Design of a Dual-polarization Dual-band MIMO Antenna for Wireless Applications

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***Abstract*—A compact dual-polarization dual-band planar antenna with two orthogonal stubs structure is proposed for MIMO mobile handsets in the paper. The antenna can cover more than ten mobile applications in dual-bands with -6dB bandwidth of 34% (1.987-2.8GHz) for TD-SCDMA (2.3-2.4GHz), WCDMA (1.92-2.17GHz), LTE33-41 (1.9-2.69GHz), ISM2.4GHz (2.4-2.4835GHz), WLAN (802.11b/g/n:2.4-2.48GHz), Bluetooth, GPS, COMPASS, GLONSS, GALILEO and 38.6% (4.364-6.449GHz) for WLAN (802.11a/n:5.15-5.35GHz), ISM5.8GHz(5.725-5.85GHz) wireless applications. The antenna is fabricated on a 1.6 mm-thick FR4 substrate with dielectric constant of 4.4, and the size is 100*100mm2. The good agreement between the measurement results and the simulation validates the proposed design approach and meets the requirements for various wireless applications.**

Keywords-dual-polarization; dual-band; compact antenna; MIMO

I. INTRODUCTION

Miniaturized multi-broadband planar Multiple-Input Multiple-Output (MIMO) antennas have been widely used in mobile terminal devices in recent years. In order to better achieve the multiband and miniaturization, many technologies have been studied, such as coupling feed technology [1-3], slot loaded technology [4-5], loading the matching network [6], and loading printed distributed inductance technology [7] and fractal technology [8]. Inverted L-slot patch with a defected ground plane is used for triple-band operation in [9], whereas three circular-arc-shaped strips whose whole geometry looks like “ear”-type antenna are reported to cover the desirable bands for WLAN/WiMAX wireless communication terminal in [10]. A square slot, a pair of L-strips, and a monopole radiator are used to excite three different resonances in [11]. A microstrip feed line, a substrate, and a ground plane on which some simple slots are etched to achieve triband operation in [12]. The requirement of dual polarization is added in the antenna technology in [13-15]. In [16], dual-element antenna arrays for small devices of MIMO applications which have semi-printed structure, and operate in ISM 2.4GHz band as well as between 5 and 6 GHz. Several works have proposed adding slots in the PCB to realize wave-traps [17-18].

In this paper, a dual-polarization planar antenna with two orthogonal branches structure is proposed and designed for wireless communication systems that can support dual-band applications. The antenna covers more than ten mobile applications of TD-SCDMA(2.3-2.4GHz), WCDMA(1.92-2.17GHz), LTE33-41(1.9-2.69GHz), ISM2.4GHz(2.4-2.4835GHz), WLAN(802.11b/g/n:2.4-2.48GHz), Bluetooth, GPS, COMPASS, GLONSS, GALILEO, WLAN(802.11a/n:5.15-5.35GHz), and ISM5.8GHz(5.725-5.85GHz) wireless applications.

II. ANTENNA STRUCTURE AND DESIGN PROCEDURE

A. Characteristics of Antenna Structure

The configuration of the proposed antenna is shown in Figure I with dimensions in Table I. The antenna has two orthogonal branches structure radiator with a rectangle slot in one branch. The antenna is designed on FR4 substrate with height of 1.6mm, dielectric constant (εr) of 4.4 and loss tangent (δ) of 0.02.

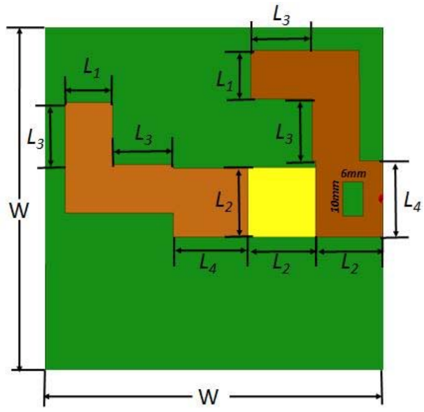


FIGURE I. LAYOUT OF PROPOSED ANTENNA.

TABLE I. DIMENSIONS OF PROPOSED ANTENNA (MM)

W	L_1	L_2	L_3	L_4
100	14	20	18	22

B. Performance of Simulation

The simulation is conducted by Ansoft HFSS 15.0. Figure II illustrates the reflection loss (S11) curves at different branch lengths and widths. Figure III shows the voltage standing wave ratio (VSWR) curve of the antenna.

It can be seen that the proposed antenna can operate at dual-bands centered at 2.3GHz with -11.55dB reflection loss and 5.15GHz with -10.61dB reflection loss. The simulated -

10dB bandwidth is 252MHz for the first band (2.159-2.411GHz) and 274MHz for the second band (5.026-5.3GHz).The simulated -6dB bandwidth for the first band (1.987-2.8GHz) is 34% and the second band (4.364-6.449GHz) is 38.6%. These bands cover several commercial application bands of 3G, 4G, WiFi, Bluetooth and navigations, as given in Table II, III.

