A Novel Patch With Optimized Circular DGS For CB Radio And 5G

Ribhu Abhusan Panda, Debasis Mishra

Abstract:The conventional circular patch in modified in such a way that the resultant shape resembles biconvex lens structure. The frequency of operation is chosen as 27 GHz which is suitable for many applications like satellite communication, fixed & mobile service except Aeronautical mobile service and CB Radio. A DGS has been applied having a circular shape in the ground plane. After simulation the focus has been made for the S_{11} plot (<10 dB). The antenna gain in dB has been found out at the frequency where the proposed antenna resonates. To find out the desired resonant frequency radius of the proposed DGS has been optimised with the help of optimised tool in HFSS software. a comparison has been made between the simulated parameters of the proposed patch with DGS and without DGS. Other parameters like VSWR Directivity, Radiation efficiency, etc have been determined.

Index Terms:Reshaped Circular Patch, DGS, CB radio, S_{11}, Antenna Gain, HFSS, VSWR.

1 Introduction

A PPRECIABLE perturbations have been made in past few years to the conventional circular patch for different applications. Some of them resulted in biconvex and biconcave shaped patch [1],[2],[3],[4],[5],[6]. Many gain and bandwidth enhancement techniques have been proposed in recent years [7],[8],[9],[10]. Defective ground Structure (DGS) is a very prominent method to enhance the antenna gain and bandwidth. In recent years different type of DGS have been proposed for specific applications [11],[12],[13],14],[15],16]. Defective ground represents the modified ground plane where specific type of slots in it. For improvement of specific parameters like bandwidth, cross polarisation characteristic, reduction of mutual coupling, ground noise suppression and common mode suppression etc DGS plays a vital role. In this article a simple circular DGS is considered at the middle point of the ground plane and the perturbed circular patch is designed in such a way that the distance between the two arcs is equal to the wavelength calculated from the design frequency. The proposed patch is designed on a substrate of dimension 40mm×40mm×1.6mm. The ground plane is having the same dimension as that of the substrate. Material for the substrate is FR4 Epoxy which is plentily available and high resistive towards the fire. This antenna is designed for 27 GHz application which includes 5G communication [17] and another unique application known as CB radio communication. CB radio refers to citizen band radio generally uses 26 GHz to 28 GHz frequency band [18].

2 Antenna Design

2.1 Design of modified patch structure

Unique specifications have been considered to design the proposed antenna. The resonant frequency is taken as 27 GHz and the corresponding wavelength (λ=c/f=11.11mm) has been calculated. The maximum distance between the two arcs of the prosed modified circular patch is having same value as that of the corresponding wavelength.

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2.2 Design parameters for Substrate, DGS and Ground

Dimensions of the substrate and ground plane (length × breadth) is 40mm×40mm. The heights of ground plane and substrate is 0.01 mm and 1.6 mm respectively. The width of the of feed is considered as 3 mm. A simple circular DGS has been implemented on the ground plane at the centre position. The radius of the designed DGS has been optimised and at the best suited value of the radius different parameters like S_{11}, VSWR, Antenna Gain, Directivity etc have been calculated.

