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Microstrip Antenna with Wideband Circularly Polarization

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Abstract
A novel planar microstrip-fed antenna with wideband circularly polarization (CP) is presented. By using a novel dipole structure, wideband circularly polarization is created. The simulated results of the proposed antenna are demonstrated to explain the operating mechanism and to verify the proposed idea.

Keywords:*Microstrip antennas, wideband circularly polarization*

1. Introduction

The antenna is one of the fundamental components in many microwave circuits and systems, such as GPS, wireless local area networks (WLANs), wireless medical monitoring, and mobile communications [1]. Increasing interest of CP antenna design has also been gained in antenna research community due to its intrinsic advantage of insensitivity to depolarization effects and improved immunity to multi path propagation [2-3]. Reviewing the literature reveals a great effort in implementing various methods and techniques for achieving wideband circularly polarized antennas [4-5]. However, most of these feature unsatisfied axial ratio (AR) bandwidth. Since wider bandwidth is the key factor to increase communications speed and capacity, it is highly necessary to propose a novel antenna structure both with wide AR bandwidth and impedance bandwidth.
Microstrip (MS) antenna is one of popular antenna structures because of its inherent merits, i.e., easiness to integrate with other circuit components, low cost fabrication, etc. Many CP antennas with MS structure have been reported [6].
In this paper, a quasi-dipole MS antenna having wideband circularly polarization (relative AR bandwidth: 70.4%) is presented. By using asymmetrical feedline techniques [7] and trimming the radiator shape, wideband circularly polarization is achieved. Compared with reference [8], the proposed structure replaces the rectangular stub with triangle metal which makes it much simpler. Additionally, the height of the triangle, only one physical parameter instead of length and width for the original rectangular stub, can be applied to optimize the AR bandwidth and impedance matching, which simplifies the design process.

2. Design of the CP Antenna

The proposed antenna is developed from the basic dipole configuration [9] with the radiator's shape and feeding position modified and optimized. The whole structure is designed on the RT Duroid substrate with a thickness of 1.6 mm and a dielectric constant of 2.2. It consists of two parts, i.e., the two radiators each of which is a rectangular metal loaded with a triangle stub printed on the top or bottom layer of the substrate and having the same dimensions, the microstrip feedline located asymmetrically with respect to the top layer radiator, as shown in *Figure1*. The rectangular top and bottom radiators can be treated as the two arms of a printed dipole and are separated by the gap, along the y-axis. It is worth to note that the proposed structure is similar with the reference [10] but loading the triangle-shaped stub which makes it much simpler.

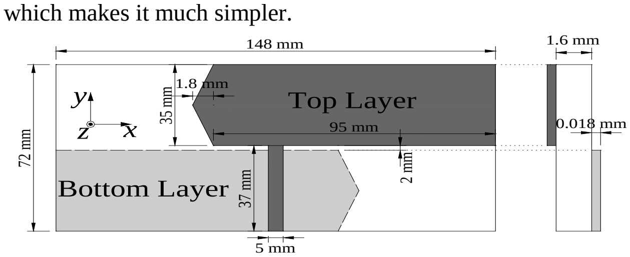

Figure1. Layout of the proposed antenna.

The CP mode accounts for generation of the orthogonal radiation signals with equal amplitude and 90° phase difference. In this work, asymmetrical feedline is used to create orthogonal signals. The amplitude and phase differences can be optimized by tuning the gap between two radiators and the dimensions of the radiators, since the gap and the dimensions of the radiators significantly affect the magnitude and phase differences of the orthogonal signals. The optimized dimensions of the proposed structure are listed in Figure1.

3. Simulated Results

In order to explain the polarization operating mechanism, surface current distribution at 2 GHz on the radiators with various time phases is depicted in *Figure 2*. The polarization sense is left hand (LH) in the +z direction, so LHCP can be achieved.
The simulated S11 value and axial ratio (AR) for the proposed antenna are shown in *Figure 3*. The -10-dB bandwidth and 3-dB AR bandwidth was found to be approximately 2.57 GHz (1.35 GHz – 3.92 GHz, relative bandwidth of 97.5%) and 1.5 GHz (1.38 GHz – 2.88 GHz, relative bandwidth of 70.4%), respectively. *Figure 4* is the LHCP and RHCP radiation patterns.

