Simple Rectangle Patch Antenna with Defective Ground Structure Operating at 10.36 GHz with Gain 8.2039 Db and Bandwidth 734.6 MHz

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Abstract— In this paper we are using Rectangular Patch with DGS. The height of substrate is 1.77 mm and material used RT/Duriod 5880 with 2.2 Dielectric Constant. The structure resonates at 10.36 GHz with 8.2036 db Gain and Bandwidth is 734.6 MHz. The E plane and H plane radiation pattern are also finding out.

Key words: Defective Ground Structure (DGS), Rectangular Patch, Coaxial Probe Feeding, HFSS

I. INTRODUCTION

An antenna is the basic element which can radiate or receive electromagnetic wave. Though antennas may seem to be accessible in many different shapes and sizes, they all job according to the same basic principles of electromagnetic. There are many types of moveable electronic devices, such as cellular phones, electronic devices, GPS receivers, pagers, laptop, computers, and telemetric unit in vehicles that need an effective and efficient antenna for communicate wirelessly with other fixed or mobile communication units. Improvement in digital and radio electronics have results its output in the fabrication of a new type of personal communications equipment affectation special exertion for antenna designers. The personal wireless communication devices have produced an improved demand for compact antennas. The increase in satellite communication has also improved the demand for antennas that are compact and supply reliable transmission.

Today micro - strip patch antenna are favoured over the other antennas because they have better compatibility is to be fit in Aircraft, Mobile, Satellites and they have very small sizes than the other commercial antenna which are existing in present world circumstances[1]. Hence design and expansion of higher and cost effective micro - strip patch antenna has become an attractive research area. The micro - strip Patch antenna have radiating patch on one side of dielectric substrate and ground plane on the other side as shown in Figure 1. The patch is made of conducting material such as copper or gold and can take any probable shape.

The patch is normally can have square, rectangular, triangular, circular, and elliptical or some other general shape. For a rectangular micro - strip patch antenna, the length L of the patch is $0.3333\ \lambda 0 < L < 0.5\ \lambda 0$, where $\lambda 0$ is the wavelength in free - space. The patch is to be very thin such that $t << \lambda 0$ (where t is the thickness of patch). The height h of the dielectric substrate is typically chooses in the rage $0.003\ \lambda 0 \leq h \leq 0.05\ \lambda 0$.

The dielectric constant of the substrate (ε_r) is usually in the range $1 \leq \varepsilon r \leq 12$. Micro - strip patch antennas radiate principally because of the fringing fields between the patch edge and the ground plane. For good antenna performance a thick dielectric substrate with low dielectric constant is desirable and this provides improved efficiency (as much as 90%), improved bandwidth (up to 35%). However, such a construction leads to a larger antenna size. In order to miniaturization methods, these are slot on the patch, dielectric substrate of high permittivity [2], DGS at the ground plane.

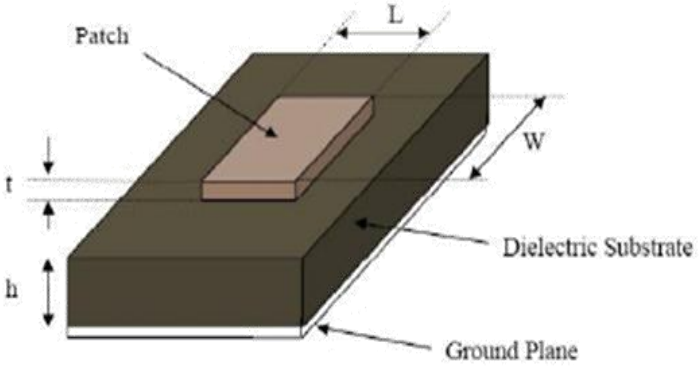

Fig. 1: Basic Micro – Strip Patch Antenna

II. USED FEEDING METHOD

In this paper we are using Probe Feeding technique for the micro - strip patch antenna. This technique is generally a direct feeding method. In this feeding, the RF power is feed directly to the radiating patch by inner conductor of coaxial cable.

A. Coaxial feed or probe feed

The Coaxial feed or probe feed is a very general technique used for feeding Micro - strip patch antennas. The inner conductor of the coaxial connector extends throughout the dielectric substrate and is soldered to the radiating patch and the outer conductor is connected to the ground plane as shown in Figure 2.

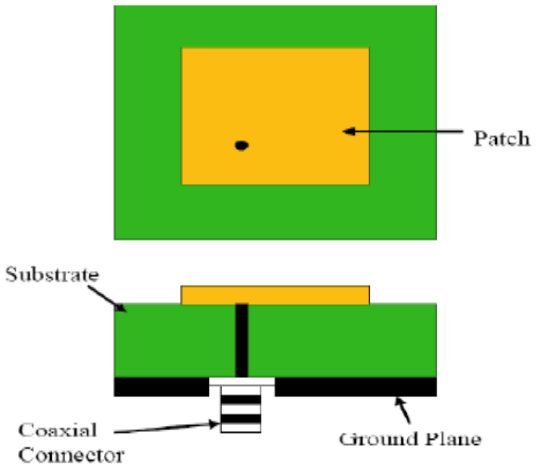

Fig. 2: Probe Feeding Technique

The main advantage of this feeding is that the feed can be placed at any needed location inside the patch in order to match with its input impedance. Its main disadvantage is that it provides narrow bandwidth and is a hole has to be drilled in the substrate. If the thickness of substrate is increases the probe length also increases this makes input impedance more inductive leading matching problem.

