The MIMO Antenna Design for a TD-LTE Mobile Phone

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***Abstract*: TD-LTE mobile communication systems use MIMO technology. In this paper, a mobile phone MIMO antenna design with two elements having high isolation is presented. The antenna can work in 2300/2500MHz frequency bands. The method of distance isolation is used to reduce the coupling between the two antenna elements. HFSS is used in the simulation analysis and optimization of the antenna. Test results show that antenna return loss, gain and isolation between the two elements meet the TD-LTE phone needs.**

Key words: TD-LTE; MIMO; mobile phone antenna; HFSS

Ⅰ.INTRODUCTION

TD-LTE uses MIMO technology to further improve the efficiency of using radio spectrum. MIMO technology can realize high-data-rate and large user capacity. In developing a TD-LTE mobile terminal, designing a MIMO antenna of high isolation is a key factor. This paper presents a TD-LTE dual band PIFA (planar inverted-F antenna) antenna covering 2300/2500MHz LTE bands. Generally, small separation distance between antenna elements increases the mutual coupling and reduces isolations between them. In this paper, the simple method of increasing the separation distance between antenna elements is used to provide high isolation. The whole size of the PIFA antenna designed is 18mm*9mm*4mm.

Ⅱ. ANTENNA CONFIGURATION

In this paper, the antenna is designed as dual-branch structure and each branch operates in different frequency bands. Figure 1 shows a single antenna element structure and measured dimensions. The single antenna element is made up of a radiating unit, a ground board, a short patch and a feed patch. The radiating unit consists of two G-branches, their lengths are about λ/4 respectively corresponding their required operating frequency bands. By changing the length of antenna branches and using the bending side of the structure, the operating frequency of the antenna can cover the two TD-LTE bands of 2300-2400MHz and 2570-2620MHz. The whole ground floor size of the mobile terminal is 60 * 110mm. Antenna height from the floor is 4mm. The feed port is marked with different color from the short patch. Upper part of the antenna in Figure 1 is designed for frequency band 2500MHz, and the lower is for 2300MHz. In the figure, the gray area is a folding part perpendicular to the antenna floor, which is designed to increase the effective area of the antenna.

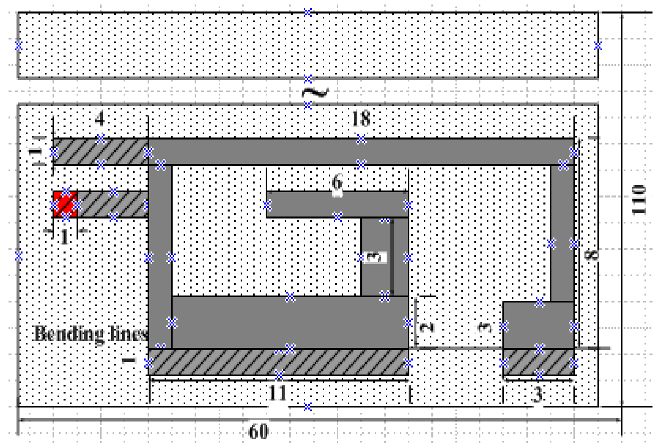

Fig . 1 . Configuration of a signal element.

Ⅲ. ANTENNA SIMULATION

Simulations are performed on Ansoft's HFSS. The MIMO antenna single model is shown in Figure 2. The working frequency is set in 2.3GHz and the sweeping frequency range is from 2GHz to 3GHz. Figure 3 shows the output S11 result, the reflection loss at an input port of a single radiator. As can be seen from the figure, S11 can be lower than -19 dB in the frequency range 2268-2407MHz and 2533-2472MHz. 3D pattern of the MIMO antenna single model is shown in Figure 4.

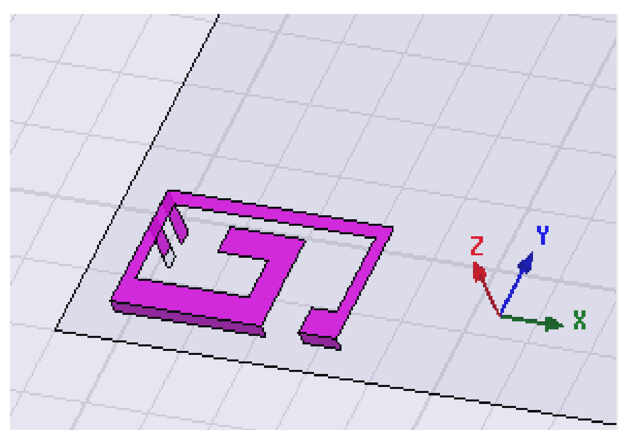

Fig . 2 . Antenna element model.

