Compact LTE/WWAN Antenna with Reduced Ground Effects for Tablet/Laptop Applications

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***Abstract* – A compact uniplanar antenna design for tablet/laptop applications is proposed. The main design principle of this antenna is the use of coupling-feed mechanism. The proposed antenna is composed of a T-shaped feeding strip, parasitic shorted strip, and a step tuning stub. With a small size of 50 mm × 15 mm × 0.8 mm, the proposed antenna is able to excite dual wideband operation that can cover the entire LTE/WWAN operations 698–960 MHz and 1710–2690 MHz. Furthermore, the proposed antenna also exhibits reduced ground effects, in which reducing the ground size of proposed antenna will not affect the antenna's performances.**

***Index Terms* — Uniplanar antenna, LTE/WWAN, T-shaped coupling feed, reduced ground effects.**

1. Introduction

Modern tablet/laptop design requires the features such as thin, light in weight and compact in size. Thus, their corresponding antenna designs must also be small enough to insert into the tablet/laptop devices, and at the same time be able to operate within the LTE/WWAN operation. Therefore, many related antenna designs were reported recently, and in the designs reported in [1-6], the technique of introducing coupling-feed mechanism into the antenna design is very popular, because it can aid in achieving wide bandwidths and at the same time reducing the antenna size. Notably, the antenna sizes of [1-6] are between 75 mm × 10 mm × 0.8 mm and 85 mm × 10 mm × 4 mm. Amid these reported ones, a unique method of using strip line as equivalent LC matching circuit is proposed, in which impedance matching can be achieved without the actual use of inductor and capacitor.

Besides [1, 2] that apply planar structure, the designs in [3-6] used folding structures that will increase the antenna's height (maximum 4 mm) and fabrication difficulty. Nevertheless, the above designs have never discussed their related ground plane effects on the antenna performances. In this paper, a dual wideband uniplanar antenna that has a small size of 50 mm × 15 mm × 0.8 mm is proposed. Besides showing good antenna efficiencies and gains, the performances of this proposed one will not be affected by changing the ground size.

2. Antenna Structure and Designs

The geometry of proposed antenna is shown in Fig. 1. The proposed antenna is composed of a T-shaped feeding strip, parasitic shorted strip, and a step tuning stub. It is mounted on a 200 mm × 150 mm system ground, fed by a 50 ohms mini coaxial cable. Here, the parasitic shorted strip and step tuning are for achieving good impedance matching across the LTE/WWAN bands. The effects of removing the step tuning stub and applying a horizontal tuning stub are compared with the proposed one that has a step tuning stub, as shown in Fig. 2. In this figure, it is obvious that the step tuning stub can aid in improving the impedance matching (> 6 dB return loss) at approximately between 2100 and 2400 MHz.

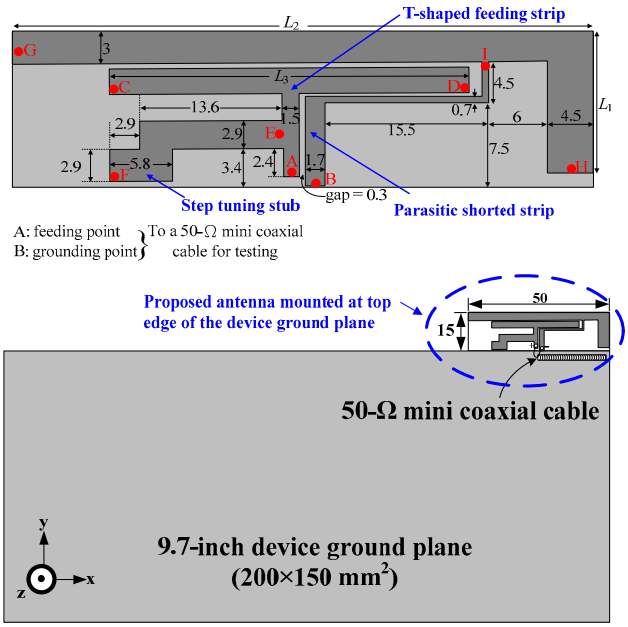

Fig. 1. Geometry of proposed antenna, $L_1 = 14.5$. $L_2 = 50$, $L_3 = 34$. Unit: mm.

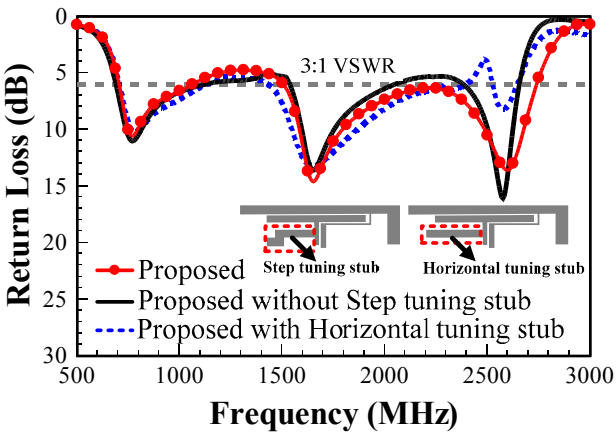

Fig. 2. The effects of applying different tuning stubs.

