A Study of Performance Comparison of Stacked Dielectric Resonator Antenna

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Abstract- *In this paper, a study of performance comparison of Proposed Stacked Dielectric Resonator Antenna with other Dielectric Resonator Antenna is presented which is working at 5-6GHz frequency band for wireless applications. Various designs of Dielectric Resonator Antenna with different shapes are described in this paper. In this design, proposed stacked DRA was used as the dielectric resonator as it offers more option to control the resonant frequency. The performance of the dielectric resonator antenna is simulated by electromagnetic simulator CST Microwave Studio. This paper gives a better understanding of the design parameter of an antenna and their effects on return loss. The proposed design is suitable for WLAN IEEE 802.11 & Wi-MAX IEEE 802.16 standard applications which operate at 5.15 GHz -5.825 GHz & 5.3GHz- 5.8GHz respectively.*

Keywords- Dielectric Resonator Antenna, Return Loss, WiMAX, WLAN, Feed techniques, CST Microwave Studio.

I. INTRODUCTION

The dielectric resonator antennas (DRAs) have become increasingly popular in microwave and millimeter wave applications due to their attractive features and inherent merits like high quality factors structures, high radiation efficiency, light weight, compactness, low profile, low temperature coefficient of frequency, zero conducting losses and suitable scale [1]. Dielectric resonators of low loss dielectric material, having dielectric constant as $2< \varepsilon r< 100$ are ideally suitable for antenna applications, so that a compromise can be made between size, operating frequency and other antenna radiation characteristics. These antennas can also be easily integrated into portable communication devices [2]. Significant advances are being made for many applications. It has been demonstrated that dielectric blocks of cylindrical, rectangular parallelepiped, hemispherical, half-split cylindrical, equilateral triangular shapes can be designed as antennas [3]. Different types of feeding structures such as coaxial probe, microstrip line and coplanar waveguide have been proposed [4]. The rectangular shape offers a second degree of freedom, making it the most versatile of the basic shapes. There is a greater amount of flexibility in designing rectangular DRAs to achieve the desired profile and bandwidth characteristics for a given resonant frequency and dielectric constant, since the width/height and width/depth can be chosen independently [5]. Applications in the wireless and mobile communication areas require the development of radiating elements, which have as compact/low profile and wideband as possible. Hence, a lot of research is directed towards an increase of the bandwidth of the DRAs while keeping the size compact/low profile [6].

II. DIELECTRIC RESONATOR ANTENNA

In this paper, The Omnidirectional rectangular dielectric resonator antenna (DRA) using its higher-order mode is proposed for the gain enhancement. It was for 5.8GHz WLAN applications. Its simulated return loss, and antenna gain of the proposed DRA are -36dB and 3.63dBi, respectively. The DRA has a square cross section (a=b=18.8mm), a height of h1=49mm and a dielectric constant of εr =10. It is centrally fed by a probe with a radius of r2 =0.635mm and a height of h2=6.7mm. The omnidirectional DRA is more popular because it can provide larger coverage than the broadside DRA. Rectangular DRA using its higher-order mode is proposed for 5.8 GHz WLAN (5.725-5.85GHz) applications. The proposed DRA was designed using HFSS Software [1].

In this paper, A novel beam-steering cylindrical dielectric resonator antenna (DRA) is presented in this paper. The proposed DRA consists of a cylindrical dielectric resonator with dielectric constant of 80 and two symmetrical microstrip transmission line feeding ports. It is fabricated and mounted on a grounded FR-4 microwave dielectric material. The simulated return loss which is about -16.5dB at 5.5GHz obtained. The radiation pattern of the beam-steering DRA can be controlled by tuning the phase differences of the two feeding ports. The resonant frequency of the DRA is about 5.5GHz, which can be tuned to 5.8GHz easily through adding a metal screw on the back of the dielectric resonator for dedicated short-range communication [2].

