

Design of Micro-Strip Patch Antenna Array Using DGS for ISM Band Applications

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Abstract

Micro strip patch antennas are highly in demand because of having so many advantages like small size, low cost, light weight but this antenna also have some drawbacks like low gain, narrow bandwidth, low efficiency, surface wave excitation. In this paper, performance parameters of micro strip patch antenna array which is applying with a novel geometry of defected ground structure (DGS) is calculated. Here we first discuss about the introduction of micro strip patch antennas and array after that we will discuss the parameters which we can improve using antenna array and defected ground and then discuss the simulated results.

Keywords: Micro strip patch antenna (MPA); Micro strip patch antenna array (MPAA); Defected ground structure (DGS); Return loss; Directivity; Gain

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Introduction

Major requirements of antennas in today's wireless communication systems should have good performance parameters in terms of return loss, bandwidth, gain, radiation pattern, antenna efficiency. Micro strip patch antennas fulfill all these requirements [1]. Along with these advantages, these antennas also suffers from so many disadvantages including low gain, narrow bandwidth, low efficiency, low power handling capacity, surface wave excitation [2]. These limitations make the performance of micro strip antennas poor. A micro strip antenna consists of three layers; one is a radiating patch, a dielectric substrate and a ground plane on the other side. Radiating elements and feed lines are photo etched on the dielectric substrate (**Figure 1**) [3].

Patch may be of any shape like square, rectangular, circular, elliptical, triangular or any other configuration. But configurations which are mostly used are rectangular and circular [4]. Antenna array is combination of individual antennas together [5]. They can provide circular. This is because of their small size as compared with other shapes. One of the techniques which are used to improve the performance of Microstrip patch antenna is using antenna array [6]. Antenna array is just collection of individual the capability of a steerable beam (radiation direction change) as in smart antennas. They can provide a high antenna gain by using simple antenna elements. It provides a diversity gain in multipath signal reception. They enable array signal processing and

overcome the disadvantages of patch antennas [7]. It enhances the performance of patch antenna [1,8]. Further improvement in results can be done by applying defects in ground plane. This is realized by etching off simple shape from the ground plane. These structures are used to make the antenna size small and good performance in wireless communication. These defects can be of any shape and size. These can be placed anywhere in the ground plane. For better results, its geometry can be chosen from simple to complex as discussed in to reduce mutual coupling. There is no need of large area for its implementation [2,9]. DGS have relocated frequency which makes antenna small. It also reduces the mutual coupling in antenna arrays (**Figures 2-4**).

Antenna design

A proposed micro-strip patch antenna array is shown in **Figure 5**. The proposed antenna array consists on a single substrate [10]. The antenna design is made on a FR4 substrate having dielectric constant of 4.4 and height of the dielectric substrate is chosen as 1.5 mm. 50 Ω micro-strip feed lines are used to feed the radiating patch [11]. The dimensions of antenna are selected such that it should have good performance in terms of return loss, directivity and gain. A novel design of micro-strip patch antenna array of 2×1 is designed. Antenna array is mainly used to improve the antenna parameters [12]. In the proposed antenna array, all the designing parameters are selected based on transmission line mode. Using the dimensional equations, the dimensions of the

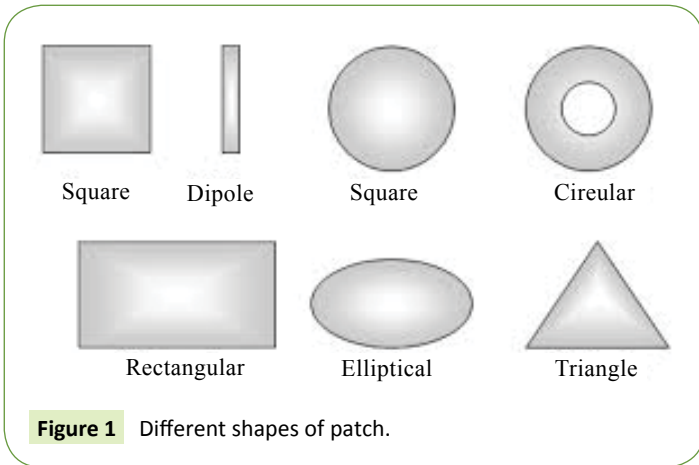


Figure 1 Different shapes of patch.

