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Design of Frequency Tunable Circular Microstrip Antenna Integrated with Novel Defective Ground Structure

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Abstract- **In this paper, a circular patch antenna is miniaturized using a novel defective ground structure. The circular patch antenna was found to resonate at 5.8 GHz. Using the defective ground structure, 3 antennas resonating at 1.8 GHz, 2.4 GHz, and 3.5 GHz respectively were designed of the same size and hence, appreciable miniaturization was achieved.**

Keywords: **circular microstrip antenna; Defective ground structure; Slots; Miniaturization.**

I. INTRODUCTION

Microstrip antennas are directional antennas which produce hemispherical coverage. Due to low cost, low profile, and easy fabrication, patch antennas have found a widespread use in the field of communication.

In recent years, compact sizes of devices have drawn great attention. The technologies have reached the houses of common men and to their daily lives because of the compact and portable sizes. Size reduction in wireless devices like mobile phones and modems have become a vital need. [1] [3] [6]Different techniques are available for the size reduction of the microstrip antennas such as introducing slots or slits in the patch or the ground, loading high value permittivity in the substrate and magneto- dielectrics in the substrate of the antenna or a combination of all of the above.

However, in this paper, a novel spiral defective ground structure is used to achieve militarization for wireless applications of circular microstripantenna. The DGS (defective ground structure)changes the resonating frequency of the antenna by disturbing the shielded current distribution in ground surface.Using the DGS, the antenna was made to resonate at 1.8 GHz, 2.4 GHz and 3.5 GHz, which can be used for wireless applications.[1] [3]

II. DESIGN PRINCIPLES

Initially, the circular microstrip antenna was designed to resonate at 5.8 GHz. The radius of the circular patch was 6.9 mm. FR4_epoxy with dielectric constant 4.4 was used as the substrate of the antenna. Probe feeding was used at coordinates (0.7, 2.1) for excitation of the patch. The geometry of the antenna without the DGS is shown in fig.1. The return loss, radiation pattern and other such results were obtained using electromagnetic simulation tool IE3D Zeland.

Then 3 different circular microstrip antennas resonating at 1.8 GHz, 2.4 GHz and 3.5 GHz respectively were designed using the proposed DGS. The shape of the DGS is shown in the fig.2. The radius remained same i.e. 6.9mm. The probe feed of the antenna was kept at (0.7, 2.1).

