Design of Dual Cross Dipole Antennas with Dual Frequencies and Dual Circularly-polarized

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Abstract— An integrated antennas are presented with dual frequencies and dual circularly-polarized (CP) in a common aperture. The proposed integrated antennas are consisted of dual crossed dipole antennas (CDA) with stacked structure, which used 90° self-phase shifting structures in both CDAs for CP wave achieving by adjusting the proportion of the orthogonal arm lengths for 90° phase difference forming. The upper CDA covers 4.7% relative bandwidth from 1.55 GHz to 1.625 GHz with VSWR less than 2 and axial ratio (AR) less than 3 dB of left-hand CP (LHCP) and the nether CDA covers 3.4% relative bandwidth of 2.44∼2.525 GHz for right-hand CP (RHCP).

1. INTRODUCTION

With the rapid development of satellite communication and navigation technology, CP antennas' requirement has greatly aroused, recently. CDA is a common terminal antenna for satellite communication for its well CP performance and broad beam. Usually, the CP performance of CDA is

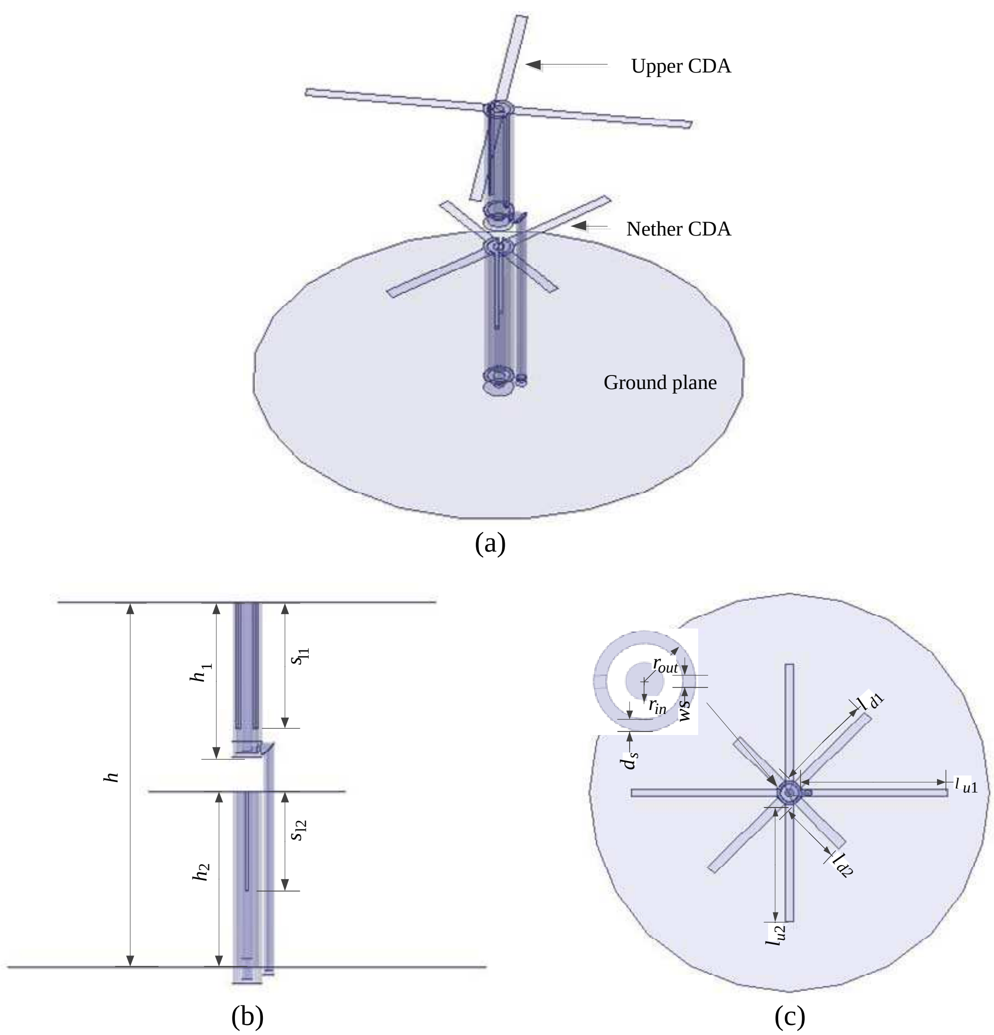


Figure 1: Antenna configuration: (a) 3-D view, (b) side view, and (c) top view.