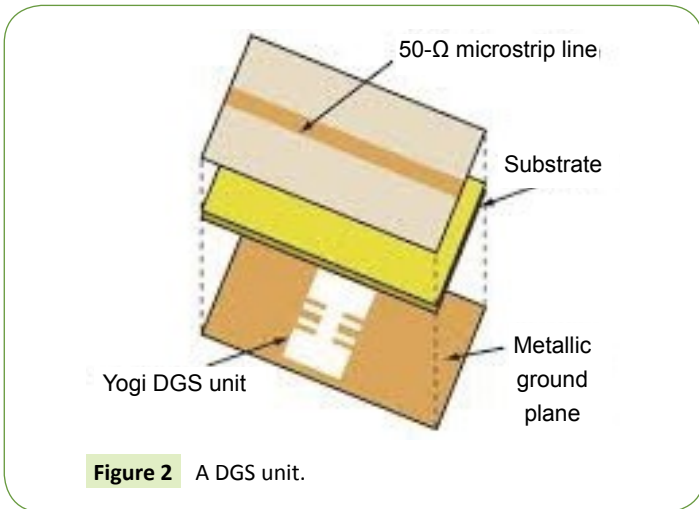


Figure 2 A DGS unit.

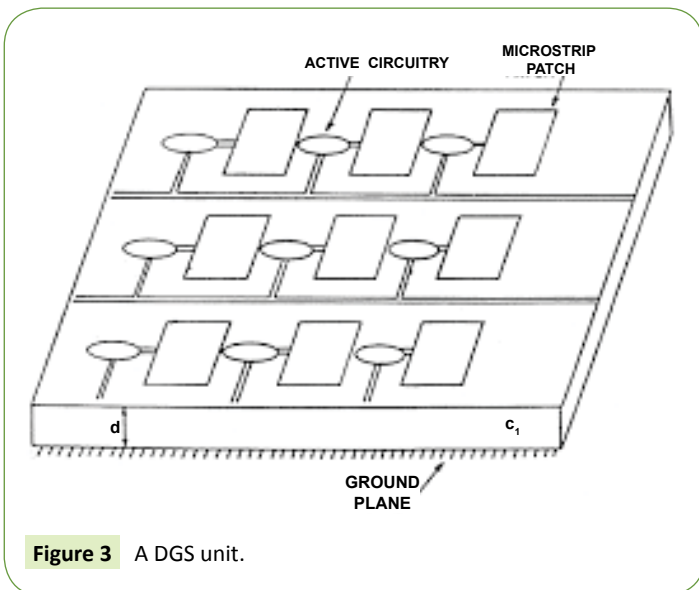


Figure 3 A DGS unit.

this antennas are the length of the ground plane L_g is 120 mm, width of the ground plane W_g is 50 mm. Length of the feed L_f is 9 mm and width of the feed W_f is 2 mm. antenna is simulated using the Electromagnetic simulator, IE3D. By using these dimensions a single micro-strip patch antenna is designed [13]. By using T-power divider circuit micro-strip patch antenna array

with same dimensions is designed on a same substrate. Micro-strip patch antenna array is designed to increase the gain [14]. The array antenna consists of two single patches on the same substrate. In this array antenna the gap between the antennas is 80 mm (Table 1; Figures 4 and 5).

For further improvement in performance of antenna, a new geometry of DGS is used. Length of DGS L_a, L_b is used. Width of DGS W_a, W_b is used. An improved structure of DGS is applying on an antenna array enhances the overall performance of an antenna. Simulated results of the antenna array are discussed below. Geometry of DGS can be of any shape [15].

Simulated results

In this work, simulations results of return loss, directivity and gain of the designed antenna array are measured and presented (Figure 6) [16]. This design shows value of the directivity 6.827 at frequency of 7.642 (Figure 7).

