Design and Analysis of a Compact Rectangular Microstrip Patch Antenna with Defected Ground Structure

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Abstract- In this paper a rectangular microstrip antenna with defected ground structure (DGS) is proposed. In the absence of DGS the structure is found to resonate at 5.3 GHz. When the DGS is introduced a frequency shift of 5.3 GHz to 1.8 GHz is observed. The main contribution of this paper is the miniaturization of 88.95% which is very much encouraging.
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Keywords: **Microstrip antenna, Defected Ground Structure, Miniaturization.**

I. INTRODUCTION

Microstrip antennas have been used widely in wireless communications due to their light weight, low profile, low cost and ease of fabrication and excellent compatibility with planar integrated circuits and even non planar surfaces. In recent years, as the demand of the small systems have increased, small size antennas at low frequency have drawn much interest from researchers [1, 2, 3]. Many kind of miniaturization techniques, such as using of dielectric substrate of high permittivity [4], slot on the patch, DGS at the ground plane or a combination of them have been proposed and applied to microstrip patch antennas. The other method to miniaturize the microstrip antenna is to modify its geometry using irises [5] or folded structures [6], [7] based on the perturbation effect [8]. In this paper DGS is used to miniaturize the rectangular microstrip antenna.The present work deals with design and analysis of a rectangular compact microstrip antenna for wireless application. The design incorporate circular spiral shaped defected ground structure which is on the ground plane, which disturbs shielded current distribuation in ground plane [9],[10]. Initially the antenna is designed to resonate at the frequency of 5.3 GHz and then using DGS the resonant frequency is brought down to 1.8 GHz. So a size reduction of 88.95% is achieved.

II. DESIGN PRINCIPLES

The geometry of the proposed antenna is shown in Fig.1.The substrate FR4_epoxy of dielectric constant 4.4 and dielectric loss tangent of 0.002 has been taken in this design. The antenna has been designed and simulated with Zeland. Initially the antenna is designed for the resonant frequency of 5.3 GHz and then using DGS the resonant frequency is brought down to 1.8 GHz. So a size reduction of 88.95% is achieved. The length and width of the rectangular patch are 17 mm and 13 mm. The feed point is taken at (0,3) in absence DGS at the ground plane. For the data as mentioned above, the resonant frequency is found to be 5.30 GHz. The spiral shaped DGS as shown on Fig. 2. is incorporated at the ground plane with total length of the spiral being 24mm and spiral width being 1.5mm. The spiral DGS is placed at a distance of 8.5mm from the left edge. The feed point is taken at (0,3) in presence of DGS at the ground plane. Now in the presence of DGS at the ground plane the resonant frequency is found to be 1.8 GHz.

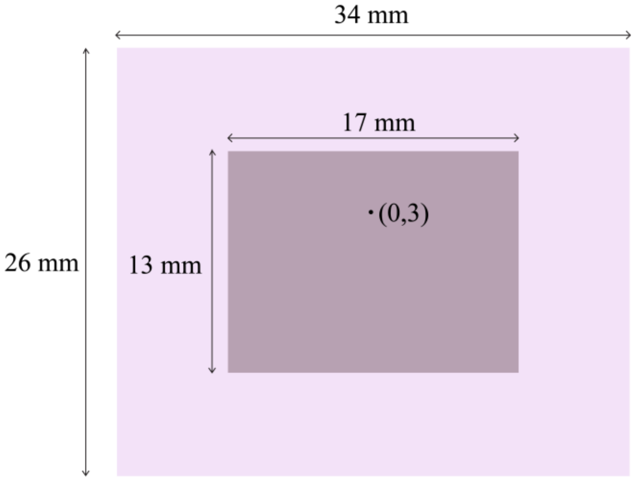

Fig.1. Front view of the proposed antenna

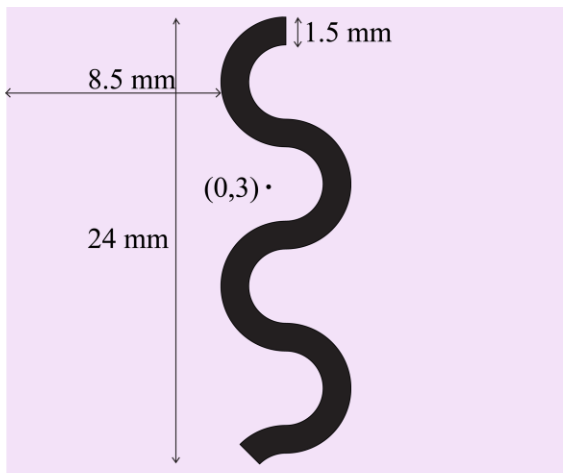

Fig2. Back view of the proposed antenna

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III. RESULTS

Return Loss of the rectangular patch with DGS and slots and without DGS and slots is given in the Fig. 3 and Fig. 4 respectively. It is observed from Fig. 3 that return loss at 5.3 GHz is -13.76dB in absence of DGS at the ground plane. From Fig. 4, it is seen that return loss at 1.8 GHz is -13.65dB in presence of DGS at the ground plane.

