Wideband Truncated Micro Strip Rectangle Patch Array Antenna

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Sandeep Barua[1]

Abstract

Paper presents a new geometry and recognition of wideband truncated microstrip rectangle shaped antenna array having operating frequency of dual band 2.5 GHz and 2.6175 GHz. In this antenna design the material used for designing antenna is FR-4 lossy dielectric substrate and relative permitivity ($\varepsilon_r = 4.3,\ \tan\delta = 0.026$), height of the substrate is 1.6 mm, with circular slot cuts on square patch gives the enhanced bandwidth of antenna 232.1MHz. Further, with the help of DGS, the bandwidth of antenna enhanced by 1103.1MHz. Operating on wideband frequency 1.8969-3GHz and the Return loss is -28.96dBi at 2.6175GHz. The results of the new design are in conformity.

Keywords

Microstrip Patch Antenna, Wideband Antenna, Array Antennas

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[1]Department of Electronics, Madhav Institute of Technology and Science, Gwalior, Madhya Pradesh, India.

Corresponding author:
Email: Sandeepbarua09@gmail.com

Introduction

Antenna is an essential part into the wireless communication method. It is waves [1] advancement used in transmit and receive EM communication techniques shows in very instant expansion, especially in satellite communications field. Micro-strip patch antenna its intrinsic properties light weight, compact size, low cost [2]. Micro-strip word is made from two words that is micro (very slim/small) and strips (slab or piece) [3]. Micro-strip antenna-array using square patch comparing two elements are connected in operating frequency in S band for truncated Microstrip patch antenna planer technique [4,5]. Antenna used thin board operates in Microwave frequencies. In this type of antenna comprised of dielectric substrate middle layer into ground plane into the patch [6]. In New Mexico (1953), microstrip antenna reflection coefficient and bandwidth was firstly introduced [5,7]. Micro-strip antenna commonly exhibits restricted polarization. Since the nano-satellite is for eternity rotary, the dipole antenna required has the similar power into the perpendicular and horizontal ground [2,8]. The choosing of design parameters is important as of antenna performance depending parameters and high permitivity substrate minimize to the antenna size [9,10]. Microstrip array antenna techniques enhance the bandwidth, increasing gain and directivity, lower side lobe level of the antenna system, many applications require radiation characteristic but not achieved in single elements and they used array element [11,12]. Microwave circuit design referred to DGS technique because etched slot defects (single and multiple) embedded on the ground plane consider as DGS [5,13–16].

Antenna Design

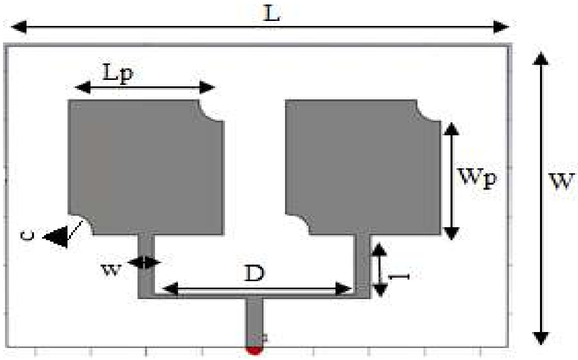
Design an array of two element array, the two elements are connected by using T-Junction Feed line characteristics 50 Ω and the distance between two elements are optimized to achieve the wide bandwidth. All the simulation of the proposed design have been simulated on CST microwave studio software 2018 [15,17]. The design of new antenna is being elaborated in the work ahead.

(A) Antenna Array without DGS

The geometry of proposed truncated micro strip square antenna array has been shown in Figure 1 and their resonant optimum dimensions are shown in Table 1 [10]. The conceptual issues are also taken into consideration while designing the antenna.

