# 2.45 GHz Microstrip Patch Antenna with Defected Ground Structure for Bluetooth

**Rajeshwar Lal Dua, Himanshu Singh, Neha Gambhir**

***Abstract— In this paper, a rectangular microstrip patch antenna with DGS has been analyzed and simulated for the wireless applications. The proposed antenna has been simulated at 2.45 GHz frequency. This compact antenna fed by Quarter Transformer feeding. This type of feeding is mostly used for impedance matching purposes. The antenna is simulated by the software HFSS. HFSS, high frequency structure simulator is employed to analyze the proposed antenna and simulated results on return loss, the E and H plane radiation pattern and polar plot gain is presented. The resultant antenna with Defected Ground Structure has improved in parameters performance.***

***Index Terms— DGS, HFSS, Microstrip, Quarter.***

## I. INTRODUCTION

Communication plays an important role in the worldwide society now days and the communication systems are rapidly switching from "wired to wireless". Wireless technology provides less expensive alternative and a flexible way for communication. Antenna is one of the important elements of the wireless communications systems. Thus, antenna design has become one of the most active fields in the communication studies. One of the types of antenna is the microstrip patch antenna.

A Microstrip patch antenna is a type of antenna that offers a low profile, i.e. thin and easy manufacturability, which provides a great advantage over traditional antennas. Patch antennas are planar antenna used in wireless links and other microwave applications. The Microstrip technique is a planar technique used to produce lines conveying signals and antennas coupling such lines and radiated waves. It uses conductive strips and/or patches formed on the top surface of a thin dielectric substrate separating them from a conductive layer on the bottom surface of the substrate and constituting a ground for the line or the antenna. A patch is typically wider than a strip and its shape and dimension are important features of the antenna. Microstrip antennas are particularly suitable for use as active antennas. Active antenna is an antenna having all of the necessary components such as an antenna element, a feeding circuits, active devices or active circuits, integrally provided on a monolithic substrate, thus producing compact, low cost, multi-function antenna equipment. Microstrip patch antennas are probably the most widely used type of antennas today due to their advantages such as light weight, low volume, low cost, compatibility with integrated circuits and easy to install on the rigid surface. Furthermore, they can be easily designed to operate in dual-band, multi-band application, dual or circular polarization. They are important in many commercial applications.

However, microstrip patch antennas inherently have narrow bandwidth and bandwidth enhancement is usually demanded for practical applications, so for extending the bandwidth many approaches have been utilized. In addition some applications of the microstrip antenna in communication systems required smaller antenna size in order to meet the miniaturization requirements. So significant advances in the design of compact microstrip antennas have been presented over the last years.

Defected Ground Structure is one of the methods which is used for this purpose. The defect in a ground is one of the unique techniques to reduce the antenna size. So design the antenna with the defected ground structure, the antenna size is reduced for a particular frequency as compared to the antenna size without the defect in the ground.

DGS is realized by introducing a shape defected on a ground plane thus will disturb the shielded current distribution depending on the shape and dimension of the defect .The disturbance at the shielded current distribution will influence the input impedance and the current flow of the antenna. It can also control the excitation and electromagnetic waves propagating through the substrate layer.

When we use microstrip patch antenna the problems which will occurs are high loss and surface waves in the substrate layer, as the losses will always occur in the radiation as the antenna is transmitting the signals .The losses that are due to the surface waves excitation will cause decrease in the antenna efficiency, gain and the bandwidth because when surface waves occur, it can extract total available power for radiation to space wave.

Thus the microstrip antenna without DGS, the bandwidth is narrow and the return loss is high. On the other hand, microstrip antenna with DGS will provide higher operating bandwidth and less return loss. Therefore, the DGS can be integrated onto the ground plane of such antenna in order to improve its radiation, besides not requiring additional circuits are for implementation.

In this paper, using the microstrip patch antenna with Defected ground structure which is very suitable for the applications in the wireless communication systems. DGS is any defect etched in the ground plane of the microstrip can give rise to increasing the effective capacitance and inductance.

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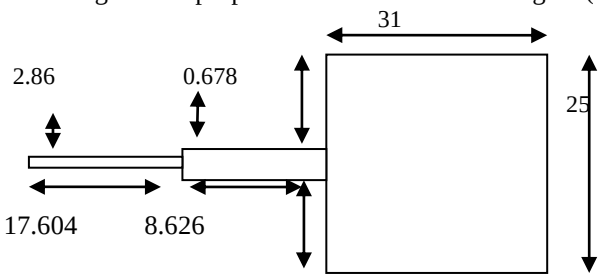
DGS have the characteristics of stopband slow wave effect and high impedance. Different DGS structures are used Each DGS has its own characteristics.

DGS is basically used in microstrip antenna design for different applications such as antenna size reduction, cross polarization reduction, mutual coupling reduction in antenna arrays, harmonic suppression etc. DGS are widely used in microwave devices to make the system compact and effective. Therefore, in this paper we design a microstrip patch antenna with Defected Ground Structure for bluetooth to determine the effect of using DGS.