III. DESIGN PRINCIPLES

A. For Rectangular Patch Antenna:

We can calculate the dimension of rectangular patch antenna by using some mathematical formulation, before the we know basic three fundamental terms value that are Frequency of operation (f_O) Dielectric constant of the substrate (ε_r) and Height of dielectric substrate (h) and these play an important role in calculation of width (W) and length (L) of patch [3]. The steps for calculation of patch dimension are as follows:

1) Step 1: The width of patch is calculated by following expression:

$$W = \frac{c_o}{2f_r}\sqrt{\frac{2}{\epsilon_r + 1}}, c_o \text{ is speed of light}$$

2) Step 2: Due to fringing field effect the Effective Dielectric Coefficient (ε_{reff}) and Effective Length (ΔL) is calculated by following expression:

$$\epsilon_{reff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2}$$

$$\frac{\Delta L}{h} = 0.412\frac{(\epsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\epsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)}$$

3) Step 3: The actual length of patch is calculated by the following expression:

$$L = \frac{c_o}{2f_r\sqrt{\epsilon_{reff}}} - 2\Delta L$$

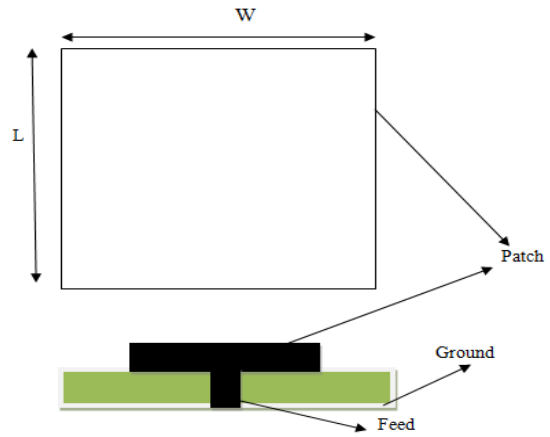

Fig. 3: Top and Side View of Rectangular Patch Antenna

The parameters used in this design are shown in Table 1. The arrangement of DGS which is used in design is as shown in Figure 3 (4).

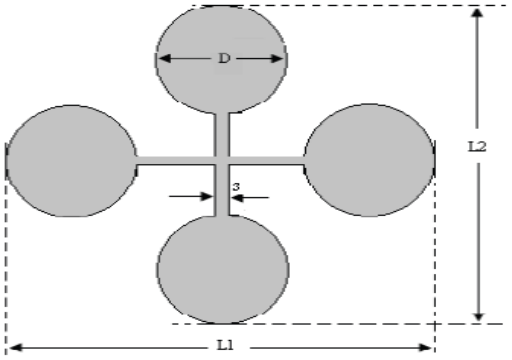

Fig. 4: DGS Arrangement

IV. CALCULATED PARAMETER

Parameter	Value
h	1.77 mm
ε_r	2.2
L	24 mm
W	18 mm
D	11 mm
s	2 mm
L1	32 mm
L2	34 mm

Table 1: Used Parameter

Here we use two feeding points for coaxial probe feed these are p1 (0,0,0) and operating frequency (f_o) is 10.36 GHz

V. DESIGN AND SIMULATION RESULT

For the design and simulation for Simple Rectangle Patch Antenna with Defective Ground Structure we use the HFSS Software. The design result is shown in Figure 5, the parameter use in this design are shown in Table 1. The operating frequency (f_o) is 10.36 GHz and coaxial probe feed is connected at point p1 (0,0,0). The simulation results are shown in Figure 6 to Figure 9. Figure 6 shows the simulated return loss of Simple Rectangle Patch Antenna with Defective Ground Structure. It shows that resonant frequency is 10.36 GHz. On the other hand B.W of rectangular patch is 734.6 MHz & Return loss is -23.2546 db.

Figure 7 shows gain of Simple Rectangle Patch Antenna with Defective Ground Structure. It shows that the gain of Simple Rectangle Patch Antenna with Defective Ground Structure is 8.2039 db. Figure 8 shows E plane (phi = 0 degree) and H plane (phi = 90 degree) radiation pattern of Simple Rectangle Patch Antenna with Defective Ground Structure and Figure 9 shows VSWR and value is 1.1482.

