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Bandwidth and Return Loss Enhancement of Microstrip Antenna using DGS

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Abstract: This paper focuses on an inset-feedmicrostrip antenna (MSA) and enhancement of its Bandwidth and return loss using Defected Ground Structure (DGS).Two rectangular slot are used as DGS on the ground plane to get the desired results. The proposed antenna gives better result of bandwidth with DGS and return loss with DGS when compared with reference MSA without any DGS. This proposed resonating antenna is having frequency at 2.4 GHz where the bandwidth is around 290 MHz whereas the conventional antenna is having bandwidth of 76 MHz . The return loss of proposed antenna is found to be -39.11 dB

General Terms
Enhanced Bandwidth, Enhanced Return Loss, Electromagnetic Band Gap (EBG)
Keywords: Defected Ground Structure (DGS), Microstrip Patch Antenna (MSA), Bandwidth, Return Loss

I. INTRODUCTION

Recently, improved antenna performance is in demand due to a growing popularity of microwave and wireless communication systems which is having number of applications. Therefore, we need to choose a suitable microstrip antenna which can be used in various fields like telecommunication, medical application, satellite and military system. However, microstrip antenna has some of disadvantage like narrow bandwidth where the center frequency is typically 5%.There are number of miniaturization techniques from which we can take dielectric substrate of high permittivity [2], slot on the patch of the antenna, DGS at the ground plane or a combination of them are some of the techniques[3]. These techniques have been applied to MPA to have better bandwidth.

To achieve higher frequency cylindrical microstrip antenna is used which comes under category of conformal microstrip antenna, that has been focused by many researchers [4-5]. These antennas are used in reduction of the antenna size and widening the radiation pattern. However the wide use of microstrip antenna is again affected by surface wave and to reduce its effect, electromagnetic band gap (EBG) or photonic band gap (PBG) structure, which also exhibit band-gap feature [6]. The EBG structure is inserted into the substrate to reduce the effect of surface waves, increase the directivity of the antenna and also to enhance its radiation pattern [8-9]. However, wide area is required to bring out the periodic patterns in EBG and there is also complexity of the unit element of EBG.DGS and EBG have some specific properties with respect to microwave circuit.

The DGS can also alter the guided wave properties by providing a band-pass filter or band stop filter and the element of this structure can easily be defined [10]. The shape or structure of DGS is quite simpler and a large area is not needed. The main principles of this structure is that the shield current distribution is disturbed by DGS in the ground plane[7], which affects current flow of the antenna and input impedance thus increasing the bandwidth.

There are some shapes of DGS slot which are studied in planar microstrip antenna designs [5-8], which helps in size reduction, increase in impedance bandwidth and enhance the gain of the antenna. Specific slots are planted in the ground of microstrip antenna to reduce the size of antenna and boost the bandwidth and enhancing the gain of antenna [4].

In this paper work, two rectangular slot mirror image of each other is being investigated and it is found to be elegant method to reduce the antenna size at the same time enhancing other parameters of antenna. The Proposed antenna design uses two rectangular slot Defected Ground Structure in ground plane to get impedance bandwidth enhancement.

II. ANTENNA DESIGN

A conventional MSA and proposed antennas are designed with CST Microwave Studio Software. The substrate of the proposed antenna is FR-4(lossy) with thickness (h) of 1.6 mm having relative permittivity (ε_r) of 4.4. The magnitude of patch is 38.03mm × 28.56 mm with thickness (t) of 0.03 mm. The ground dimension is 47.63 mm × 37.90 mm with same thickness (t) of 0.02 mm. Characteristics impedance of inset feed microstrip antenna is 50 Ω. The complete different parameters of conventional MSA are shown in Table.1.

The different parameters like Width, length of the MSA are taken from the standard expressions used for MSA. For a given Frequency and substrate, we can easily derive different parameters of MSA as follows.

A. *Parameter Calculation*

1) *Width Of Patch(W)*

$$W = \frac{c_0}{2f_0}\sqrt{\frac{2}{1+\varepsilon_r}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Here c_0 is the speed of light i.e 3×10^8 m/sec and ε_r is the dielectric constant which value is 4.4.

2) *Effective Dielectric Constant(ε_{reff})*

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{\frac{-1}{2}} \ldots . (2)$$

3) *Effective Length(L_{eff})*

$$L_{eff} = \frac{c_0}{2f_0\sqrt{\varepsilon_{reff}}} - 2dL \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

4) *Length Extension(dL)*

$$dL = 0.412h\frac{(\varepsilon_{reff} + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon_{reff} - 0.258)(\frac{W}{h} + 0.8)} \ldots\ldots\ldots (4)$$

5) *Actual length Of Patch(L)*

$$L = L_{eff} - 2dL \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

B. *Parameter Table*

Using all these equations, different parameters of MSA is calculated and shown in table 1.

