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A Wideband Circularly Polarized Cross-Dipole Antenna With L-shape Slots

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***Abstract*—A wideband circularly polarized cross-dipole antenna with L-shape slots is proposed in this paper. The proposed antenna contains two pairs of orthogonally placed wide rectangular dipoles and a metal ground. Two L-shape slots are embedded into each arm of the cross dipoles to broaden the AR bandwidth. Simulation results show that an impedance bandwidth of 66.2% from 1.77 GHz to 3.52 GHz and an AR bandwidth of 42.2% from 2.26 GHz to 3.47 GHz are obtained. The average CP gain of the proposed antenna within the operating frequency band is 8 dBic.**

***Keywords*—Circularly polarized; cross dipole; L-shape slot; wideband.**

I. Introduction

In past decades, circularly polarized (CP) antenna have attracted considerable interests for their advantages in low multipath interference, improving the sensitivity of the system and good polarization matching. Nowadays, CP antennas are widely used in modern wireless communication system, such as the global positioning system (GPS), wireless local area network (WLAN), and internet of thing (IoT).

Typically, there are many methods to achieve circular polarization, including the patch antenna [1], magneto-electric dipole [2] and the cross-dipole antenna [3], [4]. For the simple structure and the compendious CP radiation mechanism, cross-dipole antenna has attracted a lot of attention. In [3], a cross-dipole antenna with the wider rectangular patch as its arm is proposed, and the 3-dB axial ratio (AR) bandwidth of 27% as well as the impedance bandwidth about 50.2% are obtained. AR bandwidth of 28.6% is achieved in [4] by adding four parasitic loops into the cross dipole.

In this paper, a wideband circularly polarized cross-dipole antenna with L-shape slot is proposed to achieve wider AR bandwidth and impedance bandwidth. The proposed antenna is mainly composed of two pairs of orthogonally placed wide rectangular dipoles and a metal ground. By embedding two L-shape slots into the wide rectangular arm of the cross dipoles, two separated parasitic elements are formed to improve the impedance bandwidth and the AR bandwidth. Finally, the impedance bandwidth of 66.2% (1.77 GHz -3.52 GHz) and the AR bandwidth of 42.2% (2.26 GHz -3.47 GHz) are realized simultaneously.

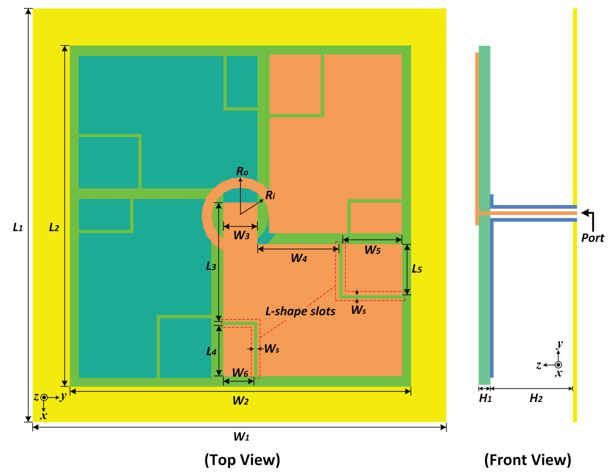

Fig. 1. Geometry of the proposed antenna

TABLE I
Geometrical Parameters for the Proposed Antenna (unit: mm)

L_1	L_2	L_3	L_4	L_5	W_s	R_o	R_i
108	55	17.5	7.5	7.5	0.5	5.7	4.2
W_1	W_2	W_3	W_4	W_5	W_6	H_1	H_2
108	55	5	12	8.75	4.5	1.524	28

II. Antenna Configuration

The geometry of the proposed wideband cross-dipole antenna is shown in Fig.1. In this case, the wide rectangular patch is used as the arm of the cross dipole in order to obtain the broadband performance. The cross dipoles are printed on both side of a Roger 4003C substrate with a dimension of 55 $\times$ 55 mm^2. The thickness of the substrate is 1.524 mm and its relative permittivity is 3.38. Two L-shape slots are embedded into each arm of the cross dipoles and two separated parasitic elements are formed. The proposed antenna is fed by a 50 Ω coaxial cable and a metal ground is places at the back of the proposed cross-dipole antenna as a reflector. The detail parameter values of the proposed antenna are listed in table I.

