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Microstrip Antenna Array with I-Shaped DGS

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***Abstract*— This paper proposed a microstrip antenna array with DGS (Defective Ground Structure). The structure in this work is 2*1 microstrip patch array antenna using substrate with h= 0.762 mm and ε_r = 3.2. Two triangular-shaped patches are located on opposite side of PCB and spaced 14mm apart by a small ground portion. The proposed DGS of I-shape is placed in the ground plane. It does provide a method to improve antenna performance. In this way, return loss i.e., $S_{11} \leq$ - 34.829dB at resonant frequency 9.60GHz is obtained. The proposed antenna is suitable for X-band applications such as satellite communications, medical applications, radar applications and other wireless applications. The analysis has been done by using IE3D software based on MOM (Method of Moments).**

***Keywords*— *DGS, Microstrip Antenna, Array Antenna, Return Loss, Gain, Directivity, Antenna Efficiency, Radiation Efficiency*.**

I. INTRODUCTION

In modern communication industry, the most important element required to make a communication link is antenna. With the increasing number of users and limited bandwidth that is available, operators are trying hard to optimize their network for larger capacity and improved quality coverage. This surge has led the field of antenna engineering to constantly evolve and accommodate the need for wideband, low-cost, miniaturized, high efficiency characteristics, and easily integrated antennas. Microstrip antenna satisfies all of these requirements. This antenna provides all of the advantages of printed circuit technology. These advantages of microstrip antennas make them popular in many wireless communication applications such as satellite communication, radar, medical applications, etc [1]. But at the same time patch antenna have disadvantages. One disadvantage is the excitation of surface waves that occurs in the substrate layer. Surface waves are undesired because when a patch antenna radiates, a portion of total available radiated power becomes trapped along the surface of the substrate. It can extract total available power for radiation to space wave. Therefore, surface wave can reduce the antenna efficiency, gain and bandwidth. For arrays, surface waves have a great effect on the mutual coupling between array elements [2].
Recently DGSs and EBGs (Electronic Band Gap) have come into play to improve microstrip patch antenna characteristics. DGS is an intentionally etched defect into ground plane. The purpose of using DGS as a technique to improve the antenna performance on the basis of basic parameters is to make use of the ground plane itself to prove a filter effect. This effect suppresses the mutual coupling between antennas thereby improve the antenna performance. In [3-6], DGS are introduced to improve antenna performance characteristics like size reduction, gain and bandwidth enhancement, and it is also used in reduction of mutual coupling between antenna elements. DGS may come in number of geometries and sizes depending upon their mode of application, as well as the frequency of operation.
In this paper, a I-shaped DGS with microstrip patch antenna without using much spacing between the elements is proposed.

II DESIGN OF MICROSTRIP PATCH ANTENNA

The configuration of microstrip antenna is shown in figure1.

