Design of a Compact LTE MIMO Antenna for Laptop Comupters

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***Abstract*—A design of compact multiple-input-multiple-output (MIMO) antennas, which consists of two identical monopole antennas in the LTE700 (0.698 – 0.787 GHz), LTE2300 (2.305 – 2.4 GHz) and LTE2500 (2.5–2.69 GHz) bands, is proposed and designed for laptop computers. The two antenna elements are located on the two sides of an FR4 substrate with a size of 70 × 8 × 0.8 mm³. A simple technique is used for achieving both compact size and high isolation. S21 of the design are all below -15dB within the operating bands.**

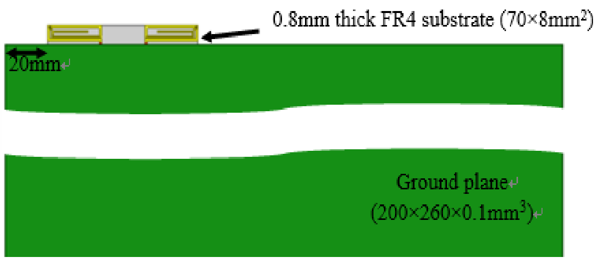
Keywords—MIMO; LTE; laptop antenna; isolation

I. INTRODUCTION

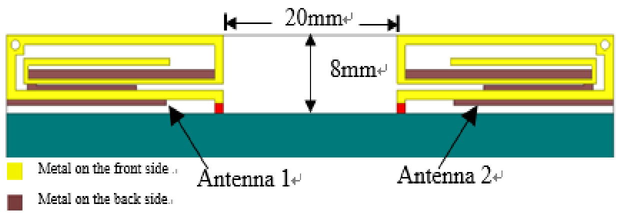
In recent years, the communication technology is grown rapidly, and many antenna designs for wireless portable devises have been proposed. The consumer market needs a portable with light, thin and small, which means there is limited space for antennas to create a huge of challenge for antenna designer. For laptop computers, in order to reduce the volume of the antenna, some methods are also proposed and listed in the references. The design used the parasitic branches on the back of the substrate to affect the characteristics of the resonant mode [1]. A compact antenna design with a cavity-backed slot structure reduced the dimension of the antenna [2]. The antenna used two sides of the substrate and the strip on the front side connected to the strip on the back side of the substrate by some via holes [3]. And, some antennas are designed on the communication bands include dual-band (2.4/5.2 GHz) WLAN [4-5] and LTE [6] bands. However, a single antenna cannot satisfy consumer market's demand. LTE integrated with MIMO technology is able to provide high-speed data transmission and high channel capacity. For MIMO antenna, the isolation between antennas is important. Nowadays, most of the MIMO antennas for laptop use decoupling structure to achieve better isolation performances. There are many techniques [7-13] have been published to deal with the coupling problem in MIMO antennas. Some designs use a wide distance to separate two antennas, and some designs use polarization diversity [7-10], some papers restrain surface currents by using meander slot [8-12] between two antennas. A design adopts a neutralization line between two antennas [10] to achieve the design goal. In this paper, we propose a different technique by using two sides FR4 substrate to obtain compact size and enhanced isolation, and without any decoupling structure. The proposed antenna covers LTE700/2300/2500 bands. The overall S21 is below -15dB. Detailed parameters and performances of the proposed LTE MIMO antenna are described and discussed in the paper.

II. ATENNA DESIGN

The proposed design of LTE MIMO antennas is printed on an FR4 substrate, which has a thickness of 0.8 mm, a relative permittivity of 4.4, and a loss tangent of 0.0245. The antenna's geometry is shown in Fig. 1. The detail antenna dimensions are also listed as Table 1. The overall antenna dimensions are 70 × 8 × 0.8mm³ and the size of each LTE antenna is 25 × 8 × 0.8mm³. There is a 20 mm gap between two LTE antennas. For effectively using the limited space, the antenna uses the two sides of metal printed on the FR4 substrate to reduce the antenna size as Fig. 1(b)-(d). In addition, S21 of the design is lower than -15dB without any decoupling structure. The metal arms on two side of the FR4 substrate of the each antenna are connected by via-hole from front to back (Q1 to O1 and Q2 to O2). The metal arm in the front side excites the mode of 0.7 GHz and the mode of 2.5 GHz. The metal arm on the back side excites the mode of 0.77GHz and the mode of the mode of 2.3 GHz. Therefore, the proposed antenna can cover the LTE three bands.



