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Research Article

Effect of DGS technique in MIMO Antenna

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Abstract

The goal of this paper is to use DGS in MIMO antenna to enhance the antenna performance parameter. The concept of DGS with MIMO antenna reduce antenna size and reduce mutual coupling between the antenna elements. It also enhances parameters such as gain, directivity, return loss, and efficiency. The MIMO antenna have two symmetric monopole, one metal strip, one triangle and two novel bent slits. In this paper double E shaped DGS connected to each other are etched in the ground plane. The analysis has been done by using IE3D software based on method of moments (MOM). The result shows that parameter $|s_{11}| \leq$ -10db is achieved at freq. 6.07 GHz with double E shaped DGS and parameter $|s_{11}| \leq$ -10db is achieved at freq. 6.18 GHz with modify double E shaped DGS. The result comparison of antenna with and without DGS are also shown in this paper.

Keywords: *DGS, MIMO antenna, return loss, gain, directivity, antenna efficiency, radiation efficiency.*

Introduction

The idea of using MIMO antenna configuration instead of single one, enhance the data rate, increase capacity, and the overall performance of radio network (A.J. Paulraj *et al* 2004). When MIMO antenna is applied in a multifunctional portable device, high isolation was demanded. By etching the slits in the ground plane high isolation Was achieved (Qing-Xin Chu *et al* 2012). A metal strip of size 18*1 mm^2 is applied to decrease the mutual coupling caused by near field. Two triangle with height t_h= 3mm and the width t_l= 4 mm are cut in the ground plane to change the distribution of the ground surface currents.

In this paper DGS technique in which intentionally added defect in the ground plane is to make use of the ground plane itself to prove a filter effect which in turn suppresses the surface wave (L.H.Weng *et al* 2008). DGS also improve the antenna parameter such as gain, directivity, return loss, efficiency and reduce the mutual coupling between the antenna elements. Double E shaped DGS (35*18mm) connected to each other and the modified double E shaped DGS (30*18mm) are etched in the ground plane. The MIMO antenna with double E shaped DGS is resonance at freq. 6.07 GHz and MIMO with modify double E shaped DGS are resonance at freq. 6.18 GHz for EMC application.

MIMO Antenna with DGS Technique

The MIMO antenna with double E shaped DGS and with modify double E shaped DGS are shown in fig. 1 and fig. 2 respectively. The MIMO antenna is printed on the upper part of a partially grounded FR4 substrate with dimension 78*40*1.6 mm^3 and relative permittivity 4.4. Two bent slits with length 22 mm are etched in to ground plane to reduce mutual coupling caused by surface currents. Each slit is coupled fed by a 50Ω microstrip line. A metal strip between the two monopole is applied to decrease the mutual coupling caused by near field. On the back surface of the substrate, the main rectangular ground plane of 40 mm in width and 60 mm in length isprinted (Qing-Xin Chu *et al* 2012). The two symmetric monopole have length 18 mm.

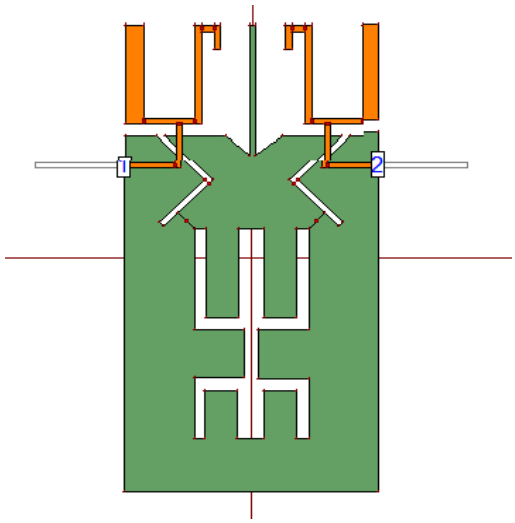


Figure 1 MIMO antenna with double E-shaped DGS

*Corresponding author **Manisha Dhiman** is a M.tech Scholars**; Sonia Saini and Dimpy Ahuja** are working as Assistant Professors

