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Enhancing parameters of MSA for satellite application by using dumb shell oval head DGS technique

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Abstract — A novel design of various defective ground structured co-axial feed micro strip rectangular patch antenna resulting to highly enhanced parameters when compared with results of fundamental MSA antenna , is proposed in this paper. Further this low profile antenna dimension can be varied with no trouble to make it perform on different frequency bands. Proposed design in paper resonates at 2.25 GHz and parameters S11, VSWR, input impedance are enhanced by employing DGS technique. Initially the antenna design will be presented and then it is simulated by using ANSOFT HFSS 13.0 [12]and then results will be deeply studied.

Keywords — dumb shell oval head, dgs, HFSS, msa, co-axial feed.

1. INTRODUCTION

As displayed in figure 1, micro strip Patch antenna is formed by sandwiching the dielectric substrate in between radiating patch and ground plane. Gold and silver are primary priorities for constructing the radiating[2]. Further by photo etching this radiating patch along with the feed lines are employed on the dielectric substrate, where the basic radiation of the micro strip patch antennas occurs as result of an occurrence of fringing fields in middle of patch edge and that of the ground plane[1]. Among few MSA shapes the most preferable Micro strip resonant patches are rectangular and circular which are extensively employed in multiple applications. The proposed design operates in between the frequency span of 2GHz - 2.5GHz and is proposed for satellite devotion. After designing it on (FR-4) 2 sided Fiber Reinforced epoxy , the performing characteristic parameters like the S11, VSWR, and input impedance were taken from the HFSS 13.0and then further these parameters of the fundamental MSA is enhanced by employing the dumb shell oval head defective ground structure technique in this paper.

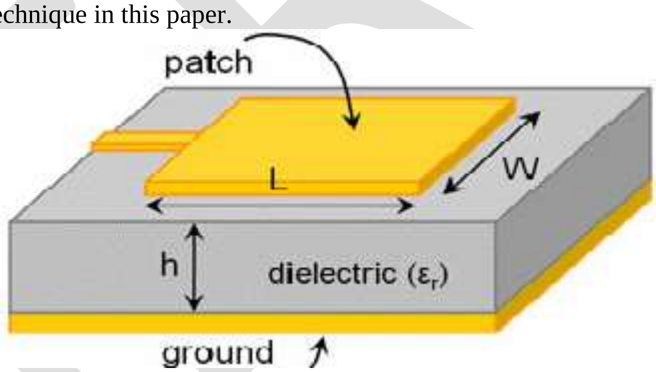

FIGURE 1 – Micro strip patch antenna

1.1 OVERVIEW OF DGS TECHNIQUE

DGS is a technique which intrude the shield distribution of current in the ground plane due to defect in the ground which is cascaded periodic or may be non-periodic carved configuration defect in the ground of a planar transmission line[3]. Like line capacitance and inductance, there are many transmission line characteristics which will get change due to this intrusion[5]. Any proper designed DGS and carved on right coordinates will be highly beneficial in rising an effective capacitance and inductance. Among numerous shapes of DGS , in this paper a dumb shell oval head dgs is used. To construct this DGS shape , the two circular shapes along with a rectangle sandwiched in between them which joins the two circles are united and this constructs the complete structure of dgs, as shown in figure 2