Return loss is -21.993 at the frequency of 7.642 that will be applicable for ISM band applications (Figure 8 and Table 2) [17].

Conclusion

In wireless communication system, important Antenna requirements are including low cost, small size, directivity, high efficiency characteristics and easily integration. By this review, it is described that patch antenna satisfy all of these requirements. Because of good nature of micro strip patch antenna array

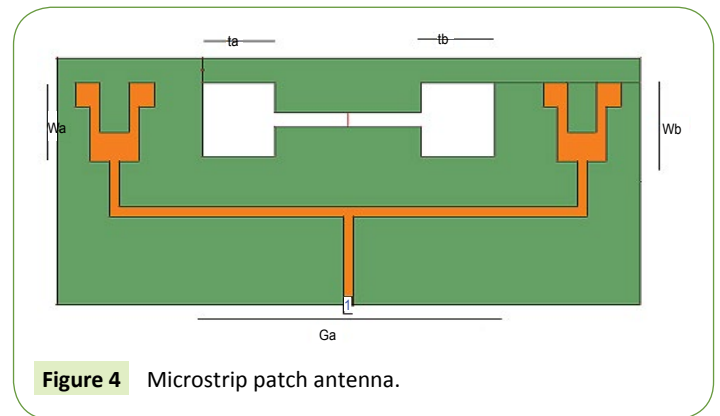


Figure 4 Microstrip patch antenna.

Table 1: Dimensions of micro-strip patch antenna array.

Parameters	Value(mm)
L_g	120
W_g	50
L_p	16
W_p	16
L_f	2
W_f	9
W_1, W_2	5
W_3, W_4	11
L_1, L_2	5
L_3	10
G_a	80
W_a, W_b	15
L_a, L_b	15

Table 2: Results.

Parameters	Frequency	Value
Directivity	7.642	6.827
Gain	7.642	6.774
Return loss	7.642	-21.993

Total Field Directivity vs. Frequency

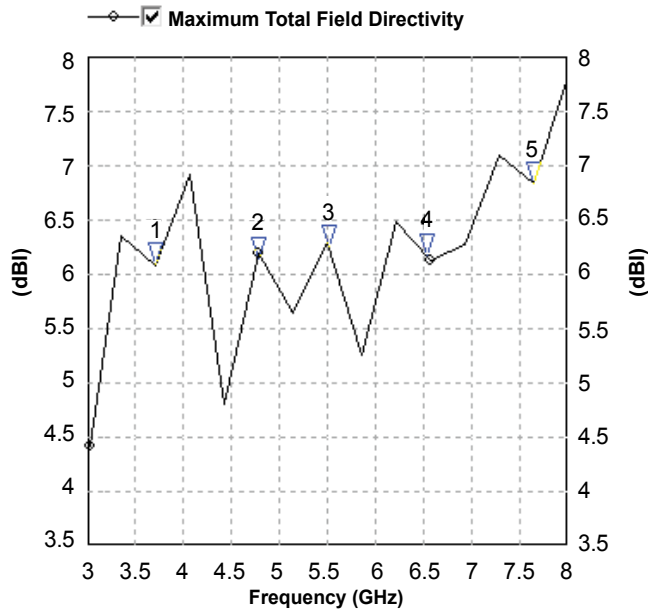


Figure 5 Antenna array.

