

# Dual-Wideband Combined-Type Antenna for LTE Tablet Device

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**Abstract** - A dual-wideband combined-type antenna with its lower wideband and higher wideband respectively contributed by two separate radiating portions thereof is presented. The two separate radiating portions (one low-band antenna and one high-band antenna) are easily combined into a compact structure for the LTE operation in the 698~960 and 1710~2690 MHz bands. In addition, the proposed antenna requires a very small ground clearance of  $10 \times 30 \text{ mm}^2$ . By further using a simple matching circuit disposed on the device ground plane, the antenna's low-band and high-band bandwidths can be greatly enhanced. Details of the proposed antenna are presented.

**Index Terms** — Mobile antennas, combined-type antennas, inverted-F antennas, small antennas, dual-wideband antennas.

## I. INTRODUCTION

For recent applications to cover the LTE operation in the 698~960 and 1710~2690 MHz bands, many promising internal antennas related to the inverted-F antenna structure have been reported [1], [2]. It is noted that some resonant modes in the higher band may also share the same resonant path with the resonant mode in the lower band (698~960 MHz). This will cause inconvenience in fine-adjusting the desired lower and higher bands for practical applications.

Hence, it motivates the present study of using a combined-type antenna design to achieve the dual-wideband operation for the internal LTE tablet device antenna. In the proposed antenna, the low-band and high-band radiating portions thereof are less correlated, and the low-band and high-band operations can generally be independently controlled by the low-band and high-band radiating portions. Furthermore, the two radiating portions can be combined into a compact structure, which makes it attractive for practical mobile device applications.

## II. PROPOSED ANTENNA

Fig. 1 shows the geometry of the proposed antenna. A photo of the fabricated antenna in this study is shown in Fig. 2, wherein the fabricated antenna mounted along the top edge of the device ground plane of size  $150 \times 200 \text{ mm}^2$  for the experimental study is also shown.

The antenna can be decomposed into a low-band antenna and a high-band antenna as shown in Fig. 3. The low-band and high-band antennas are denoted as Ant1 and Ant2 in the figure, and their equivalent circuits are also shown. The low-

band antenna is mainly an inverted-F antenna. The main radiating arm of the inverted-F antenna is the bent metal plate, which is connected to the feeding strip (section AB) through a chip inductor ( $L_1$ ) of 12 nH. The inductor  $L_1$  can lead to a decreased resonant length of the low-band antenna to generate a resonant mode at about 900 MHz [3]. The chip inductor ( $L_2$ ) of 10 nH embedded in the shorting strip and the chip capacitor ( $C_1$ ) of 2 pF in the matching circuit are formed as a high-pass matching circuit to greatly enhance the low-band bandwidth to cover the 698~960 MHz band.

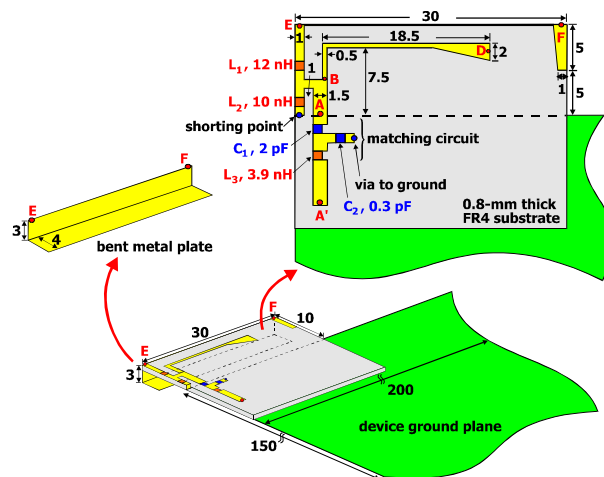
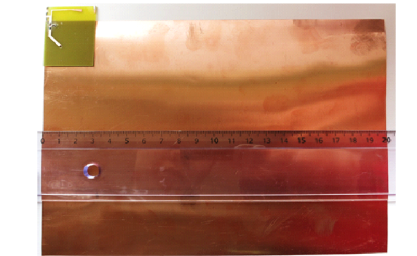
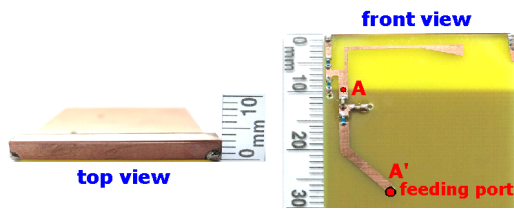


Fig. 1. Geometry of the proposed dual-wideband combined-type antenna.

