

A Dual Frequency Dielectric Resonator Antenna for Wireless Communication Applications

N.Ananda Rao, M.Sekhar

Abstract— A dual frequency Dielectric Resonator antenna for wireless communication applications in the S and C bands with an operating frequency of 2.65GHz and 4.62GHz is presented. The patch is a dielectric material with a high dielectric constant value of 20. A 50Ω strip line is considered as feed and is coupled to the dielectric radiator via the rectangular slot etched in ground plane. The slot etched in ground plane is made so as to facilitate the power from the feed line to the radiator. The overall dimension of the antenna is 100mm×35mm×0.8mm. A dual frequency antenna has been proposed which will be operational at the frequencies of 2.65GHz and 4.62GHz with a gain of 4.42dB and 7.78dB respectively. Low cost FR4 material is been used as the laminate base for the antenna which will act as the dielectric material.

Keywords— Compact, Stacked Patch, WIRELESS COMMUNICATION Applications.

I. INTRODUCTION

Though microstrip antennas are having considerable advantageous features when compared to conventional antennas in terms of size and power consumption still they have some limitations in terms of some antennas parameters like gain and bandwidth. This limitation is because of the physical structure of the patch antenna which is inevitable. The basic structure of microstrip antenna consists of conductors and dielectric materials. The usage of the conducting material as a source for radiation and the implementation of the above said feeding technique are the fundamental sources for the limitations of microstrip antennas.

The radiating element will be placed on the dielectric material and on the other side we will be having a ground plane. When the radiator is excited by power there will be a generation of some unwanted waves in the substrate which are called as surface waves which flow in the substrate and will reduce the efficiency of the antenna. This effect will be more in case of microstrip feed line as both the conductors are on the same plane and the generation of the unwanted surface waves will be very high.

In the case of coaxial feed the conducting pin which carry the power from transmitter to patch which surpasses from substrate. This will lead to the generation of the surface waves which will reduce the antenna efficiency.

Researchers around the world proposed different techniques to overcome these limitations and enhance gain and Bandwidth of the microstrip antennas.

In [1] the authors proposed a air gap in between the ground and substrate layers.

In [2] a technique has been proposed to increase the gain of the antenna by taking a group of antennas and joining them as an array such that the power from all the individual elements will combine and form a single beam. In [3] Stacked patch techniques has been proposed which can be used for both gain enhancement and bandwidth enhancement depending upon the dimensions of the parasitic patch element.

In [4] the authors proposed a air gap in between the ground and substrate layers. In [5] a technique has been proposed to increase the gain of the antenna by taking a group of antennas and joining them as an array such that the power from all the individual elements will combine and form a single beam. In [6] Stacked patch techniques has been proposed which can be used for both gain enhancement and bandwidth enhancement depending upon the dimensions of the parasitic patch element. But all these techniques have complexity in designing either in terms of designing or in terms of cost. So to overcome these limitations we proposed a technique of Dielectric Resonator Antenna(DRA) where we use Dielectric material as a radiator instead of conductor. In [7] an four element antenna array has been proposed where all the four elements are been excited with a single feed and because of this the control over the phase of the input signal is not possible which is very essential in the phased array antenna applications especially in RADRA's where we need to steer the beam in different directions. In [8] an four element antenna array has been proposed where a separate feeding structure has been used to excite the individual antenna elements. For this proximity feeding concepts are been used which will require two different substrates for the development of the antenna and is not encouraged as it will increase the cost of the antenna. In [9] an four element antenna array has been proposed to achieve high gain but to excite the antenna elements a complex directional coupler network has been used and this is bringing difficulty in antenna fabrication and also the feed network is generating some surface waves which will reduce the efficiency of antenna.

In this paper, A dual frequency DRA patch antenna has been designed for the wireless communication applications with operating frequency of 2.65GHz and 4.62GHz. Microstrip line is used for excitation. For the required operating frequency the ground plane is etched with a slot right below the DRA.

