# Design of Frequency Tuned Circular Microstrip Antenna with Angular Unconnected DGS

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***Abstract*—In this paper a circular microstrip antenna with a novel angular unconnected defected ground structure (DGS) is proposed. In the absence of DGS the structure is found to resonate at the WLAN band i.e 5.8 GHz. When the DGS is introduced, the antenna is observed to resonate at the Bluetooth band i.e. 2.4GHz. Gradually as the length of the DGS is modified, the antenna is made to resonate at WiMAX band i.e. 3.5GHz and at IMT band i.e. 3.8GHz. Thus the antenna has been frequency tuned by modifying the length of the DGS to resonate at the Bluetooth, WiMAX, and IMT bands respectively. The proposed DGS integrated microstrip antenna is therefore suitable for implementation in wireless applications.**

***Index Terms*— Defected Ground Structure, Frequency Tuning , Microstrip antenna, , Miniaturization,**

## I. INTRODUCTION

Microstrip antennas have been widely designed and implemented for various practical applicationsin the recent times because of its manifold advantages.[1] These antennas are light weight, compact and small in size, easy to fabricate and can perform excellently with both planar and non-planar circuits and surfaces.[2],[3] In the modern days, the need for miniaturization has also led to application based research of the microstrip antenna and different techniques to reduce the size of the antenna without degrading the antenna performance has been cultivated.[4],[5] It has been observed that introduction of a defect in the ground plane of the microstrip antenna, disturbs the current distribution and thus the antenna is found to resonate at a lower frequency band.[6] In the given paper, the design of a circular microstrip antenna with a novel angular unconnected defected ground structure has been proposed. Without the DGS, the antenna is found to resonate at 5.8 GHz; however with the implementation of DGS, the resonant frequency of the antenna can be brought down to the application frequency bands such as 2.4 GHz, 3.5 GHz, and 3.8 GHz respectively.

