Broadband Circularly Polarized Bowtie Dipole Antenna

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Abstract - **A wideband circularly polarized (CP) bowtie dipole antenna is proposed for wireless applications. By employing the bowtie-shape dipoles, the proposed antenna can achieve a wide impedance bandwidth. Meanwhile, by integrating with a curved-delay line which provides a 90° phase difference, the proposed antenna can radiate a CP pattern. Four parasitic square patches are utilized around the radiation patch to enhance the Axial-ratio (AR) bandwidth. The simulated results show an impedance bandwidth for VSWR≤2 of 44.7% (2.02-3.18GHz) and a 3-dB AR bandwidth of 37.3% (2.18-3.18GHz).**

Index Terms — **Circularly polarized, Bowtie antenna, wideband antenna.**

1. Introduction

Circularly polarized (CP) antennas have gained increasing attention in wireless systems such as satellite communication [1], the global positioning system (GPS) [2] due to their great ability in anti-interference, better mobility, and multipath suppression. Cross-dipole antenna is a conventional approach to achieve CP radiation owing to its advantages of relatively lower cost, lighter weight, and simpler structure. The initial realization of the cross-dipole antenna is achieved by employing two crossed dipoles with different lengths, which ensures the two orthogonal fields with equal amplitude and 90° phase difference [3]. However, the restriction associated with the conventional cross-dipole antenna is the narrow impedance. For wideband operation, several approaches have been proposed. A bowtie dipole antenna with impedance bandwidth of 32% and AR bandwidth of 7.3% is proposed in [4]. By employing a sequentially rotated configuration, the dipole antenna in [5] achieves a 30.7% impedance bandwidth and a 15.6% AR bandwidth, respectively. Though these cross-dipole antennas can achieve wide impedance bandwidths, the AR bandwidths are narrow. The cross-dipole antenna in [6] and the cavity-backed detached dipole in [7] can both realize broadband CP properties. The 3dB AR bandwidths range from 26.8% to 30% may satisfy the requirements for modern wideband communication systems. In [8], extra resonances are realized by introducing half-wavelength parasitic resonators, which can generate a new minimum AR point. However, the antenna with the half-wavelength parasitic patches has relatively large sizes.

In this paper, a CP bowtie dipole antenna is proposed, which has a wide AR bandwidth by employing four parasitic square patches. The two crossed dipole elements are designed as a

shape of bowtie, which contributes to achieving a wide impedance bandwidth. In order to generate a CP radiation, a curved-delay line is employed. Four parasitic square patches around the cross-dipole can effectively suppress the cross-polarization and enhance the co-polarization at high frequencies. The proposed antenna can realize the AR bandwidth enhancement. The AR bandwidth can be enlarged from 9.3% of the structure without parasitic patch to 42.8%.
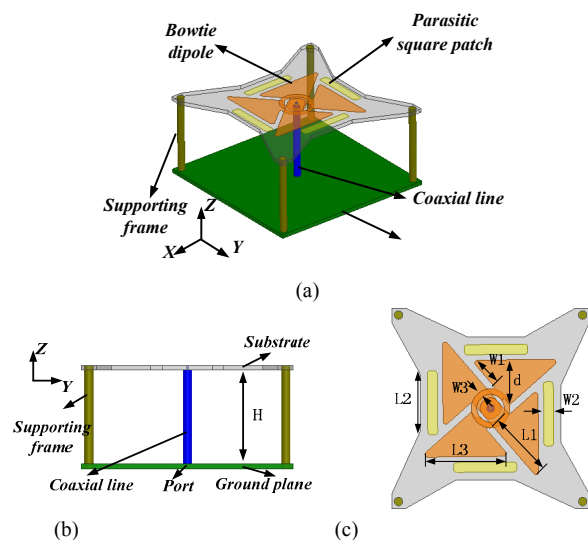

Fig.1. Configuration of the proposed antenna. (a) Perspective view. (b) Side view. (c) detail view. (H=31mm, W1=13.5mm, W2=3.5mm, W3=2.5mm, d=15.6mm, L1=24mm, L2=22.3mm, L3=31.5mm)

2. Antenna Design

The configuration of the proposed cross-dipole antenna is shown in Fig. 1. The proposed antenna is fabricated on a substrate with a thickness of 1.6 mm, a permittivity of 4.4, and a loss tangent of 0.02. The proposed antenna consists of six parts: bowtie dipoles, a curved-delay line, four parasitic square patches, four Supporting frames, a ground plane and a coaxial line. In order to achieve a wide impedance bandwidth, two pairs of bowtie dipoles are employed in the proposed antenna, which are designed on both sides of the substrate. Each pair is formed by two right-angled triangles. A curved-delay line is employed to connect the two bowtie dipoles, which can generate a 90° phase difference. Four parasitic square patches are printed on the same layer of the substrate with the corresponding dipole. The proposed antenna is

located a quarter-wavelength away from the ground plane. The antenna is fed by a 50 Ohm coaxial line at the center.

