

A Novel Multi Mode Rectangular Dielectric Resonator Antenna for WLAN, Wi-Max Applications

Ekta Bhayana¹, Dr. Alok Agarwal²

^{1,2}Department of Electronics and Communication, Lingaya's Vidyapeeth, Faridabad

Abstract— A Multi-mode Rectangular Dielectric Resonator Antenna is presented in this paper. The studied RDRA is designed for the applications in predominant wireless application bands like LTE, WLAN, Wi-Max. In this design, total DGS is incorporated to obtain multimode RDRA for improved frequency response with high precision for modern day's wireless applications. Dielectric Resonator Antenna (DRA) of dimension 100 x 100 x 1.6 mm³ is designed and simulated on substrate FR4 using strip line feeding mechanism with an impedance matching of 50 ohms. Wide bandwidth of 21.6% is achieved for optimised DGS. Presented antenna shows multi mode characteristics with fractional Bandwidth of 21.6%. There are 3 modes excited at frequencies 2.6 GHz, 3.8 GHz to 5.1 GHz. The less value of VSWR ensure lossless performance characteristics of RDRA at a wide range of frequencies with an impedance bandwidth of 21.6 % with Peak Gain of 4.5dB, which inturn makes this design predominantly suitable for LTE, Wi-MAX and WLAN (ISM BAND). The Proposed RDRA Antenna is designed in simulation with HFSS 13, FEM based 3D EM Simulation Software.

Keywords— *Rectangular Dielectric Resonator Antenna (RDRA), Radiation Pattern, Multimode and wide Band, Reflection coefficient, (defective ground structure).*

I. INTRODUCTION

The initiation of current wireless advancements, the need for dual, multiband, antennas is taking place stridently. The merits of such type of antenna systems are such that they can maintain superior data transfer at enhanced speeds along with easiness in space allocation. For comprising the demands of compressed & modest, multi band and wideband, competent structures of antenna are essential.

Rectangular Dielectric resonator antenna (RDRA) is a proficient support as a radiator in Multi/wideband due to its physical compactness, light weightiness as micro strip, high temperature stability, cost effectiveness as well as ease of fabrication [1].

RDRA/DRAs display higher radiation efficiency (η), due to absence of conductors from the edges of the radiator. Consequently, the DRAs compatibility with different coupling methods such as coaxial line probe, coplanar waveguide[CPW], micro-strip slot coupling, strip line

coupling, aperture slot coupling, along with dielectric image guide method pin more features to it [2, 3].

Numerous approaches have been in print to augment the bandwidth of the DRAs keeping the gain steady. By incorporating the DGS in the ground plane of the DRA, lowering down the Q-factor, results in bandwidth enrichment of the DRA. RDRA operated at the fundamental mode can be investigated through software simulation and experimentally, it is observed that by changing the size of the slot can remarkably affect the radiation properties [4].

By adding E shape slot to rectangular patch antenna or Dielectric Resonator antenna and applying stacked layer technique for broad band and wide band operation can be suitable for Wi-Max and WLAN application. The patch is designed to operate within range 5.15-5.85GHz [5]. Bandwidth enhancement can also be achieved by changing shapes of DRA. DGS formation can be another method to enhance the Bandwidth along with the high gain achievement [6].

The different approaches are carried out by cutting the U slot with inset feed so that the multiband DRA in turn achieves the bandwidth at the frequency range of 1.84GHz and 2.4 GHz and is suitable for the WLAN and GSM applications [7]. The different shapes like rectangle, circle, square and meander patches are also simulated to achieve better results and have been compared using different parameters like VSWR, Radiation Pattern, return loss and gain. The results achieved at 2.4GHz [8].

For wireless communication Antenna can also be comprises with the slot of double I-shape along with Dumbbell shape DGS the obtained results are Multiband of the frequency ranges from 2.45GHz, 3.58GHz, and 5.50GHz.

Antenna can be further altered by putting some Parasitic elements parallel to the radiating edge of the patch, with these effects the antenna starts radiating at four frequencies 2.45 GHz, 3.60GHz, 4.68GHz and 5.50GHz [9]. Another approach to enhance Bandwidth is by designing a novel feed, thereby exciting multiple modes is also presented [10].

Paper Presents, the multimode RDRA is designed for improved frequency response with high precision for modern day's wireless applications like LTE, Wi-MAX, WLAN. The

Defective Ground Structure is incorporated in the ground plane in proposed rectangular dielectric resonator antenna along with spiral shaped DGS with rectangular edges. The dielectric material foam of permittivity 9.8(alumina ceramic) with 3 modes of dielectric resonator antenna excited are precisely useful for the wireless telephony, mobile cellular communication and wireless sensor networks etc. It is also compatible with advance circuitry.

