International Journal of Modern Trends in Engineering And Research
www.ijmter.com
e-ISSN No.:2349-9745, Date: 2-4 July, 2015

Effect of Defected Ground Structure On Radiation Pattern of Ultra-Wideband Antenna (UWB)

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Abstract-This paper presents about comparison of octagon patch shape microstrip antenna with and without Defected Ground Structure (DGS) for improvement of the radiation pattern of ultra-wide band. It consist of rectangular-shaped slot in ground,which is presented to enhance the bandwidth of the microstrip patch antenna .The proposed antenna has improved radiation characteristic with defected ground structure. Finite Element Machine based High Frequency Structure Simulator (HFSS) software Version-11.0 is used to obtain the performance parameters of the proposed antenna. A comparison is also presented for the proposed antenna with the antenna structure without defect. The proposed antenna resonates at a frequency of 5.40 GHz with a bandwidth of 3458 MHz. A very good return loss of -18.50 dB is obtained with rectangular shaped Defected Ground Structure.

Keywords- Defected Ground Structure, Ultra Wideband and Radiation Pattern.

I. INTRODUCTION

In recent years, there have been growing demand of microwave and wireless communication systems in various applications developed an interest to improve antenna performances. Hence, the selection of microstrip antenna is suitable to apply at various fields such as military systems, satellite, medical application and telecommunication. But, microstrip antenna has its instinctive drawback such as narrow bandwidth, typically 5% of the center frequency and half space radiation [2]. Various miniaturization techniques, like using of dielectric substrate of high permittivity [3].

Conformal microstrip antennas have been paid more attention by many researchers for higher frequency, such as the cylindrical microstrip antenna [4-6] that reduces the size and widen the radiation beam. The surface wave restricts much use of microstrip antenna, electromagnetic bandgap (EBG) or photonic band gap (PBG) structure is a method to reduce the surface waves, which exhibit band-gap feature [7] too. EBG has been applied in the field of antenna to improve the performance of the antenna [8-13], such as suppression of surface wave propagation, enhance the gain of the antenna and improves the radiation pattern by inserting the EBG structure into the substrate [14-16]. However, in implementing EBG, a large area is needed to implement the periodic patterns and it is also difficult to define the unit element of EBG.

Defected ground structure has identical microwave circuit properties as EBG; it can also modify guided wave properties to provide a band-pass or band-stop like filter and can easily define the unit element. DGS geometry can be one or few etched structures which are simpler and do not need a large area to implement it [17]. DGS is realized by introducing a shape defected on a ground plane, thus will disturb the shielded current distribution depending on the shape and dimension of the defect. The disturbance in the shielded current distribution will influence the input impedance and the current flow of the antenna, also control the excitation and electromagnetic waves propagating through the substrate layer .

In this paper work, ground structure named Defected Ground Structure (DGS) has recently been investigated and found to be a simple and effective method to reduce the antenna size and enhance antenna parameters. The proposed antenna design incorporates the octagon radiating patch and rectangular shaped slot (DGS) in ground plane.

II. ANTENNA DESIGN

Antennas in Fig. 1 and Fig.2 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. octagon-shape patch is of 3mm arc and θ =45^o ,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 [1].

2.1. Design of Octagon MSA with DGS and without DGS

Octagon -shape Patch was designed to have dimensions of 14x10mm^2 and it is fed by a feeder of 2.5 x10mm^2. The patch and feeder are printed on substrate of 24x20 mm^2 in dimension. The printed patches are made of copper of 0.1 mm thickness (t). The width of the microstrip feed line is chosen as 2.5 mm to achieve the characteristic impedance of 50Ω for good RF impedance matching. The gap between the ground plane and radiating patch is 0.5 mm for simulated antennas, as it is an important parameter to control the impedance bandwidth. The complete geometry of MSA without DGS is shown in Fig. 1 and Fig. 2 shows octagon MSA with DGS.

