Improved performance of antenna using DGS for 5G applications

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Abstract - In the world of communication 5th generation is mostly used technique. The study of communication system is used in the operation of antenna. Some characteristics of antenna are light, compact and less cost that are continue high performance above vast spectrum of frequencies. In this paper design and calculate the parameter of patch antenna is presented at 28GHz. In this antenna feed used by microstrip line and antenna structure is simple. Good results appear in antenna with reference to gain and return loss. Using air substrate the antenna gain is improved. The antenna is design by Higher Frequency Structural Simulator (HFSS) software. The microstrip patch antenna plot present outcome of a very low return loss of -30.71 dB. Defected ground structure (DGS) technique used for improving parameter of patch antenna. DGS and without DGS both result are present in this paper.

***Key Words*: HFSS, DGS, Microstrip Patch Antenna, 28GHz, High Return Loss.**

1. INTRODUCTION

Antenna is an electrical conductor be the part of transmitting or receiving system that is designed to emit or collect electromagnetic waves. Microstrip patch antenna made up of narrow metal conductor be connect to narrow grounded dielectric substrates. Due to the large network demands the speedy development of wireless communication, the 5G (5th generation mobile network) technology growth will be necessary. In 5G antenna manufacturing, various applications require particular materials, mainly to save costs, moreover they need to be flexible, suitable for small size presentations, easy and fast to manufacture, And also lightweight.

1.1 Feeding Technique

There are different number of method which have been describe for increase the variable of normal microstrip antenna, different feeding technique such as Frequency Selective Surfaces (FSS), Electromagnetic Band Gap (EBG), Photonic Band Gap (PBG), and Meta material. Defected Ground Structure such as Microwave element with Defected Ground Structure (DGS), defects integrated about the ground plane of microwave planar circuits. The demand to get the better of the provocation of advancing 5G wireless communication are the advance patch antenna found high appreciate gain of 9.51 dB and extremely low reduction loss of -30.71 dB Higher appreciate gain and extremely low return loss than other mention effort are provided by the antenna that's means due to us advance design emit extra efficiently.

2. ANTENNA DESIGN

To study and design of microstrip patch antenna and implement this antenna using HFSS software. Firstly select the substrate and ground and it is necessary to select both. The width of substrate h=0.5 and the dielectric constant ∈r=1. After that to select patch antenna and the material of patch and ground are used as a copper. There are transmission line model, cavity model and full wave model these are the technique of modeling. The transmission line model represents rectangular microstrip patch antenna slot different at a low impedance transmission line of length. Microstrip patch antenna designing by following parameter, the speed of light and the resonant frequency of an antenna. And the dielectric constant of an antenna from that all parameter calculated the width of patch antenna using the following equation

$$W = \frac{c}{2f\sqrt{\frac{\epsilon r+1}{2}}} \quad \text{..... (1)}$$

Actual increase value of length is calculated by the following formula,

$$L = Leff - \Delta L \quad \text{..... (2)}$$

$$Leff = \frac{c}{2f\sqrt{\epsilon eff}} \quad \text{..... (3)}$$

Effective refractive index: Within the designing of microstrip patch antenna the effective refractive index value is most important parameter to calculate the effective length of patch. The radiations move from the patch antenna to the ground go by way of air and some through the substrate .When we find the value of effective dielectric constant during air and the substrate have different dielectric values. The following equation shows how to calculate the value of the effective dielectric constant.

$$\in eff=\frac{\epsilon r+1}{2}+\frac{\epsilon r-1}{2}[1+12\frac{h}{w}]^{-1/2} \quad \text{..... (4)}$$

Size of patch antenna increase as number of L. Calculated ERI value from the step 2 put it in the below equation and find the value of ΔL.

$$\Delta L = 0.412h\frac{(\epsilon r+0.3)(\frac{w}{h}+0.264)}{(\epsilon r-0.258)(\frac{w}{h}+0.8)} \quad \text{..... (5)}$$

The above all equations of design microstrip patch antenna using HFSS Software. The design of patch antenna view as shown in figure 1. The ground and substrate designed at make use of parameter of Ws × Ls with air substrate which has height and dielectric constant are 0.5 and 1 respectively.

