ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 5, Issue 4, April 2018

# Circularly Polarized 2 Element Rectangular Dielectric Resonator Antenna Array

[1] Khudkhudiya Heema, [2] Dr.Yagnesh Shukla, [3] Prof. Renuka Makwana
[1][2][3] Svit Vasad , Gujarat, India

**Abstract: Circularly-polarized (CP) rectangular Dielectric Resonator Antenna (DRA) array is designed on 5.8GHz. Initially, a single element DRA is designed by feeding with two orthogonal microstrip lines to obtain circular polarization. The gain of the proposed DRA array is 5.11dBi obtained over the 5.8GHz. This DRA can be used for WLAN.**

**Keywords— Dielectric resonator antenna (DRA), Microstrip feed, Circular polarization**

## I. INTRODUCTION

Dielectric resonators antenna (DRA) was first proposed by professor Long in 1983, the DRAs have been an active research area for the last two decades due to the several characteristics such as high radiation efficiency, small in size, light weight and low profile [1]. Antennas that use dielectric resonators experience very low loss, so they ensure higher efficiency without conductor loss [1]. DRAs are able to perform with different performance such as wide-band, ultra- wideband, dual-band, and multi-band. In adittion DRAs can produce circular polarized field by exiting orthogonal modes [1]. There are three major dielectric resonator shapes; Hemispherical, Cylindrical, Rectangular which rectangular one has more advantages rather than two others because of having two aspect ratios and simplicity of fabrication. Various types of feeds can be employed to excite DRAs such as Microstrip feedline, coaxial probe, aperture coupling, and coplanar waveguides (CPWs) [1].

The DRA versatility in shape and feeding mechanism gives the antenna designers the freedom to select among many different options in order to attain desired radiation characteristics, such as linear or circular polarization (CP) and broadside or monopole-like radiation patterns [2]. Initial studies of DRAs were concentrated on linearly polarized (LP) designs [2]. As compared with LP systems, CP systems are less affected by the problems of antenna misalignments and propagation effects [2]. The main methods for the generation of circular polarization by dielectric resonator antennas may be categorized as single-feed, double-feed, and multiple-feed structures [2]. The technique for generating circular polarization using a single excitation relies on exciting two quasi-degenerate modes in the dielectric resonator antenna that are spatially orthogonal and in phase quadrature [2].

The antenna element is presented in Section II. The design and analysis of the proposed antenna are discussed in Section III. In Section IV, the simulated results for Dielectric resonator antenna.

## II. ANTENNA DESIGN

### *1 Single Element DRA*

Using two sides of orthogonal feeding, linearly polarized antenna converted into circularly polarized antenna because of their input generate same magnitude. In this paper, a rectangular DRA has been excited by two orthogonal microstrip lines technique with 90° phase difference between them. By adding extra λ+λ/4 length to one feed line with respect to another, the 90° phase difference has been created. The DRA elements have been placed in series with a distance of 25.86 mm. It yields a higher gain in broadside direction with a gain of 5.11 dBi.

Resonant frequency of TEnml mode:

$F_0 = c/2\pi \sqrt{\epsilon_r} \times \sqrt{k_x^2 + k_y^2 + k_z^2}$ (1)

$k_x = m\pi/a$ , $k_y = n\pi/b$ , $k_z = l\pi/2d$ (2)

$k_x^2 + k_y^2 + k_z^2 = \epsilon_r k_0^2$ (3)

Using equation no 1,2,3, find the dimensions of dielectric element. In equation no 2,value of the n,m,l is 1,1,1 and resonant frequency is 5.8GHz.

The configuration of the single element DRA has been shown in Fig. 1. It has been use Alumina for dielectric material of dielectric constant 9.8 with length and width of 10.14 mm each and FR4 substrate with thickness of 1.5 mm, and dielectric constant of 4.4. The height of the DRA has been 20.28 mm. The microstrip line technique has been used to feed the DRA.