3. Antenna Results

The bowtie dipole antenna has been proposed following the design dimensions. As is shown in Fig.2, the simulated impedance matching bandwidth for VSWR≤2.0 is approximately 44.6% ranging from 2.02 to 3.18 GHz.
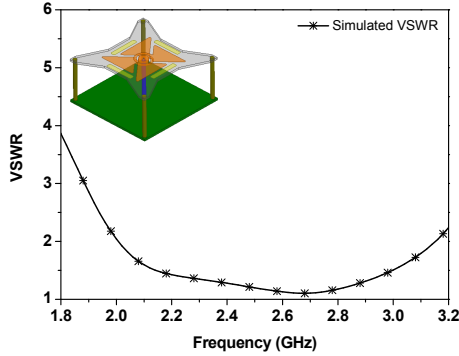

Fig.2. Simulated and measured VSWR.

The radiation patterns at 2.2, 2.6, and 3.0 GHz are respectively plotted in Fig. 3. Simulated results also show stable HPBW, versus frequency in XOZ-plane and YOZ-plane, The results indicate its co-polarization is right-hand circularly polarized (RHCP) and good half-power beamwidths of about 800, 820, and 830 are obtained at the frequencies of 2.2, 2.6, and 3.0 GHz, respectively.
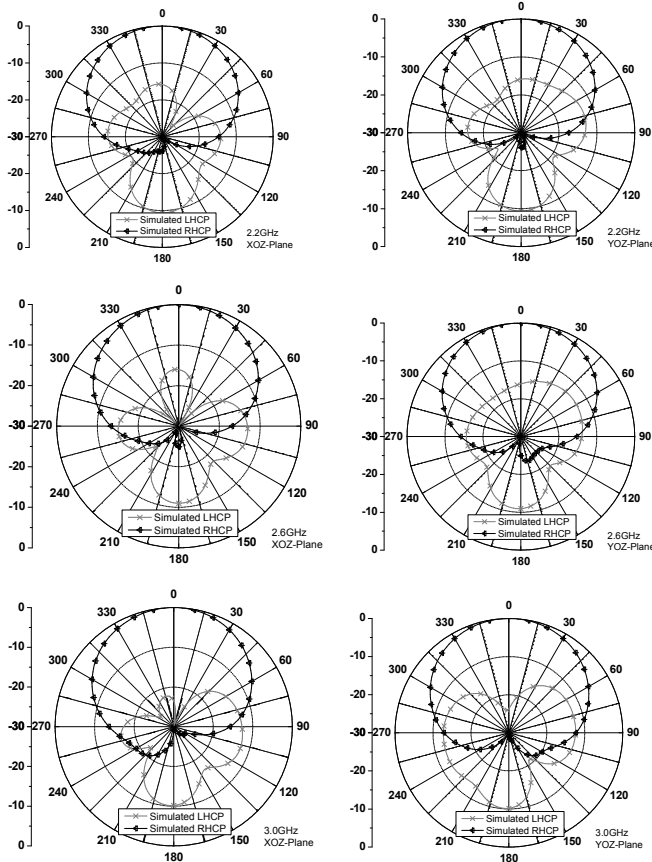

Fig.3. Simulated and measured radiation patterns of the array at 2.2, 2.6, and 3.0GHz.

As apparently depicted by the simulated results reported in Fig. 4, the AR is less than 3.0 dB over the whole operating band ranging from 2.18 to 3.18 GHz. The gain varies from 5.8 to 7.1 dBic in the overall band.
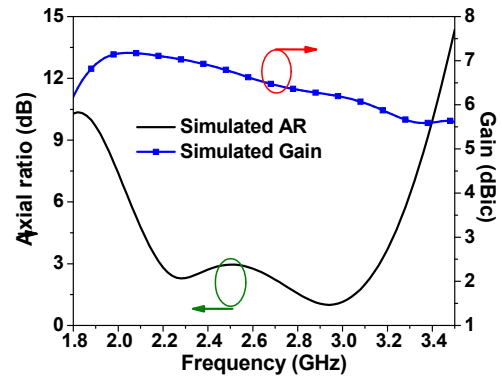

Fig.4. Simulated AR and gain against frequency.

4. Conclusion

A printed cross-dipole with four parasitic square patches is proposed for a broad AR bandwidth. It has been demonstrated that the cross-polarization can be suppressed and the co-polarization can be enhanced by introducing the four parasitic square patches. Hence, a broadband CP performance can be achieved. The proposed antenna can be a good candidate for modern wireless systems.

Acknowledgment

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