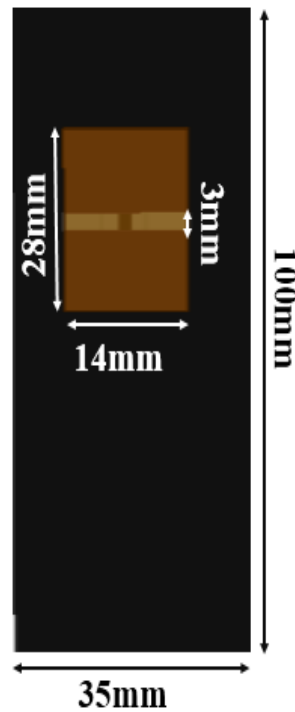
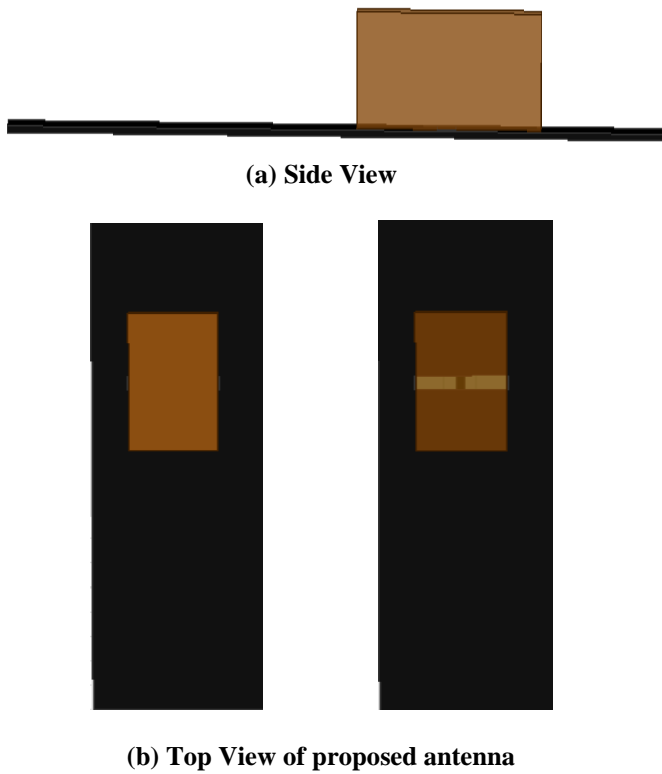
II. PROPOSED ANTENNA DESIGN

A dual frequency DRA which operates at 2.65GHz and 4.62GHz is proposed. Low cost flame retardent material has been used as the substrate material with a thickness of 0.8mm.

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(c) Schematic Model
Fig. 1. Proposed antenna

III. RESULTS

The performance of the antenna is measured by analyzing various parameters which includes impedance matching and radiation characteristics. Under impedance matching we will verify two parameters namely return loss also called as S_{11} and Voltage standing wave ratio which is simply called as VSWR. [7]. Figure 3 and Figure 4 below shows the impedance matching characteristics of the antenna. Figure 3 depicts that the antenna is radiating at the two frequencies of 2.65GHz and 4.62GHz. with return loss

of -25dB and -39dB respectively. Which indicated that there is a good impedance matching for the antenna with the input power source.

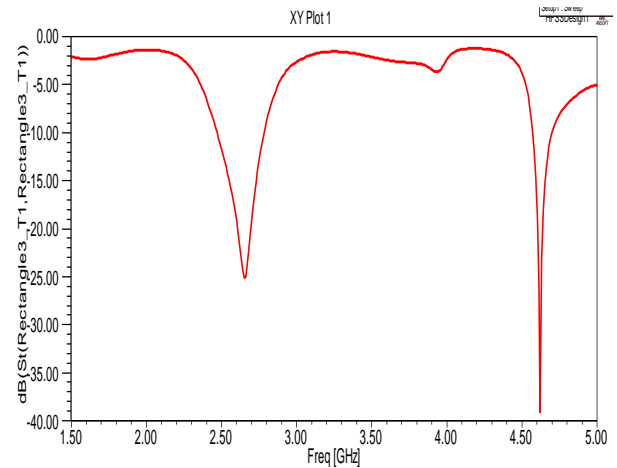


Fig. 3. Return loss

From VSWR graph in figure 4 it we can know that the antenna is radiating in the frequencies of 2.65GHz and 4.62GHz with a vswr of 1.1dB and 1.2dB respectively.

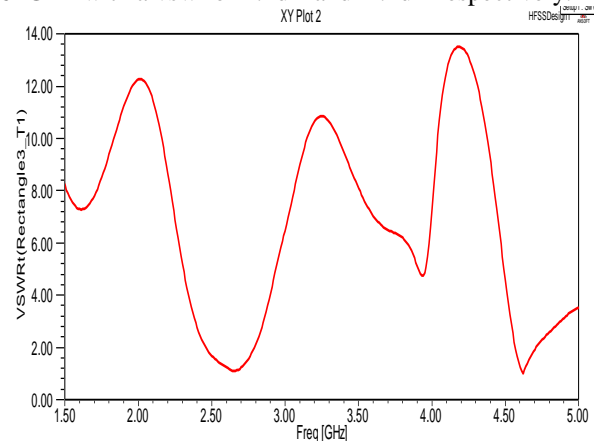


Fig. 4. VSWR

From the two gain plots in figure 5 and figure 6 below we can observe that there is a uniform distribution of the power in different theta angles without any nulls which is very essential for wireless communication applications [8,9].

