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Bandwidth Improvment of Multiband Microstrip patch antenna using DGS and H-shaped patch

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Abstract—Microstrip Patch antenna is designed with the H-shaped slot on its patch and defected ground structure. Defected ground structure is formed by inserting U shaped slot on it. again defected Ground Structure is designed by cutting a combination of U and L shaped slots for reducing the size of patch and Ground plane. This leads to increase in current distribution path accompanied by increase in electric length of the antenna. The designed Microstrip patch antenna has bandwidth 58 MHz for 2 GHz with Defected ground structure and 43 MHz for 3.1 GHz without defected ground structure. Reflection coefficient comes out -12.20 for 2.4 Ghz and -14 for 2 Ghz frequency.
The simulation is done on high frequency structure simulator (HFSS). The different parameters like bandwidth, S-parameter, VSWR of antenna is calculated

Keywords—Microstrip patch antenna, Micro strip feeding, VSWR, Defected ground Structure (DGS), S-Parameter

I. INTRODUCTION

The micostrip patch antenna is characterized by planar structure, low profile, light weight, moderate efficiency. Due to which it is used in number of applications in the field of wireless communication system. It consist of patch, ground plane, substrate and feed line. There are different types of feed line like aperture feeding, coaxial probe, microstrip line feeding, proximity coupling. Feed line is broadly divided into two categories-contacting and non-contacting.

In contacting method, RF power is directly feed to the radiating patch with the help of microstrip line. In non-contacting method electromagnetic field coupling is performed for transferring power between radiating patch and microstrip line. Micro strip line and coaxial probe feeding technique comes under contacting method. Aperture coupling and proximity coupling comes under non-contracting method. Planner structure of microstrip patch antenna is formed by etching feed line on the same substrate. For reducing the size, cost and complexity linearly polarized microstrip patch antenna array is generally designed.

Defected ground structure is employed in antenna design to improve the characteristics of microwave devices. The main advantage of defected ground structure is, it reduces the mutual coupling and cross polarization.

Microstrip patch antenna are used in ultra high frequency band. Microstrip patch antenna are easy to fabricated and comfortable on curved surface. Microstrip Patch antenna can be made with different shapes like square, rectangular, Circular, etc. Substrate are of different types like Horney comb, Duroid, FR4 epoxy. Al203 having very high permittivity substrate is generally use for reducing the size of patch antenna [1]. But the pitfall using this method is radiation efficiency reduces. Cost is directly proportional to permittivity. If permittivity of substrate is high then cost is also high [2]. There are different methods for reducing the size of patch antenna. One is if the patch is shorted to the ground plane then reduction in size take place in greater extent. But it will affect the gain of antenna [3]. For reducing the size of antenna Meta materials may used [4]. By using Complementary split resonator only 10% size is reduced [5]. Multi band antenna is used for covering many useful application which reduced the requirement of multiple antenna. Different techniques are proposed for designing multiband antenna such as Fractal shape, Slotted shape of patch. [6].

In this paper Micro Strip Patch antenna having multi band response for reduction in size is proposed. Patch is made up of H-shape and defected ground structure is used. Defected ground structure is formed by cutting U shaped slots. Due to this slot Current distribution path is increased. By varying the length of slots multiple bands can be adjusted.

II. MICROSTRIP PATCH ANTENNA

In this paper Microstrip patch antenna shown in figure 1 is designed for 2.4 Ghz frequency using FR4 epoxy substrate which having the permittivity of 4.4 and the height of substrate is 1.6 mm. The calculation of patch is done using EM talk calculator for given frequency.
The result are, patch length=29.44mm and width of patch=38.03 mm.

Microstrip line feed is used for feeding the antenna. Microstrip line feed is constructed as a conducting strip is connected directly to the edge of the patch.

