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Effect of Defected Ground Structure Shape on Radiation Pattern of UWB

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ABSTRACT

The effect of shaping the ground plane on the performance octagon shape microstrip antenna is reported in this paper. The Simulation results of reflection coefficient, VSWR, radiation pattern and current distribution are presented. The antenna has been designed on an FR4_epoxy substrate with dielectric constant $\varepsilon_r = 4.4$, loss tangent (tan δ) =0.002. It is observed based on the results that shaping the ground plane significantly affects the reflection coefficients, bandwidth and gain.

Key words: Defected Ground Structure (DGS), Microstrip Antenna (MSA), Radiation Pattern, Ultra Wideband.

1. INTRODUCTION

Printed antennas have been a famous research topic since the last decade. The reason is due to their major advantages such as low profile, ease of manufacture, low cost and light weight. Printed antenna performance is well known to be dependent on the ground plane; this aspect has been actively researched [1]-[4]. Electromagnetic Radiation from the ground plane is crucial and unavoidable as the electric currents are distributed on both the radiator and on the ground plane. Chen, See and Qing reported in [1] that by cutting a notch from the radiator, it would be possible to reduce the ground-plane effect on the performance of a small printed UWB antenna.

In another effort, a microstrip-fed printed rectangular monopole antenna has been examined by introducing windowed ground plane, with the intention to reduce the ground-plane-dependent effects [2] and modified ground [5]-[6] have been designed for various purposes.

1.1 Designing Steps of Defected Ground Structure (DGS)

In this paper, a study is conducted to analyze the performance of the octagon shape microstrip antenna when its ground plane is gradually changed. Figure 1 depicts designing steps of DGS also the effect on antenna parameter that includes reflection coefficient, bandwidth, radiation pattern and gain are studied and discussed.

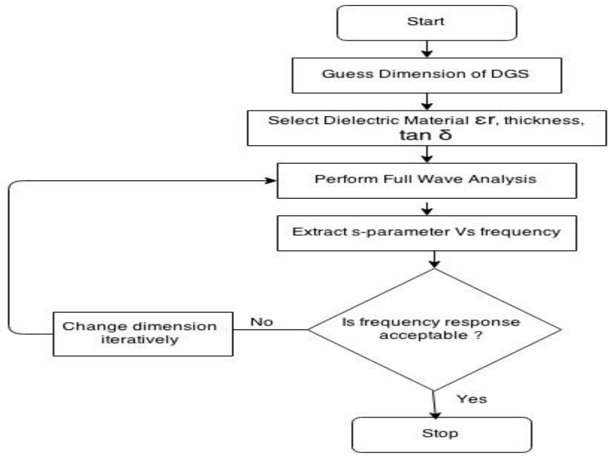

Figure 1: Designing steps of DGS

2. ANTENNA DESIGN

Antennas in Figure 2, figure 3and figure 4 are designed on FR4 substrate, its thickness is 1.6 mm and relative dielectric constant ε_r 4.4, loss tangent (tan δ) =0.002.The radiating element and feeding line are printed on the top side of the substrate and the ground plane on the bottom side. The octagon-shape patch is of 3mm arc and $\theta = 45^{\circ}$, truncated corners have less influence on the radiation patterns in the low frequency band, but can improve the radiation characteristics in the high frequency band [7].