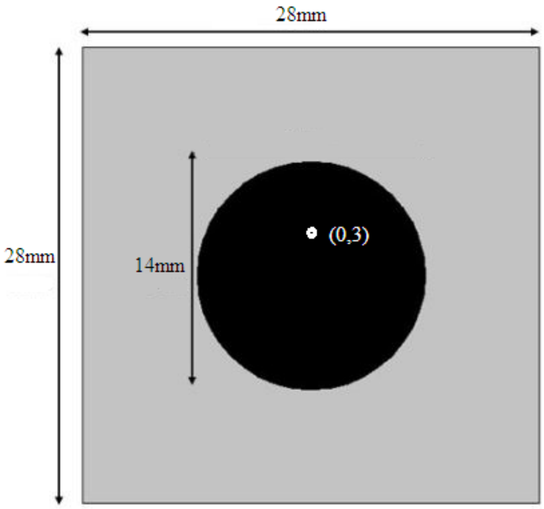


Fig.1. Front view of the microstrip antenna without DGS, resonant at 5.8GHz

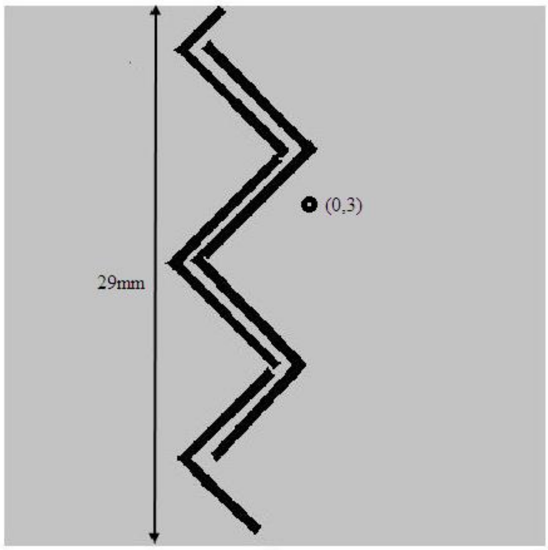


Fig.2. Rear view of the microstrip antenna with DGS, resonant at 2.4GHz



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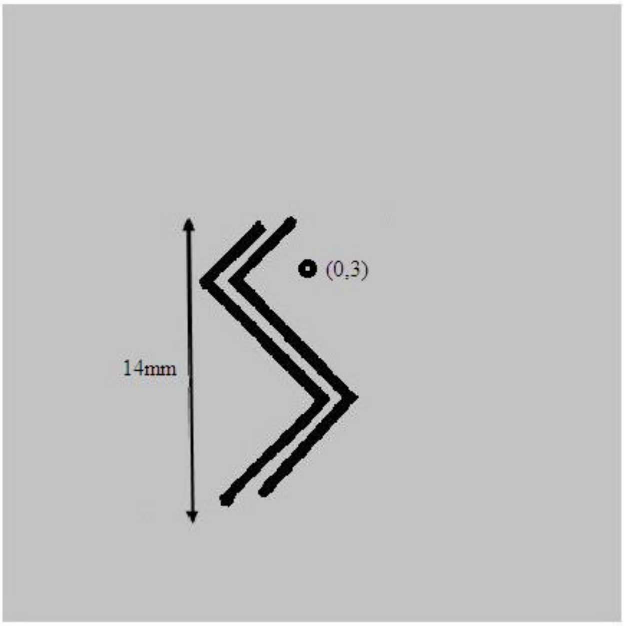


Fig.3. Rear view of the microstrip antenna with DGS, resonant at 3.5GHz

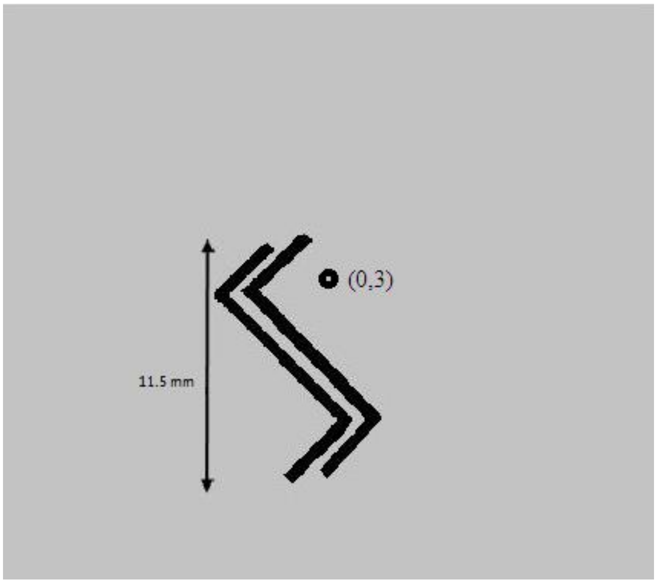


Fig.4. Rear view of the microstrip antenna with DGS, resonant at 3.8GHz

## II. DESIGN PRINCIPLES

The design of the proposed circular microstrip antenna without DGS is shown in Fig. 1. The antenna is found to be resonant at the WLAN band i.e.5.8GHz. With introduction of DGS structures in the antenna, as shown in Fig. 2, the antenna is found to be resonate at the Bluetooth band i.e. 2.4 GHz. The length of the DGS is gradually decreased to tune the antenna from 2.4GHz to the WIMAX band i.e. 3.5GHz and IMT band i.e. 3.8GHz respectively, as shown in Fig.3 and Fig.4. The coaxial feed is approximated at (0,3) and the dimensions of the ground plane is taken to be 28 mm*28 mm while the radius of the circular patch is taken as 7 mm. The material used as dielectric substrate for the given microstrip antenna is FR4_epoxy with dielectric constant to be 4.4 and the dielectric loss tangent is taken as 0.002. For DGS integrated microstrip antenna, the thickness of each angular unconnected DGS is taken as 0.5 mm. The length of the DGS is taken to be 29mm for 2.4GHz, 14mm for 3.5GHz and 11.5mm for 3.8GHz frequency bands respectively. The design of the proposed circular microstrip antenna has been carried out using the EM simulator tool Zeland IE3D.

## III.RESULTS

*A. S11 versus frequency*

The return loss characteristics for the proposed microstrip antennas are shown in the following figures. It is seen from Fig. 5 that the microstrip antenna without DGS resonates at a frequency of 5.8 GHz with -24dB return loss. However by gradual reduction of length and with the proper positioning of DGS structure, the resonating frequency can be tuned to2.4GHz with return loss of -40dB, as can be seen from Fig.6. On further tuning of the length of the DGS, the antenna is made to resonate at 3.5GHz with -23dB return loss and 3.8Ghz with -17dB return loss,as given in Fig.7 and Fig. 8 respectively.

