Broadband Dual-Polarized Base Station Antenna for LTE/5G C-band Applications

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***Abstract*—In this paper, a broadband ±45° dual-polarized base station antenna excited by a square loop structure is proposed. The operating bands of the proposed design are in LTE2300/ LTE2500/ WRC15 C-band (3400-3600MHz)/ China 5G C-band (3300-3600MHz). The antenna consists of two pairs of coplanar symmetrical dipoles, and two microstrip lines, and square loop-shape structures, and two metal cylinders and a reflector. The square loop-shape structure connected by the microstrip line is electromagnetically coupled to feed the dipoles, and its dipoles and metal cylinder are connected to the reflector. By changing the geometry of the square loop structures and symmetrical dipoles, the impedance bandwidth of the design is 51.11% (2.17 - 3.66 GHz), when the impedance bandwidth and isolation are defined by S_{11} less than −10dB and S_{21} less than −20dB separately. The simulated half-power beamwidth (HPBW) of the design is greater than 60 degree at 2.3 GHz, 3 GHz, and 3.6 GHz, and the simulated gain is from 7.91 dBi to 10.44 dBi. Since port 1 and port 2 are almost symmetrical, there is a stable radiation pattern in both +45°-plane and −45°-plane. In addition, the overall antenna architecture is simple and easy to fabricate in base stations that can be used in 4G and future 5G mobile communication systems.**

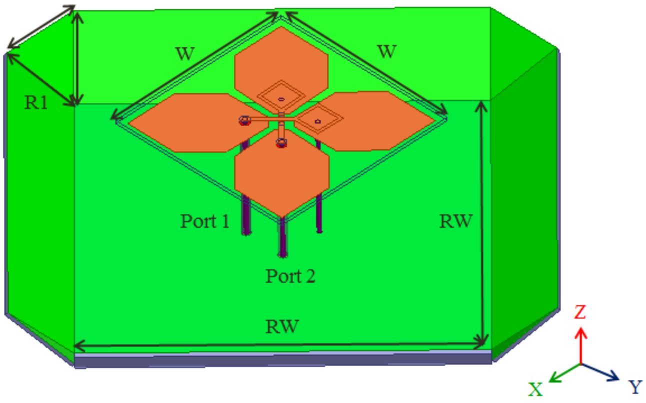
Keywords*—dual-polarized antenna, square loop structure, base station antenna, LTE, 5G

I. INTRODUCTION

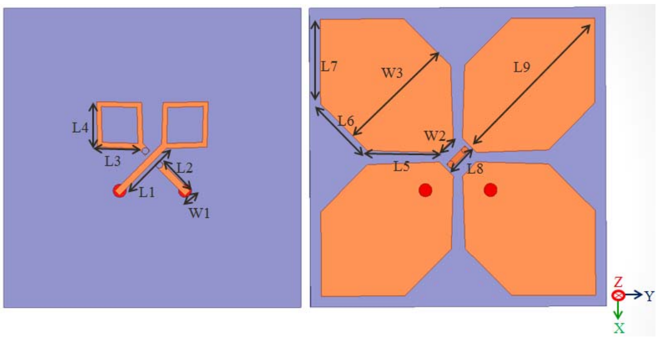
With the rapid development of wireless communication technology, the broadband dual-polarized antenna is widely used [1] - [8]. Dual-polarized antenna can reduce multipath fading and increase channel capacity. In order to meet the requirements of modern wireless communications, the antenna with multi-frequency, dual-polarization, and miniaturization, high gain, high isolation, low cross-polarization, front-to-back ratio and HPBW are all demand for consumer applications. Some single-polarization and dual-polarized antennas were mentioned in [1] - [8]. In [5], a coplanar asymmetrical folded dipole antenna excited by an L-shaped microstrip line to achieve a broadband, high gain, and a stable radiation pattern with a half-power beamwidth greater than 65 degree is proposed. In [6] - [8], a broadband dual-polarized antenna excited by a T-shaped microstrip line is proposed to improve the radiation pattern and achieve broadband, stable radiation pattern and high gain. In the paper, the dual-polarized antenna design is proposed and applied in the frequency bands of LTE2300, LTE2500, WRC15 C-band, and China 5G C-band announced by the Ministry of Industry and Information Technology (MIIT) [9] in China. More results and discussions will be mentioned in detail in this paper.

