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Research Paper

Comparative Analysis of Edge Feeding and coaxial Feeding Technique with Fixed Frequency

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Abstract

The performance of rectangular microstrip patch antenna with the edge feeding and coaxial feeding techniques with DGS (Defective ground structure) and DSS (Defective substrate structure) are analyzed. It was observed that the return loss for Edge feeding is -28.39dB, for DSS it is - 26.44 and return loss for coaxial with DGS is -27.50dB and for DSS is -28.52. VSWR is approximately equal to 1 for all designs and also it was observed that the Gain is enhancement in Edge feeding and Bandwidth is improvement with coaxial feeding. The antenna designing and simulation is done by using the ANSOFT HFSS Software**.**

Keywords: *Microstrip Antenna, Edge Feeding, Coaxial Feeding, Feeding Point.*

1. Introduction

The designing of microstrip patch antennas has become a prominent research area in the present wireless technology [1] due to their low profiles , cost effective and easy to fabricate characteristics. The main application of the microstrip patch antenna are more useful in Vehicles based satellite links [2] and Global position satellite [3] and also in Radar for telemetry. Actually the wireless applications lies in the range of 2 to 12GHZ.The designed antenna can be operated in multiband frequencies with the frequency range of 2.75GHZ to 9.95GHZ.

In the earlier designed antenna [4] with the substrate height of 1.57mm using RT/duriod5880. It was observed the return loss is -30.79dB with a bandwidth of 28MHZ , Gain is 6.732dB and they founded that the VSWR is approximately equal to 1.06.The designed antenna is found to give a enhanced bandwidth and with multiband operating frequencies when compared with the earlier antenna . The antenna designing and simulation is done by using the ANSOFT HFSS software [5].

2. Feeding techniques

The microstrip patch antenna can be fed in different ways. The most popular feeding techniques for the microstrip antennas

1. LINE FEEDING
2. COAXAIL FEEDING
3. APERTURE COUPLE FEED
4. PROXIMITY COUPLED FEED

The type of Feeding technique [6] can show more impact on the antennas and also it can change the operating of the antennas. In general line feeding is of two types Edge feeding and Inset feeding. The line feeding can avoid a multilayer board whereas the coaxial feeding is very easy to fabricate and it can get the better matching impedance because the feed can be placed at any point on the patch. In aperture feeding technique, the

shielding is provided for the feed circuitry from antenna by a conducting plane to transmit energy to antenna. Proximity coupled feeding is also be

known as the electromagnetic coupling. This feeding technique utilizes dual substrates and the radiating patch is on the upper substrate. In this feeding technique there is an improvement in the bandwidth of about 13%.

3. Antenna design

The main aim for a micro strip patch antenna design is to determine the patch dimensions necessary to satisfy the specific performance characteristics over the required frequency band.

Knowing the thickness of a substrate and dielectric constant the microstrip patch antenna which operates at the required resonant frequency band can be designed by using formulae stated in equation 1 to 7. Here h is the height of a substrate and value is 1.57mm.

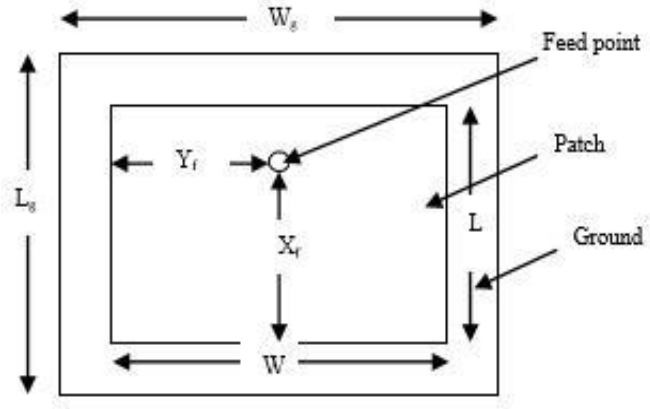

Fig. 1: Top view of micro strip patch antenna

Step 1: calculation of width (W)

$$W = \frac{c}{2 f_0 \sqrt{\frac{\varepsilon_r + 1}{2}}} \quad (1)$$

Step 2: Calculation of effective dielectric constant (εreff)

