A Strip-helical DipoleAntenna with Wide Bandwidth and High Gain

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***Abstract*-A wideband circularly polarized (CP) strip-helical dipole antenna is presented in this paper. Two tapered strip-helixes with one turn are placed over a ground plane and symmetric to each other with respect to the Z-Axis. Each of them is respectively fed with same magnitude and phase difference of 180^o thus the whole radiator works as a helical dipole. Numerical results show that the proposed strip-helical dipole antenna has a wide 3-dB axial ratio (AR) bandwidth of 68%, an average high gain of 11.6dBi and symmetric radiation patterns.**

***Index Terms*—Wideband, helical dipole antenna, circular polarization, high gain.**

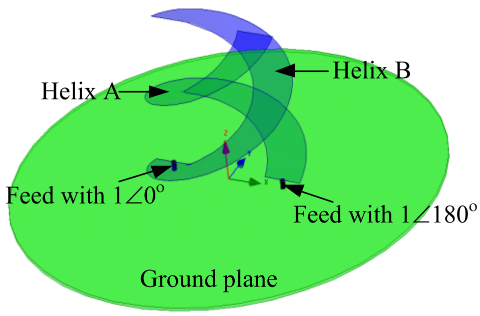
1. Introduction

Wideband circularly polarized (CP) antennas have received much attention in modern wireless communication systems, such as satellite communication, radio frequency identification (RFID), and the global position system (GPS). There are several typical types of wideband CP antennas, such as helical antennas [1], and CP dipoles [2] [3]. A wideband two-arm hemispherical helical antenna, known as a hemispherical helical dipole antenna, has been reported in [4].

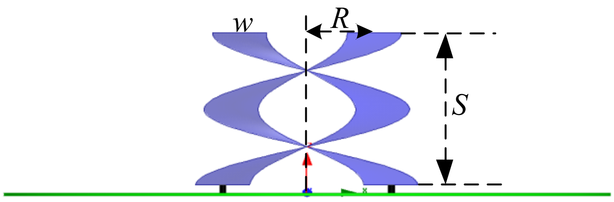
In our pervious work, a wideband single-fed strip-helical antenna [5] has been described, which has wide impedance and axial ratio bandwidths. However, its asymmetric structure deteriorates the characteristics of broadside radiation patterns. In this paper, an idea structure of CP strip-helical dipole antenna with two feed is numerically studied. Results show that it has much better performances on radiation patterns and gain than that in [5].

2. Antenna Structure

The geometry of the proposed strip-helical antenna is demonstrated in Fig.1. It consists of two tapered strip-helixes with one turn, Helix A and Helix B, and a circular ground plane. Helix A and Helix B are symmetric with respect to the Z-Axis. The two strip-helixes have uniform width (w) of 16 *mm* and are rolled in right-hand direction for right-hand circular polarization (RHCP). The radius of one helix (R) is defined as the distance from the Z-axis to the center of the strip. It has an initial value of 25 *mm* at the feed end and linearly reduces to 20*mm* at the open end. The average circumference of one helix C is equal to 141 *mm*. The spacing between turns (S) of one helix is 55 *mm* and the corresponding pitch angle (α=arctan (S/C)) is 21^o. A circular ground plane with a diameter of 180*mm* is laid under the strip-helixes for suppressing back radiation. The distance between the strip-helixes and the circular ground plane is 3 *mm*. Helix A and Helix B are respectively fed with same magnitude and phase difference of 180^o. Thus the proposed strip-helical antenna is named strip-helical dipole antenna.



(a)



(b)

Fig. 1.Geometry of the proposed strip-helical dipole.(a) 3D view, (b) Side view.

3. Results

The performances of the proposed strip-helical dipole are obtained with the aim of the commercial simulation software 'HFSS'. The magnitudeof the current densities (Jsurfs) on the center of the strip along HelixA at 2*GHz*, 2.5*GHz*, 3*GHz* and 3.5*GHz* are displayed in Fig. 2, respectively. Considering the symmetric feature of the two helixes, the magnitude of current distributions on Helix B should be the same as that on Helix A. It is obviously observed that the forward travelling currents decay along Helix A from the feed end to the open end at all frequencies.

