Internal Dual-Mode Monopole Antenna for Mobile Phone Application

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1. Introduction

Planar metal-plate monopole antennas are easy to implement and can provide a wide impedance bandwidth [1, 2], making them very promising to be applied to some wireless mobile devices [3]. However, conventional planar monopole antennas usually have a large profile and need to be protruded from the mobile phone casing when used as mobile phone antennas, which greatly limits its practical applications. In this paper, we demonstrate a promising wideband metal-plate monopole antenna for mobile-phone applications, especially for dual-mode mobile phone capable of mobile (UMTS) and wireless local area network (2.4/5.2/5.8 GHz WLAN) communications. The proposed antenna occupies a compact volume of $10 \times 20 \times 20$ mm^3 only, making it very promising to be embedded within the casing of a practical mobile phone. Note that, the proposed antenna has an asymmetrical two-branch feeding strip for input section. This structure is very promising for achieving bandwidth enhancement for a planar monopole antenna, which can easily provide a wide operating bandwidth of about 5 GHz (1818−6746 MHz here). In addition, the antenna with the proposed feeding strip together can easily be fabricated using a single metal plate, and no external feeding network [4] is required. Details of the antenna design are described, and the experimental results of a constructed prototype are presented.

2. Antenna Design

Figure 1(a) shows the geometry of the proposed internal wideband metal-plate monopole antenna for UMTS/WLAN dual-mode mobile phones. The antenna is easily fabricated by bending a single metal plate (a 0.2-mm-thick copper plate) shown in Figure 1(b). The antenna shows a small cross-sectional area of 10×8 mm^2 and a length of 19 mm with a feed gap of 1 mm and is mounted at the center of the small ground plane (size 10×20 mm^2) protruding from the system ground plane. Note that between the feed gap is the central conductor (diameter 1.2 mm) of a 50 Ω SMA connector located below a via-hole in the center of the small ground plane. In addition, the length and width of the system ground plane are chosen to be 100 and 70 mm respectively, which are reasonable dimensions for a practical PDA phone.

The proposed antenna, with the asymmetrical two-branch feeding strip and the bending process shown in Figure 1(b), can be divided into several portions, which easily makes the obtained impedance bandwidth to have a lower edge frequency less than 2 GHz and provide a wide operating bandwidth of about 5 GHz. This behaviour is largely because the several resonant paths are obtained, which control the occurrence of the antenna's different resonant modes. Moreover, a much more uniform current distribution in the planar monopole antenna is achieved. Note that the asymmetrical two-branch feeding strip can provide additional coupling between the proposed antenna and the antenna ground plane, which helps improve the impedance matching of the antenna, leading to a much wider impedance bandwidth obtained. In addition, owing to the asymmetrical two-branch feeding strip, the proposed monopole antenna height above the small ground plane is reduced, which helps achieve a compact size for the antenna.

3. Results and Discussion

The proposed antenna was constructed and studied with the design dimensions shown in Figure 1. Figure 2 shows the measured and simulation return loss for the constructed prototype. The simulation results are obtained using the Ansoft simulation software high-frequency structure simulator (HFSS) [5], and good agreement between the experiment data and simulation result is seen. A very wide impedance bandwidth, defined by 10-dB return loss, is obtained. The measured impedance bandwidth is about 5 GHz (1818−6746 MHz), which makes the antenna easily cover the UMTS band for mobile communications and 2.4/5.2/5.8 GHz bands for WLAN communications. The radiation characteristics were also studied. Figure 3 plots the measured radiation patterns at the center frequency (at 2045 MHz) of the UMTS band. Figure 4 and 5, respectively, show the measured radiation patterns at the center frequencies (at 2442 and 5500 MHz) of the 2.4 GHz WLAN band and the 5 GHz (5.2/5.8 GHz) WLAN band. By comparing the radiation patterns at 5500 MHz to those at 2045 and 2442 MHz, it is observed that the radiation patterns at 5500 MHz are seen to be less smooth. This characteristic is largely because, for higher frequencies, the proposed antenna and the main ground plane together operate in the high-order resonant modes, thus leading to less smooth radiation patterns.

