

A Compact Design of Microstrip Patch Antenna with Defected Ground Structure for X Band

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ABSTRACT: A compact design of microstrip patch antenna for X band applications is proposed here. Defected ground structure is used for antenna miniaturization and to improve the antenna performance. The proposed antenna is compact in size with dimension of 10×10×1.07mm³. For designing and simulation of the antenna structure FR-4 substrate of thickness 1.07mm with dielectric constant 4.4 is used. Ansoft HFSS 13.0 simulator is used to simulate the antenna parameters like return loss, VSWR, gain etc. The proposed antenna will resonate at 10GHz which is in X band. The applications of this antenna are radiolocation, radio navigation and satellite communications in X band.

KEYWORDS: Microstrip patch antenna, DGS, X band, Return loss, VSWR, Gain

I. INTRODUCTION

According to IEEE specifications X band ranges from 8 to 12 GHz which belongs to microwave radio region in the frequency spectrum. X band radar frequency sub bands are allocated for civil and military for weather forecasting, air traffic control and motor vehicle speed detection. Small and cheap antennas with high rotation speed are required for a very fair maximum range and better accuracy. So microstrip patch antennas are used as X band radar antennas since they are small in size, light weight, low cost, very high accuracy in manufacturing and easy to integrate with other circuits. But these type of antennas have some disadvantages such as narrow bandwidth and low gain. In order to overcome these disadvantages structure of defected ground is introduced. DGS structure is realized by etching simple shape from the ground plane. DGS disturbs the distribution of current in the ground plane cause the defect in the ground. Due to this disturbance there will be some changes in transmission line parameters such as capacitance and inductance. In this paper a compact microstrip patch antenna with defected ground structure is designed for X band applications. The feeding of antenna is provided by an inset feed technique since it is easy to design and fabricate compared to other feeding technique.

The performance of the proposed antenna is optimized by introducing circular shape on the ground plane.

II. ANTENNA DESIGN

The microstrip patch antenna with DGS parameters are calculated from the formulae given below.

- 1) Width of the patch:

$$W = \frac{C}{2 f_r \sqrt{\frac{(\epsilon_r + 1)}{2}}}$$

2) Effective dielectric constant:

$$\epsilon_{r_{eff}} = \frac{(\epsilon_r + 1)}{2} + \frac{(\epsilon_r - 1)}{2} \left[1 + 12 \frac{h}{W} \right]^{-\frac{1}{2}}$$

3) The actual length of the patch:

$$L = L_{eff} - 2\Delta L$$

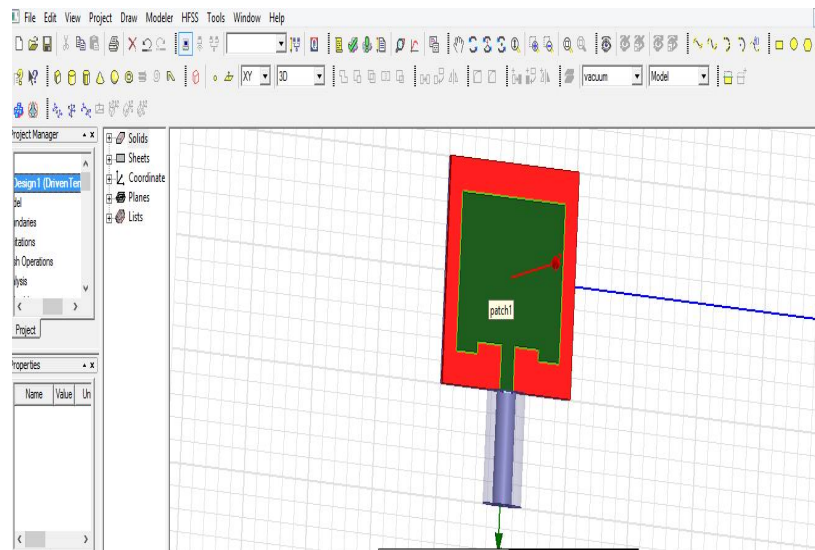
Where,

$$\Delta L = \frac{0.412h [\epsilon_{eff} + 0.300] \left[\left(\frac{W}{h} \right) + 0.264 \right]}{[\epsilon_{eff} - 0.285] \left[\left(\frac{W}{h} \right) + 0.8 \right]}$$

The proposed antenna structure is designed using FR4 substrate with 1.07mm thickness and dielectric constant 4.4 at resonant frequency 10GHz.