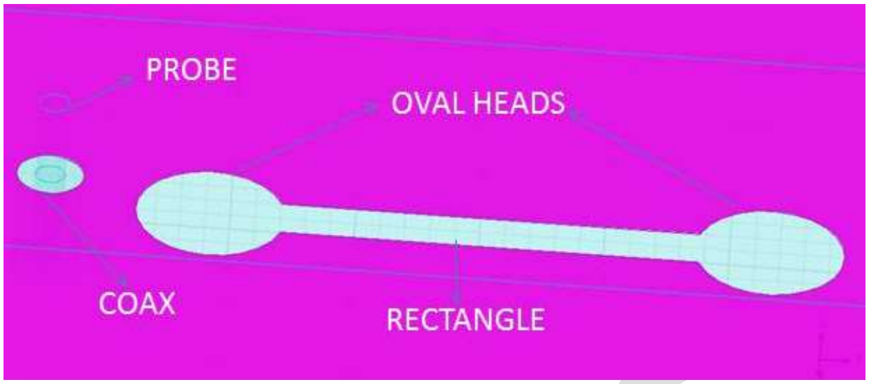

FIGURE 2 – Dumb shell oval head dgs on HFSS 13.0

1.2 ANTENNA DESIGN

The design of coaxial fed micro strip rectangular patch antenna and dumb shell oval head defective ground structured coaxial fed micro strip rectangular patch antenna are displayed in Figure 3(a) and 3(b) which are operating on single band WLAN application. An excitation of an antenna is implemented by coaxial feed line which is intended for characteristic impedance of 50 ohm. It is carved upon a substrate which has thickness of a 1.6mm , it has relative permittivity of 4.4 and at last having a loss tangent of 0.0009. The table 1 which is written below mentions proposed design without DGS dimensions:

VARIABLE	***VALUE***
Patch width	**40.57mm**
Patch length	**31.43mm**
Patch height	**1.6mm**
Ground width	**50.32mm**
Ground length	**41.19mm**
Interior Feed center radius	**0.3mm**
Exterior Feed center radius	**0.675mm**

Table 1 Dimensions of the co-axial fed rectangular patch antenna without dgs for 2.25 GHz frequency

The feeding of the designed antenna is done by co-axial cable which experiences the 50 ohms of characteristic impedance. The material used in order to make outer conductor is substrate material and for inner conductor, PEC material is used. An outer conductor runs from bottom to top of ground where inner conductor runs from the top of the patch to the bottom of ground. The feed point of the design without DGS is (30.5, 16.66) and the feed point of the design with that of DGS is (31, 16.35). The brilliant 47.1626 ohms of an impedance matching has been obtained as accurate impedance matching every time yields the brilliant results. Positioning measurements of shapes and design of proposed DGS antenna are described in table 2:

VARIABLE	***VALUE***
Patch width	**40.57mm**
Patch length	**31.43mm**
Patch height	**1.6mm**
Ground width	**50.32mm**
Ground length	**41.19mm**
Interior Feed center radius	**0.3mm**
Exterior Feed center radius	**0.675mm**
Radius of DGS ovals slot on the ground	**1.2mm**
Length & breath of DGS rectangle slot on the ground	**8.4mm , -1mm**

Table 2 Dimensions of the DGS MSA operating at 2.25 GHz Frequencies.

