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DESIGN AND SIMULATION OF CIRCULAR DISK ANTENNA WITH DEFECTED GROUND STRUCTURE

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ABSTRACT

A circular microstrip patch antenna with defected ground structure is presented in this paper. A defected ground structure (DGS) is proposed to maximize the gain of microstrip patch antenna. The DGS pattern is simple and easy to etch on a commercial microstrip substrate. The results has been examined and verified experimentally for a particular DGS pattern using a circular patch as the radiator. We used HFSS (high frequency structured simulator) software for simulation of antenna and to find out the results. Both simulation results are presented. On the basis of return loss, directivity, radiation pattern and gain microstrip patch antenna with DGS and microstrip patch antenna without DGS is compared. Coaxial feeding technique has been used as it is easier to implement.

Keywords: Circular Microstrip Patch Antenna, Defected Ground Structure, Microstrip Antenna, Operating Frequency 4.5ghz.

I. INTRODUCTION

Now a day's communication plays important role in the world and hence communication is also switching from wired communication to wireless communication. The telecommunication always tries to reach best performance, the reliability and the efficiency with the lowest possible costs. For telecommunication systems antenna is a basic element, which allows the electromagnetic wave transmission in free space.Several types of antennas are present which are differentiated by their geometrical shape and capacity of transmission. Microstrip antennas are used in wide range of applications from communication systems to biomedical systems because microstrip patch antennas are easy to fabricate, simple, cost effective, light weight, low profile and reliable[1-3]. Microstrip antennas are divided into 4 different categories they are:

- Microstrip Patch antenna
- Microstrip dipoles
- Printed slot antennas
- Microstrip travelling wave antenna

Microstrip patch antenna has received lot of popularity and considered as most dynamic field in communication. Patch antennas are planar antenna used in microwave applications and in wireless links. The Microstrip technique is a planar technique which produces lines conveying signals and antennas coupling such lines and radiated waves. Shape and dimension of a patch which is wider than a strip are important features of the antenna. A large number of microstrip patches have been developed to be used in wireless applications.

The design of Microstrip patch antennas is easy to operate in dual-band, multi-band application, dual or circular polarization. But, microstrip patch antennas inherently have narrow bandwidth and for practical applications bandwidth enhancement is usually demanded, so for increasing the bandwidth many approaches have been used. The microstrip patch antenna with Defected ground structure is very suitable approach for the applications in the wireless communication systems. In DGS any shape of defect is etched in the ground plane of the microstrip antenna which gives rise to increasing the effective capacitance and inductance. DGS have the different characteristics for different DGS structures.

DGS is basically used in microstrip antenna design for reducing the size of antenna, reducing cross polarization, reducing mutual coupling and for harmonic suppression etc. Therefore, this paper presents design of microstrip patch antenna with Defected Ground Structure to determine the effect of employing DGS with microstrip patch antenna.

II. CONVENTIONAL CSMA DESIGN AND RESULTS

For the design steps of the Microstrip antenna, the desired resonant frequency, dielectric constant and thickness of the substrate are known or selected initially. Here the circular microstrip antenna is designed employing FR4 substrate with height of 1.59 mm, dielectric constant 4.4 and tan δ=0.02. Then the patch antenna is designed at 2.45GHz operating frequency by using transmission line model [4]. Co-axial feeding technique is used as feeding method to excite the antenna.

The formula for calculating actual radius of the circular patch [5] is given below:

$$a = \frac{F}{\sqrt{\left\{1+\frac{2h}{F\pi\varepsilon_r}\left[In\left(\frac{\pi F}{2h}\right)+1.7726\right]\right\}}} \tag{1}$$

Where,

$$F = \frac{8.791 \times 10^9}{f_r\sqrt{\varepsilon_r}} \tag{2}$$

Effective radius of circular patch is given by:

$$a_e = a\sqrt{1+\frac{2h}{\pi a}\left[In\left(\frac{a}{2h}\right)+1.7726\right]} \tag{3}$$

Where,

f_r = Operating frequency

a_e = effective patch radius

a = patch radius

h = thickness of the substrate

ε_r = dielectric permittivity of substrate

By using above formulae the actual radius (a) of circular patch is 17.22mm; also effective radius is 17.41 mm. The proposed antenna is shown in Fig.1.