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 5, Issue 4, April 2018

The λ/4 length is not enough to feed the DRA horizontally for this design. So using λ+λ/4 length, DRA element horizontally to feed. In DRA, excited two orthogonal TE111 modes with 90° phase shift and circular polarization is achieved.

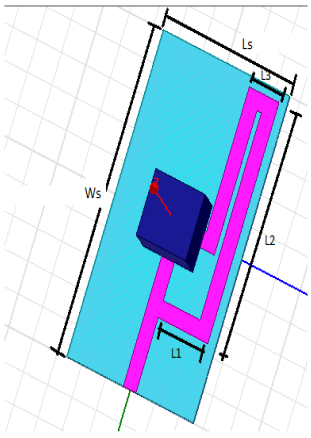


***Figure 1: Schematic diagram of the DRA element. L=W=10.14mm, Ws=50mm, Ls=12.93mm, L1=12.8mm, L2=34.6 mm, L3= 6.1 mm, L4=22.245 mm, L5=3.05 mm.***

***2 2 elements DRA array***

Structure of 2 elements DRA array is shown in figure 2. Distance between 2 DRA elements is λ/2.

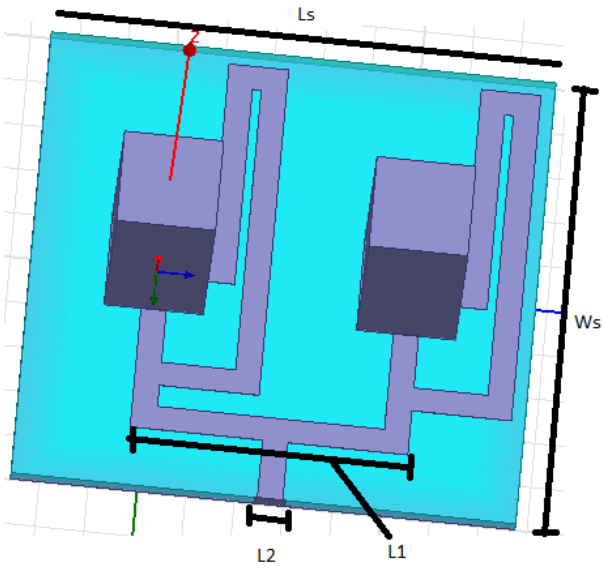


***Figure 2: Design of Rectangular DRA array with orthogonal feeding for 2 element, Ws=50 mm, Ls=51.72 mm, L1=28.46 mm, L2= 2.6 mm***

## III. SIMULATED RESULTS

A. Single element

The CP-DRA element excited in TE111 mode resonates at 5.8 GHz.

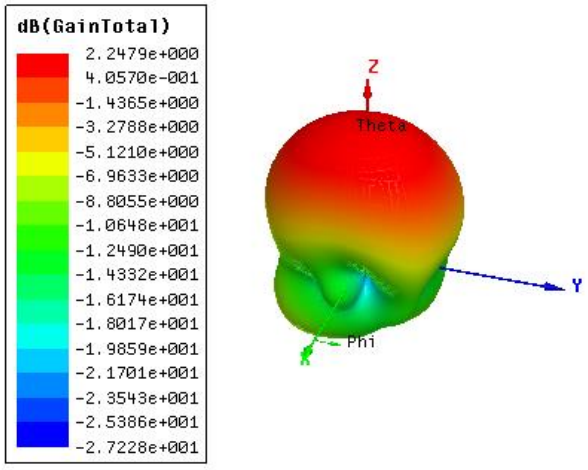


***Figure 4: Gain of a rectangular DRA at 5.8 GHz***

For single element, value of gain is 2.24dBi. Their directivity of single element is 8.06dB.