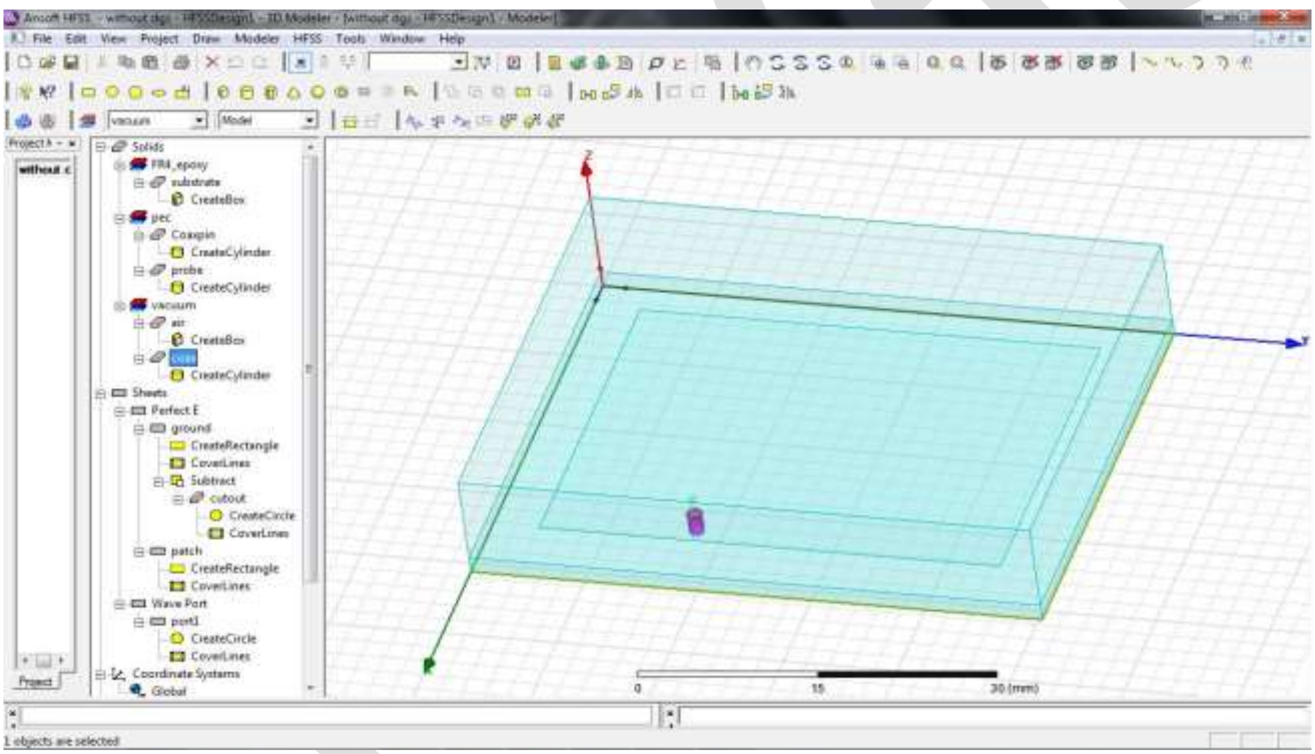

FIGURE 3(A) MSA without DGS on HFSS 13.0 operating at 2.25 ghz

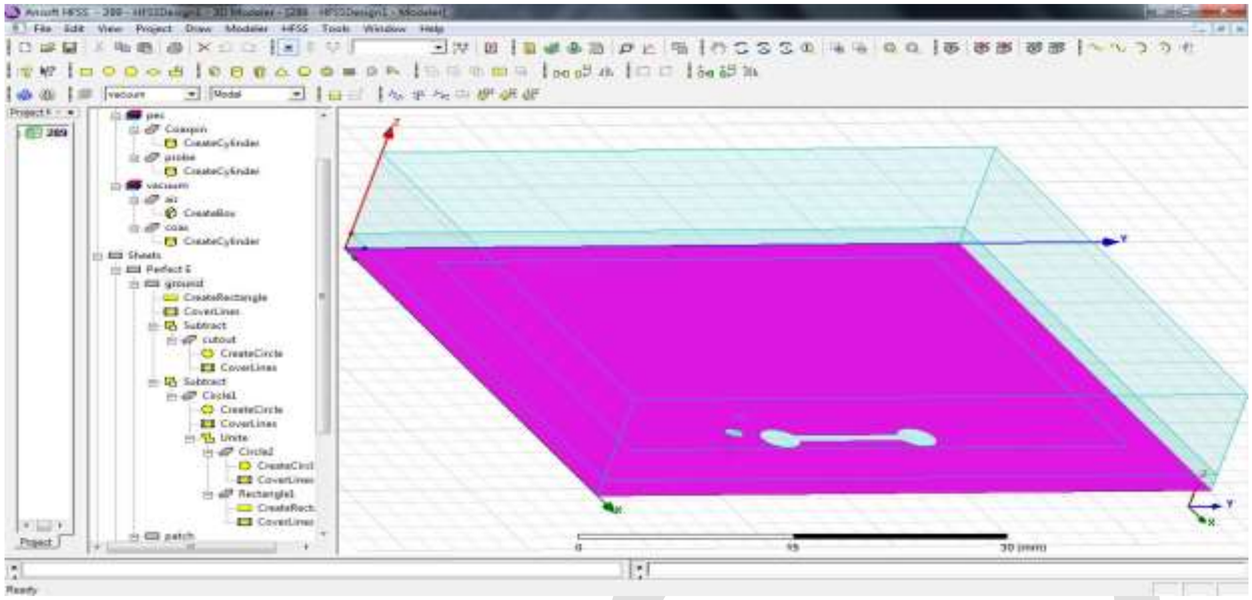

FIGURE 3(b) Proposed design on HFSS 13.0 of MSA with dumb shell oval head shape DGS

