Regular Shaped DGS on SQMSA to Enhance the Performance

Vidyadhar S. Melkeri[1], P V Hunagund[2]

[1] *Research Scholar, Department of Applied Electronics Gulbarga University, Kalaburagi-06, Karnataka, India*
[2]*Professor, Department of Applied Electronics Gulbarga University, Kalaburagi-06, Karnataka, India*

Abstract: **- Miniaturization and performance enhancement of the antenna is the major task in the field of microwave engineering. In this paper Square Mictrostrip antenna is designed for 2.4GHz frequency. For the antenna miniaturization and Bandwidth Improvement Regular Shaped DGS on Square microstrip Patch antenna (SQMSA) is used. The Design of DGS has been analyzed for different regular shaped slot DGS. The Simulation process has been done through High Frequency electromagnetic field Simulation Solution (HFSS-2013) which uses the highly accurate finite element method (FEM). The properties of antenna such as reflection co-efficient, bandwidth, virtual size reduction are determined and compared with the conventional Antenna without DGS. It is found that the antenna resonates at 1.6GHz with bandwidth 38 MHz and overall size reduction is found to be >53.12% in comparison with convention antenna. Further it's also observed that simulated antenna has application in L-band and satellite phone.**

Keywords- **Square Microstrip Patch antenna (SQMSA), VSWR, Defected Ground Structure, Return Loss, HFSS**

I. INTRODUCTION

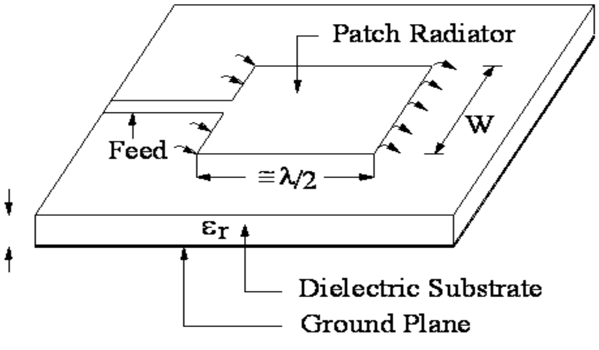
In today's wireless communication, such as Satellite communication and Mobile communication, global positioning system (GPS) ,WiMax, RFID and WLAN and medical application. The requirements of antenna for wireless communication application are small, low cost and low profile. Microstrip antenna meet all this requirement. Although Microstrip patch antennas have many very desirable features, they generally suffer from limited bandwidth. So the most important disadvantage of microstrip resonator antenna is their narrow bandwidth. To overcome this problem without disturbing their principal advantage (such as simple printed circuit structure, planar profile, light weight and cheapness), a number of methods and structures have recently been investigated. [1]

In order to achive the desired performance from an regular Microstrip antenna the efforts are made to study on defected ground structure (DGS) which was previously called as Photonic band gap which works as a band stop filter. DGS slots create an inductance and capacitance in the ground plain which in turn give an advantage to the patch to resonate in the lower band of its regular patch design. [3] Defected Ground Structure is a new face or we can say a new era of research and application on printed circuit Microstrip antennas. Since DGS used antenna has a different ways of understanding about the Microstrip antennas it is being introduced in this paper to give a broad perspective and understanding about DGS. Intentionally created error or the slot in the ground plane of a Microstrip antenna is referred as the Defected Ground Structure (DGS) and is used for different applications. The defects introduced in the ground plane can be single or multiple. The defects are introduced to reduce the harmonics and to suppress mutual coupling between elements. DGS has opened a new face of exploration in the fields of microwave engineering which leads to thousands of applications and developments till date. Many patents are been already made using DGS in antennas and there are many technical papers, articles. In this paper it is tried to introduce to the new face of development especially in the field of Microstrip antennas, giving an insight to applications and developmental challenges on microstrip antennas in improving, bandwidth, polarization, compactness in size and multiband applications