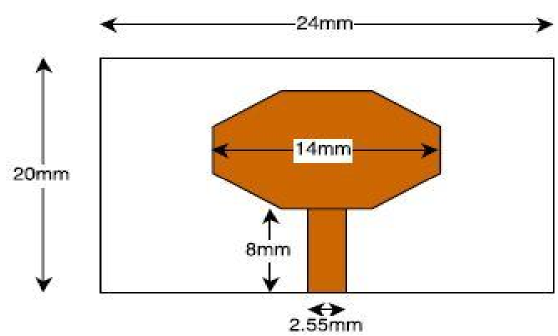

Figure 2: Octagon antenna front view

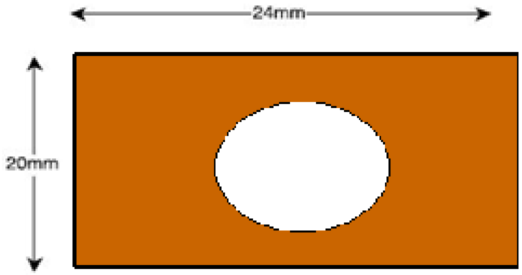

Figure 3: Octagon antenna back view with -circle shape DGS

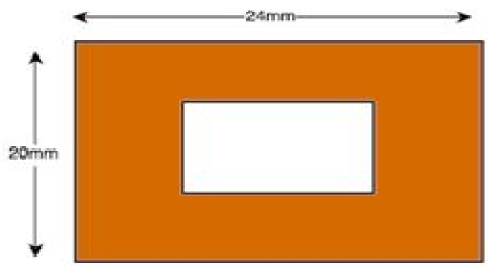

Figure 4: Octagon antenna back view with -rectangle shape DGS

3. SIMULATION RESULTS AND ANALYSIS

3.1 Return Loss (Reflection Coefficient)

Figure 5 shows a graph of reflection coefficient in dB verses frequency. Here at 5.64 GHz frequency octagon antenna with circle DGS exhibit reflection coefficient of -12.4110 and bandwidth of 702 MHZ, octagon antenna with rectangle DGS at 5.40 GHz exhibit reflection coefficient of -18.5053 and bandwidth of 3458 MHZ.

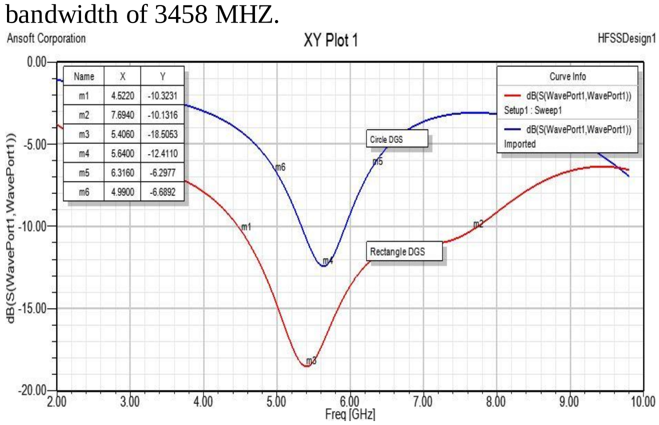

Figure 5: Return Loss Graph of Octagon MSA with Circle (blue) and rectangle (red) DGS.

3.2 VSWR (Voltage Standing Wave Ratio)

Figure 6 shows a graph of VSWR verses frequency. Ideally VSWR should be 1 for perfect matching .Here at 5.64 GHz frequency simulated octagon MSA with circle DGS alone exhibits the VSWR of 1.63 and At 5.43 GHz frequency octagon MSA with rectangle DGS exhibits the VSWR of 1.27

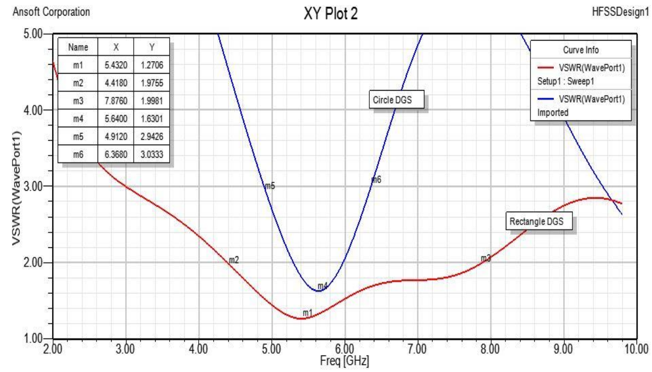

Figure 6: VSWR Graph of Octagon MSA with Circle (blue) and rectangle (red) DGS

3.3 Radiation Pattern

Figure 7 and Figure 8 Shows the result of radiation pattern. The Radiation pattern of these UWB antennas is bidirectional in E-Plane.Figure9 and Figure 10 Shows the 3D radiation pattern.

