Double Back Cylindrical Shaped Dielectric Resonator Antenna with Enhanced Gain and Bandwidth

Chahak[1], Charanjeet Singh[2,] Purnima[3]
[1]M. Tech. Student (ECE),[2]Assistant Professor, [3]M. Tech Student(ECE)
DCRUST, Murthal

Abstract: A cylindrical dielectric resonator antenna (DRA) is projected in this paper. This antenna consists of a double back cylindrical shaped DR. A metallic divest is functional at the surface of the DR. The necessary and advanced order cross modes are exhilarated in the antenna geometry because of the explicit structure. The antenna with double back cylindrical DR postulates the quantified axial ratio (AR) of 3dB with bandwidth of 10% in upper band and 25% in lower band. The upper band with 3-dB AR replication can be tweaked in different passbands of 10-dB impedance of the antenna by transmuting the locale and thickness of the metallic divest. Antenna replication can withal be tweaked to achieve the CP operation in triple band.

Index Terms— Double back cylindrical DRA, Dielectric resonator antenna, Circular polarization.

I. Introduction

However, unless advanced design solutions predicated on the integration of congruous dielectric superstrates or lensing structures are adopted, the antennas typically suffer from narrow impedance bandwidth and diminished radiation efficiency caused by the effect of lossy silicon substrate materials [1-10]. On the other hand, dielectric resonator antennas (DRAs) have the congruous characteristics which makes it a better option to opt it in lieu of the conventional radiating elements at the higher frequencies, especially for applications at millimeter waves and beyond This method is mainly predicated on a postulation that the DRAs do not give any conduction loss thus It will give the maximum radiation efficiency when it is exhilarated opportunely [11-15].

In tardy 60's the dielectric resonator has been utilized in the elevation Q-factor in wireless applications due to low – loss ceramics [16]. Dielectric Resonators have more condensed substitutes to waveguide- nook resonator and highly responsive to the integration of printed circuits. For relatively excessive dielectric constant ($\mathcal{E}r \geq 35$) the cylindrical Dielectric resonator antennas are typically utilized. The maximum radiation and high-quality factor it can be achieved by the enclosing DRA's in metal enclosures. By abstracting shielding and congruous victualing to exhilarate the opportune mode these resonators are efficient radiators [16-24]. We can uphold the radiation variation over a more astronomically immense range of frequencies just by minimizing the dielectric constant. In early 1980's the resonator was found to a good. It was withal examined that the sundry characteristics of DRA's like cylindrical, Rectangular and hemispherical shapes give the eminent result in terms of high gain and withal provides an alternative to Low gain elements like microstrip patches, monopoles and dipoles [17]. In tardy 80's and early 90's the researchers focused and analyze the different modes of excitation, that can be possible with simple shapes and additionally analyze variety of aliment mechanism and withal applying the mathematical techniques to ameliorate the gain, Q factor and radiation pattern of the antenna. In mid-90's work commenced towards the linear and planner arrays of DRA's. This period also worked upon the low profile compact designs and mutual coupling of circular or rectangular shapes DRA's.

Now in incipient millennium research has taken another challenge towards the involution on incipient resonator antenna shapes, including spiral, conical, elliptical and stair-stepped shapes or verbalize more cross mode structures.

In this paper, double back cylindrical DR is used. The cylindrical DR is made by splitting a cylinder into two haves and then unite them together [24]. Also, Circular polarization is used instead of linear polarization as linear polarization has more polarization mismatched losses and signal interference as compared to Circular polarization. Also, higher order modes ($HEM31\delta$, $HEM41\delta$, $HEM22\delta$ and $HEM22\delta$+1) exist in the design [20-24].

2. Antenna Configuration and Design

In this sector, the design and investigation of the projected antenna is shown in Figure 1 is discussed. DR antenna is computer generated by High Frequency Structure Simulator (HFSS) software.