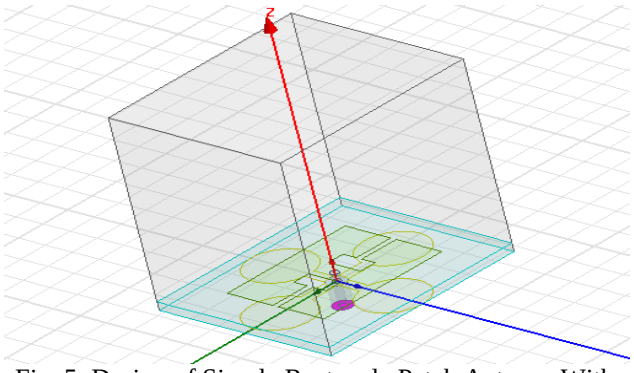

Fig. 5: Design of Simple Rectangle Patch Antenna With Defective Ground Structure

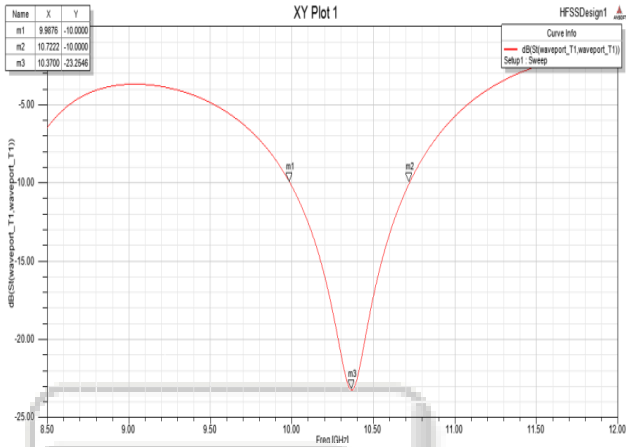

Fig. 6: Return Losses of Simple Rectangle Patch Antenna With Defective Ground Structure

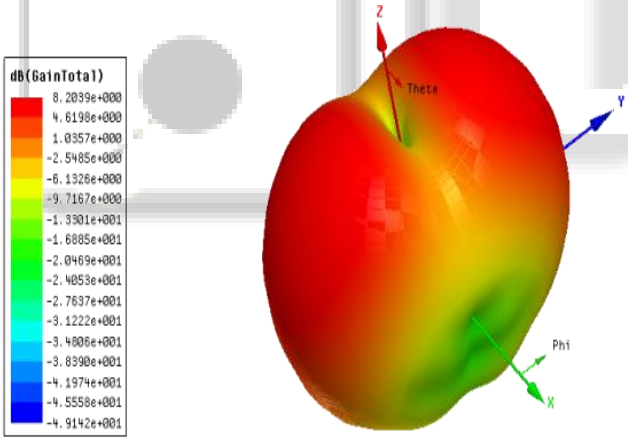

Fig. 7: Gain of Simple Rectangle Patch Antenna With Defective Ground Structure

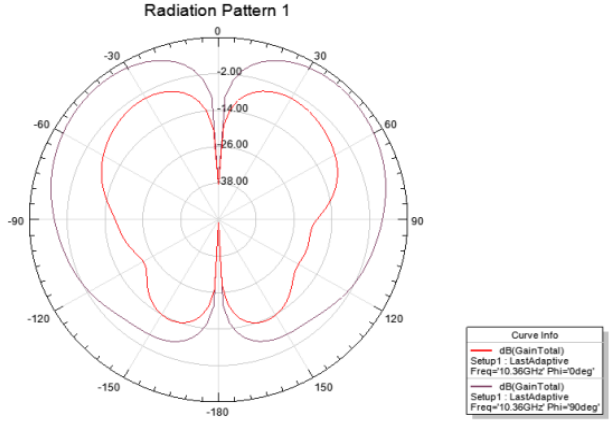

Fig. 8: E Plane and H Plane Radiation Pattern af Simple Rectangle Patch Antenna With Defective Ground Structure

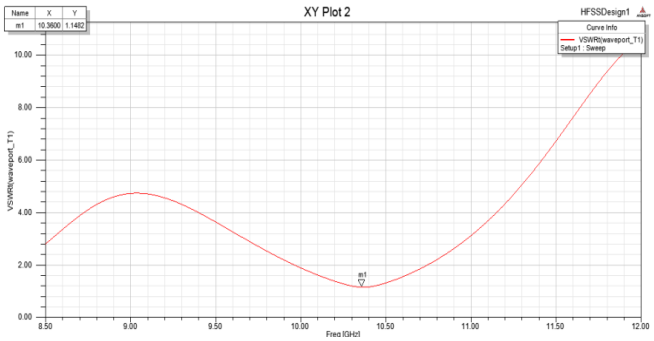

Fig. 9: VSWR of Simple Rectangle Patch Antenna With Defective Ground Structure

VI. CONCLUSION

Design of rectangular micro - strip patch antenna with DGS is carried out in this work. A bumble shaped DGS in the ground plane is used and it resonate at 10.36 with 8.2036 db Gain and Bandwidth is 734.6 MHz the antenna to be used for wireless application

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