In the higher band, the inductors  $L_1$  and  $L_2$  will provide high inductance to behave like an open circuit. In this case, the bent metal plate and the shorting strip can have very small effects on the high-band operation. In addition, the high-pass matching circuit ( $L_2$  and  $C_1$ ) will also show small effects at high-band frequencies. Hence, in the higher band, the antenna can be considered as the high-band antenna shown in Fig. 3. The high-band antenna is a simple monopole antenna with a radiating strip (section AD) and a low-pass matching circuit formed by a parallel capacitor ( $C_2$ ) and a series inductor ( $L_3$ ). Tuning the length of section AD can adjust the excited resonant mode in the higher band, while the low-pass matching circuit results in an additional resonance occurred near the excited resonant mode so as to greatly enhance the high-band bandwidth to cover the 1710~2690 MHz band.



antenna with the device ground plane

Fig. 2. Photos of the fabricated antenna.

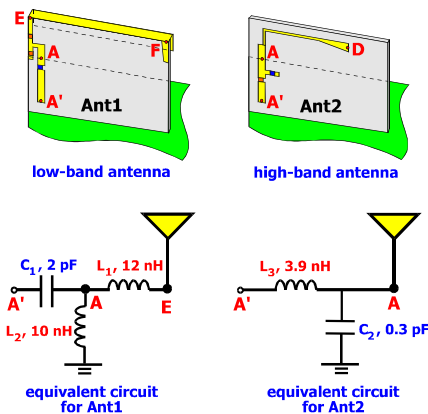


Fig. 3. Structures of Ant1 (the low-band antenna) and Ant2 (the high-band antenna) and their equivalent circuits.

### III. EXPERIMENTAL RESULTS

The measured and simulated return losses of the fabricated antenna are presented in Fig. 4. Agreement between the measured data and simulated results is seen. The measured and simulated antenna efficiencies of the fabricated antenna are shown in Fig. 5. The measured antenna efficiency is respectively about 50~62% and 66~90% in the lower and higher bands, which are acceptable for practical mobile communication applications [4].

### IV. CONCLUSION

A dual-wideband combined-type antenna suitable for LTE tablet device applications has been proposed. The antenna comprises two separate radiation portions and matching circuits and can be decomposed into a low-band antenna (an

inverted-F antenna) and a high-band antenna (a monopole antenna) with small correlation. Good radiation performance for frequencies over the two wide operating bands has also been obtained. The proposed antenna provides a new antenna design concept with compact size and easy tuning for achieving two wide operating bands for the LTE operation.

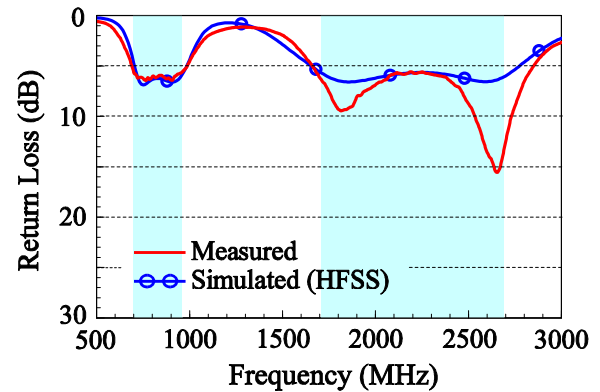


Fig. 4. Measured and simulated return losses.

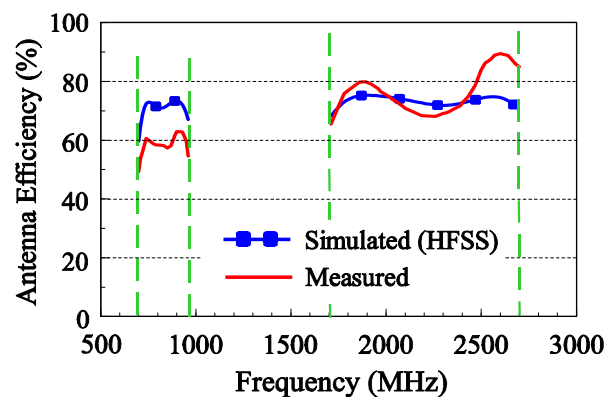


Fig. 5. Measured and simulated antenna efficiencies.

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