

DESIGN AND ANALYSING OF COMPACT MICROSTRIP ANTENNA WITH DEFECTED GROUND STRUCTURE FOR UWB APPLICATION

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Abstract

In this paper a small size microstrip antenna with DGS (Defected ground structure) is designed and analyzed for UWB(Ultra Wide Band) application. This antenna cover the complete frequency range of 3.1 to 10.6 GHz with a very small geometry as compared to a conventional antenna Dielectric substrate use in this antenna is Fr-4. This antenna is designed with a dimension is 36mm × 34 mm on a dielectric substrate Fr-4 whose permittivity $\epsilon_r = 4.4$ and height $h = 1.6$ mm. The result for return losses and radiation patterns is simulated by using HFSS (High Frequency structure simulation) software. The High frequency structure simulator is employed to analyze the planned antenna and simulated results on return loss, The ground element of the proposed antenna is taken in the form of defected ground structure (DGS).

Key Words: Microstrip Antenna, UWB, DGS, Wide band, HFSS

1. INTRODUCTION

Micro strip patch antenna is wide beam width, narrowband antenna. And consists of three major part there is ground, patch, substrate (here used FR-4). There are numerous substrates that can be used for the design of microstrip antennas, and their dielectric constants are usually in the range of $2.2 \leq \epsilon_r \leq 12$ [4][5] [6]. In this paper used Defected Ground Structure technology. Defected Ground Structure is unique technology to reduce the antenna size. A DGS may come in a variety of geometries and sizes, depending upon their mode of application, as well as the frequency of operation [8][9]. The Defected Ground Structure (DGS) technology are various type there is Dumbbell-shaped, Square heads connected with U slots, H-shaped[9], Meander line, U-shaped[9], T-shaped, DGS in T-shaped and rectangular shaped. And Ultra wide band range (UWB) released by Federal Communications Commission (FCC) since 2002. It Covers frequency range 3.1 GHz to 10.3 GHz.[2] [3]. The ultra-wideband (UWB) systems advantages is it is consist high speed data, small size, not expensive, low complexity[1-4,1][10]. This anteaen is simulated by HFSS. HFSS is integral equation and method of the moment based Electromagnetic simulator.

2. ANTENNA STRUCTURE AND EQUATION

In Fig. 1 and Fig. 2 show geometry of the proposed microstrip patch antenna with DGS on the Fr4 substrate together with its geometrical dimensions. In the table 1 and table 2 also refer the dimension value of microstrip patch antenna. Value of antenna is taken in mm. Also equation 1,2,3,4 are calculate the dimension of the microstrip antenna.

