

MIMO dongle antennas for LTE700 applications

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Abstract – A design of compact MIMO antenna achieving the band of LTE 700 for fourth generation (4G) technology is proposed and studied. A very compact meandered monopole using the spaces on the front side and back side of the substrate is adopted for the design. The overall size of the design is $60 \times 35 \times 0.8 \text{ mm}^3$, and the antenna portion of the antenna is $20 \times 35 \times 0.8 \text{ mm}^3$, implemented on the FR4 substrate with a relative permittivity of 4.4. The antenna portion is composed of identical two compact meandered monopole antennas to achieve the design goal. The isolation element with M-shaped strip extended from the system ground plane and a small rectangular slot is placed between two antennas to eliminate the induced current between them. The isolation mechanism is produced good isolation. From the experimental results, the antenna achieves the isolation performance and the required bandwidth for LTE 700. Further discussion will be included in the paper.

Index Terms — MIMO Antennas, LTE700, USB Dongle, Isolation.

1. Introduction

Long Term Evolution (LTE) wireless communication system supports MIMO technology to enhance transmission speed. An important feature of LTE USB devices is small size, low cost and portable. In practice, LTE 700 band of 698-787 MHz is the important band for LTE systems. In the prior of literatures, several designs have been proposed for USB dongle. In [1], the MIMO antenna with a big metal ground strip to achieve the isolation effect. In [2], two monopole antennas use an out of the meandered path to obtain the good isolation for the design. In [3], the design uses two spiral antennas to achieve the operating band and two capacitors and an inductance to control isolation.

In this paper, a MIMO antenna design adopts a design of [4] with compact size. The design with introduction of an isolation mechanism reduces the influence of two antennas to get the good isolation. Further parameters discussion will be included in the following section.

2. Antenna Design And Result

The geometry of the proposed design is shown in Fig. 1. The proposed design is fabricated on FR4 substrate, which has a thickness of 0.8 mm, and a loss tangent of 0.024. The design with the overall dimensions of $60 \times 35 \text{ mm}^2$ ($L \times W$) contain an antenna portion of $20 \times 35 \text{ mm}^2$ and a ground plane of $40 \times 35 \text{ mm}^2$. The detail parameters and dimensions of the design are shown in Fig. 1 and also listed in Table I, respectively. Two 50-ohm mini-cables are applied to feed for RF signal input. The compact monopole antenna [4] consists

of the strips occupied on the two sides of the substrate to excite the band at LTE700. The isolation mechanism uses M-shaped strip extend from the ground plane and a small rectangular slot to achieve good isolation. The simulated and measured results are shown in Fig. 2. From the measured results, the S11, S22 are less than -6 dB and S12 and S21 less than -10 dB, which covering the band of LTE 700(698-787 MHz). The simulated results in the paper are performed by HFSS. Fig. 3 shows the S-parameters of the antenna with/without the isolation mechanism. The impedance matching over the operating band becomes good, but the S21 increases from -10 to -7 dB while the design without the isolation mechanism. Fig. 4 shows the Envelope Correlation Coefficient (ECC) calculated by the measured radiation patterns, and the value is less than 0.4, which is less than 0.5. For simulating the practical applications, the end of the antenna with a T-shaped structure to connect a 13 inches ground plane of $267 \times 205 \text{ mm}^2$ in Fig. 5. The simulated results of the design with a large ground plane are shown in Fig. 6. From the results, the bandwidth and isolation of the design become better than that of the design without connecting the large ground plane.

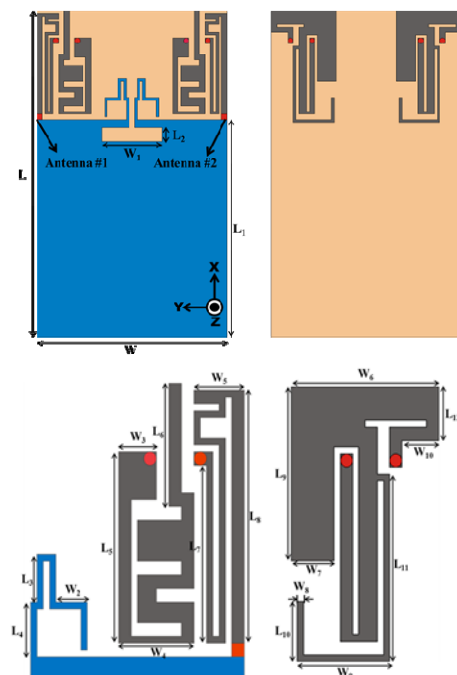


Fig. 1. Antenna geometry of the proposed design

TABLE I
Antenna structure parameter

Parameter	L	L ₁	L ₂	L ₃	L ₄	L ₅
(mm)	60	40	2.5	3.5	4	14
Parameter	L ₆	L ₇	L ₈	L ₉	L ₁₀	L ₁₁
(mm)	9	13	18.5	13	4.5	14
Parameter	L ₁₂	W	W ₁	W ₂	W ₃	W ₄
(mm)	4	35	11	2.5	3	6
Parameter	W ₅	W ₆	W ₇	W ₈	W ₉	W ₁₀
(mm)	4	12	3.5	0.5	7.5	3