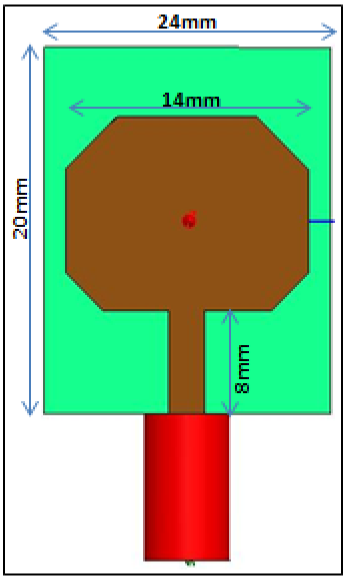


Figure 1. Octagon Microstrip patch antenna without DGS

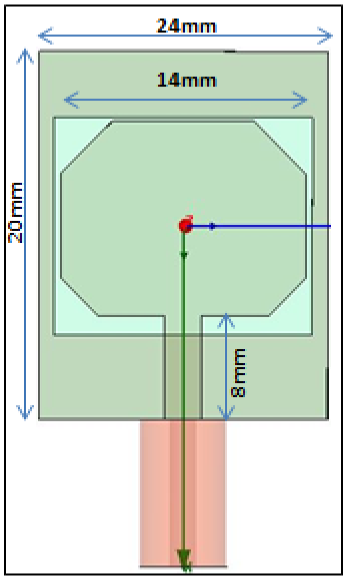


Figure 2. Octagon Microstrip patch antenna with antenna with DGS

2.2 .Simulated Results of Octagon MSA without DGS and with DGS

2.2.1 Return Loss (Reflection coefficient)

Fig. 3 shows a graph of reflection coefficient in dB verses frequency. At 6.55 GHz frequency simulated octagon microstrip patch antenna alone exhibits reflection coefficient of – 14.38 dB and bandwidth of 468 MHZ, by introducing DGS to octagon microstrip antenna the resonant frequency get shifted from 6.5 GHz to 5.40 GHz also octagon MSA with DGS structure exhibits the reflection coefficient -18.50 dB along with bandwidth improvement up to 3458 MHz

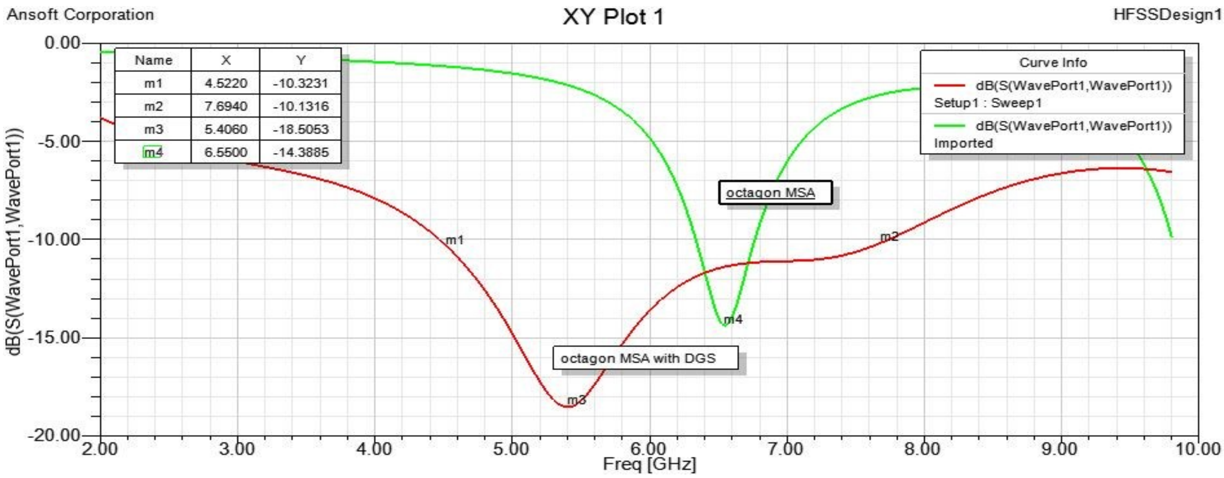


Figure 3. Reflection coefficient of Octagon MSA without DGS (green) and with DGS (red)

2.2.2 VSWR

Fig. 4 shows graph of VSWR verses frequency of OMSA. At 6.55 GHz frequency, simulated Octagon MSA alone exhibits the VSWR of 1.47 and at 5.40 GHz frequency; simulated Octagon MSA with DGS structure exhibits VSWR of 1.27.

