Compact Internal Coupled-fed PIFA for Mobile Phone

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Abstract

This paper proposes a compact internal coupled-fed PIFA antenna for mobile phone application. The operating bands, which are resonated by a meandered radiating strip and an L-shaped feeding line, cover GSM900/DCS/PCS/UMTS applications. The proposed antenna also has the advantages of compact size, simple structure, ease fabrication, and low cost.

Keywords : mobile phone antenna PIFA coupled-fed

Introduction

Recently, the planar inverted-F antenna (PIFA) used in the mobile phone has been widely studied [1]. The feeding mechanism of PIFA using a coupled-fed to replace the directed-fed for dual-band or multiband operation becomes a popular technique [1] Unlike the conventional half-wavelength or one-wavelength loop antennas which occupy a large volume inside the mobile phone [2] or low-profile monopole antennas which are easily affected by ground plane [3], PIFAs having compact volume and less grounding influence provide board operation bandwidth for mobile application.

In this study, we present a promising coupled-fed PIFA design which can be printed on the system circuit board with a compact area in the mobile phone and provides two wide operation bands centered at about 900 and 1900 MHz. The two operation bands defined by 6-dB return loss (890-962 and 1710-2190 MHz) cover GSM900 (890-960 MHz) and DCS/PCS/UMTS (1710-1880, 1850-1990, 1920-2170 MHz) applications. The proposed PIFA consists of a meandered radiating strip connected to the system ground on one side and an L-shaped feeding line on the other side. The radiating strip operates a quarter-wavelength resonant mode at around 900 MHz and a half-wavelength resonant mode at around 1700 MHz. The L-shaped feeding line not only acts as feeding line, but also resonates a quarter-wavelength resonant mode at around 2000 MHz.

Antenna Design

Fig. 1 shows the geometry of the proposed coupled-fed PIFA for mobile phone application. The proposed antenna is fabricated on an FR4 substrate with a relative permittivity of 4.4 and a loss tangent of 0.02. The top side of substrate consists of a meandered radiating strip that occupies size of 40×10 mm^2 and a system ground with size of 40×70 mm^2. An L-shaped coupled-fed line is printed on the back side. A 50-Ω SMA connector is used to feed the antenna from the end of the feed line. The overall dimension of the design is $40\times80\times0.8$ mm^3 and fits the practical size of mobile handset.

The resonant bands of the coupled-fed PIFA are obtained through the L-shaped coupled-fed line to excite the meandered radiating strip. The radiating strip of about 76 mm in length operates a quarter-wavelength resonant mode at about 900 MHz and a half-wavelength resonant mode at about 1700 MHz. The L-shaped line, which is composed of two bars with widths of 1.5 mm, uses as feeding line (the portion underneath the ground plane) and operates a quarter-wavelength resonant mode at around 2000 MHz (the portion over the ground plane).

Results

The configuration of the proposed antenna shown in Fig. 1 was fabricated and tested. Fig. 2 shows the measured and simulated return losses of the proposed antenna, and the simulated results are obtained by using Ansoft HFSS [4]. Defined by the 6-dB impedance bandwidth, which is widely used as the design specification of the internal mobile phone antenna, two operating bands are obtained. The bandwidth of the lower band is about 72 MHz (890-962 MHz), and that of upper band is about 480 MHz (1710-2190 MHz). The lower and upper bands meet the application requirements of GSM900/DCS/PCS/UMTS bands. Fig. 3 shows the simulated radiation efficiency and antenna peak gain for the proposed antenna. The simulated radiation efficiency is about 79~82% for the lower band and about 62~88% for the upper band, which are all better than 50% and are acceptable for practical mobile phone applications. The simulated antenna peak gain is about -1.3~-0.6 dBi for the lower band and about 0.8~3.7 dBi for the upper band. Fig. 4 and Fig. 5 show the simulated far-field radiation patterns at 925 and 2050 MHz, respectively. Because the two operating frequencies are obtained by different paths (meandered radiating strip with the system ground and L-shaped feeding line), the two patterns have dipole-like radiation patterns with omnidirectional radiation in the azimuthal plane (y-z plane) [5].

Conclusion

The coupled-fed PIFA for mobile phone application has been proposed. The proposed antenna successfully uses the L-shaped feeding line to excite the meandered radiating strip. The two operating bands (lower band and upper band) meet GSM900 and DCS/PCS/UMTS applications. Beside, the compact size of the proposed antenna is suitable for applying in mobile handset.

