Application of DGS in Microstrip Patch Antenna

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ABSTRACT
This paper aims to analyze the effect of application of defected ground structure (DGS) on the resonating properties of microstrip patch antenna. In order to obtain the comparative results a small size DGS has been introduced in the ground plane exactly under the feeding strip of the patch antenna. The representative results obtained from the simulations have revealed that the proposed antenna with DGS possesses better impedance matching and wider bandwidth than its original structure without DGS. The presented antenna is small size and low profile antenna suitable for X-band applications.

Keywords
Bandwidth, DGS, Return Loss.

1. INTRODUCTION
Defected Ground structure (DGS) can be used as an alternative approach to improve the resonating performance of the microstrip patch antennas [1]. It can be formed by making simple slot in the ground of the antenna which effects the distribution of the current in the ground plane leading a controlled propagation of electromagnetic (EM) waves through the dielectric layer [2,3]. As per the literature reviewed, DGS provide the considerable miniaturization, good impedance matching and wider bandwidth in the design engineering of patch antennas [4]. DGS structures are periodic lattices, which can provide effective and flexible control over the propagation of the EM waves within a particular band [5]. The main limitation of microstrip patch antennas is narrow band and so far several solutions have been provided in the literature such as introduction of slots in the patch, higher dielectric substrate, coplanar wave guide feeding method, DGS, etc. to increase the bandwidth. Among them DGS can be the better option because besides wider bandwidth it also provides miniaturization to the antenna structure [6-8]. In the similar approach, an attempt has been made in this paper to introduce the defects in the ground plane exactly beneath the feed strip to provide better impedance matching and bandwidth.

2. DESIGN AND STRUCTURE
The proposed antenna structure is a simple patch antenna with square shape having side of the square (*S2*) of 10 mm. The feeding strip is designed in such a way to obtain 50 ohms impedance. The width of the strip (*W*) is 5 mm. Square shape is the candidate structure for the ground plane having side (*S1*) of 20 mm. In order to further enhance the resonating performance of the proposed antenna, a small size rectangular DGS has been introduced in the structure. The length (*L1*) of the DGS is 10 mm and width (*W1*) of the defect is 1mm. The structure of the proposed antenna with and without DGS has been shown in fig. 1.

