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# A Survey on recent techniques to achieve Circular polarization for Wideband Dielectric Resonator antenna

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## ABSTRACT

This article deals with a technical survey of wide- band dielectric resonator antenna (DRA). The goal of this survey is, to feature the strategies utilized by different authors in attaining the large bandwidth and circular polarization in Dielectric Resonator Antenna. Initially, a general thought about Dielectric resonator antenna and its advantage is introduced, and afterward all the advancements made in the DRA to achieve wideband and circular polarization is featured. The accentuation of the paper is on the wideband characteristics of the DRA. The present cutting edge and all the feasible highlights of the DRA are presented.

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## INTRODUCTION

This paper discusses Dielectric resonator antenna which has the potential to replace microstrip antenna specially at high frequency. There are certain advantages that DRA offers such as it has high radiation efficiency, negligible metallic losses, adaptable structure, cheap, low profile and availability of dielectric material having dielectric constant ranging from 1 to 1000.Many present and potential future wireless communication applications require broadband antennas which can work over a wide frequency range. This article first examines the achievable bandwidth by a simple shape dielectric resonator antenna. Then the modern enhanced techniques presented by different authors are discussed.

The bandwidth of the dielectric resonator antenna is inversely proportional to the dielectric constant of the material. Due to this reason the best wideband performance can be achieved by using the material having lower dielectric constant. The simple rectangular dielectric resonator antenna having relative permittivity of 10 can achieve a bandwidth of about 20 percent; moreover the cylindrical shaped dielectric resonator antenna can achieve the percentage bandwidth in the 20 to 30 percent. This result does not include the effects due to the feed line. It is possible to achieve higher bandwidth performance by exciting more than two modes.

There are various methods proposed in literature to enhance the bandwidth of dielectric resonator antenna. One such technique is to make use of stacked configuration wherein two dielectric of different permittivity is stacked together in order to achieve the enhanced bandwidth performance[1-9]. The bandwidth achieved ranges from 25 to 80 percent. Analogous results have been achieved by modifying the shapes of the dielectric and by considering different feeding structure [10-21]. Furthermore, there is one more method called as hybrid design wherein, dielectric resonator antenna is combined with other antennas such microstrip antenna, monopoles etc in order to achieve enhanced bandwidth performance up to 117 percent. All these techniques are making use of the principle of combining resonance of individual antennas to obtain the broad bandwidth.

This paper deals with the review of some of the recent techniques used by authors to achieve wideband as well the circular polarization. The circular polarization provides the definite advantage over Linear Polarized DRA such as low polarization loss and reduced fading and multipath effects.

## RECTANGULAR DRA WITH ORTHOGONAL MICROSTRIP FEED LINE[22]

To obtain high gain circularly polarized wideband dielectric resonator antenna, the author discusses a new way of feeding the Dielectric resonator antenna using microstrip lines which are perpendicular to each other; it is being used to fed the single element DRA. The microstrip lines are perpendicular as wells as the length has been properly selected in such a way that the lines have a phase difference of 90 degree, this article also discusses the array of single fed DRA using microstrip line as excitation. A 6 dB power divider has been properly designed in order to feed all the elements of the array. The dielectric material used is having the relative permittivity of 20. The impedance bandwidth obtained is 17 percent (6.2 to 7.35 GHz) and the axial ratio obtained is 10 percent (6.2 to 6.85 GHz).The peak gain obtained is 13.6 dBi. Figure 1 depicts the design of single DRA fed using two orthogonal microstrip feedline design.Figure 2 presents the top view and side view of array of DRA (4 elements). The reason the two microstrip lines have been used is to excite two orthogonal modes TE111 with 90 degree phase shift, this leads to the higher bandwidth. The number of elements used in array is 4.Table 1 provides all the dimensions that has been used in order to design the antenna.

