarization radiation patterns of the implemented antenna in the x-y, z-y and x-z planes at seven different frequencies. Through this figure we can see that the maximum peak gain and average gain of GSM band are -0.71dBi, -3.64dBi, respectively. For the DCS band, the maximum peak gain and average gain are 2.06dBi, -2.815dBi, respectively. For the K-PCS band, the maximum peak gain and average gain are 2.58dBi, -2.74dBi, respectively. For the US-PCS band, the maximum peak gain and average gain are 3.22dBi, -0.155dBi, respectively. For the Bluetooth band, the maximum peak gain and average gain are -0.94dBi, -3.72dBi, respectively. For the Wibro and WLAN bands, the maximum peak gain and average gain are -1.9dBi, -3.62dBi, respectively.

4. Conclusion

We proposed a multi-band folded PIFA for mobile communication. We designed and fabricated the multi-band PIFA for GSM, DCS, K-PCS, US-PCS, Bluetooth, Wibro and WLAN bands and measurement showed suitable performance. We expect that the proposed PIFA is applicable for mobile communications.

References

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