

PIFA with a Bent, Meandered Radiating Arm for GSM/DCS Dual-Band Operation

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Introduction

PIFAs (Planar inverted-F antennas) have been widely used as internal antennas for mobile handsets, and many novel dual-frequency designs for achieving GSM (890–960 MHz) and DCS (1710–1880 MHz) operations have been reported [1]. In these designs, the radiating arm or the top patch of the PIFA is usually mounted above the ground plane, and a feed pin and a shorting pin, having a length the same as the distance between the radiating arm and the ground plane, are then connected at proper positions on the radiating arm. In this paper, we present an innovative PIFA design in which the feed pin, the shorting pin and the radiating arm of the PIFA are all printed on a flexible printed circuit board (FPCB), which is then bent by 90° and attached to and supported by a foam base. Without the need of soldering the feed pin and the shorting pin to the radiating arm, the proposed PIFA design is easier to construct. An example for the proposed PIFA applied to a folder-type mobile handset for GSM/DCS operation is demonstrated. In this case, the PIFA is positioned such that the distance between the user's head and the antenna is maximized, which can result in a much lower EM wave power absorption in the user's head, thereby reducing the risk of biological damage [2].

Antenna Design

Fig. 1(a) shows the geometry of the proposed PIFA mounted at the bottom end of a bent ground plane comprising an upper ground and a bottom ground, both with the same size of $40 \times 80 \text{ mm}^2$. The bent ground plane can be considered as the system ground plane of a practical folder-type mobile handset. An example of a user with a handset having the proposed PIFA is shown in Fig. 1(b). The upper ground portion usually accommodates the loudspeaker and the display, and also functions as the cover of the handset. For the bottom ground, it usually accommodates the microphone and the keypad. Also note that, in the talk condition, the flare angle between the upper and bottom grounds is denoted as α .

The proposed PIFA mainly consists of a meandered radiating arm, a feed portion and a shorting portion, all printed on a flexible printed circuit board (FPCB) of size $15 \times 40 \text{ mm}^2$. Along the bending line $\overline{DE}$, the PIFA is bent by 90° , and attached to and supported by a foam base of size $40 \times 8 \times 7 \text{ mm}^3$, which results in a compact structure of the PIFA. Also note that the total length of the meandered radiating arm is about 95 mm, close to a quarter-wavelength at 900 MHz. By properly meandering the radiating arm, which affects the frequency ratio of the PIFA's first two resonant modes, not only the first resonant mode occurred at about 900 MHz for GSM operation, but also the second mode at about 1800 MHz for DCS operation. For feeding the PIFA, a 50Ω mini coaxial line is used. For the shorting portion (line section between points C to B), it has a length of about 19 mm. The length and width of the shorting portion have great effects on the impedance matching of the proposed PIFA. With the selection of the optimal length and width to be 19 and 0.5 mm, good impedance matching for the PIFA is obtained.

Experimental Results and Conclusions

Fig. 2(a) shows the measured and simulated return loss for the condition with $\alpha = 135^\circ$. Two separate wide resonant modes are successfully excited. With the 2.5:1 VSWR impedance bandwidth definition, which is acceptable for practical applications, the lower resonant mode has an impedance bandwidth of 74 MHz (886–960 MHz), satisfying the bandwidth of the GSM band. For the upper resonant mode, the obtained impedance bandwidth is 242 MHz (1655–1897 MHz), also covering the bandwidth of the DCS band.

Figs. 3 and 4 plot, respectively, the measured radiation patterns at the center frequencies (925 and 1795 MHz) of the GSM and DCS bands. Other frequencies across the GSM and DCS bands were also measured and showed similar patterns as plotted here; that is, the proposed PIFA has stable radiation patterns across its lower and upper bands. Measured peak antenna gain for the proposed PIFA with $\alpha = 135^\circ$ was also measured. The antenna gain obtained is about 0.5–1.4 dBi across the GSM band, and that for the DCS band is about 1.3–3.2 dBi. The conditions with the bent ground plane having various possible flare angles were also studied. More results will be given in the presentation.

References

- [1] K. L. Wong, *Planar Antennas for Wireless Communications*, John Wiley & Sons, New York, 2003, Chap. 2.
- [2] F. Colli, A bio-compatible cellular telephone apparatus, World Intellectual Property Organization, Int'l Pub. No.: WO 99/27656 (1999).