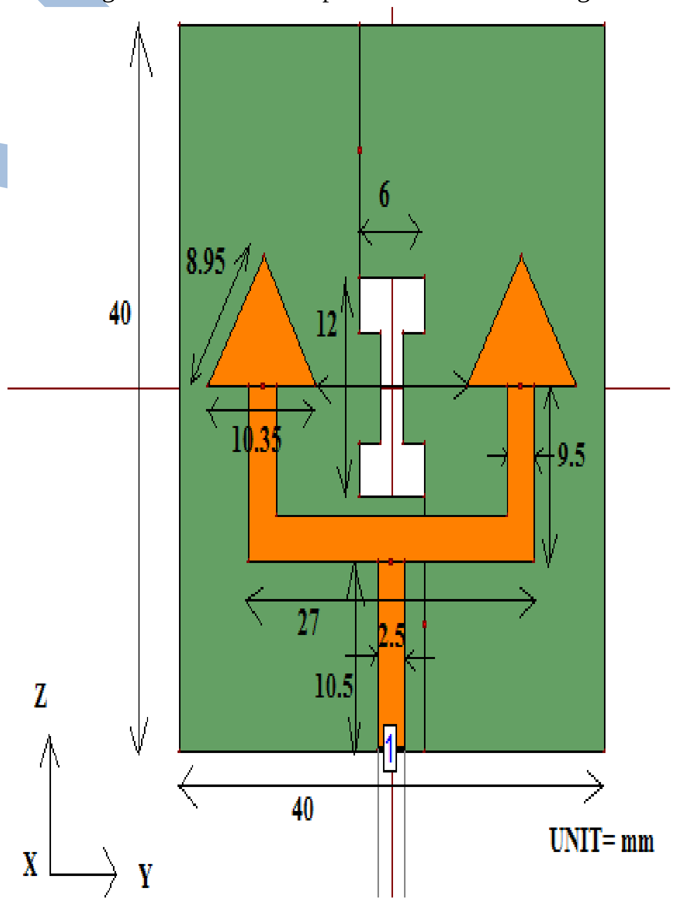

Fig: 1(a) Proposed Antenna with I-shaped DGS

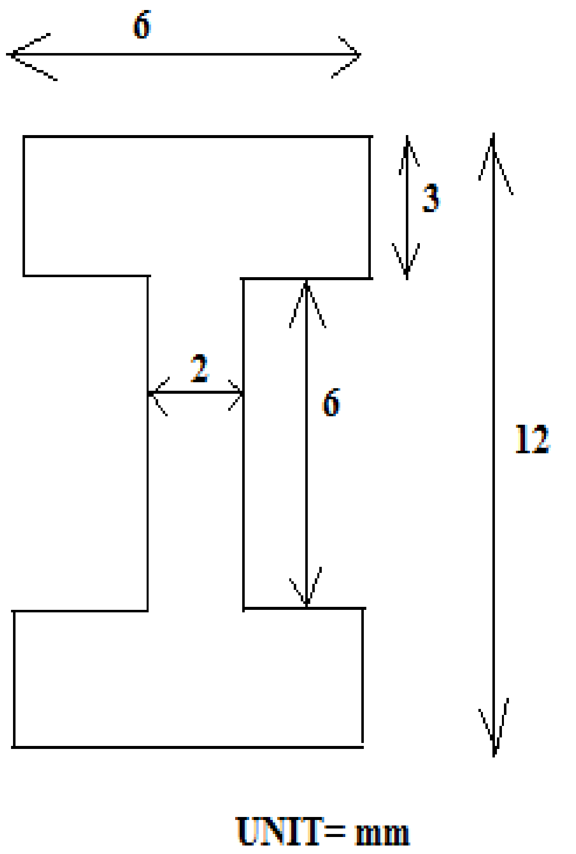

Fig: 1 (b) Schematic Diagram of I-Shaped DGS

The antenna without DGS, is designed on a single layer dielectric substrate with ε_r = 3.2, thickness of 0.762 mm and tangential loss of 0.004. Two element triangular-shaped microstrip antenna arrays are mounted on the same plane and spaced 14 mm apart by a small ground portion. The antenna array consists of a branching network of two-way power dividers. Quarter-wavelength transformers (70 Ω) are used to match the 100 Ω lines to the 50 Ω lines. The design of 2x1 planar array antennas with the edge feeding network is proposed. Then after, I-shaped DGS is inserted into the ground plane of the antenna with position between the two element triangular patches.

III RESULTS &DISCUSSION

Microstrip antenna array with DGS presented in this paper has been designed and simulated using IE3D software. The simulation results of microstrip antenna array with DGS are shown in the figures 2(a-d).

Performance Parameters of Microstrip patch Antenna with DGS Structure

(i) S- Parameters

It describes the amplitude of a reflective wave relative to that of incident wave. S_{11} represents how much power is reflected through antenna, and is mainly called as the reflection coefficient (sometimes written as gamma or return loss).