achieved by orthogonal dipoles with feeding excitations of equal amplitudes and 90° phase difference [1]. However, the feeding excitation is obtained by phase shifting network placing at the back of antenna. CDA can also obtain CP performance using self-phase shifting structure with more simple and reliable structure [2–5]. Several researches are done for frequency band widening, beam broadening and miniature [6–8]. However, designs of CP antennas integrating for multifunction are seldom seen in the published literatures, which is the newest rising requirement for satellite communication and navigation. In Beidou satellite navigation system (BD) application, terminal antenna must radiate dual CP waves at different frequencies for receiving and transmitting. The integrated antennas with dual frequencies for BD satellite navigation's up-link and down-link of LHCP and RHCP radiation patterns.

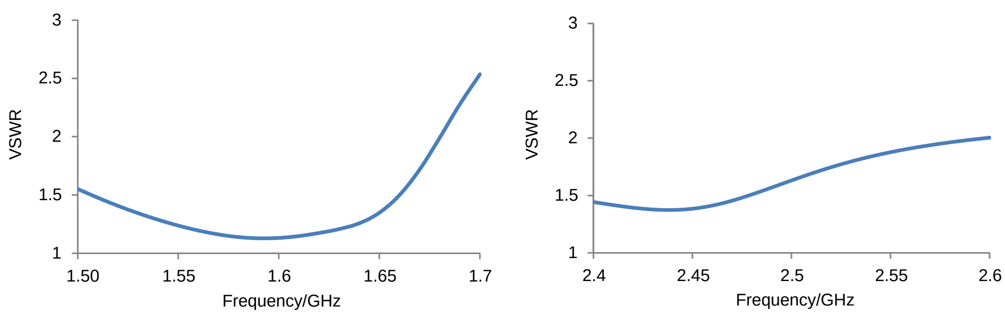
In this paper, we integrate two CDAs with different CP characteristics in a common three-dimensional aperture. The CDA with lower frequency is at the bottom and the other is at the top. The proposed antenna operates at 1.55∼1.625 GHz with LHCP and 2.44∼2.525 GHz with RHCP.

2. ANTENNA CONFIGURATION

The configuration of the proposed dual-frequencies and dual CP antenna is shown in Figure 1(a). The antenna is comprised of two CDAs with low frequency CDA at the top and the high frequency CDA at the bottom. The upper CDA is fed by a coaxial line expanded to the ground and the nether CDA's feeding port is at the ground too. The detail parameter of the proposed antenna is shown in Figure 1(b) and Figure 1(c). The proposed antenna is designed for low AR and well VSWR at the center frequency at 1.616 GHz and 2.492 GHz, which obtained the parameters as: $h = 87$ mm, $h_1 = 39.5$ mm, $h_2 = 42$ mm, $s_{11} = 30$ mm, $s_{12} = 24$ mm, $l_{u1} = 49.6$ mm, $l_{u2} = 38.4$ mm, $l_{d1} = 28.8$ mm, $l_{d2} = 23.2$ mm, $r_{out} = 4$ mm, $r_{in} = 1.5$ mm, $w_s = 1$ mm, $d_s = 1$ mm.