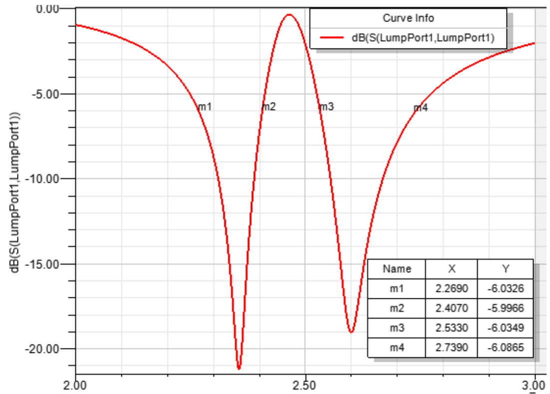

Fig .3 . simulated S11 parameter of a signal element.

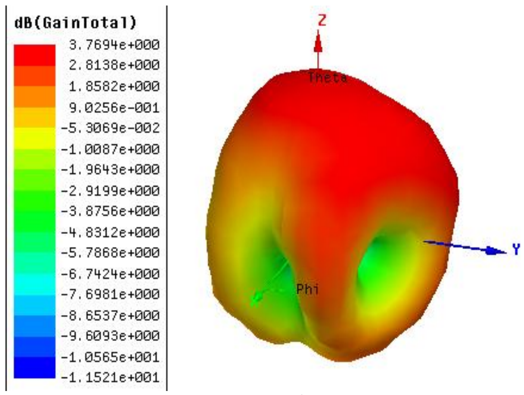

Fig .4 . Simulated 3D pattern of the designed antenna.

A MIMO antenna in a mobile terminal is generally using the form of dual antenna elements. Measures must be taken to improve isolation between two elements because of the mutual coupling. Measures used now are that a ground slot, an extending ground, adjusting the relative position of the two antenna elements, using large-impedance materials, adding decoupling unit and adding parasitic elements, etc. Typically, the first two methods will change the original size and structure of the ground floor. The last three methods increase the number of components on the ground floor, so that increase the complexity of mobile phone. In this paper, we use the method that is always called distance isolation combining with a fold fide to adjust the place of antenna elements. By putting antenna elements as far away as possible from another, the isolation between the two elements can be improved. In this way, the design requirement can be satisfied without increasing the ground floor size and adding other material components. According to the relative position between antenna elements and ground floor, three models shown in Figure 5 called H1, H2 and H3 respectively were simulated. In the mobile terminal, if the separation distance between the two single antenna elements is larger than λ/2, the lower cross-correlation can be obtained. In the three models, H1 and H2 have a larger antenna separation than λ/2, the separation in H3 is approaching to λ/2. The simulated S-parameter results are respectively shown in Figure 6, Figure 7 and Figure 8.

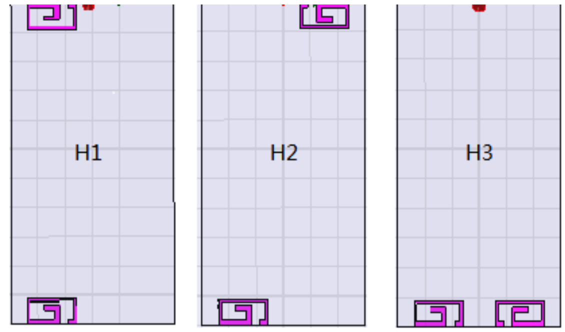

Fig .5 . Three models with different relative positions.

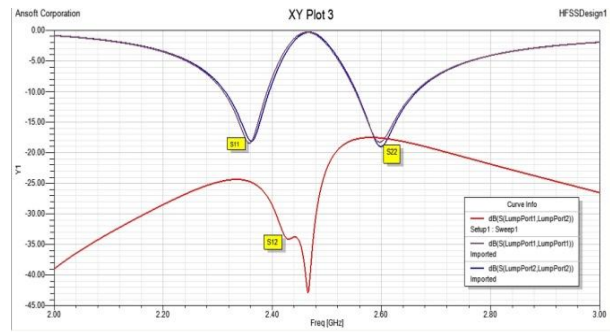

Fig .6 . Simulated S-parameters H1.