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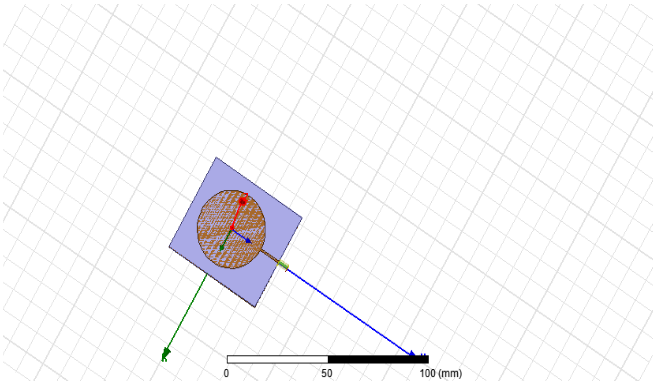

Fig.1 Conventional Circular Microstrip Antenna (csma)

We simulate the proposed antenna on HFSS 15.0 (High Frequency Simulation Software) software.

Fig.2 shows the return loss plot. In this figure the central frequency is 2.44 GHz and the higher and lower frequencies at -10 db are 2.47 GHz and 2.42GHz. Therefore the bandwidth calculated at -10 dB is 50 MHz.

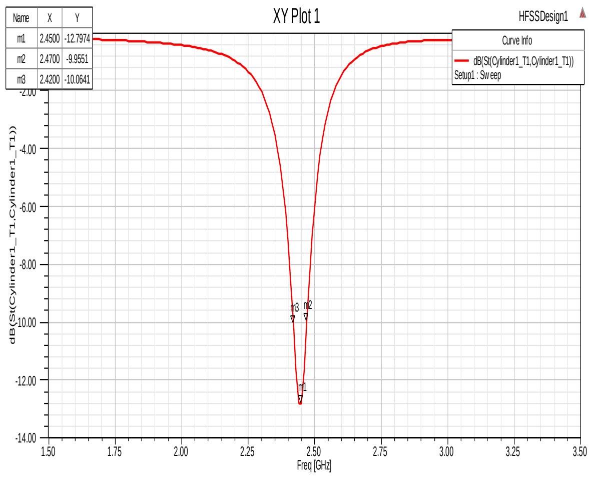

Fig.2 Plot of Return Loss

Fig. 3 shows the Voltage Standing wave Ratio (VSWR) with VSWR ≤ 2.

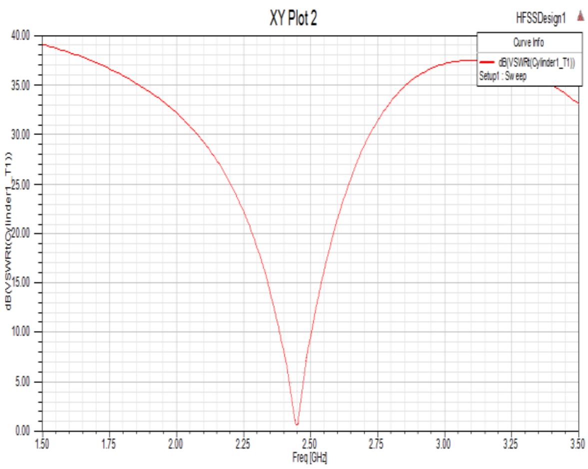

Fig.3. Plot of Voltage Standing Wave Ratio (vswr)

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III. CSMA WITH DGS- DESIGN AND RESULTS

DGS is realized by introducing a shape defected on a ground plane. The disturbance at the shielded current distribution depends on the shape and dimension of the defect which will influence the input impedance and the current flow of the antenna. It can also control the excitation and electromagnetic waves propagating through the substrate layer .We used the rectangular DGS of 9mm by 3mm dimension as shown in Fig.4.

