A Compact Size Dielectric Resonator Antenna for Multiband Application: Design and Analysis

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ABSTRACT--- In this paper we discussed about an optimum design of Dielectric Resonator Antenna (DRA) for wireless Applications with single feed structure has been designed and investigated in this paper. Proposed antenna radiates at 4th band Resonating frequencies are 2.38GHz, 3.56GHz, 4.59GHz and 8.26GHz and gain of the Antenna are respectively 6.42,5.65,6.7, and 5.9 respectively which is widely used for the Wireless applications. The 10dB fractional Bandwidth of the Antennas are 10%, 5%, 3.7% and 11%. A micro-strip feed line is used to excite the antenna; length of slot is used for impedance matching.

From the return loss plot it is verified that it is Multiband Antenna.

Key words- Hemisphere, DRA, Cross-slot, Coax feed, Length of slot.

I. INTRODUCTION

The need for antennas with low size, low cost and low metallic loss has lead to the introduction of new kind of antennas using dielectric materials as the radiating element namely Dielectric Resonator Antennas (DRA). By using DRA's we can eliminate the unwanted currents produced by the conventional antenna with conductors. These DRA's will have good radiation characteristics and can be used in all kind of antenna applications. Just like conventional antenna in DRA's also we have different radiation elements shapes like cylinders, semi circles, cuboids, semi toroid's etc. which can be used to generate resonance at require operating frequencies. In the DRA's the excitation of the dielectric material is done using different feeding techniques depending upon the application and the requirement. The beauty of DRA's is that in a single antenna we can combine two different shapes of resonators to get our required output characteristics. A Dielectric Resonator Antenna is proposed in this paper in which a hemisphere radiating structures is considered as primary resonator. A microstrip feed line structure is used to excite the resonator which is on the other side of the substrate. To allow the excitation from feed to the resonator we are using a cross slot which is placed right under the radiating structure. The cross slot is responsible for the frequency of operation.

In this section, we design a new type of DRA designed for wireless application a new hemisphere dielectric resonator antenna (DRA) design with a micro strip feeding [4] is attainable for Multiband Antenna for wireless applications. The result displays that the Design antenna realises an impedance bandwidth about 10% , 5% , 3.7% 11% from 2.15GHz to 2.67GHz covering complete Bluetooth and specifically getting multiple resonating frequencies at 3.45- 3.63 GHz, 4.47-4.72GHz and 8.01-8.94GHz bands. From the return loss plot and studied antenna parameters of the antenna are carried out by changing the length of the slot and radius of the hemisphere dielectric resonator antenna and simulated results for wireless applications are presented.

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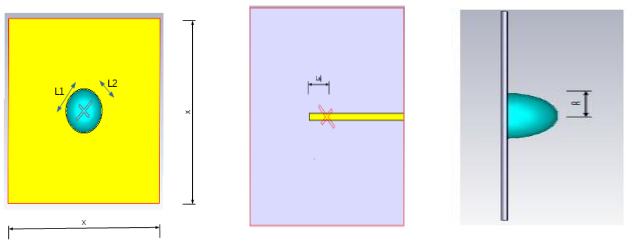
II. ANTENNA DESIGN AND CONFIGURATION

The Design of DRA hemisphere structure is shown in the fig. 1.1. This antenna contains of a hemisphere sphere shape Dielectric Resonator and a centre- feed micro-strip line and inductive cross slot which etched on substrate of ϵ_r = 10 and the radius of DRA r = 18mm length of long slot arm L_1 = 21mm, Length of short slot arm = 14mm, Height of substrate h= 1.57mm Length and width of substrate x = 150 width of slot w =2, width of micro-strip line W_h = 4.7mm. Antenna is placed above a cross- slot fed by 50 Ω micro-strip line.



(a) (b) (c)

Fig 1.1 Design antenna structure (a) front view (b) top view (c) back view.

TABLE I

Symbol	Name of the parameter	Value (mm)
r	Radius of DRA	12
h	Height of DRA	15
x	Length of Substrate	150
x	Width of Substrate	150
L_1	Length of Long slot arm	21
L_2	Length of short slot arm	14
W	Width of slot	2
W_h	Width of micro strip line	4.7