## STACKED RECTANGULAR DRA WITH FEEDLINE INSERTED[23]

In [23], a novel technique has been proposed for wideband as well as compact DRA. The design has two rectangular DRA and the microstrip feed line is inserted between the two rectangular DRA. The impedance bandwidth obtained is 88.2 percent (4.78-12.32 GHz) and the design provides low cross polarization. Figure 3 depicts the design wherein feed line has been inserted between two rectangular DRA (RDRA).Figure 4 presents the expanded side-view of the design. Table 2 provides the dimension of all the parameters that has been used in the design.

## LATTICE STRUCTURED DRA[24]

This article presented new design of lattice structure DRA, which helps in achieving broad bandwidth using compact structure. The design was backed by the cavity which made use of substrate integrated waveguide technology; this was done in order to reduce the surface wave losses. The peak gain obtained is 9.6dBi and the bandwidth obtained is 39 percent. The slot feeding is used for excitation. Figure 5 presents the geometry of lattice structure rectangular DRA. Table 3 provides the dimension of all the parameters that has been used in the design.

## STAIR SHAPED SLOT EXCITATION OF RECTANGULAR DRA EMBEDDED BETWEEN HALF CYLINDRICAL DRA[25]

In this paper [25], a new design in which rectangular DRA is been placed between two split half cylindrical DRA. The entire structure is excited using slot excitation having the shape of stairs. This structure provides both circular polarization as well as broad bandwidth. The bandwidth achieved is around 41 percent. Figure 6 depicts the design of the antenna wherein rectangular DRA is placed between two cylindrical DRA kept on the top side and this antenna is excited using stair shaped slot. Table IV list down all the dimension of the parameters that is used in the geometry.