## II. ANTENNA AND DESIGN SIMULATION

The design of the proposed antenna is shown in figure (1).




This figure shows the microstrip rectangular patch antenna with quarter transformer feed. In this proposed antenna rectangular shaped patch is used and feeding which is used to patch antenna section to 50Ω transmission line.

The most commonly used configuration for the patch antenna is rectangular. It is easy to analyze using both transmission line model and cavity model which are most accurate for thin substrates. A quarter transformer feeding is used to excite the antenna. This feeding is often used for matching purposes. The rectangular patch antenna dimension is 15mm×18mm using the dielectric substrate having permittivity 3.2 and thickness is 0.762mm.The dimension of quarter transformer feed which is used for the rectangular patch antenna of the resonant frequency 5 GHz are length 9.5mm and width 0.56mm and feed line width is 1.83mm which results in a good match with 50Ω.

The design of proposed patch antenna with DGS is shown in the figure (2).

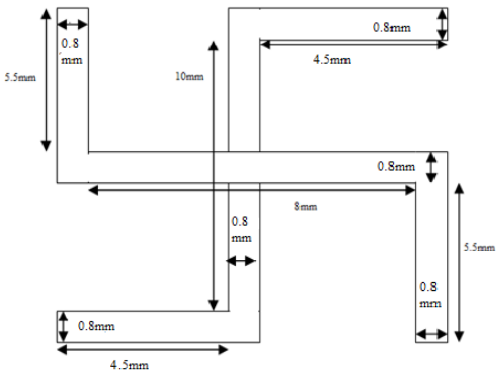



**Fig.(2) DGS**

This figure shows the process of building the new shaped DGS patch antenna. In this antenna design, a rectangular patch on the upper plane of the antenna and etched meander shape structure on the ground plane. The dimension of swastik shaped DGS are8 mm, 4.5mm, 5.5mm, 10mm, 4.5mm, 5.5mm in length and 0.8 mm is wide.

## III. RESULTS

The antenna performance with DGS has been investigated through simulation via a finite element program HFSS. High frequency structure simulator is used for analyze the antenna with DGS.The simulation results of Microstrip rectangular patch antenna with DGS are shown in the figures (3) .

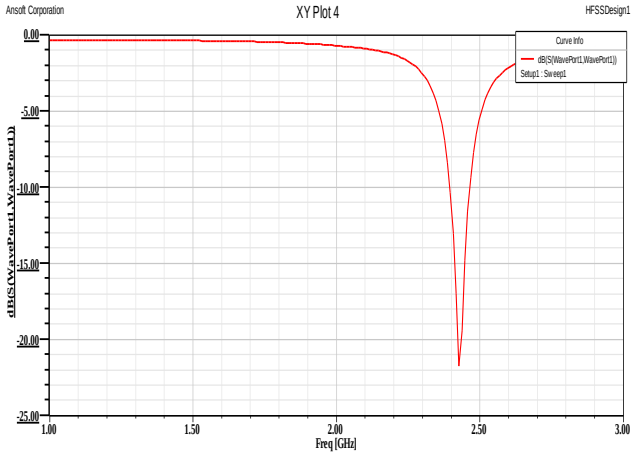



**Fig.(3.1)Return loss of antenna with DGS for 2.45 GHz**

The figure(3.1) shows the return loss of the antenna with DGS.The result shows return loss -10dB down for the bluetooth.The return loss graphs shows S-parameter versues frequency for which antenna is designed.The antenna which is designed shows return loss at 2.45GHz frequency.

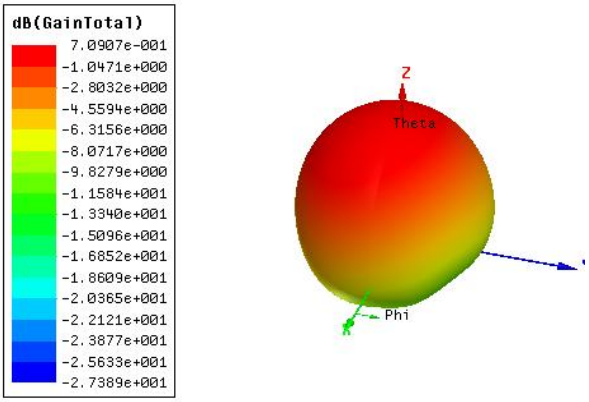



**Fig.(3.2)3D polar plot of antenna with DGS for 2.45 GHz**

The 3D view for the gain of antenna with DGS is also shown in the figure(3.2).The gain of antenna with swastik shaped structure is efficient for antenna to operate well at 2.45 GHz frequency.

