Planar Small-size Octa-Band LTE/WWAN Internal Mobile Phone Antenna

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***Abstract* - This study proposes a small-size printed antenna with multi-band WWAN/LTE operation in a mobile phone by introducing dual parasitic shorted strips and a C-shaped ground plane. The obtained impedance bandwidths across LTE and WWAN operating bands approach 263 MHz and 1093 MHz, respectively. The proposed printed monopole antenna reduces the antenna size by at least 22 % since the overall antenna size is only 35 × 10 × 0.8 mm^3. The measured peak gains and antenna efficiencies are approximately 2 / 3.6 dBi and 80 / 75 % for the LTE/WWAN bands, respectively.**

***Index Terms* —Monopole antenna, long-term evolution (LTE), wireless wide area network (WWAN).**

I. INTRODUCTION

Recently, due to significantly higher data rate than that of 3G wireless wide area network (WWAN) operations, the long term evolution (LTE) system [1] has received much attention for use in 4G wireless wide area network (WWAN) systems in mobile devices. Meanwhile, to fulfill the bandwidth specifications of the 4G system and ensure the ability to embed into a limited space, multi-band antennas appear to be the optimal candidate for providing commercial broadband coverage in the 698 – 960 / 1710 – 2690 MHz bands for LTE / WWAN mobile systems. Several planar internal mobile phone antennas (MAs) have been presented for LTE/WWAN operation [2-14], however, with a greater planar dimension. Meanwhile, slim profile has become a trend for the handsets by accommodating the battery to decrease the total required thickness of the hanset. Thus, this article proposes dual shorted strips to generate dual 0.25-wavelength resonant modes at approximately 798/940 MHz bands to cover the LTE700/GSM850/900 operating bandwidth. Next, an F-shaped driven monopole strip is devised to excite a resonant mode in the upper (1710 – 2690 MHz) band of the desired antenna with a C-shaped ground plane [15] introduced to enhance the operating bandwidth of an antenna disposed on the shaped system circuit board. As for the overall antenna volume, the proposed monopole antenna with a small size of 35 × 10 × 0.8 mm^3 (280 mm^3) has an antenna size at least 22 % less than that of the smallest internal mobile phone antenna with a dimension of 30 × 15 × 0.8 mm^3 [6] for the LTE/WWAN operations. Therefore, the proposed design is more feasible for embedding into a mobile phone.

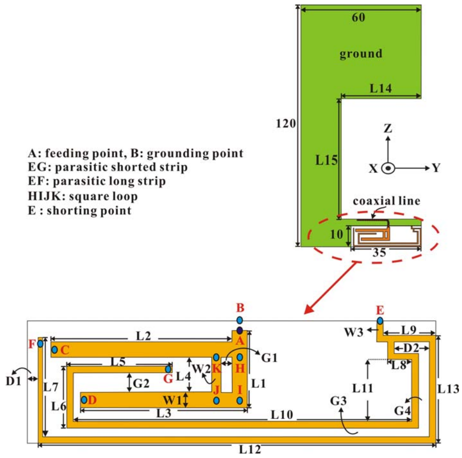


Fig. 1. Geometry of the proposed compact multi-band monopole antenna with the F-shaped driven monopole strip for a mobile phone.

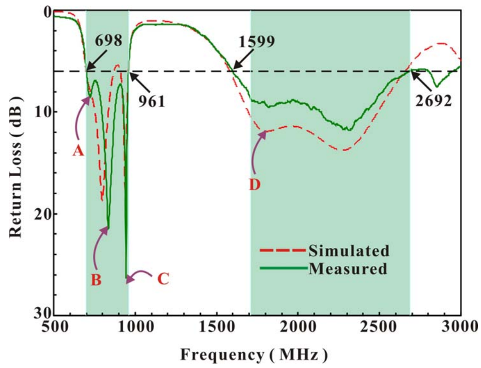
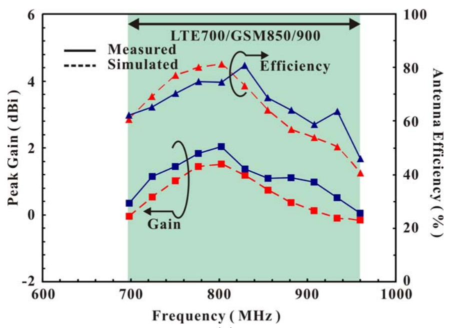