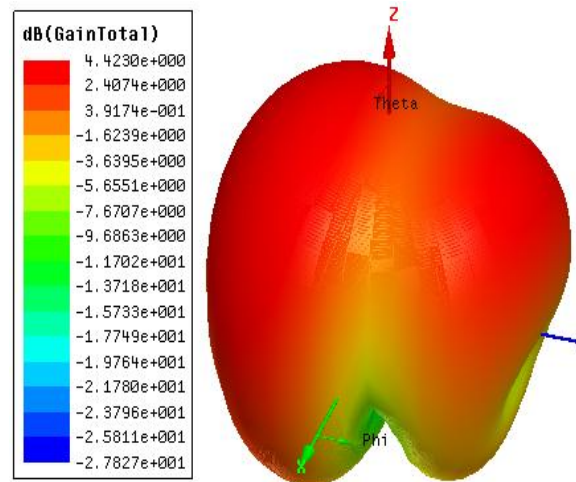


Fig.5. Gain at 2.65GHz

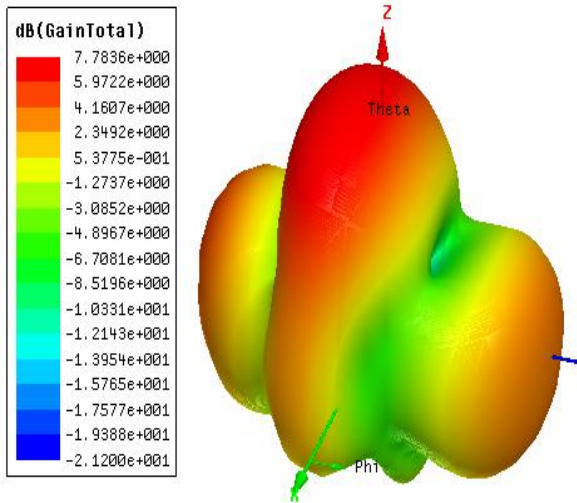
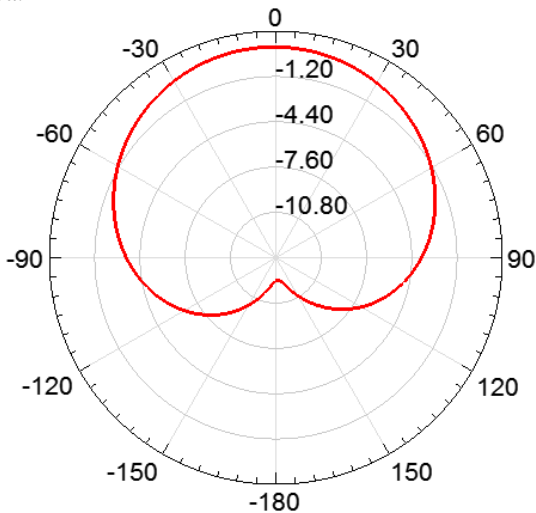
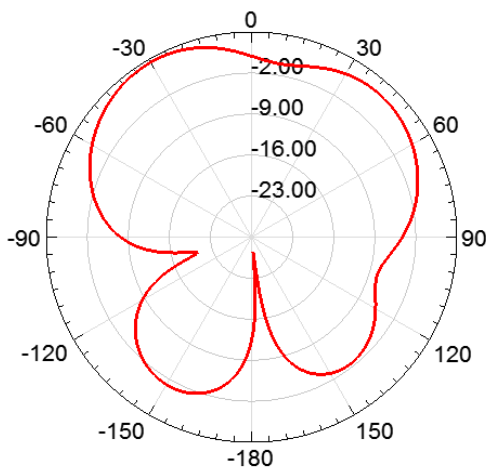


Fig. 6. Gain at 4.62GHz

The radiation characteristics of the antenna at the center frequency of 2.65GHz and 4.62GHz are shown below in Figures 7 and 8. To analyze the radiation characteristics of the antenna we need to check both the elevation plane and azimuthal. Both the patterns are having uniform distribution of the power in different theta angles without any nulls which is very essential for the wireless communication applications for proper planning of the antenna coverage area.