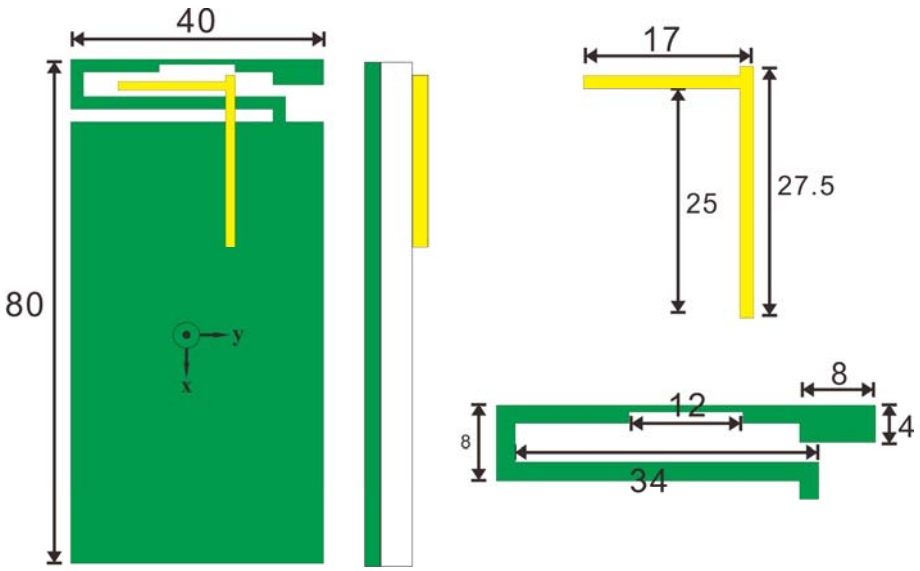

Fig. 1 Geometry of the proposed coupled-fed PIFA for mobile phone application.

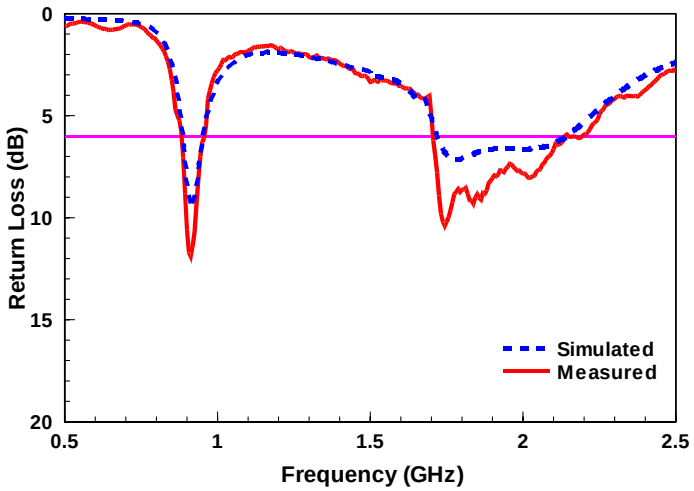

Fig. 2 Measured and simulated return losses for proposed antenna.

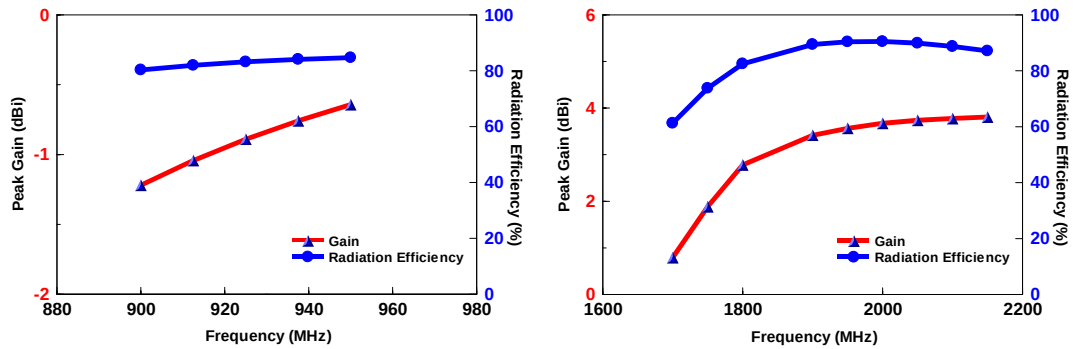

Fig. 3 Simulated radiation efficiency and antenna peak gain for the proposed antenna.

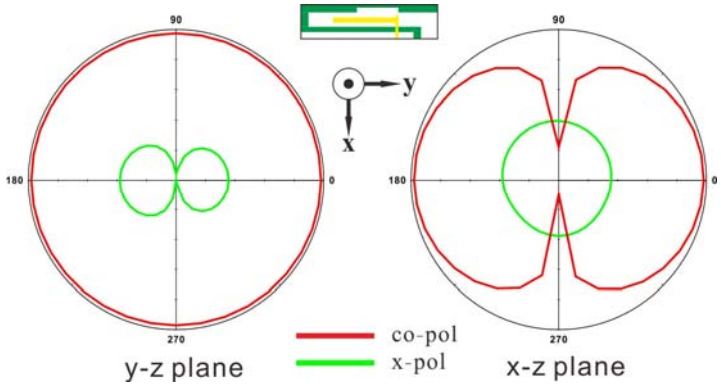

Fig. 4 Simulated radiation patterns at 925 MHz for the proposed antenna.

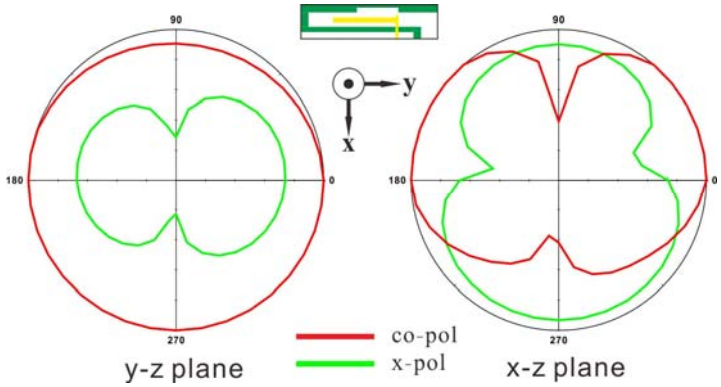

Fig. 5 Simulated radiation patterns at 2050 MHz for the proposed antenna.

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