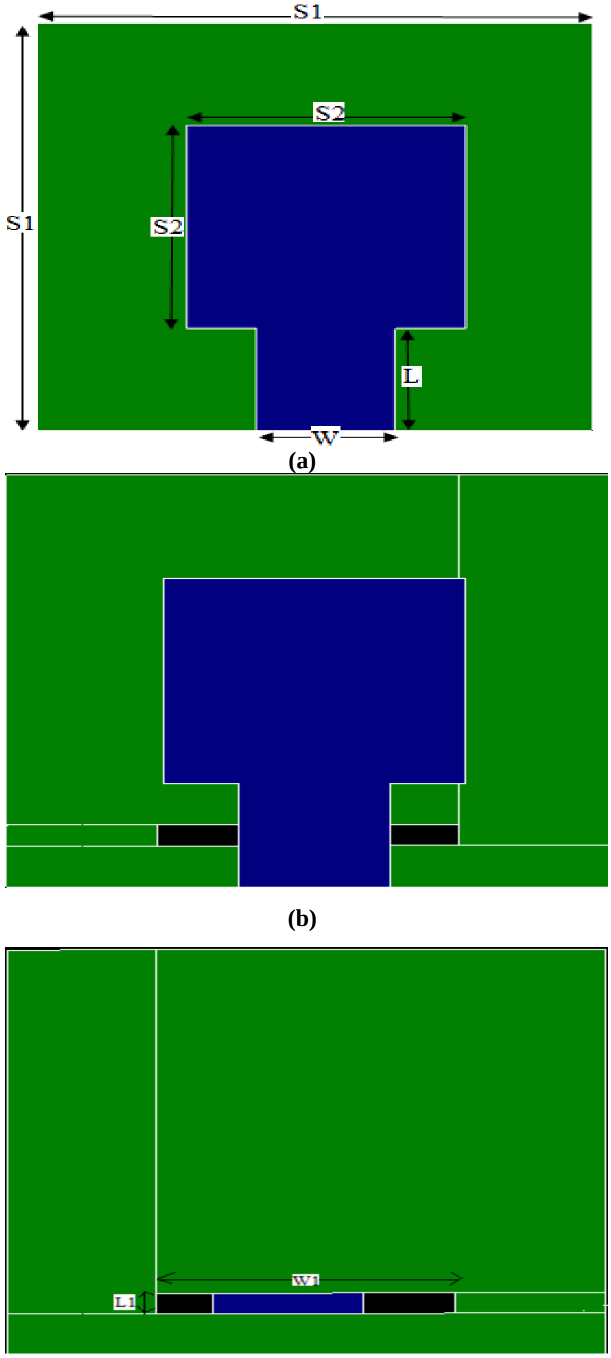

Fig 1: Geometry of proposed antenna (a) without DGS (b) with DGS (c) bottom view of DGS

3. RESULTS AND DISCUSSION

3.1 Resonant Parameters

The analysis of presented antenna has been done using method of moment based IE3D EM solver. The graphical plot of scattering parameters of both the antennas (with and without DGS) has been given in fig. 2 and 3. The obtained results reveals that the antenna structure with the implementation of DGS under its feeding strip provide wider bandwidth and better impedance matching in comparison to its original structure without DGS. The detailed resonating parameters of both the antennas have been given in table 1.

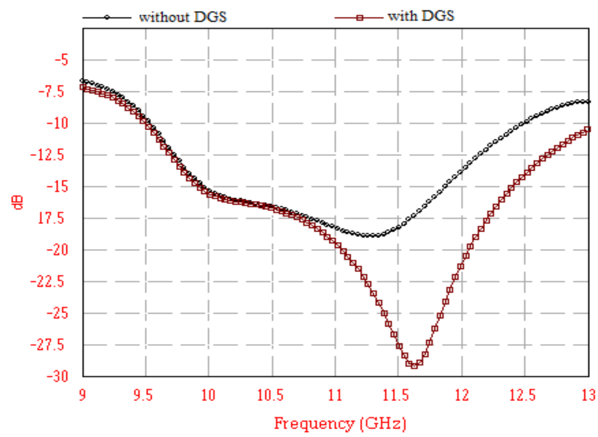

Fig 2: Simulated s-parameters of proposed antenna for both with DGS and without DGS structure.

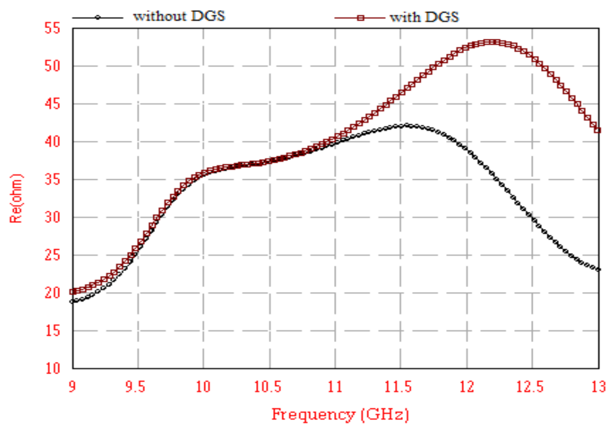

Fig 3: Simulated input impedance of proposed antenna for both with DGS and without DGS structure.

Table 1. Comparison of Resonating properties with and without DGS

Structure	Resonating Frequency (GHz)	Return Loss (dB)	Input Impedance (ohms)	Bandwidth (GHz)
Without DGS	11.26	-18.95	41.14-j5.25	2.91
With DGS	11.63	-29.18	48.09-j2.82	3.48

3.2 Radiation Patterns

The radiation patterns of the proposed antenna with DGS is shown in fig 4 and the presented results reveals that the radiation pattern in the E-plane is bidirectional and in H-plane is omnidirectional.

