Broadband internal antenna of planar monopole type for mobile handsets

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Abstract

This paper presents a novel internal antenna of planar monopole type. The proposed antenna fed by a 50Ω microstrip line operates at DCS (1710-1880 MHz), PCS (1750-1870 MHz), and IMT-2000 (1885-2200 MHz) bands. The size of the antenna which do not include the supporter is 20 × 17 × 0.2 mm^3. The bandwidth of the proposed antenna (S11<10 dB) has 740MHz starting from 1620 MHz to 2360 MHz. Numerical simulation and experiment results are performed with considering the antenna itself, phone case, and battery.

1. Introduction

The advantages of internal antennas compared to external antennas in handset terminal are simple terminal design, compact, and serviceability. In addition, it can be protected from breakage and improved aesthetic appearance due to placing inside mobile handsets [1]. Due to small size, however, the internal antenna has several disadvantages such as diminution in performance of gain, efficiency, bandwidth, and radiation pattern [2]. There are many types of internal antenna such as meander-line antenna (MLA), ceramic chip antenna (CCA), the dielectric resonator antenna (DRA), and planar monopole antenna ([2]-[3]). Especially, planar monopole antenna is one of the most common antennas used for wireless communication because of its simple structure and omnidirectional radiation characteristic. Recently, the broadband antenna structure such as square, bowtie, elliptical, and trapezoidal plates have been introduced ([3]-[4]).

In this paper, a novel internal antenna of the planar monopole type for application in mobile phones is presented. The proposed antenna size has a small volume of 20 × 17 × 4.7 mm^3 which includes the supporter and it can be achieved a broad bandwidth about 740 MHz. The antenna is applied to the practical mobile handsets and the measured and simulated results are presented.

2. Antenna design

The configuration of the proposed antenna is shown in Fig. 1. The size of main substrate is 40 × 75 × 1 mm^3 which can be considered to be the circuit board of a practical handset. As seen in Fig 1(a), the antenna is fed by a 50Ω microstrip feed line which is consists of a metal strip width of 1.68 mm. In order to achieve the broad bandwidth, the feed which is connected between the microstrip line and antenna is a trapezoidal shape with the tilted angle of 34.7°. By adjusting distance of the bottom (W_b) and top side (W_t) of a trapezoidal feed, the broad bandwidth can be achieved[4] due to the tilting copper plate, the resonant frequency can be down because traveling current path is longer. As a result, the broad bandwidth can be achieved. The antenna is placed on an supporter which is 4.5 mm in height and has relative permittivity $\varepsilon_r = 2.6$. As seen in Fig. 1(b), the basis of the proposed antenna is a planar monopole type of three pieces of copper strip with dimensions 20 × 17 × 0.2 mm^3 which occupies a small volume in handsets. Figure 2 shows the antenna on the practical hand phone which has the dimensions of 46.16 × 92.24 × 21.64 mm^3. In order to find the optimized antenna characteristics, Ansoft HFSS and Microwave Studio (MWS) are used to tuning the each associated parameters of antenna structure. Fabrication and measured results were compared with the simulation ones.

3. Results

The designed antenna has fabricated and measured with an Agilent 8510C network analyzer to confirm its performance. Figure 4 and 5 show the measured and simulated return losses and radiation patterns of the proposed antenna. The experimental results have a good agreement with the simulated results. In Fig. 3, the antenna resonates at 1810 MHz with the bandwidth 41.1% at VSWR < 2. The radiation pattern is similar to that of a monopole antenna in Fig. 5. The measured maximum gain has 2.9 dBi, while the simulated maximum gain has 2.54dBi at 1800 MHz. This slight discrepancy can be attributed to the effects of the conductor loss and dielectric loss. Figure 4 describes the measured and simulated results. In Fig. 3, the data is the measured return losses in case of considering handphone case and battery. The resonated frequency is shifted by affected case and battery. Each bandwidth is 680 MHz (1590-2270 MHz) with case, 450 MHz (1570-2020 MHz) with case and battery. Figure 6 and 7 show the radiation pattern of antenna added case and battery, respectively. The measured maximum gain at 1800 MHz is about 2.8dBi and 3.9dBi, respectively.

4. Conclusion

A novel internal antenna of planar monopole type suitable for DCS, PCS, and IMT-2000 bands has been proposed and experimentally studied. In addition, the antenna is applied to the practical handsets. The proposed antenna is a compact dimensions of $20 \times 17 \times 4.7$ mm^3 and when it is considered case and battery in practical handsets, further reduction size of the antenna is possible. The obtained bandwidth is 740 MHz at VSWR < 2 and the maximum gain is 2.9dBi without considering the battery and handset case. Its omnidirectional radiation pattern is similar to that of monopole antenna. These features make the proposed antenna attractive for mobile handsets.

