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Dual Band Stacked Rectangular Dielectric Resonator Antenna with Elliptical Slot DGS for 5G Application

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Abstract: Presently wireless applications have lot of evolution in technology which is being monitored through antenna. So, in this paper dual band stacked rectangular DRA with elliptical slot DGS for 5G applications were implemented. In this work it is need to manage in such a way that slot and feed line should be matched. The antenna operates at dual band frequencies. In this Arlon AD350 lossy material for substrate and material for DRA is Arlon AR1000 lossy is used. The antenna resonates at two frequencies 8.92 GHz & 9.75 GHz.

Keywords: Dielectric resonate antenna; Defective ground structure; Microstrip line; VSWR; Mutual coupling

I. INTRODUCTION

5G technology is going to be a new mobile revolution in mobile market. Through 5G technology we can use worldwide cellular phones and this technology also strike the China mobile market. A user being proficient to get axis to Germany phone as a local phone. Through 5G technology a user can manage his whole office in his finger tip through phone. The development of 5G technologies aimed at increasing data rates of wireless communication networks by some factors like large band width, small size, low cost, and temperature independent. To implement all these factors many researches are trying to propose the utilization of higher frequency spectrum due to increasing requirements for wider and dual band systems. 5th Generation Mobile Network or simply 5G is the fourth coming revolution of mobile technology. The features and its usability are much beyond the expectation of a normal human being. With its ultra-high speed, it is potential enough to change the meaning of cell phone usability [1-8].

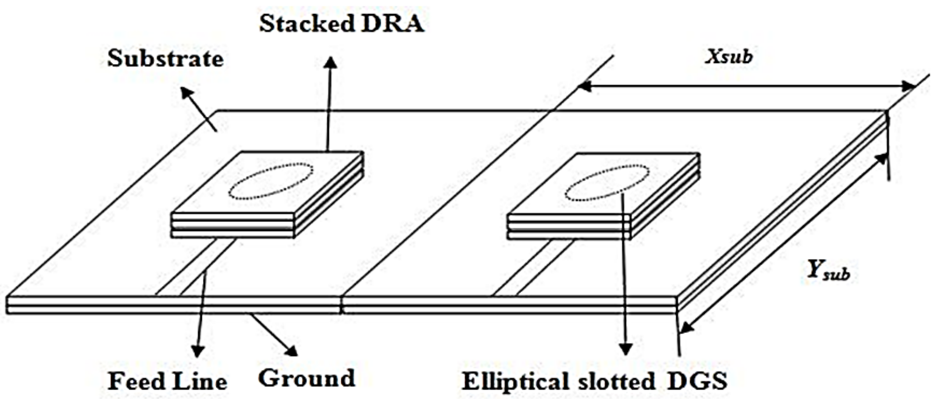

Figure 1: 3D view of geometry of the proposed 5G antenna.

5G would have a huge task to offer services to heterogeneous networks, technologies, and devices operating in different geographic regions. So, the challenge is of standardization to provide dynamic, universal, user-centric, and data-rich wireless services to fulfill the high expectation of people.

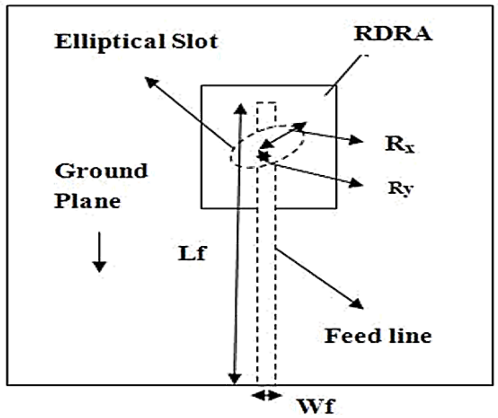

Figure 2: Top view of geometry of the proposed 5G antenna.

5G technology has extraordinary data capabilities and has ability to tie together unrestricted call volumes and infinite data broadcast within latest mobile operating system. 5G technology has a bright future because it can handle best technologies and offer priceless handset to their customer [9-11].

DRA is a radio antenna mostly used at microwave frequencies and higher, that consists of a block of ceramic materials of various shapes. The DRA mounted on a metal surface, ground, radio wave, are introduced inside the resonator material. Advantage of DRA is that they lack metal parts, because they are lossy at higher frequencies, dissipated energy, so that the antenna has lower losses and more efficient than metal antenna at microwave & milliwave frequencies [12-17].

