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A Dual-Band Circularly Polarized Antenna with Slotted Reflector for GPS Applications

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Abstract

In this paper, a dual band circularly polarized (CP) antenna is proposed. The antenna consists of a radiator placed above a slotted reflector at a certain distance resulting in significant improvement of the front to back ratio (FBR). The antenna has a 10-dB impedance bandwidth of about 36 % (1.17-1.69 GHz), with a 3-dB axial ratio bandwidth (ARBW) of 8 % (1.21-1.31 GHz) in the lower band and 11.7 % (1.53-1.72 GHz) in the upper band, which makes the antenna suitable for global positioning system (GPS) applications. The FBR of the antenna is about 20 dB over the frequency bands of interest.

1 Introduction

There has been a remarkable development in wireless communication technologies since the past years. Antennas play an important role in wireless communications. Circularly polarized (CP) antennas have some advantages compared to linearly polarized (LP) ones [1, 2]. One of such advantages is the insensitivity toward the orientation of both transmitter and receiver antennas, causing the reduction of polarization mismatch losses, and reduction of multipath interference and fading effects [3, 4]. Global positioning system (GPS) is used for several applications such as location tracking of vehicles, military and civilian fields [5, 6, 7]. For GPS applications, a right handed circular polarization (RHCP) wave is needed to be radiated. Two different GPS frequency bands are located at 1.227 GHz (L2) and 1.575 GHz (L1). As a result, a dual band CP antenna is required for mentioned application. Another important characteristic of GPS antennas is their front to back ratio (FBR) where the left handed circular polarization (LHCP) wave radiated from the ground should be eliminated or minimized as much as possible in order to avoid interference. In the past years, several techniques have been proposed in order to make an antenna unidirectional, among them are using reflectors, metallic and air-filled cavities [8, 9, 10].

In this paper, a dual band CP antenna with a slotted reflector is proposed, which works in both GPS L2 and L1 bands. The slotted reflector enhances the FBR of the antenna for both frequency bands to a high value, making the antenna suitable for GPS applications.

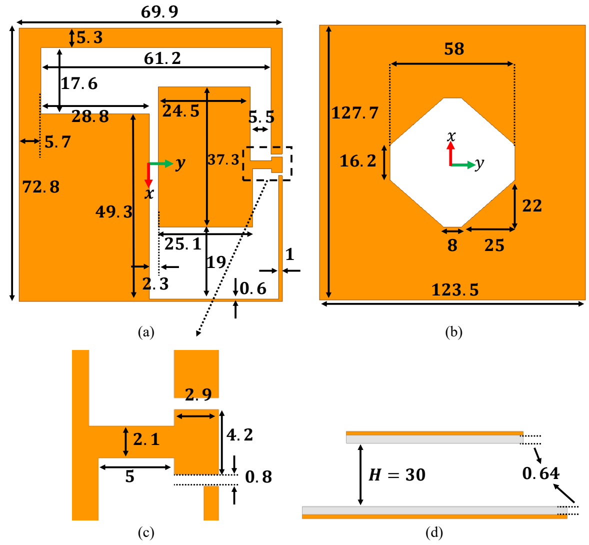

Figure 1. Geometry of the proposed antenna, (a) top view, (b) bottom view, (c) enlarged feeding section, (d) side view (dimensions are in mm).

2 Antenna Design and Geometry

The geometry of the proposed antenna is demonstrated in Fig. 1. It consists of a radiator with the size of $0.28\lambda_0 \times 0.27\lambda_0$ and a slotted reflector with the size of $0.49\lambda_0 \times 0.48\lambda_0$ with a distance of $0.117\lambda_0$ below the radiator, where λ_0 is the lowest frequency of the operating bandwidth. The antenna is designed on a Rogers RO3006 substrate with a dielectric constant of $\varepsilon = 6.15$ and thickness of 0.64 mm. A coplanar waveguide (CPW) structure is used for the feeding of the antenna with a 50 Ω input impedance. To enhance the FBR of the antenna, an octagonal-shaped slot is employed at the center of the reflector. This causes a significant decrease in the LHCP gain value, resulting in an increase in the RHCP gain value at zenith.