Fig.4 shows the design of new L-shaped DGS patch antenna. A circular patch on the upper plane of the antenna and etched rectangular-shape structure on the ground plane is designed. The dimension of rectangular shaped DGS as shown in above figure. We simulate circular microstrip antenna with rectangular shape DGS on HFSS.

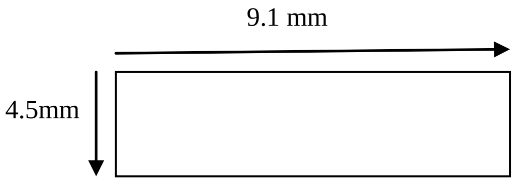

Fig.4 dgs

Fig.5 shows the circular microstrip patch antenna with rectangular shaped DGS.

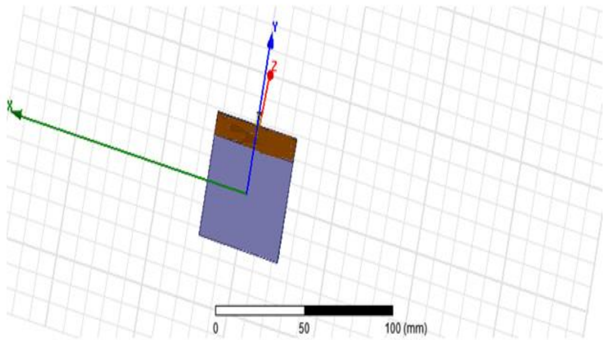

Fig.5 Circular Patch Antenna with Rectangular Shape dgs

The simulated results are as shown in following figure.

Fig.6. shows the return loss plot. In this figure the central frequency is 2.45 GHz and the higher and lower frequencies at -10 db are 2.82 GHz and 1.91GHz. Therefore the bandwidth calculated at -10 dB is 910 MHz.

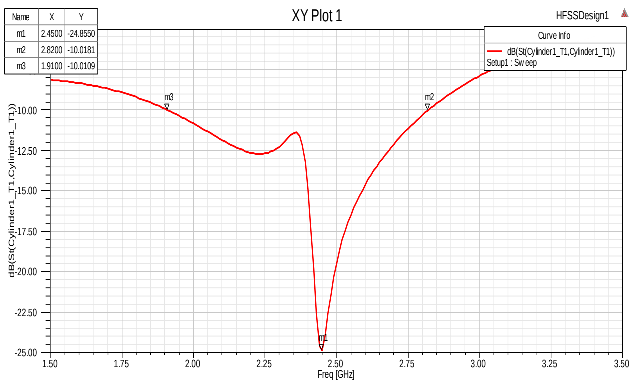

Fig.6. Plot of Return Loss .

Fig. 7 shows the Voltage Standing wave Ratio (VSWR) with VSWR ≤ 2.

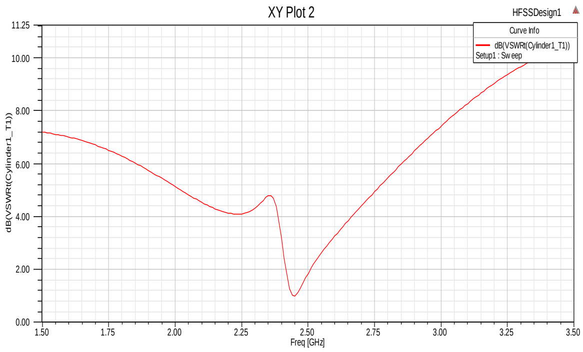

Fig.7. Plot of Voltage Standing Wave Ratio.

IV. RESULTS

Table 1.shows Comparison between CMSA and CMSA with L-shape DGS at 2.45 GHz.

Table1. Comparison

Parameters	CSMA	CSMA with Rectangular shape DGS
Bandwidth(MHz)	50	910
Return Loss (dB)	-13	-25
VSWR	1.1	1

V. CONCLUSION

This study provided an insight in determining the performance of circular microstrip antenna with and without DGS. The impedance bandwidth and gain of a circular microstrip antenna with DGS using coaxial feeding method is improved as compare to the conventional microstrip patch antenna. From the results it is observed that proposed circular microstrip antenna will work in frequency range 2.40GHz to 2.45 GHz.

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