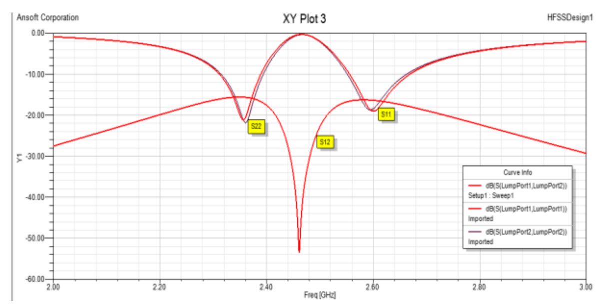

Fig .7 . Simulated S-parameters of H2.

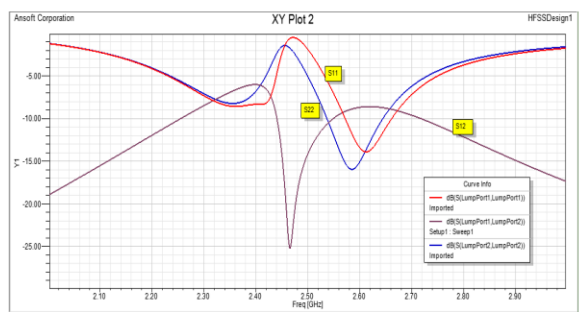

Fig .8 . Simulated S-parameters of H3.

Through analyzing and comparing the simulation results of H1, H2 and H3 models, the following results can be concluded. In H3, the difference between the S11 parameters of the two antenna elements is under 3dB. S11 parameter can reach -8dB in 2300MHz band and -15dB in 2500MHz. S12 is only -6dB and can't meet the needs of TD-LTE MIMO antenna isolation. The situation is similar in H2 that S11 can reach -22dB in 2300MHz band and -18dB in 2500MHz. But its S12 can reach -16dB and this meets the requirement of TD-LTE MIMO. In H1, S11 parameters of the two single MIMO antennas are also approximately equal. S11 in 2300MHz can reach -22dB and -

18dB in 2500MHz. S12 can reach -19dB and meets the required isolation. By comparing, H1 has both the lower S11 and gives high isolation, so H1 is chosen as the MIMO antenna design of mobile terminal.

Ⅳ. TEST OF THE MIMO ANTENNA

A prototype of the antenna is fabricated based on model H1. Fig.9 gives the hand form block in comparing a Hisense T96 mobile phone. The prototype is tested with an Agilent's E5071C network analyzer and the results are shown in Figure 10. By comparing testing results with simulation, they are in good agreement. This designed antenna can cover 2300-2400MHZ and 2570-2620MHz and the S12 can reach -20dB.

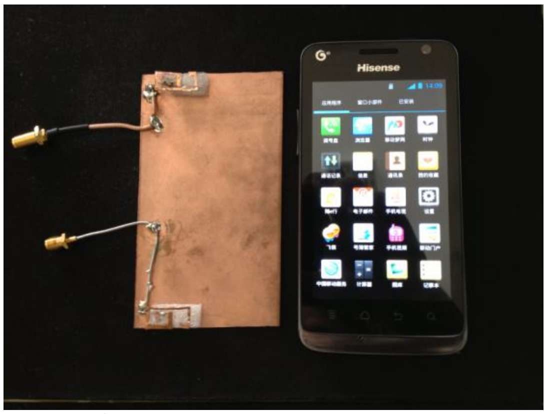

Fig .9 . Prototype of the proposed antenna in comparing with HisenseT96.

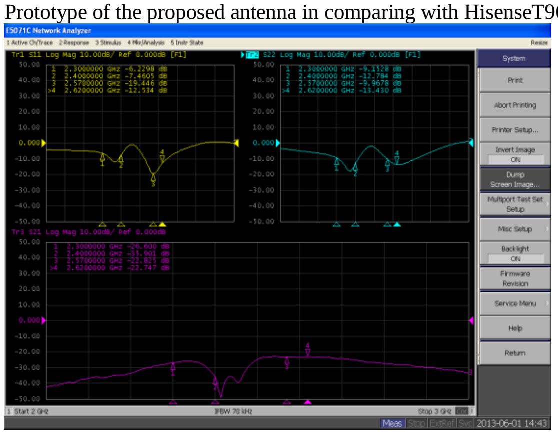

Fig .10 . S-parameters tested

V. CONCLUSION

According to the simulations performed in Ansoft's HFSS and the S-parameter results tested in network analyzer, we know that H1 model with appropriate relative position between antenna and radiation ground is the most suitable MIMO antenna layout in these three models. This small MIMO antenna can cover 2300/2500MHz bandwidth with high isolation and works as a mobile phone MIMO antenna in TD-LTE communication system.

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