GEOMETRY AND DESIGNING

Fig.1. demonstrate the configuration of the projected antenna of Multi mode RDRA. In this geometry, a substrate of 100mm² has a height of 1.6mm and the dimensions of ground plane are 57mm X 100mm X 0.018mm. The ground plane is above the substrate of FR4 epoxy having a relative permittivity of 4.4. The rectangular DRA is made up of alumina ceramic having the relative permittivity of 9.8 and the dimension for the same is 24mm X 20mm X 30 mm. The antenna feed employed is strip line feed.

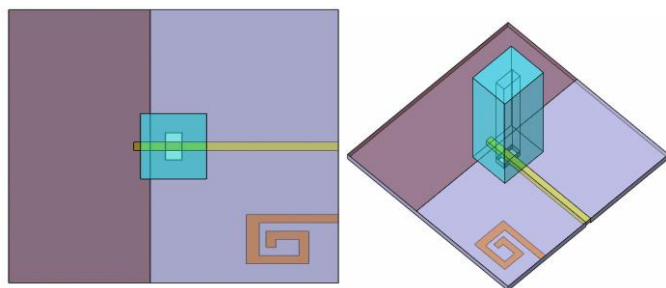


Fig1. Geometrical configuration of RDRA with DGS

Fig.2. shows the geometrical aspects of the designed antenna. As shown in figure, The Defective Ground Structure is incorporated in the ground plane along with spiral shaped DGS with rectangular edges. DGS of spiral shape consists of dimensions m= 28mm, n=12mm, c=12mm, d=9mm, e=7mm, f=7mm, g=3mm, j=3mm, k=4mm respectively.

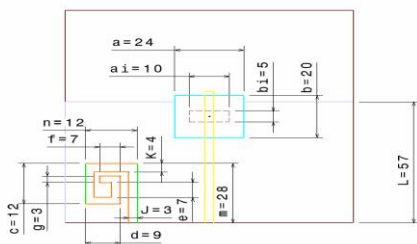


Fig 2. Shows the 2d view Diemnsions of RDRA

RESULTS AND DISCUSSION

- The frequency response with a bandwidth of 21.6% is achieved at the frequency range between 2.6GHz and 5.1GHz with a peak gain of 4.5dB and peak directivity of 4.98dBi.
- Fig.3. the broadband radiation pattern is achieved as S11 Parameter of optimized DGS with partial ground. The different modes are excited with the frequency range for both the dips in which it is radiating E.g The different modes are excited within 2.6587GHz to 2.8166GHz, 3.56GHz to 3.87GHz and 4.81GHz to 5.18GHz with resonant frequencies of 2.84GHz, 3.7Ghz and 5.1Ghz respectively.
- Fig.4. shows the graph drawn between the reflection coefficient affecting the s11 frequency response of

ground plane with/ without spiral shaped DGS in rectangular DRA. The good results are achieved at the optimized DGS with (Partial Ground).

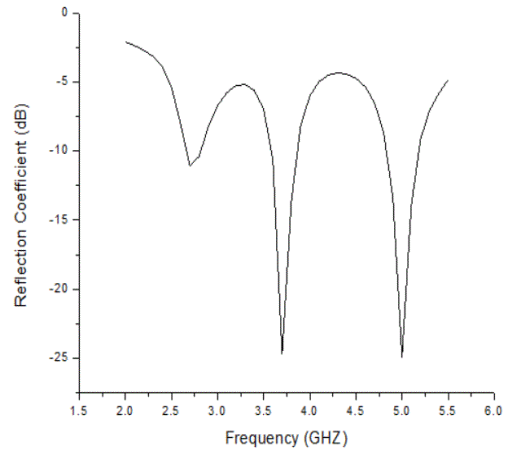


Fig.3. Shows S11 parameter optimized DGS with Partial Ground

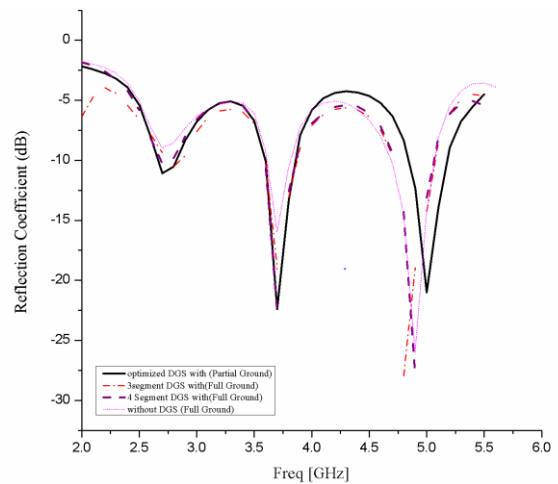


Fig.4. Shows reflection coefficient vs frequency with and without Partial/ full Ground with 3and 4 segment DGS

