A New Design of Multilayer Dielectric Resonator Antenna for Wireless applications

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ABSTRACT In this paper, multilayer dielectric resonator designed and simulated using CST Microwave studio. In this design the multiple square shaped were used as the dielectric resonators as it offers more option to control the resonant frequency. The purpose of this paper is to design a low profile, small size antenna with high bandwidth along with good compromise in other factors like gain, directivity, efficiency etc. In this paper, the DRA of permittivity, $\varepsilon_r = 55$ was designed to operate at 5.5GHz. The DRA is excited by direct microstrip line of 50 Ω which is an effective mechanism to obtain better radiation. Here a good return loss is obtained at a peaks whose value are -33.2 dB at 5.76GHz. A directivity 6.86 dBi & gain 6.7dB is obtained. The proposed design is suitable for the wireless applications. It could be design for possible application in many systems which are wireless system like WLAN if properly scaled to frequency band allowed.

KEYWORDS: Dielectric resonator antenna, return loss, microstrip feed line, CST Microwave studio.

INTRODUCTION

The increasing use of wireless mobile communication systems demand the antenna for different system and standard with properties like reduced size, broadband, multiband operations, moderate gain etc. the planar and dielectric resonator antenna are the present day antenna designer’s choice. Dielectric resonator antenna became very popular in the core sector’s of a country like defence, military, radar and especially for satellite and millimeter wave applications. The resonating frequencies of a dielectric resonator antenna are nothing but the function of size, shape and dielectric constant only. Due to this flexibility in DRA’s, they can be designed with different shapes as per coverage requirement depending upon the application in the wireless communication industries. Wireless application have grown at a very rapid pace across the world.
over the last few years, which provide a great flexibility in the communication infrastructure of environments such as hospitals, factories, and large office buildings. [1], [2]. WiMAX and WLAN are the standard based technologies enabling the delivery of last mile wireless broadband accessories.

To achieve the necessary application a high performance wideband antenna with excellent radiations characteristics are required [1]. over the past few year, the dielectric resonator antenna has received extensive attention due to its several advantages such as light weight, low dissipation loss, high dielectric strength and higher power handling capacity [2],[5]-[7].

Figure 1. Geometry of DRA

DRA can be in a few geometrics including cylindrical, rectangular, spherical, hemispherical and triangular shaped. In the last 2 decades, two classes of novel antenna have been investigated and extensively reported on. They are the microstrip patch antenna and the dielectric resonator antenna. Both are highly suitable for the development of modern wireless communications.

DRAs can be designed with different shapes to accommodate various design requirements. DRAs can also be excited with different feeding methods, such as probes, microstrip line, slots, and co-planar lines [1]. As compared to the microstrip antenna, the DRA has a much wider impedance bandwidth due to their many advantages features. These include their compact size, light weight, the versatility in their shape and feeding mechanism, simple structure, easy fabrications and wide impedance bandwidth. Operating bandwidth of DRA is varied by choosing different dielectric constant from 8 to 100 of resonant material.

ANTENNA CONFIGURATION AND DESIGN

The structure of the Dielectric resonator antenna is shown in figure1. The DRA was fed with direct 50 Ω microstrip line which wide and length were 1.9mm and 36mm respectively. This microstrip line was photo-etched on the substrate of permittivity, 3.38. In this paper, the DRA of permittivity, $\varepsilon_r = 55$ was designed to operate at 5.5GHz. The height of the substrate was
0.813mm while the width and length were 64mm and 64mm, respectively. The dimensions of the DRA1 was 25mm length and 25mm width with height was 1mm. The dimensions of the DRA2 was 16mm length and 16mm width with height was 1mm. The dimensions of the DRA1 was 9mm length and 9mm width with height was 1mm. In this design, the distance between the DRA and open end of the microstrip line was 4mm as the positions where the finest coupling was obtained. DRA has a much impedance bandwidth then microstrip antenna because it radiates through the whole antenna surface except ground port. While microstrip antenna radiates only through two narrow radiation slots. Avoidance of surface waves is another attractive advantage of DRAs over microstrip antenna. DRA has high degree of flexibility and versatility, allowing for designs to suit a wide range of physical or electrical requirement of varied communication applications.

In microstrip line feed, a conducting strip is connected directly to the edge of the patch a common method for coupling to dielectric resonator in microwave circuits is by proximity coupling to microstrip line. Microstrip coupling will excite the magnetic fields in the DRA to create the short horizontal magnetic dipole mode. The level of coupling can be changed by the lateral location of the DRA with respect to microstrip line and on the relative permittivity of the DRA [2]. The design parameter for the design is summarized in the table shown below.

<table>
<thead>
<tr>
<th>DRA design parameter</th>
<th>dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substrate</td>
<td>Length = 64mm, Width = 64mm, Height = 0.813mm, $\varepsilon_r = 3.38$</td>
</tr>
<tr>
<td>DRA</td>
<td>Length = 25mm, Width = 25mm, Height = 1mm, $\varepsilon_r = 55$</td>
</tr>
<tr>
<td>DRA</td>
<td>Length = 16mm, Width = 16mm, Height = 1mm, $\varepsilon_r = 55$</td>
</tr>
<tr>
<td>DRA</td>
<td>Length = 9mm, Width = 9mm, Height = 1mm, $\varepsilon_r = 55$</td>
</tr>
<tr>
<td>Feed line</td>
<td>Length = 36mm, Width = 1.9mm</td>
</tr>
</tbody>
</table>

RESULT AND DISCUSSIONS

The commercial 3D Full wave electromagnetic (EM) Simulated software CST Microwave Studio, based on FIT method is used for simulation purposed. In this paper, the DRA of permittivity, $\varepsilon_r = 55$ was designed to operate at 5.5GHz. The DRA is excited by direct microstrip line of 50 Ω which is an effective mechanism to obtain better radiation. DRA whose return loss is -33.2dB at 5.76. A directivity 6.86 dBi & gain 6.2dB is obtained. The proposed design is suitable for the wireless applications. The lowest the return loss, the minimum is the loss and the DRA can accept maximum power from the source.
Figure 2. Return loss

Figure 3. Far field
Table 2- Performance summary of proposed DRA

<table>
<thead>
<tr>
<th>OUTPUT PARAMETERS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Return Loss</td>
<td>-33.2 dB at 5.76 GHz</td>
</tr>
<tr>
<td>Directivity</td>
<td>6.86 dBi</td>
</tr>
<tr>
<td>Gain</td>
<td>6.2 dB</td>
</tr>
<tr>
<td>VSWR</td>
<td>1</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>High</td>
</tr>
<tr>
<td>Substrate</td>
<td>$\varepsilon_r = 3.38$</td>
</tr>
<tr>
<td>Feeding method</td>
<td>Microstrip line</td>
</tr>
</tbody>
</table>

![Farfield Directivity Abs (Phi=90)](image)

![Theta / Degree vs. dBi](image)

**CONCLUSION**

In this paper, the Dielectric Resonator Antenna of permittivity, $\varepsilon_r = 55$ was designed to operate at 5.5GHz. Here a good return loss is obtained at a peaks whose value are -33.2 dB at 5.76GHz. A directivity 6.86 dBi & gain 6.2dB is obtained. The proposed design is suitable for the wireless applications. DRA was used as it offers more flexibility in controlling resonant frequency, hence it provide high degree of freedom in controlling antenna performance. Microstrip feed line used in the design is efficient, simple and easy to be implemented and suitable for wireless
applications. Dielectric resonator antenna became very popular in the core sector's of a country like defence, military, radar and especially for satellite and millimeter wave applications.

**REFERENCE**


