Planar Two-Arm Spiral Antenna Fed by Microstrip Line

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***Abstract*- A planar microstrip-fed two-arm spiral antenna has been designed for achieving wideband circularly polarized bandwidth in this paper. Compared with conventional spiral antennas, a simple feeding line is employed to feed the antenna. The planar structure can be printed using a single layer substrate without an external balun. In addition, the arc-shaped cut is embedded in the ground plane and a tapered impedance transformer is utilized to improve the impedance matching across a wide frequency band. The obtained results confirm that the proposed antenna can achieve a circularly polarized bandwidth from 2 to 4 GHz with the peak realized gain varying from 2 to 3.7 dBi.**

Keywords: wideband antenna, circularly polarized antenna, spiral antenna, microstrip-fed antenna

I. Introduction

In the last several decades, planar spiral antennas have been popular candidates for a variety of applications, as they have advantages of low profile, easy fabrication and providing broadband circularly polarized radiation. However, traditional spiral antennas such as planar Archimedean or equiangular spiral antennas have an intrinsic impedance of above 200Ω and an external impedance transformer is required for matching the 50Ω input port. In addition, it is necessary to employ a feeding balun to excite the two-arm or four-arm spiral antennas, leading to a complicated design and bulky size [1-2].

To maintain the wideband circularly polarized bandwidth while avoiding external feeding networks, several feeding mechanisms have been proposed to excite spiral antennas [3-6]. A stripline-fed Archimedean spiral antenna in [3] has integrated a stripline feeding network into one of its two spiral antennas and can operate from 2 to 20 GHz, though it is fabricated using two layers of substrates. A Dyson balun has been integrated with a planar millimeter-wave two-arm spiral antenna in [4] while it occupies a large size. A compact planar bidirectional wideband modified equiangular spiral antenna with an integrated parallel-plane perpendicular-current feed has been proposed in [5]. It has achieved a frequency range from 3.1 to 10.6 GHz, while it needs two layers of substrates with the feeding network and equiangular spiral arms printed on different substrates respectively. In addition, H. Nakano has proposed a single-arm wideband spiral antenna which is fed by a coaxial feed and can radiate circularly polarized wave [6]. The presented antenna can provide directional radiation patterns when a low-profile cavity is employed.

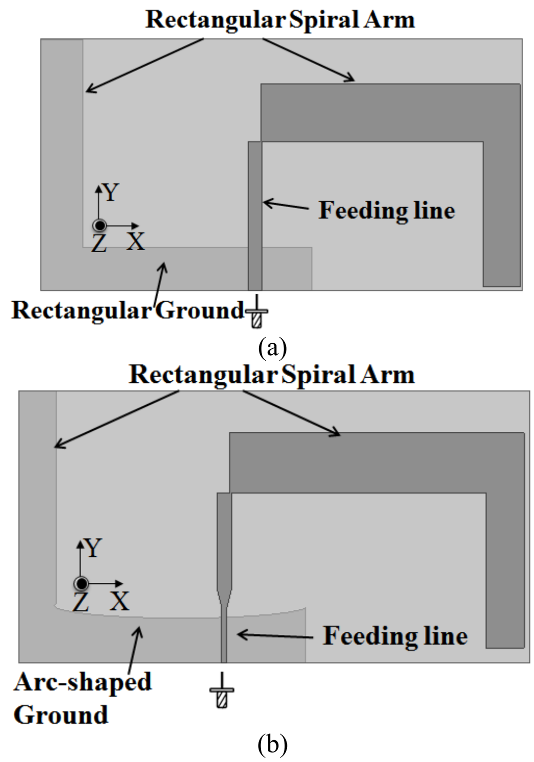

Figure 1. Geometry of the proposed microstrip-fed two-arm spiral antenna (a) with a rectangular ground and feeding line, (b) a modified ground and a tapered impedance transformer.

In this paper, a planar microstrip-fed two-arm spiral antenna is proposed. A single layer of FR4 substrate is employed with two arms printed on opposite sides of the substrate. An integrated tapered impedance transformer has been integrated with the antenna to improve the impedance matching over a wide frequency band. The rest of the paper is organized as follows: the configuration, design and results of the proposed planar two-arm spiral antenna are demonstrated in Section II, a conclusion is drawn in Section III.

