Very-Low-Profile Dual-Wideband Tablet Computer Antenna for LTE Operation

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***Abstract* - A very-low-profile (8 mm in height), small-size (8 × 3 × 40 mm^3), and dual-wideband loop antenna suitable for applications in the LTE tablet computer is presented. Dual-wideband operation is achieved using a wideband feed structure formed by a coupling feed, a high-pass matching circuit, and a tuning inductor. The coupling feed leads to successful excitation of a quarter-wavelength loop mode in the desired lower band. The high-pass matching circuit widens the low-band bandwidth to cover the 698~960 MHz band. The tuning inductor can adjust the frequency ratio of the first two higher-order loop modes to form a wide higher band to cover the 1710~2690 MHz band. Details of the proposed antenna are presented.**

***Index Terms* — Mobile antennas, tablet computer antennas, LTE antennas, very-low-profile antennas, loop antennas.**

I. INTRODUCTION

For the tablet computer to achieve the LTE operation, the embedded antenna with a very low profile (8 mm or less in height) is becoming very attractive and demanded for practical applications. Some interesting low-profile LTE tablet computer antennas have been recently reported to cover the 698~960 and 1710~2690 MHz bands [1-4], many of them requires a height of at least 10 mm or 15 mm above the top edge of the device ground plane.

In this paper, we present a promising dual-wideband loop antenna to achieve a very low profile of 8 mm and a small size of 8 × 3 × 40 mm^3. The antenna can cover the 698~960 and 1710~2690 MHz bands for the LTE operation. Details of the structure and working principle of the proposed antenna are addressed in this study. The antenna was also fabricated and tested. The experimental results are presented and discussed.

II. PROPOSED ANTENNA

Fig. 1 shows the geometry of the proposed very-low-profile dual-wideband loop antenna. Photos of the fabricated antenna are also shown in Fig. 2. The device ground plane size is 150 × 200 mm^2. The antenna is formed by a printed metal pattern and a bent metal plate. The printed metal pattern is disposed on a 0.8-mm thick FR4 substrate of relative permittivity 4.4 and loss tangent 0.024. The antenna occupies a volume of 8 × 3 × 40 mm^3 above the top edge of the device ground plane.

The antenna is mainly a loop antenna formed by a loop strip (section D′FGE) fed by a wideband feed structure. The loop strip has a length of about 80 mm, close to 0.25 wavelength at 900 MHz. The wideband feed structure includes a coupling feed, a high-pass matching circuit (chip capacitor C_1 = 2.4 pF, chip inductor L_2 = 11 nH), and a tuning inductor (chip inductor L_1 = 6.2 nH). The equivalent circuit model of the feed structure is shown in Fig. 3.

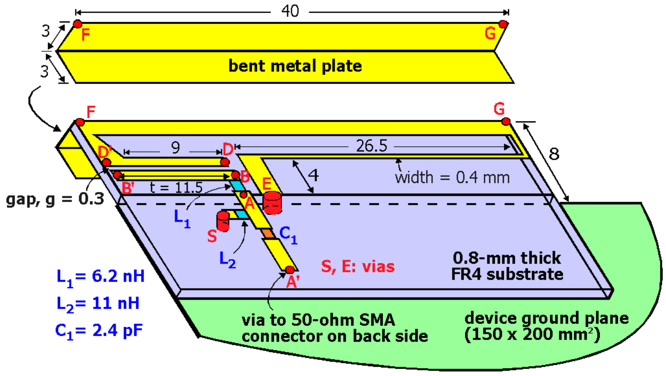


Fig. 1. Geometry of the very-low-profile dual-wideband loop antenna.

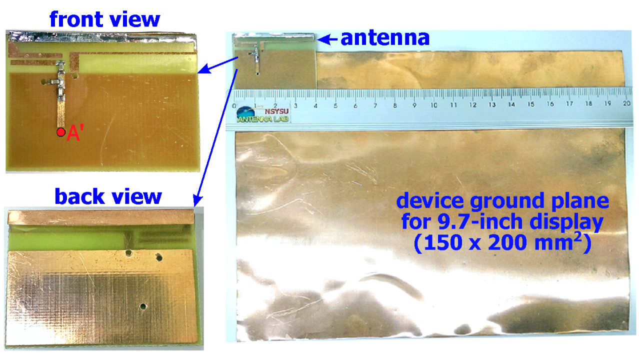


Fig. 2. Photos of the fabricated antenna.

Higher-order loop modes can also be generated for the proposed antenna. The tuning inductor L_1 can adjust the frequency ratio of the first two higher-order loop modes, such that a wide higher band can be obtained to cover the 1710~2690 MHz band. Hence, the proposed antenna can provide a dual-wideband operation to cover the LTE lower and higher bands of 698~960 and 1710~2690 MHz.