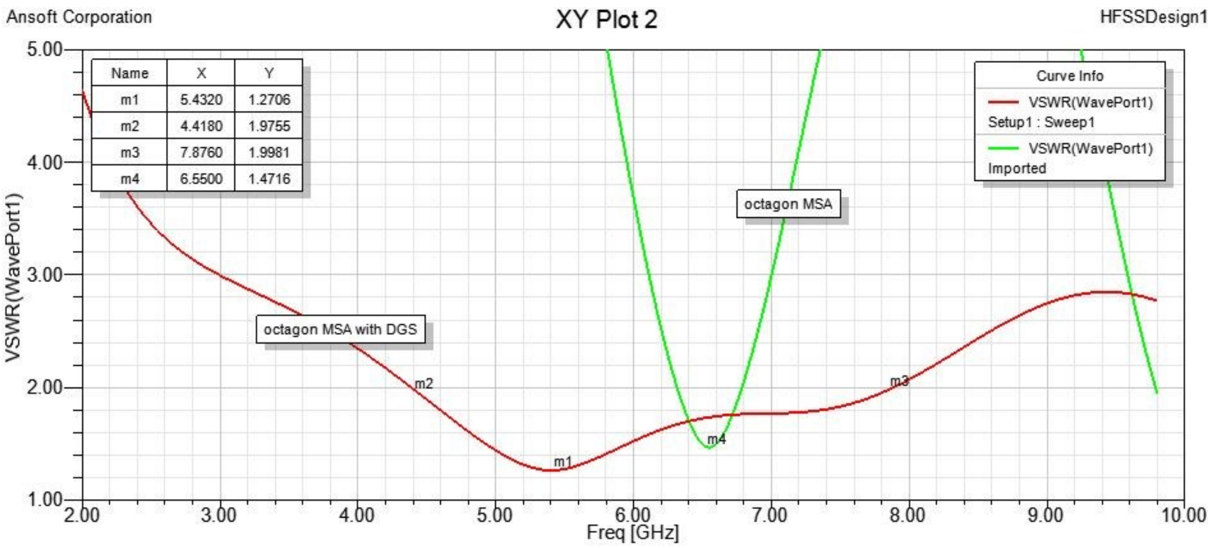
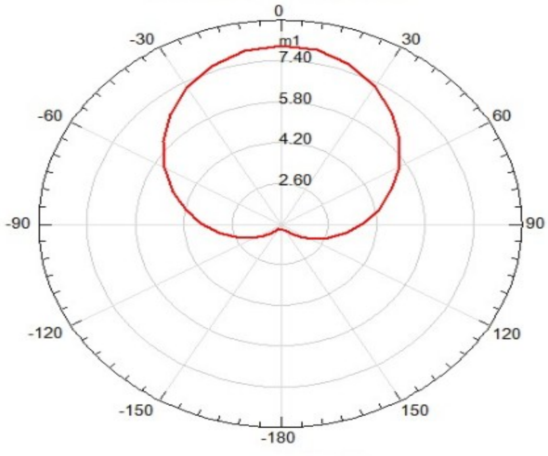


Figure 4. VSWR of Octagon MSA without DGS (green)and with DGS (red)

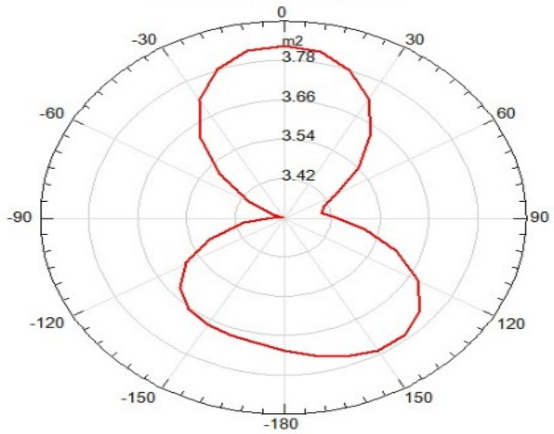
2.2.3 Radiation Pattern

Fig. 5 shows radiation pattern of octagon MSA having maximum gain of 8.2dB & Fig. 6 shows bidirectional radiation pattern of octagon MSA with DGS having maximum gain of 3.82dB



Name	Theta	Ang	Mag
m1	360.0000	-0.0000	8.21

Figure 5. Radiation Pattern graph of Octagon MSA without DGS



m2	360.0000	-0.0000	3.8260

Figure 6. Radiation Pattern graph of Octagon MSA with DGS

RESULTS & COMPARISON

Table 1. Comparison of Simulated Results of Octagon MSA & Octagon MSA with DGS

Sr.No.	Parameters	Octagon MSA	Octagon MSA with DGS
1	Frequency (GHz)	6.55	5.40
2	Return loss (dB)	-14.38	-18.50
3	VSWR	1.47	1.27
4	Bandwidth (MHz)	468	3458
5	Directivity (dB)	8.21	3.82

III. CONCLUSION

In this paper octagonal shaped microstrip antenna with and without DGS were designed & simulated using Ansoft HFSS. It is observed that, The center frequency varies from 6.55 GHz down to 5.40 GHz with implementation of DGS also bandwidth of the microstrip patch antenna with same dimensions as mentioned above but without slotting is 468 MHz at frequency 6.55 GHz with return losses (S11= -14.38dB) as shown in Fig. 3. While the octagon microstrip patch antenna with rectangular-shape DGS provides a bandwidth of 3458 MHz and return losses reaches up to -18.5 dB. Thus the proposed system with defected ground structure is suitable to improve the bandwidth which was the main drawback of patch antenna. To further improve the directivity symmetric approach can be adopted.

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