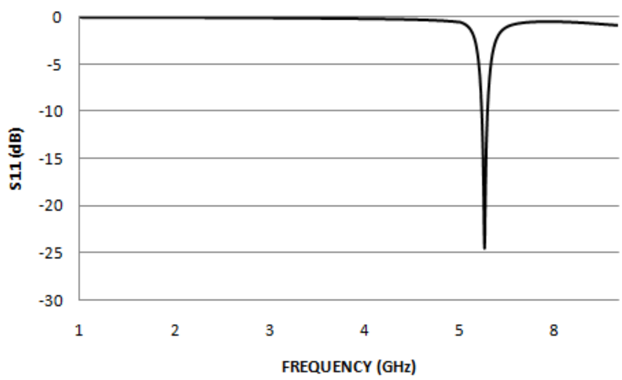


Fig.5. S11 versus frequency plot of the microstrip antenna resonant at 5.8GHz

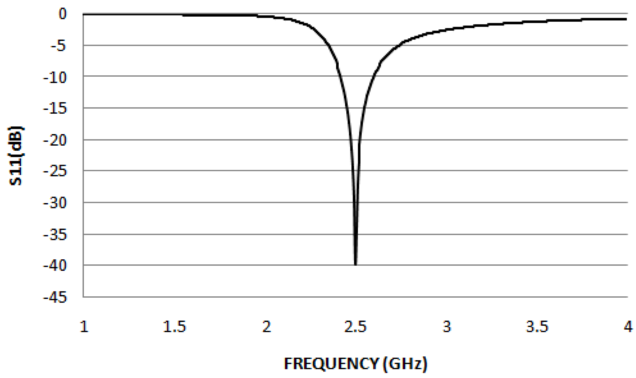


Fig.6. S11 versus frequency plot of the microstrip antenna resonant at 2.4GHz



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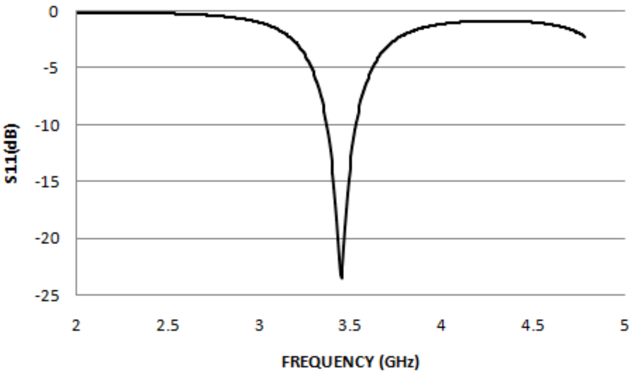


Fig.7. S11 versus frequency plot of the microstrip antenna resonant at 3.5GHz

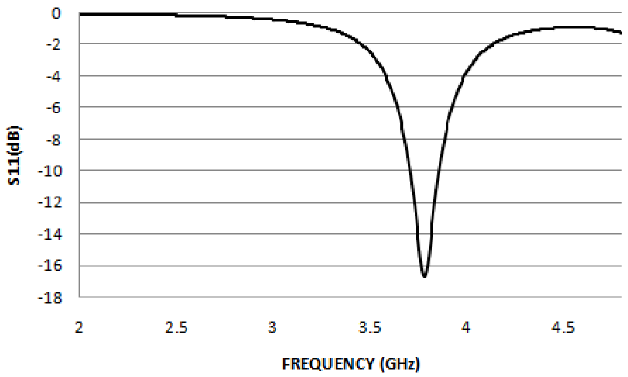


Fig.8. S11 versus frequency plot of the microstrip antenna resonant at 3.8GHz

*B. Impedance versus frequency*

At resonance the real part of impedance of the circular microstrip antenna should be ideally the characteristic impedance of the external transmission cable i.e. 50 ohms. As the net reactive component at resonance is zero, so the imaginary part of impedance of the antenna is ideally 0 ohm. Fig.9, Fig.10, Fig.11 and Fig.12 demonstrates the impedance versus frequency plot for the circular microstrip antenna without and with the DGS respectively. From the figures it can be observed that at resonance, the real part of impedance for the proposed microstrip antennas are approximately close to 50ohms and the imaginary part of impedances are almost equal to 0ohm. So for optimum performance the proposed frequency tunned circular microstrip antenna is perfectly matched at the resonance.