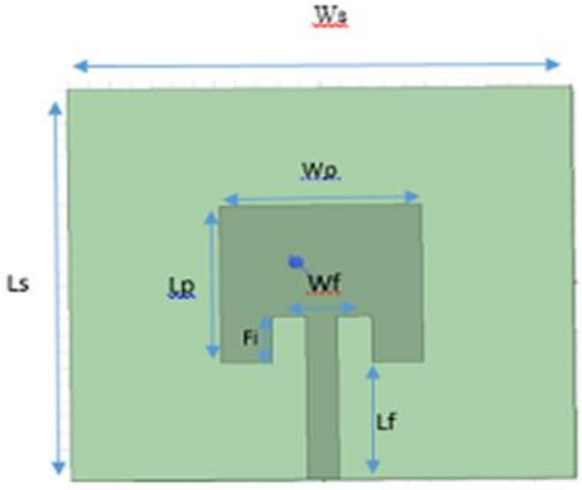

Fig-1: Design microstrip patch antenna

The all parameters of microstrip patch antenna are indicate in following Table 1.

Table -1: The designed 5G antenna parameters

Parameters of antenna	Parameters Description	Values
Lp	Length of patch	4.8mm
Wp	Width of patch	4.8mm
Lg	Length of Ground plane	6.0mm
Wg	Width of ground plane	6.0mm
Wf	Width of feed line	0.75mm
Fi	Insertion Feed	1.4mm
Ls	Length of Substrate	6.0mm
Ws	Width of Substrate	6.0mm
hs	Height of Substrate	0.5mm
∈r	Dielectric constant	1.0mm

3. DISCUSSION AND RESULTS

The patch antenna simulation is achieve using HFSS electromagnetic software model 19

A. Before DGS

Microstrip patch antenna results are following below

(a)Return loss: A plot is supposed to be well matched if the return loss is high. Return loss is the difference between forward and reflected power in dB. Return loss report the input output connection in the middle of ports. All the power is give back among the antenna, not a thing is emit it means the return loss is 0 dB. Return loss value should be at the minimum -10 dB to offer structured show at the antenna. If the value of return loss is less than the greater show of the antenna. Therefore our patch antenna has return loss value is -17.20 dB at 28 GHZ

Return loss:-17.20

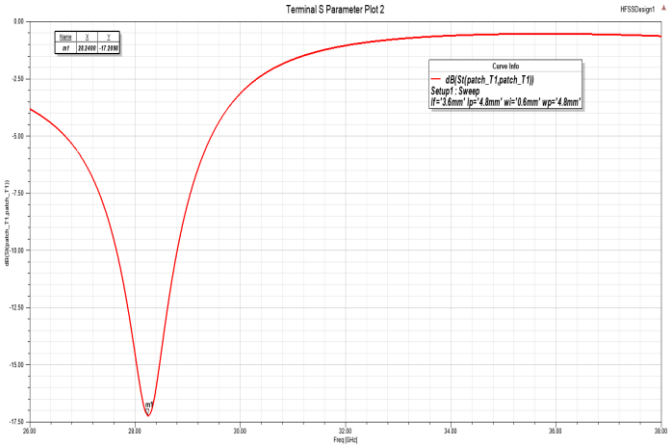

Fig. 2 Return Loss of patch Antenna before using DGS

(b)Radiation pattern: A radiation pattern defines the difference of power emit at an antenna while a basis of the direction to one side from the antenna. In the area of antenna design the name radiation pattern mention to the directional subservience of the power of the radio waves among the antenna or other source. The antenna radiation pattern make a use of regarding energy is emit at the antenna. The specific radiation design as it shown both 3D and 2D as indicate in Figure 04(a) and Figure 04(b).

In the figure of polar plot the red color indicate the electric field highest intensity and blue color indicate the electric field lowest intensity. A polar diagram is a plot that indicates the magnitude of the reaction in either direction. The radiation pattern shown on a polar diagram is taken as the plane in which the diagram itself plots.