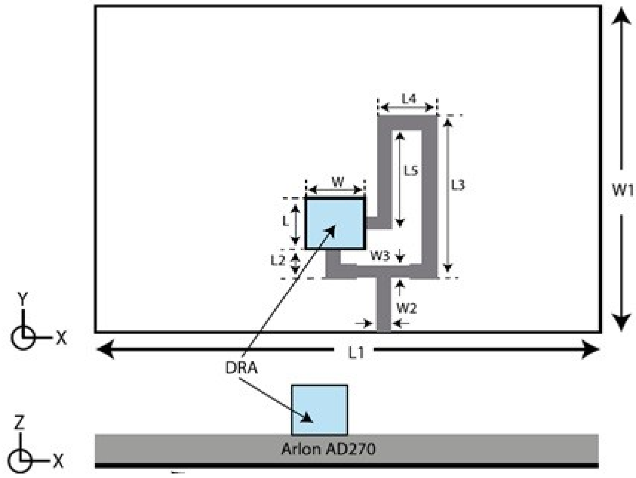


**Fig. 1. Rectangular DRA with orthogonal microstrip feeding line having 90 degree phase shift[22]**

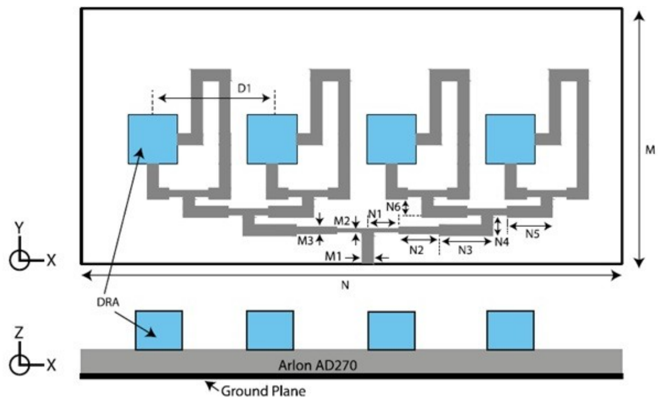


**Fig. 2. Top view and side view of array of DRA [22]**

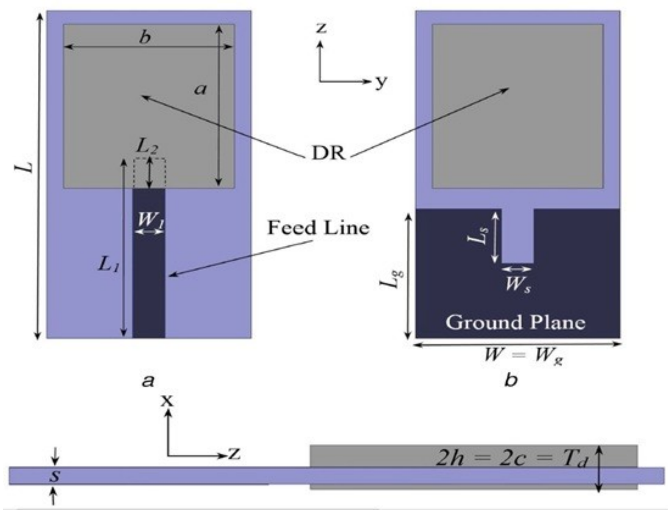


**Fig. 3. Geometry of the stacked design with feedline inserted between them[23]**

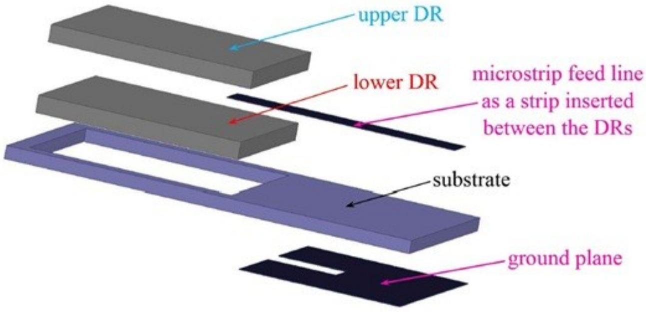


**Fig. 4. Expanded sideview of stacked design with feedline inserted between them**

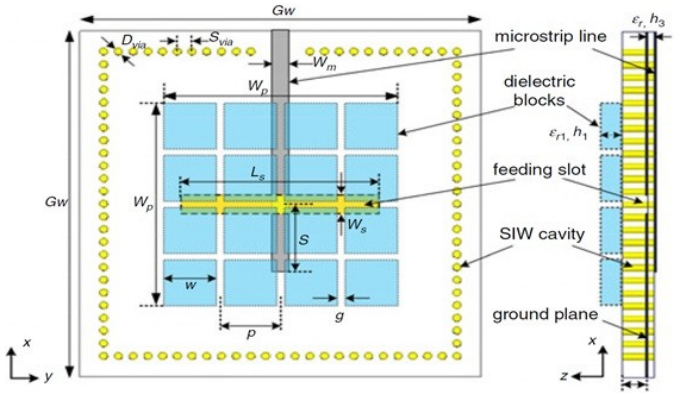


**Fig. 5. Configuration of the lattice structured DRA with Substrate integrated waveguide based cavity backed [24]**

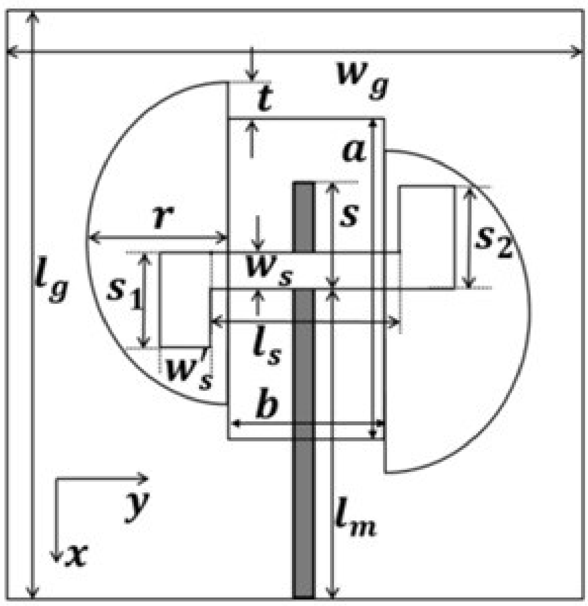


**Fig. 6. Geometry of the stair shaped slot excitation of rectangular DRA between two split half cylindrical DRA**

**TABLE 1 Parameter Dimensions of Rectangular DRA with Orthogonal Microstrip Feedline[22]**

| Parameter | Dimension (mm) | Parameter | Dimension (mm) |
|---|---|---|---|
| L | 9.525 | $W_2$ | 2.13 |
| $L_3$ | 24.9 | $L_1$ | 70 |
| $W_3$ | 1.2 | $L_4$ | 7.5 |
| $W_1$ | 48 | $L_2$ | 6.7 |
| $L_5$ | 12.37 | $D_1$ | 23 |
| $N$ | 135 | $M$ | 48 |
| $M_1$ | 2.13 | $M_2$ | 0.58 |
| $M_3$ | 1.2 | $N_1$ | 6 |
| $N_2$ | 7.77 | $N_3$ | 10.3 |
| $N_4$ | 4 | $N_5$ | 8.68 |
| $W$ | 9.25 | $N_6$ | 3.54 |

**TABLE 2 Parameter Dimensions of Staked DRA with Feedline inserted in betweem**

| Parameter | Dimension (mm) | Parameter | Dimension (mm) |
|---|---|---|---|
| L | 24 | $W = Wg$ | 12 |
| a | 11 | b | 9 |
| c=h | 1 | $Ws$ | 1.9 |
| s | 0.75 | $Lg$ | 9.5 |
| $W_1$ | 1.9 | $L_1$ | 11 |
| $L_2$ | 2.6 | $Ls$ | 4 |

**TABLE 3 Parameter Dimensions of Lattice Structure DRA [24]**

| Parameter | Dimension (mm) | Parameter | Dimension (mm) |
|---|---|---|---|