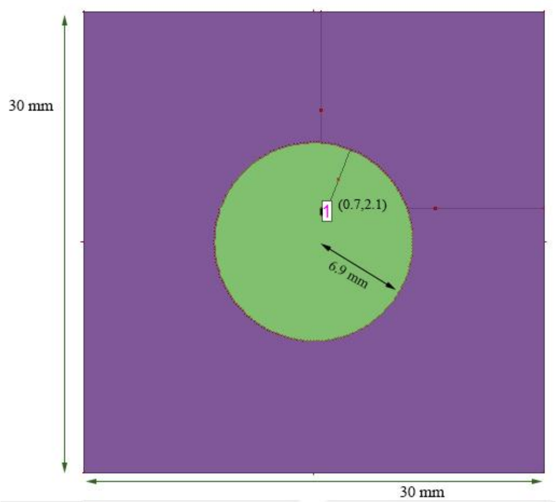

Fig.1 Front view of the circular microstrip antenna without DGS

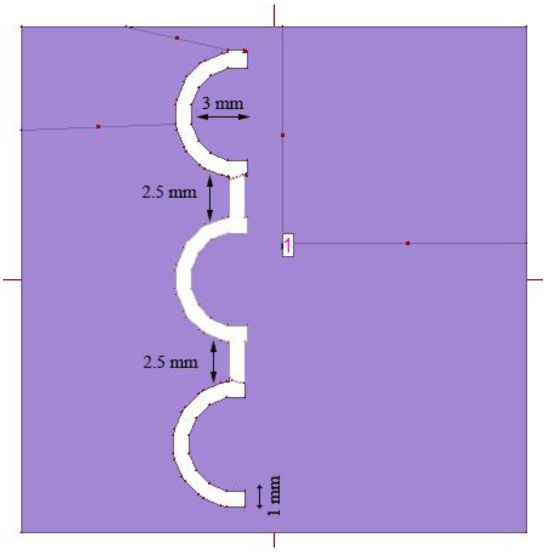

Fig 2(a) Back view of the antenna resonating at 1.8 GHz having DGS

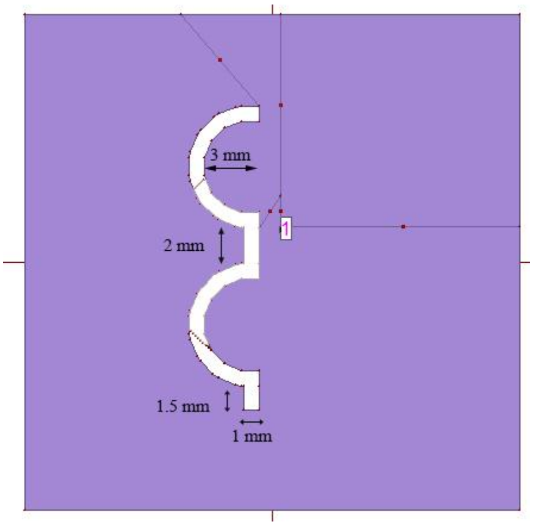

Fig 2(b) Back view of the antenna resonating at 2.4 GHz having DGS

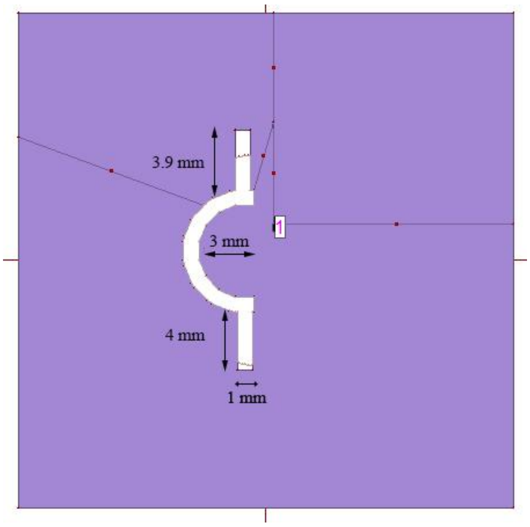

Fig 2(c) Back view of the antenna resonating at 3.5 GHz having DGS

III. RESULTS

I. S_{11}vs frequency

The return loss vs frequency plot of the antenna without DGS is shown is fig 3 and the return loss of the antennas with DGS are shown in figure 4(a), 4(b) and 4(c) for antennas resonating at 1.8 GHz, 2.4 GHz and 3.5 GHz respectively. The return loss of the proposed antenna was -26 dB. The return losses of the antenna with DGS resonating at 1.8 GHz is -24.5 dB, 2.4 GHz is -36.5 dB, and 3.5 GHz is -39 dB.

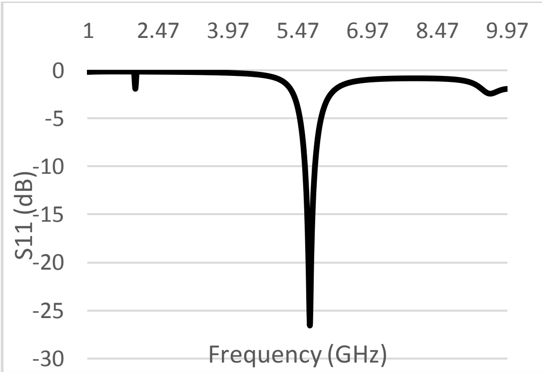

Fig 3. S11 vs frequency of the antenna without DGS

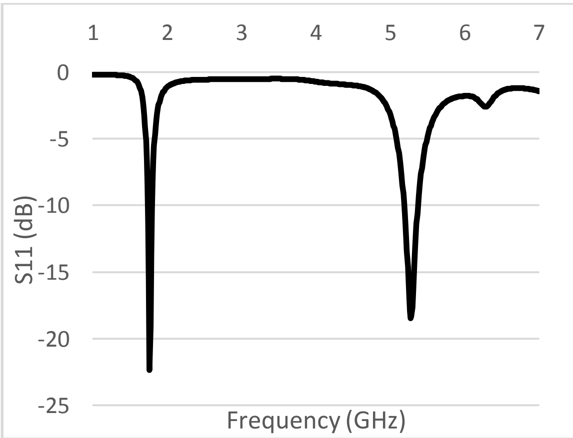

Fig 4(a) S11 vs frequency of antenna resonating at 1.8 GHz

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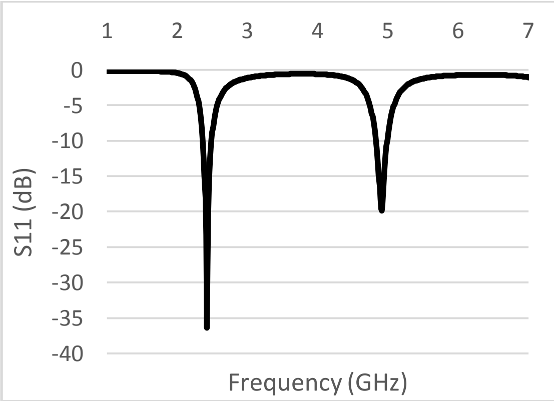

Fig 4(b) S11 vs frequency of the antenna resonating at 2.4 GHz

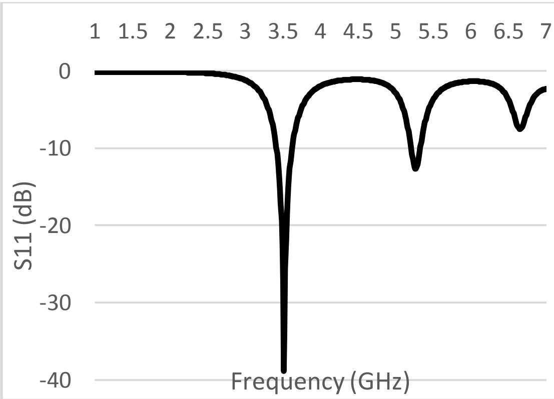

Fig 4(c) S11 vs frequency of the antenna resonating at 3.5 GHz

II. Radiation Pattern

The radiation pattern of a Microstrip antenna helps us understand the directions in which it radiates power. It gives us the idea of directivity of the antenna.[1] [2] [3]