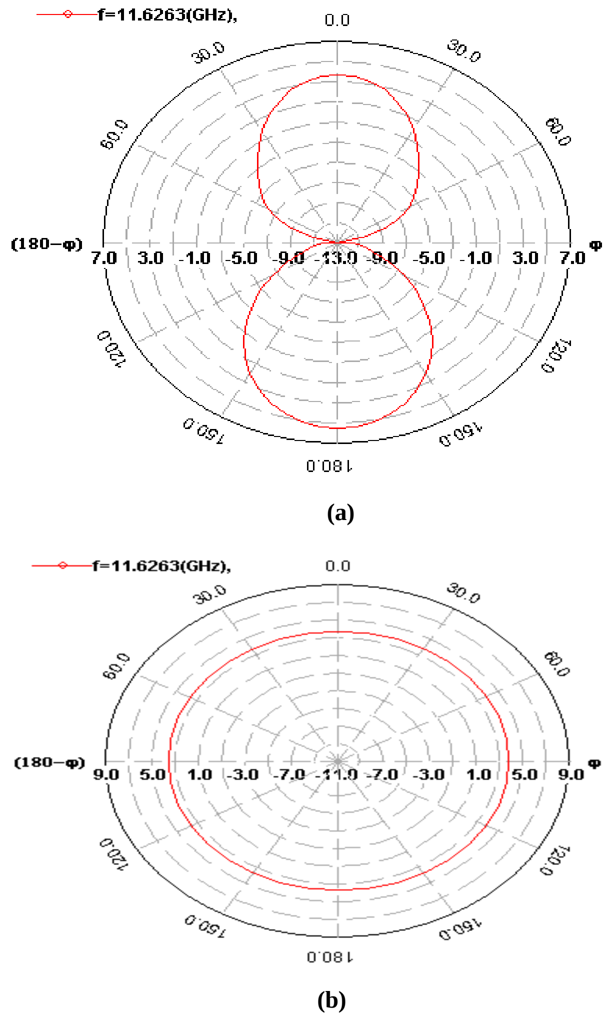

Fig 4: Radiation pattern of the proposed antenna with DGS (a) E-plane (b) H-plane

3.3 Gain

The gain vs. frequency plot of proposed antenna with DGS is shown in fig. 5. The maximum achievable gain of the antenna is 6.77 dBi at 11.63 GHz resonant frequency.

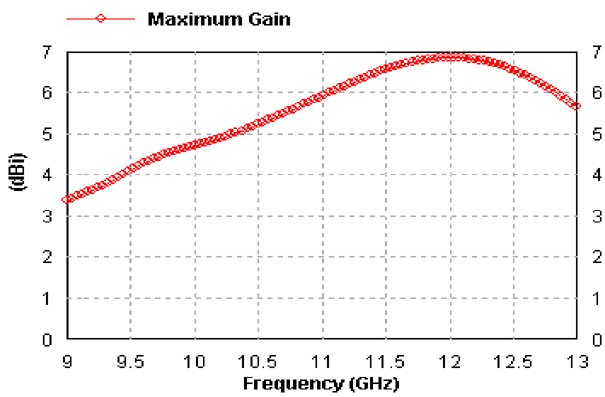

Fig 5: Gain of the proposed antenna with DGS

4. CONCLUSION

This paper proposed a simple microstrip patch antenna with the introduction of DGS beneath the feeding strip. In order to obtain the effect of DGS, critical simulated study has been done using IE3D simulator. The presented results reveal that the proposed antenna with DGS provides better impedance matching and wider bandwidth than its original structure. The proposed antenna is small size, low profile antenna that can be used for various wireless applications in X-band region.

The analysis about the performance of DGS antenna in respect of coupling effect and band notching parameter, can be consider as a wider scope for future.

5. REFERENCES

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