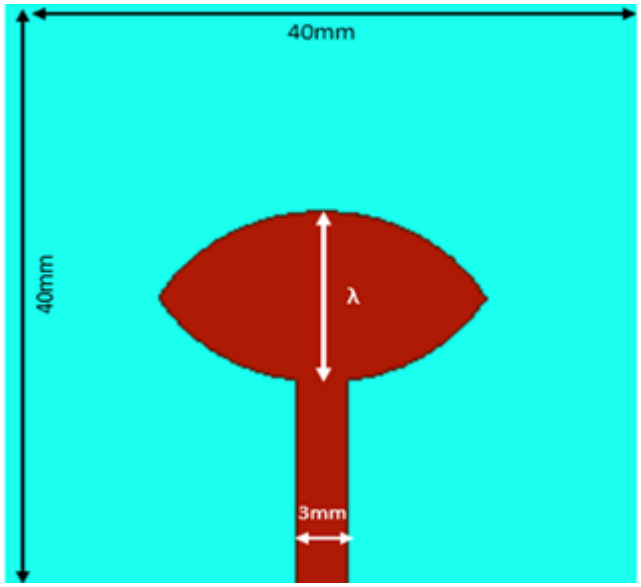

***Figure 1**: Proposed patch geometry (top view)*

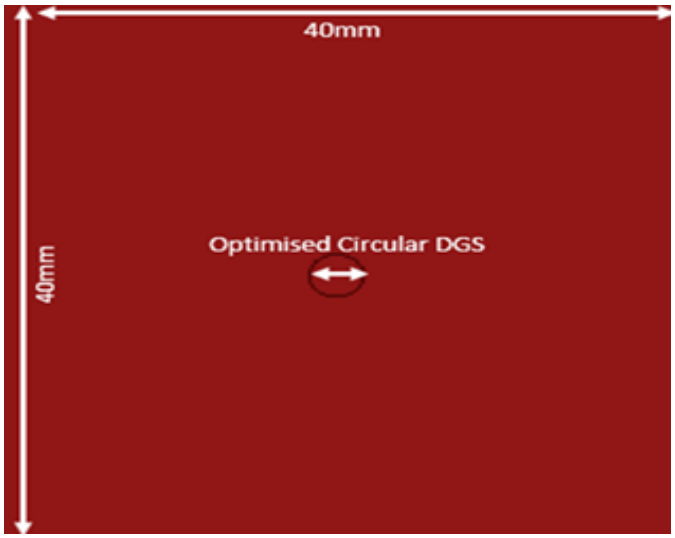

Figure 2: *Proposed Ground Plane with DGS (bottom view)*

3 RESULT STUDY

The focus has been done on the prominent plots like Return loss and VSWR. If the resonant frequency is the desired value with appreciable amount of Return Loss and VSWR then it can be concluded that the antenna can be operated in the desired frequency range. The transmission line model of the proposed antenna gives the idea of standing waves. Termination of one end of the transmission line produces the reflected waves and combinedly the incident and the reflected wave gives rise to the standing wave. Voltage standing wav ratio is the ratio between the peak to peak of these standing waves. Value of the voltage standing wave ratio as 1 is considered as the best as at this value there is least amount of loss from the reflected waves and anything nearer to the unity is appreciable. For this proposed antenna the VSWR has been found as 1.0028 which is nearly equal to 1. The resonant frequency is 27 GHz which includes 5G communication. Return loss value (S_{11}) is -56.99 dB at the resonant frequency. The S_{11}plots has been shown in

