Small-size Dual-Antenna with π-Shape Grounded Strip for LTE Tablet Device

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***Abstract* - A small-size dual-antenna for the LTE operation in its high band of 1710~2690 MHz is presented for the LTE tablet computer application. The dual-antenna occupies a small volume of 10 × 45 × 0.8 mm^3. The dual-antenna provides acceptable isolation better than about 10 dB and good antenna efficiency better than about 55% over a wide operating band of larger than 1 GHz. This leads to acceptable envelope correlation coefficient (less than 0.3 for the proposed dual-antenna) obtained for the LTE high-band operation. Results of the fabricated dual-antenna are presented, and the MIMO performance of the dual-antenna is discussed.**

***Index Terms* — Mobile antennas, dual-antennas, tablet computer antennas, LTE antennas**

I. Introduction

The LTE operation generally includes the low band of 698~960 MHz and the high band of 1710~2690 MHz. The dual-antenna with a small size is demanded for practical applications. It is noted that the wideband dual-antennas that have been reported [1] show a high profile, which limits its possible applications. The spacing or ground clearance region allowed for the embedded antennas therein is becoming very narrow, which is generally 10 mm or even smaller. It is also demanded that the antenna's occupied ground clearance be as small as possible, such that more antennas or dual-antennas can be embedded inside the mobile terminal device.

To meet such application requirements, the proposed dual-antenna occupies a small ground clearance of 10 × 45 mm^2. The dual-antenna comprises two back-to-back folded loops separated by a π-shape grounded strip. For each antenna, the wideband operation is obtained by two resonant modes excited respectively by the folded loop and one arm of the π-shape grounded strip. Also, the other arm of the π-shape grounded strips can provide a resonant path to direct the surface currents excited on the device ground plane. This decreases the coupling between the two feeding ports of the dual-antenna, making it acceptable for MIMO applications. The MIMO performance of the dual-antenna is also discussed in this study.

II. Proposed Antenna

Fig. 1 shows the geometry of the proposed dual-antenna. The dual-antenna is printed on a 0.8-mm thick FR4 substrate of size 10 × 45 mm^2, relative permittivity 4.4, and loss tangent 0.024. The device ground plane has a size of 200 × 150 mm^2. The device ground plane size is selected to fit for a 9.7-inch tablet computer.

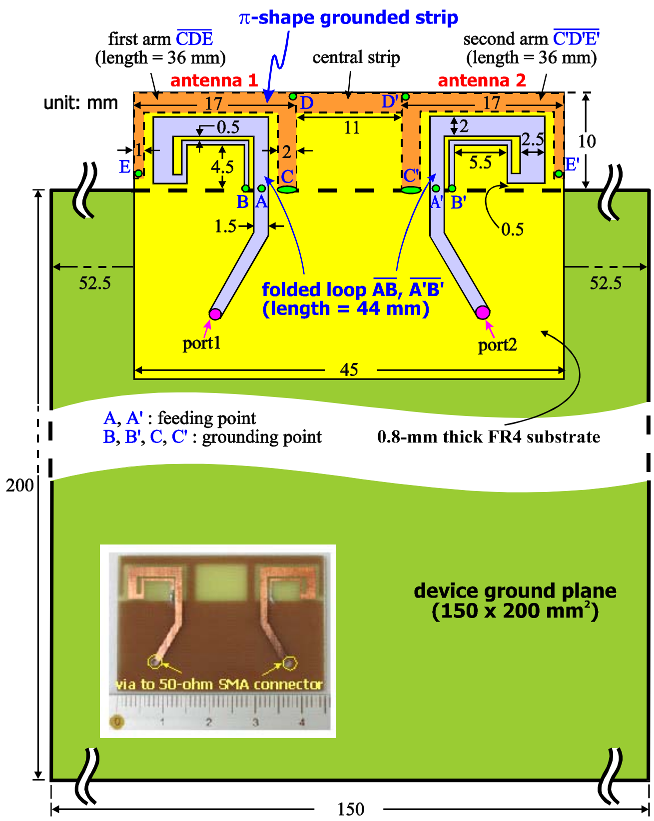

Fig. 1. Geometry of the proposed dual-antenna.

The two antennas (antenna 1 and 2) in the proposed dual-antenna are symmetric in structure and have same dimensions. Antenna 1 and 2 are fed through port 1 and 2, respectively. The dual-antenna is formed by two back-to-back folded loops (loop 1 and 2) and a π-shape grounded strip placed in-between. The grounded strip has a first arm (section CDE, length 36 mm), a second arm (section C'D'E, length 36 mm), and a central metal strip (section DD', length 11 mm). Antenna 1 can be considered to comprise loop 1 and the first arm, while antenna 2 includes loop 2 and the second arm. Both loop 1 and 2 have a length of about 44 mm and are directly excited to generate a half-wavelength loop mode at about 2.6 GHz. Since the loop antenna has a closed resonant path, the electric field of the loop resonant mode thereof will be weak. This property can help decrease the coupling between port 1 and 2 in the dual-antenna.

