

# Design and Comparison of Microstrip Patch Antenna with Different Ground Structure

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**Abstract**— The shape and structure of ground of microstrip patch antenna plays an important role in different characteristics of antenna. In this paper, a comparison has been done in different shapes of ground structures. The shape of patch antenna used is rectangular of size 22x20 mm<sup>2</sup> in all antennas on the 1mm thick dielectric substrate FR4\_epoxy. Feeding technique used in all antennas is microstrip line feeding.

**Key words:** Microstrip Patch Antenna, Ground Structure

## I. INTRODUCTION

During past some times, wireless communication changed the world. We are surrounded by many wireless electronic devices which day by day becoming a vital part of our life. Many of these wireless devices are required to give multiple services at same time. For those purpose multiband antennas has required for multi frequency operations. Microstrip patch antennas are suitable for that purpose.

Microstrip patch antennas are very popular among the researchers in wireless communication field because of its advantages like low profile, light weight, low cost, ease of fabrication and ease of integration with microwave integrated circuits. Microstrip patch antenna also shows both types of polarization, that is, linear polarization as well as circular polarization. Besides it there are certain disadvantages of patch antennas such as narrow bandwidth, relatively low efficiency and lower gain [1]. There are some techniques by which these disadvantages can be overcome and good results can be obtained. So researchers take interest in this antenna to optimize the design and to get better results. Defected ground structures are one of those techniques which are used to improve the performance characteristics of antenna. Defected ground structure is one of the latest technique in which a defect is done in the infinite ground plane. In some designs finite ground planes are also used. Different structures have been designed so far. Defected ground structure has been derived from the concept of photonic band gap (PBG) structure which is used in different electromagnetic applications [2]. Various researches are done on the defected ground structure [3]-[10]. Increased bandwidth and good radiation pattern can be obtained by using defected ground plane. The size of patch and total size of antenna is reduced by using the defected ground plane [8].

In this paper, a comparison of various size and shapes of ground structure is done on the various parameters like return loss and radiation pattern. The shape of radiating patch used is rectangular in the all antennas. The size and shape of patch is same for all antennas. Also the same substrate is used with a constant thickness 1mm.

## II. ANTENNA GEOMETRY

Geometry of antenna is shown in the figure 1(a) and 1(b). The shape of patch is rectangular which is shown in figure 1(a) and different shapes of ground plane are used. All other parameters of antenna used are taken same as the dielectric material, the thickness of substrate, shape and size of antenna and the feeding method. The dielectric substrate used is FR4\_epoxy with the thickness of 1mm. Dielectric constant of substrate is 4.4 and loss tangent is 0.02. Dimension of dielectric substrate is 22x27 mm<sup>2</sup> and dimension of radiating patch is 13x12 mm<sup>2</sup>. The feeding technique used is microstrip line with the dimension of microstrip line is 1.9x8 mm<sup>2</sup>. The shapes of ground plane used are I-shaped, U-shaped and C-shaped which dimensions are shown in the table1. In which I-shaped ground is shown in figure 1(a) and C-shaped and U-shaped ground plane is shown in the figure 1(b). The design and simulation of the proposed antenna is done on the software HFSS v13.

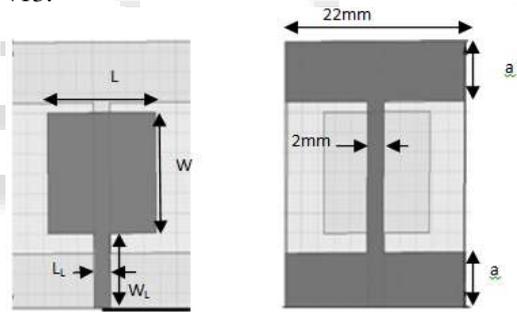


Fig. 1 (a): Geometry of proposed antenna and I-shaped ground plane

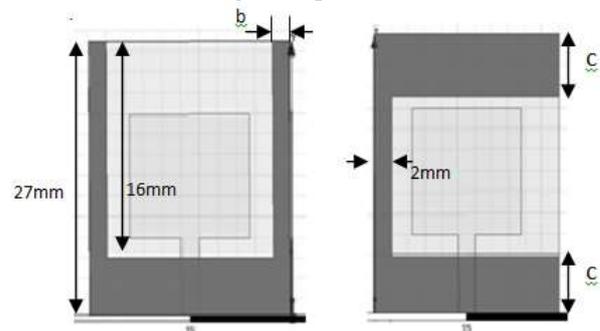


Fig. 1(b): U-shaped and C-shaped ground  
 The table below contains the dimensions of various antennas.

Parameters	Dimension(In Mm)
L	13
W	12
L <sub>L</sub>	1.9
W <sub>L</sub>	8

Table 1: Substrate Dimension- 22x27 mm<sup>2</sup> Dielectric Constant- ( $\epsilon_r = 4.4$ ) Substrate thickness- 1mm

### III. SIMULATED RESULTS AND COMPARISON

In this section various results and comparison is done. S11 parameters of different shaped ground structure are shown below. In each results various variation in parameter is also shown. In figure 2(a), S11 parameter of rectangular patch antenna with I-shaped ground is shown. In figure 2(b) and figure 2(c), S11 parameter of rectangular patch antenna with U-shaped ground and C-shaped ground plane is shown. Comparing the return loss curve of these three we find that in I-shaped ground we achieved two bands with three resonance points with good return loss, in U-shaped ground we get two resonance points but the band is shifted towards right and return loss is up to -34dB in this. In another antenna in which C-shaped ground plane is used we obtained less value of return loss in comparison of previous two and three resonance points is achieved.

