A Circularly Polarized Radial Line Dielectric Resonator Antenna Array

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***Abstract* - This paper presents a circularly polarized dielectric resonator antenna (DRA) array. The DRA array feeds by a radial waveguide, to simplify the traditional feeding structure. The proposed dielectric resonator antenna array, feeding by four ports excited with a difference phase equal to 90°, working at 12GHz, achieves a directivity of 26 dBi, a aperture efficiency of 44% and a good circularly polarization property.**

***Index Terms* — dielectric resonator antenna; antenna array; circularly polarized.**

1. Introduction

The dielectric resonator antenna (DRA) is a kind of high efficiency antenna. Based on its easily manufactured and low cost, DRA is widely used in the communication system.

DRA array has many feeding modes. However, traditional feeding structures have its own disadvantages. Stripline feeding network has complex structure and power loss through stripline transmission [1]. Waveguide probe feeding structure causes difficulty to process [2]. Accordingly, we need to excite DRA arrays in a high efficiency and simple processing way.

The radial line slot antenna (RLSA) is a slotted waveguide planar antenna, which is a high efficiency and high gain antenna for DBS reception [3]. Generally, the transmission loss in a waveguide is very small in comparison with other feedlines such as a microstrip line and a suspended line. Many researchers have used various methods to adjust the RLSA parameters in order to have better gain, directivity, and other characteristics [4]. Xiang-Qiang Li has proposed to use the radial line waveguide to excite helix antenna array [5], which proves feasible in using radial line waveguide to feed the antenna array. And a linearly polarized radial line dielectric resonator antenna array has been proposed.

In this paper, we propose to use a circularly polarized radial line waveguide as a feeding structure to excite the DRA array.

2. Antenna Structure

Fig. 1 shows the structure of a concentric arrangement circularly polarized radial line dielectric resonator antenna array. It is composed of two parts. One is the resonator antenna array (DRA) (labeled 1 on Fig. 1) , the other one is radial line waveguide (labeled 2-5 on Fig. 1). The top layer of the waveguide (label 2 on Fig. 1) precisely arranged slot pairs to feed the DRA array. Label 3 is the feeding structure, which includes four feeding coaxial probes. We fill the dielectric into the waveguide for the purpose of suppressing grating lobes. The dielectric constant is ε_r=1.6.

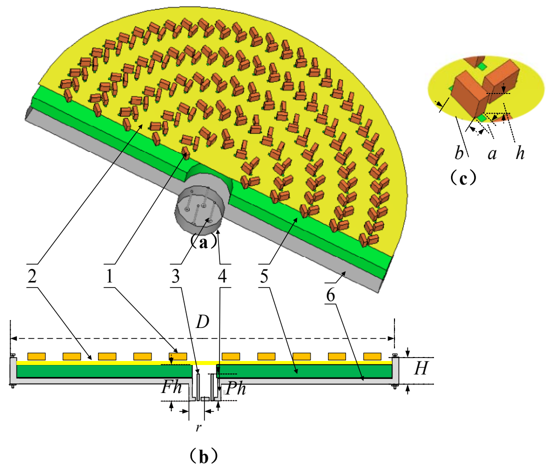

Fig. 1. The structure of radial line dielectric resonator antenna array (a) three-dimensional structure (b) section plan (c) the magnified DRA array in section(a).

There has a clearly magnified view in Fig. 1 (c) shows the DRA structure, which has a dielectric constant of ε_r=6.15 selecting Rodgers RO3006 material (label 1 on Fig. 1) and dimensions of *a*, *b* and *h* and are mounted on the top layer of the waveguide to radiated electromagnetic energy from slots.

In the design process, we adopt the basic design principles to optimizatize the circularly polarized radial line dielectric resonator antenna array, just as follows [6].

1) To realize circular polarization arrangement, the array elements are arranged as concentric circles. All slots of different circles radially spaced by one dielectric guide wavelength. Each slot pairs of same circles rotate the same phase. A couple of slots tilted 90° one respect the other in order to get the left hand circular polarization.

2) Two DRAs, which have the same angle along the radial direction are used as a unit radiator. Besides, two DRAs of a unit are perpendicular to each other to create circulary wave and place right on the corresponding slots.

3) The rotating angle of each unit is decided by numbers of units in the same circle. Each pair of slots in the same circle are at a distance of 1/4 waveguide wavelength.

The parameters of the designed antenna can be obtained in table I.

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TABLE I

Antenna Parameters for the Analysis (UNIT:MILLIMETERS)

Dimension	Value
λ_0	25
λ_g	20
D	240
H	8
A	2
B	5
H	4
ε_r	6.15
SL	7
R	12.5
FH	15.4
PH	7.65
FX	6.5

3. Results and Discussions

(1) Return Loss

Fig. 2 shows the return loss of the DRA array. As the figure shows, the reflection coefficient of the circular polarized radial line dielectric resonator antenna array are both less than - 10dB from 11.7GHz to 12.2GHz and produces a strong resonance in the 12 GHz, which meets the requirement of circularly polarized radial line dielectric resonator antenna array.

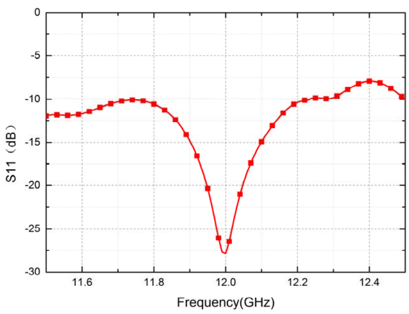

Fig. 2. The return loss of the DRA array.

(2) Gain and Axial ratio

Fig. 3 shows the simulated directivity radiation pattern of the array in 12 GHz at *YOZ* plane. The peak directivity appears at the axial direction as we designed. This DRA array achieves a directivity of 26 dBi with 368 elements and thus obtains an aperture efficiency of 44% at 12 GHz. The main beamwidth of the circular polarized radial line dielectric resonator antenna array is wide, which leads to the low orientation.

Fig. 4 presents the curve of gain and axial ratio when the frequency changes from 11.4GHz to 12.6GHz. We can see from the curve that the gain is relatively stable over the entire frequency range and the axial ratio is less than 3dB too.

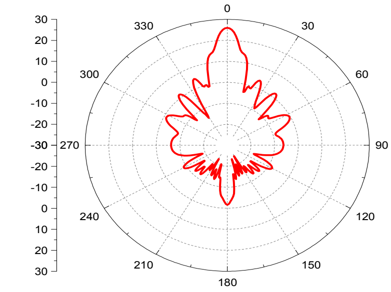

Fig. 3 The directivity pattern of the DRA array.

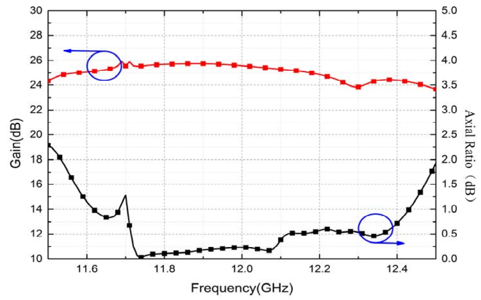

Fig. 4 The gain and axial ratio of the DRA array.

4. Conclusion

We presented a DRA array, fed by radial line waveguide to simplify the feeding structure. The structure is very simple, radial line slot antenna excited by four vertical posts, so we can reduce the processing complexity. Moreover, the DRA array achieves a directivity of 26 dBi, an aperture efficiency of 44%, which shows good characteristics of the antenna. But the aperture efficiency is not ideal, so we need a further optimization.

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