Stub-loaded Broadband Dual-Polarized Antenna for 2G/3G/LTE Base Stations

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***Abstract* - A stub-loaded wideband dual-polarized antenna is proposed, which is composed of two orthogonal cross loop dipoles, branch-shaped coupling feed line and a box-shaped reflector. The stub inside the loop dipoles are adopted to enhance the impedance bandwidth. A new resonate mode is induced in the higher frequency by using the stub. Therefore, the impedance bandwidth is greatly expanded. Design, simulated and experiment of the proposed antenna is presented. Measured results shown an enhanced bandwidth of 57.5% (1.67-3GHz) for |S11|<-15dB.**

***Index Terms* — stub-loaded, broadband antenna, dual-polarized antenna, LTE.**

1. Introduction

With the growing development of wireless communication systems, dual-polarized antenna have been widely used to increase the channel capacity and communication quality [1]. And it is desirable for base station antennas to have wider impedance and more compact configuration. Recently, a lot of dual-polarized antenna have been proposed [2]-[8]. However, it is still difficult to achieve wide bandwidth, stable radiation pattern and low cross polarization simultaneously.

In [3], a wide impedance bandwidth was achieved by using Y-shaped coupling strip line and octagonal loop dipoles. However, it is not wide enough. In this paper, a stub-loaded wideband dual-polarized antenna is proposed with simple structure. There are two resonate modes of the cross square-shaped loop dipoles in the desired frequency band, originally. With four stubs loaded inside the loop dipoles, a new resonate mode is created in the higher frequency. And this mode can be moved mainly by the size of the square stub. Therefore, a wider impedance bandwidth can be achieved. Furthermore, the antenna exhibit a stable radiation pattern and low cross polarization.

2. ANTENNA DESIGN

(1) Configuration

The configuration of the ±45°dual-polarized antenna is shown in Fig.1. The structure of the proposed antenna consists of two perpendicularly cross square-shaped loop dipoles over the box-shaped reflector in the direction of -45° and +45° for dual-polarization. Both of the branch-shaped coupling feed line and the stub-loaded loop radiators are printed on the double sides of FR4 substrate with a relative permittivity of ε_r=4.4, a dielectric loss tangent of 0.2, and a thickness of 0.08mm. Each stub-loaded loop dipole is excited by the branch-shaped coupling feed line which is printed on the front side of FR4 and connected by the inner conductor of coaxial line. And the outer conductor, which is printed on the back side of FR4, is connected with the loop radiator. A photo of the proposed antenna is illustrated in Fig.2.

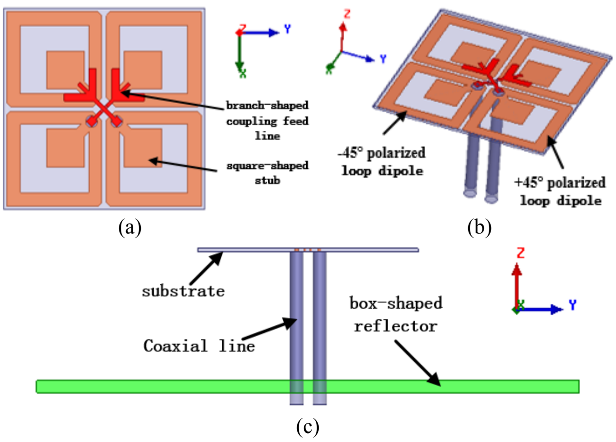


Fig. 1. Antenna configuration (a) top view, (b) 3D view, (c) side view.

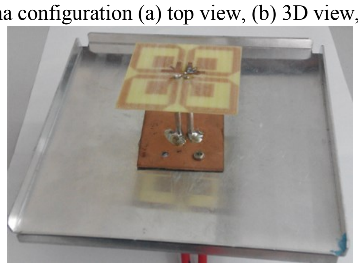
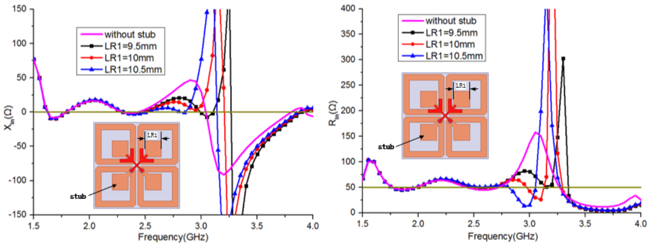


Fig. 2. A photo of the dual-polarized antenna.

(2) Mechanisms

The cross dipoles is placed symmetrically in the direction of -45° and +45° for dual-polarization. For the reason that when one of the dipole is excited, the other one is act as a parasitic element, and the bandwidth can broaden obviously. Moreover, a branch-shaped coupling line is used in the proposed antenna, which can further improve the impedance match and broaden the impedance bandwidth [3] [4]. Furthermore, with square stub loaded inside the loop dipoles, another resonate mode is induced in the higher frequency. The real part of input impedance decrease obviously. We can see clearly the modes movement mechanisms from the input impedance and the $|S_{11}|$ of the proposed antenna in Fig.3 and Fig.4. As the increase of LR1 (the length of the stub) the zero point of the imaginary part moves lower and the real part smoothly close to 50Ω at the same time. That is to say, the higher resonate mode moves lower and the impedance match better. Therefore, a wider impedance bandwidth of 57.5% is achieved with three resonate modes in the operating band. The radiation patch has a compact size of 52mm*52mm ($0.38\lambda_0$* $0.38\lambda_0$, λ_0 is the free-space wavelength at 2.2GHz). And by adjusting the physical size of reflector, the antenna shows stable radiation pattern over the operating frequency band. The radiator is firstly designed with a height of 35mm ($0.25*\lambda_0$) from the reflector.