Gain: 9.75

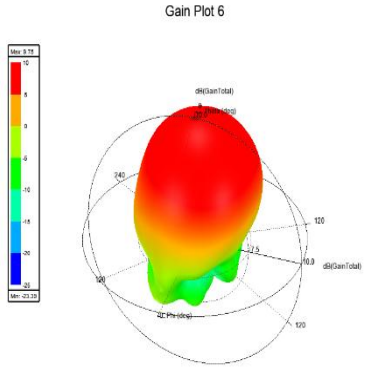

Fig.3 3D Radiation pattern of patch antenna before using of DGS

B. After DGS

The used of DGS to increase the gain and bandwidth of microstrip patch antenna and the feature of the microstrip patch antenna are defeat the higher mode harmonics, reciprocal integrate between close to element. The compact structural slots set operating the ground plane of the microwave circuit are known as the Perfect Ground Structure (DGS).

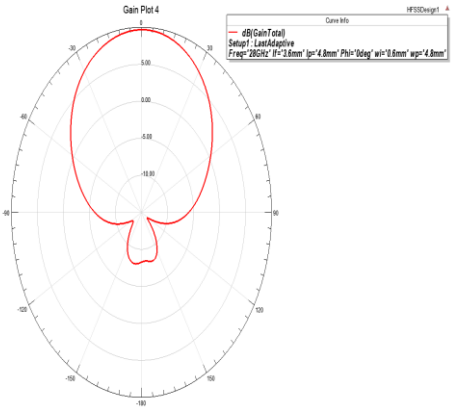

Fig.4 (a) 2D at 28GHZ when phi = 0°

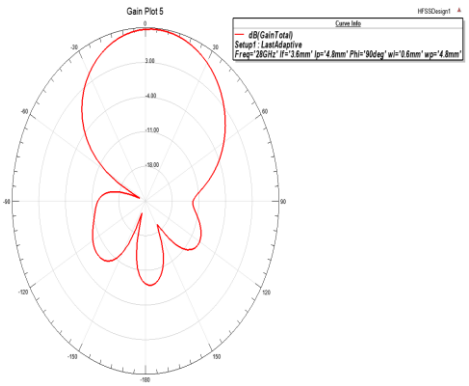

Fig.4 (b) 2D at 28GHZ when phi = 90°

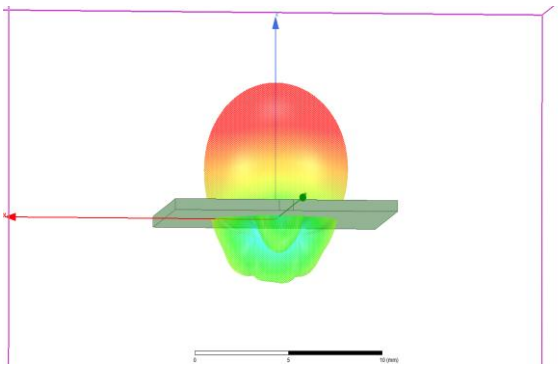

Fig.5 Fairfield Transparent 3D radiation pattern

Ground plane faults impair the present issue of the ground plane, this intrusion change the feature of the transmission parameters alert line parameters by integrate some parameters. Slots or fault on the ground plane of the planar circuit be known even as defect ground structures. DGS is go too far as a come out technique for better different variable of microwave circuits, reduce bandwidth, cross polarization, low gain.

After found results of microstrip patch antenna are hand over in the below figure. In the following figure the return loss value is -30.71 dB.