II. CONFIGURATIONS OF PROPOSED ANTENNA

Based on geometry of the proposed dual band antenna is shown in Figures 1 and 2. The configuration of proposed antenna is directed by using Arlon dielectric material as substrate of type Arlon AD350 (lossy) of thickness 0.8*mm*, dielectric constant, $\in = 3.5$ and loss tangent of Tg = 0.0003. The substrate dimensions having length of Ysub = 48mm and width of Ysub = 40 mm. Resonant frequency of RDRA, it has been already design by dielectric waveguide model. Resonant frequency can be calculated using below equation (1).

$$f_r = \frac{c}{2\pi\sqrt{\in_r}}\sqrt{k_x^2 + k_y^2 + k_z^2} \quad (1)$$

$$k_x = \frac{m\pi}{a}; k_y = \frac{n\pi}{b}; k_z = \frac{l\pi}{2d}$$

Where $\in_r$ is the permittivity of dielectric resonator and k_x, k_y, k_z represents the wave numbers along *x*, *y*, *z* directions within the RDRA antenna respectively *a*, *b*, *c* and d are dimensions of RDRA along the *x*, *y*, *z* axis. The proposed dual band 5g antenna is shown in Figures 1 and 2. The structure consists of stacked RDRA along- with elliptical slot DGS and micro strip line feed [18,19].

The RDRA is made up of Arlon AD350 (lossy) dielectric material having permittivity $\in = 10$ with loss of tangent $\delta = 0.03$. The dimensions of RDRA are width a=14, length b=15 along with height is about 1.28.

Rectangular DRA is printed on the grounded substrate and is connected to the microstrip feed line through an elliptical aperture. The microstrip feed line having dimensions W_f X L_f = 2.4 × 31 mm² is printed on the dielectric substrate. Elliptical coupling slot is printed at the center of the grounded structure of the resonator and is used to excite the DRA. For improving the impedence matching of the structure the elliptical shaped slot is used here. A good orientation (adaption) has been obtained by making an angle of alpha = 20°. The elliptical slot having" dimensions R_x X R_Y = 4.8 × 1.8mm^2

The antenna parameters are shown in Table 1.

Part	Parameter	Values(mm)
Rectangular dielectric	Height, d	1.28
	Length, b	15
Dielectric resonator (for one layer)	Width, a	14
	Height, h	0.8
Substrate	Height, h	0.8
	Length, Ysub	48
Feed line	Width, Wf	2.4
	Length, Lf	31
Coupling	Long radius,Rx	4.8
Elliptical slot	Small radius,Ry	1.8

Table 1: Optimized geometrical parameters for the poroposed antenna.

III. RESULTS AND DISCUSSION

The simulated results for proposed antenna with return losses |S11| and |S12|. The return loss of dual band 5g antenna is shown in Figures 3 and 4. By seeing the figure, we observed that the return loss must be less than -10dB and it is operated at dual frequency bands 8.92 GHz and 9.75 GHz. The antenna performance reflects reference impedence and reflection coefficient.

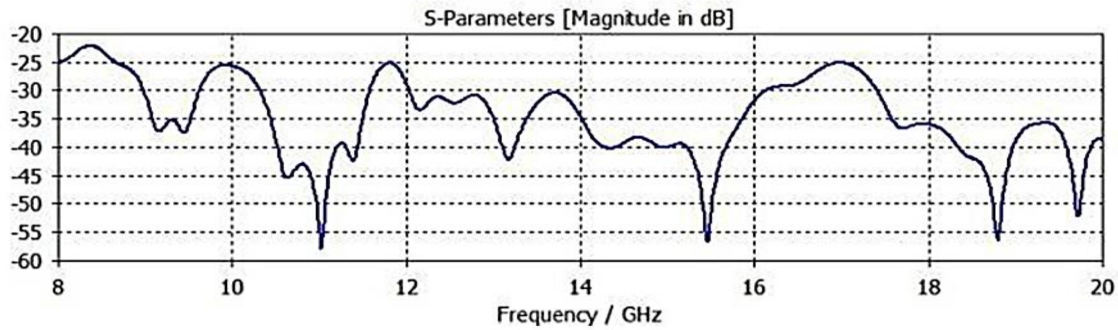

Figure 3: Simulated reflection coefficient (S11) characteristics of antenna.

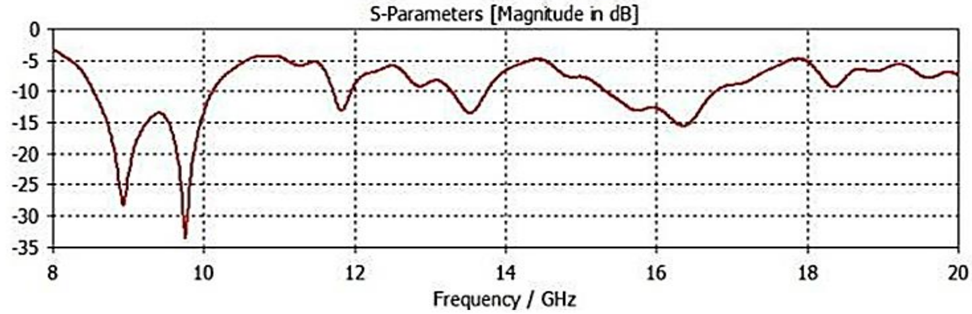

Figure 4: Simulated reflection coefficient (S12) characteristics of antenna.