| $ttw$ | 50 | $Wp$ | 28 |
| $sr$ | 45 | $p$ | 7 |
| $g$ | 0.7 | $h_1$ | 2.2 |
| $Ls$ | 24 | $Ws$ | 1.2 |
| $S$ | 9.7 | $h_2$ | 3.25 |
| $Wm$ | 1.8 | $h_3$ | 0.813 |
| $Svia$ | 1.8 | $Dvia$ | 1 |

**TABLE 4 Parameter Dimensions of Stair Shaped Slot Excitation of Rectangular DRA embedded between Half Cylindrical DRA [25]**

| Parameter | Dimension (mm) | Parameter | Dimension (mm) |
|---|---|---|---|
| $a$ | 24 | $b$ | 12 |
| $h$ | 45 | $r$ | 7 |
| $s$ | 0.7 | $t$ | 2.2 |
| $lg$ | 24 | $wg$ | 1.2 |
| $S_1$ | 9.7 | $S_2$ | 3.25 |
| $lm$ | 39.25 | $h_3$ | 0.813 |
| $Ws$ | 1.8 | $Ws^j$ | 2.5 |

**TABLE 5 Performance Comparison**

| | Orthogonal microstripline fed RDRA | feedline inserted between RDRA | Lattice structure RDRA | RDRA between half CDRA |
|---|---|---|---|---|
| $fc$ | 6.11 | 48 | 6.3 | 4.75 |
| $sr$ | 20 | 20 | 45 | 12.8 |
| excitation | Microstrip fed | Microst rip fed | slot fed | stair shaped slot fed |
| Max Dimension | 70 × 48 | 24 × 12 | 50 × 50 | 80 × 80 |
| BW(GHz) | 6.22-6.85 | 4.92-6.21 | 4.43-6.58 | 4.24-6.57 |
| BW(%) | 10 | 88 | 39 | 49.67 |
| Max Gain(dBi) | 13 | N/A | 9.6 | N/A |
| Ref | 1 | 2 | 3 | 4 |

## COMPARISON

Table 5 provides the comparison of different performance parameters such as percentage bandwidth, type of excitation, compactness of antenna, maximum gain achieved and dielectric constant used.

## CONCLUSION

This article is an effort to review and compare some of the recent advances that have taken place in the field of dielectric resonator antenna. The primary focus was on the articles that aimed towards achieving broad bandwidth as well as which tries to achieve circular polarization. The performance comparison of some of the recent techniques is done.

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