AN INTERNAL ANTENNA FOR PCS/IMT-2000/BLUETOOTH TRIPLE-BAND MOBILE PHONE

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An internal triple-band antenna fed by a microstrip line is proposed for operating PCS, IMT-2000, and Bluetooth bands. By using the two branchs of meander line, the desired resonant frequencies can be achieved. A broadband characteristic for each band is optimized by tunning the parts of radiating patch and size of each strip line segments. The proposed antenna and substrate are small enough to be built in a practical mobile handset. Details of the proposed technique and experimental results are presented and discussed.

1. Introduction

In recent years, interest of internal antenna is being increased in mobile handset antenna applications. Antenna must be small enough to be built in practical mobile handsets and have a good performance with respect to bandwidth and gain. Most of internal antenna proposed up to now consist of Planar Inverted F-Antenna (PIFA) type [1]-[3], chip antenna of the meander type [4], and planar monopole antenna [5]-[7]. For the planar inverted-F antenna (PIFA) reported in [1]-[3], there are advantages of low profile, compact size, and multiple-band operations for mobile phones. However, there are limitations in bandwidth for each band and in needed heights (6 ~ 10*mm*) from substrate to obtain the desired results [1]-[3]. In addition, additional shorting pins must be needed more than one and additional parasitic patch to achieve multi-band operation [3]. Thus, there are some problems to be installed in practical mobile phone. For the ceramic chip antenna of the meander type [4], although ceramic chip antenna is very small, the fabrication is difficult and the cost per unit of production is too high. Good characteristic for the gain also can not be achieved due to the high dielectric material. For the planar monopole antennas, a variety of designs have also been reported [5]-[7]. Most of those are printed on a substrate by easy processing and have a simple structure. However, sizes of those antennas and needed ground should be large to achieve the multi-band operation [6]-[7]. Although the low-profile planar monopole antenna has small size, the broadband characteristic is limited [5]. The proposed antenna is suitable to multi-band operation, covering the Korean PCS (1750-1870 *MHz*), IMT-2000 (1920-2170*MHz*) and Bluetooth (2402-2483.5*MHz*) bands.

2. Antenna Design and Results

The proposed internal triple-band antenna of the novel planar monopole type for PCS/IMT-2000/Bluetooth applications is shown in Fig. 1. The dimension of a radiating element with thickness of 0.5mm is 12.5 × 27 × 3.5mm3. Two edge corners of the proposed antenna are folded, which have advantage of easy assembly on the substrate and the reduced size of antenna. The proposed antenna is mounted on the FR4 substrate (εr=4.6) with thickness of 0.6mm and dimensions of 72 × 30mm2, as shown in Fig. 1. Overall size of antenna and substrate are small enough to be built in practical mobile handsets. A 50Ω microstrip line is used to feed the internal antenna, and is printed on the same substrate. The bent microstrip line is vertically connected to the feeding part of antenna. By adjusting the width W at the bent microstrip line, we can achieve a good matching between input impedance of antenna and microstrip feed line. On the other side of the PCB, the ground plane

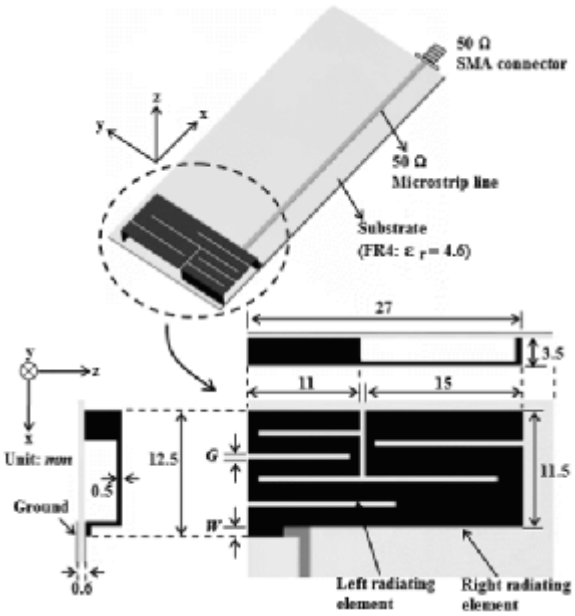

Fig.1. Configuration of the proposed internal antenna for PCS/IMT-2000/Bluetooth triple-band mobile phone.

is cut at the end of the microstrip feed line.

By using the two branches on the meander line, rectangular patch is separated into two radiating elements, left radiating element for Bluetooth band and right radiating element for PCS/IMT-2000 bands. Resonant frequencies can be controlled by adjusting the lengths of meander line and vertical segment length *G*. Broadband characteristic of most of planar monopole type antenna can be achieved by ensuring enough length and width of the patch [6]-[9], which are regulated to the resonant wavelength at the operating frequency. However, length of antenna in the direction of x axis as shown in Fig. 1 should be small enough to be built in the practical mobile handsets. In the proposed antenna, by folding edge corners of the radiating patch, reduction of antenna length and broadband characteristic can be obtained. Optimum height of the proposed antenna is only 3.5*mm* less than that of most of PIFA [1]-[3]. In order to obtain the triple bands, the optimized parameters of antenna are illustrated in Fig. 1. Especially, the vertical segment length *G* has tuned at 0.5*mm*, and feeding width *W* has 1.5*mm*. Fig. 2 shows the simulated results and measured return loss of the proposed antenna. The wide impedance bandwidths (PCS/IMT-2000 and Bluetooth bands) are obtained. There is good agreement with the measured result and simulated one. Simulation was carried out using

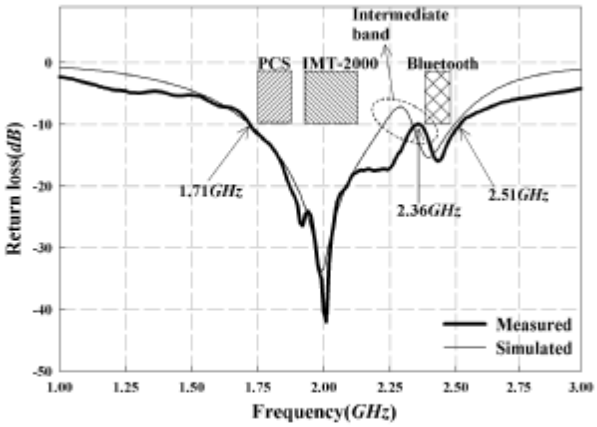

Fig. 2. Simulated and measured return loss for the proposed antenna.