II. Antenna Design

Figure 1 presents the configuration of the proposed planar two-arm spiral antenna, which is printed on a low-cost FR4 substrate. The structure presented in Figure 1(a) is formed by two half-turn rectangular spiral arms and a microstrip line with one arm acting as a ground plane. Compared with traditional spiral antennas which require feeding baluns, the proposed

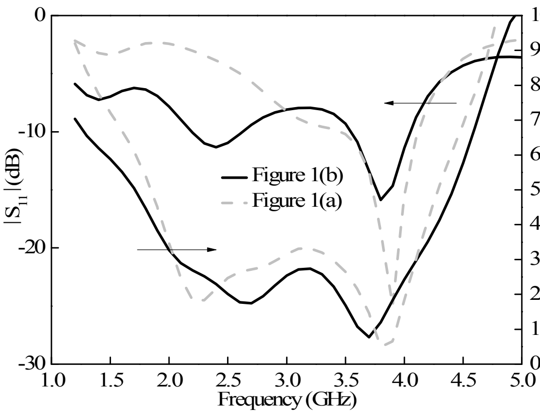

Figure 2. Simulated results of reflection coefficient and axial ratio of the proposed antenna.

design can achieve wideband circularly polarized bandwidth with a simple feeding line. To further improve the impedance matching, a tapered impedance transformer has been employed and an arc-shaped cut is embedded in the ground plane. The simulated results of reflection coefficient and axial ratio are compared in Figure 2. As observed, both designs have a 3-dB axial ratio bandwidth of 50% (2-4 GHz) due to the characteristic of the two-arm spiral antenna while the design in Figure 1(a) with a rectangular ground plane and feeding line only resonates at a single frequency, leading to a narrower bandwidth. However, the design in Figure 1(b) with arc-shaped cut in the ground plane and a tapered impedance transformer has better impedance matching over a wide frequency band from 2 to 4 GHz. The impedance matching over a broader bandwidth can be achieved when the number of turns is larger. The simulated left-handed circular polarization (LHCP) and right-handed circular polarization (RHCP) radiation patterns in two principal planes at different frequencies are presented in Figure 3. As shown, the presented configuration can generate LHCP wave in the +Z direction while RHCP wave in the –Z direction. A reflector or absorber can be employed when unidirectional patterns are required. Figure 4 presents the simulated peak realized gain across the frequency band. It is shown that, the peak realized gain of the proposed antenna increases from 2 to 3.7 dBi when the operating frequency ranges from 2 to 4 GHz.

III. Conclusion

The design of a microstrip-fed two-arm spiral antenna has been designed in this paper. It consists of two rectangular spiral arms and a simple feeding line. The proposed antenna can achieve a circularly polarized bandwidth from 2 to 4 GHz while the external feeding balun is not needed.

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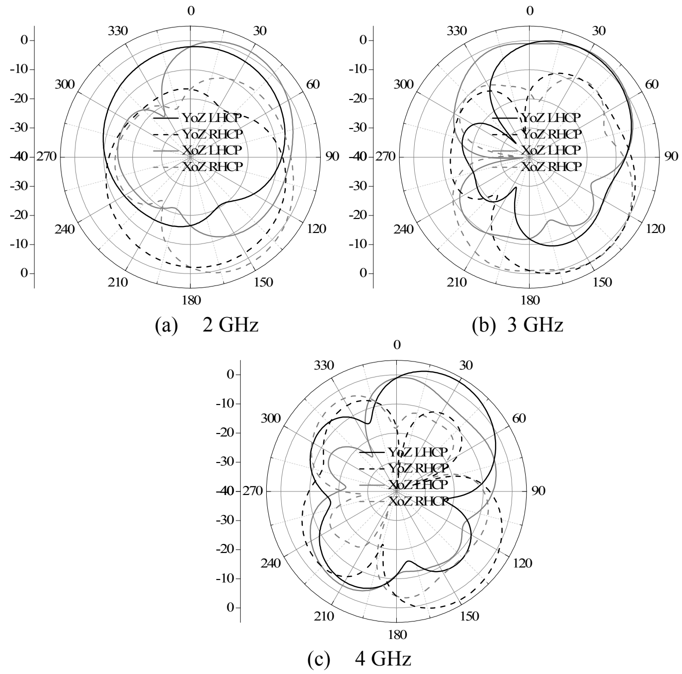

Figure 3. Simulated LHCP and RHCP radiation patterns in two principal planes at different frequencies.

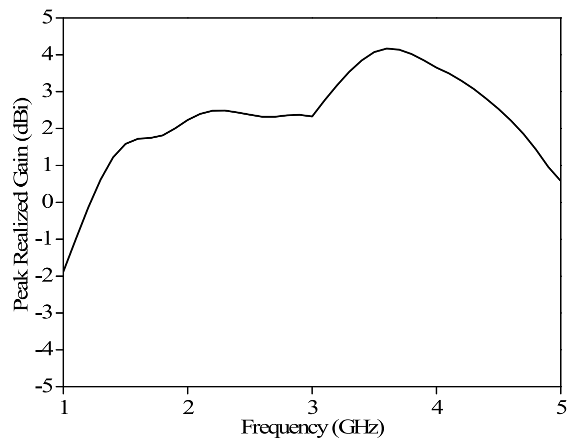

Figure 4. Simulated peak realized gain across the frequency band.

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