A. Antenna Geometry

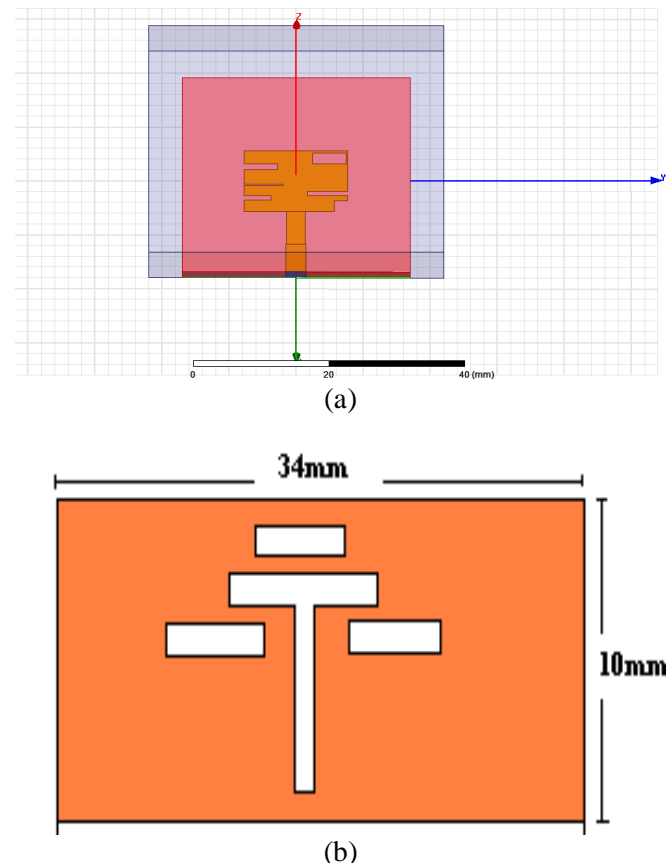


Fig.1- Microstrip antenna on FR-4 Substrate

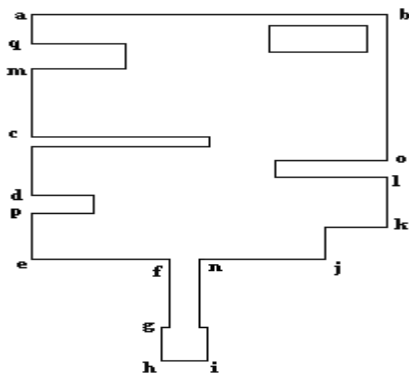


Fig. 2- Patch of antenna

Table - 1. Antenna Dimension

S.NO	Description	Value in mm.
1	Antenna length	36
2	Antenna width	34
3	Antenna thickness	1.6

Table- 2. Antenna Patch Dimenison (mm)

ab	15.4	pe	2.2
bo	7.5	cm	2.7
lk	2	qa	2.5
fg	6	dc	1.8
hi	3		

(1) Calculation of width of patch:

$$W = \frac{c}{2 f_r} \sqrt{\frac{2}{\epsilon_r + 1}} \tag{1}$$

(2) Calculation of effective dielectric constant:

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

(3) Calculate of Fringing field

$$\Delta L = 0.412 h \frac{(\epsilon_{reff} + 0.3) \left(\frac{W}{h} + 0.264 \right)}{(\epsilon_{reff} - 0.258) \left(\frac{W}{h} + 0.8 \right)} \tag{3}$$

(4) Calculate of Length of the substrate

$$L = \frac{c}{2 f_r \sqrt{\epsilon_{reff}}} - 2 \Delta l \tag{4}$$

Where

- c = Velocity of light in free space
- f_r = Resonant frequency
- h = Height of the substrate

- ε_r = Dielectric constant of the dielectric
- ε_{eff} = Effective dielectric constant of substrate
- Δl = Fringing field
- L = Length of the substrate
- W = Width of the substrate

This is equation determine the value of substrate of width , effective dielectric constant of substrate, Fringing field, Length of the substrate.

3. ANTENNA RESULT

1)- Return loss versus Frequency

In the Fig.3 show simulation result for return loss versus Frequency graph of microstrip patch antenna with Defected ground structure for UWB application. which is provide five bands at different frequencies such as 3.26 GHz, 4.55GHz, 6.72 GHz, 7.76 GHz and 9.36 GHz along with their different Return Loss values. This graph behavior is multi-band. At the frequencies i.e. 3.26 GHz, 4.55 GHz, 6.72 GHz and 7.76 GHz and 9.36 GHz obtained Return Loss values are -51.87 dB, -20.96 dB, -24.15dB, -21.51 dB and -39.10 dB. Which is show in Table 3.

Table 3. Return Losses Vs Frequency

Frequency	3.26 GHz	4.55 GHz	6.72 GHz	7.76 GHz	9.3 GHz
Return Loss	-51.87	-20.96	-24.15	-21.51	-39.10