Figure 2 depicts the reflection coefficient of two elements proposed array antenna in the impedance bandwidth range 0-3GHz. The antenna array is excited by the T- junction feed line by using a 50 Ω SMA (Sub Miniature version A) connector. This arrangement has been done using standard mathematical modeling. The proposed antenna resonant on dual frequency of 2.5GHz and 2.6175GHz with a return loss of -25.489dB and -40.292dB correspondingly the band-width of antenna is 232.1MHz. It shows lower frequency and upper frequency is 2.4438GHz-2.675GHz. The quality parameter of the antenna has been plotted on x-axis and y-axis using standard simulated results.

Other parameters of the antenna performance are also required to be verified in accordance to the desing compatibility. The other parameter in Figure 3 has been presented, which is co and cross polarization radiation pattern of the proposed antenna-array at both the frequency of 2.5GHz and 2.6175 GHz. Gain of the proposed antenna-array is 5.141dB with directivity of 7.093 dB. The polarization is one of the most important parameter, which plays role while wavefront is in travel in the air.



(A) Radiating Patch View

(B) Ground View

Figure 1. Simulated result of the proposed antenna array (a) Radiating patch view (b) ground view

Table 1. Optimum dimensions of the proposed Antenna

S.No.	Dimension parameters	Values
1.	Substrate length side (L)	80.0 mm
2.	Substrate width side (W)	56 mm
3.	Patch length (lp) / width (wp)	27.76 mm
4.	Patch width (wp)	27.76 mm
5.	Distance between feed line patch (D)	42 mm
6.	Feed line length (l)	19.3 mm
7.	Feed line width	2.88 mm
8.	Truncated corner (c)	3.88 mm

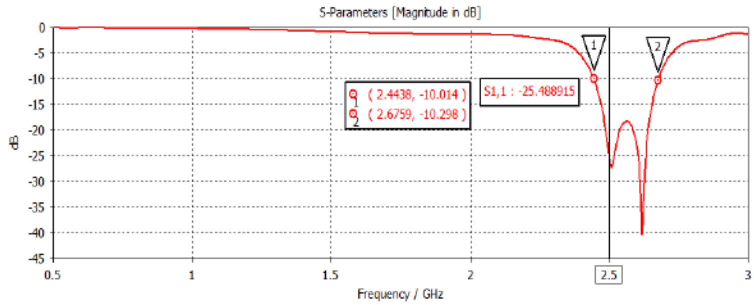
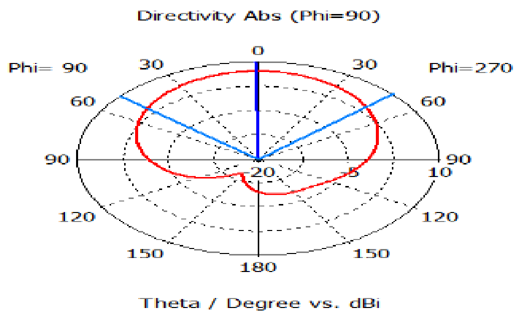
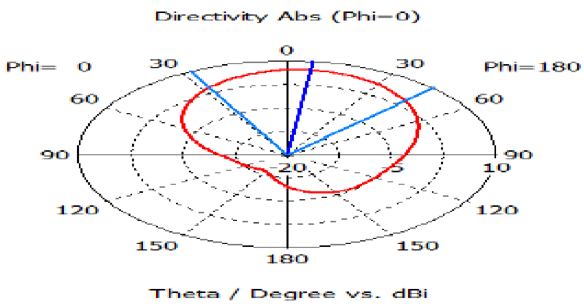


Figure 2. Simulated result with frequency response of the proposed antenna-array without DGS