Table 1: Parameters details of Reference Antenna at 2.4 GHz

Antenna Part	Parameter(symbol)	Value (mm)
Patch	Width(W)	38.03
	Length(L)	28.56
	Thickness(t)	0.03
Substrate	Width(Ws)	47.63
	Length(Ls)	37.90
	Height(h)	1.6
Inset FeedLine	Length(Lf)	9.5
	Width(Wf)	3.083
	X0 and Y0	1.35&5

98

For the simple MSA, infinite ground plane is taken

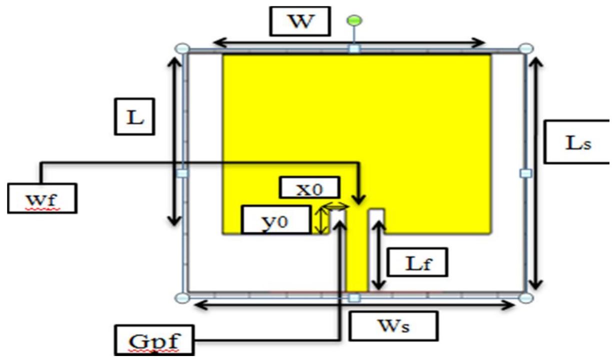

Figure 1: Top View Of Inset-Feed Microstrip Patch Antenna

Figure 1 and 2are showing the top and bottom view of the reference microstrip patch antenna at 2.4 GHz where all the parameters are shown with proper labeling.

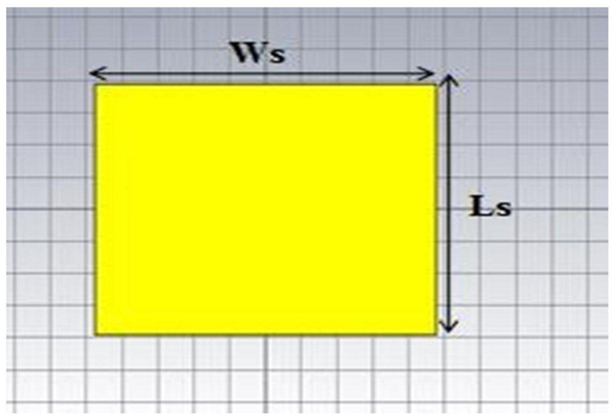

Figure 2: Back view of Rectangular MSA deign at 2.4 GHz

In DGS, there is an introduction of shape that is etched on the ground plane This will affect the current distribution thus changing its impedance.
Two rectangular slots are etched into ground plane to create defected structure. All other parameters are same as the conventional MSA. The two rectangular slots with dimension (17.085 mm *8 mm) are mirror image of each other which is shown in figure 3.
Microstrip antenna with DGS will improved return loss, VSWR and provides higher bandwidth overcoming the limitations of conventional microstrip patch antenna.

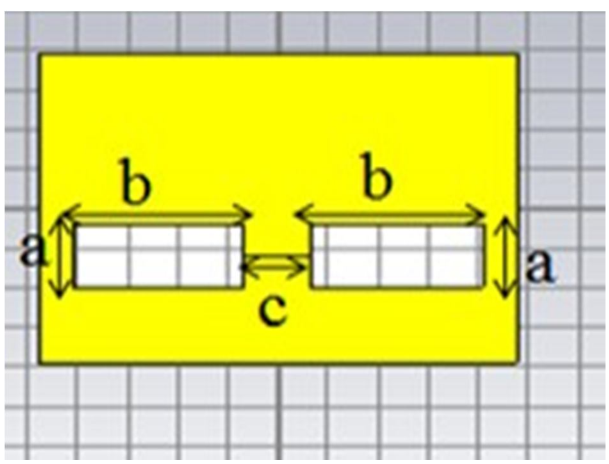

Figure 3: Back view of Rectangular MSA deign using at 2.4 GHz

III. RESULT AND DISCUSSION

First the conventional microstrip antenna was simulated using CST microwave studio and different results were analyzed. Figure 4 shows the return loss (S_{11}parameter) is -16.78dB. The resonating frequency is 2.45 GHz. The antenna bandwidth is said to be those area of frequency where the return loss is needs to be -10dB which correlate to a VSWR of 2. The bandwidth of the antenna is 76MHz (2.413GHz-2.489 GHz) that can be verified from the result shown in figure 4. Figure 5 shows the VSWR plot versus frequency of the reference antenna which is 1.338 at resonating frequency. Figure 6 shows the radiation plot DGS and directivity is found to be 5.89 dBi.