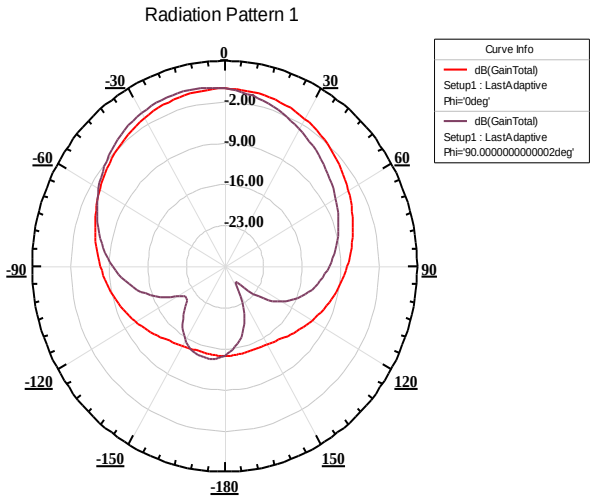
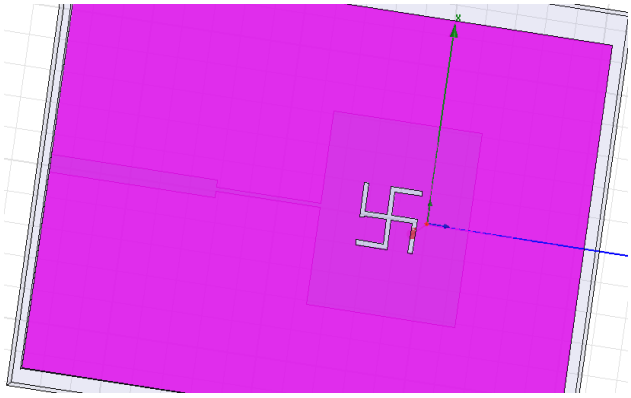



**Fig.(3.3)Radiation pattern of antenna with DGS for 2.45 GHz**

The radiation pattern of antenna is also shown in figure(3.3) in which fields are presented.In this radiation pattern both E and H plane are presented.



**Fig(3.4) View of DGS with Rectangular Patch Antenna for 2.45 GHz**

The Defect in the ground in swastik in shaped of the rectangular patch antenna with quarter transformer feeding is shown in the figure(3.4).This figure shows the designing of swastik shaped with the help of using the software HFSS.

## IV. CONCLUSIONS

This new patch antenna with Defected Ground Structure (DGS) demonstrate properties: improved returning loss, VSWR bandwidth, gain of the antenna as compared to the conventional antenna. These fundamental parameters are modeled with the equations and estimated with HFSS software and measured the result of the antenna designing with DGS with network analyser. The effects of introducing DGS into the ground plane of the antenna have been successfully investigated. The antennas operate well at their corresponding frequencies of operations. The rectangular patch antenna designed with swastik structure DGS shows gain of 7 dB.

Moreover, the radiating patch area is smaller as compared to the conventional antenna without DGS. So, this antenna design with DGS not only improve the parameters of the antenna without DGS but also can provide a smaller size of radiating patches, which will cause an overall reduction in antenna size.

## REFERENCES

1. Ashwini K. Arya, M. V. Kartikeyan, A .Patnaik, "Defected Ground Structure in the perspective of Microstrip antenna," Frequenz, Vol.64, Issue5-6, pp.79-84 , Oct 2010.
2. L. H. Weng, Y. C. Guo, X.W. Shi , X. Q. Chen," An overview on defected ground structure," Progress in electromagnetic Research B, Vol.7, pp.173-189, July 2008.
3. "Microstrip patch antenna," www. electronicshome.com, Jan 2007.
4. H. M. Chen, "Microstrip fed dual frequency printed triangular monopole antenna," Electron Letter, Vol.38, pp.619-620, June 2002.
5. W. L. Stutzman and G. A. Thiele, Antenna Theory and design ,second edition John Wiley & Sons,1998,pp.172-173.
6. C. A. Balanis, "Antenna Theory and Analysis," Second Edition, John Wiley & Sons, 1997.
7. Keith R. Carver, James W. Mink, "Microstrip Antenna Technology," IEEE Transactions on Antenna and Propagation Vol.29, No.1, Jan1981.
8. Jong –Sik Lim, Jun-SeokPark,Young-Taek, Dal Ahn,Sangwook Nam, "Applications of Defected ground structures in Reducing the size of Amplifiers," IEEE Microwave and Wireless Components Letters ,Vol.12,No.7, July 2002
9. R.B.Waterhouse, "Microstrip patch antenna, a designer guide," Kluwer Academic publishers 2003.

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Professor **Rajeshwar Lal Dua** a Fellow Life Member of IETE and also a Life member of: I.V.S & I.P.A, former "Scientist F" of the Central Electronics Engineering Research Institute (CEERI), Pilani has been one of the most well known scientists in India in the field of Vacuum Electronic Devices for over three and half decades. His professional achievements span a wide area of vacuum microwave devices ranging from crossed-field and linear-beam devices to present-day gyrotrons He was awarded a degree of M.Sc (Physics) and M.Sc Tech (Electronics) from BITS Pilani. He started his professional carrier in1966 at Central Electronics Engineering Research Institute (CEERI), Pilani. During this period, indigenous know how was developed for several types of fixed frequency and tunable magnetrons of conventional and coaxial type. He headed the team for the production of specific Magnetrons for defense and transferred the know how to industries for further production. He also has several publications and a patent to his credit.

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