2.1 DOUBLE BACK CYLINDRICAL DIELECTRIC RESONATOR ANTENNA PROPOSAL

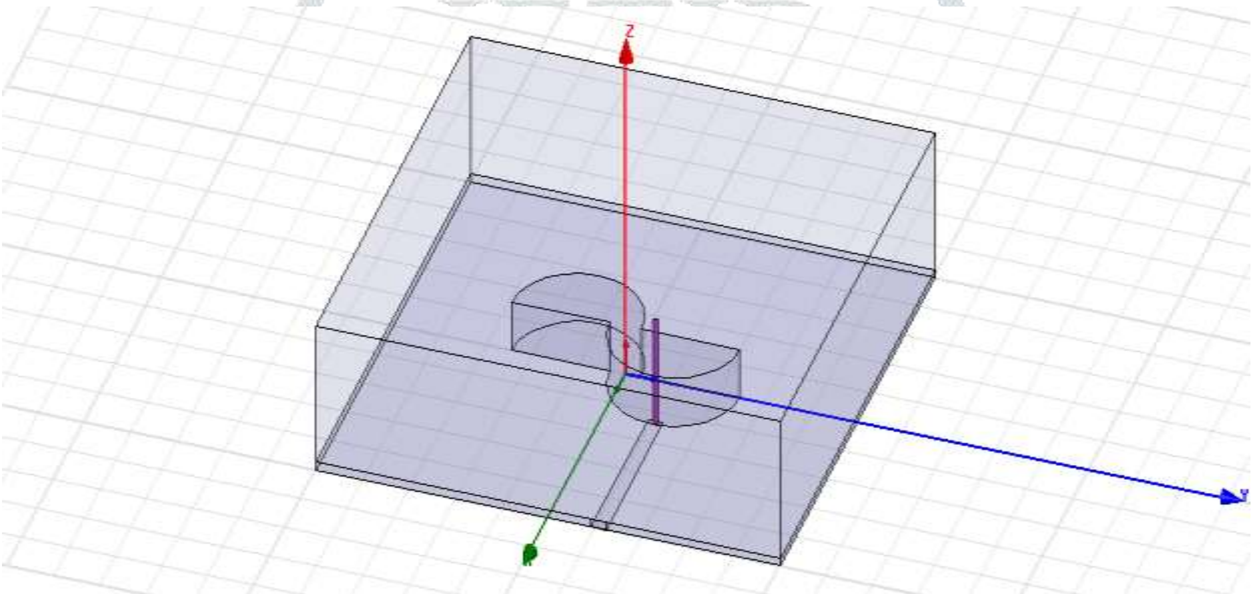

Figure 1: 3D View of the Projected Antenna

ls = 50, ws = 50, r = 7, h = 5, wst = 2.1, w =3.4, p=11.25, wf = 1.6, lf=18.5, hp =11 and t =0.5mm

The basic schematic of DRA configuration is shown in the figure 1. A DRA is designed and computer generated here. The recommended tactic of research work is optimized design of antenna with felicitous victual [24]. In projected antenna microstrip patch antenna technique is used. First of all, we design the substrate having dimension 50 × 50 × 0 mm. The substrate has material Fr4 which has relative permittivity of ε_r = 4.4 with 0.8 mm thickness. After designing the substrate, on the top side of the substrate, a radiating patch with double back cylindrical DR is printed with feeding points (0, -5.3,0). The dimension of rectangular patch is 11 mm and dimension of rectangular patch is 0.5 × 5 mm and the DR used has radius=7mm with height=5mm along with dielectric Er=20. The ground plane is laid full size on the antithesis of the substratum. The major intention of the overall work is to enhance the bandwidth & decrement the return loss.

The projected antenna is designed and computer generated in High Frequency Structure Simulator (HFSS) software. The patch is operated at frequency of 18.3 GHz.

3. Results and Discussion

These days it is a mundane routine to estimate the performance of the system through computer aided simulator before the realistic time execution. A simulator “Ansoft HFSS” predicated on predetermined component method is used to compute bandwidth, return loss, and gain. This tool additionally avails to minimize the cost of fabrication as the antenna with high performance can easily be fabricated [1] but in this paper only antenna is projected. Fig 3 shows the computer-generated results of the return loss of the projected antenna. After analyzing the model, the return loss attained is -35.7673 dB at bandwidth of 56 MHz at 18.3GHz with gain 9 db. The 3D polar plot of gain is shown in fig 2. Return Loss Vs Frequency is shown in fig 3. The more negative value of return loss shows that the antenna losses are less at 18.3 GHz frequency.