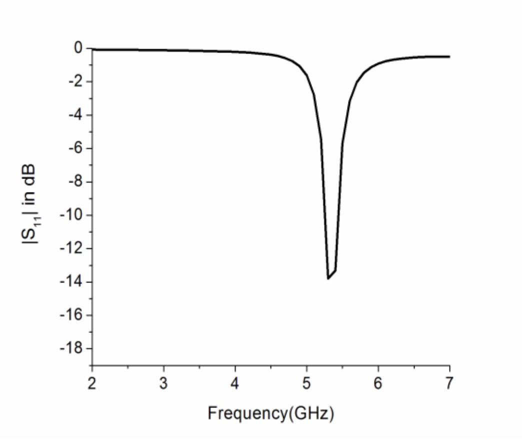

Fig.3 Simulated return Loss of the proposed Antenna without DGS

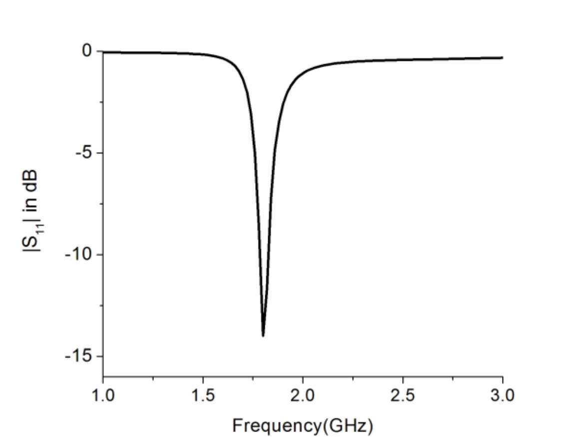

Fig.4. Simulated Return Loss of the proposed antenna with DGS

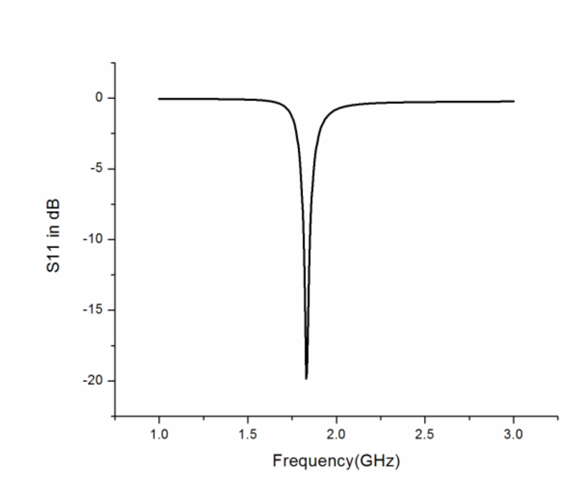

Fig.5 Measured return loss of the proposed Antenna

Radiation Pattern

The microstrip patch antenna radiates normal to its patch surface. So the elevation pattern for φ= 0 and φ= 90 degrees are important for the measurement. Fig. 5 below shows the E-plane and H plane radiation pattern at 5.3 GHz. The maximum gain is obtained at resonant frequency for the microstrip antenna without DGS at the ground plane is 6.02dBi for both φ= 0 and φ= 90 degrees. Fig. 6 below shows the E-plane and H plane radiation pattern at 1.8 GHz. The maximum gain is obtained at resonant frequency for the microstrip antenna with DGS at the ground plane is 1.149 dBi for both φ= 0 and φ= 90 degrees.

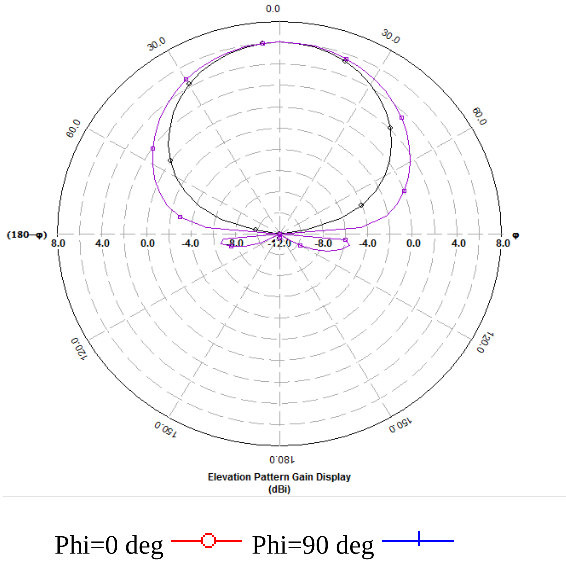

Fig.6. Radiation Pattern without DGS 5.3GHz

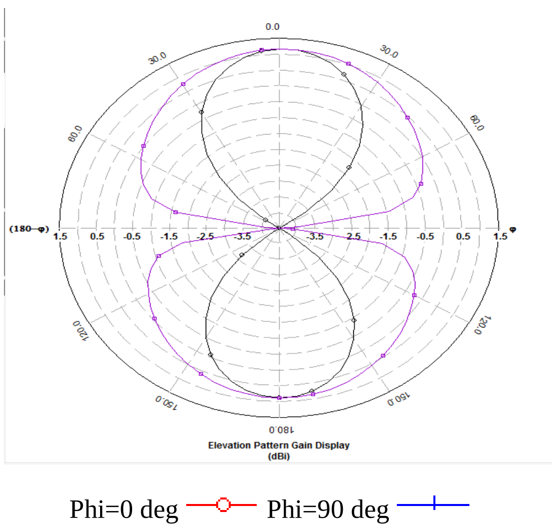

Fig.7 Radiation Pattern with DGS at 1.8 GHz

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IV. CONCLUSION

Design of rectangular microstrip patch antenna with DGS is carried out in this work . A circular spiral shape DGS in the ground plane found to give a size reduction of about 88.95% and shift the resonant frequency 5.3 GHz to 1.8 GHz with 50 MHz bandwith facilitating the antenna to be used for wireless application

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