An Internal Dual Band Antenna for Bluetooth / DMB Applications

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In this paper, an internal dual band antenna is proposed for Bluetooth and Digital Multimedia Broadcasting (DMB) services. This novel antenna fed by a 50Ω coaxial cable operates at Bluetooth(2400-2483 MHz) and DMB(2535-2655 MHz) bands, respectively. The size of this antenna is 17 × 10 mm^2 and its height is 7 mm. When this antenna is applied for handset case, the bandwidth of presented antenna is 290 MHz starting from 2400 MHz to 2690 MHz for VSWR < 2.0. The simulated and measured results were obtained by considering antenna itself and handset case including battery.

Introduction

Recently, the development of wireless communication has led to a great demand of designing attractive handset devices. So internal and multi bands antennas covering two more different frequency bands are becoming proper applications in mobile handsets. The advantages of internal and multi band antenna such as good appearance and diverse service bands are reported in [1-3]. And Planar Inverted F Antenna (PIFA) has primarily used in mobile handsets due to some reasons such as small size and ease to hide within mobile phone. Designing an internal antenna means to consider the effect between antenna and metallic objects like a PCB and battery. At this point of view, PIFA performs reasonably well compared to other antennas [1-2].

The proposed antenna is covering both Bluetooth and Digital Multimedia Broadcasting (DMB) frequency bands. This novel internal dual band antenna is designed to PIFA type and built in the commercial handset case. The proposed antenna has a small volume of 17 × 10 × 7 mm^3 including supporter. The simulated and measured results are presented with and without handset case including battery.

Antenna Design

The geometry of the proposed internal dual band antenna for Bluetooth/DMB applications is shown in Fig. 1. This novel antenna is mounted on the FR-4 ground substrate whose permittivity is 4.6 and dimension is 90 × 40 mm^2, which is fit for commercial handset case. And the basis of the proposed antenna is PIFA of copper strip with dimensions 17 × 10 × 0.2 mm^3 which occupies a small volume in handsets case and its height from substrate is 7 mm. The antenna is fed by a 50Ω coaxial cable. As shown in Fig. 1 (b), part A is ground line and part B is signal line with feeding point. Part C, D, and E are radiating blanches to resonate the desired frequency band. The geometrical parameters of the length and width of metallic lines are optimized in an attempt to achieve design goals at 2.5 GHz band. The length and width of part C and D are 12 mm and 1.5 mm, respectively. The length and width of part E are 7 mm and 2 mm. In order to achieve 2.5 GHz band resonant mode, the branch starting from feeding point (part B) to the end of points (part C, D, and E) is chosen to be 30 mm, which approximately corresponds to an electrical quarter-wave length at the operating frequency. By placing three similar branches of part C, D, and E from the feed point, the broad bandwidth and high radiation efficiency can be achieved for making other traveling current paths. The antenna is placed on the supporter whose height is 7 mm and relative permittivity is 2.8. And commercial handset case and battery are considered to compare with real situations. The permittivity and conductivity of handset case are 2.8. And, the permittivity and conductivity of battery are 3.0 and 0.5, respectively. In order to find the optimized antenna characteristics, Ansoft HFSS is used to tuning the each associated parameters of antenna structure. Fabrication and measured results were compared with the simulation ones.

Results

Computed and measured return losses data versus frequency are compared in Fig. 2 (a). Also, comparison of return loss considered handset case is shown in the Fig. 2 (b). The experimental results have a good agreement with simulated results. There is 120MHz shift into lower frequency when the proposed antenna is considered with handset case. In order to check the operating mechanism of the proposed antenna, Fig. 3 shows the surface current distributions at the operating frequency. Basically, the radiating mechanism is similar to those of dipole antenna. Through the modification of dipole antenna branch like a part C, D, and E, this proposed antenna can achieve a broad bandwidth. And the resonance frequency can be obtained by controlling these branches. In Fig. 3, the dominant current distribution is occurred at the part C, D, and E which have approximately electrical quarter-wave length about 30 mm. And the induced current is also observed at the part A, as indicated by the arrows in Fig. 3. The simulated and measured radiation patterns for designed antenna under both antenna and handset case are plotted in Fig. 4, 5, 6, and 7. The simulated and measured results agree well with each other. The maximum radiation gain without considering the handset case is 2.79 dBi and 2.74 dBi at 2.44 GHz and 2.6 GHz, respectively.