4. Conclusion

A wideband metal-plate monopole antenna suitable for applications of an internal mobile-phone antenna, especially for PDA phones capable of UMTS/WLAN dual-mode operation, has been proposed. The antenna has a simple configuration and is easy to implement at a low cost. In addition, a wide bandwidth of about 5 GHz has been achieved. The experimental results also indicate that good radiation characteristics over the UMTS and WLAN bands have been obtained.

References

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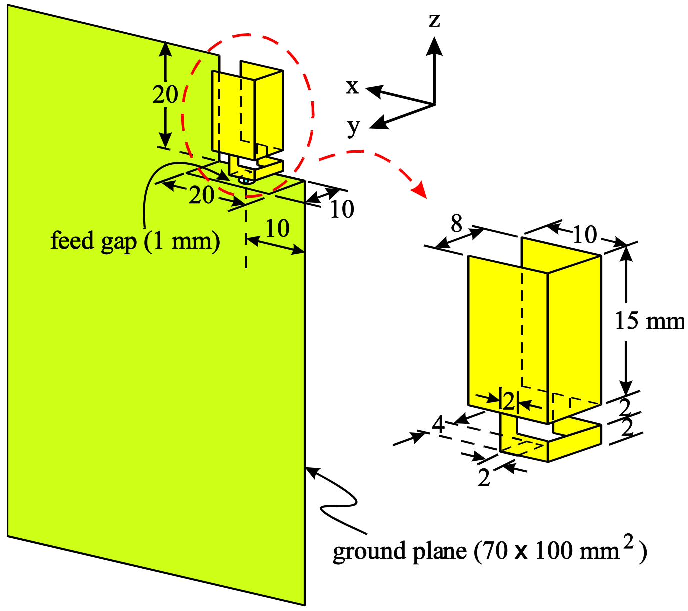
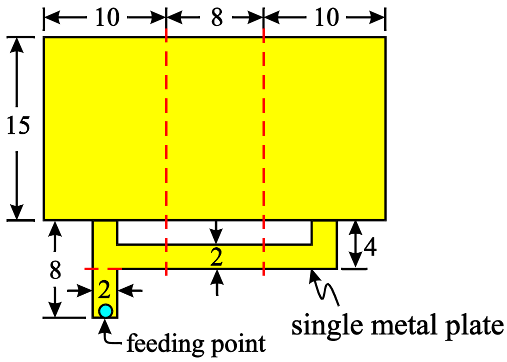


(a)



(b)

Figure 1: (a) Geometry of the proposed internal wideband monopole antenna; (b) detailed dimensions of the single metal plate used for fabricating the antenna.

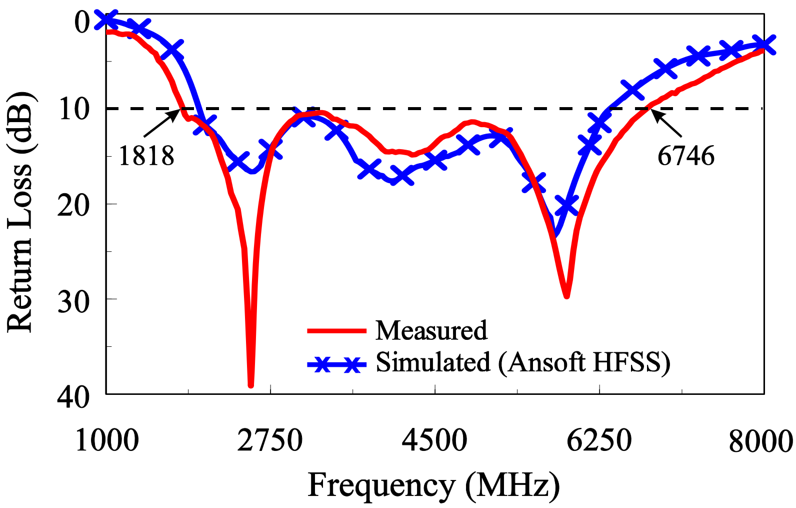


Figure 2: Measured and simulated return loss for the proposed antenna.