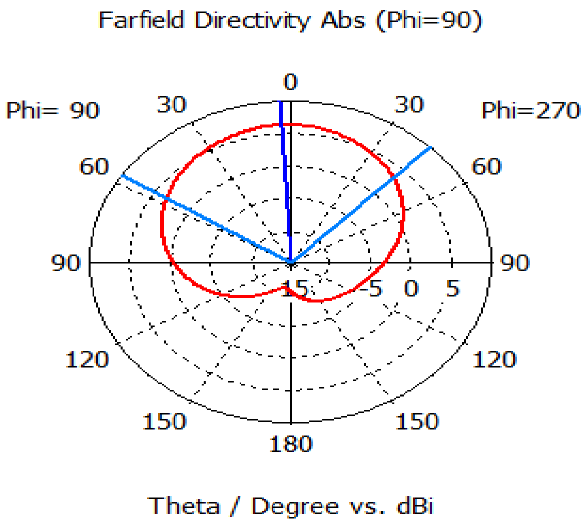
(a) Cross polarization at 2.5GHz



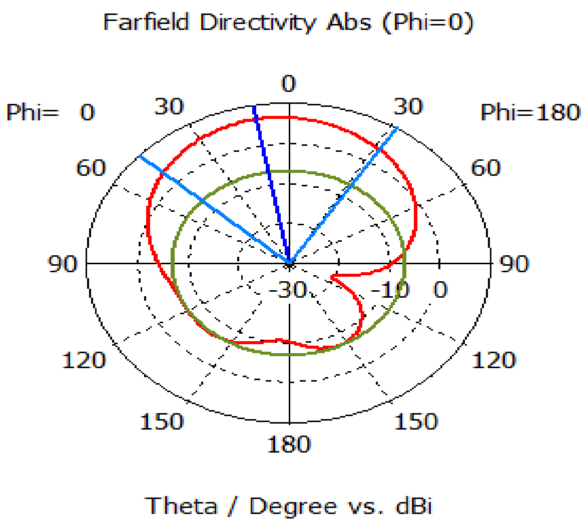
(b) Co polarization at 2.5GHz

Figure 3. Co and cross polarization radiation pattern at 2.5GHz

Figure 3 depicts the co and cross polarization radiation pattern of proposed antenna-array at both frequency of 2.5GHz and 2.6175GHz.



(c) Cross polarization at 2.6175GHz



(d) Co polarization at 2.6175GHz

Figure 4. Co and cross polarization radiation pattern at 2.6175GHz

(B) Antenna Array with DGS

All the measurement of proposed antenna is same instead of ground plan. The dimension of ground plane is 80mm$\times$17.5mm in the proposed design.

The ground view of proposed antenna array with DGS is shown in Figure 4. The proposed design is as per mathematical measurements and simulated using CST.

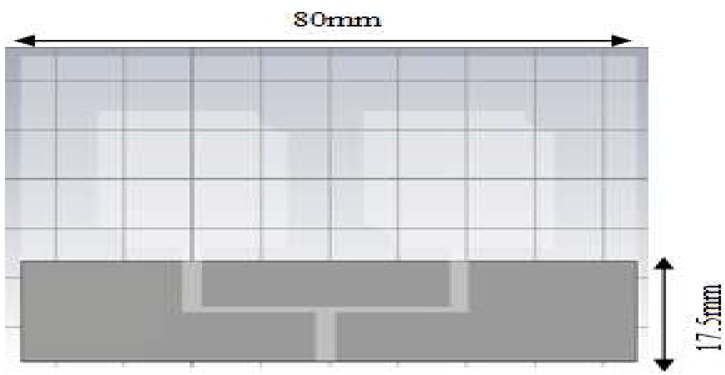


Figure 5. Ground view of proposed antenna array with DGS.

Figure 5 depicts reflection coefficient and bandwidth of proposed antenna-array with DGS. The bandwidth is 1103.1 MHz. With lower frequency of 1.8965 GHz, and upper frequency of 3GHz and return-loss of-28.96 dBi at 2.6175 GHz frequency. The achieved return loss is proved to be a good parameter, which will prove this design as performing design.