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{-1/2} \quad (2)$$

Step 3: Calculation of Effective Length (Leff**)**

$$L_{eff} = \frac{c}{2 f_o \sqrt{\varepsilon_{reff}}} \quad (3)$$

Step 4: Calculation of length Extension (ΔL**)**

$$\Delta L = 0.412h \frac{\left(\varepsilon_{reff} + 0.3\right)\left(\frac{w}{h} + 0.264\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{w}{h} + 0.8\right)} \quad (4)$$

Step 5: Calculation of actual length of patch (L**)**

$$L = L_{eff} - 2\Delta L \quad (5)$$

Step 6: Calculation of ground plane dimensions

$$L_g = 6h + L7 \quad (6)$$

$$W_g = 6h + W \quad (7)$$

Where L_g and W_g are width and length of Ground

4. Results and discussions

The proposed antenna can be designed using the FR4 material with the Resonant frequency 2.4GHZ and height of the substrate is 1.57mm.

In this paper the designing of the Edge feeding antenna and coaxial feeding antenna is done using FR4 substrate same with the Resonant frequency and a comparison has been done on both the feeding techniques Table 1 and Table .2 show the parameter specifications for the both Edge feeding and coaxial feeding respectively.

Table 1: Dimensions of the patch for Edge feeding technique

Parameter	Dimensions	Units
Height	1.57	Mm
Frequency	2.4	GHZ
Width of patch	49.41	Mm
Length of patch	41.36	Mm
Width of matching	0.97	Mm
Length of matching	17	Mm
Width of the feed Line	4.912	Mm
Length of feed line	43.02	Mm
Substrate	FR4_epoxy	

Table 2: Dimensions of patch for coaxial feeding Technique

Parameter	Dimensions	Units
Frequency	2.4	GHZ
Height	1.57	Mm
Substrate	FR4_epoxy	
Width of the patch	49.41	Mm
Length of the patch	38.36	Mm
DGS shape	Swastic	

3.1 Edge feeding

A microstrip with Edge feeding is designed with the length of patch as 41.36 mm, width of the patch of the patch is 49.36mm, and resonant frequency is 2.4GHZ. The selected antenna is found to have minimum return loss. The design of antenna without DGS is shown in Figure 2.

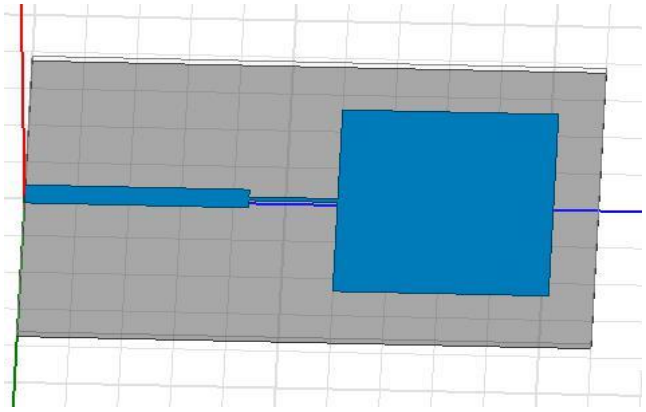

Fig. 2: Proposed antenna with Edge feeding

The designing of Rectangular microstrip patch antenna with swastic shaped DGS as shown in the Figure 3.