HFSS to understand the behavior of the antenna model and optimize the suitable parameters at the operating frequencies. The measured impedance bandwidth for 10-*dB* return loss is about 32.0*%* starting from 1.71 to 2.35*GHz* at the lower frequency (2.0*GHz)*, which is enough to cover the PCS (1750-1870*MHz*) and IMT-2000 (1920-2170*MHz*) bands. Also, for the higher resonant frequency (2.44*GHz*), the measured impedance bandwidth is enough to cover the Bluetooth (2402-2483.5*MHz*) band. As shown in Fig. 1, the size of right radiating element is larger than left one. This indicates that at the lower band, right radiating element is more dominant for intense radiation and broadband characteristic due to a larger current distribution. As shown in Fig. 2, the intermediate band of around 2.3GHz at the simulation result is reduced up to about -7*dB* level and the measured result shows better result, about -10*dB* level.

The simulated and measured radiation patterns at the resonant frequency of 2.0*GHz* are plotted in Fig. 3. The measured and calculated results agree well with each other. The ripples in the measured radiation pattern are due to the effect of the feeding cable. It is seen that the radiation patterns at 2.0*GHz* are approximately omni-directional and similar to those of x-directed electric monopole placed on a finite ground plane. A maximum antenna gain of about 2.7*dBi* is measured at 2.0*GHz*. There is a difference of only 0.22*dBi* compared with simulated gain, 2.92*dBi*.

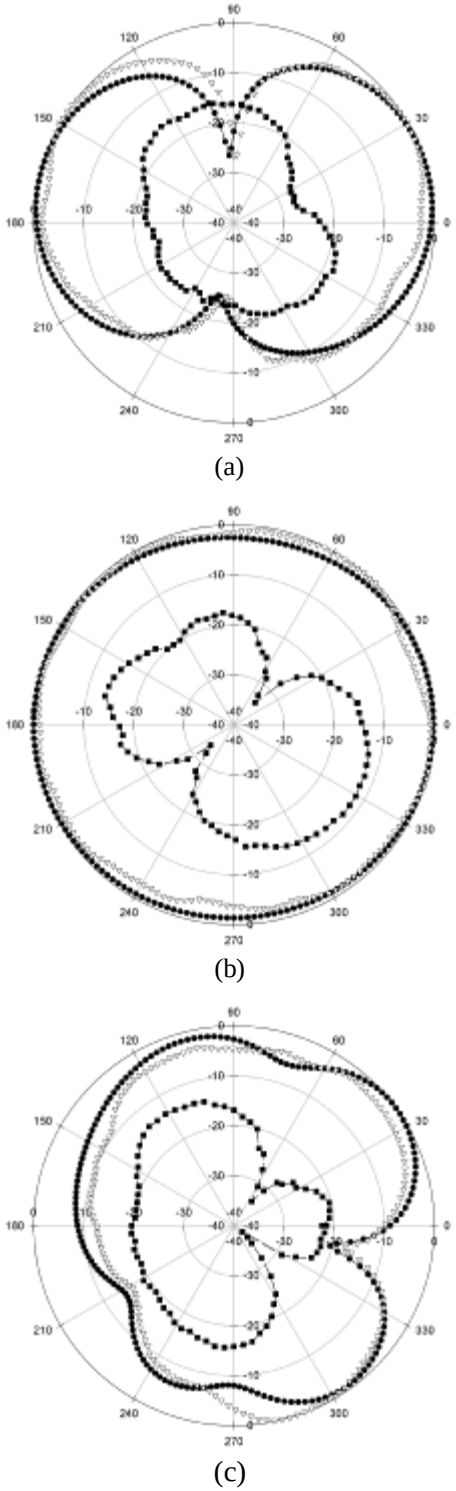

Fig. 3. Simulated and Measured radiation patterns for the proposed antenna at frequency of 2.0 GHz. (a) x-z plane, (b) y-z plane, (c) x-y plane.

3. Conclusion

It was demonstrated that a novel planar type meander line antenna can serve as a broadband internal antenna for PCS/IMT-2000/Blutooth mobile handsets applications. By adjusting width of folded part of microstrip feed line, the antenna achieves a good match between input impedance of antenna and microstrip feed line. The lower resonant frequency at the PCS/IMT-2000 bands and high resonant one at the Bluetooth band can be adjusted quite easily by properly optimized the dimensions of antenna parameters. Also, the two folding parts of upper left and right corners play an important roles of broadband characteristic, reduced size, and easy placement of antenna. Additionally, this folding part roles as the enhanced performance of S_{11} value at the intermediate band region. A prototype of the proposed antenna has been successfully fabricated, and the antenna size has a small enough to be placed on internal area, $11.5 \times 27 \times 3.5 mm^3$ of practical mobile handsets for multi-band operation. It was shown that the proposed antenna is suitable for PCS/IMT-2000/Bluetooth applications because their performances and size have very attractive features.

Acknowledgements

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