A compact circularly polarized SIW slot antenna

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***Abstract* - A substrate integrated waveguide (SIW) cavity-backed slot antenna with circularly polarized radiating pattern is presented. Four circular radiation slots and four insert metallic via arrays are introduced to from the radiation waves. Some metallic vias in the center of the cavity are set to prevent the fundamental mode. The proposed antenna have the advantage of a compact structure and high axial ratio (AR) performance, the measured reflection coefficient is 3.7%, the simulated and measured axial ratio is 1% and 0.8%, the minimum point is 0.37 dB at 10 GHz and 1.2 dB at 9.94 GHz, respectively. The measured maximum gain is 6.64 dBic in 9.94 GHz as well.**

***Index Terms* — Circularly polarized antenna, Compact, Slot antenna, Substrate integrated waveguide.**

1. Introduction

Circularly polarized (CP) antennas are widely used in wireless communication and satellite communication systems, multiple techniques are used to perform the circular polarized waves, such as the patch antenna and the slot antenna. Recently, the substrate-integrated waveguide (SIW) techniques are introduced to design CP antennas [1]-[7]. A SIW cavity backed CP antenna with dual-mode fed by microstrip line have been studied in [1]. Low profile SIW cavity backed, crossed slot antennas for dual frequency, dual linear polarization and circular polarization applications have been proposed in [2], with the comparison of the slot antennas, the radiation pattern are discussed, the proposed antennas are suitable for planar integration. A novel compact dual-mode monopulse cavity backed SIW antenna has been analyzed in [3], [4]. The TE_{10} and TE_{20} modes are excited in the multimode section to produce sum and difference pattern, by using this antenna element, a high efficiency CP monopulse cavity backed SIW antenna array is performed. In order to get the high performance of circularly polarized radiation, a slot split ring resonator has been introduced in [5], in which two orthogonal modes are carefully excited, the CP waves is formed. In [6], a compact CP SIW array antenna has been presented for the high gain and conical beam, the array consists of four CP SIW slot antenna and a probe feed section in the centre. A ring slot radiates energy and a pin in the ring slot is used to generate circular polarization. The gain performance is critical for the CP antenna, in order to get high gain performance of the CP antenna, a planar dual-mode SIW cavity backed CP antenna element is reported [7]. By introducing perturbing structures, a simulated high gain with 10.28 dBi is obtained. Owing to the compact structure, the antenna element is easy to from the arrays.

In this paper, we propose a compact slot antenna based on circular SIW cavity for radiating CP waves. By inserting four array of metallic vias, a CP slot antenna is obtained.

2. Antenna Design

The geometry of the proposed slot antenna is shown in Fig. 1. The SIW cavity is constructed by metallized via arrays, a Rogers-duroid 5880 substrate with thickness h=1.57 mm, dielectric constant of 2.2 and loss tangent of 0.0009 is employed in the design scheme.

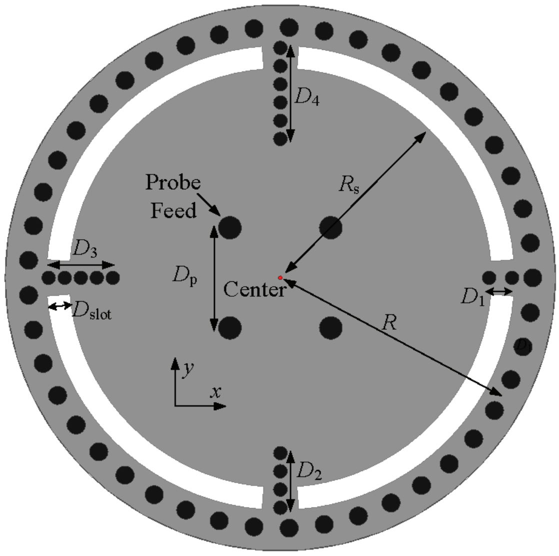

Fig. 1. Geometry of the proposed antenna. R=12 mm, R_s=9.2 mm, D_{slot}=1 mm, D_1=1 mm, D_2=2.4 mm, D_3=2.8 mm, D_4=4 mm, D_p=4.4 mm.