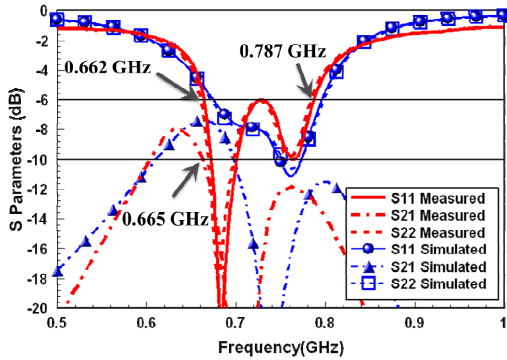


Fig. 2. Simulated and Measured S-parameters of the proposed design

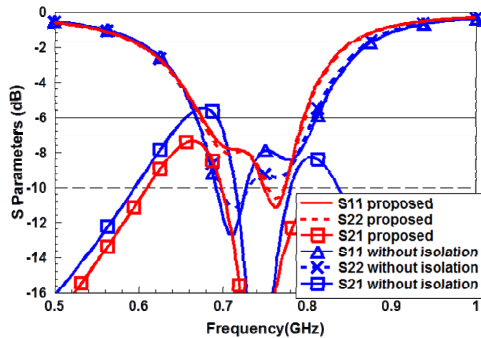


Fig. 3. Simulate S-parameters with/without isolation mechanism

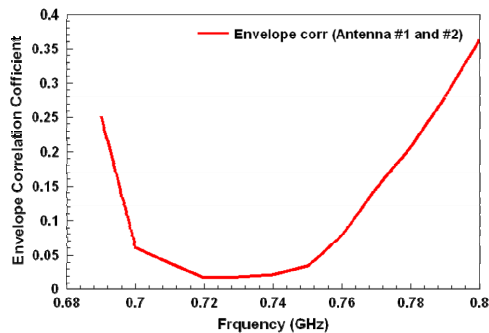


Fig. 4. Envelope Correlation Coefficient (ECC) of the proposed design

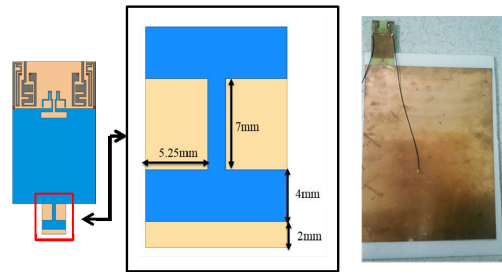


Fig. 5. Simulated and Measured of the Antenna geometry of the proposed design with USB connector (T-shaped structure) connecting 13 inch ground plane

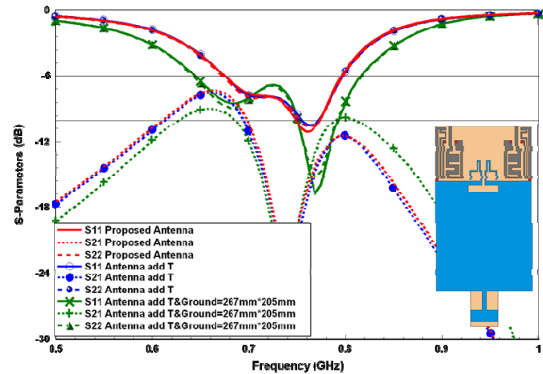


Fig. 6. Simulated S-parameters with T-shaped structure connecting a large ground plane

3. Conclusion

The design of LTE700 MIMO antennas in small size has been proposed and investigated. The design of MIMO antennas uses two meandered compact monopoles using two sides on the substrate to reduce the antenna size. The design using M-shaped strip and a small rectangle slot between two compact monopole antennas achieves the good isolation for LTE 700 band. From the simulated and measured S-parameter, the isolation achieves +10dB and impedance bandwidth defined as less than -6 dB covers the band of LTE 700. With the advantages of good performances, planar structure, and small size, the proposed design becomes highly competitive among the MIMO antennas in dongle devices.

References

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