Conclusion

A novel internal antenna of PIFA type suitable for Bluetooth and DMB bands has been proposed. In addition, this proposed antenna is applied to the commercial handset case. This antenna has a compact size, high radiation gain, and ease to mass production due to metallic plate type. Moreover, DMB service, which provides high quality and various broadcasting channel services by satellites, is commercialized in 2005. It is expected that the DMB service market is going to be dramatically expanded to a couple of times in a few years. So, this antenna can be very attractive for next generation mobile handsets.

Acknowledgement

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References

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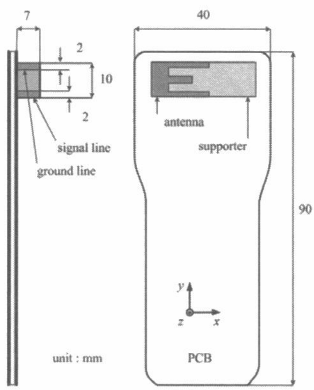
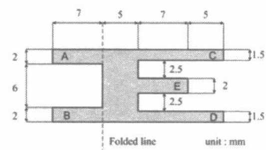
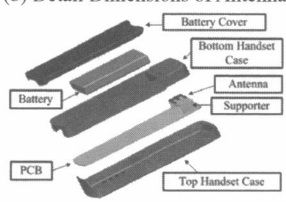


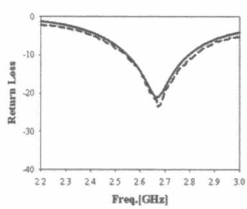


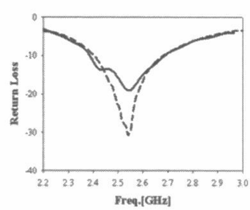
(b) Detail Dimensions of Antenna



(a) The Side and Top Views of Antenna (c) Antenna and Handset Case

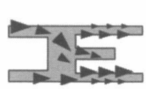
Figure 1. The Overview of Proposed Antenna





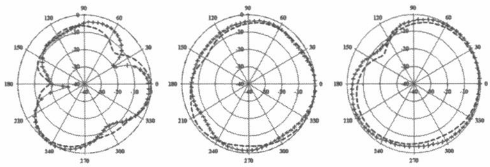
(a) Proposed Antenna (b) Proposed Antenna with Handset Case

Figure 2. Return Loss (——— simulation - - - - - Measurement)



(a) At 2.44 GHz (b) At 2.6GHz

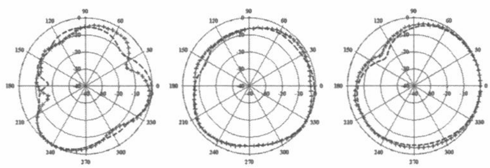
Figure 3. Current Distribution



(a) xy plane(E_φ) (b) yz plane(E_φ) (c) zx plane(E_θ)

Figure 4. Radiation Patterns at 2.44 GHz

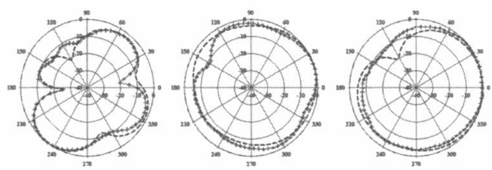
(- - - - Simulation + + + + Measurement)



(a) xy plane(E_φ) (b) yz plane(E_φ) (c) zx plane(E_θ)

Figure 5. Radiation Patterns at 2.6 GHz

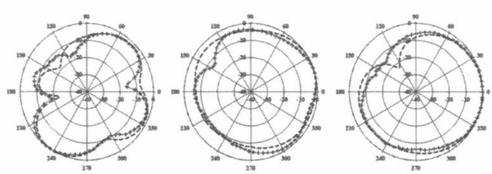
(- - - - Simulation + + + + Measurement)



(a) xy plane(E_φ) (b) yz plane(E_φ) (c) zx plane(E_θ)

Figure 6. Radiation Patterns at 2.44 GHz with Handset Case including Battery

(- - - - Simulation + + + + Measurement)



(a) xy plane(E_φ) (b) yz plane(E_φ) (c) zx plane(E_θ)

Figure 7. Radiation Patterns at 2.6 GHz with Handset Case including Battery

(- - - - Simulation + + + + Measurement)