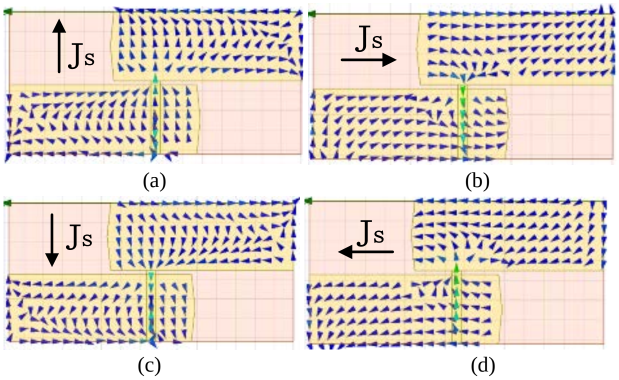

Figure2. Simulated surface current distributions on the proposed antenna (a) 0° , (b) 90° , (c) 180° , and (d) 270°

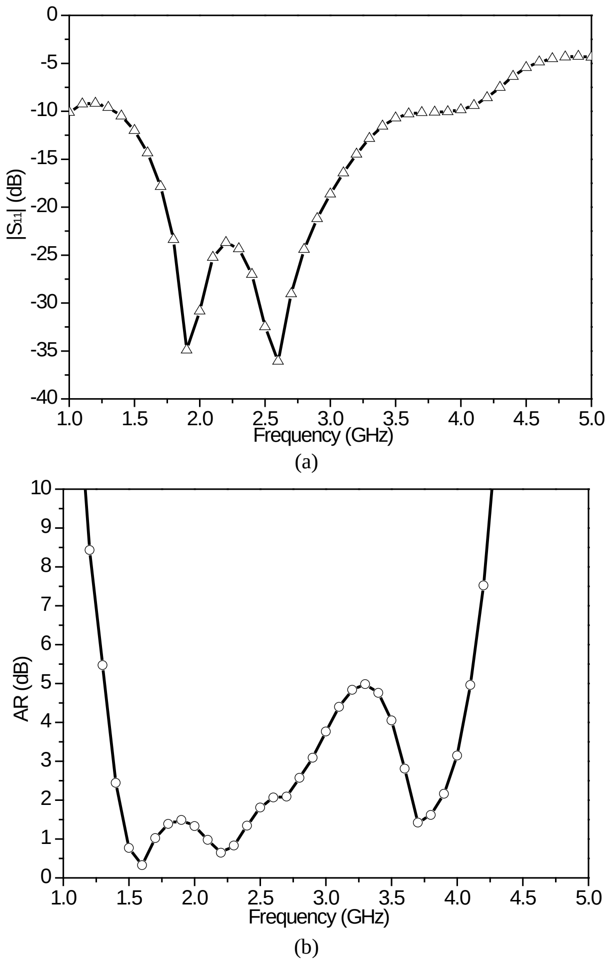

Figure3. Simulated (a) |S11| and (b) AR versus frequency for the proposed antenna.

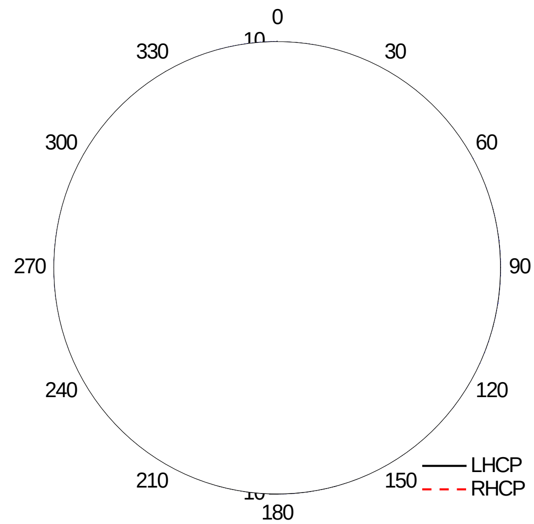

Figure 4. Simulated radiation patterns in the *x-z* Plane (phi = 0°) at 2 GHz.

4. Conclusions

By using a novel dipole structure, wideband circularly polarized antenna is obtained. Simulated results including return losses, radiation pattern, and AR are presented to explain the operating principle and verify the proposed idea. Both wide impedance bandwidth (97.5%) and AR bandwidth (70.4%) are achieved by adopting asymmetrical feedline and optimized radiator. Therefore, the proposed antenna is an excellent candidate for applications such as high speed wireless communications and satellite systems that require high communication capacity.

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