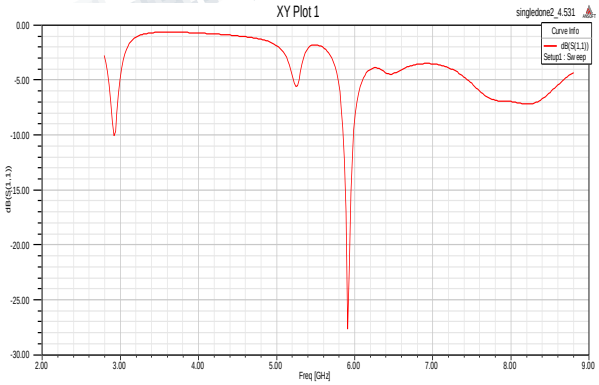


***Figure 5: Return loss of a rectangular DRA at 5.8 GHz***

The simulated result of DRA is in the figure 4 and figure 5. Return loss S(1,1) of single element is -12.3dB. The two DRA elements have the same dimensions. The proposed 1×2 DRA array has been shown in Fig. 4. FR4 substrate with λ/4 transformer to have equal power distribution to all output ports.

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 5, Issue 4, April 2018

***B. 2 elements DRA array***

A simulation results for the proposed structure has been from Alumina materials of εr=9.8 as shown in Figure. 6.

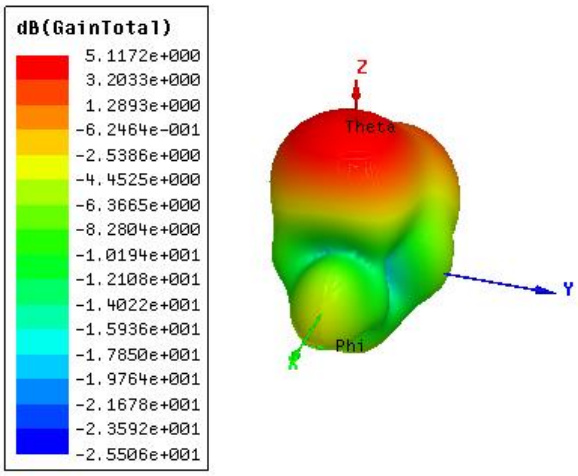


***Figure 6: Gain of 2 elements DRA array***

In shown in figure 7, return loss of 2 elements DRA array. Gain is increase 2.24 to 5.11dBi. Directivity of 2 elements DRA array is 8.97dB.

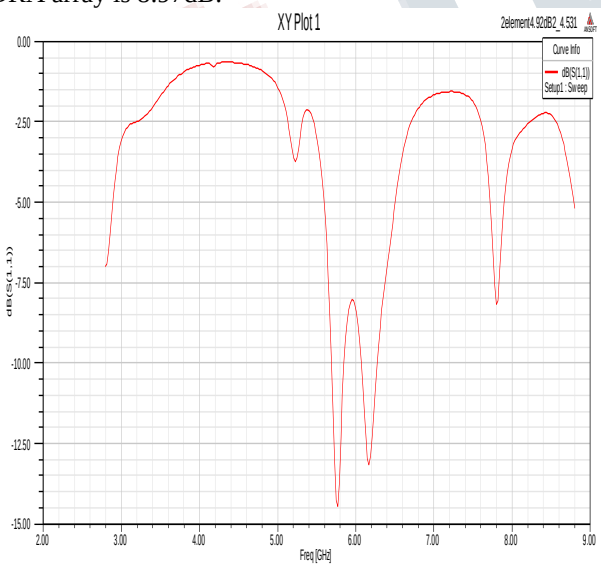


***Figure: 7 Simulated Return loss at F= 5.8 GHz***

## CONCLUSION

In this paper, rectangular shape orthogonal microstrip feeding technique is proposed to excite the circularly polarized dielectric resonator antenna for Wireless applications. The simulated results demonstrate that the proposed DRA achieves 5.11dBi at frequency 5.8 GHz with high directivity. Thus, it can be a good for WLAN.

## REFERENCES

[1]. Raghuraman Selvaraju, Mohsen Khalily and Jamal Nasir ,"Dual Band Rectangular Dielectric Resonator Antenna Design," , IEEE Antennas and Wireless Propagation Letters , Vol.59 , 2011.