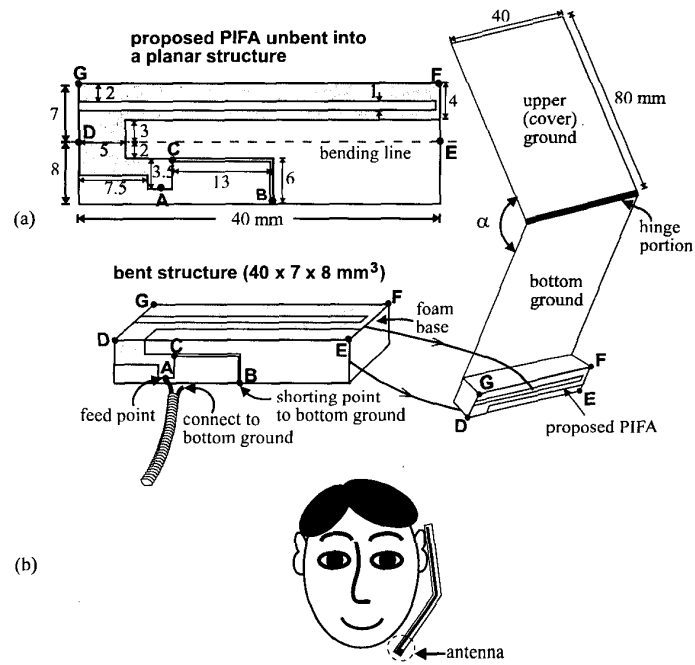


Fig. 1 (a) Geometry of the proposed PIFA. (b) An example of a user with a folder-type mobile handset having the proposed PIFA shown in (a).

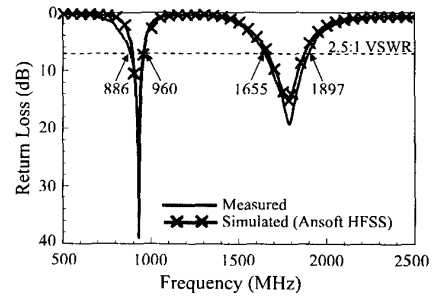


Fig. 2 Measured and simulated return loss for $\alpha = 135^\circ$.

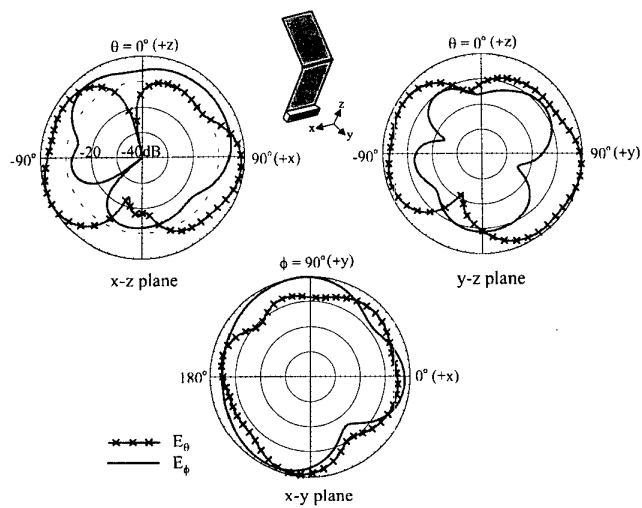


Fig. 3 Measured radiation patterns at 925 MHz for $\alpha = 135^\circ$.

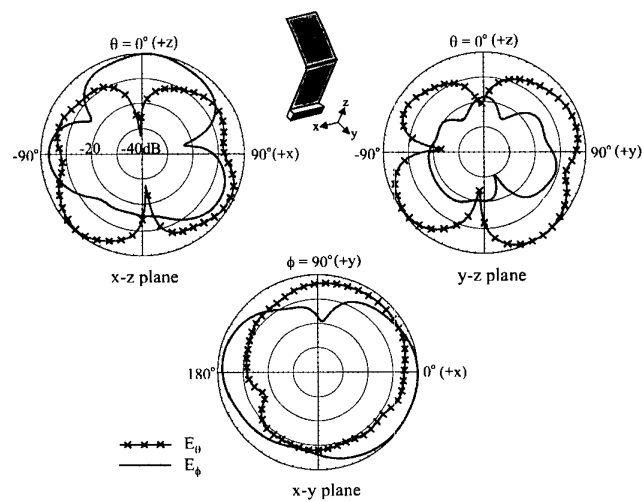


Fig. 4 Measured radiation patterns at 1795 MHz for $\alpha = 135^\circ$.