The proposed microstrip antenna with DGS was designed at center frequency 2.4 GHz and the structure was simulated on FR-4 dielectric substrate with height 1.59 mm. When two slots are made on ground plane, it changes the current distribution of the antenna thus improving the overall bandwidth of the antenna. Figure 7 shows the return loss plot for the antenna. It gives a return loss of -39.18 dB with a bandwidth of 290 MHz (2.266 GHz-2.556 GHz). Figure 8 shows the VSWR plot versus frequency of the suggested antenna. The directivity of the antenna is found to be 4.54dBi.

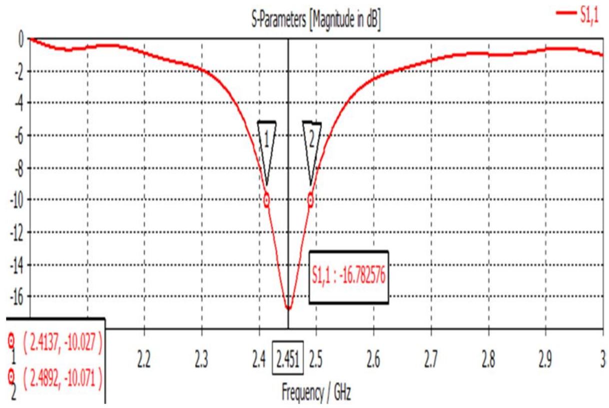

Figure 4: Return Loss Plot Of Reference Antenna

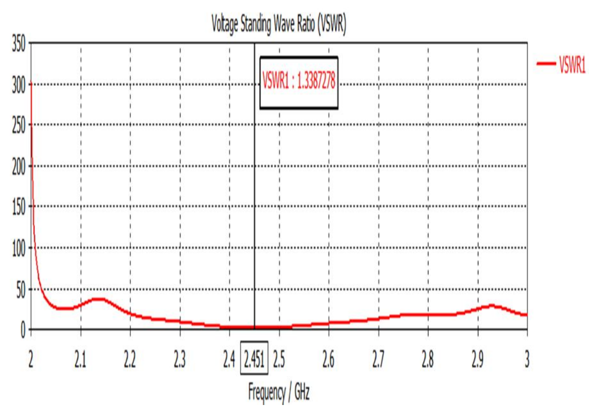

Figure 5: VSWR of Reference Antenna

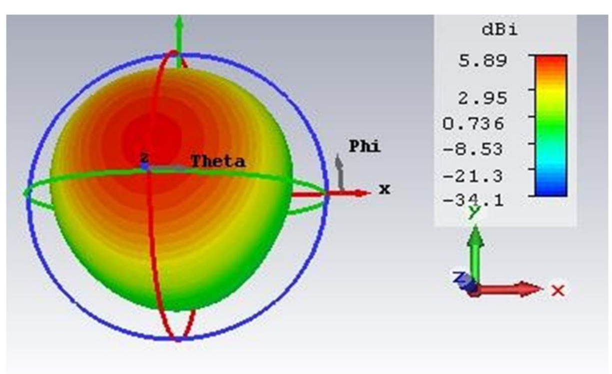

Figure 6: Radiation Pattern of Refernce Antenna without DGS

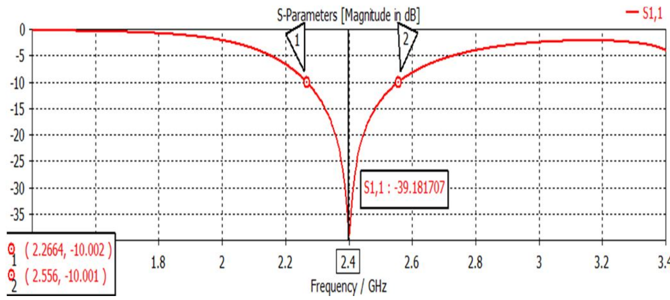

Figure 7: Return loss plot of suggested antenna (With DGS)