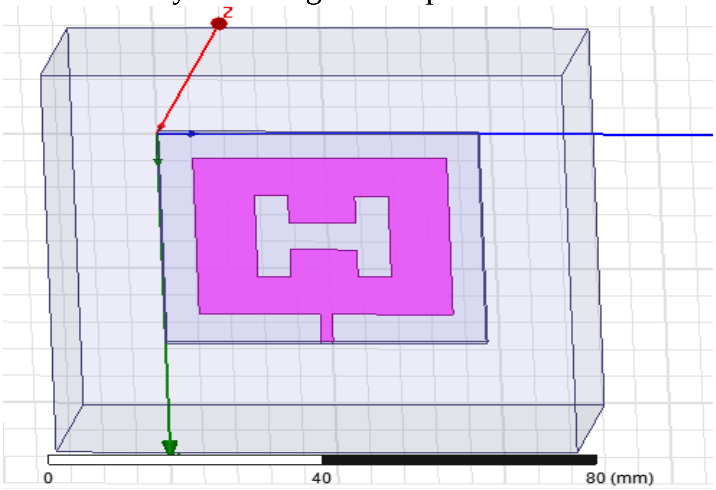

Figure 1: HFSS Implementation of Microstrip patch antenna

II. MICROSTRIP PATCH ANTENNA USING DGS AND H-SHAPED PATCH

Patch antenna is shown in Figure 2. The dimension of patch are as follow, 28 mm in length (Lp) and having 33 mm width (Wp). H-shaped slot is designed on the patch having dimensions as, length of vertical arm (Lb) is 20 mm, length of horizontal arm (La) is 10 mm and thickness of H is (Lc) having dimension 1.5 mm.

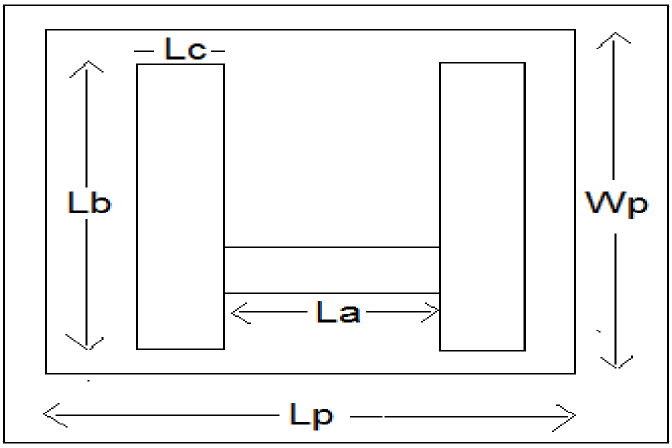

Figure 2: Dimensions of Patch antenna (La=10mm,Lb=20mm,Lc=1.5mm,Lp=28mm,Wp=33mm)

The bandwidth is enhancement due to the H-Shaped slot because it provides capacitive effects which counteracts inductance of the probe. Figure 3 is the back view (Ground plane) of our patch antenna. The ground plane is 52mm long (Lg) and 58mm wide (Wg).

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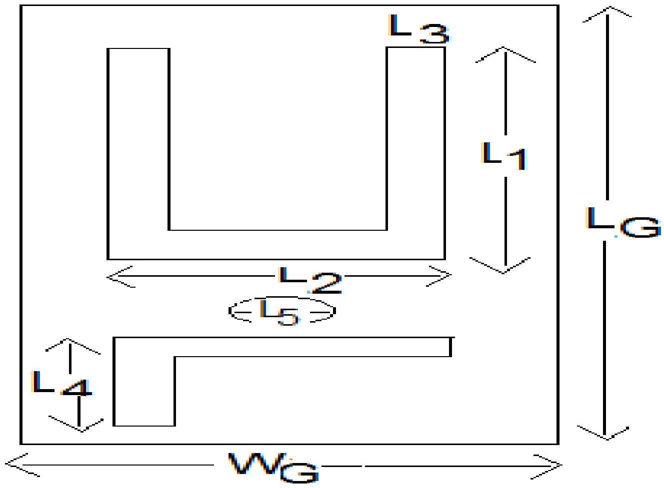

Figure 3: Dimensions of Bottom view (L1=L4=20mm,L2=18mm,L3=1.5mm,L5=2.37mm,LG=52mm,WG=58mm)

U and L shaped slots is designed on the ground plane. Both the slots have horizontal slot lengths of 20mm which is represented by L2. While vertical arm lengths of both the slots (L1 and L4) are 19mm, L3 represents thickness of U having dimension 1.5 mm. L5 represents diameter of circle having length 2.37 mm. These slots leads to the increase in current distribution paths on the ground plane and force the current to follow multiple paths. Due to this multiband response is obtained. This means these slots also contribute in the bandwidth enhancement. FR4 is used as a substrate which having the thickness 5 mm. Co-axial type feeding technique is used.

