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Multiband MIMO Antenna for Satellite Communication

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***Abstract*—Multiband multiple input multiple output (MIMO) antenna is presented. Antenna is composed of two symmetrical radiating connected by neutralizing line to cancel the reactive coupling. The radiating element is designed for different operating frequencies in 4.4GHz and 6.2GHz and 8.9 GHz and 9.6GHz for x band application, which consist of a folded monopole and a beveled rectangular metal patch. The presented antenna is fed by using 50Ω coplanar waveguide (CPW) transmission lines. Four slits are etched into the ground plane for reducing the mutual coupling. The measured results show that the proposed antenna has good impedance matching, isolation, peak gain ,and radiation patterns.**

***Index Terms*—Antenna feed system, x band application, multiband, multiple-input–multiple-output (MIMO) antenna.**

1.INTRODUCTION

The Long Term Evolution is the next generation mobile communication standard expected to provide high data rate, which is set to occupy frequency range from 400MHz to 4GHz. For most countries in the world, LTE-E 2300 and LTE-D 2600 MHz bands are the uppermost frequencies, especially in some Asia countries. China started LTE network construction from the end of 2011 and operated commercial LTE mobile communications services in December 2013. So far, there are more
than 1 million LTE base stations for outdoor and indoor applications in china. As a key component of

the LTE wireless system, the multiple input multiple output antenna has attracted significant research power in the recent years for its well known advantages of increasing transmission capacity and reducing multipath fading.

MIMO (multiple-input–multiple-output) system could significantly improves the performance of wireless communication systems. For better communication service, multiple antennas deployed at the base station and at the mobile-terminal side are necessary. In addition, the wireless communication network has become a mixture of different networks, so multi-mode mobile terminals have attracted widely attention [1]. Thus, multiple antenna system for multi-mode smart phone is necessary.

Recently, many MIMO antennas for LTE mobile handsets have been reported. A 3-D inverted-F antenna associated to a parasitic element operating in the LTE 700 MHz and LTE 2.5– 2.7 GHz bands was used for MIMO operation. An MIMO antenna with a T-shaped parasitic element for mobile handsets was proposed for most LTE, WiMAX , and WLAN bands corresponding to 1.79–3.77 GHz. These MIMO antenna designs are mainly discussed on LTE frequencies for mobile handsets use. However, there are two very important aspects that deserve attention greatly in the Chinese daily life. On the one hand, plenty of users will continue using 2G for voice communication.

The MIMO antenna for wireless communications
required to have a multiple bandwidth to cover the GSM , DCS, and LTE bands. On the other hand, it is said that about 70% of the user demands and mobile flow for high-speed data services occur in indoor environment. In indoor applications, the
compact planar and easily fabricated MIMO antenna is obviously a good candidate. Unfortunately, discussions on compact planar multiband MIMO antenna for GSM, DCS, and LTE
applications are scant, especially in the real indoor experimental environment.