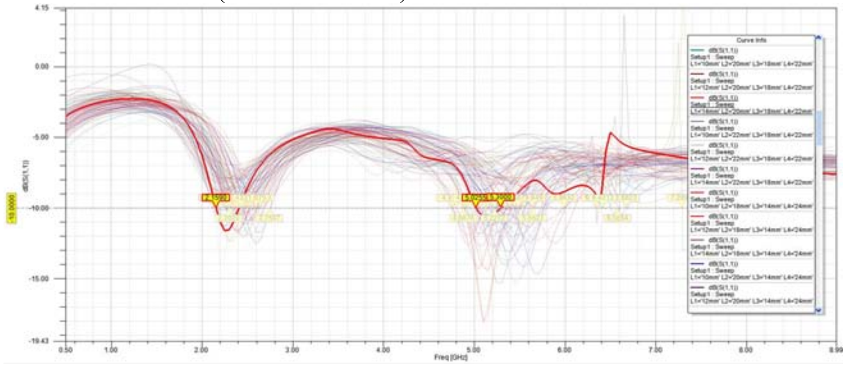


FIGURE II. COMBINED SIMULATED REFLECTION LOSS AT DIFFERENT L

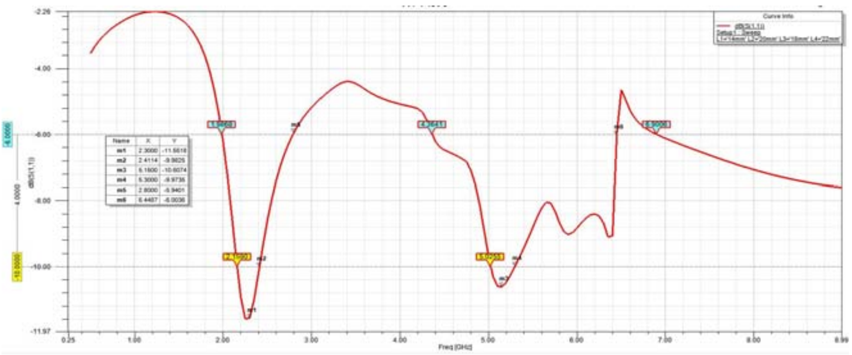


FIGURE III. SIMULATED REFLECTION LOSS OF THE PROPOSED ANTENNA

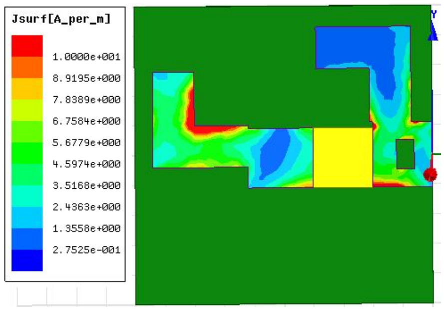
TABLE II. -10DB FREQUENCY BANDS COVERED BY ANTENNA

Band No.	-10dB Bandwidth	Covered Commercial Bands
1	2.159-2.411GHz	LTE40,TD-SCDMA, ISM2.4GHz, Bluetooth
2	5.026-5.3GHz	WLAN(802.11a/n:5.15-5.35GHz)

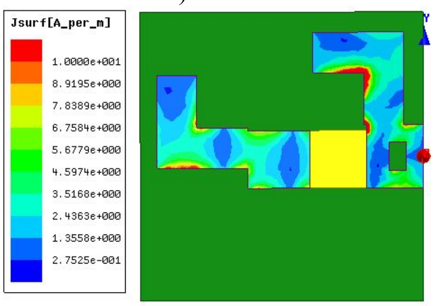
TABLE III. -6DB FREQUENCY BANDS COVERED BY ANTENNA

Band No.	-6dB Bandwidth	Covered Commercial Bands
1	1.987-2.8GHz (34%)	TD-SCDMA(2.3-2.4GHz), WCDMA(1.92-2.17GHz), LTE33-41(1.9-2.69GHz), ISM2.4GHz(2.4-2.4835GHz), WLAN(802.11b/g/n:2.4-2.48GHz),Bluetooth, GPS, COMPASS, GLONSS, GALILEO
2	4.364-6.449GHz(38.6%)	WLAN(802.11a/n:5.15-5.35GHz), ISM5.8GHz(5.725-5.85GHz)

The surface current amplitude distribution on radiator of the proposed antenna that work at the center frequency of 2.3GHz and 5.15GHz, respectively, are shown in Figure IV. For 2.3GHz frequency, the current is more concentrated at the distal part of the radiator, as shown in Figure IV (A). As the frequency increase, the proximal part of the radiator has more current, as shown in Figure IV (B).