The E-plane and H-plane radiation pattern of the proposed antenna without DGS is illustrated in fig 5. The radiation patterns of the antennas with DGS, resonating at 1.8 GHz, 2.4 GHz and 3.5 GHz are shown in fig 6(a), 6(b) and 6(c) respectively.

The optimum gain achieved at resonance when both φ is and 0°and φ is 90° for the antenna without DGS is 4.4 dBi and for the antennas with DGS resonating at 1.8 GHz is 0.8 dBi, for antenna at 2.4GHz is 1.4 dBi and the antenna at 3.5 GHz is 2.3 dBi.

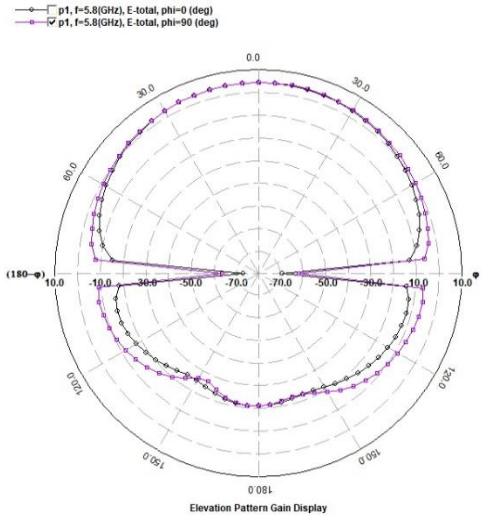

Fig 5. Radiation pattern of antenna without DGS at 5.8 GHz

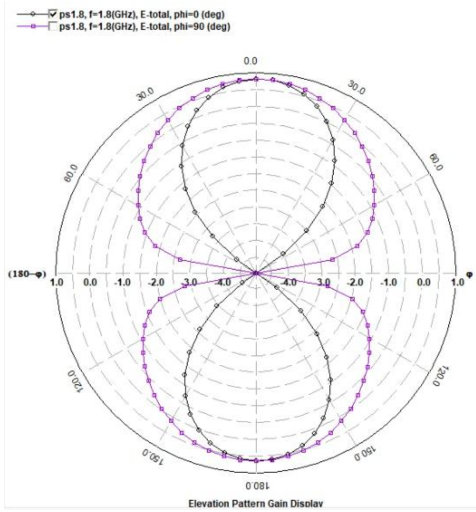

Fig. 6(a). Radiation pattern of antenna with DGS, at 1.8 GHz

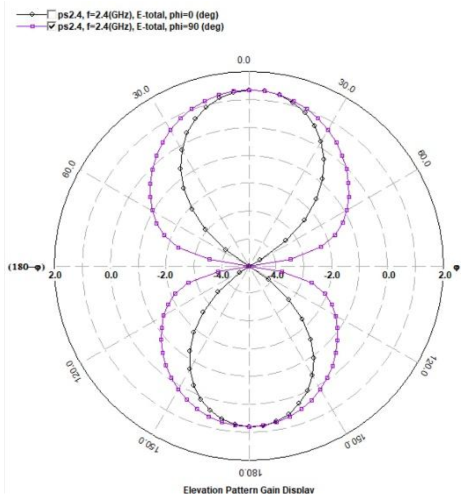

Fig. 6(b) Radiation pattern of antenna with DGS, at 2.4 GHz

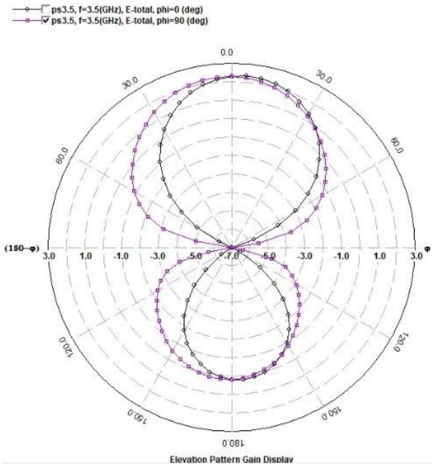

Fig. 6(c). Radiation pattern of antenna with DGs at 3.5 GHz

IV. CONCLUSIONS

Three circular microstrip antennas are designed in this work. Using a novel defective ground structure, miniaturization is achieved. The DGS was implemented on an antenna which was resonating at 5.8 GHz to shift the resonating frequency to 1.8 GHz, 2.4 GHz and 3.5 GHz. These antennas can be used for wireless applications.

V. ACKNOWLEDGMENT

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