(a)



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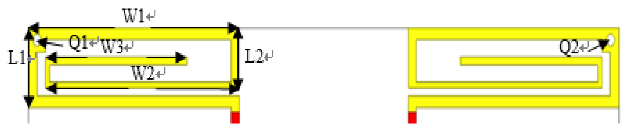

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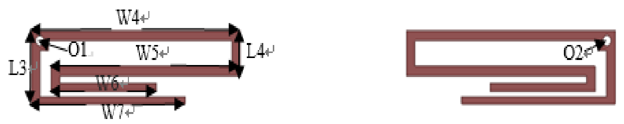


(d)

Fig. 1. Geometry of the proposed antenna: (a) overall view, (b) optimized view, (c) front view, (d) back view

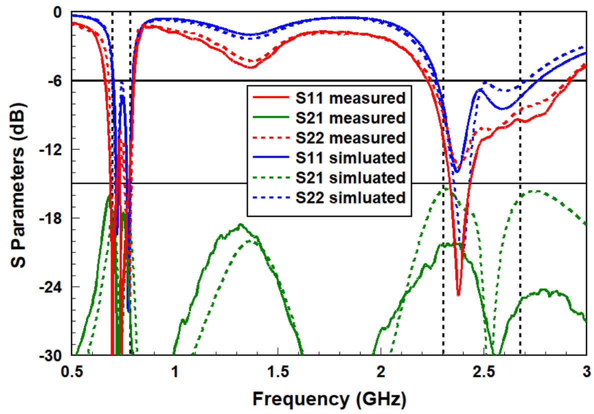


Fig. 2. Measured and simulated S parameters of the proposed antenna

TABLE I. DETAIL DIMENSIONS OF THE PROPOSED ANTENNA

Parameters	W1	W2	W3	W4	W5	W6
Unit (mm)	25	23	16.8	25	22.6	12.6
Parameters	W7	L1	L2	L3	L4	
Unit (mm)	18.4	6.6	5	7.2	4.5	

III. RESULTS AND DISCUSSION

Fig. 2 shows the simulated and measure S parameters of the proposed antenna. From the results, the both of measured and simulated S21 are below -15dB. All the excited modes are better than -6dB in LTE three bands. In Fig.3, the results show that the mode of 0.7 GHz and the mode of 2.5 GHz shift to higher frequency when the W3 length reduces. In Fig.4, the results show that the mode of 0.77 GHz and the mode of 2.3 GHz as well as the mode of 2.5 GHz shift to higher frequency when the W6 length reduces. In Fig.5, the results show that the mode of 2.3 GHz shifts to high frequency when the W7 length reduces. Fig. 6 (a) plots the simulated efficiency and gain at 0.69-0.78 GHz. It shows that the peak efficiency is 40% and the peak gain is 2.6dBi. Fig.6 (b) shows simulated efficiency gain in 2.3-2.69 GHz. It shows that the peak efficiency is 70% and peak gain is 2dBi. Fig. 7 shows the simulated 2-D radiation patterns at 0.7 GHz, 2.3 GHz, and 2.5 GHz are presented, respectively. All frequencies are near omni-directional in X-Z plane.