2. SIMULATIONS AND RESULTS

The results of both above described antennas generated through the aid of HFSS 13.0 and parameters like S11, directivity, impedance & voltage standing wave ratio are simulated below:

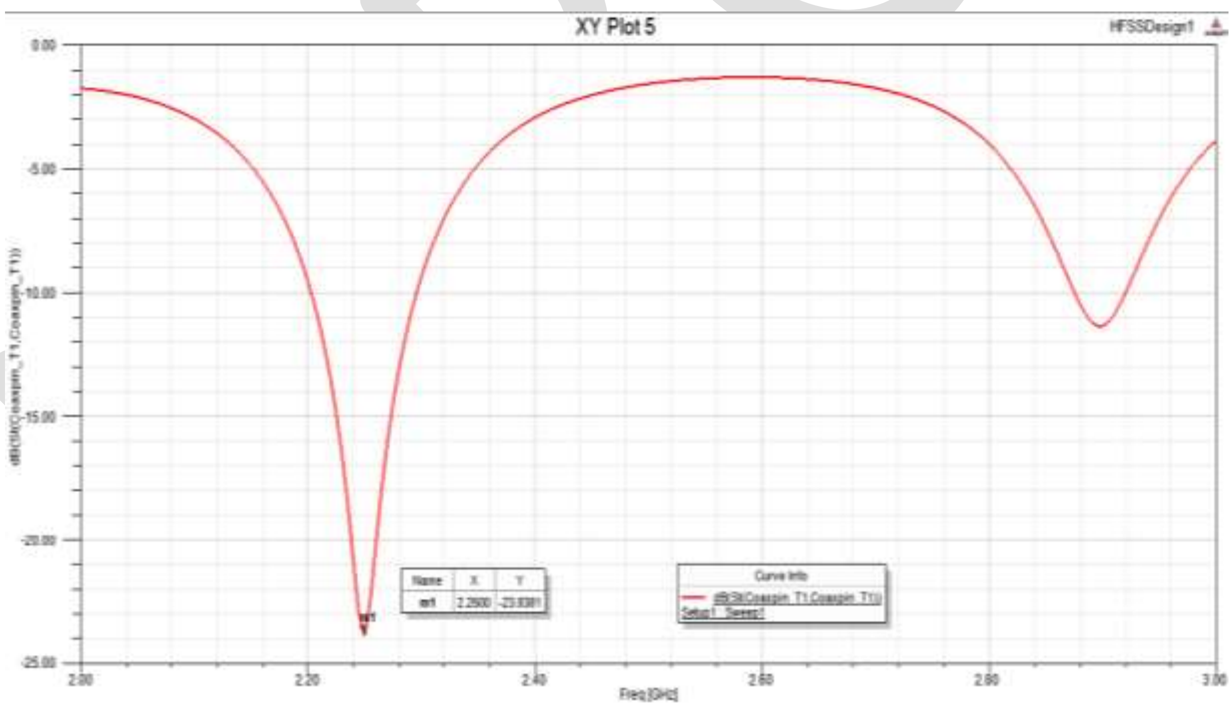

Figure 4 Simulated S11 on HFSS 13.0 of MSA without DGS operating at 2.25 GHz

The return loss S11 resulted by design without DGS is -23.8 which very close to -24 which is brilliant result while operating upon 2.25 GHz that is appropriate for Wireless Local Area Network and results the bandwidth of nearly 90 MHz. The WAN standards are - 2.2 - 2.483 GHz for IEEE 802.11 b/g and to calculate the bandwidth, the lower frequency is subtracted at -10 dB from upper bandwidth. Proposed design with DGS provides impedance of 44.8 ohms representing that antenna is approximately matched and the loss of power is very minimum. Here is represented the result of designed antenna:

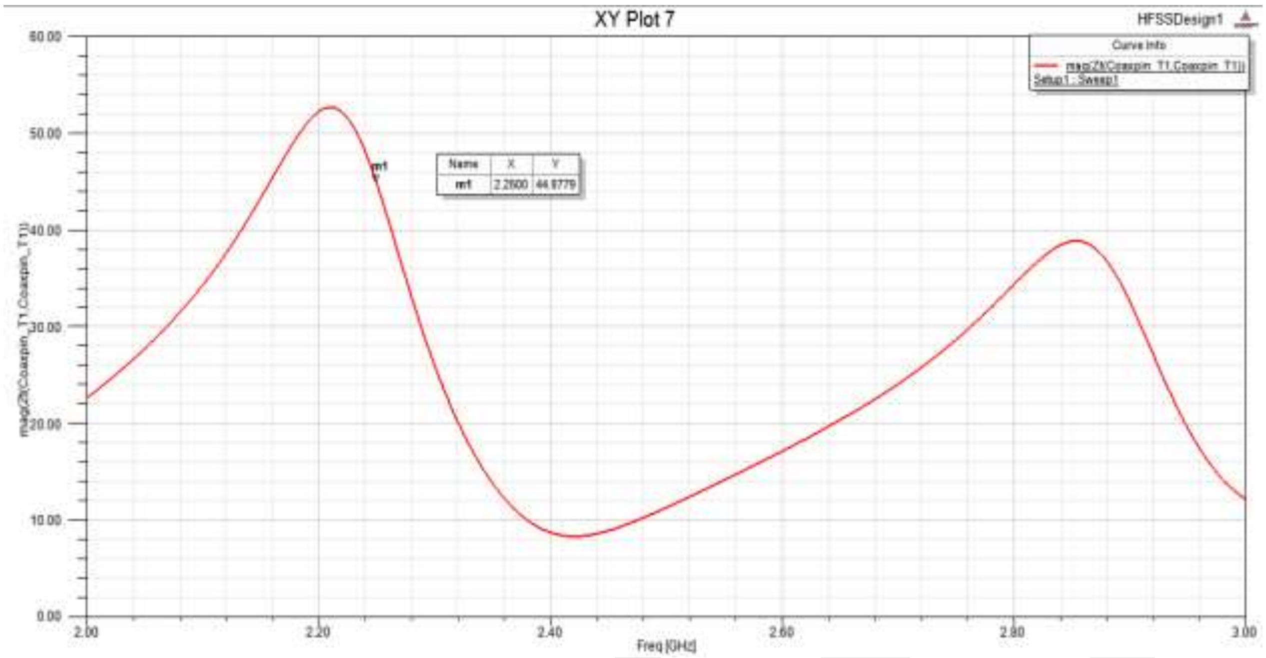

FIGURE 5 Simulated impedance on HFSS 13.0 of MSA without DGS operating at 2.25 GHz

The proposed design without DGS results out VSWR of 1.1374 in operating upon 2.25 GHz

