DESIGN AND ANALYSIS OF 5.8GHZ DEFECTIVE GROUND STRUCTURE MICROSTRIP PATCH ANTENNA

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Abstract: Internet of Things (IOT) and Radio Frequency Identification (RFID) are famous technologies which will help widely for the civilian and military applications, visually impaired people to solve their daily life problems, identifying and tracking a tag attached to an object etc. In this paper, a Microstrip patch Antenna with a high Gain along with a good Return Loss (S11) and VSWR that will work for 5.8 GHz ISM band RFID applications, is proposed. The Antenna has been designed and simulated using dielectric substrate FR4 glass epoxy having dielectric constant 4.4. The Patch dimensions are 96 X 156.5 X 1.6 mm3 and has a Microstrip Line feed. The microstrip patch antenna with DGS has return loss of -15dB and the VSWR is 1.43 at 5.8 GHz frequency. The Gain is also improved about 5.81 dB. As compared to the UHF band designs, the proposed design provides a better range coverage as well as better speed since the Gain is high. The designed antenna has a rectangular shape Defective Ground Structure and is designed with the help of Ansoft High Frequency Simulation Software (HFSS).

IndexTerms - Microstrip line feed, DGS, RFID.

I. INTRODUCTION

The prodigious development in the field of RFIDs and their corresponding uses and applications has led to the requirement of smaller size and low profile components that can be feasible for implementation [1]. Most of the RFID Applications works with a bandwidth of around 180 to 300 MHz for different bands such as Low Frequency (LF) 120–150 kHz, High Frequency (HF) 13.56 MHz, Ultra High Frequency (UHF) 433 MHz, 865–868 MHz (Europe) 902-928 MHz (North America) UHF ISM band, Microwave 2450-5800 MHz ISM band and Ultra Wide Band of 3.1–10 GHz [2]. As frequency range is increased data transfer rate and the range of the reader antenna is also increased. Hence, ISM band frequency range antennas should have better reading range. In RFID antennas the data rate and the size of the antenna is important. To transmit data with high speed the frequency range should be large, size should be small, and gain of the antenna is also high. Therefore use of a Microstrip antenna is a very good option as it satisfies our requirements.

DGS is realized by introducing a shape defect on a ground plane that disturbs the shielded current distribution depending on the shape and dimension of the defect [3]. It can also control the excitation and electromagnetic waves propagating through the substrate layer. The disturbance at the shielded current distribution will influence the input impedance and the current flow of the antenna. In the RFID application the bandwidth decides the rate of data transmission. Insertion of DGS in the microstrip patch antenna leads to the improvement in the bandwidth.

II. ANTENNA DESIGN

A microstrip patch antenna has been designed, simulated and fabricated for 5.8 GHz frequency. A microstrip patch antenna contains a dielectric substrate FR-4 glass epoxy having dielectric constant 4.4 is used. The height of the substrate is 1.6mm.The proposed antenna design equations are as follows.

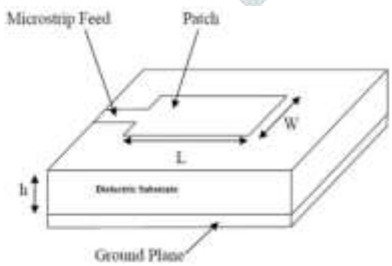


Fig.1. Structure of microstrip patch antenna

The width of the patch is calculated by

$$W = \frac{c}{2f}\sqrt{\frac{2}{\varepsilon r+1}}$$

Where, εr is the dielectric constant of the substrate.
f - Center frequency (5.8 GHz)
c - Velocity of light in free space
In order to compensate for the fringing field effect, we introduce a new dielectric constant called Effective dielectric constant(εreff).The value of this effective dielectric constant is given by,

$$\varepsilon reff = \frac{(\frac{\varepsilon r+1}{2})+(\frac{\varepsilon r-1}{2})}{(\sqrt{1}+\frac{12h}{w})}$$

Where h is the height of the substrate which here is 1.6 mm. The value of Effective dielectric is such that it is close to but less than the original dielectric constant εr. Next is the calculation of the effective length L_{eff} which is given by

$$Leff = \frac{C}{2f\sqrt{\varepsilon reff}}$$

Due to the fringing effect, the extension in length L is given by

$$\Delta L = 0.412\text{h}\,\frac{(\varepsilon r + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon r - 0.258)(\frac{W}{h} + 0.8)}$$

Hence the Length L of the patch is given by the equation,
L = Leff – 2ΔL

III. SIMULATION RESULTS

The microstrip patch antenna has been simulated in HFSS software. Following fig shows the simulated front view and the ground structure of the antenna with and without DGS.