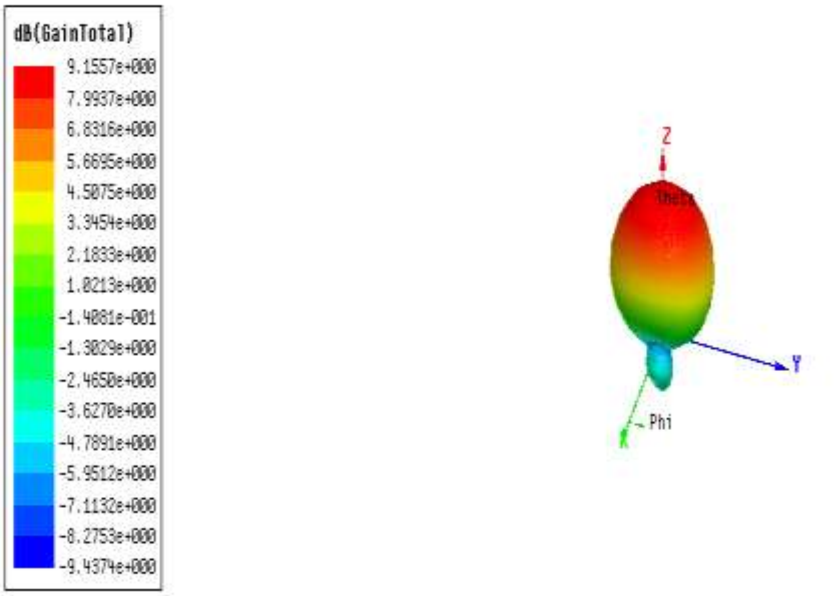

Figure 2: Gain of the Projected Antenna

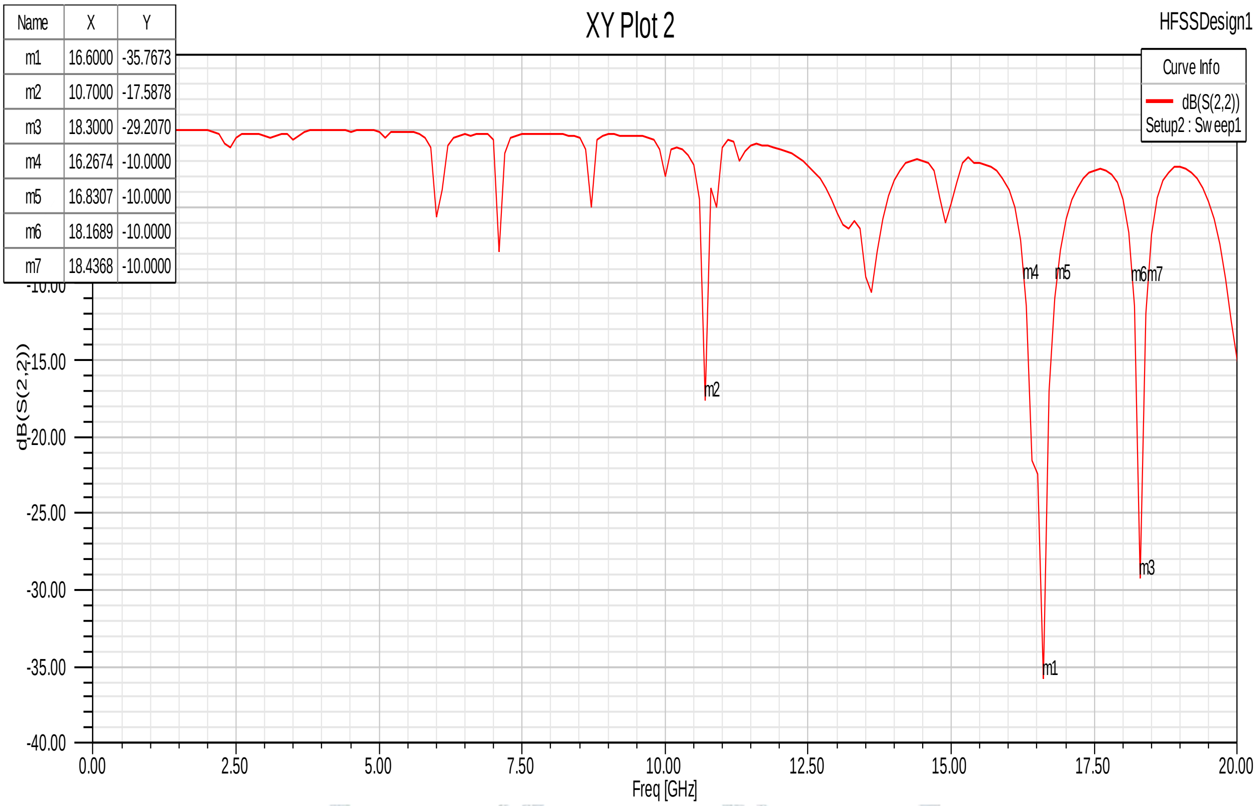

Figure3: Return Loss of the Projected Antenna

The computer-generated results for return loss and gain that are obtained from the projected antenna at 18.3 GHz are shown in figure 3 and figure 4 respectively. These figures show frequency versus S11 parameter graph. The gain is given in variation of theta & phi and range of theta and phi is taken from 0 to 90 degrees.