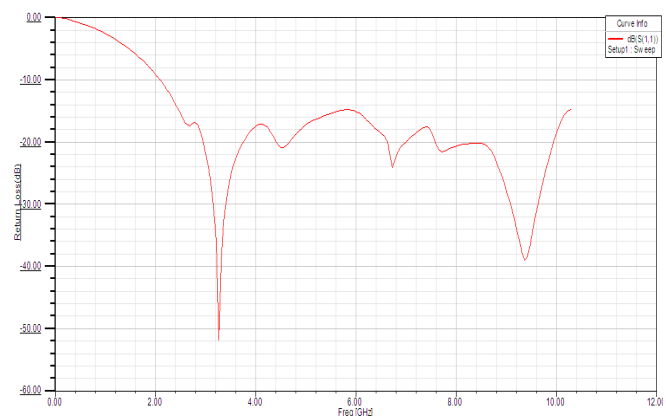
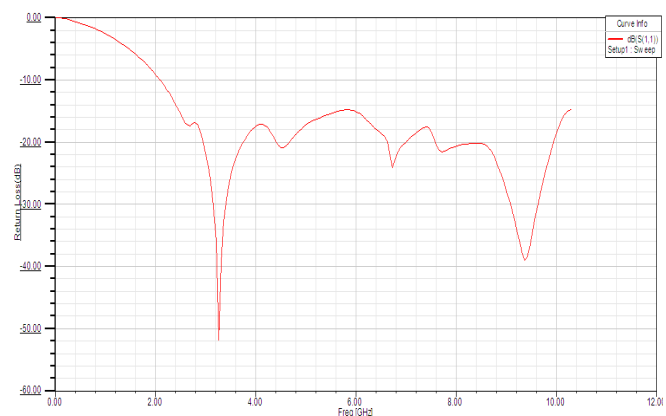


Fig.3- The Return loss versus frequency (GHz) plot for antenna design.

2)- VSWR versus Frequency

In the Fig.4 show result for VSWR versus Frequency graph of microstrip patch antenna with Defected ground structure for UWB application. which is provide three different VSWR value at the frequencies i.e. 4.55 GHz, 6.72 GHz and 7.76 GHz obtained VSWR values are 1.55 , 1.07, and 1.46. Which is show in Table 4.

Table 4. VSWR Vs Frequency

Frequency	4.55 GHz	6.72 GHz	7.76 GHz
VSWR	1.55	1.07	1.46

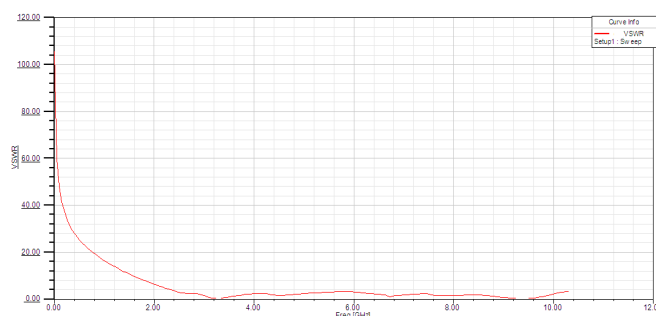


Fig. 4 - VSWR versus frequency (GHz) plot for antenna design.

3)- 3D Radiation Pattern of antenna

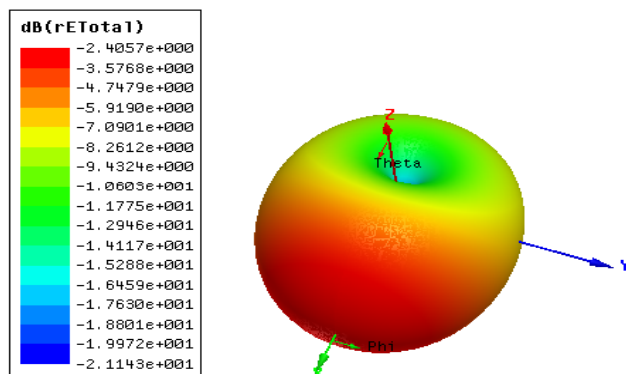


Fig. 5 - 3D Radiation Pattern of Antenna

IV. CONCLUSION

In this work, a Microstrip antenna with DGS for ultra wide band (UWB) Application has been design and simulated. This is a new patch antenna with defected Ground Structure (DGS) properties: improved Return loss (S_{11} db), VSWR. And the size of this antenna is small. Fundamental parameters are modeled with the equations and estimated with HFSS software. Microstrip patch antenna application in as like Mobile Communication, Global Positioning System, Interoperability for microwave access (Wi-Max), WLAN, Cognitive Radio, and UWB

V. REFERENCES

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