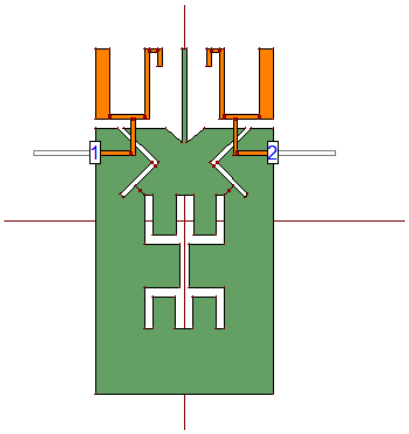
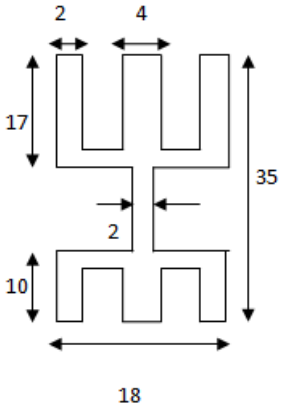


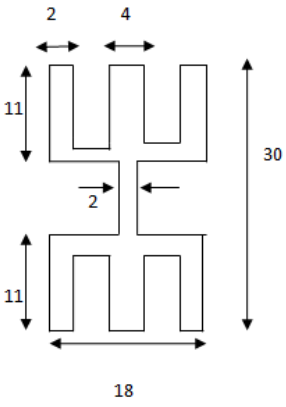
Figure 2 MIMO antenna with modify double E-shaped DGS

DGS Dimensions

The main objective of using DGS is to reduce mutual coupling, return loss and improved the antenna parameter.Depending upon the shape and the dimensions of the defect, the current distributions in the ground plane is disturbed and resulting in propagation of EM wave through the substrate. The shape of the DGS may change from one dimensions to other dimensions for better performance (Shikha *et al* 2013). In this paper we will discuss the influence of double E shaped DGS and modified double E shaped DGS toward to achieve the better performance and reduction in return loss.



Shape (1) Double E- Shaped DGS



Shape (2) Modify Double E-Shaped DGS

Result and Discussion

The result graph and comparison table shows that MIMO with modified DGS have much improvement as compare to MIMO antenna. The proposed MIMO antenna with DGS technique has been simulated using IE3D software.

Return loss

Return loss (S11) represents how much power is reflected from the antenna, and hence is known as the return loss reflection coefficient (sometimes written as gamma or reflection coefficient.). Simulated results of S11 of the MIMO antenna system with double E-shaped DGS and modified DGS is shown in figure 5 and 6 resp.

The parameter S11≤ -10db is achieved at freq. from 5.99 to 6.23GHZ with double E –shaped DGS whereas S11 ≤ -10db at freq. from 6.02 to 6.42 GHZ with modify double E- shaped DGS hence bandwidth enhancement.

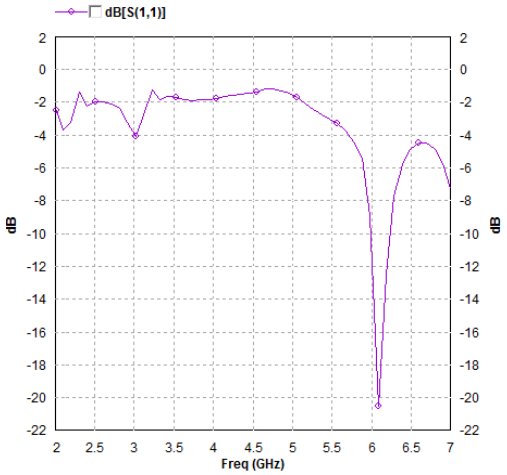


Figure 3 simulated S parameter of MIMO with double E-shaped DGS

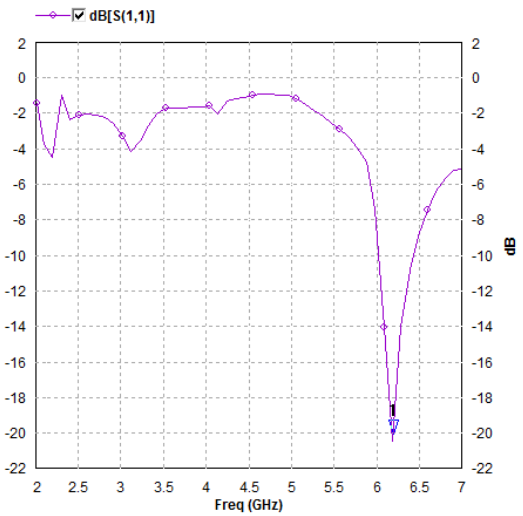


Figure 4 simulated S parameter of MIMO with modify double E-shaped DGS

Gain

The gain of antenna has to deal with how effectively an antenna can convert its input power to the radio wave at the transmission side and vice –versa at reception side. The figure shows the simulated graphs of gain with double E- shaped DGS and with modify DGS shape. The graph shows the improvement at a freq. 6.18 GHz with modified DGS.