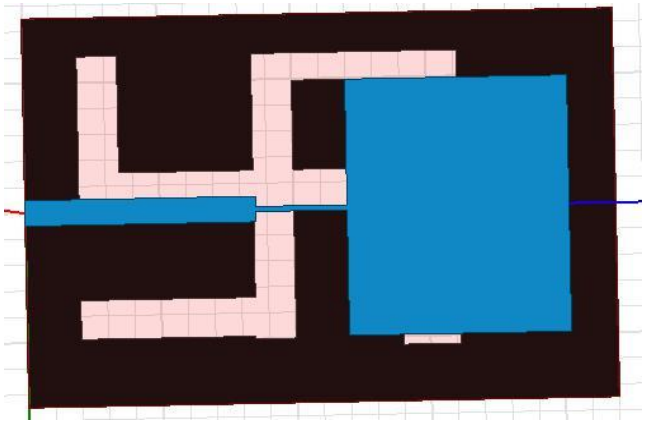

Fig. 3: Proposed antenna with DGS

The designing of proposed antenna with the DGS and Defective substrate structure with length of patch is 41.36mm and width of the patch is 49.41mm as shown in Figure 4.

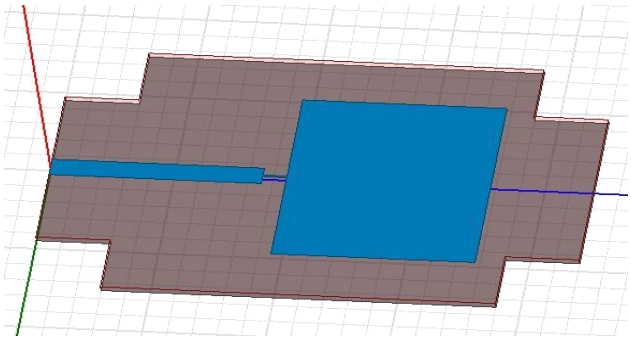

Fig. 4: Proposed antenna with DGS and DSS

*1) **Return loss**:*

Figure 5, 6, and 7 show the return loss of the proposed antenna with Edge feeding.