Fig. 4 shows the simulated return loss for the proposed antenna, the case without the tuning inductor L_1 and the high-pass matching circuit formed by L_2 and C_1 (denoted as Ant1), and the case without the high-pass matching circuit formed by L_2 and C_1 (denoted as Ant2). For Ant1, a resonant mode occurred at about 800 MHz is seen. In the desired higher band, a resonant mode is also occurred at about 2100 MHz, which is the antenna's first higher-order resonant mode.

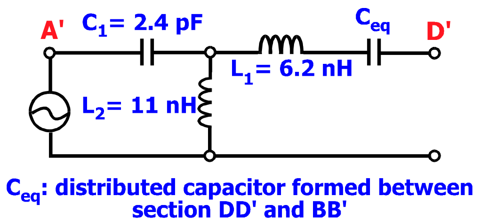


Fig. 3. Equivalent circuit model of the feed structure.

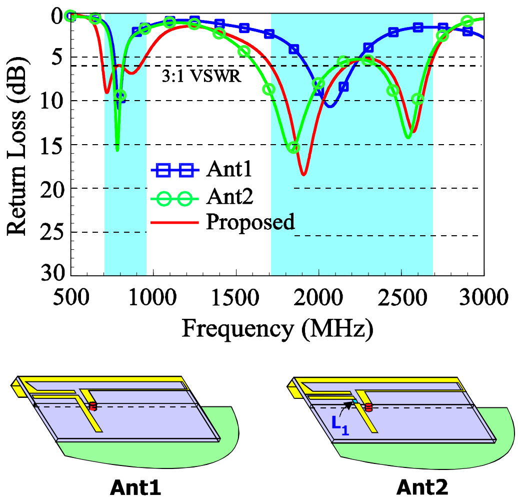
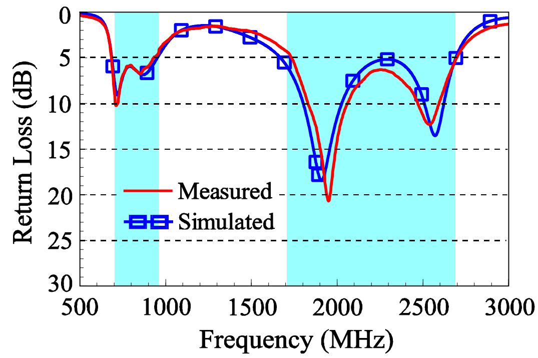


Fig. 4. Simulated return loss for the proposed antenna, Ant1 and Ant2.

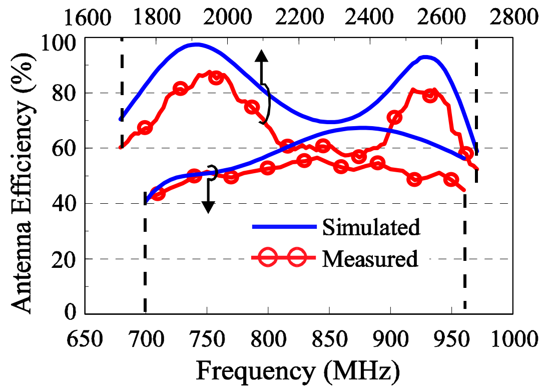
Simply by adding a tuning inductor L_1 of 6.2 nH to Ant1, a second higher-order resonant mode is shifted from higher frequencies to be at about 2600 MHz, while the first higher-order resonant mode is moved to be at about 1900 MHz. In this case, a wide higher band covering the LTE high band of 1710~2690 MHz is obtained. Then, by further adding a high-pass matching circuit to Ant2 (i.e., the proposed antenna), an additional resonance occurred in the desired lower band is obtained, which combines with the quarter-wavelength loop mode to form a wide lower band covering the LTE low band of 698~960 MHz.

III. Experimental Studies And Discussion

Fig. 5(a) shows the measured and simulated return losses of the fabricated antenna. Good agreement between the measurement and simulation is seen. The measured and simulated antenna efficiencies are shown in Fig. 5(b). The antenna was measured in a far-field anechoic chamber. The measured efficiencies are respectively about 40~56% and 56~88% in the lower and higher bands, which are acceptable for mobile communication applications.



(a)



(b)

Fig. 5. Measured and simulated (a) return losses and (b) antenna efficiencies for the proposed antenna.

IV. Conclusion

A very-low-profile loop antenna with a small size to provide dual-wideband operation for the LTE tablet computer has been proposed. The loop antenna occupies a volume of 8 × 3 × 40 mm^3 and uses a wideband feed structure to achieve the LTE dual-wideband operation. Working principle of the wideband feed structure has been addressed. The proposed antenna is promising for applications in modern slim tablet computers with a narrow spacing between the display panel and the device frame thereof.

References

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