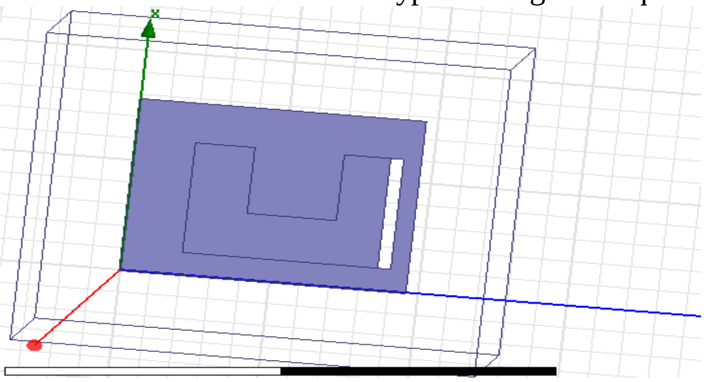

Figure 4: HFSS Implementation of DGS

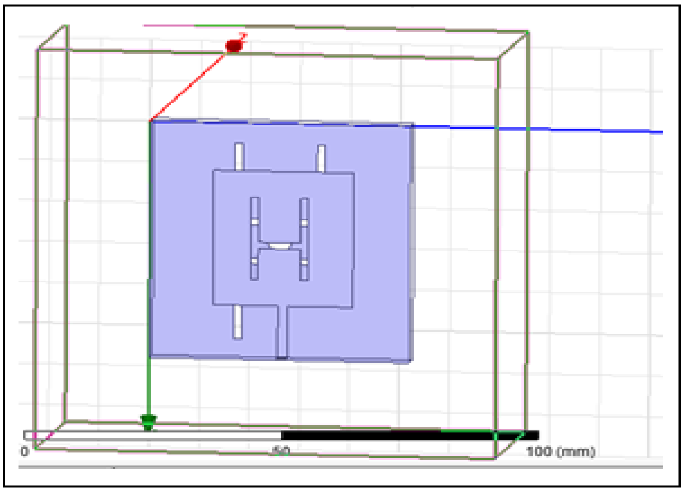

Figure 5: HFSS Implementation of Microstrip patch antenna using DGS and H-shaped patch

III. SIMULATION RESULT

Gain, Return Loss, Impedance bandwidth are calculated for different frequencies. All the result are pointing toward satisfied result.