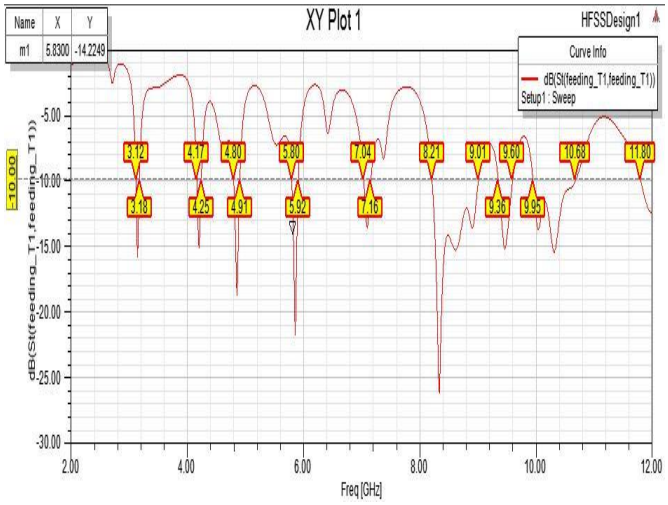

Fig. 5: Return loss vs. freq for the normal patch

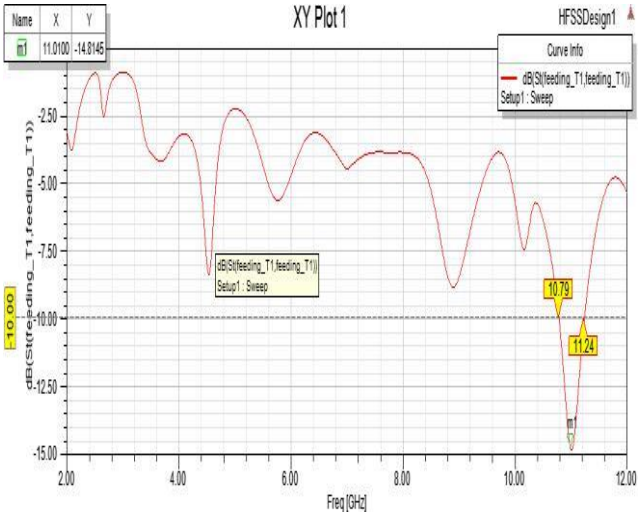

Fig.6: Return loss Vs. freq for the line feeding with DGS

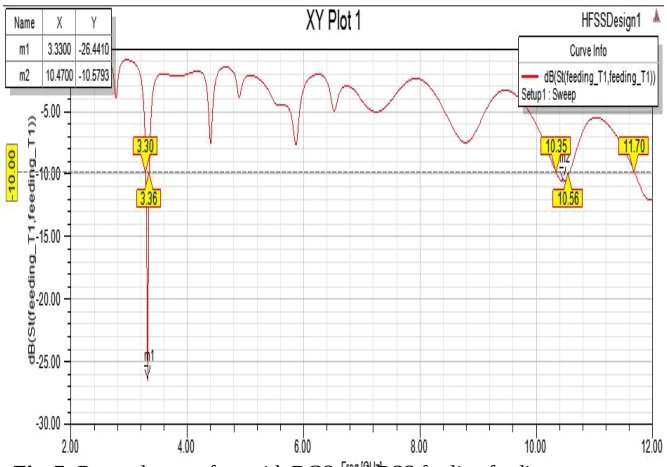

Fig. 7: Return loss vs. freq with DGS and DSS for line feeding

Figures 5 to 7 show the return loss for the Edge feeding. It was observed that the normal edge feeding operates in the multi-band -26.49dB and with DGS the loss is low with single band.

*2) **VSWR**:*

Figure 8, 9, and 10 shows the VSWR of the microstrip patch antenna with the Edge feeding,