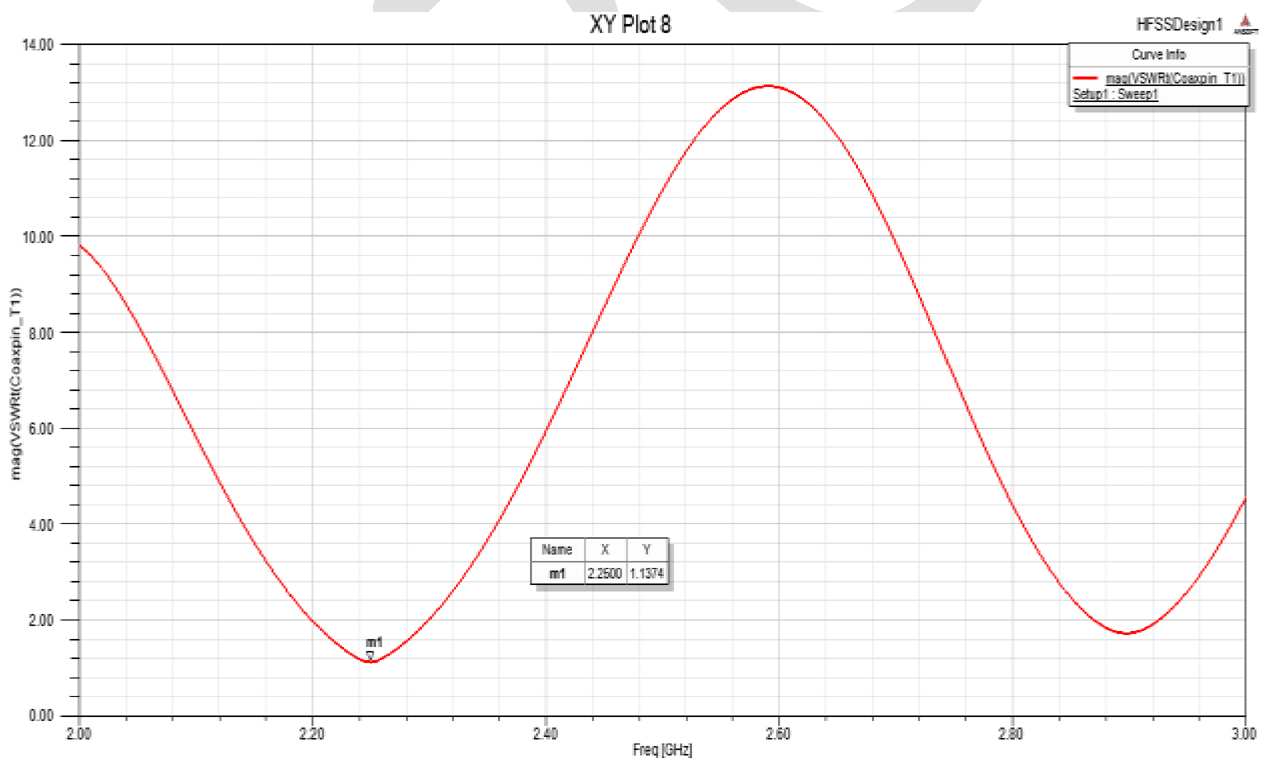

FIGURE 6 Result of VSWR of MSA without DGS at 2.25 GHz on HFSS 13.0

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The summarization of results generated above by HFSS 13.0 in the form of table 3 as below:

Parameters	**Values**
Operating frequency	2.25Ghz
Return loss	-23.8381
Impedance	44.8779
VSWR	1.1374
Bandwidth	90

Table 3 Summary of results of designed antenna without DGS at 2.25 GHz frequency on HFSS 13.0.

2.1 SIMULATION RESULT FOR DUMB SHELL OVAL HEAD SHAPE

The design dumb shell oval head defective ground structured co-axial feed micro strip rectangular patch antenna results out the S11 return loss of -29.5415 dB shown below which is far better than previous design.