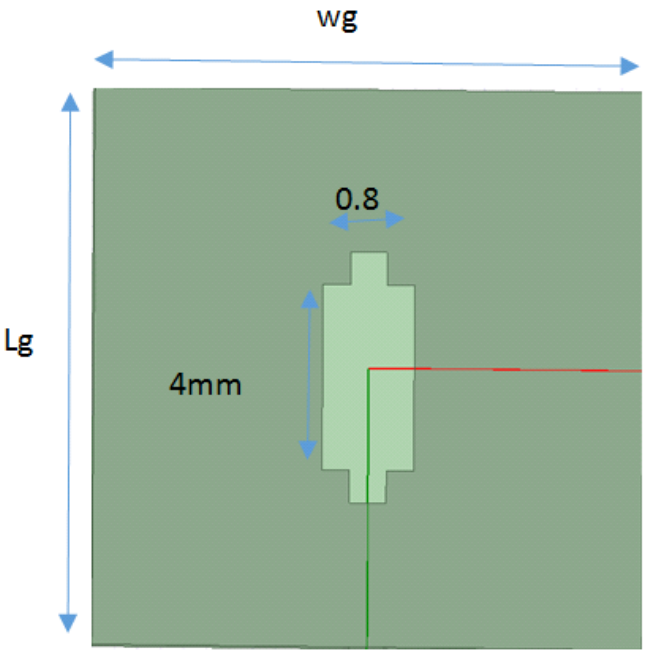

Fig.6 ground plane with defected ground structure

Return loss: -30.71

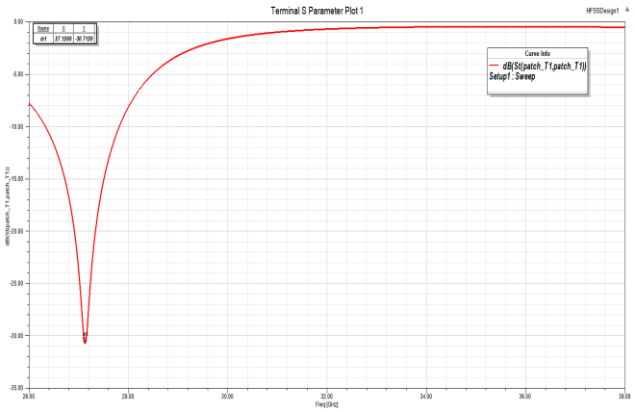

Fig. 7 Return Loss of microstrip patch Antenna after using DGS

Gain: 9.51

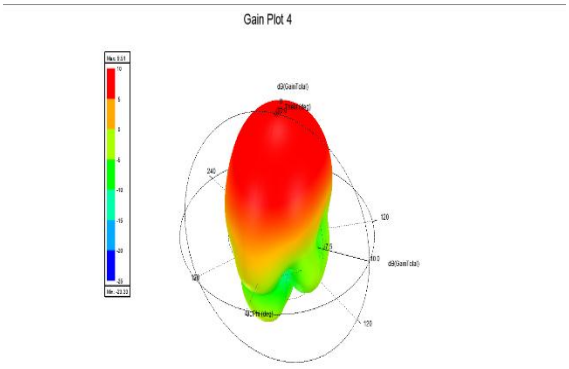

Fig. 8 3D Radiation Pattern of microstrip patch Antenna after using DGS

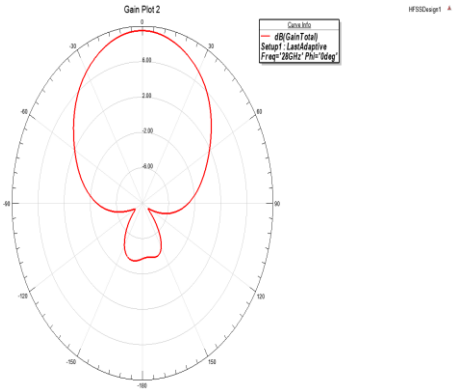

Fig. 9 (a) 2D at 28GHZ when phi = 0°

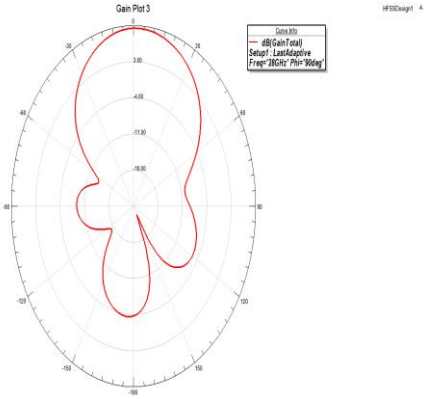

Fig.9 (b) 2D at 28GHZ when phi = 90°

4. CONCLUSIONS

In this project a microstrip patch antenna is going to designed about a low frequency at 28 GHz. HFSS software used for designing Microstrip patch antenna. The focus here project be about to better the

presentation of microstrip patch antenna for 28GHz frequency implementation make use of Defected Ground Structure technique (DGS). The DGS has freaked out the frequency, making the antenna compact and low return loss. Because of the placing of the DGS slot in the middle of ground plane that's why the gain is improved. The antenna return loss is better with a factor of 13%.

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