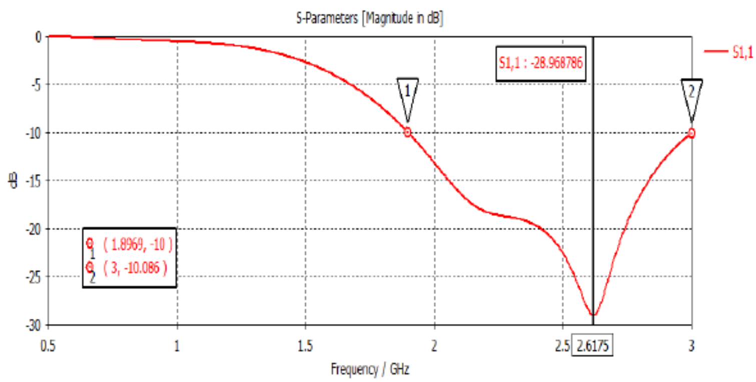
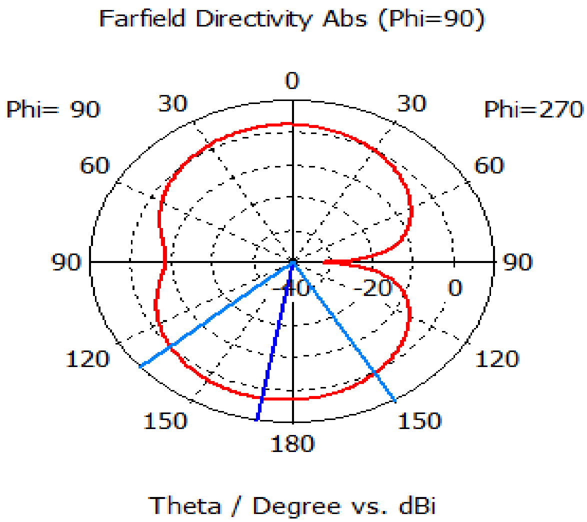
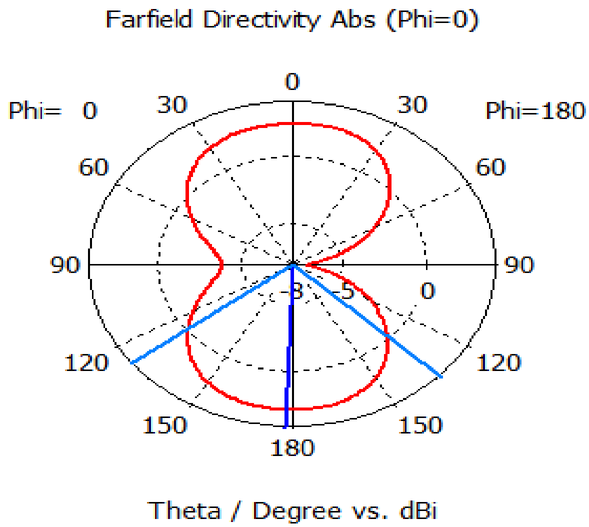


Figure 6. Simulated result with frequency response of the proposed antenna array using DGS.

Simulated co and cross polarization radiation pattern of proposed antenna-array with using DGS at 2.6175 GHz. Cross and co polarization is shown in Figure 6 a and b. It has shown that the H plane of the antenna is omnidirectional pattern with a gain of 2.736dBi and directivity 4.653dBi while eight shape patterns have occurred for co polarization. The eight shape patter is clearly showing the improvement in the polarization issues and has good performance as per the prediction in theoretical analysis.