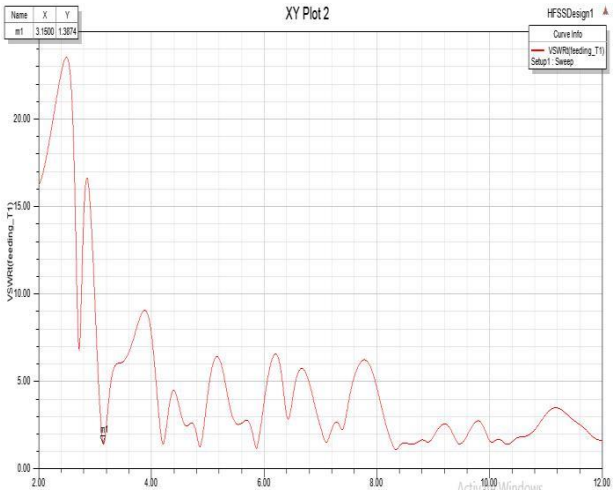

Fig. 8: VSWR vs. frequency for the normal line feeding

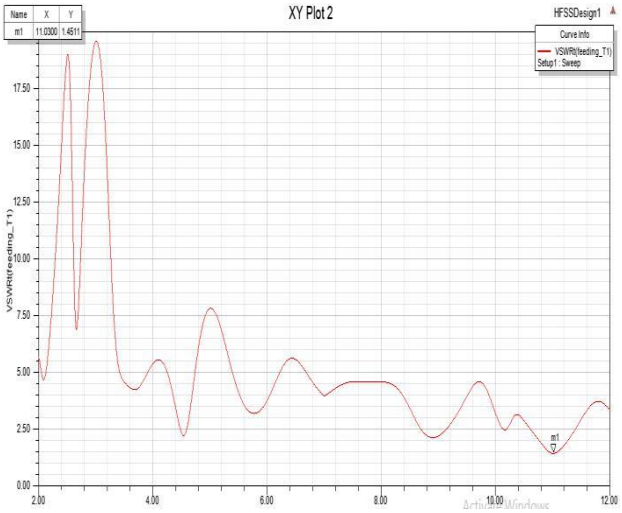

Fig. 9: VSWR vs. frequency for the line feeding with DGS

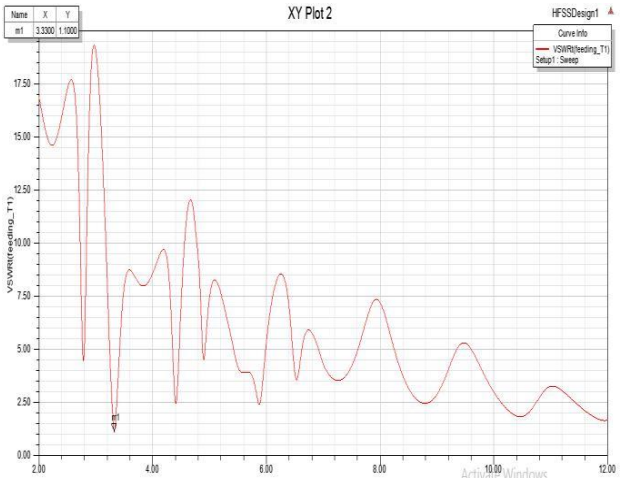

Fig. 10: VSWR vs. frequency for the line feeding with DGS and DSS

3) *Gain:*

Figure 11 to 13 shows the gain of the microstrip patch antenna with the Edge feeding. It was observed that the gain for normal patch is 6.1509dB, with DGS is 1.6017 dB and with both DGS and DSS is 4.1310dB.

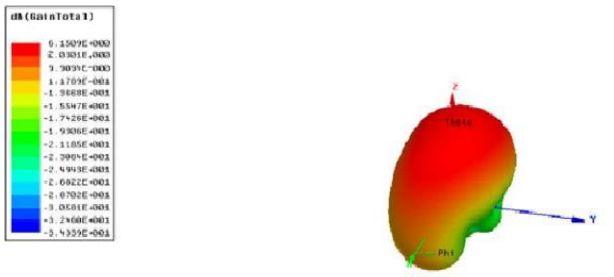

Fig. 11: Gain for the line feeding

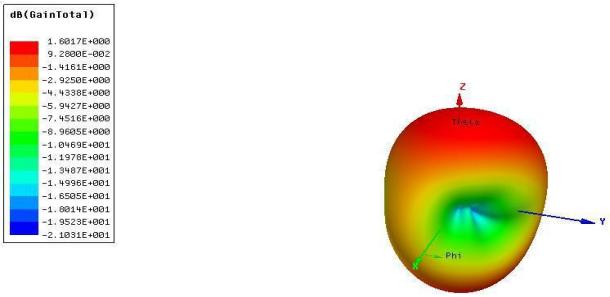

Fig. 12: Gain for the line feeding with DGS

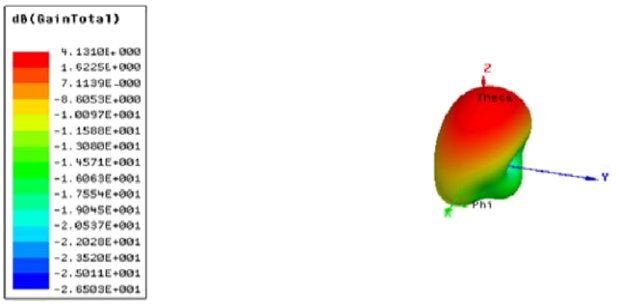

Fig. 13: Gain for the line feeding with DGS and DSS

3.2 Coaxial Feeding

A microstrip with Edge feeding is designed with the length of patch as 38.36mm, width of the patch of the patch is 49.41mm, and resonant frequency at 2.4GHZ. The selected is found to have minimum return loss. The design antenna without DGS as shown in Figure 14.

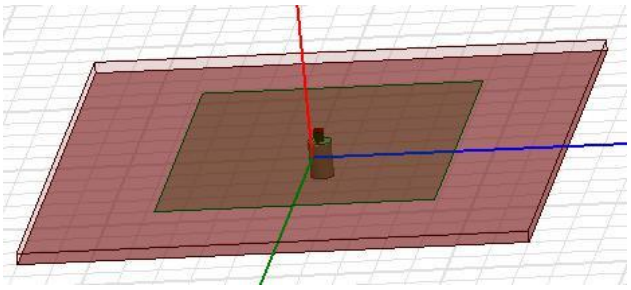

Fig. 14: Proposed antenna with the coaxial feeding.