(a) (b)

Fig.3. Effects of LR1 of the proposed antenna for (a) Imaginary part of input impedance, (b) Real part of input impedance.

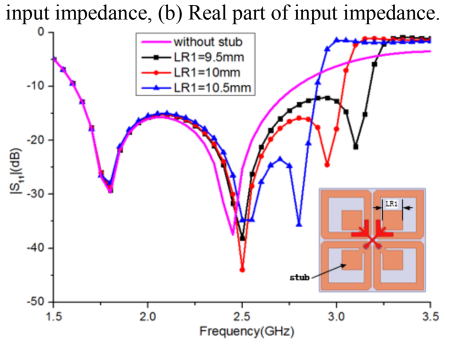
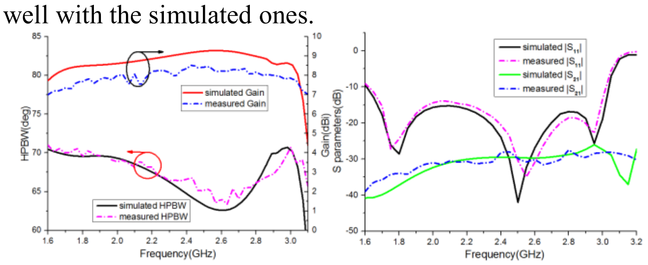


Fig.4. Effects of LR1 for $|S_{11}|$ of the proposed antenna.

3. Measured and Simulated Results

The antenna was designed and simulated by using Ansoft HFSS. Due to the symmetry of the proposed antenna, only one port's S-parameters and radiation patterns are presented. Fig.5 (a) shows a good agreement between measured and simulated S parameters. The impedance bandwidth for $|S_{11}|$<-15dB is 57.5% (1.67-3.0GHz) and the isolation is more than 28dB. As shown in Fig.5, the average gain is 8dBi and the half power beam width (HPBW) is 66±3.5° at horizontal plane (H-plane) and 66±4° at vertical plane (V-plane). The measured and simulated radiation pattern of the dual-polarized antenna for 45° polarization at 1.7GHz and 2.8GHz are illustrated in Fig.5 (b). The S-parameters are measured by an Agilent N5230A vector network analyzer and the radiation patterns and gain of the proposed antenna are measured by an anechoic chamber. Measured results agree well with the simulated ones.



(a) (b)

Fig.5. Measured and simulated (a) S parameters, (b) Gain and HPBW at H-plane, of the proposed antenna.

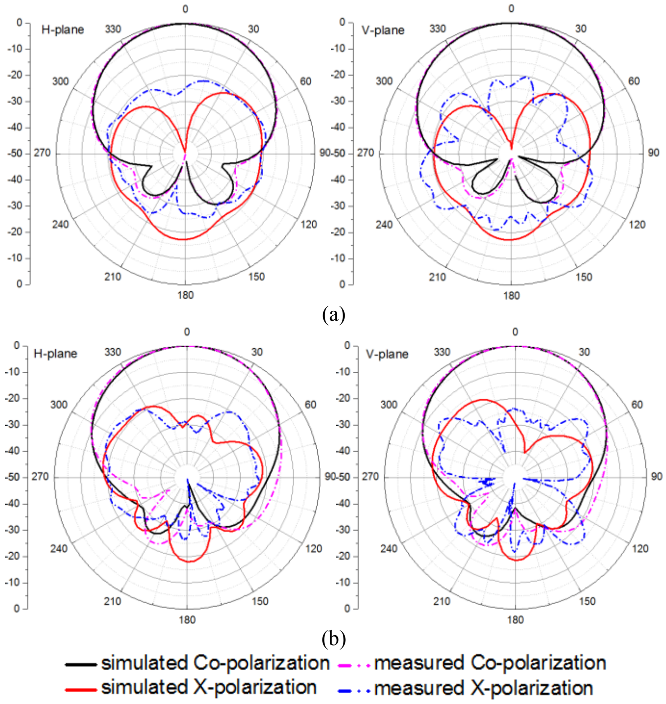


Fig. 6. Measured and simulated radiation pattern of the dual-polarized antenna for 45° polarization at (a) 1.72GHz, (b) 2.8GHz.

4. Conclusion

A stub-loaded broadband dual-polarized antenna has been presented, which has a compact configuration. By using four stubs inside the cross dipole antenna. A new resonate mode is created. And this mode can be moved by adjusting the size of the stub. Therefore, the impedance bandwidth is greatly broadened to 57.5% (1.67 to 3GHz) with |S11|<-15dB. Furthermore, the antenna exhibits stable radiation pattern and low cross polarization. These makes it a promising choice for 2G/3G/LTE base station applications.

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