3 Simulation Results

The simulation results of the proposed antenna are shown in Fig. 2. As can be seen in Fig. 2 (a), the 10-dB impedance bandwidth of the antenna is about 36 % (1.17-1.69 GHz), and the 3-dB axial ratio bandwidth (ARBW) is about 8 % (1.21-1.31 GHz) in the lower band and 11.7 % (1.53-1.72 GHz) in the upper band, with AR of 1.96 dB at 1.227 GHz and 1.86 dB at 1.575 GHz. Also, as illustrated in Fig. 2 (b),

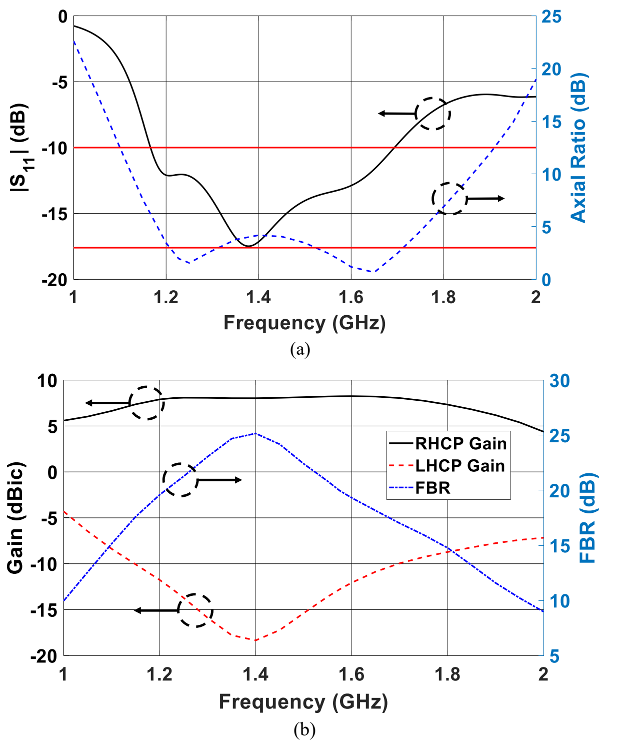

Figure 2. Simulation results of the proposed antenna, (a) reflection coefficient and axial ratio, (b) RHCP gain at $\theta = 0^o$ and LHCP gain at $\theta = 180^o$, along with the FBR.

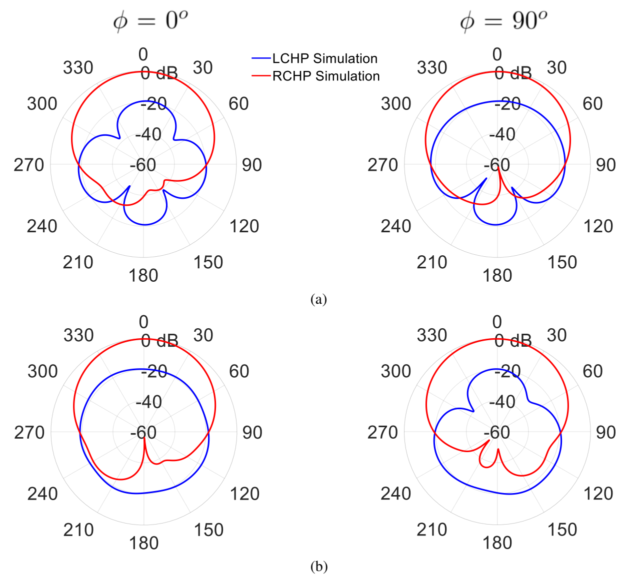

Figure 3. Simulated normalized radiation patterns of the proposed antenna at two different planes of $\phi = 0^o$ and $\phi = 90^o$ in two different frequencies, (a) 1.227 GHz, (b) 1.575 GHz.

the antenna shows a constant 3-dB gain bandwidth of 64.8 % (1 - 1.96 GHz), with values of 8 dBic and 8.2 dBic at L2 and L1 bands, respectively. Furthermore, the FBR of the antenna is about 20 dB and 21 dB at GPS L2 and L1 bands, respectively. Normalized radiation patterns of the proposed antenna at GPS L2 and L1 bands at two different planes of $\phi = 0^o$ and $\phi = 90^o$ are demonstrated in Fig. 3. As can be seen in Fig. 3, the half power beamwidth (HPBW) of the antenna is more than 70 degrees at both frequency bands of interest. The results show that the performance of the proposed antenna is good and acceptable for GPS applications.

4 Conclusion

In this paper, a dual band CP antenna suitable for GPS applications is proposed. The overall size of the antenna is about $0.49\lambda_0 \times 0.48\lambda_0 \times 0.117\lambda_0$ at the lowest frequency of the operating bandwidth. A slotted reflector is placed below the radiator to enhance the FBR of the antenna in the desired frequency bands. The simulation results show an acceptable performance of the proposed antenna for GPS applications.

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