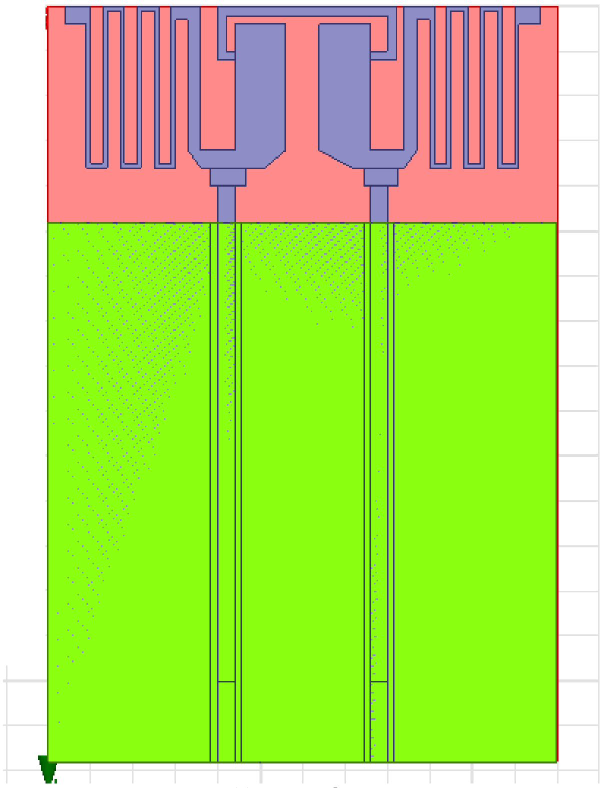

Fig 1(a) Proposed Antenna

TEST VALUES OF THE THREE KINDS OF ANTENNA FEED SYSTEMS IN LTE INDOOR EXPERIMENT

Types	RSRP (dBm)	Download speed (Mb/s)	Upload speed (Mb/s)
Single antenna and 50 Ω load	-74	53.2	5.8
Two single antennas	-64	74.2	9.8
Proposed MIMO antenna	-68	71.8	9.2

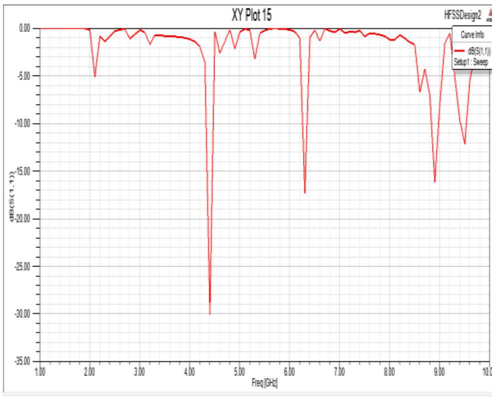

Fig. 2. S11(dB)

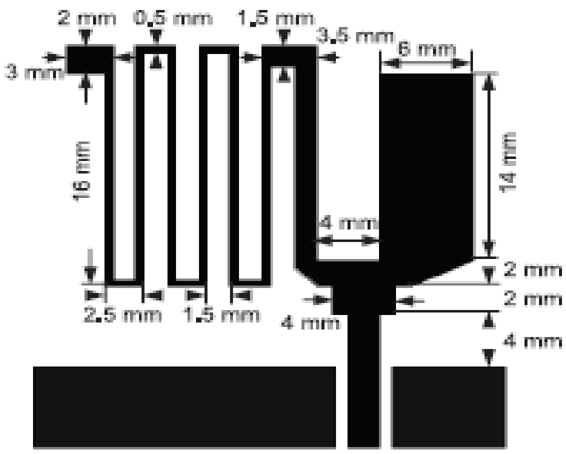

Fig 1(b) Detailed View

II. ANTENNA DESIGN AND RESULTS

A. MIMO Antenna Configuration

Fig. 1(a) shows the geometry and configuration of the proposed antenna. It was fabricated on a 60 × 84 × 0.8-mm3 FR4 epoxy substrate with dielectric constant $\varepsilon r = 4.4$ and loss tangent tan $\delta = 0.02$. The antenna consists of two symmetrical radiating elements. The coplanar waveguide (CPW) transmission lines of 50 Ω feed the radiating elements connected by a 1-mm-wide shorting line. The shorting line takes the role of neutralizing the currents from two elements to increase their isolation.

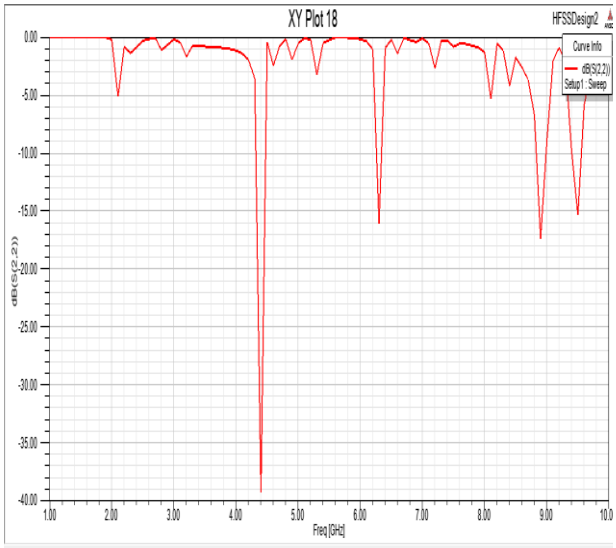

Fig.3. S22(dB)