Acknowledgement

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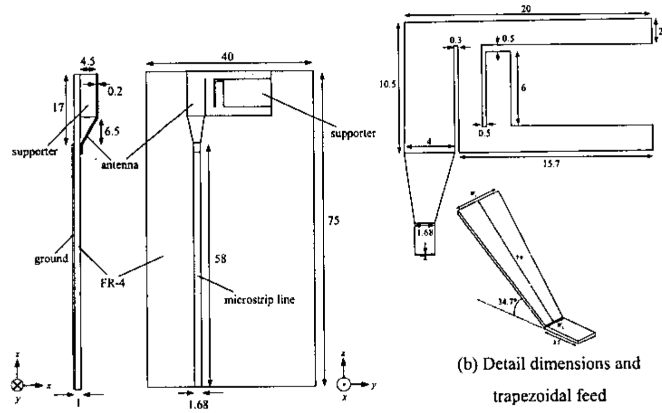
References

[1] J. Rasinger, A. L. Scholtz, W. Pichler, and E. Bonek, "A new enhanced-bandwidth internal antennafor portable communication systems," *Vehicular Tehnology Conference 1990 IEEE 40th*, pp.7-12, 1990

[2] D. S. Yim, and S. O. Park, "Small internal ceramic chip antenna for IMT-2000 handsets", *Electronics Letter*, vol. 39, pp.1364-1365, 2003

[3] Z. N. Chen, "Broadband planar monopole antenna," Microwaves, Antennas and Propagation, IEE Proceedings pp. 526-528, 2000

[4] Z. N. Chen, M. Y. W. Chia, "Impedance characteristics of trapezoidal planar monopole antenna," *Microw. Opt Technol. Lett.*, pp. 120-122, 2000



(b) Detail dimensions and trapezoidal feed

(a) The side and top view

Figure 1. Geometry of the proposed planar monopole antenna

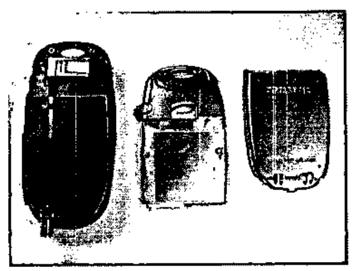


Figure 2. Practical handphone case and battery used to measurement

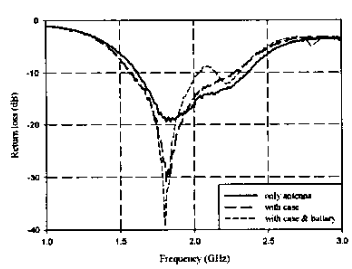


Figure 3. Measured return losses considering handphone case and battery

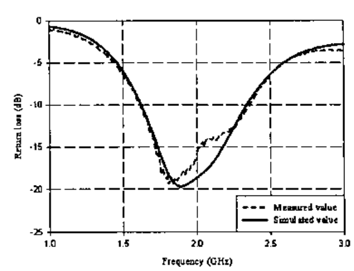
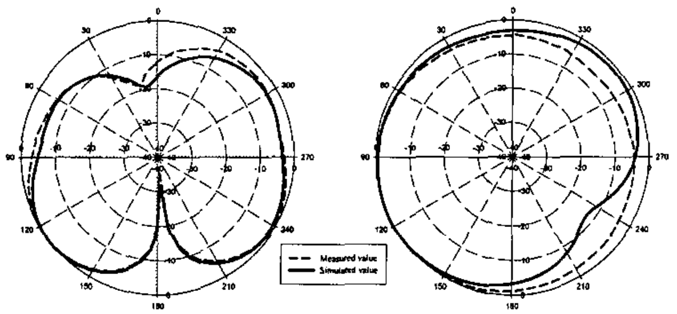
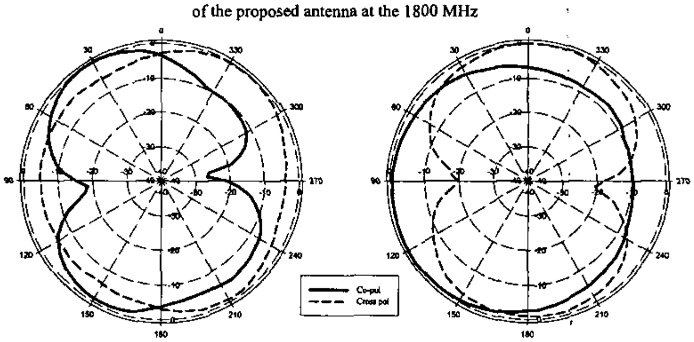


Figure 4. Measured and simulated return losses of only antenna



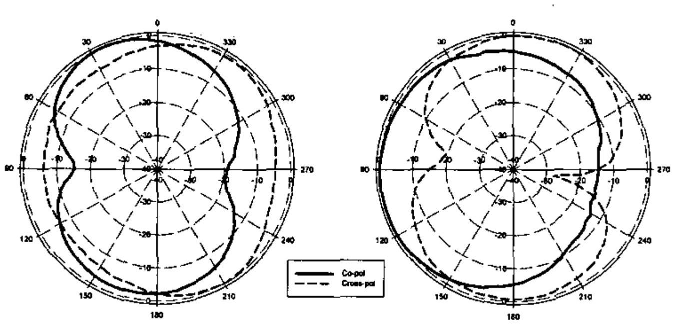
(b) *x-z* plane (1800 MHz) (c) *x-y* plane (1800 MHz)

Figure 5. Measured and simulated radiation patterns of the proposed antenna at the 1800 MHz



(a) *x-z* plane (1800 MHz) (b) *x-y* plane (1800 MHz)

Figure 6. Radiation pattern considering handphone case



(a) *x-z* plane (1800 MHz) (b) *x-y* plane (1800 MHz)

Figure 7. Radiation pattern considering handphone case and battery