In this paper, A design of rectangular dielectric resonator antenna (RDRA) with return loss of -36dB at 5.7GHz is described. The antenna consists of dielectric constant of 10 and 32, RDRA vertically to obtain improved bandwidth as compared to the conventional RDRA. The parameters of antenna are 17x7x4.56 mm3 with grounded substrate size: 80x50 mm2. The prototype is fabricated. Measured and simulated results are both in good agreement. The prototype antenna designed to operate in band from 5.0 to 5.7 GHz with measured gain at 5.7GHz resonant frequency. The proposed antenna is suitable for wireless local area networks (WLAN) applications in 5-6 GHz frequency band (in the frequency range 5.15-5.35GHz and 5.5-5.7GHz) [3].

In this paper, A new rectangular dielectric resonator antenna (DRA) design with CPW feeding is presented for wireless local area network (WLAN) applications. This antenna consists of a rectangular DR with a center-fed CPW inductive slot which is etched on a Teflon substrate (εr=2.1, T=1.25mm). DR is placed above the inductive slot with an offset Lc from the slot to the lower edge of the DR. The 50Ω CPW line is designed with the center metal strip width Wc=2.5 mm and a gap width=1.0 mm. The Simulated result shows that the proposed antenna have a return loss of -34.6dB at 5.7GHz & an impedance bandwidth from 5.45GHz to 6.22GHz covering 5.8GHz WLAN band. Parametric studies of the antenna carried out by varying the length of the horizontal slot and simulated results for 5.8 GHz WLAN application are presented here [4].

In this paper, A Dielectric resonator antenna design is presented for Wireless Local Area Network (WLAN) applications. By using a dielectric resonator with an inverted U-shape cross section and optimized rectangular patch adhered in between the dielectric resonator as a feeding mechanism. The Simulated result shows that the proposed antenna have a return loss of -22.7dB at 5.5GHz and an impedance bandwidth of about 15.7% and covering a frequency range of 5.1 to 5.97GHz is achieved and resonating at 5.5GHz. This DRA suitable for the IEEE 802.11a wireless local area network (WLAN) applications (5.15-5.35 GHz and 5.725-5.825 GHz) within a 2:1 VSWR. The CST Microwave Studio is used for simulation [5].

In this paper, aperture-coupled circular DRA antenna composed with high permittivity for application in WLAN is presented. the measurement results of the dielectric resonator antenna with High permittivity is obtained. With this technique, a high bandwidth (return loss < -10 dB) of center frequency at about 5-6 GHz for application in WLAN has successfully been achieved. The cross-polarized patterns are about 10 dB less than the co-polarized patters in the broadside direction. A return loss is obtained at a peaks whose value are -30dB & gain 5.9dB at frequency of 5.36GHz is obtained. The gain variations are less than 2.0dBi for frequencies within the -10 dB S11 bandwidth. The diameter and thickness of the presented DRA antenna with high permittivity are 8.8 and 4.2 mm, respectively. A compact size of DR antenna with high permittivity as compared to a conventional DR antenna has been successfully achieved [6].

III. PROPOSED STACKED DRA CONFIGURATION AND DESIGN

The Stacked 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. The dimensions of the DRA1 was 25mm length and 25mm width with height was 1mm and permittivity, εr=55. The height of the substrate was 0.813mm while the width and length were 64mm and 64mm. The dimensions of the DRA2 was 16mm length and 16mm width with height was 1mm. The dimensions of the DRA3 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.