3. Results and Discussion

The simulated and measured return losses of proposed antenna are shown in Fig. 3. Five resonant modes are observed in this figure, in which the two lower ones (f_1 and f_2) forms the lower operating band f_L, and the three upper ones (f_3, f_4, and f_5) forms the higher operating band f_H. The measured f_L and f_H were 41.3% (698–1062 MHz) and 57.6% (1506–2725 MHz), respectively.

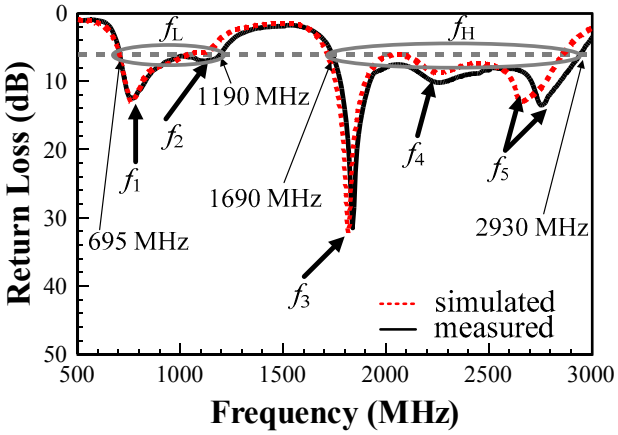

Fig. 3. Return losses of proposed antenna.

The current distribution diagrams of the proposed antenna at f_1 to f_5 are shown in Fig. 4. At each frequency, the distributions of the current are mainly trapped at around the main radiating element of the proposed antenna and the ground section that is in close proximity with it. By further observing Fig. 5, this reduced ground effects (less current distributions on ground plane) can aid in maintaining the impedance matching the proposed antenna, even though a change in system ground plane sizes between Case A (140 mm × 100mm) and Case B (260 mm × 200 mm) are applied. Therefore, the proposed antenna is a versatile type that can be fitted into any tablet/laptop device that has a small ground size. The measured antenna gain of f_L and f_H were 1.13–3.45 dBi and 2.56 – 3.46 dBi, and their corresponding radiation efficiencies were 60.8–88.2% and 64.3 – 91.1%. For brevity, their diagrams are not shown in here.

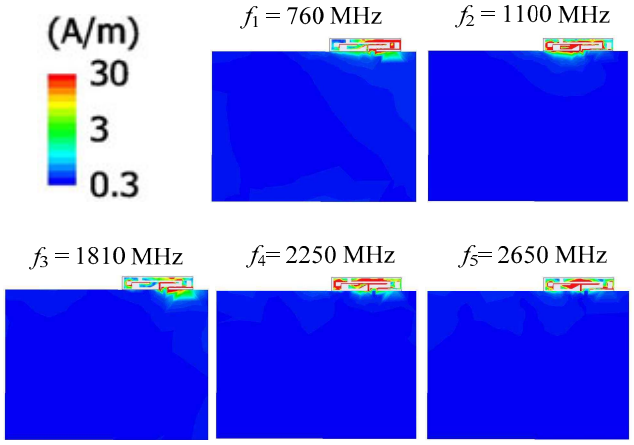

Fig. 4. Current distribution of proposed antenna at f_1 to f_5.

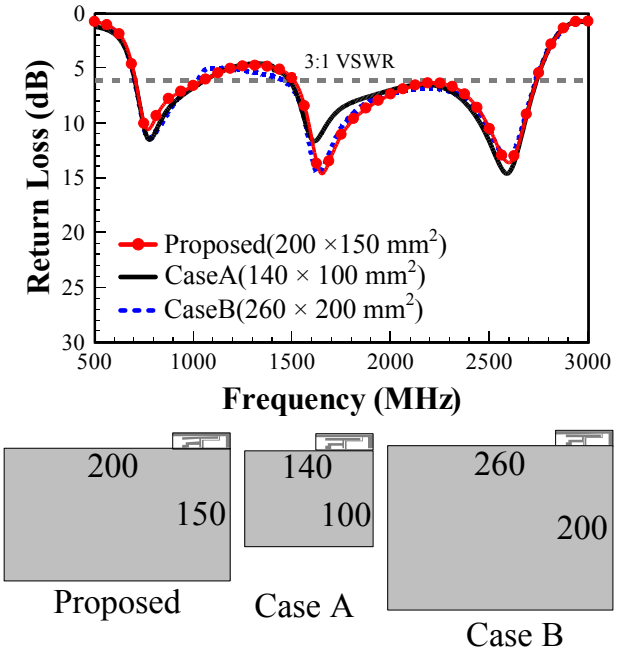

Fig. 5. The effects of changing the system ground size.

4. Conclusion

A compact size dual wideband antenna that can exhibit good impedance bandwidths of 41.3% and 57.6% in the lower and higher bands is successfully discussed. The proposed antenna has desirable gain and radiation efficiencies. Because the proposed antenna also exhibits reduced ground effects, therefore, it is good for any tablet/laptop with different ground size.

Acknowledgment

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