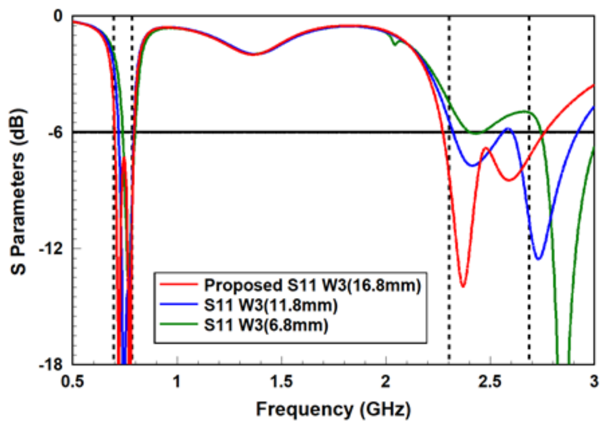


Fig. 3. The simulated S parameters with different lengths of W3

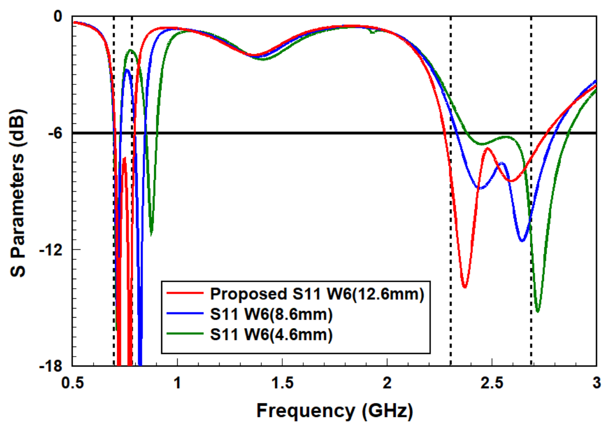


Fig. 4. The simulated S parameters with different lengths of W6

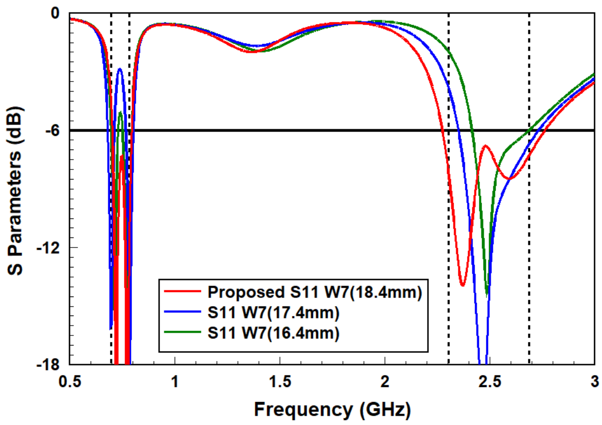
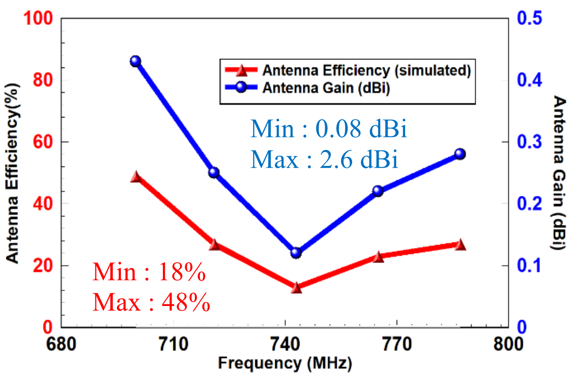
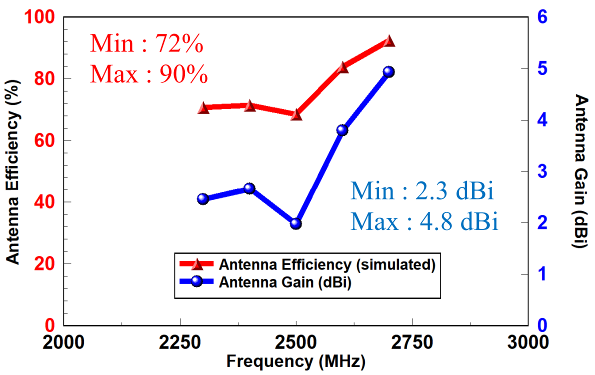


Fig. 5. The simulated S parameters with different lengths of W7



(a)



(b)

Fig. 6. The simulated efficiency and gain in (a) low frequency band and (b) high frequency band of the design

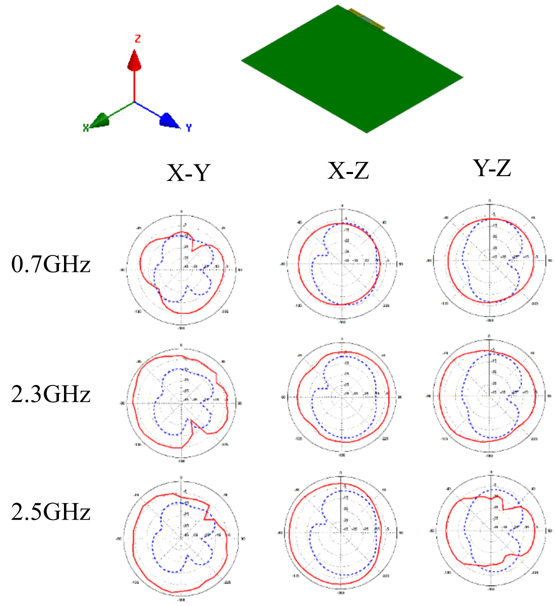


Fig. 7. Simulated 2-D radiation patterns

IV. CONCLUSION

The design of LTE700/2300/2500 MIMO antennas use a pair of compact monopole antenna printed two sides of the FR4 substrate. There is only 20mm gap between two LTE antennas and without any decoupling structure. The S21 of the design is below -15dB in LTE three bands. With the advantage of compact size, high isolation, MIMO configuration, and without decoupling structure, the proposed design is more suitable for MIMO antennas in laptop computers.

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