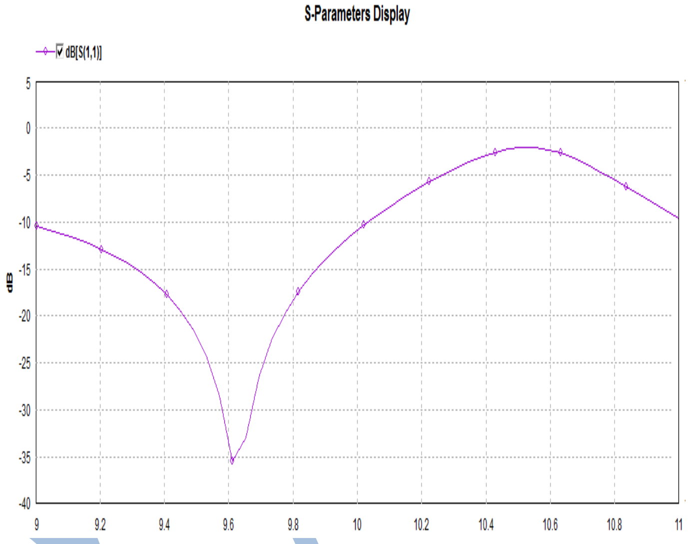

Fig: 2(a) S Parameters of antenna array with DGS

Simulated result of S_{11} of the antenna array with I-shaped DGS is shown in figure 2 (a). The antenna which is designed shows return loss at 9.6 GHz frequency.

(ii) Gain

As a transmitting antenna, gain defines how well the antenna converts input (electrical) power into radio (electro-magnetic) waves headed in a particular direction. As a receiving antenna, gain defines how well the antenna converts radio waves arriving from a specified direction into electrical power. Higher range antennas have the advantage of long range and better signal quality but must be aimed carefully in a particular direction.

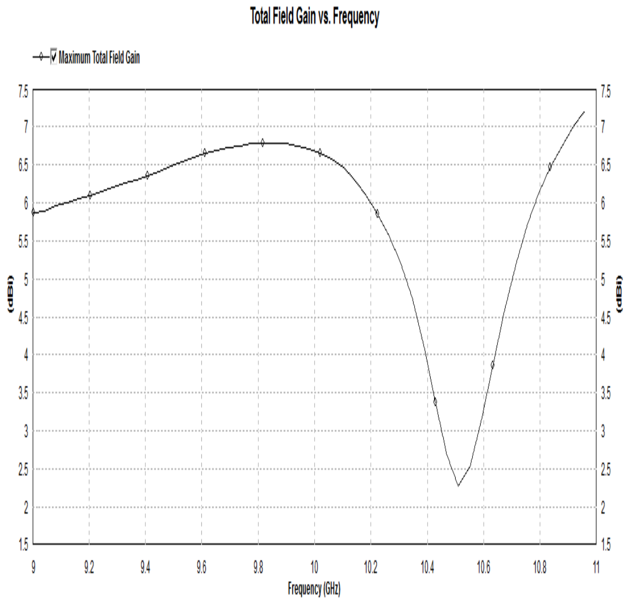

Fig: 2(b) Gain of antenna array with DGS

Figure 2(b) depicts the simulated graph of gain vs. frequency of proposed design. According to the simulated results, value of gain is found to be 6.638 dBi at 9.6 GHz.

(iii) Directivity

Directivity is the ability of an antenna to focus energy in a particular direction while transmitting, &mainly to receive energy better from a particular direction. It is defined as a ratio of power radiated by antenna in a particular direction to power radiated by an ideal isotropic radiator. Value of directivity varies from 1.76dBi for short dipole to 50 dBi for large dish antennas.

Simulated result of directivity of the microstrip antenna array system with I-shaped DGS is shown in figure 2 (c). According to the simulated results, value of directivity is found to be 6.64 dBi at 9.6 GHz.