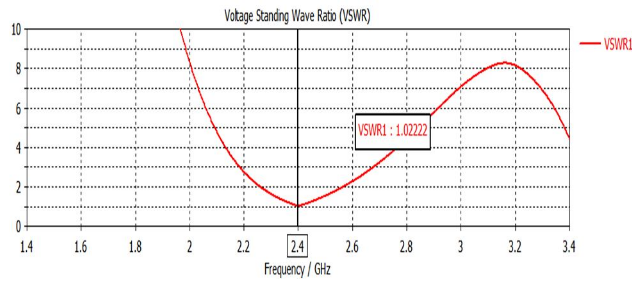

Figure 8: VSWR Plot of suggested antenna (With DGS)

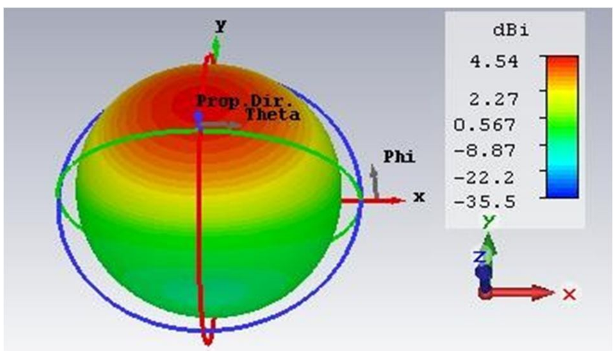

Figure 9: Radiation Pattern of recommended antenna at 2.4 GHz

The below table no 2 summarizes the whole simulated results of both reference antenna i.e. without DGS and proposed antenna with DGS.

Table 2: Comparison of simulated results of reference antenna

Sl.No	Parameters	Without DGS	With DGS
1	Reflection Coefficient	-16.78 dB	-39.18 dB
2	VSWR	1.338	1.022
3	Bandwidth	76MHz	290MHz
4	Directivity	5.89 dBi	4.54dBi
5	Bandwidth %	3.10%	12.08%

IV. CONCLUSION

A novel antenna, working at 2.4 GHz has been successfully simulated in this paper. The bandwidth of the MPA with DGS is 290 MHz .Centre frequency is 2.4 GHz with return losses (S11 = -39.18 dB) while microstrip patch antenna without DGS gives bandwidth of 76 MHz and return loss is 16.78 dB. So the proposed antenna has overcome the disadvantage of conventional microstrip antenna i.e. narrow bandwidth by achieving 12.08 % bandwidth percentage with reduction in size of ground plane by inserting 2 rectangular shaped slot in the ground plane.

V. ACKNOWLEDGMENTS

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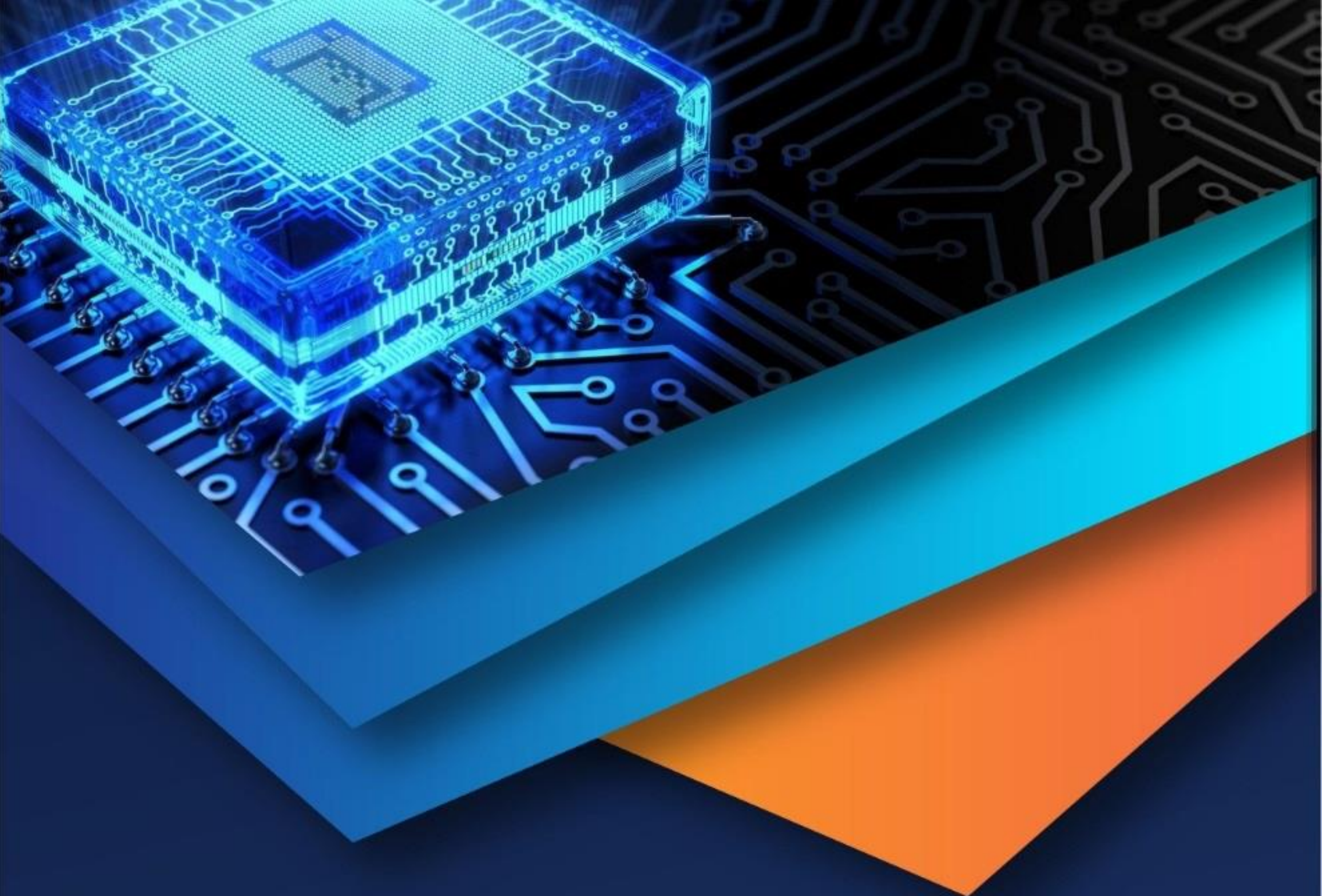
REFERENCES