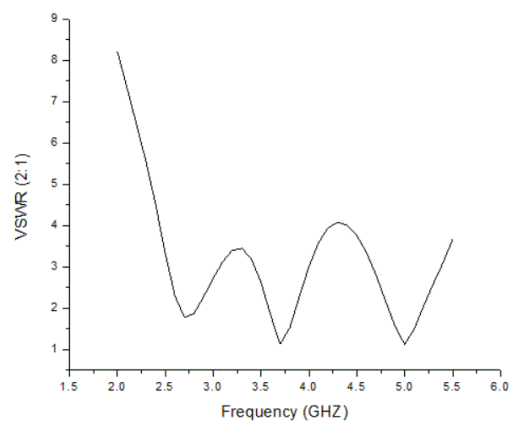


Fig.5. Shows VSWR of optimized DGS with Partial Ground

- Fig.5. shows the lower VSWR values to ensure lossless performance characteristics of antenna at a wide range of frequencies.
- Fig.6. shows the broadband radiation pattern is also achieved.

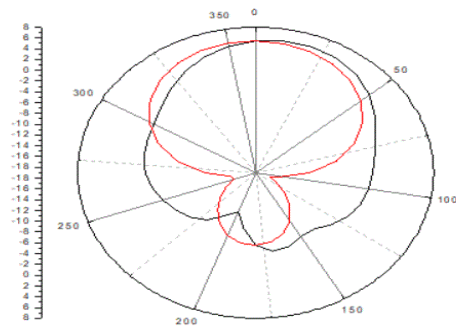


Fig.6. Shows Radiation pattern of optimized DGS with Partial Ground

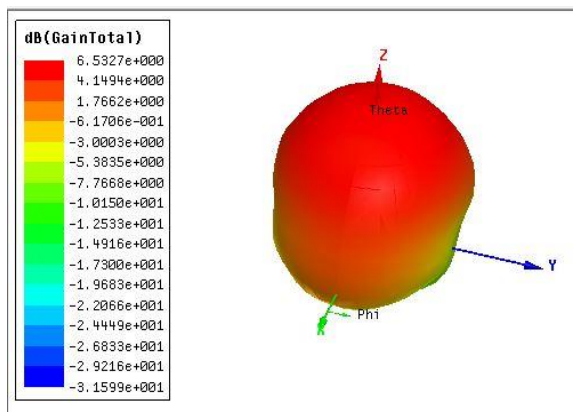


Fig.7. 3D Polar Plot

- Fig.7. shows the broadband radiation pattern of rectangular dielectric resonator antenna radiating at high gain with minimum losses is also achieved

II. CONCLUSION

The presented antenna is compact with a novel design and provides a high gain of 4.5dB and a bandwidth of 21.6%. The purpose of this antenna is to radiate in ISM Band and the desired result is achieved accordingly. The simulated results confirm the same with reflection coefficient and radiation parameter. The antenna is much useful in LTE, WLAN and Wi-MAX Applications.

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Author profile:

Ekta Bhayana received her Diploma in Electronics and communication engineering from State Board of Technical Education Haryana, CHD in 1999. B.Tech in Electronics and communication from Lingaya's Institute of Management and Technology, Faridabad, Haryana, in 2004. M.Tech. in Digital Signal Processing from Lingaya's University, Faridabad, Haryana, in 2009, and Pursuing Ph.D. in (Electronics & Communication Engineering) Title "Design and Development of wide band Rectangular Resonator Antenna for Wireless Communication Application", Lingaya's Vidyapeeth, Faridabad, Haryana. Presently working as a Manager in Lumax Mannoh Allied Technology Ltd., IMT Manesar, Gurugram. She is having more than 13 years of experience in academia as well as in Industry.



Alok Agarwal received his B.Tech. Degree in Electronics from Bhilai Institute of Technology, Durg, Raipur University, India, in 1996, M.Tech. Degree in Digital Communication from U.P. Technical University, Lucknow, India, in 2009, and Ph.D. (Electronics & Communication Engineering) title "Design and Analysis of Wideband Micro strip Antenna", JNT University, Jhunjhunu (Raj), awarded in 2014.



Presently he is working as an Associate Dean (R & D and Doctoral Research) & Professor in the School of Electronics and Electrical Engineering in Lingaya's University, Faridabad, India. He is having more than 18 years of experience.