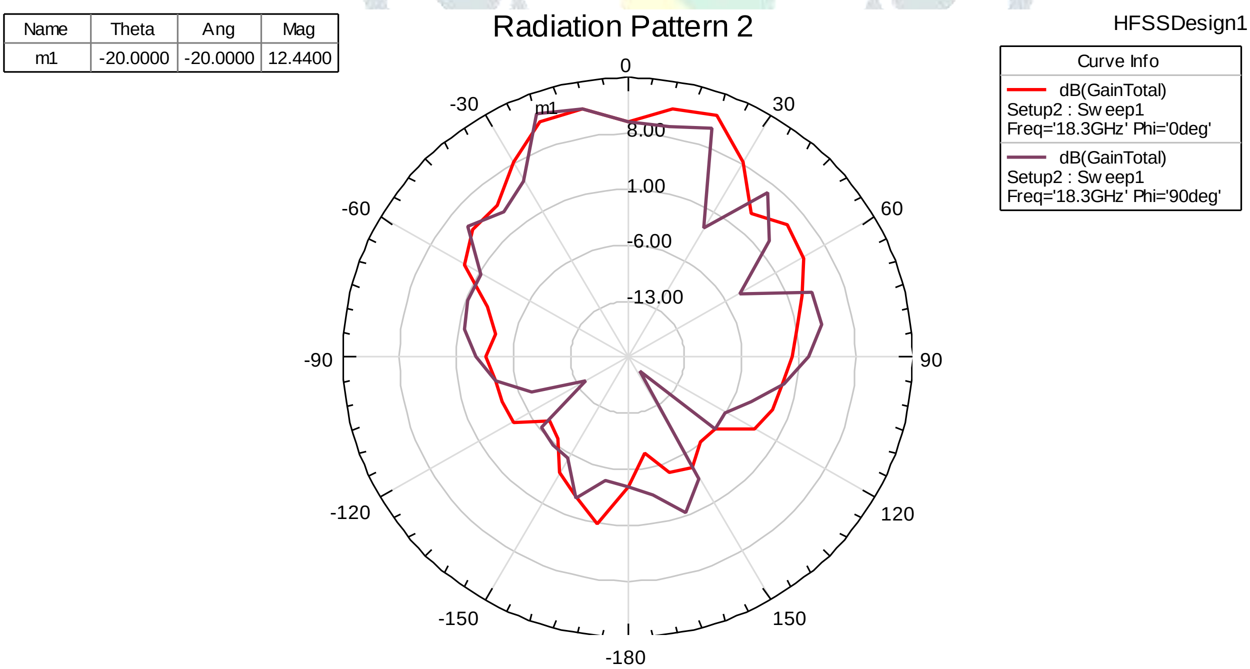

Figure4: Radiation Pattern of the Projected Antenna at 18.3 GHz.

Table 1. Comparative analysis of Projected Antenna& Conventional Antenna

Sr. No.	Parameter	Base Paper	Projected Antenna
1.	Return loss	-30 dB	-35.7673 dB
2.	Gain	4.3 dB	9 dB
3.	Bandwidth	40 MHz	56 MHz
4	Resonant frequency	11 GHz	18.3 GHz

4. CONCLUSION

In this paper, a DR antenna for various applications has been presented. The DR antenna mostly used in hilly and icy areas where network is not available most of the times because of the freezing of the ice. The goals of this paper are to design and simulate DR antenna that can operate at 18.3 GHz and study the performance of DR antenna briefly. From the computer-generated results, it is seen that the performance of the projected antenna is better that of the conventional DR antenna. In future, our targets are to design another DR antenna that can operate at higher frequency. The projected antenna works at 18.3 GHz and obtained return loss of -35.7673 dB with gain 9 dB and bandwidth 56 MHz

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