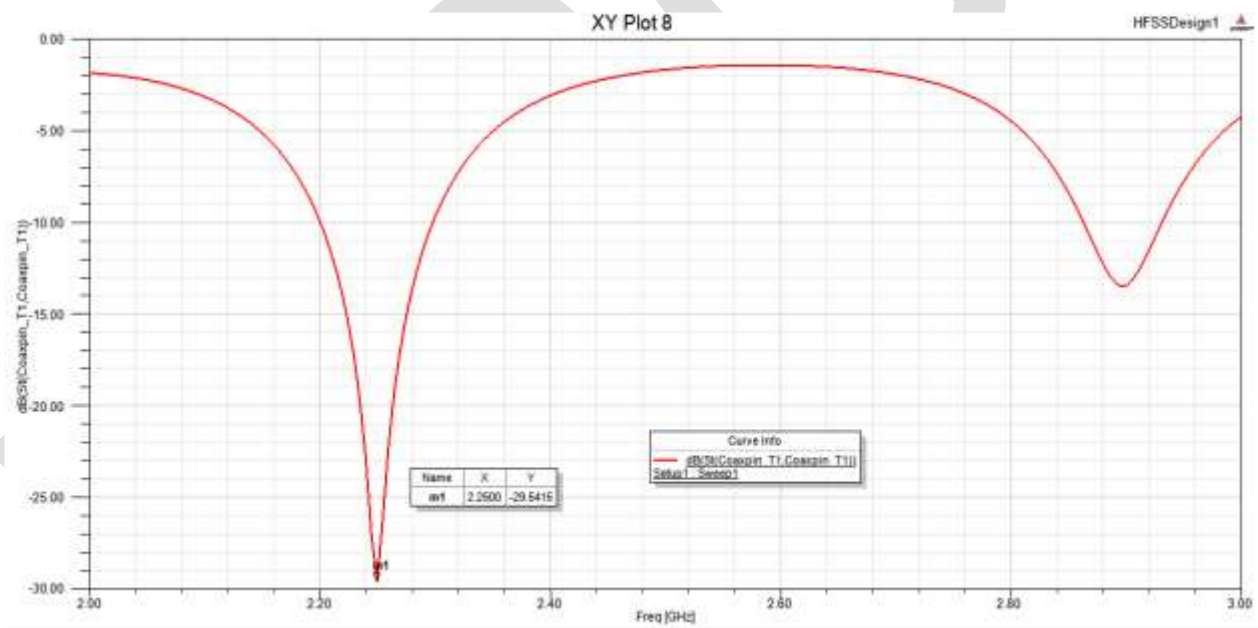

Figure 7 Simulated S11 of MSA with DGS operating upon 2.25 GHz on HFSS 13.0.

The design dumb shell oval head defective ground structured co-axial feed micro strip rectangular patch antenna results out an impedance of 47.1626 ohms which is satisfactory. The result is displayed below.

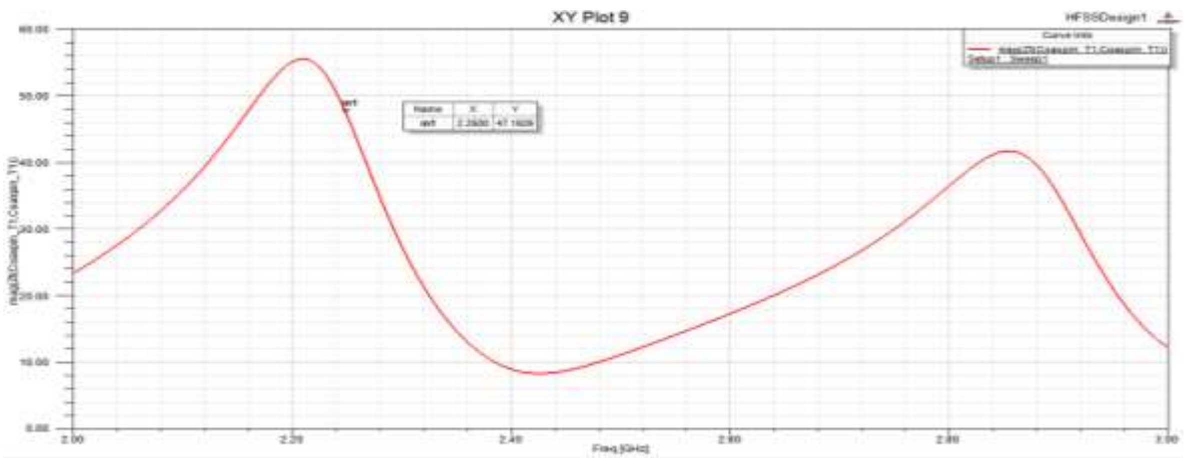

Figure 8 Simulated impedance of MSA with DGS operating at 2.25 GHz on HFSS 13.0

The DGS MSA results out VSWR of 1.0690 operating upon 2.25GHz which is nearly expected and result is displayed below:

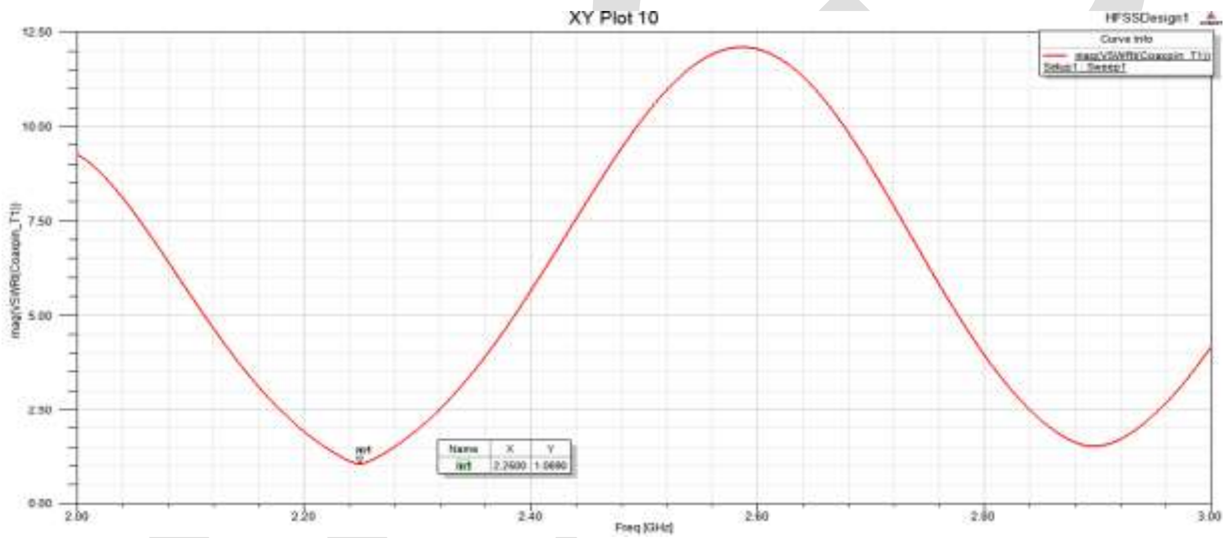

Figure 9 Simulated VSWR of DGS MSA operating at 2.25 GHz on HFSS 13.0

The summarization of results generated above by HFSS 13.0 in the form of table 4 as below:

Parameters	**Values**
Operating frequency	2.25Ghz
Return loss	-29.5415
Impedance	47.1626
VSWR	1.0690
Bandwidth	90

Table 4 Summary of results of Designed Antenna with DGS at 2.25 GHz frequency.

3. CONCLUSION

This paper represents the designs of two antennas of co-axial feed micro strip rectangular patch antenna , with and without dumb shell oval head DGS technique , operating in between frequency spectrum of 2GHz−2.5 GHz. it is also simulationly proven that the design results out a bandwidth of nearly 4% which will always provide stable radiation pattern in between the allotted frequency range. In the center frequency the proposed design exhibit excellent impedance match of nearly 50 ohms. as proved above the enhancement of parameter by employing the dumb shell oval head DGS technique and further the comparison of both with and without DGS technique is displayed below. Which at last proves that dumb shell oval head DGS enhances an overall efficiency of co-axial feed micro strip rectangular patch antenna.

Parameters	**Without DGS MSA Values**	**With DGS MSA Values**
Operating frequency	2.25Ghz	2.25Ghz
Return loss	-23.8381	-29.5415
Impedance	44.8779	47.1626
VSWR	1.1374	1.0690
Bandwidth	90	90

Table 5 Comparison of results of with and without DGS technique in MSA operating upon 2.25 GHz

As it is clear that for numerous applications this design is acceptable as proved that S11 , VSWR are minimum in dumb shell oval head shape of DGS antenna and is also proven that there is enhanced line impedance when it is brought in comparison with other simple antenna (without DGS). This all will practically results into an excellent communication.

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