The designing of patch antenna with swastic shaped DGS as shown in the Figure 15.

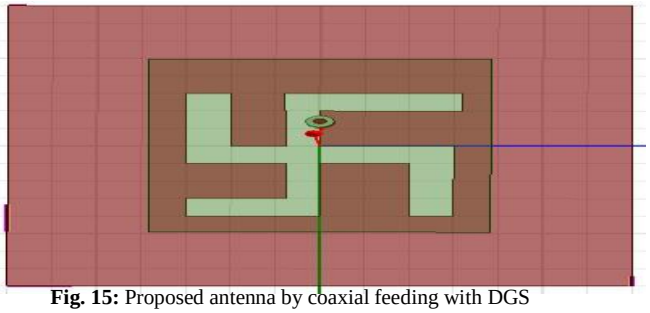

Fig. 15: Proposed antenna by coaxial feeding with DGS

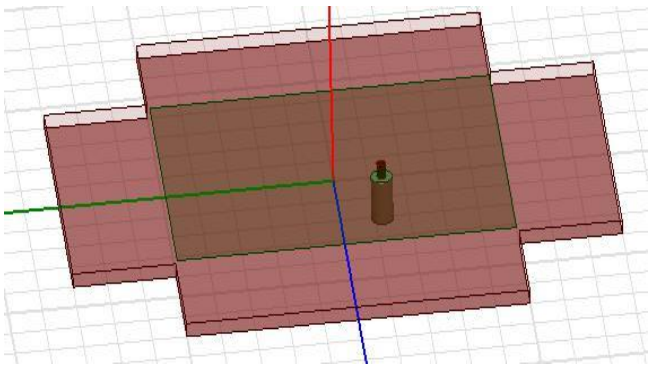

Fig. 16: Proposed antenna by coaxial feeding with DSS and DGS

1) *Return loss:*

Figure 17 to Figure19 shows the return loss of the coaxial feeding for the microstrip patch antenna with DGS, DSS and without DGS.