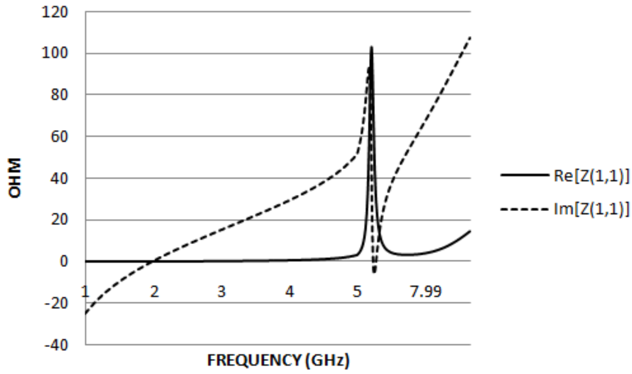


Fig.9. Impedance versus frequency plot of the microstrip antenna resonant at 5.8GHz

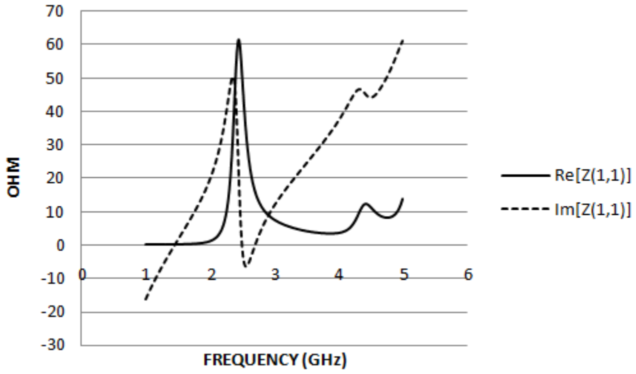


Fig.10. Impedance versus frequency plot of the microstrip antenna resonant at 2.4GHz

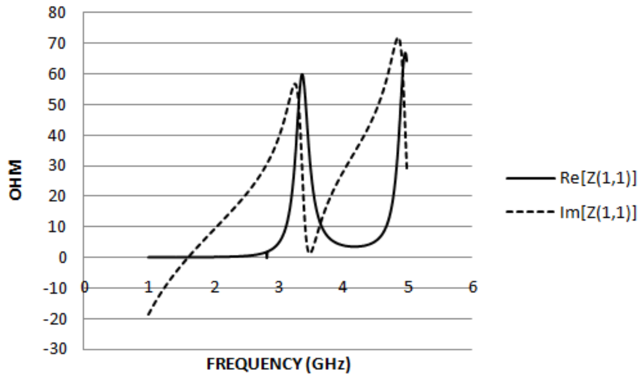


Fig.11.Impedance versus frequency plot of the microstrip antenna resonant at 3.5GHz

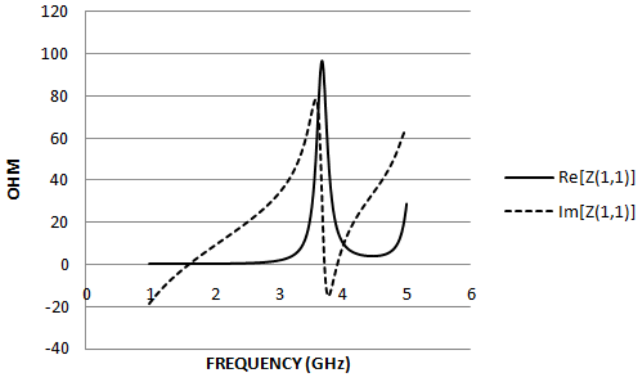


Fig.12. Impedance versus frequency plot of the microstrip antenna resonant at 3.8GHz

*C.Radiation pattern*

The microstrip patch antenna radiates normal to its patch surface and so the elevation pattern for φ= 0 and φ= 90 degrees are important for the measurement. Fig. 13, Fig. 14,Fig. 15 and Fig. 16 gives the E-plane and H plane radiation pattern of the microstrip antenna resonant at 5.8GHz, 2.4GHz,3.5Ghz and 3.8GHz respectively. From the figures it can be seen that at 5.8GHz the microstrip antenna is found to have maximum gain of 5.652dBI at resonance. Similarly the maximum gain at the resonant frequencies of 2.4GHz, 3.5GHz and 3.8GHz are given as 2.138 dBI, 3.191 dBI, and 3.628 dBI respectively. Thus the given frequency tuned microstrip antenna can be effectively used for wireless application purposes.