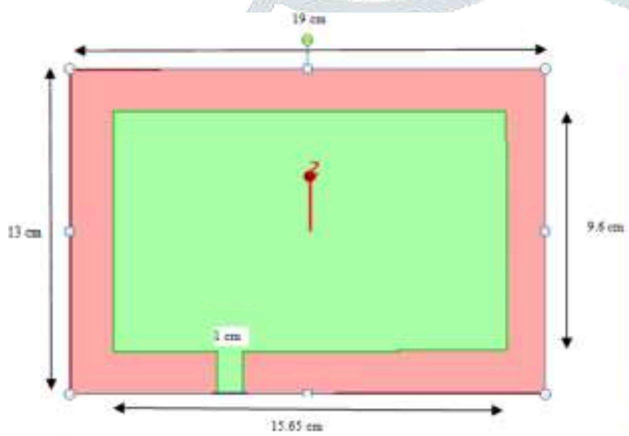


Fig.2. front view of the microstrip patch antenna without DGS

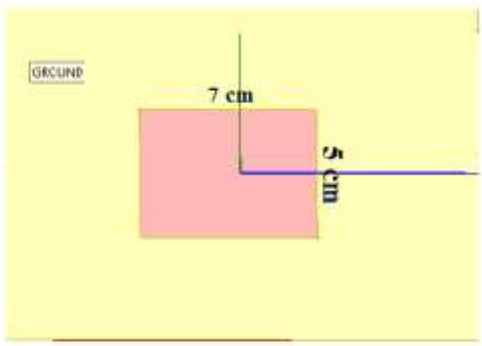


Fig.3. Ground of the microstrip patch antenna with rectangular DGS

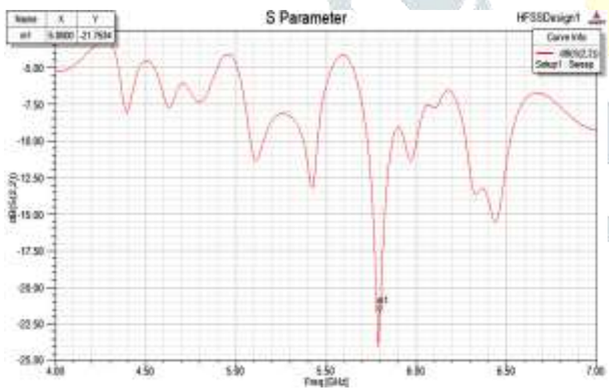
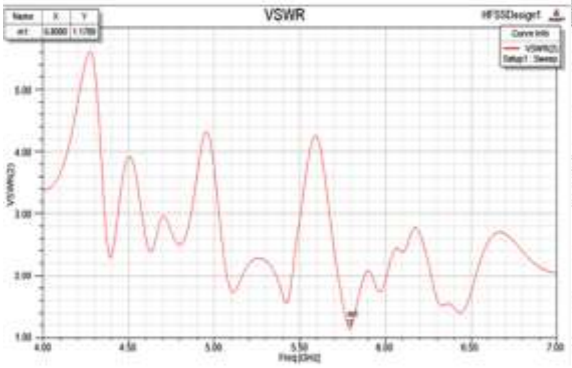


Fig.4. S11 parameter of the microstrip patch antenna without DGS.

Fig.5. S11 parameter of the microstrip patch antenna with DGS.

From fig 4 and 5 shows the s11 parameter of the microstrip patch antenna without and with DGS. Inserting DGS in the ground will improve the S11 performance. At 5.8 GHz S11 is -16 dB and the bandwidth is improved from 40MHz to 120 MHz.
The fig 6 shows the voltage standing wave ratio at 5.8 GHz is 1.4324.



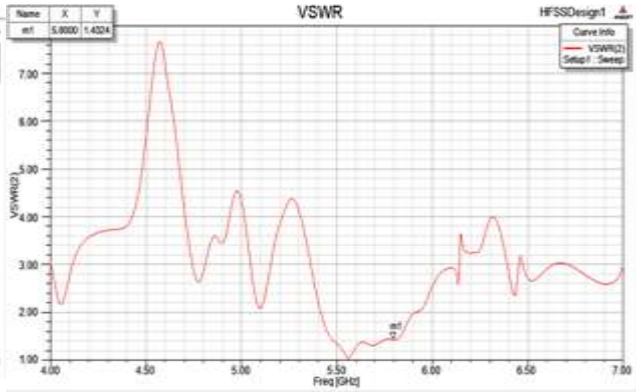
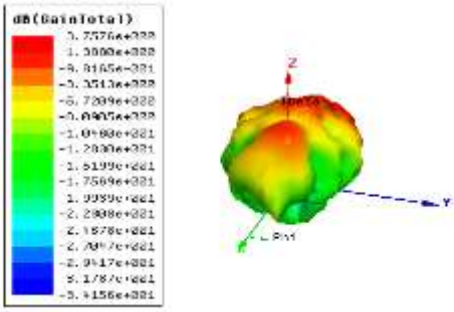


Fig.6. VSWR parameter of the microstrip patch antenna with DGS.