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III. RESULTS

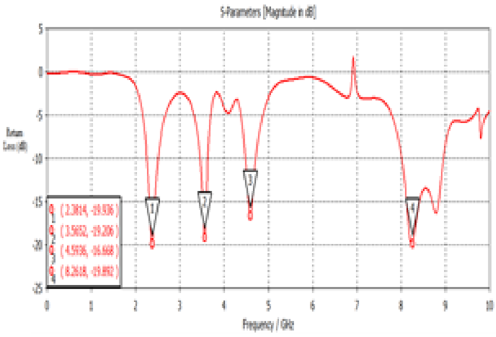


Fig 1.2 Simulated Return loss Plot

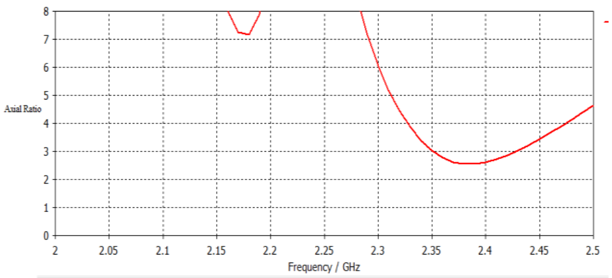


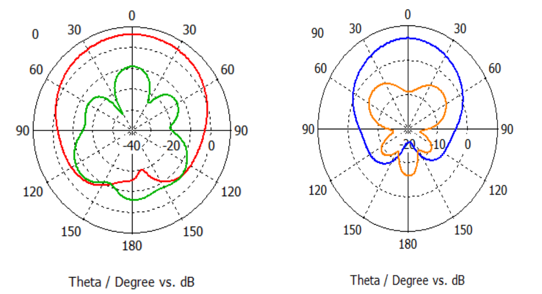
Fig. 1.3 Axial Ratio Vs Frequency Graph

Fig 1.2 Simulated results for reflection coefficient design DRA the simulated fractional bandwidth ($|S_{11}| < 10dB$) 4th band DRA and the fractional bandwidth are respectively 10%, 5%, 3.7%, 11%.

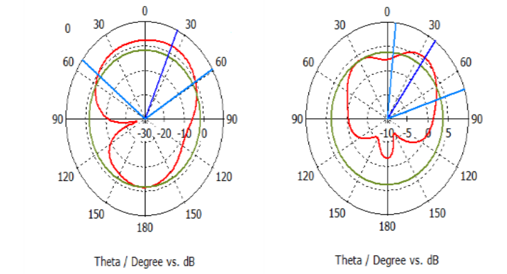
Gain bandwidth efficiency and fractional bandwidth are listed in the Table II.

TABLE II

Frequency	Gain	Efficiency (%)	Impedance Bandwidth
2.38	6.42	98	(2.15-2.66 GHz) 10 %
3.56	5.65	97	(3.45-3.63GHz) 5%
4.59	6.7	74	(4.47-4.72 GHz) 3.7%
8.26	5.9	85	(8.01-8.94GHz) 11%



(a)



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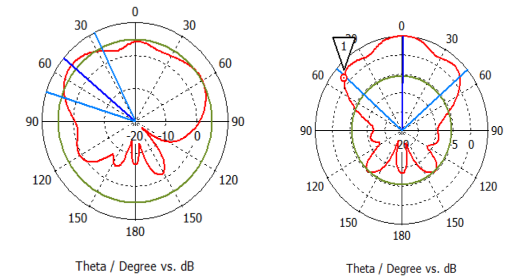
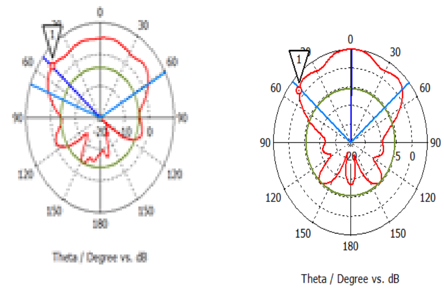
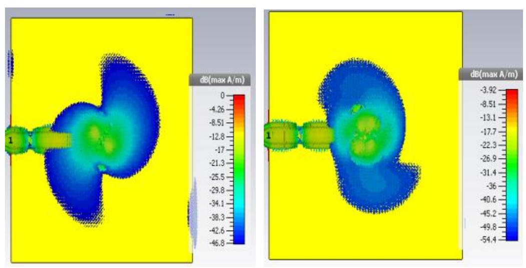


(c)

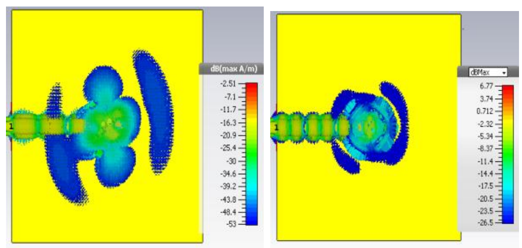


(d)

Fig 1.4 Simulated radiation Pattern of Design Antenna at frequencies
(a) 2.38GHz (b) 3.56GHz (c) 4.59GHz (d) 8.26GHz



(a) (b)



(c) (d)

Fig. 1.5 The Surface current distribution at (a) 2.38 GHz (b) 3.56GHz (c) 4.59GHz (d) 8.26 GHz

All simulation are done using the CST Tool from the Return Loss plot we can observed that there is 4th Band the reference return loss is $|10dB|$ in 10dB 90 percent of power is transmitted to antenna and 10 percent of power is reflected back. In Fig 1.3 the simulated Axial Ratio plot as a function of frequency from Axial Ratio Plot the graph is below the 3dB in first Band and it is circularly polarized. The cross- slot can be equivalent to two magnetic currents perpendicular to each other. Since the change in operating frequency will result in the change in electrical lengths of the slot arms. Fig. 1.4 shows the simulated Radiation pattern at resonance frequency at 2.38 GHz, 3.58GHz, 4.95GHz and 8.26 GHz. It is observed that the lower band is left hand circularly polarized where all other bands are linearly polarized.

IV. CONCLUSION

A new Hemisphere dielectric resonator antenna is realised by changing Length and slots of DRA by designing the slot length of DRA we get the circular polarization in DRA results in which first band is circular polarization and all other bands are linearly polarized. Simulated results are shown that the designed antenna offered four resonance frequencies which cover the WLAN application band. This antenna provide determined gain of 6.7 dBi The design of this hemisphere shape DRA is well suited for other wireless applications, fabrication of design antenna will be carried out in future.

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