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# Design of Broadband Monopole Dielectric Resonator Antenna for Wi-Fi and Wi-Max Application

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## ABSTRACT

*The presented antenna is implemented by using four identical square DRs which are cut down in middle to achieve a star DR to increase the antenna bandwidth for broadband wireless applications. The substrate and DR material used for investigation are FR4 and sapphire, which has a dielectric constant ($\varepsilon_r$) of 4.4 and 10 respectively. A centre feed coaxial line is used to provide input to DRA. Parametric analysis on the antenna is performed using ANSOFT HFSS solver by varying different parameter and shape of DR and length of the feed line. The simulated result shows that the proposed geometry offers a broadband for $|S_{11}|$ < --10dB from 2.065 to 3.395 GHz, which has a fraction bandwidth 39.7% .The presented DRA has a single band and it resonate at 2.4 GHz which has many application in IEEE802.11a standard. The peak gain of proposed DRA is 4.44 dB and offered bandwidth is 1.33 GHz.*

***Keywords—DRA; ultra wideband; millimeter wave; RDRA, Wi-Max , interference, efficiency.***

## I INTRODUCTION

A dielectric resonator antenna (DRA) has become a popular discussion topic among researchers and engineers since it has introduced in the early eighties. DRA has a much wider impedance bandwidth as compared to microstrip antenna because the microstrip antenna radiates only through the narrow radiation slots, whereas the DRA radiates through the whole DRA surface except the ground part [1]. Surface waves avoidance is another attractive feature of the DRA. The dielectric wavelength is smaller than the free space wavelength by a factor of 1/ $\varepsilon_r$ , both of them can be made smaller in size by increasing $\varepsilon_r$ [1].

DRAs offer many advantages, such as low-profile, low-cost, ease of excitation and high radiation efficiency [2]. It has many applications, such as mobile handsets, laptops, or for medical equipment, where compact size of antenna is required. The application of DRAs at lower frequencies becomes questionable, due to the increase in their dimensions. The most popular method to reduce the DRA size is the use of very high dielectric constant materials [3]. DRAs can be designed for high data rate local area wireless communication systems, imaging system in microwave and millimeter wave regions, responding to the high demand of wide band application and benefiting from their higher efficiency and gain performance. However broad band and ultra wide band DRA structures are still suffering from some designing disadvantages making them less competitive such as complex geometries, relative bigger size, higher dielectric constant material involved and/or the incompactness of proposed DRAs [4].