III. EXPERIMENT RESULTS

Fig. 2 shows the measured and simulated *S* parameters of the fabricated dual-antenna. Good agreement between the measurement and simulation is obtained. Fig. 3 shows the measured and simulated antenna efficiencies of the fabricated dual-antenna. The measured antenna efficiencies for the fabricated dual-antenna are varied from about 52% to 84% for frequencies over the LTE high band. The obtained antenna efficiencies are acceptable for practical mobile communication applications [2]-[4].

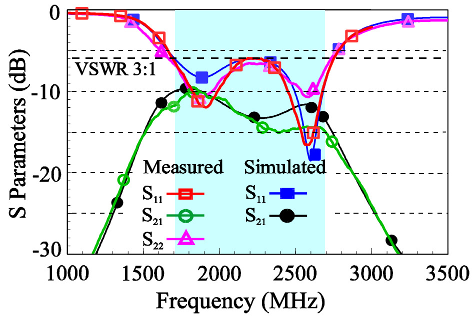

Fig. 2. Measured and simulated *S* parameters.

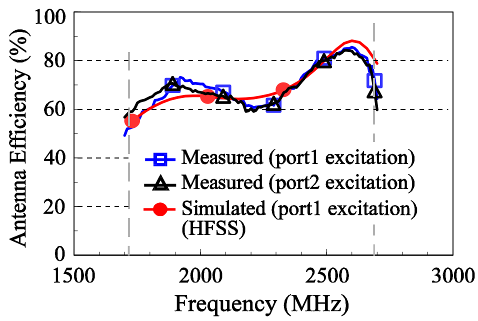

Fig. 3. Measured and simulated antenna efficiencies.

IV. MIMO PERFORMANCE

Fig. 4 shows the simulated envelope correlation coefficient (ECC) obtained using HFSS version 15 and the calculated ECC from the measured electric-field patterns of the fabricated dual-antenna. Results indicate that the ECC is less than 0.3 over the entire LTE high band.

Fig. 5 shows the ergodic channel capacities of the fabricated dual-antenna. The condition of uncorrelated transmitting antennas and i.i.d. (identically and independently distributed) channels with Rayleigh fading environment is assumed. At each frequency, the capacity is averaged over 10,000 Rayleigh fading realizations with a signal-to-noise ratio of 20 dB at the mobile terminal. The obtained capacities are varied from 9.3 to 11.0 bps/Hz, close to that of the perfect (efficiency = 100%, ECC = 0) dual-antenna.

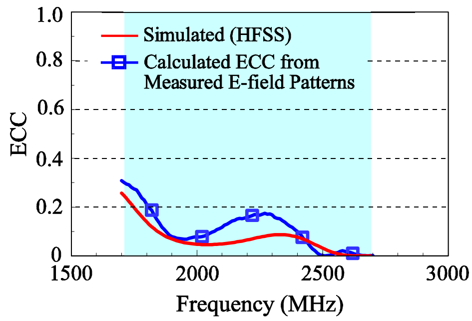

Fig. 4. Comparison of simulated ECC and calculated ECC from the measured E-field patterns.

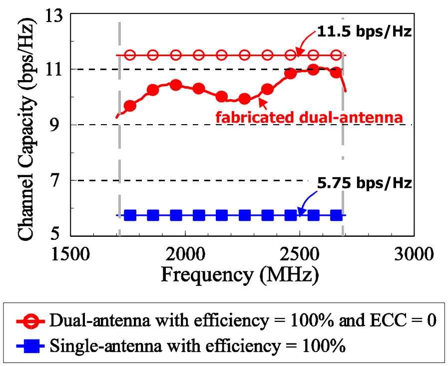

Fig. 5. Ergodic channel capacities of the fabricated dual-antenna.

V. CONCLUSION

A small dual-antenna with a π-shape grounded strip for LTE tablet computer application has been proposed. For decreased coupling, it is because the π-shape grounded strip can effectively detour the surface currents excited on the device ground plane. This leads to acceptable isolation obtained for the dual-antenna, although the two antennas thereof are very closely spaced. The ECC is less than 0.3 over the LTE high band, while the calculated ergodic channel capacities are about 9.3~11.0 bps/Hz, much larger than that of single-antenna and close to that of a perfect dual-antenna. The proposed dual-antenna is promising for the tablet computer application in the LTE high band.

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