Name	Theta	Ang	Mag
M1	360.0000	-0.0000	5.8767

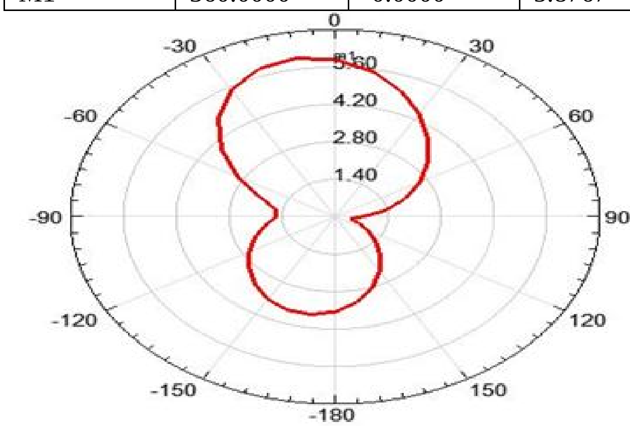

Figure 7: Radiation pattern of octagon antenna with circle shape DGS

Name	Theta	Ang	Mag
M2	360.0000	-0.0000	3.8260

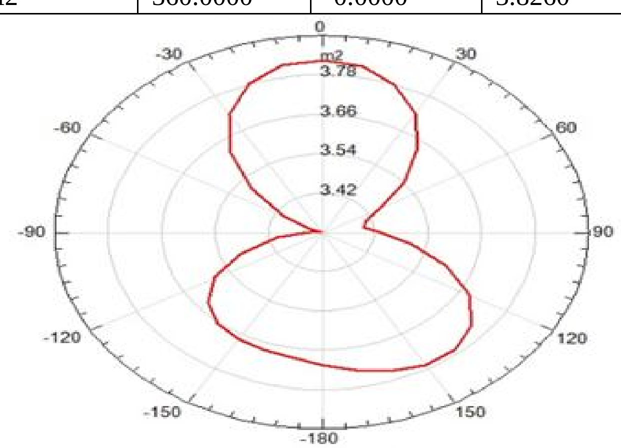

Figure 8: Radiation pattern of octagon antenna with rectangle shape DGS

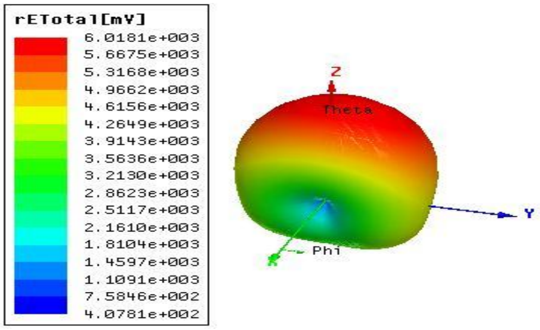

Figure 9: Current distribution of octagon antenna with circle shape DGS

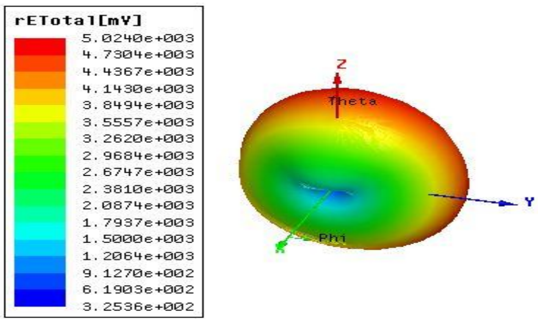

Figure 10: Current distribution of octagon antenna with rectangle shape DGS

4. COMPARISON OF RESULTS

Table 1 shows Attributes Comparison of results of octagon MSA with circle DGS and octagon MSA with rectangle DGS

Parameter	Octagon MSA with Circle DGS	Octagon MSA with Rectangle DGS
Frequency(MHz)	5.61	5.40
Return Loss(dB)	-12.41	-18.5
VSWR	1.63	1.27
Bandwidth(GHz)	702	3458
Directivity (dB)	5.79	3.82

Table 1: Comparison between different shapes of DGS of OMSA

5. CONCLUSION

In this paper, the ground plane effect has been studied on a simple octagon patch micro strip antenna. The edges of the ground plane where the currents are concentrated have been gradually shaped and the antenna characteristics have been studied. In comparison to the octagon MSA with circle DGS, here octagon MSA with rectangle DGS exhibit better results. The study has shown that the ground plane has its wide effect on antenna parameters.

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