S-Parameters Display

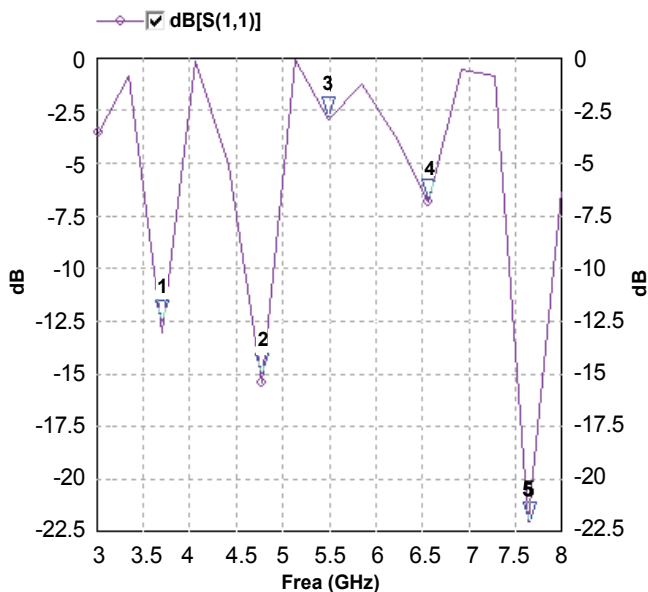


Figure 6 Shows the simulated directivity of micro-strip patch antenna.

S-Parameters Display

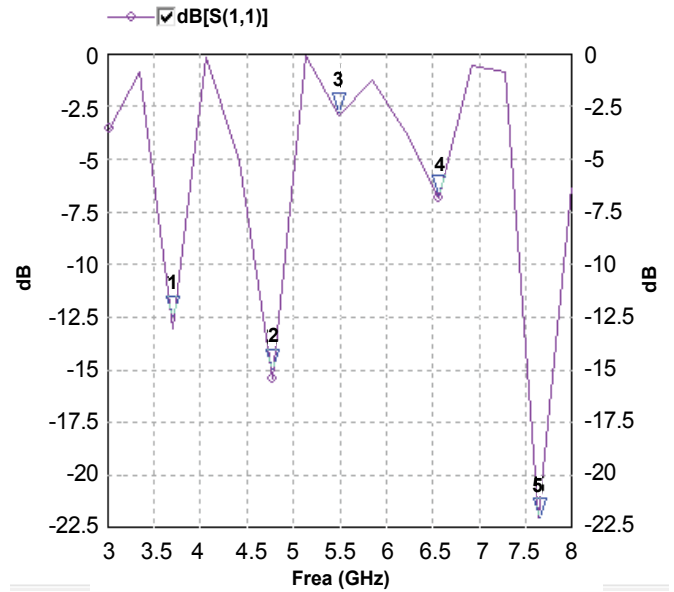


Figure 7 Shows the simulated return loss of micro-strip patch antenna array.

Total Field Gain vs. Frequency

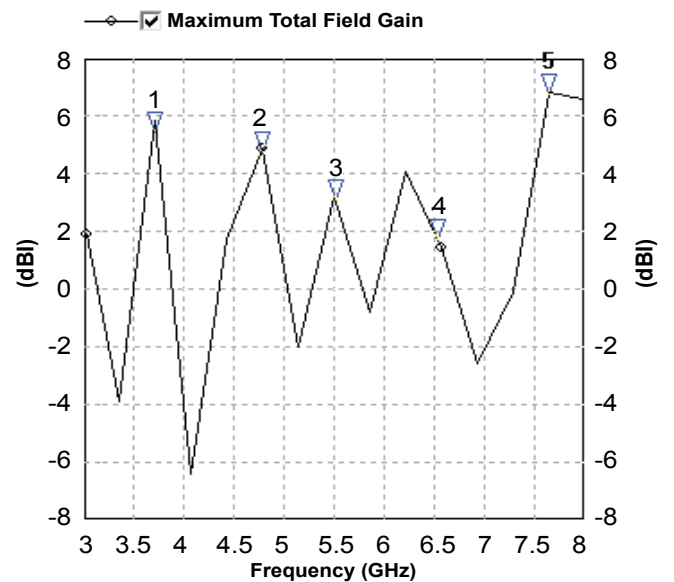


Figure 8 Shows the simulated return loss of micro-strip patch antenna array.

(MPAA) as compared to micro strip patch antenna (MPA), it should enhance the resulting parameters in terms of bandwidth, return loss, beam width, radiation pattern, directivity, pattern, return loss, directivity and efficiency. In addition, by using defected ground structure the size of an antenna become small. It also reduces the mutual coupling. DGS micro strip array antenna should collectively improve the overall performance of an antenna.

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