II. ANTENNA DESIGN

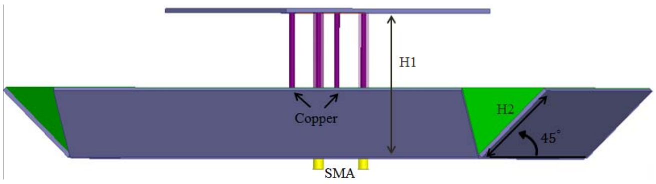
The dual-polarized antenna geometry is shown in Fig. 1. The photo of the design is also shown in Fig. 2. The dual-polarized configuration is ±45°. One is located at −45° and the other is located at +45°. The antenna uses two square loop-shape structures connected by microstrip lines that cross each other vertically, and two pairs of coplanar symmetric dipoles, and two coaxial cables, and a reflector made of a ground that connected four reflectors of 45 degree and four copper sheets of equilateral triangles. Microstrip line and square loop-shaped structure are printed on FR4 substrate (with a dielectric constant of $\varepsilon_r = 4.4$, a loss tangent of 0.02, and a thickness of t = 0.8 mm), and two pairs of coplanar symmetric dipoles are printed below the FR4 substrate. The dimension of the antenna substrate is 45 mm × 45 mm (W × W), and the dimension of the reflector is 80 mm × 80 mm (RW × RW), and the dimension of four reflectors is 18 mm × 80 mm (H2 × RW). The proposed antenna is fed by a 50Ω coaxial cable connected to an SMA connector. The outer conductor of the coaxial cable is soldered with the dipoles, whereas the inner across the substrate and connected the feed to the square loop-shape structure. Between the two metallic cylinders connect dipoles and the reflector. Four reflectors connect 45 degree to the bottom metal, and the four reflectors are connected with equilateral triangles form the reflector of the design. As shown in Fig. 2, the height between the reflector and the antenna is 27 mm. By properly adjusting the length and width of L3 and L4, the good impedance matching and stable radiation pattern can be achieved. Table I listed the dimensions of the antenna. The overall dimension of the antenna is 105 × 105 × 27 mm^3. The result of simulation and analysis and the far-field radiation patterns are all obtained by using HFSS.



(a)



(b)



(c)

Fig. 1. The geometry of the proposed dual-polarized antenna. (a) 3-D view. (b) Front side and back side. (c) Side view.

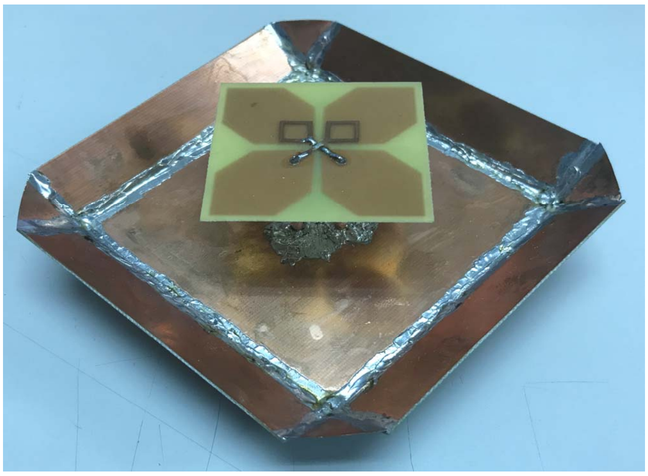


Fig. 2. The prototype of the proposed dual-polarized antenna.

TABLE I. PARAMETERS OF THE PROPOSED ANTENNA

Parameters	L1	L2	L3	L4	L5	L6
Unit (mm)	10	6.5	6.16	6.82	10.96	10
Parameters	L7	L8	L9	W1	W2	W3
Unit (mm)	12.72	4	27	1	1.5	18
Parameters	W	RW	R1	H1	H2	
Unit (mm)	45	80	18	27	18	

SIMULATION RESULTS AND DISCUSSION

The Fig. 3 shows of the dual-polarized antennas measured and simulated S_{11} and S_{22}. The both of simulated and measured S_{11} and S_{22} can fit the bands of LTE2300/ LTE2500/ WRC15 C-band (3400-3600MHz)/ China 5G C-band (3300-3600MHz). The Fig. 4 shows the measured and simulated S_{11} of the two ports. And the S_{21} between the two ports are large than 20 dB over the operating bands. Table II lists the summary of antenna radiation performances of the proposed antenna. It can be found that the half-power beamwidth of the design is larger than 60 degrees, and the simulated gain is 7.91 to 10.44 dBi. The Fig. 5 shows the simulated 2D radiation patterns at port 1 of the design at 2.3, 3, 3.6 GHz. The design has the advantage of stable gain and stable radiation patterns.