III. SIMULATON RESULTS

This proposed antenna structure is simulated in HFSS 13.0 simulator software is given in fig.1.



a)

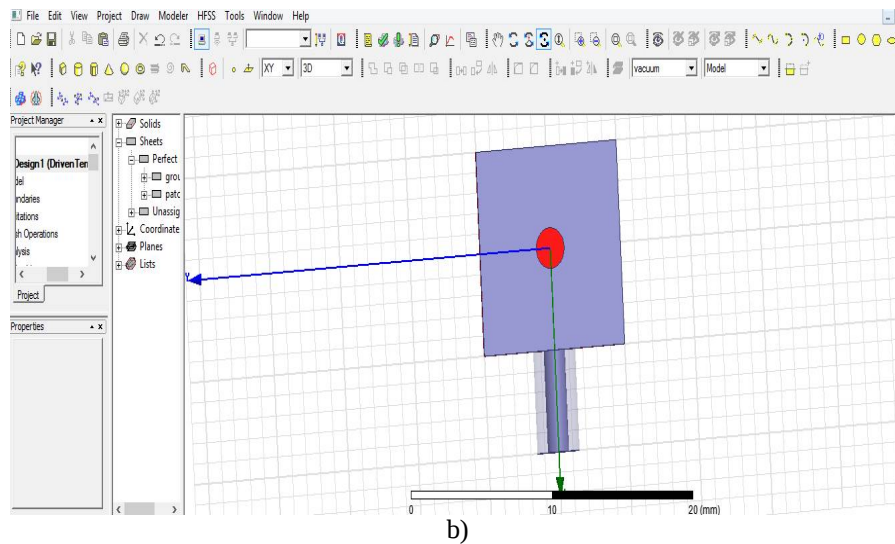


Fig.1a) The proposed antenna structure b) DGS structure on ground

After completing the simulation the of the antenna design, the results such as return loss, antenna gain and VSWR are figured given below.

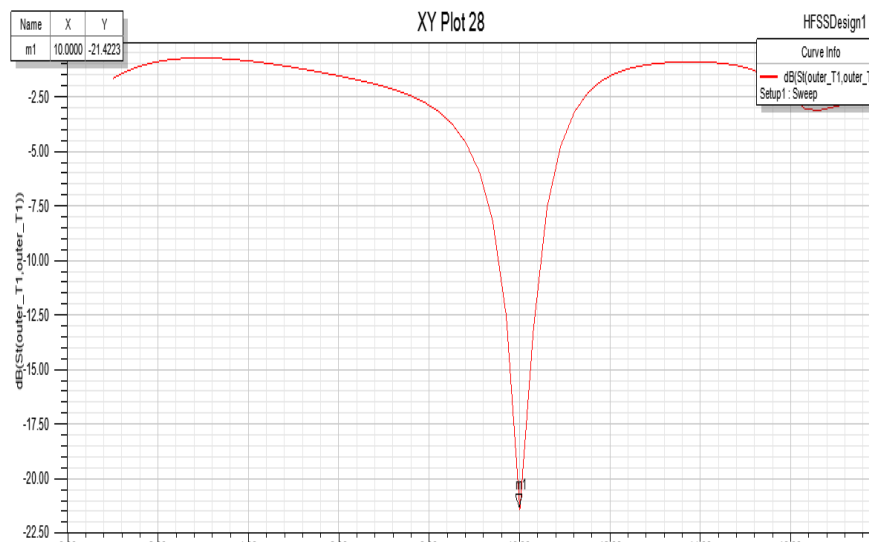


FIG 2 RETURN LOSS VS FREQUENCY

The designed antenna gives us a return loss of - 21.42 dB at 10GHz.

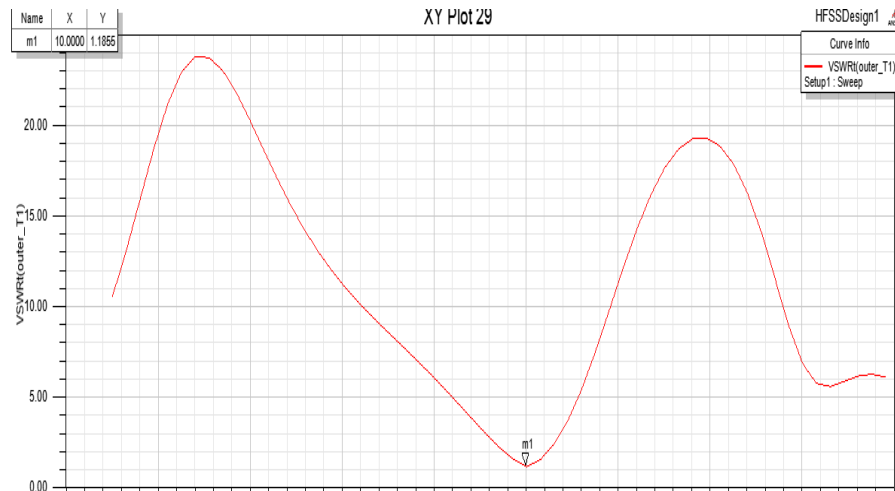


Fig3 VSWR at 10GHz

Fig.3 shows the VSWR of 1.18 for the designed antenna at 10 GHz.



Fig 4 Antenna gain

It shows the 3D pattern with gain of 3dB for designed antenna structure at resonant frequency of 10GHz.

IV. CONCLUSION

A compact microstrip patch antenna with DGS is designed and demonstrated using HFSS 13.0. The important antenna parameters at resonant frequency 10GHz has been studied in this paper. At resonant frequency the return loss is -21.42dB, gain is 3dB and VSWR is 1.18. The antenna proposed in this paper can be used in many applications such as radiolocation, radio navigation etc. The antenna structure with DGS proposed in this paper is small in size low profile antenna that can be used in X band applications.

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