II. BASIC OF SQUARE MICROSTRIP PATCH ANTENNA

A. Introduction

Microstrip Patch Antenna is also known as a printed antenna, is an antenna fabricated using microstrip techniques on a printed circuit board (PCB). Microstrip antenna are mostly used at microwave frequencies. The Rectangular microstrip patch antenna, microstrip transmission line and ground plane are made of high conductivity metal typically we are using copper material . The patch is of length *L*, width *W*, and sitting on top of a substrate of thickness *h* with permittivity. The upper face is Radiating surface and lower face is acting as a ground. Fig-1 [2]



Square Microstrip Antenna

Fig.1 Shows the Typical Microstrip Patch Antenna

III. ANTENNA DESIGN

The essential parameters for the design are:

- Frequency of operation f_0 = 2.4 GHz
- Dielectric constant of the substrate ε_r = 4.2
- Height of dielectric substrate h = 1.6 mm

For a Square patch, the length L of the patch is usually 0.3333λo < L < 0.5λo, where λo is the free-space wavelength. The patch is selected to be very thin such that t << λo (where t is the patch thickness). The height h of the dielectric substrate is usually 0.003 λo ≤ h ≤ 0.05 λo . The dielectric constant of the substrate (ε_r) is typically in the range 2.2≤ ε_r≤12. Fig-2 [1][2].

The expression for ε_{reff}can be given as:

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

The dimensions of the patch along its length have now been extended on each end by a distance ΔL, which is given empirically as:

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

The effective length of the patchL_{eff}now becomes:

$$L_{eff} = L + 2\Delta L$$

For a given resonance frequency f_0 the effective length is given by as:

$$L_{eff} = \frac{C}{2f_0\sqrt{\varepsilon_{reff}}}$$

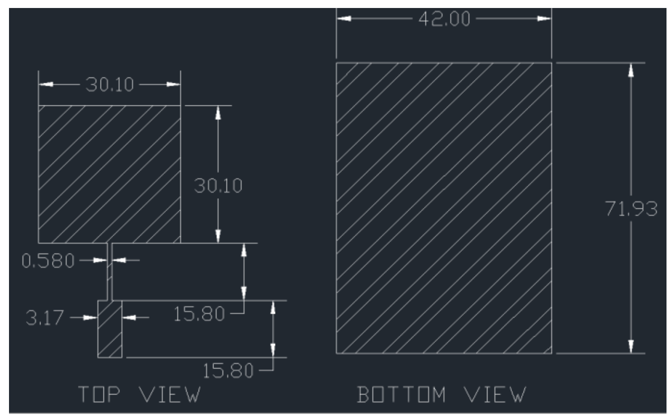
For efficient radiation, the width W is given as:

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

L=29.24mm
W=38.06mm
L_g= 6h + L =71.93 mm
W_g= 6h + W =42mm

Where,
h = substrate thickness
L = length of patch
L_{eff} *= effective length*
W = width of patch
c = speed of light
f_0*= resonant frequency*
ε_r*= relative permittivity*
ε_{reff}*= effective permittivity*

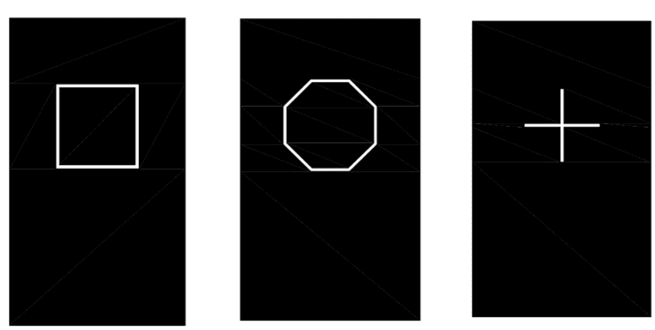
IV. DGS DESIGNS



L_g *= Length of ground plane*
W_g *= Width of ground plane*

Fig.2 Shows the Design of squarer Microstrip Patch Antenna

The regular shaped designs incorporated on the square Microstrip antenna proposed to obtain the enhanced parameter. 5 antennas were designed with different regular shaped defect following the same dimension and position, Fig-3 to observe the improved performance and enhanced parameter which are tabulated the results. [5]