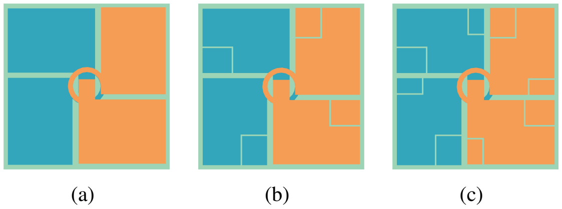

Fig. 2. Performance Comparison Cases. (a) Case 1: Without Slot; (b) Case 2: With One L-shape Slot; (c) Case 3: With Two L-shape Slots.

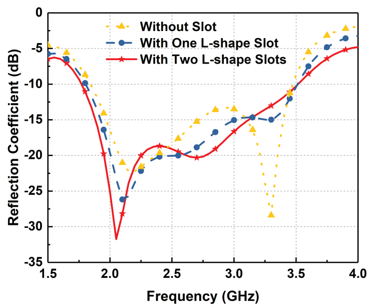

Fig. 3. Simulated Reflection coefficients

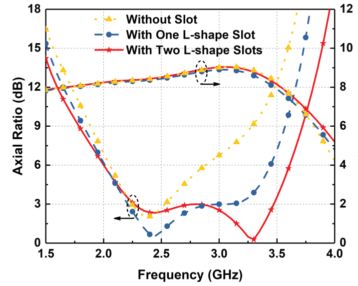

Fig. 4. Simulated Axial Ratio and Gain

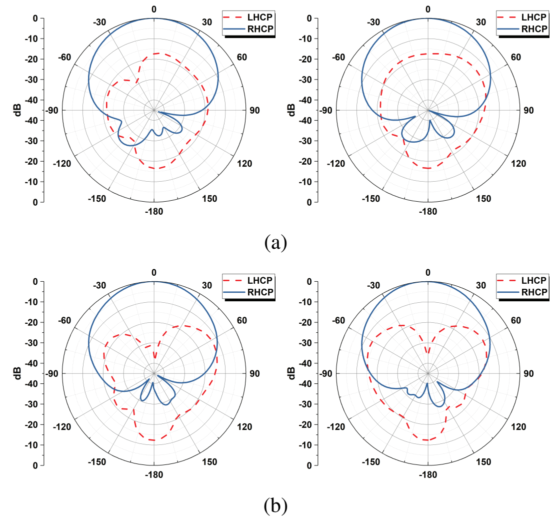

Fig. 5. Normalized Radiation Pattern at *xoz*-plane (left) and *yoz*-plane (right). (a) 2.4 GHz; (b) 3.3 GHz.

III. Antenna Performance Analysis

In order to demonstrate the effect of the two L-shape slots, a performance comparison among three cases is discussed as follows. Three cases are the cross dipole without slot, the cross dipole with one L-shape slot and the cross dipole with two L-shape slots, respectively. The corresponding antenna models of three cases are illustrated in Fig.2. From Fig.3, it is observed that with the increase of the L-shape slot, the impedance bandwidth is just slightly wider. However, it can be seen from Fig.4 that the AR bandwidth has a big change among these three cases. In case 1, the AR bandwidth of the cross dipole without slot is just about 11.7% (2.25 GHz - 2.53 GHz). When one L-shape slot is embedded into each arm of the cross dipoles, the AR bandwidth is broaden up to 33.5% (2.21 GHz - 3.1 GHz). As two L-shape slots are added into each arm simultaneously in case 3, there is the best AR bandwidth performance of 42.2% (2.26 GHz - 3.47 GHz). It concludes that the introduction of the L-shape slot has a benefit for the AR bandwidth. Besides, it is also noted that the gain of these three cases is almost the same. The average CP gain of 8 dBic is realized within the whole operating frequency band and the maximum gain is 9 dBic.

On the other hand, the CP radiation patterns at 2.4 GHz and 3.3 GHz are shown in Fig. 5, respectively. In Fig. 5, the right hand circular polarization (RHCP) gain is always lager than the left hand circular polarization (LHCP) gain, which verifies the proposed antenna is a RHCP antenna.

IV. Conclusion

A wideband circularly polarized cross-dipole antenna with L-shape slot has been presented in this paper. According to the comparison with other cases, the function in broadening the AR bandwidth of the L-shape slot is verified and the AR bandwidth is widen up to 42.2% (2.26 GHz - 3.47 GHz) of the proposed antenna. Simultaneously, the impedance bandwidth of 66.2% (1.77 GHz - 3.52 GHz) and average CP gain of 8 dBic are achieved within the operating frequency band.

V. Acknowledgment

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