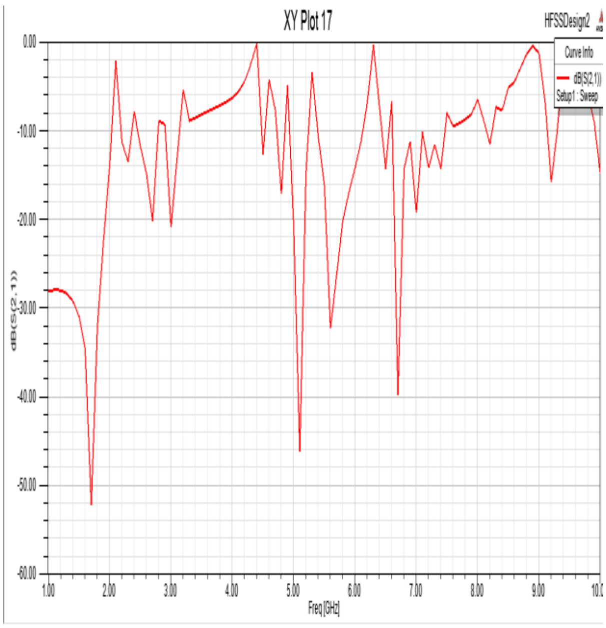

Fig.4. S12(dB)

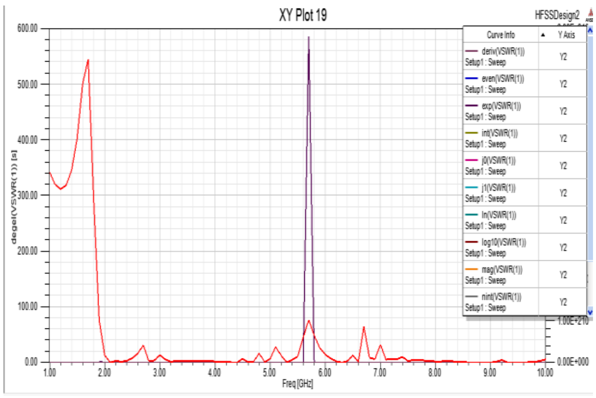

Fig.5.VSWR(1)

A. *Simulation and Experimental Results*

The measurements were carried out with a network analyzer Agilent N5230A (10 MHz–50 GHz). shows the characteristics of the measured and simulated input reflection

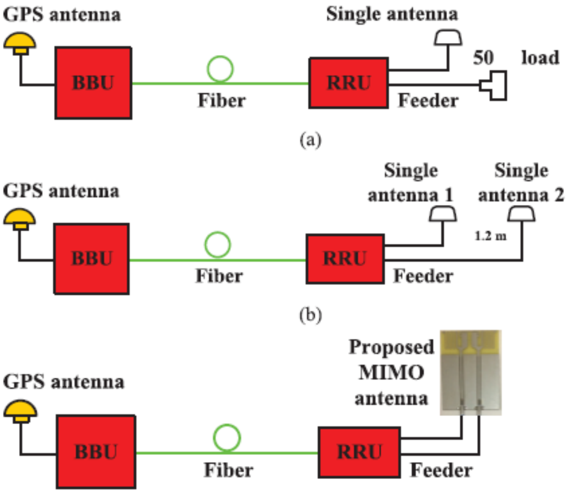

Fig.6. LTE indoor base station with different antenna feed system in test environment. (a) Single antenna and 50-Ω load. (b) Two single antennas. *(c) Proposed MIMO antenna*

coefficient |S11| of the proposed antenna, and a relative good agreement in between simulation and measurement can be observed. It is found that the input impedance of the fabricated antenna is well matched as the bandwidth covers the $|S11| < -30$ dB.

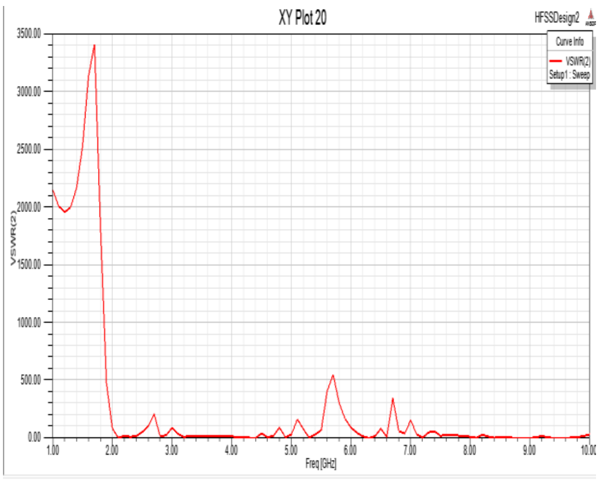

Fig.6. VSWR(2)

To analyze the working mechanism of the neutralizing line and four slits, fig.4 shows the
simulated |S12| of MIMO antennas with different decoupling configurations. It can be observed that the isolation is deteriorated seriously in the operating bands, when MIMO antenna is without neutralizing line and four slits.