Fig. 3 depicts the VSWR for Port 1, axial ratio, and gain against frequency. The proposed strip-helical dipole has an impedance bandwidth (VSWR ≤ 2) of over 52% (2.35*GHz* to 4*GHz* and beyond), A 3-dB AR bandwidth of 68% (1.85

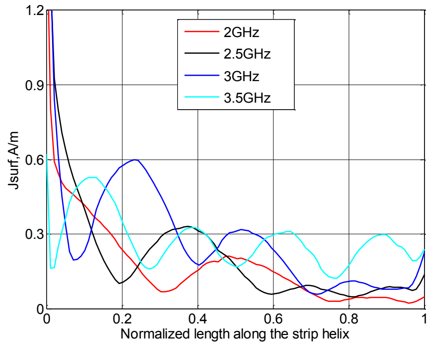


Fig.2 Current densities on the center of the strip along Helix A.

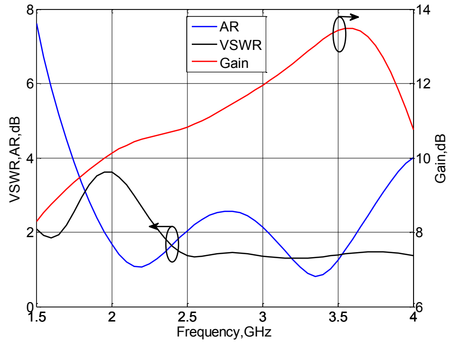


Fig. 3.VSWR, AR, and gain against frequency for the proposed strip-helical dipole antenna.

GHz to 3.8*GHz*). The normalized circumferences of C/λ varies from 0.87 to 1.78 over the AR bandwidth, where C is the circumference of the strip-helix with one turn. From the gain curve, it is clearly seen that the gain varies from 9.7 dBi to 13.5 dBi across the AR bandwidth. The size of the antenna structure is $0.63\lambda_0 \times 0.63\lambda_0 \times 0.55\lambda_0$, where λ_0 is the wavelength in free space at 2.85*GHz*.

Fig. 4 shows the simulated radiation patterns at 1.85*GHz*, 2.85*GHz* and 3.8*GHz*, respectively. The proposed strip-helical dipole antenna works in axial-mode and is right-hand circularly polarized. The radiation patterns are very symmetric about the axial direction at all frequencies owing to the symmetric antenna structure. The front-to-back ratio is more than 12 dB over the AR bandwidth.

4. Conclusion

A tapered strip-helical dipole with circular polarization is proposed. Numerical results show that it has good performances on wide AR bandwidth, high gain and stable radiation patterns.

Acknowledgment

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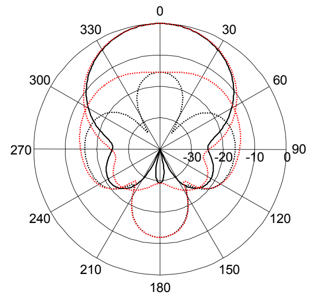

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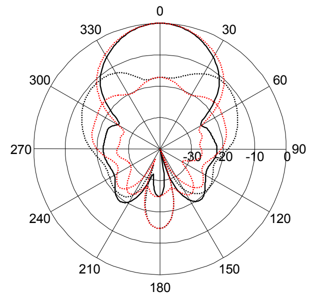

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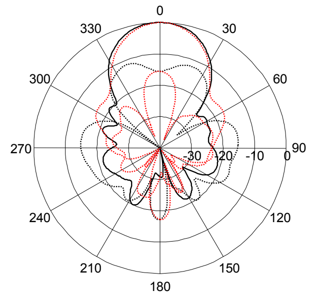

(c)

Fig. 4.Radiation patterns of the proposed strip-helical dipole antenna at 1.85 GHz, 2.85 GHz and 3.8 GHz, respectively. Black line: $\phi = 0^o$ plane, red line :$\phi = 90^o$ plane. Solid line: RHCP, dash line : LHCP. (a) f = 1.85 *GHz*, (b) f = 2.85*GHz*, (c) f = 3.8*GHz*.

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