(a) Cross polarization field pattern at 2.6175 GHz

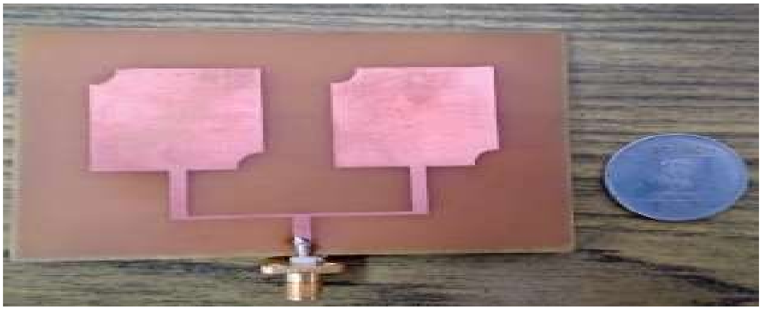


(b) Co polarization field pattern at 2.6175 GHz

Figure 7. Cross and co polarization field pattern at 2.6175 GHz

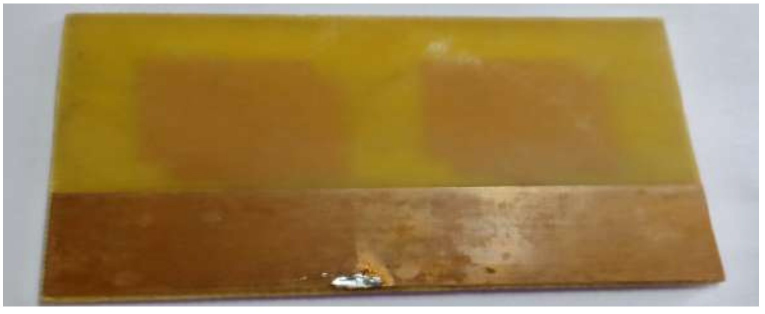
The simulated work has been fabricated using FR4 material, which is shown in Figure 7 using photograph of the fabricated truncated microstrip square patch array antenna of two elements without

DGS and with DGS represented and their result in form of return loss parameters is shown in Figure 8 with simulated results for comparison.



(A) Radiating Patch View

(B) Ground View without DGS



(C) Ground View with DGS

Figure 8. Fabricated of proposed antenna array two elements with and without DGS.

The plotted results are shown in Figure 8, which depicts the reflection coefficient and bandwidth of the fabricated proposed antenna-array without DGS is -20.6dB at a frequency 2.658GHz, with DGS -24dB at a frequency 2.61.

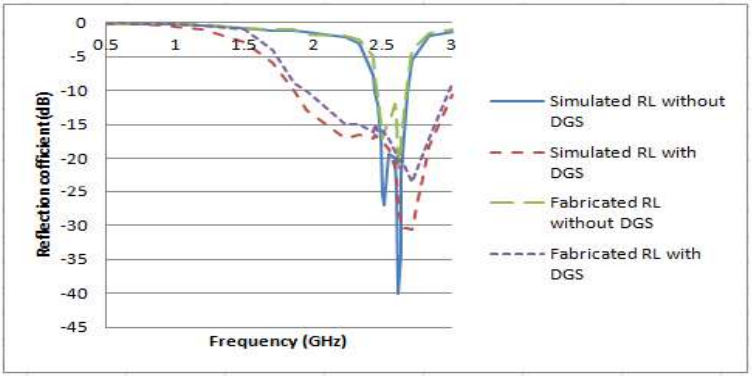


Figure 9. Comparing simulated and measurement results of the proposed antenna-array.

Table 2. Comparision between base pepar and proposed paper results

Parameters	**Base paper [1]**	**Proposed paper without DGS**	**Proposed paper with DGS**
Frequency (GHz)	2.4	2.447, 2.675	2.6175
Return loss	-19.38	-40.29	-28.96
Gain (dBi)	4.83	5.141	2.736
Directivity (dBi)	6.32	7.093	4.653
Bandwidth (MHz)	59	231.5	1103.1

Conclusion

A wideband square shaped antenna is investigated with and without DGS for Wireless application. Bandwidth of antenna is increased by using DGS technique and to form of two element array. Using DGS Bandwidth of antenna is 1103.1MHz operating wideband frequency 1.8969-3GHz gain of the antenna is 2.736dBi and Directivity 4.653dBi.

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