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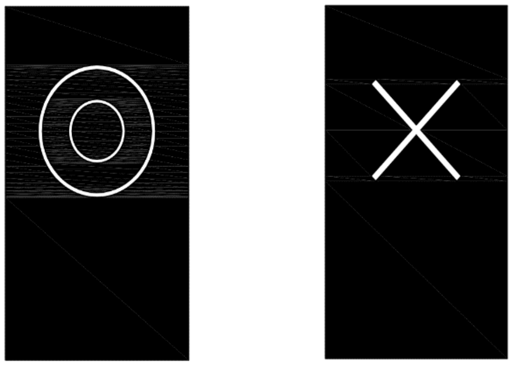

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Fig.3: Regular shaped defects embedded on ground plain below patch

V. RESULT

The S11 parameter Fig-4 for the proposed antennas was calculated and the simulated return loss results of conventional in comparison with the proposed antennas are shown in Figure 4. Return loss is a convenient way to characterize the input and output of the signal sources or when the load is mismatched, not all the available power from generator is delivered to the load. This "loss" is termed as the return loss (RL). The value of return loss is -24.6 dB in this proposed antennas. The achieved return loss value is small enough and frequency is very closed enough to the specified frequency band for 2.4 GHz.

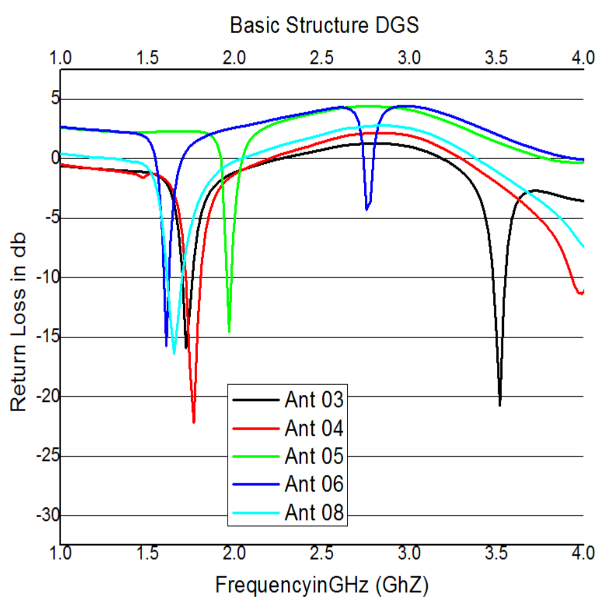

Fig.4: Return loss graph of different antennas

The conventional design antenna is of frequency 2.4GHz but the regular shaped DGS antennas are resonating between 1.5 to 2GHz frequency with return loss up to 24.25dB which can be concluded that the proposed antenna is able to work in lower ISM bands where the size of antenna is reduced to more than 50% the bandwidth is compromised and the antenna designed are narrow band antenna.

Design	Resonating frequency in GHz	Return Loss in dB	Virtual Size Reduction	BW %	BW in MHz
Conventional	2.3	-16.50dB	-	1.27	300
Antenna-3	1.7	-16.6dB	26	2.12	500
Anteena-4	1.6	-24.25dB	32	3.33	510
Antenna-5	2.1	-14.20dB	8	2.50	500
Anteena-6	1.5	-16.93dB	53	2.73	300
Anteena-8	1.65	-15.30dB	30	2.15	200

TABLE.1: Comparison table for reflection coefficients with different modifications in the DGS

The defect structure created on the convention patch antenna has given return loss with resonating frequency less than 50% of conventional band which gives the virtual size reduction up to 53.12%. with enhanced performance, only return loss and the resonating frequency is tabulated other parameters such as radiation pattern VSWR are also improved with defected ground structure on the ground plain.

VI. CONCLUSION

The Microstrip patch antenna plays a vital role in the modern communication system to reduce the cost and improve the parameters. Its seen that parameters of the conventional square patch antenna has improved, by incorporating the defect on the ground plain and keeping the patch undisturbed, the above designs have shown virtual size reduction of 53.12% in comparison with conventional design and has improved bandwidth up to 500MHz and a good impedance and return loss from -14.20 to -24.25. these designed antennas are conventional size of 2.4GHz but after embedding it with defected ground structure the antennas designed have found its application in lower ISM band applications.

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