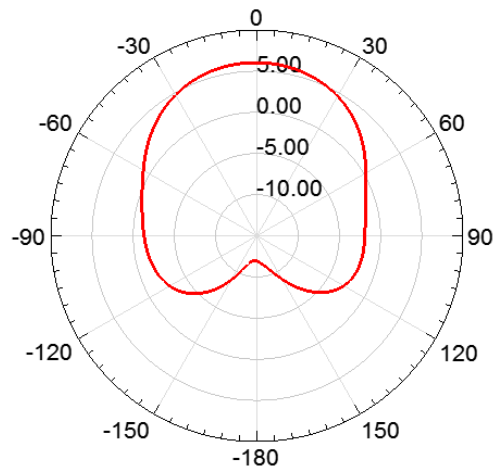


(a) Elevation Plane

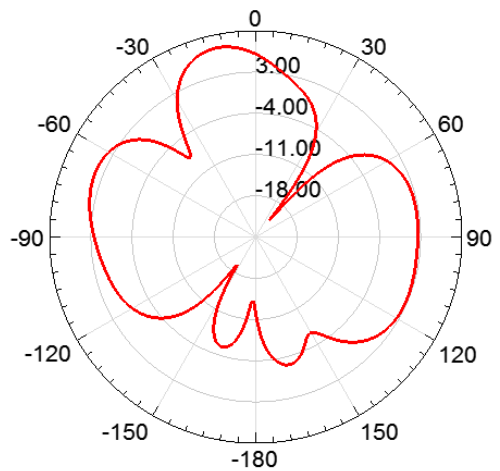


(b) Azimuthal Plane

Fig. 7. Radiation Pattern at 2.65GHz



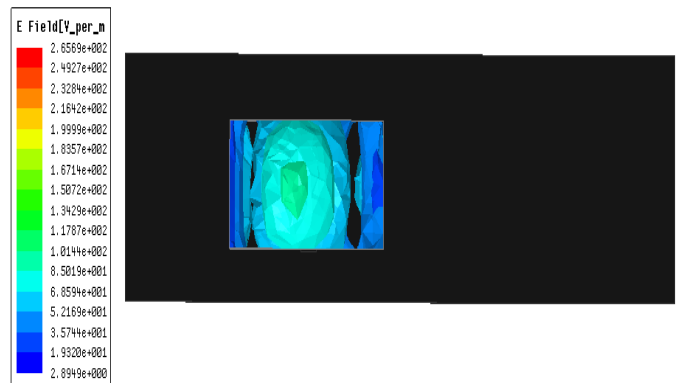
(a) Elevation Plane



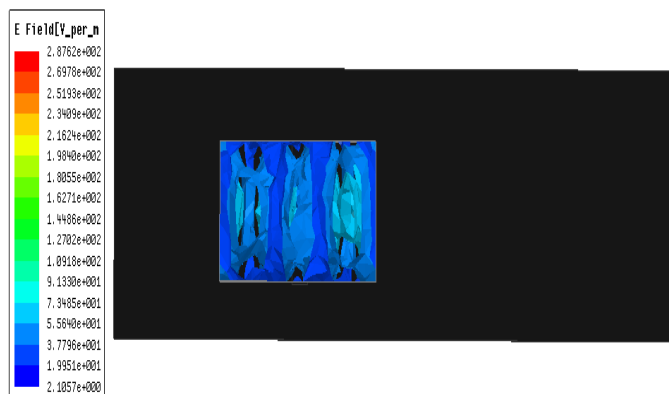
(b) Azimuthal Plane

Fig. 8. Radiation Pattern at 4.62GHz

The radiation of the antenna depends on the current fields generated in the radiating patch which are shown in figure 11 below. We can observe that the intensity of the current field is minimum at the center of the patch and maximum at the edges. The current fields will determine the overall performance of the antenna. All the governing parameters like gain, directivity and radiation pattern of the antenna are determined from the current fields generated in the antenna. From the plots below we can observe that the current fields are different at different operating frequency of the antenna.



(a) lower patch at 2.65GHz



(b) Upper patch at 4.62GHz

Fig. 9. Current distributions of the patch

IV. CONCLUSION

A dual frequency Dielectric Resonator patch antenna has been designed for the wireless communication applications in the S and C bands with an operating frequency of 2.65GHz and 4.62GHz. The patch is a dielectric material with a high dielectric constant value of 20. A 50Ω strip line is considered as feed and is coupled to the dielectric radiator via the rectangular slot etched in ground plane. The slot etched in ground plane is made so as to facilitate the power from the feed line to the radiator. The overall dimension of the antenna is 100mm×35mm×0.8mm. A dual frequency antenna has been proposed which will be operational at the frequencies of 2.65GHz and 4.62GHz with a gain of 4.42dB and 7.78dB respectively. Commercially available 3D simulator Ansys HFSS software has been used to design the proposed antenna. The current fields will determine the overall performance of the antenna. All the governing parameters like gain, directivity and radiation pattern of the antenna are determined from the current fields generated in the antenna. From the plots below we can observe that the current fields are different at different operating frequency of the antenna.

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