Fig.7. VSWR parameter of the microstrip patch antenna Without DGS



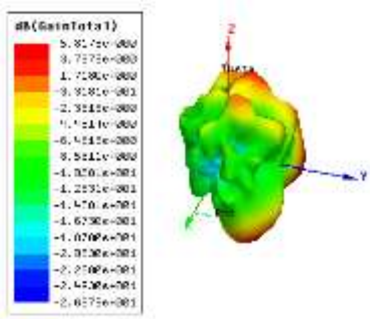


Fig.8. 3D radiation pattern of the microstrip patch Antenna with DGS.

Fig 9. shows the structure of 3D radiation pattern of the antenna Without DGS.

Fig 8 shows the simulated 3D radiation pattern of the microstrip patch antenna without DGS. From the result it can conclude that the gain of the microstrip patch antenna with DGS is greater than the gain of antenna without DGS. With DGS gain of the antenna is 5.81 dB and without DGS the gain of the antenna is 3.7 dB.Gain of the antenna is improved in with DGS microstrip patch antenna.

IV. FABRICATION RESULTS

The antenna has been fabricricated by using photolithography Techniques.The following fig shows the fabricated structure of microstrip patch antenna without and with DGS

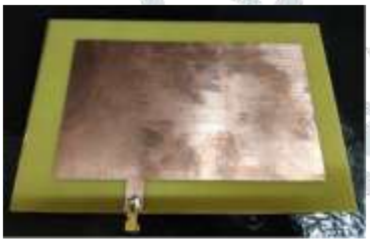


Fig 10a. Front view of the fabricated microstrip patch antenna

Fig 10b. Back view of the fabricated microstrip patch antenna

Fig 11a. Front view of the fabricated microstrip patch antenna Rectangular

Fig 11b. Ground of the fabricated microstrip patch antenna with DGS.

The fabricated results of the antenna as shown below,

Fig.12. Fabricated S11 parameter of the microstrip patch antenna antenna with DGS.

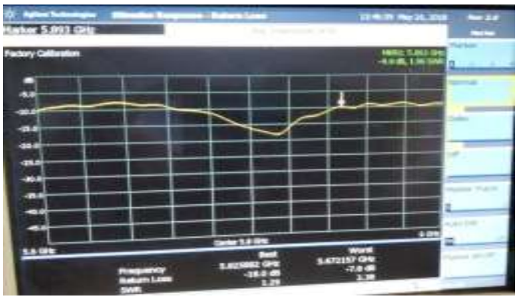


Fig.13. Fabricated S11 parameter of the microstrip patch Without DGS.

From the fabricated results it shows that the return loss of the microstrip patch antenna without DGS is –23.4dB and VSWR is 1.15 at 5.8GHz.Bandwidth of the antenna is 151MHz. Fig 13 shows the fabricated results of the microstrip antenna with DGS. From this it can conclude that the return loss is -18 dB and VSWR is 1.29 at 5.8GHz. Bandwidth of the antenna is improved from 151MHz to 266 MHz.

V. RESULTS AND DISCUSSION

S. No.	Parameters	Microstrip Patch Antenna without DGS	Microstrip Patch Antenna with DGS
1	Gain	3.75dB (5.8 GHz)	5.87dB (5.8 GHz)
2	VSWR	1.17 (5.8 GHz)	1.43 (5.8 GHz)
3	Return Loss	-21.75 dB (5.8 GHz)	-15.0dB (5.8 GHz)

Table 1.1: Comparison of Simulated Results

S. No.	Parameters	Microstrip Patch Antenna without DGS	Microstrip Patch Antenna with DGS
1	VSWR	1.15 (5.8 GHz)	1.29 (5.8 GHz)
2	Return Loss	-23.4 dB (5.8 GHz)	-18 dB (5.8 GHz)

Table 1.2: Comparison of Simulated Results

VI. CONCLUSION

A Microstrip patch antenna with dimension of Square shape DGS has been design and simulated. In order to obtain the effect of DGS, critical simulated study has been done using HFSS simulator. The presented results reveal that the proposed antenna with square shape DGS provides better impedance matching, wider bandwidth and gain than its original structure. The Microstrip patch antennas is designed to operate in C-Band (5.8GHz) communication standard. At 5.8 GHz Wi-Fi frequency corresponding value of return loss -23.4 dB which shows that the impedance matching is good at this frequency. It has good impedance matching of 50 ohm. The results is good due to defected ground structure. DGS plays an important role in modern printed antenna to improve the parameters and enhance the performance. The analysis about the performance of DGS antenna in respect of different shapes of DGS can be consider as a wider scope for future.

VII. REFRENCES

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