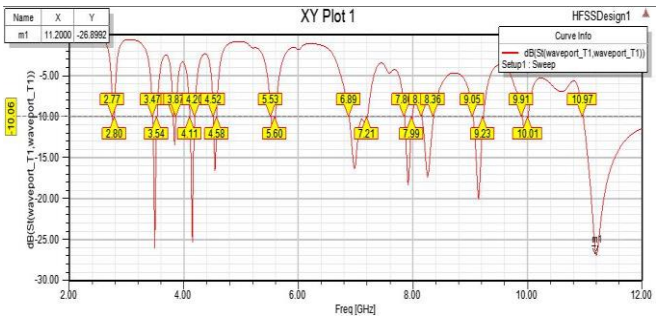

Fig. 17: Return loss Vs frequency for the normal coaxial feedin

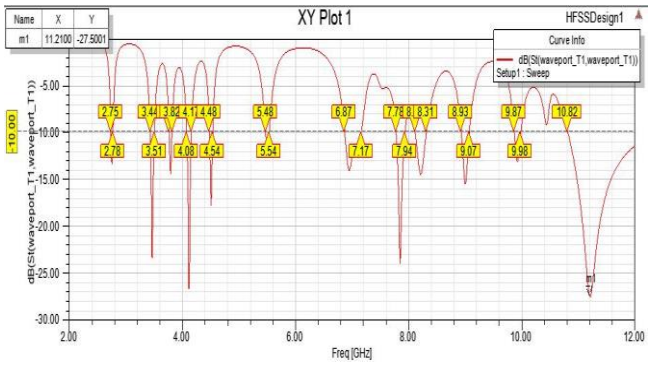

Fig. 18: Return loss vs. frequency for the coaxial feeding with DGS

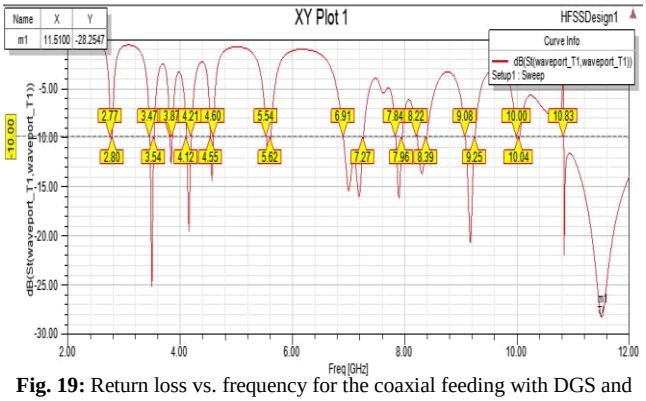

Fig. 19: Return loss vs. frequency for the coaxial feeding with DGS and DSS

It was founded that the return loss for the coaxial feeding is -27dB approximately with DGS and -28dB with DGS and DSS. It has observed that the multiband for all the designs using coaxial feeding.

2) ***VSWR****:*

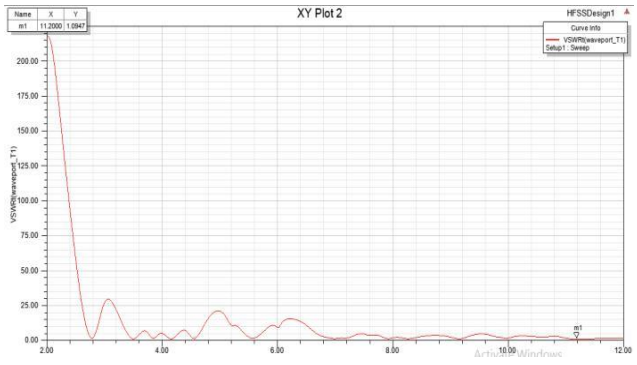

Fig. 19: VSWR vs. frequency for the normal coaxial feeding

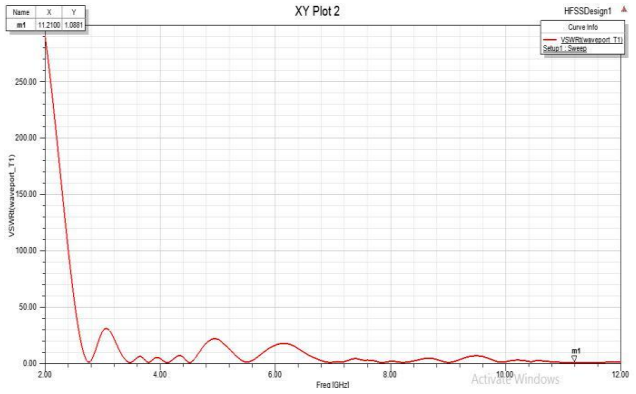

Fig. 20: VSWR vs. frequency for the normal coaxial feeding with DGS

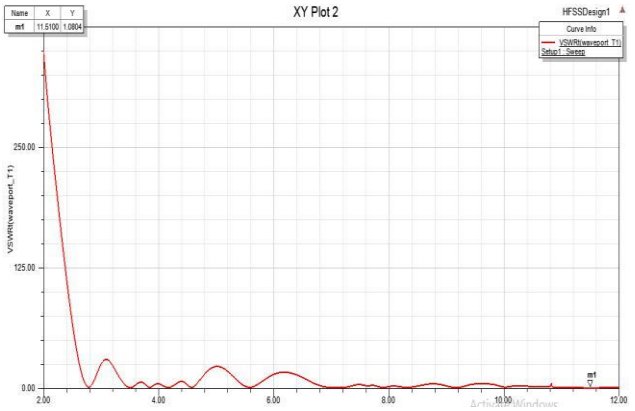

Fig. 21: VSWR vs. frequency for the normal coaxial feeding with DGS and DSS

The figures 19 to 21 show the VSWR for the coaxial feeding with and without DGS. The VSWR for all the designs is approximately equal to one.