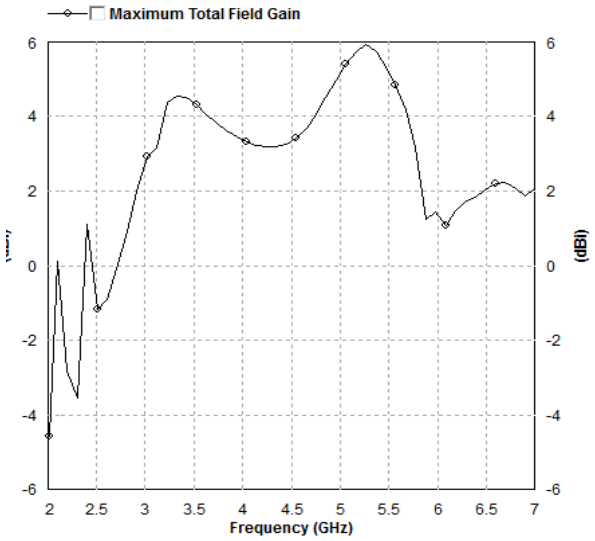


Figure 5(a) shows gain of MIMO with double E-shaped DGS

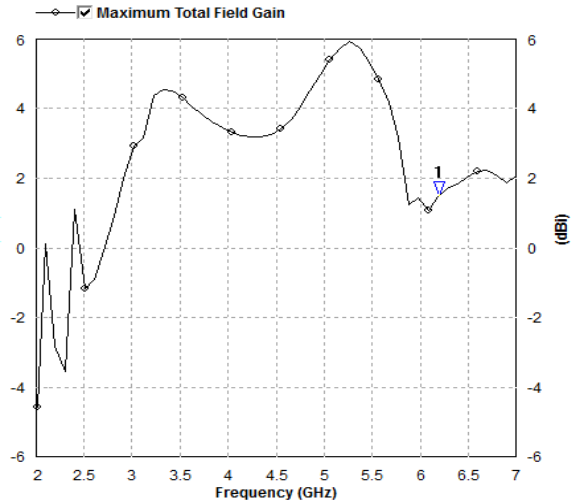


Figure 5(b) shows gain of MIMO with modify double E-shaped DGS

Directivity

Directivity is the ratio of max. radiation to the radiated reference antenna. Simulated results of directivity of the MIMO antenna system with double E-shaped DGS are shown in figure. According to the simulated results, value of directivity is found to be 5.30 dBi at 6.07 GHz. With modified double E-shaped DGS value of directivity is found to be 5.61dbi at 6.18GHz.

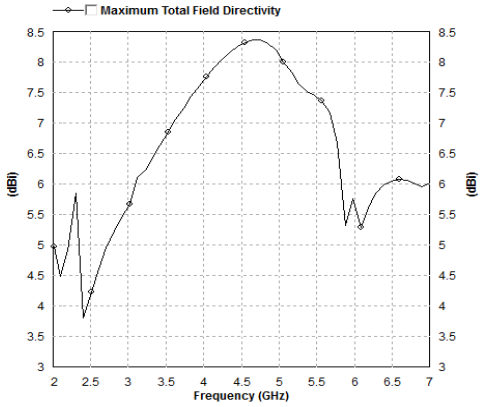


Figure 6(a) shows directivity of MIMO with double E-shaped DGS

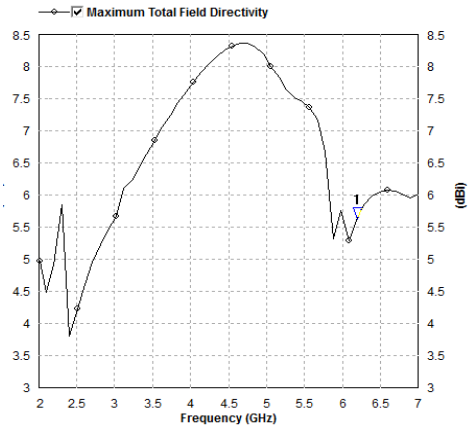


Figure 6(b) shows directivity of MIMO with modify double E-shaped DGS

Antenna efficiency

Antenna efficiency is the ratio of total radiated power to the total input power supplied to the antenna. The comparison table shows that the MIMO with modified DGS have much improvement in antenna efficiency as compare to MIMO system.