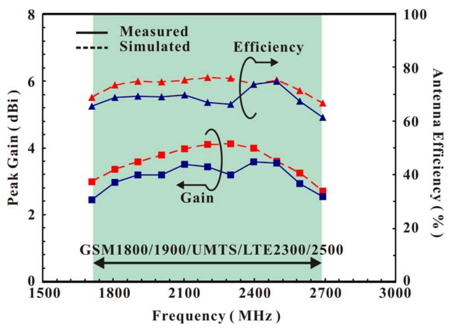
Fig. 2. Simulated and measured results against frequency for the proposed compact MA.

II. ANTENNA DESIGN AND EXPERIMENTAL RESULTS

Fig. 1 shows the geometrical configuration of the proposed small-size monopole antenna. To make it more promising for practical slim handset application, a battery is embedded into the rectangular notch with the size of 40 × 60 mm^2 While printed on the same side of an FR4 substrate with the dimension of 35 × 10× 0.8 mm^3, the antenna is mounted along the bottom-right edge of the C-shaped system ground with the dimension of 120 × 60× 0.8 mm^3. The proposed antenna consists of an F-shaped driven monopole and dual monopole strips shorted at point E. First, the surface current distribution from the shorted point E to the end edge along the square notch's edge of the C-shaped ground plane is excited at its mode at 722 / 1810 MHz (mode A and D in Fig. 2) with a 0.5 / 1.0 wavelength surface current distribution, respectively. Then, the lower meandered arm (section EF) of the dual shorted strips contributes to its quarter-wavelength resonant mode (mode B) at around 798 MHz band. Moreover, to enhance the impedance bandwidth of the lower band, the upper meandered arm (section EG) is utilized to generate 940 MHz band (mode C). Additionally, based on the above guidelines, the proposed MA is optimized by using Ansoft HFSS, a commercially available software package based on the finite element method [16]. Fig. 2 summarizes the simulation and experimental results for return loss in the proposed monopole antenna. The lower and higher band reveal a measured 3:1 VSWR (6-dB return loss) bandwidth of 263 MHz (698 – 961 MHz) and 1093 MHz (1599 – 2692 MHz), respectively. Dual wide bands can comply with the bandwidth requirements of the desired eight-band LTE/WWAN (LTE700/GSM850/900/GSM1800/1900/ UMTS /LTE2300/2500) operations. Fig. 3 presents the measured antenna gain and efficiency for the proposed compact multiband antenna. The simulation results are summarized in this figure for comparison with the measured ones. For frequencies over the lower band, the measured antenna gain and efficiency are approximately 0.1 ~ 2 dBi and 46 ~ 80 %, respectively. Meanwhile, the gain for the higher band ranges from approximately 2.4 to 3.6 dBi, while the antenna efficiency is approximately 61 ~ 75 %.



(a)



(b)

Fig. 3. Measured and simulated antenna gain and efficiency for the proposed compact printed MA studied in Fig. 2.

III. Conclusions

This work proposes a F-shaped driven monopole antenna with dual monopole strips shorted in a C-shaped system ground to achieve a small-size eight-band LTE/WWAN internal mobile phone antenna. The impedance bandwidth across LTE and WWAN bands can approach approximately 263 MHz and 1093 MHz, respectively. The measured peak gains and antenna efficiencies are approximately 2 / 3.6 dBi and 80 / 75 % for the LTE/WWAN bands, respectively. The proposed small-size printed monopole antenna reduces the antenna size by at least 22% since the overall antenna size is only $35 \times 10 \times 0.8$ mm^3.

Acknowledgment

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