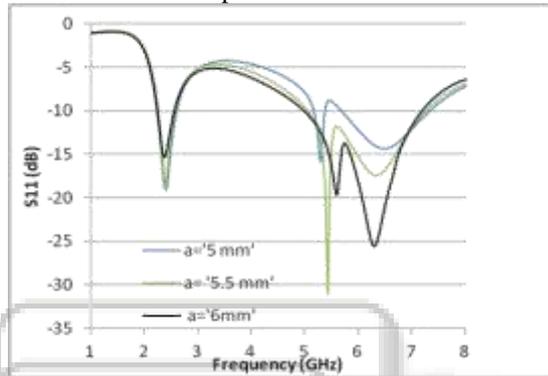


Fig. 2(a): S11 parameter of I-shaped ground plane.

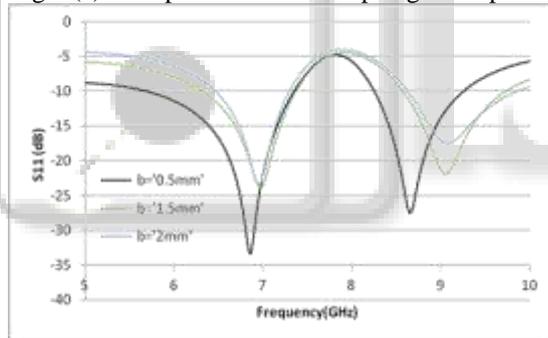


Fig. 2(b): S11 parameter of U-shaped ground plane.

Different parametric variations are also shown in the figure 2(a), 2(b) and 2(c). This parametric variation shows how varying the size of ground affects the return loss curve. Another characteristics is 3D radiation pattern of the antenna is shown in the figure 3(a) for I-shape ground, figure 3(b) for U-shaped ground and figure 3(c) for the C-shaped ground plane. All the radiation patterns are uniform and the table with it shows the magnitude of directivity in dB.

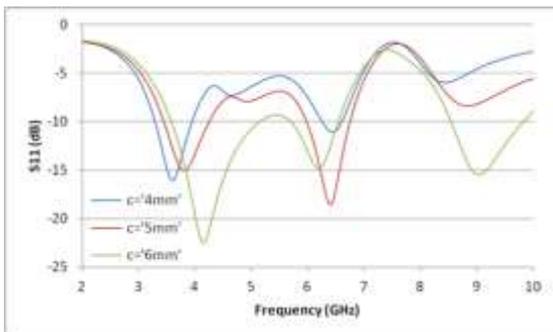


Fig. 2(c): S11 parameter of C-shaped ground plane.

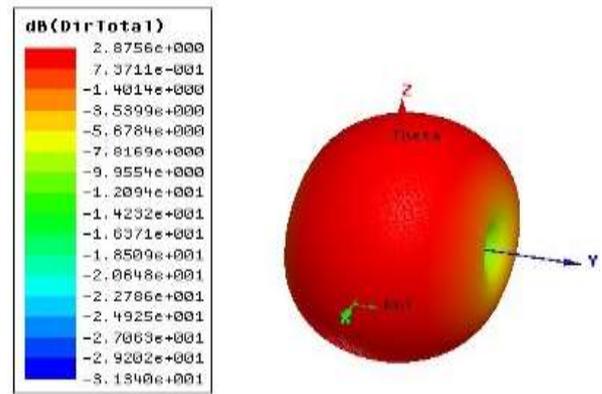


Fig. 3(a): 3D radiation pattern of I-shaped ground.

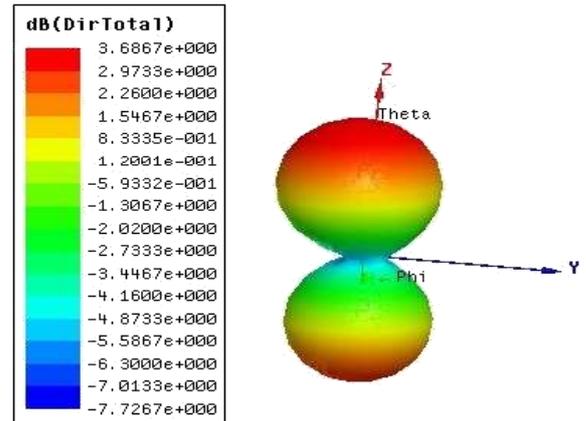


Fig. 3(b): 3D radiation pattern of U-shaped ground.

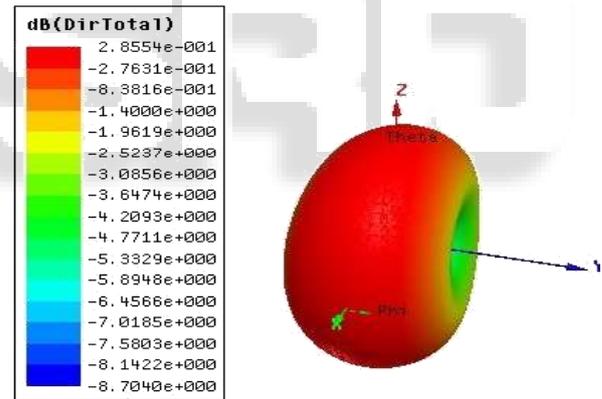


Fig. 3(c): 3D radiation pattern of C-shaped ground.

### IV. CONCLUSION

Comparison of different shapes of ground is done successfully in this paper. The shape and dimension of patch is similar for all the antenna. Dielectric substrate material, thickness of substrate and dimension of substrate is also same. It has observed that U-shaped ground gives maximum return loss up to -34 dB and C-shaped gives the lowest up to -22 dB. The radiation pattern for all three ground shapes is uniform.

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