[2]. Saeed Fakhte, Homayoon Oraizi and Reza Karimian ,"A Novel Low-Cost Circularly Polarized Rotated Stacked Dielectric Resonator Antenna," IEEE Antennas and Wireless Propagation Letters , Vol.13 , 2014.

[3]. Jiahong Lin, Wenhui Shen and Kang Yang, "A Low Sidelobe and Wideband Series Fed Linear Dielectric Resonator Antenna Array," IEEE Antennas and Wireless Propagation Letters,Vol.16 , pp. 513 - 516 , 2016.

[4]. Saeed Fakhte, Homayoon Oraizi and Ladislau Matekovits," Gain Improvement of Rectangular Dielectric Resonator Antenna by Engraving Grooves on its Side Walls", IEEE Antennas and Wireless Propagation Letters,Vol.16,pp.2167 - 2170, 9 May 2017.

[5]. Kai Xu Wang and Hang Wong," A Circularly Polarized Antenna by Using Rotated-Stair Dielectric Resonator," IEEE Antennas and Wireless Propagation Letters,Vol.16, pp.787 - 790, 2015.

[6]. Ming Su, Lin Yuan, and Yuanan Liu," A Linearly Polarized Radial Line Dielectric Resonator Antenna Array," IEEE Antennas and Wireless Propagation Letters , Vol.16 , pp. 788 - 791, 2016.

[7]. Lukui Jin, Razak Lee, Ian Robertson ,"A Dielectric Resonator Antenna Array using Dielectric Insular Image Guide," IEEE Antennas and Wireless Propagation Letters , Vol.63 , 2015.

[8]. Saeed Fakhte, Homayoon Oraizi and Reza Karimian ,"A Novel Low-Cost Circularly Polarized Rotated Stacked Dielectric Resonator Antenna," IEEE Antennas and Wireless Propagation Letters , Vol.13 , 2014.

[9]. Biswarup Rana, Ayan Chatterjee, Susanta Kumar Parui ,"Gain Enhancement of a Direct Microstrip

Line fed Dielectric Resonator Antenna using FSS," Applied Electromagnetics Conference (AEMC-2015).

[10]. Slobodan Jovic, Michel Clenet, M. M. Antar, "A Compact Wideband 4-Port Circularly Polarized Dielectric Resonator Antenna,"11th European conference on Antennas and propagation (EUCAP-2017).

[11]. Mohammad Ranjbar Nikkhah and Ahmed A. Kishk,"Wideband DRA Array Placed on Array of Slot Windows," IEEE Transactions on Antenna and propagation,Vol.63,2015.

[12]. Sajid Aqeel , M. R. Kamarudin , Aftab Ahmad Khan,"A compact frequency reconfigurable hybrid DRA for LTE/Wimax applications," IEEE Antennas and Wireless Propagation Letters , Vol.14 , 2015.

[13]. Chun-Cheng Lin and Jwo-Shiun Sun,"Circularly-polarized Dielectric Resonator Antenna Fed by Off- centered Microstrip Line for 2.4-GHz ISM Band Applications," IEEE Antennas and Wireless Propagation Letters , Vol.14 , 2014.

[14]. Muhammad Amin , Jing-Song Hong , Chao-Ming Luo and Xi Ming," A High Gain and Broadband Rectangular Dielectric Resonator Antenna with Modified Slot Aperture Feed Covering 3.6GHz WIFI Band", 2nd IEEE International Conference on Computers and Communication(ICCC),2016.

[15]. Ta-Yeh Lin, Tsenchieh Chiu and Da-Chiang Chang, "V-band dual-polarised dielectric resonator antenna with bondwire feeding structures", Electronics Letters ,Vol.53,2017.

[16]. Nipun K. Mishra, Soma Das," Circularly Polarized Cylindrical Dielectric Resonator Antenna Coupled by V-Shaped Resonating Slot", IEEE International Conference on Recent Advances and Innovations in Engineering (ICRAIE-2016).