Fig.7.Bottom view of the Antenna

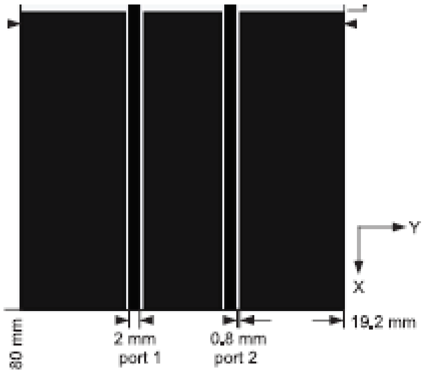

Fig.7.Bottom view of the Antenna

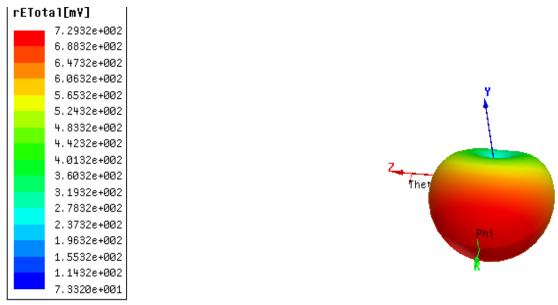

Fig.8. Gain of the proposed Antenna

III. ANTENNA TEST IN LTE INDOOR ENVIRONMENT

Generally, an LTE indoor base station includes a building baseband unit (BBU), remote radio unit (RRU), antenna feed system, and GPS antenna. BBU is connected to RRU by fiber, and the feeder links the antenna and RRU. In this letter, the LTE indoor network test environment at LTE-E 2300 MHz frequency was constructed by using Ericsson equipment BBU DUS4102 and RRUS62B40A.

Fig.9. Real LTE indoor base station environment using the proposed MIMO antenna.

Signal receiving power (RSRP), download speed, and upload speed are the three most important indexes to evaluate the operating performances of MIMO antenna in the LTE application. In Fig. 10, there are three kinds of antenna feed systems connected with RRU. The first one is including a single antenna and a 50-Ω load, as shown in Fig. 10(a). This type just has only one communication channel because the base station sends and receives signals from the single antenna, which can be called as "Single path." The second type is depicted in Fig. 10(b). There are two single antennas ending with RRU, which composes two channels and can be called as "Double paths." To decrease the coupling and avoid self-excitation

nterference, the two single antennas are usually more than 1.2 m apart in the test. The last type is shown in Fig. 10(c). RRU is linked with the proposed MIMO antenna by using two feeders, and there are also "Double paths" to process the signals. The test values of RSRP, download speed, and upload speed for these three kinds of antenna feed systems are compared in Table I. It is found that, as expected, the performances of "Double paths" (types 2 and 3) are better than that of "Single path" (type 1). For two types of "Double paths," the test values of the proposed antenna (type 3) are slightly inferior to the values of type 2. However, the type 3 not only has fewer antennas, but also saves the space for its compact and high integration

IV. CONCLUSION

A novel compact MIMO antenna for multiband indoor applications has been proposed in this letter. Using the folded monopole and the beveled rectangular metal patch as the antenna element, the characteristic of multiple bands is realized. High isolation $|S_{11}| < -30$ dB in the operating bands is achieved by using neutralizing line and cutting four slits in the back ground plane. The results of *S*-parameters, peak gains, and radiation patterns are presented. The diversity performance evaluated by radiation efficiency and diversity gain has also been studied. Furthermore, to test the performance of the pro-posed MIMO antenna in the real LTE indoor application, the LTE base stations with three kinds of antenna feed systems are constructed. The proposed antenna is a good potential candidate for LTE indoor applications and x band applications.

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