3) ***GAIN****:*

Figure 22 to Figure.3.2.12 show the gain for the microstrip antenna with the coaxial feeding with and without DGS. The Gain for the coaxial feeding with the normal patch is 2dB, with DGS is 2.303dB and with both DGS and DSS is 2.33 dB

Fig. 22: Gain for the coaxial feeding

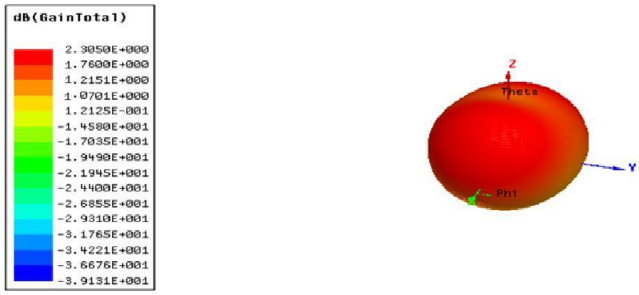

Fig. 23: Gain for the coaxial feeding with DGS

Fig. 24: Gain for the coaxial feeding with DGS and DSS

5. Comparison with the edge feeding with DGS and DSS with their responses

Table 3 shows the comparison of the Edge feeding technique with normal patch and Edge feeding DGS and DSS.

Table 3: Comparison of the Edge feeding technique with DGS and DSS

Parameter	EDGE FEEDING	EDGE FEEDING WITH DGS	EDGE FEEDING WITH DGS AND DSS
Return loss	-26.12Db	-14.81dB	-26.44dB
VSWR	1.38	1.45	1.10
Gain(dB)	6.1509	1.6017	4.1310
Band	Multiple(7)	Single	Double
Frequency (GHZ)	3.14,4.19,4.85,5.85,7.04,8.34,9.45,10.30	11.01	3.33, 10.47
Bandwidth (MHZ)	60-800	450	60, 210

Table 4 shows the comparison of the coaxial feeding with normal patch and coaxial feeding with DGS and DSS

Table 4: Comparison of the coaxial feeding technique with DGS and DSS.

Parameter	COAXIAL FEEDING	COAXIAL FEEDING WITH DGS	COXAIL FEEDING WITH DGS AND DSS
Return loss	-26.89dB	-27.50dB	-28.58dB
VSWR	1.09	1.02	1.08
Gain(dB)	2.0206	2.303	2.33
Band	Multiple (12)	Multiple (12)	Multiple(12)
Frequency (GHZ)	2.75,3.48,3.84,4.15,4.53,5.55,6.98,7.91,8.26,9.14,9.95	2.74,3.46,3.78,4.11,4.50,5.49,6.94,7.83,8.21,9.00,9.90	2.76,3.47,3.83,4.15,4.56,5.56,7.16,7.88,8.31,9.16,10
Bandwidth (MHZ)	30-320	30-300	30-170

Table 3 and Table 4 show the comparison of the coaxial feeding with DGS, DSS and Edge feeding with DGS and DSS. It is founded that the Edge feeding antenna will operates in single band with DGS and double band with DGS, DSS, and the coaxial feeding antenna operates in multi-band with an improved bandwidth

6. Conclusion

The rectangular microstrip patch antenna with Edge feeding and Coaxial feeding technique by applying the Defective ground structure and Defective substrate structure has been discussed. In the earlier design antenna the bandwidth is 28MHZ, return loss is -30dB As compared to the earlier design, it was observed that this antenna has enhanced bandwidth i.e.,, 730MHZ in edge feeding and 300 MHZ in coaxial feeding and less return loss i.e.,, -28.99dB with coaxial feeding and improvement in the gain for the edge feeding techniques i.e.,, 6.15dB, 4.13dB and also these designed antennas are operated at the solution frequency of 2.4 GHZ

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