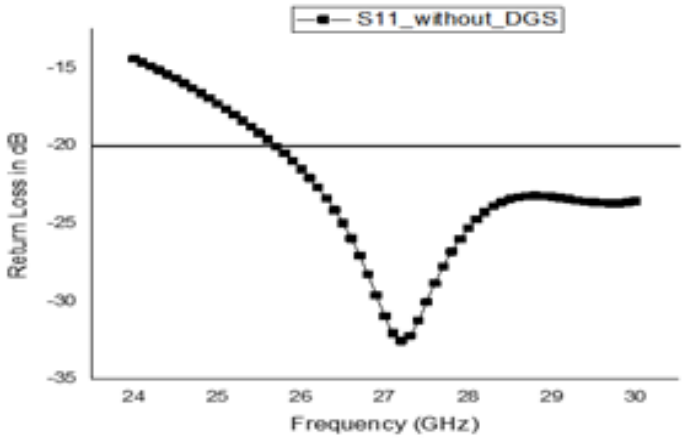

figure 3 to figure 5 *and the VSWR plot is shown in figure 6*

Figure 3: S_{11} of the antenna without DGS

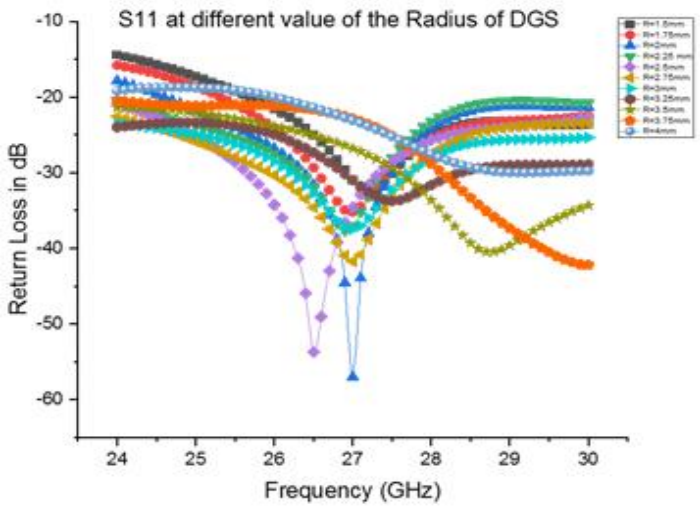

Figure 4: *S_{11} of the antenna with DGS of different Radius*

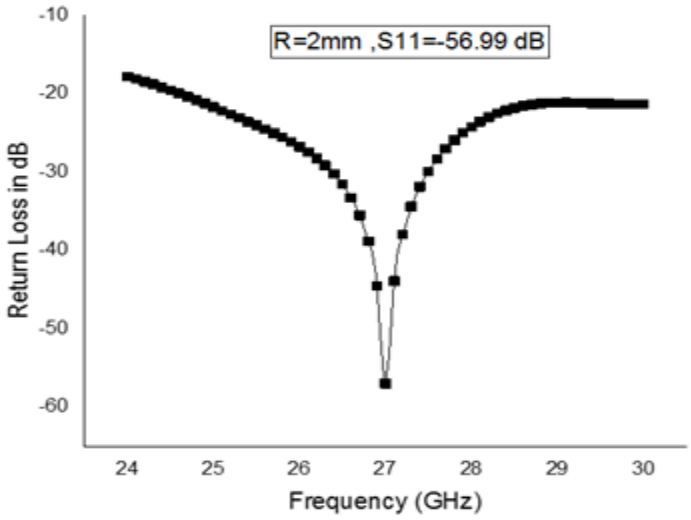

Figure 5: *S_{11} of the antenna with otimised DGS of radius R=2mm*

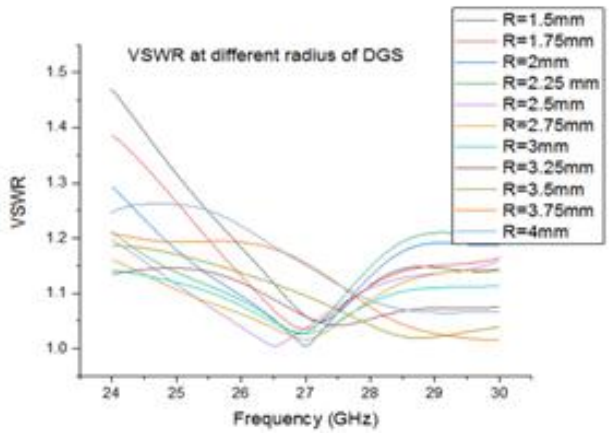

Figure 6: *VSWR of the antenna with DGS of different Radius*

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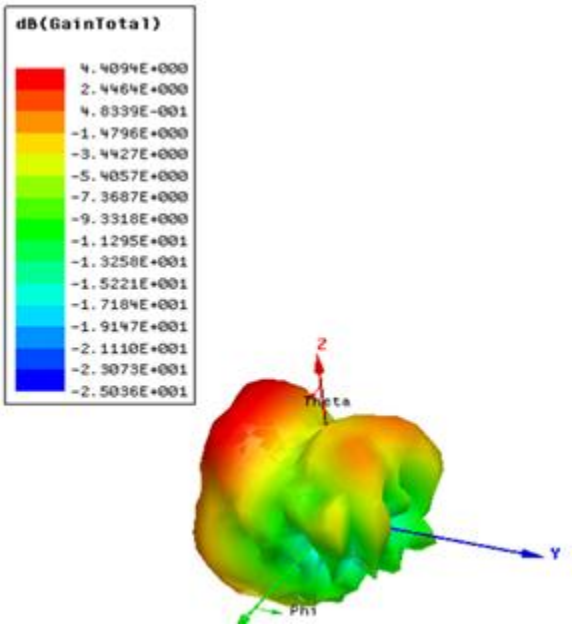

***Figure 7**: Antenna Gain pattern in 3-Dimension*

The simulated parameters are summarized in Table 1

Parameters	Without DGS	With Optimized DGS (R=2 mm)
Resonant Frequency (GHz)	27.2	27
Return Loss S_{11} (dB)	-32.54	-56.99
VSWR	1.24	1.0028
Peak Gain (dB)	1.41	4.43
Peak Directivity (dB)	4.21	8.06
Radiation efficiency (dB)	52.82	43.49

TABLE 1
SIMULATED PARAMETERS OF THE PROPOSED ANTENNA

4 CONCLUSION

The designed with optimised circular slot antenna can be used efficiently for 5G communication as the resonant frequency is 27 GHz with an appreciable amount of antenna gain and directivity of 4.43 dB and 8.06 dB respectively.

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