Cross-Arranged Dielectric Resonator Antenna with Cross Slot Excitation

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***Abstract* – A broadband circularly polarized (CP) dielectric resonator antenna (DRA) is investigated in this paper. There are four identical dielectric resonators (DRs) arranged into a cross configuration and excited by a cross slot. A significant enhancement in the axial ratio (AR) bandwidth is found due to their inherited sequential structures, with the antenna has the input impedance bandwidth of 31.2% from 4.06 to 5.56 GHz, and the 3-dB AR bandwidth of 24.2% from 4.24 to 5.41 GHz. Moreover, the presented CP DRA has a compact and low-profile structure. This design demonstrates an idea to widen the AR bandwidth of the CP DRA.**

***Index Terms* — Dielectric resonator antenna, circularly polarized, broadband.**

1. Introduction

Dielectric resonator antenna (DRA) has drawn a number of attentions these years [1] due to its low cost, high efficiency, compact structure, and convenience of excitation. With the starting investigation of the linearly polarized DRA, the enhancement of the bandwidth is the primary challenge. Nowadays, more efforts have been concentrated on the circularly polarized (CP) DRA [2]-[8] due to the higher requirement of the communication system. For example, the CP DRA can provide a polarized flexibility for the antennas in the satellite navigation system. The bandwidth, especially, the 3-dB axial ratio (AR) bandwidth is still the major parameter to evaluate the performance of the CP DRA system. Compared to the CP patch antennas [9]-[11], the CP DRAs can provide wider 3-dB AR bandwidth and higher efficiency.

There are many techniques to excite a circular polarization from DRA, the simplest way is to use dual feed with the same amplitude and orthogonal phase [2]. However, an external power divider or a coupler is required for phase and power distribution. Instead of the dual feed methodology, a singled feed [3]-[5] can also use to excite the CP DRA. For example, the DRA with a single parasitic patch for circular polarization was investigated in [3] with a single feed that achieved an AR bandwidth of 2.4%. The cross-slot-coupled feed [4] and circular-slot-coupled feed [5] are other two typical methods to excited DRA with circular polarization by the single feed excitation, despite the achieved AR bandwidths were narrow. To broaden the AR bandwidth, various techniques were applied. Multilayer DRs have been used to enhance the AR bandwidth in [6] with cross-slot feed. However, the height of the whole antenna was increased. This problem also exists in [7] which the 3-dB AR bandwidth is as wide as 21.5%. It is presented a low-profile CP DRA in [8] with a wide AR bandwidth, nonetheless the unwanted back radiation was large.

In this paper, a wideband CP DRA excited by a cross slot is investigated. The radiators of the antenna are bowtie shaped DRs arranged into a cross configuration, which can