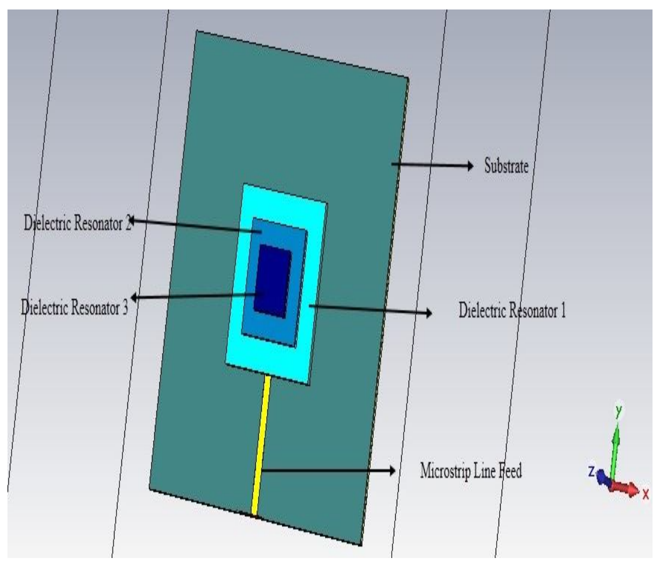

Figure 1. The Proposed Stacked DRA

IV. RESULT

The commercial Full wave electromagnetic (EM) Simulated software CST Microwave Studio is used for simulation purposed. The DRA is excited by direct microstrip line of 50Ω which is an effective mechanism to obtain better radiation. In this paper, the stacked DRA was designed to operate at 5.76GHz in which antenna radiates maximum and has lowest return loss. After simulation return loss is -45.88dB at 5.76GHz and a directivity 6.9dBi & gain 6.47dB is obtained. The lowest the return loss, the minimum is the loss and the DRA can accept maximum power from the source.

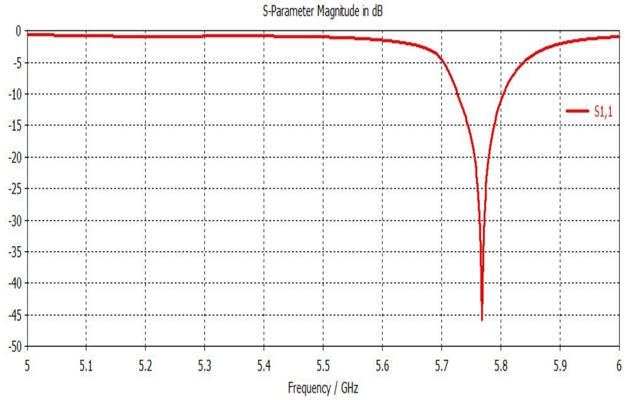

Figure 2. Simulated Return loss

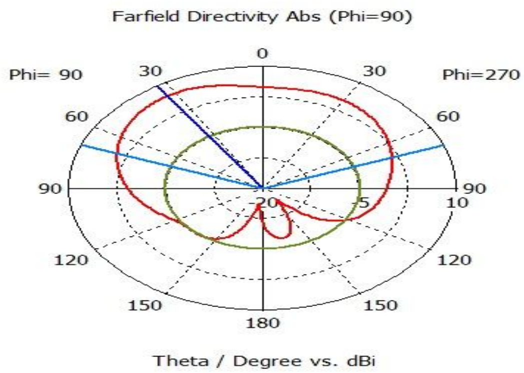

Figure 3. Polar Plot

V. COMPARISION

Comparison of Proposed Stacked DRA Design other DRA on the basis of return loss value in the 5-6GHz frequency range for the WLAN/Wi-MAX frequency band of applications is shown below in table-1.

Table 1- Performance comparison of proposed stacked DRA with other DRA

DRA Design	Return loss value(dB)	Frequency (GHz)
Gain Enhancement of Omnidirectional RDRA [1].	-36dB	5.8GHz
Design and investigation of a novel beam-steering CDRA [2].	-16.5dB	5.5 GHz
Wideband Stacked RDRA at 5.2 GHz [3].	-36dB	5.7 GHz
A Compact CPW Fed DRA for WLAN Applications [4].	-34.6dB	5.8 GHz
Inverted U-shape DRA for WLAN application [5].	-22.7dB	5.5 GHz
Low-Profile Aperture-Coupled Circular DRA for Application in WLAN [6].	-30dB	5.36 GHz
Proposed Stacked DRA	**-45.88dB**	**5.76GHz**

VI. CONCLUSION

After a comparison of proposed stacked dielectric resonator antenna with other DRA, it clear that the Proposed Stacked DRA gives a better results in the form of return loss value, so the proposed stacked DRA is suitable for wireless applications in 5-6 GHz frequency range. Due to the flexibility in DRAs, they can be designed with different shapes as per our requirements depending upon the applications in the wireless application. It is concluded that by choosing proper structure for DRAs we can easily increase improve the performance of dielectric resonator antenna. In this rapid changing world in wireless communication, Dielectric Resonator Antenna has been playing a key role for wireless service requirements.

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