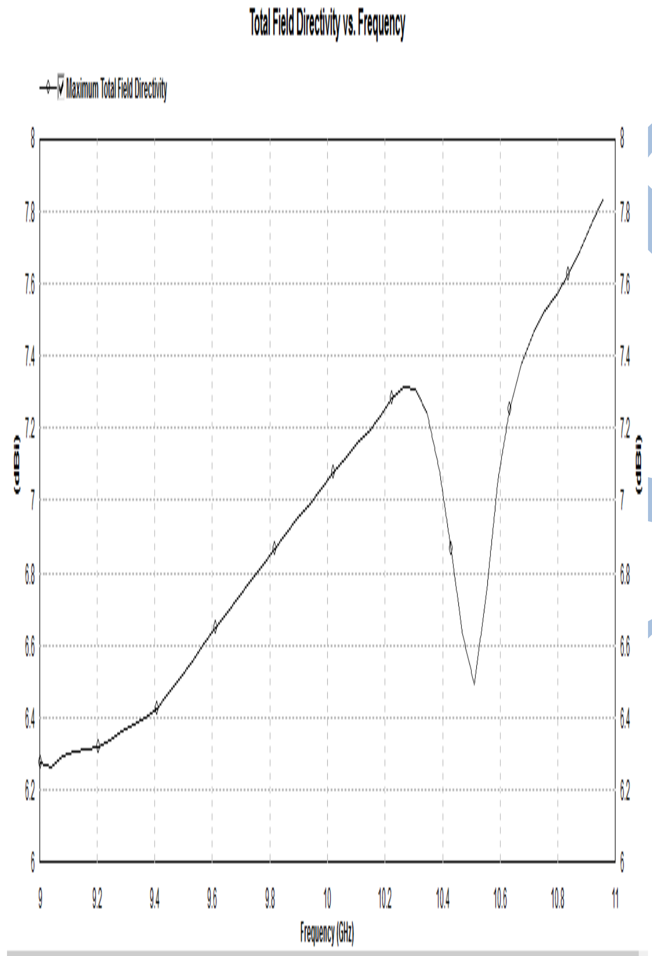

Fig: 2(c) Directivity of antenna array with DGS

(iv) Efficiency

The antenna efficiency (or radiation efficiency) can be written as the ratio of the radiated power to the input power of the antenna.

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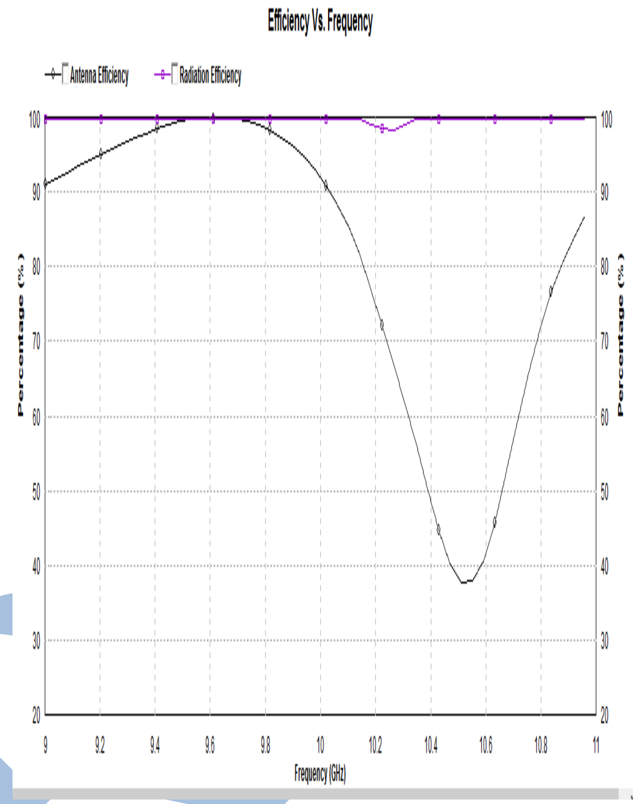

Fig: 2(d) Efficiency of antenna array with DGS

A high efficiency antenna has most of the power present at the antenna's input radiated away.

A low efficiency antenna in which most of power is absorbed as losses within the antenna, or reflected away due to impedance mismatch.

Figs. 2(d), depicts variations of efficiency (antenna efficiency, radiation efficiency) characteristics with frequency. The proposed antenna has both antenna efficiency and radiation efficiency of 100 % at resonant mode.

S. No.	Parameter	Simulated Results
1	Resonance Frequency	9.6GHz
2	10 dB Bandwidth Range	9.002-10.086 GHz
3	Return Loss (S_{11})	-34.829dB
4	Gain (G)	6.638dBi
5	Directivity (D)	6.640dBi
6	Antenna Efficiency	100%
7	Radiation Efficiency	100%

Table: 1 Simulated Results

Table1 show the readings or variations of different performance parameters (resonance frequency, 10 dB bandwidth, return loss, gain, directivity, antenna efficiency and radiation efficiency) with respect to frequency and we have noted these variations from the above graphs.

IV CONCLUSION

This paper presents a compact microstrip antenna array with defected ground for X-band applications. An intentional defect of I-shape is inserted into ground plane which suppress the level of mutual coupling among antenna elements. Suppressed level of coupling provides enhanced value of antenna performance parameters. Proposed antenna design has been analyzed with IE3D software. The technique may be useful in a number of technologies including patch array antennas.

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