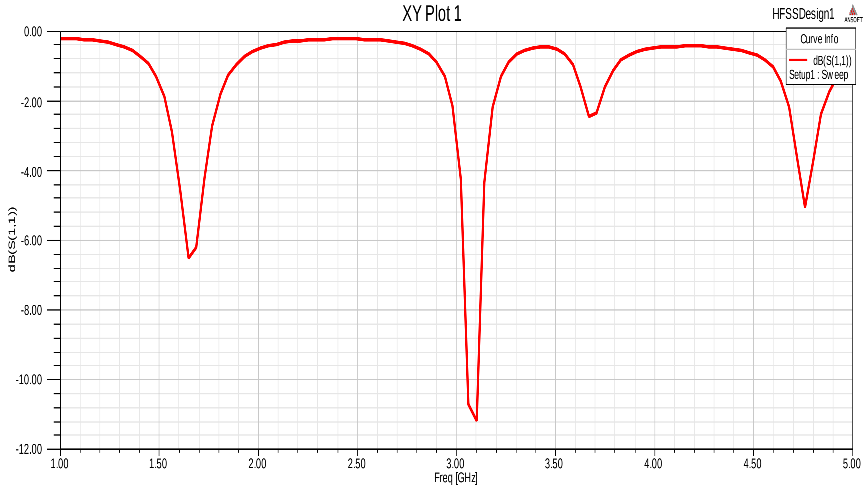

Figure 6: Reflection coefficient plot of H-shaped Microstrip patch antenna

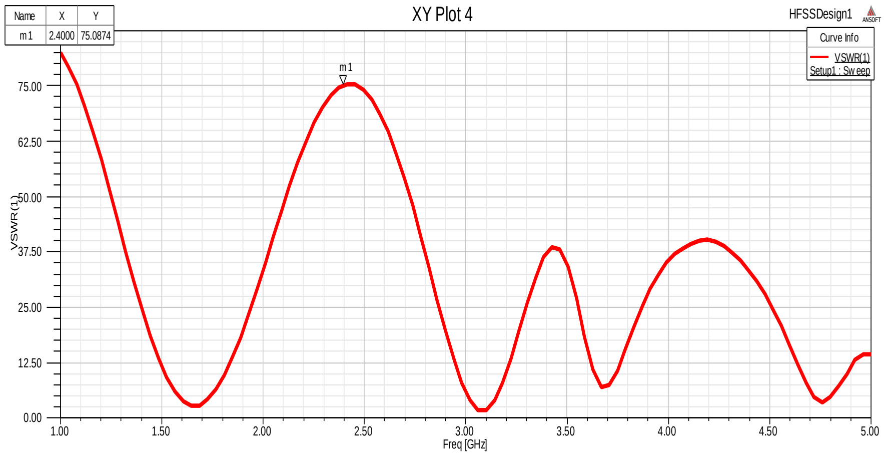

Figure 7: VSWR plot of H-shaped Microstrip patch antenna

by including DGS reflection coefficient is shifted towards left hand side of given frequency 2 GHz.