[1] Constantine A Balanis. Antenna Theory: Analysis and Design. 3rd ed. John Wiley & Sons, Inc.2005.
[2] James, J. R. and P. S. Hall, Handbook of Microstrip Antennas, Peter Peregronic Ltd., London,1989
[3] S. S. Iqbal, J. Y. Siddiqui, and D. Guha, “Performance of compact integratable broadband microstrip antenna,” Electromagnetics, vol. 25, no. 4, pp. 317–327, May/Jun.2015.
[4] M. Hanseishi and M. Konno, “Dual-polarized planar antenna fed by dog-bone slots,” in IEE 11th Int. Conf. on Antenna and Propagation, 2014, pp.45–48.
[5] LC Godara, R Waterhouse. Handbook of Antenna in Wireless Communication. Florida, USA: CRC Press LLC. 2013.
[6] Amit Kumar, Jaspreet Kaur and Rajinder Singh. Performance Analysis of Different Feeding Techniques. International Journal of Emerging Technology and Advanced Engineering. 2013; 3(3):884-890.
[7] Ashwini K Arya, MV Kartikeyan, A Patnaik. Defected Ground Structure in the perspective of Microstrip Antennas: A Review. Article in Frequenz Berlin. 2010:79-84.
[8] Jinal R Patel, Jigar B Chaudhari. Optimization and Return loss Reduction of Microstrip Patch Antenna. International Journal of Innovative Research in Computer and Communication Engineering. 2015; 3(6):4996-5003.
[9] MandaI, M. K. and S. Sanyal, "A novel defected ground structure for planar circuits," IEEE Microwave and Wireless Components Letters, Vol. 16, No.2, 93-95, February 2006.
[10] Y. J. Sung and Y. -. Kim, "An improved design of microstrip patch antennas using photonic bandgap structure," in IEEE Transactions on Antennas and Propagation, vol. 53, no. 5, pp. 1799-1804, May2005.
[11] D. Guha, M. Biswas and Y. M. M. Antar, "Microstrip Patch Antenna With Defected Ground Structure for Cross Polarization Suppression," in IEEE Antennas and Wireless Propagation Letters, vol. 4, pp. 455-458,2005.
[12] D. Ahn, J.-S. Park, C.-S. Kim, J. Kim, Y. Qian, and T. Itoh, “A design of the low-pass filter using the novel microstrip defected ground structure,” IEEE Trans. Microwave Theory Tech., vol. 49, no. 1, pp. 86–93, Jan.2001.
[13] Engheta and R.W. Ziolkowski, “A positive future for doublenegative metamaterials”, IEEE Microwave Theory Tech., vol. 53, no. 4,pp. 1535–1556, 2005C.

102



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