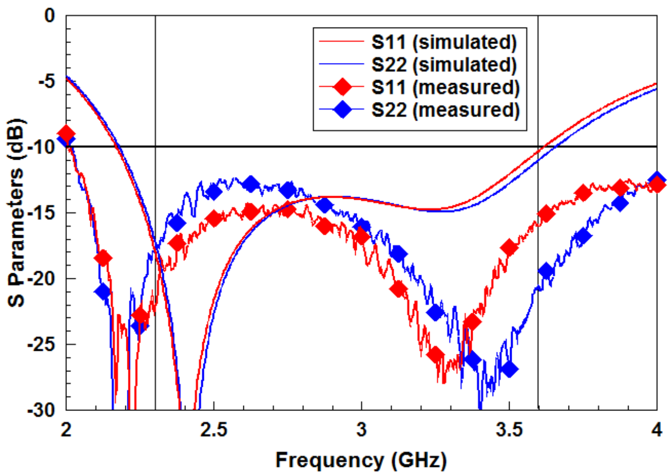


Fig. 3. Simulated and measured S_{11}, S_{22} parameters.

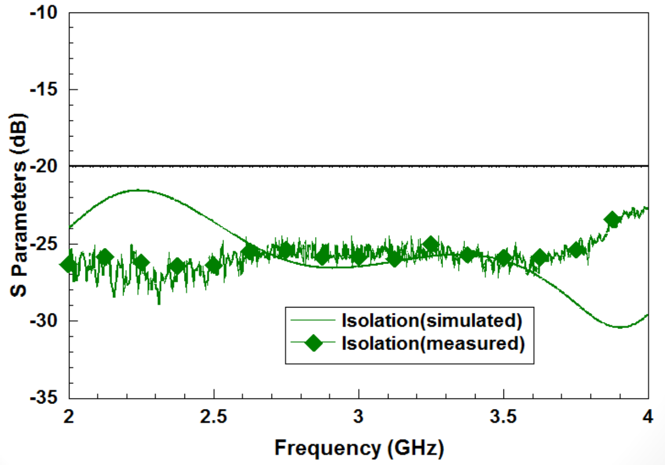


Fig. 4. Simulated and measured S_{21} parameters.

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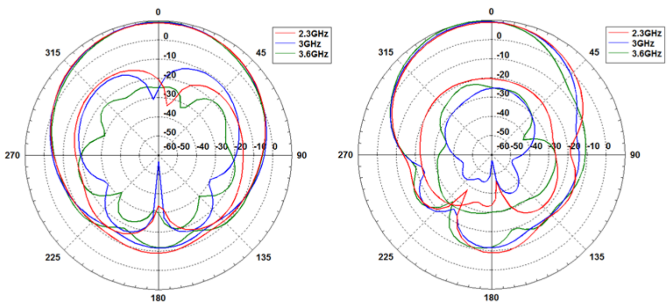
TABLE II. ANTENNA RADIATION CHARACTERISTICS AT PORT1

Frequency (GHz)	Gain (dBi)	Half-power beamwidth(°)	
		+45°-plane	-45°-plane
2.3	7.91	75.88	62.36
3	8.82	68.62	61.47
3.6	10.44	60.79	61.27



(a) (b)

Fig. 5. Simulated radiation patterns at port 1. (a) ϕ = +45°-plane (b) ϕ = −45°-plane

III. CONCLUSION

This paper presents a broadband ±45° dual-polarized antenna operating in LTE, WRC15 C-band, and China 5G C-bands. The antenna has a wide impedance bandwidth of 51.11% with $S_{11} < -10$ dB, a stable HPBW at both +45°-plane and −45°-plane, a stable antenna gain varying from 7.91 to 10.44 dBi, and a high port to port isolation ($S_{21} < -20$dB) from 2.17 GHz to 3.66 GHz. Since port1 and port2 are almost symmetrical, there is a good radiation pattern in both +45°-plane and −45°-plane. In addition, the antenna structure is simple, easy to fabricate, and suitable for base station application in 4G and future 5G mobile communication systems.

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