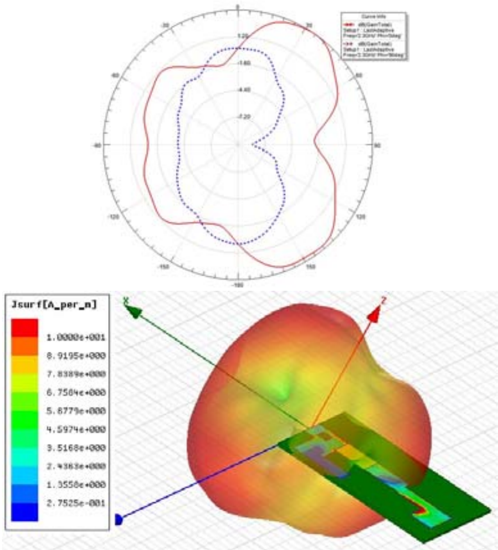
A)2.3GHZ



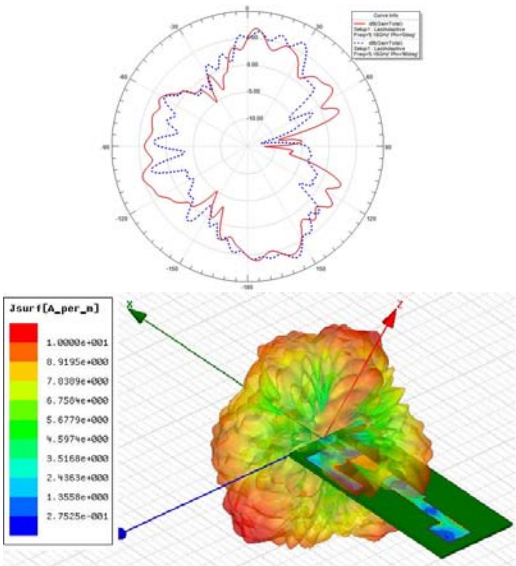
B)5.15GHZ

FIGURE IV. CURRENT DISTRIBUTION OF THE ANTENNA AT DIFFERENT CENTER FREQUENCIES

The simulated E/H-plane and 3D radiation patterns of the proposed antenna at the center frequencies of 2.3GHz and 5.15GHz are shown in Figure V. It can be seen that the patterns are close to omnidirectional at all bands.



A) 2.3GHZ



B) 5.15GHZ

FIGURE V. SIMULATED E/H-PLANE AND 3D RADIATION PATTERNS AT DIFFERENT FREQUENCIES

III. Fabrication and Measured Results

To verify the dual-band performance of the MIMO antenna, a prototype antenna is fabricated and measured. The antenna is built on 1.6mm thick FR4 substrate with loss tangent=0.02 and 30μm copper, as show in Figure VI. The antenna is tested by antenna measurement system of PNA3621.

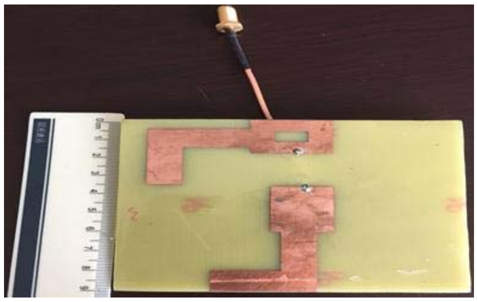
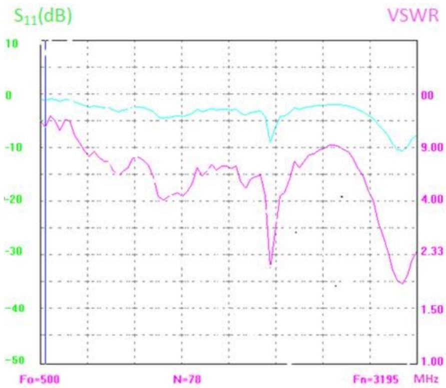


FIGURE VI. FABRICATED ANTENNA PROTOTYPE



FIGUREVII. MEASURED S11 AND VSWR CURVES

The measured reflection loss (S_{11}) and Voltage Standing Wave Ratio (VSWR) have better agreement with the simulated results, as shown in Figure VII. This makes the antenna compatible for mobile communications applications.

IV. Conclusions

A novel compact dual-polarization planar antenna with two orthogonal branches structure is developed for TD-SCDMA, WCDMA, LTE, ISM2.4/5.8GHz, WLAN, Bluetooth, GPS, COMPASS, GLONSS, GALILEO wireless applications. The better agreement between the measurement results and the simulation validates the proposed antenna meets the requirements for various wireless applications.

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