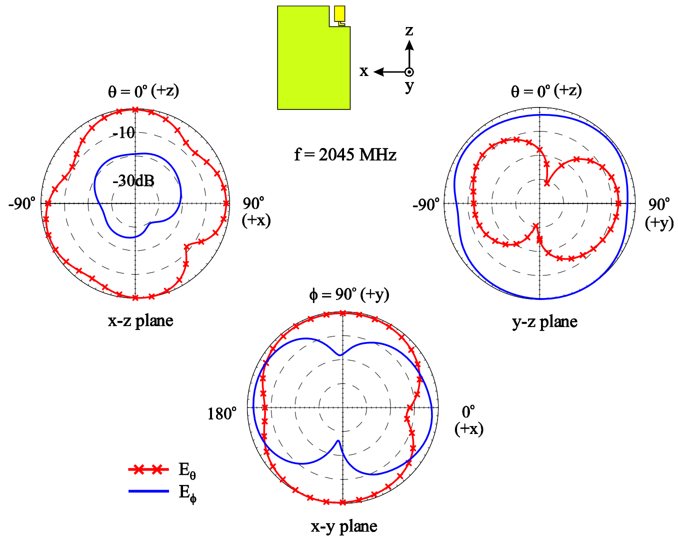


Figure 3: Measured radiation patterns at 2045 MHz

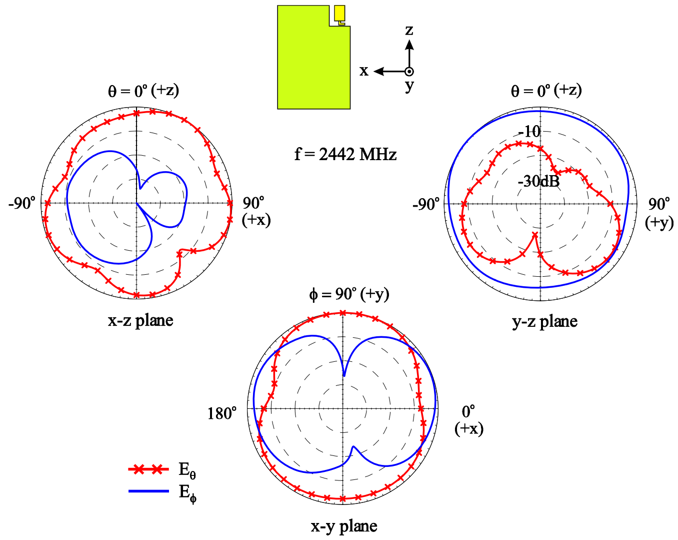


Figure 4: Measured radiation patterns at 2442 MHz

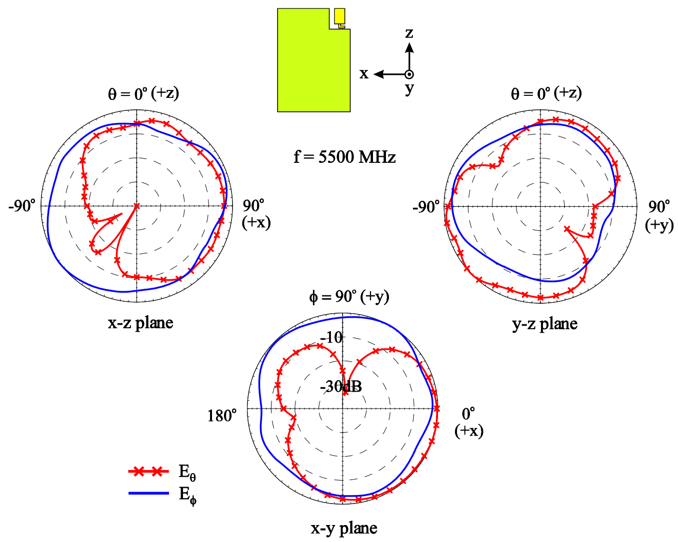


Figure 5: Measured radiation patterns at 5500 MHz