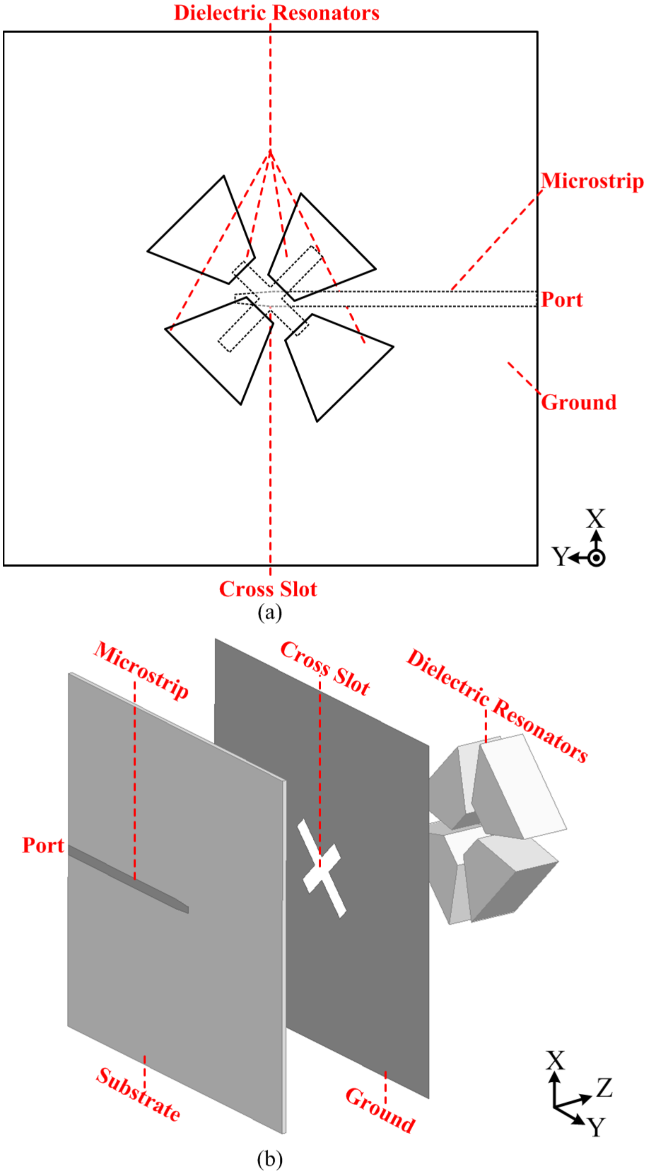

Fig. 1. Configuration of the CP DRA.
(a) Top View (b) Exploded View

enhance the AR bandwidth of the antenna. Moreover, the CP DRA with a compact and low-profile structure have a low back radiation.

2. Antenna Design

In Fig. 1, the configuration of the cross-slot-coupled four bowtie shaped DRA with a dielectric constant ε_r=10 is shown. By using the cross slot with different lengths of the two arms, two fields with equal amplitudes but 90° phase differences in the four DRs can be obtained. Therefore, it can generate a circularly-polarized field-radiation in the DRA. To obtain a satisfactory impedance matching bandwidth which can fully cover the 3-dB AR bandwidth, the end of 50-Ω microstrip line printed on the dielectric substrate which used to feed the cross slot is designed in the shape of trapezoid.

3. Antenna Performance

(1) Input Impedance matching and Axial Ratio

The simulated results of the standing wave ratio (SWR) and axial ratio (AR) of the CP DRA is shown in Fig. 2. It is found that the input impedance bandwidth is 31.2% with the working frequency range from 4.06 to 5.56 GHz, and he AR bandwidth is 24.2% with the operating frequency range from 4.24 to 5.41 GHz.

(2) Radiation Pattern

Fig. 3 shows the simulated broadside radiation patterns of the CP DRA in both planes at the center frequency of 4.83 GHz. It is found that the back radiation is relatively low when it is compared with conventional DRA designs.

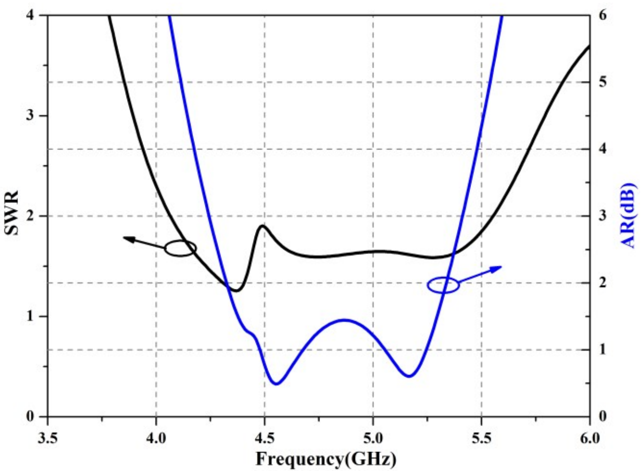

Fig. 2. Simulated SWR and AR of the CP DRA.

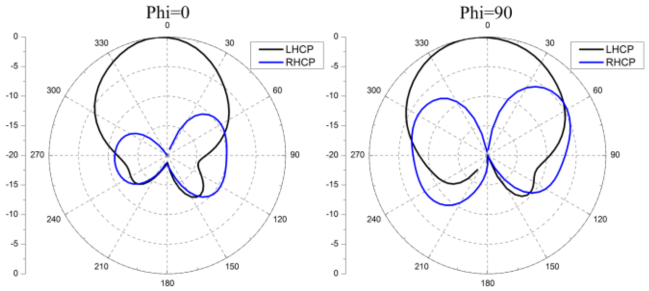

Fig. 3. Simulated radiation pattern for the CP DRA at 4.83GHz

4. Conclusion

This paper has demonstrated a technique to enhance the bandwidth and the 3-dB AR bandwidth of the CP DRA by using a cross configuration of four DRs excited by the cross slot. The AR bandwidth is 24.2%, with an obvious enhancement on the AR bandwidth. Moreover, the presented CP DRA has a compact and low-profile structure. The far-field radiation pattern is stable. In addition, this antenna can yield advantages of low back radiation.

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