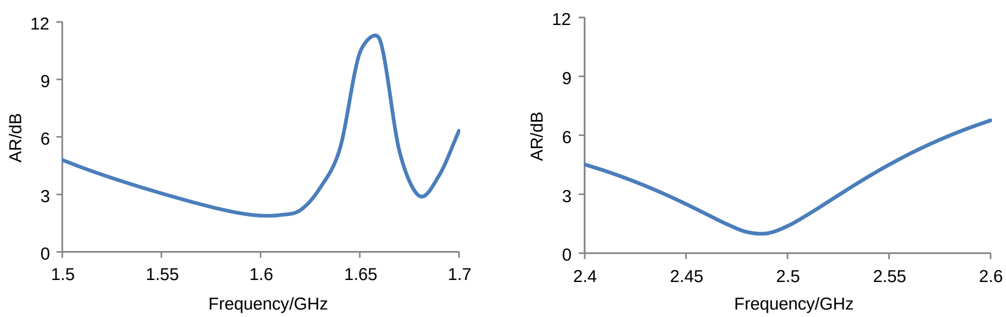
3. SIMULATED RESULTS AND DISCUSSIONS

The proposed antenna is simulated and optimized using HFSS. The simulated VSWR is plotted in Figure 2 and simulated axial ratio is shown in Figure 3. It is seen that the impedance bandwidth (VSWR ≤ 2) of the antenna is much wider than the AR bandwidth (AR < 3 dB), and so the AR bandwidth is considered as the working bandwidth in this paper. Form Figure 3(a), the upper CDA covers 0.075 GHz bandwidth (from 1.55 GHz to 1.625 GHz), which is approximately 4.7% at



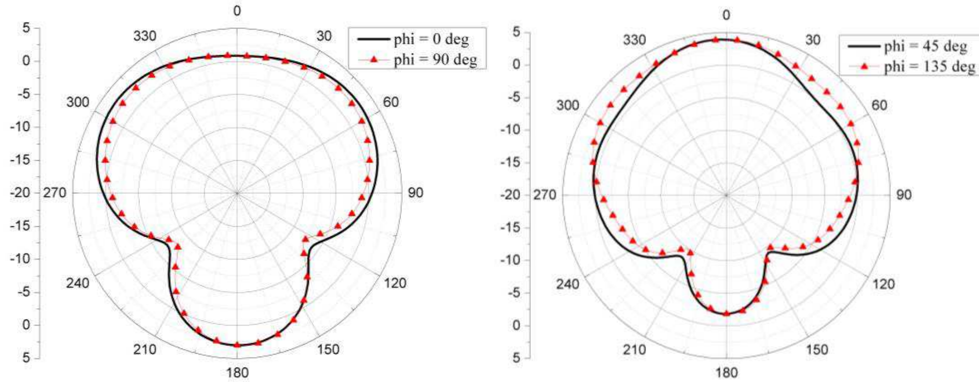
(a) (b)

Figure 2: Simulated VSWR of the proposed antenna.



(a) (b)

Figure 3: Simulated axial ratio of the proposed antenna.



(a) (b)

Figure 4: Simulated radiation patterns at (a) 1.616 GHz and (b) 2.492 GHz.

the center frequency 1.5875 GHz. Form Figure 3(b), the nether CDA covers 0.0857 GHz bandwidth (from 2.44 GHz to 2.525 GHz), which is approximately 3.4% at the center frequency 2.4825 GHz. The frequency bands of the presented antenna cover the BD working band of 1.616 GHz $\pm$ 0.01 GHz and 2.492 GHz $\pm$ 0.01 GHz.

Simulated radiation patterns at 1.616 GHz and 2.492 GHz in the elevation planes of phi = 0 deg and 90 deg are plotted in Figure 4. The gain of 1.616 GHz is larger than -0.5 dBi above the elevation angle of 10 deg, while the two patterns are well consistent. The gain of 2.492 GHz is larger than 0 dBi above the elevation angle of 10 deg, while the two patterns are well consistent.

4. CONCLUSION

An integrated design of two CP antennas in a common aperture has been presented. The operating band with VSWR < 2 and AR < 3 dB is obtained of 1.55–1.625 GHz for LHCP radiation and 2.44–2.525 GHz for RHCP radiation. The proposed antennas exhibit broad beam radiation patterns and appreciable gain above the azimuth angle of 10° at the operating band. These integrated dual frequencies and dual CP antennas are compact in their structures and suit for the BD terminal antennas.

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