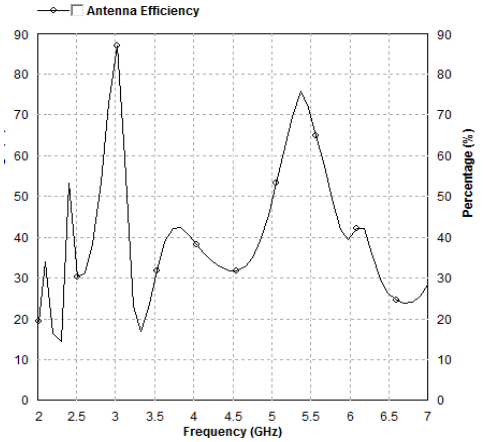


Figure 7(a) shows antenna efficiency of MIMO with double E-shaped DGS

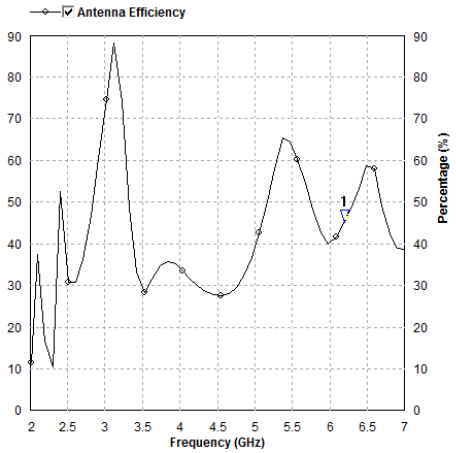


Figure 7(b) shows antenna efficiency of MIMO with modifiy double E-shaped DGS.

Radiation efficiency

Radiation efficiency is the ratio of total power radiated to the net power accepted by the antenna. It ignores the mismatch losses only look at power delivered to antenna. The simulated graph result shows the improvement with modified DGS as compare to double E- shaped DGS.

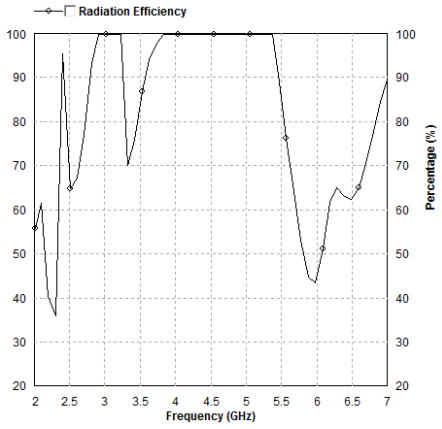


Figure 8(a) shows radiation efficiency of MIMO with double E-shaped DGS

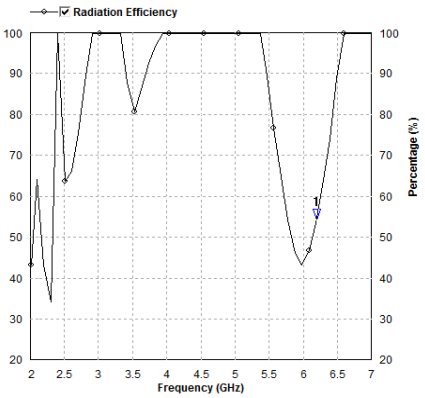


Figure 8 (b) shows antenna efficiency of MIMO with double E-shaped DGS

Comparison table

Parameter	MIMO	MIMO with DGS	MIMO with modified DGS
Resonance freq.	6.07	6.07	6.18
Return loss	-15.13	-20.30	-20.06
Gain	1.07	1.07	1.48
Directivity	5.30	5.30	5.61
Antenna efficiency	37.7	42.02	45.16
Radiation efficiency	46.72	51.04	54.10

Conclusion

This paper presents the effect of DGS technique with MIMO antenna. It has been shown that antenna performance parameters such as return loss, gain, directivity antenna efficiency, radiation efficiency are improved with DGS technique in MIMO system. As the shape of the DGS may change from one dimension to other dimensions for better performance, the modified double E-shaped DGS has much improvement as compare to MIMO system. The S11 parameter is less than 10 db is found at frequency from 6.02 to 6.42 GHz hence improves in bandwidth as compare to MIMO system.

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