The SIW cavity backed antenna consists of two pairs of slots, four inserted via arrays and four shorted vias. The signal is excited by a coaxial probe which located in the ground plane. Four inserted via arrays are employed to introduce perturbation, and then two orthogonal degenerate modes are formed in the SIW cavity. The shorted vias arranged around the center can prevent exciting TM_{010} mode in the operating band, two pairs of slots which etched on the edge of the cavity, are used to radiate elements. Consequently, the CP radiation pattern is produced when the waves combined in the far field. The simulated reflection coefficient and RHCP gain are depicted in Fig. 2, the simulated refection coefficient below -10 dB is 4.3% from 9.77 to 10.2 GHz, the maximum RHCP gain is 7.98 dBic at 10.02 GHz. The measured refection coefficient below -10 dB is 3.7% from 9.75 to 10.12 GHz, the maximum RHCP gain is 6.64 dBic at 9.94 GHz. The discrepancy between the measured and simulated reflection coefficient may be caused by the SMA connector used for measurement.

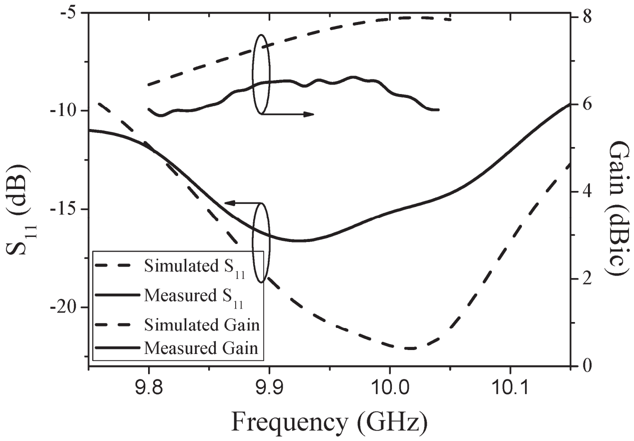

Fig. 2. Measured and simulated reflection coefficient and the gain.

Fig. 3 shows the top view and bottom view of the photograph of the fabricated antenna and the simulated and measured AR performance. The simulated 3-dB AR bandwidth is 1% from 9.95 to 10.05 GHz, the minimum point is 0.37 dB at 10 GHz. The measured 3-dB AR bandwidth is 0.8% from 9.90 to 9.98 GHz, the minimum point is 1.2 dB at 9.94 GHz. A small amount of frequency shift can be observed in Fig. 3, it is probably caused by the fabrication errors and the connection errors between the antenna and the SMA connector.

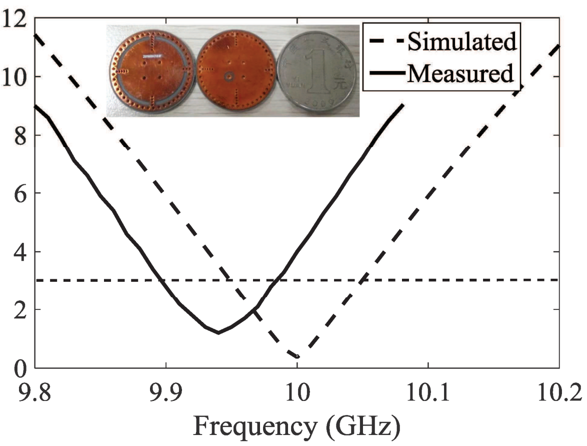

Fig. 3. AR performance of the designed antenna and its photograph.

Fig. 4 shows the simulated and measured radiation patterns at 9.94GHz of the designed antenna in two orthogonal cut planes, and the RHCP radiation is behaved. In the XZ plane the simulated half power bandwidth (HPBW) of RHCP is 64° (-28°~38°). In the YZ plane the simulate HPBW of RHCP is 64° (-26°~36°).

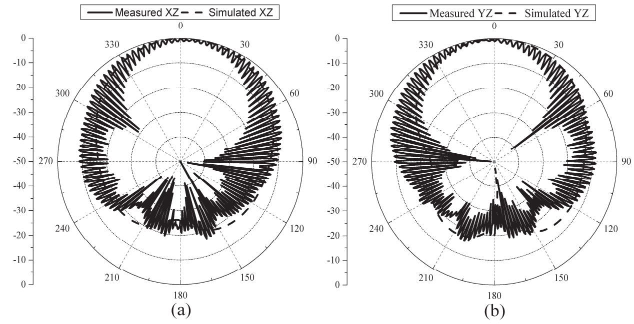

Fig. 4. Radiation patterns of the proposed antenna at 9.94 GHz, (a) XZ plane and (b) YZ plane.

3. Conclusion

In this paper, a compact cavity backed slot antenna based on the SIW techniques is designed. By introducing inserted via arrays, good CP performance and high gain is obtained. The simulated and measured performances of the designed antenna are agree well.

Acknowledgment

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