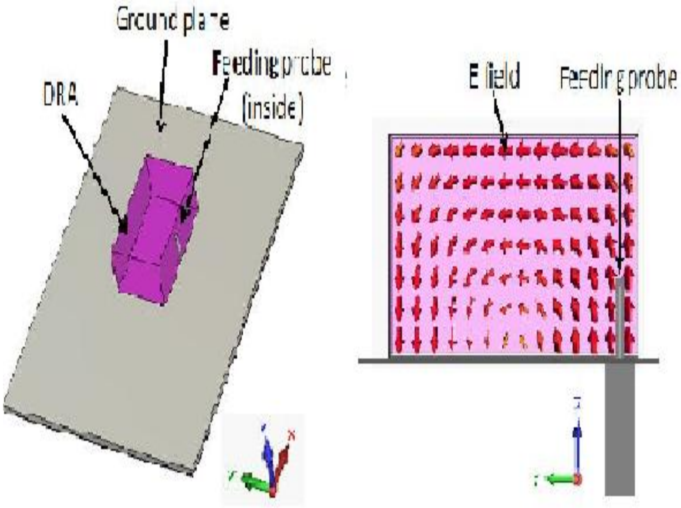


**Fig.1. Rectangular Dielectric Resonator Antenna and Field Pattern [4]**

## II PROPOSED ANTENNA DESIGN AND GEOMETRY

The proposed dielectric resonator antenna geometry is illustrated in fig. 2. The proposed antenna of size of 100 x 100 $mm^2$, is built on a 0.8 mm-thick FR4_epoxy substrate with dielectric constant of $\varepsilon_r$=4.4 and loss tangent tan $\delta$=0.02. A 24 mm thick of sapphire material with dielectric constant of $\varepsilon_r$=10 is placed on the top of the substrate. A DRA of sapphire material with polyhedral shape of 8 faces tilt with an angle of $45^o$ is inserted at the centre of the RDRA. An air gap is provided in each square box to change the coupling, the in coupling change the effective permittivity of DRA, which enhanced the end bandwidth of DRA. At the end coaxial feed is attached to provide input to the DRA which is designed with an outer conductor of 'pec' material with a radius of 2.15 mm and a height of 10 mm and the inner conductor of radius 0.6 mm and height of 10.835 mm, a teflon material is used as a insulator in the middle of conductors as shown in figure 2.

**Table 1: Presented DRA Dimensions**

| Dimension | Size |
|---|---|
| L | 100mm |
| W | 100mm |
| $L_{DRA}$ | 40mm |
| $W_{DRA}$ | 40mm |

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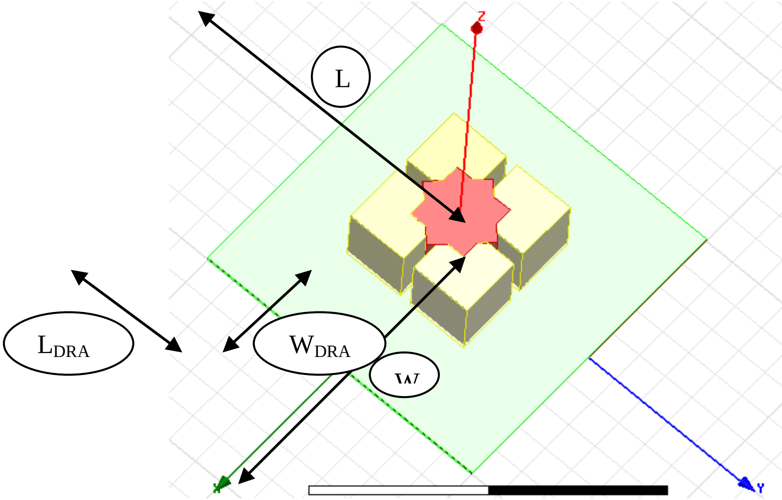
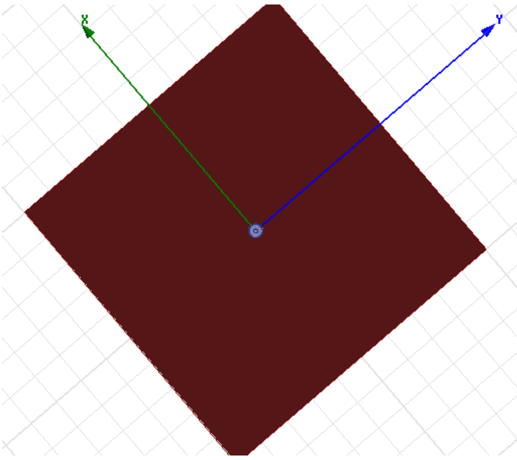



(a)



(b)

**Fig.2. Prototype of DRA (a) Top View (b) Bottom View**

## III RESULTS AND DISCUSSION

The High Frequency Structure Simulator (HFSS) is used for the simulations of the presented monopole dielectric resonator antenna by Ansoft commercial software [11]. The result of the simulation, the reflection coefficients $|S_{11}|$ for the presented DRA is shown in Fig. 3. The result of the proposed dielectric resonator antenna shows a single band for $|S_{11}|$ less than -10 dB is lies from 2.065 GHZ to 3.395 GHz with the centre frequency at 2.4 GHz which has a bandwidth of 1.33 GHz. DRA with centre frequency at 2.4 GHz can be used in Wi-Fi and Wi-Max applications. Figure 4 shows the peak gain of the DRA is 4.44 dB near the centre frequency which has significance value for the use of IEEE 802.11 b/IEEE 802.16. Fig.5. shows the efficiency cure of the simulated DRA.