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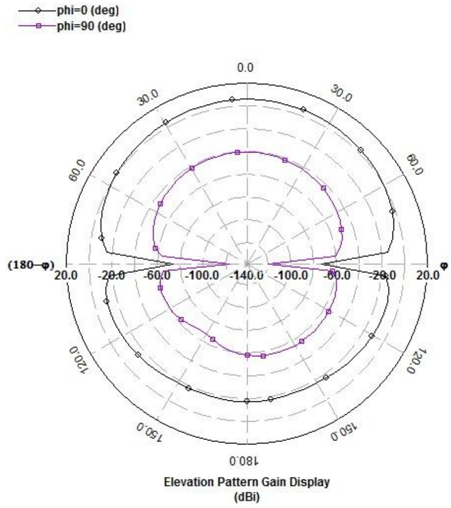


Fig.13. Radiation Pattern at 5.8GHz

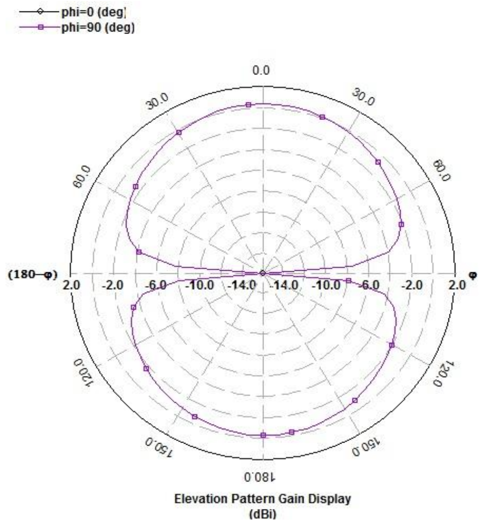


Fig.14. Radiation Pattern at 2.4GHz

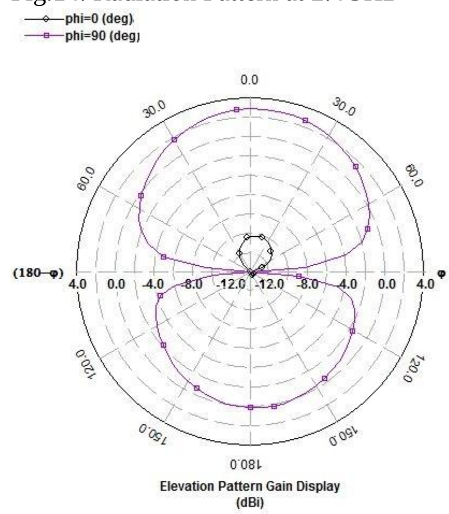


Fig.15. Radiation Pattern at 3.5GHz

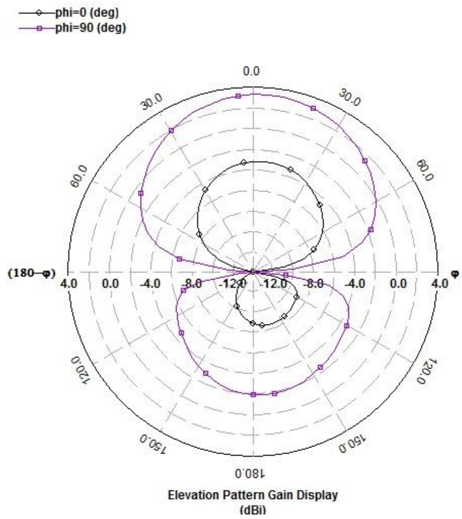


Fig.16. Radiation Pattern at 3.8GHz

## IV. CONCLUSIONS

The design of frequency tuned circular microstrip antenna with a novel DGS is implemented in this work. Anangular unconnected DGS integrated in the microstrip antenna is found to give a size reduction of about 84.5% and shift the resonant frequency from 5.8 GHz to 2.4 GHz,3.5GHz and 3.8GHz respectively with appreciable gain and bandwidth facilitating the antenna to be used for wireless communication.

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