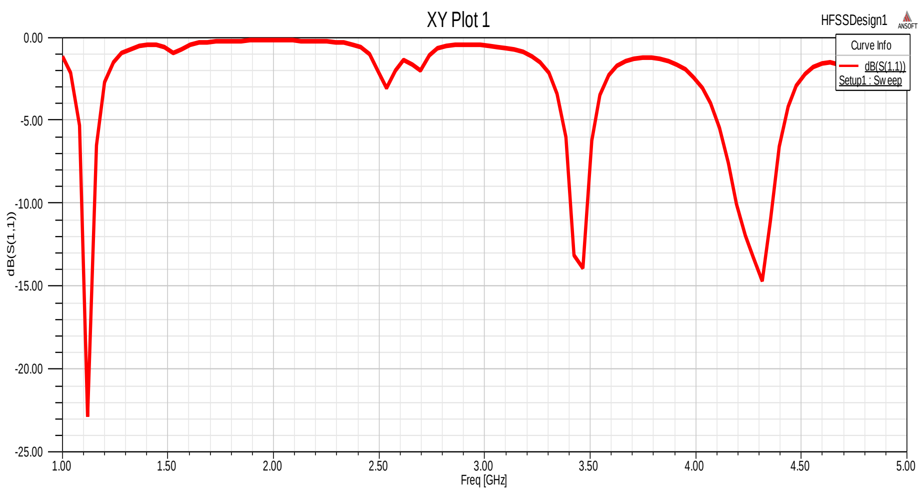

Figure 8: Reflection coefficient plot of U-shaped DGS

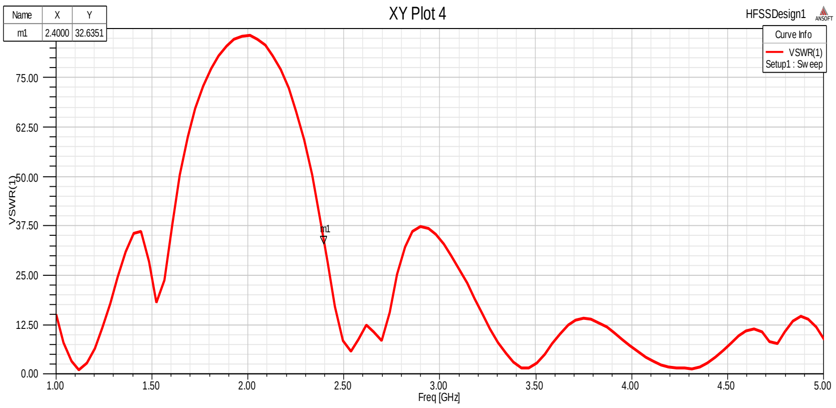

Figure 9: VSWR plot of U-shaped DGS

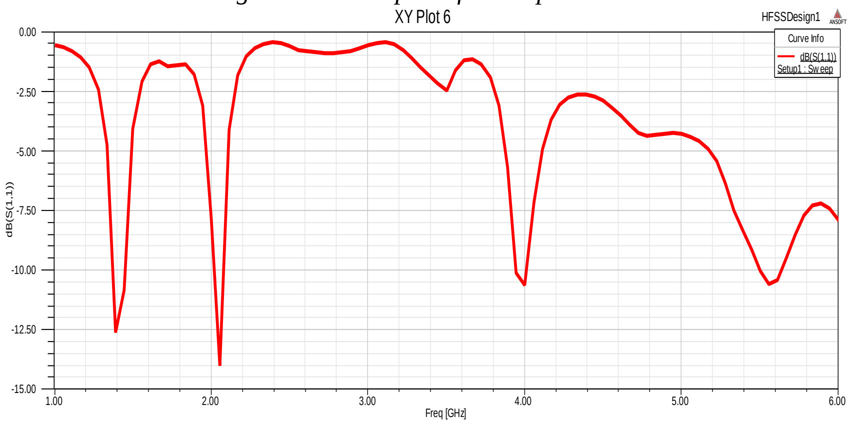

Figure 10: Reflection coefficient plot of Microstrip patch antenna using DGS

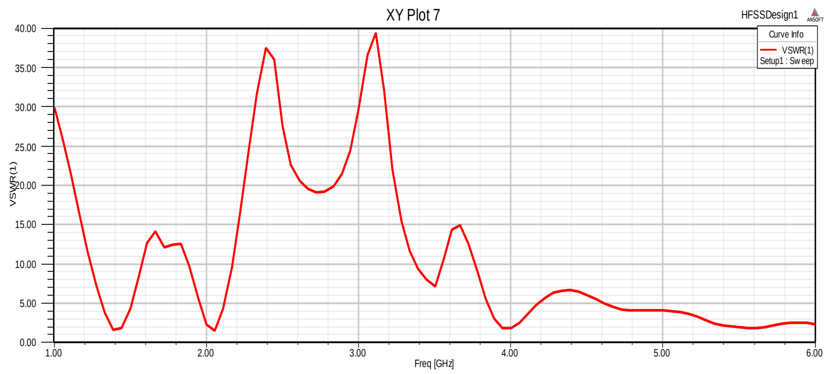

Figure 11: VSWR plot of Microstrip patch antenna using DGS

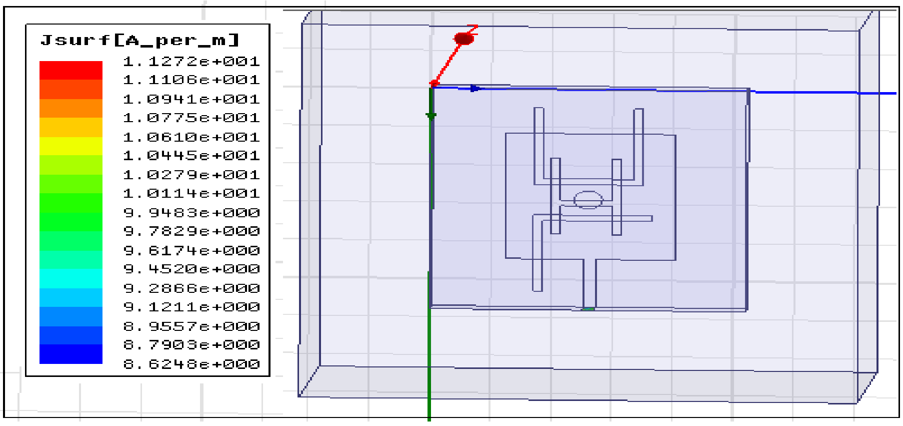

Figure 12: Current distribution plot of Microstrip patch antenna using DGS

Graph of Return loss is showing the operating frequency of patch antenna is 1.4 Ghz. The return loss for 1.4 Ghz is -12.62. The proposed antenna is resonating multiple frequency it means that the given patch antenna is showing multiband response. From the graph antenna have sufficient impedance bandwidth and resonate gain for all the bands.

IV. CONCLUSION

With the help of Defected ground structure Bandwidth of antenna is improved. The proposed antenna is used in mobile phones due to its multi band response. The designed antenna have acceptable VSWR and return loss. This antenna may cover application likes GPS/GSM/UMTS/W-LAN and HYPERLANE.

Table 1: Table showing Bandwidth improvement with DGS

Frequency	**VSWR**	**Reflection coefficent**	**Bandwidth**
3.1 GHz	1.98	-12.20	43 MHz (W'DGS)
2 Ghz	2	-14	58 MHz (DGS)

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