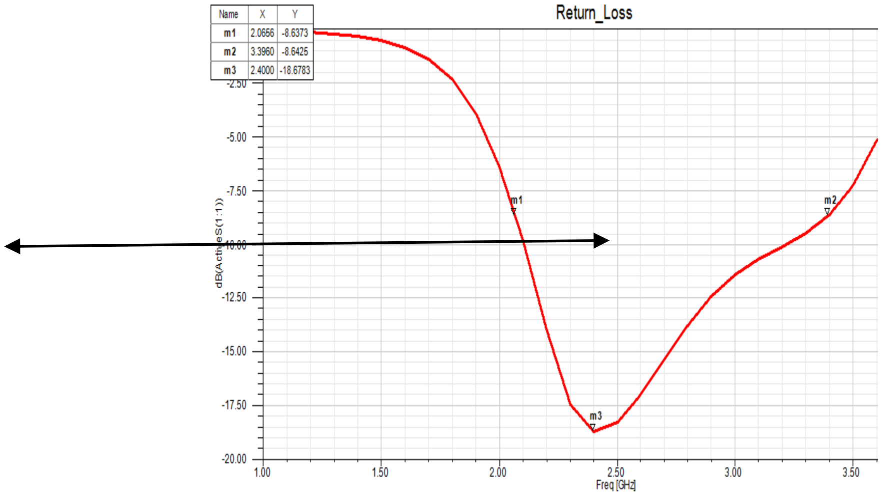



**Fig.3. Simulated Return Loss of DRA**

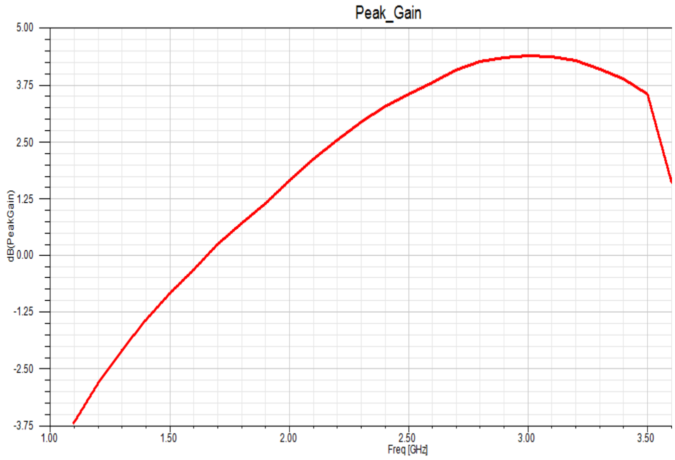



**Fig.4.Simulated peak gain of DRA**

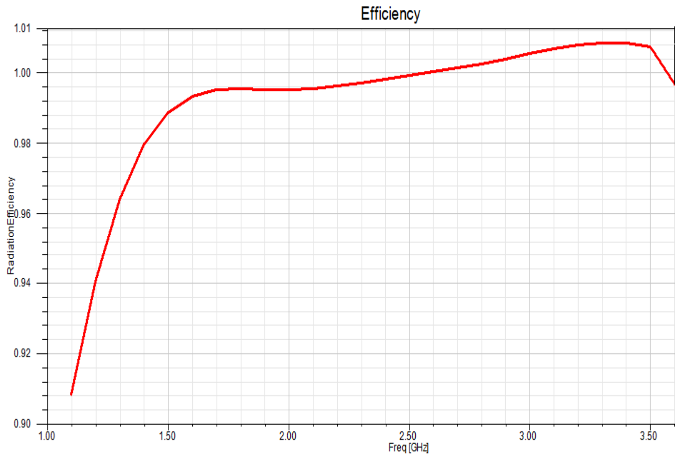



**Fig.5.Efficiency Curve of DRA**

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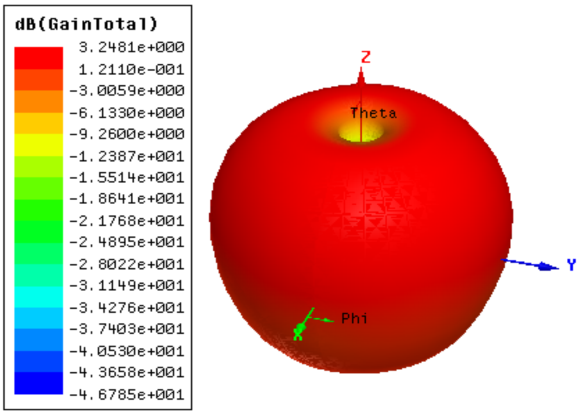
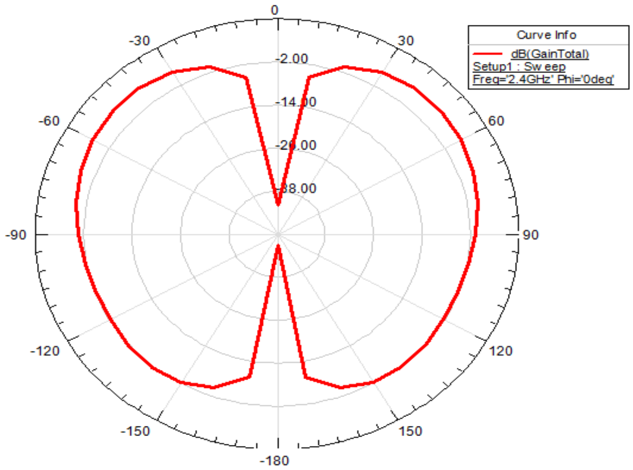
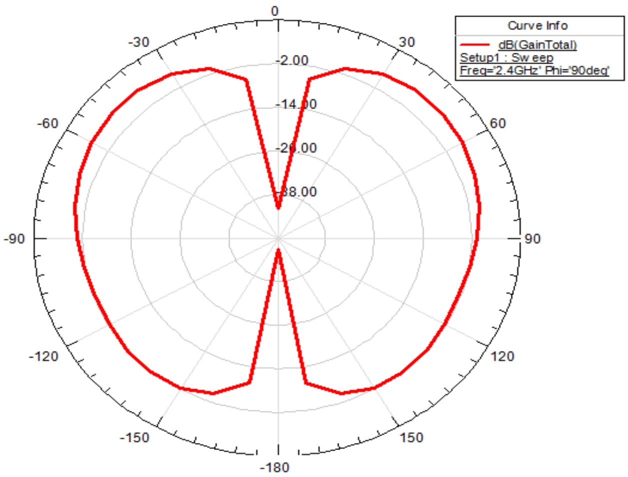



**Fig.6. Simulated 3D polar plot of DRA**




**(a) E-Plane radiation pattern at 2.4GHz**




**(b) H-plane radiation pattern at 2.4GHz**

**Fig.7. Simulated 2D polar plot of DRA in E and H plane**

Fig.6. shows the three dimensional polar plot of proposed DRA. The simulated radiation patterns of the proposed antenna in E-plane and H-plane at 2.4 GHz on azimuths 0°, 90° respectively shown in Fig.7 (a & c). The figure shows that the E-plane and H-plane patterns are quite single directional, the radiation patterns remain roughly like leading to unidirectional pattern. As shown by radiation pattern, the proposed antenna thus supports linear- Polarization.

## IV CONCLUSION & FUTURE SCOPE

A new type of single band dielectric resonator antenna for the Wi-Fi and Wi-Max is presented. Design results shows centre frequency at 2.4 GHz with a bandwidth of 1.33 GHz ranging from 2.065 to 3.395 GHz. The simulated DRA shows good result in terms of return loss, gain and radiation pattern. Present DRA belong to lower side of frequency band so interference will be low. The bandwidth achieved in design shows the broadband characteristics of the antenna design. The design illustrated a direction beam which and a handsome amount of gain makes it as a good candidate for Wi-Fi and Wi-Max applications.

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