Voltage Standing Wave Ratio (VSWR) must be less than (or) nearly equal to 2 from Figure 5. We observed that the vswr value for the two bands of interest is less than 2.

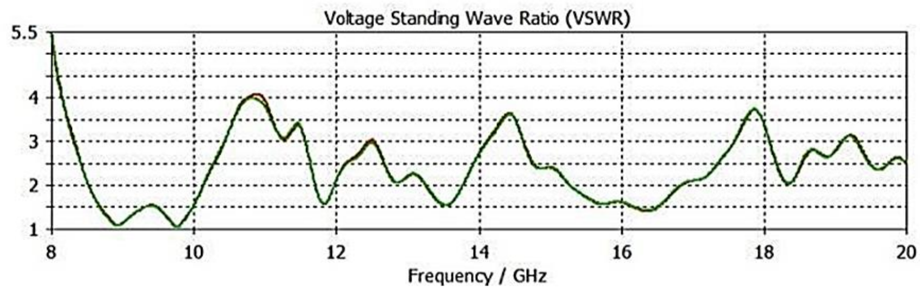

Figure 5: Simulated VSWR vs. frequency characteristics of the antenna

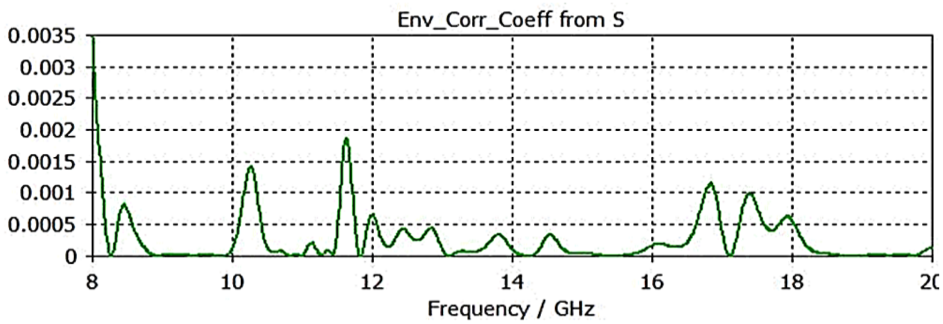

Figure 6: Simulated ECC characteristics of the antenna.

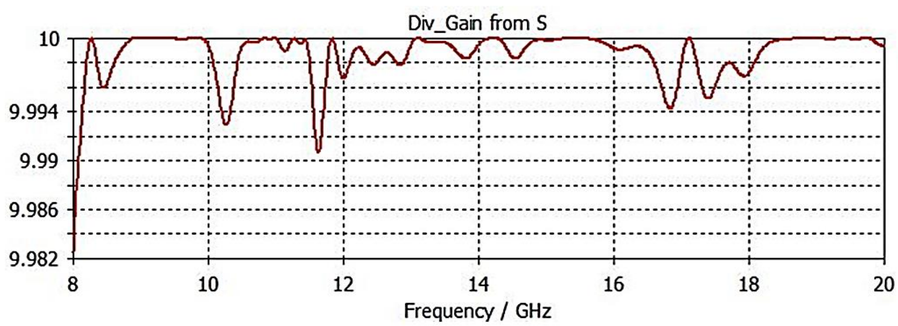

Figure 7: Simulated diversity gain characteristics of the antenna.

The Envelope Correlation Coefficient (ECC) and Gain characteristics of proposed antenna for dual frequency 8.92 GHz and 9.75 GHz are shown in Figures 6 and 7. The ECC values for proposed antenna are 1.47 at 8.92 GHz and

3.32 at 9.75 GHz. The diversity gain can be obtained 9.99 dB at 8.92 GHz and 9.99 dB at 9.75 GHz. The total efficiencies are -0.7878 dB and - 0.3726 dB and radiation pattern in terms of gain values are 5.037 dB and 6.473 dB at 8.92 GHz and 9.75 GHz respectively.

IV. CONCLUSION

The design of dual band stacked RDRA with elliptical slot DGS for 5G mobile communication system has been proposed in this paper. The proposed stacked RDRA is designed by using layers made up of low cost Arlon materials i.e., AR1000 is used for dielectric substrate and it is operated at 8.92 and 9.75 GHz band frequencies. The simulated results for the proposed antenna having good characteristics like return losses, reflection coefficient and vswr. The elliptical slot DGS gives good impedence matching at both frequencies i.e., 8.92 and 9.75 GHz the proposed antenna can be demonstrated for 5G applications. Moreover, governments and regulators can use this technology as an opportunity for the good governance and can create healthier environment, which will definitely encourage continuing investment in 5G, the next generation technology.

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