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Design of Rectangular Microstrip Patch Antenna with I-shaped DGS for Satellite Communication

Vaishali Kirar ,Sonam Ratohre
MTech Student Department of Electronics & Communication, VITS Bhopal (M.P)
HOD ECE Department of Electronics & Communication, VITS Bhopal (M.P)
Email-Vaishali.kirar18@gmail.com,rathore.005sonam@gmail.com

Abstract—The paper presents the designs of s-band antenna for communication at 4Ghz.One of the antenna is Rectangular Microstrip Patch Antenna(RMPA) and another antenna is Rectangular Microstrip patch antenna with I shaped DGS,basic property of the antenna like simulated design, Return loss, directivity, Radiation Pattern and bandwidth are discussed. When the antenna designed with I shaped DGS its performance enhance greatly its losses decreases up to 114.12% and bandwidth of the antenna with DGS increases up to 5.819% and size of the antenna with DGS is also reduced, it is very good achievement in Microstrip patch antenna for satellite communication.

Keywords—Rectangular Microstrip Patch Antenna (RMPA), DGS(Defect Ground Structure),bandwidth, return loss, directivity.

I INTRODUCTION

Microstrip antennas for commercial systems require low-cost materials, simple and inexpensive fabrication techniques. Antennas are the essential communication link for aircrafts and ships. Antennas for cellular phones and all types of wireless devices link us to everyone and everything. With mankind's activities expanding into space the need for antennas will grow to an unprecedented degree.

Antennas will provide the vital links to and from everything out there Most of the rapid advances in microstrip antennas took place in the 1980s.Firstly; these were driven by defence and space applications. Then this technology is growing rapidly in the commercial sector. Specifications for defence and space applications antennas typically emphasize maximum performance with little constraint on cost. On the other hand, commercial applications demand low cost components, often at the expense of reduced electrical performance.[1]

The parameters of antenna such as Reflection coefficient, Gain, VSWR and Band width, with and without DGS are measured using Network Analyzer. The main focus of this paper is to improve bandwidth so that patch antenna is used for wide band applications and study effect of DGS on antenna parameters. In this paper simple RMPA is designed and its performance parameters are compared with RMPA having defected ground plane. The antenna is simulated at 2.4 GHz using CAD-FEKO simulation software .This work mainly includes modification of antenna ground plane called as Defected Ground Structure (DGS) [2].

The phased antenna array is used as the receiving antenna in a commercial reader system; experimental results indicate that the coverage of the RFID system with the phased array antenna is superior to with a conventional broader beam width microstrip patch antenna. Different parameters of antenna like VSWR return loss and radiation pattern are calculated using MATLAB coding and hence their graphs are plotted in accordance with the simulated results using SONNET software. Moreover the antenna achieved and measured demonstrates a good agreement between simulation and typical results. [3]

The antenna having the property of high harmonics rejection at unwanted frequencies at 2.0131GHz, and 2.457GHz, 2.565GHz as the designed frequency is 1.3 GHz and return loss is decreased about 43.17%by the DGS structure. It is also used to remove the harmonics and reduce the size of antenna. [4]

In the paper, the design of a microstrip-fed monopole antenna with a wide slot ground plane for uwb applications is presented. A wide slot ground plane is inserted in the ground plane and etched. The substrate used is fr4 epoxy with a thickness of 1.6mm. The size of the antenna is 30*30mm, hence it's a compact one..[5]

In the paper, E-shaped microstrip patch antenna with slot is proposed for ISM BAND application. The proposed antenna project is about microstrip antenna with meandered ground plane. The design adopts contemporary techniques; coaxial probe feeding, E-shape patch structure and slotted patch. shows an comparative impedance bandwidth and its gain table for various shape arrangement. The entire project is design and simulated in an soft HFSS software. [6]

When human body is presented near the antenna the antenna performance such as S11 and bandwidth are affected, the result demonstrates that the new antenna has negligible effect compared with that of the rectangular patch antenna In this paper we present a new patch antenna as a hexagonal patch operating in the Industrial Scientific Medical(ISM) frequency band at 2.45 GHz, the proposed antenna is verifying using to different numerical techniques which are Finite Element Method FEM and Method of Moment MoM, the compression results give us good agreement. [7]

The proposed antenna gives a bandwidth of 4.84 to 6.56 GHz for S11<-10dB. The antenna has the dimensions of 20 mm by 15 mm by 0.8 mm on FR4 substrate. Rectangular slot and step have been used for bandwidth improvement A novel miniature wideband rectangular patch antenna is designed for wireless local area network (WLANs) applications and operating for 5-6 GHz ISM band, and wideband applications. [8]**.**

This paper attempts to design a triple band h-slot antenna by using feed line technique. These bands cover GSM mobile phone system (0.9 and 1.8 GHz) and ISM band which is used for Bluetooth and wireless local area network bands applications. The CST microwave studio software is used as a tool for simulation. This antenna is an attractive candidate for important applications like mobile phone communication systems, mobile phone jammer application [9]

In this paper, a compact slot antenna fed by microstrip-line for 3G/Bluetooth/Wi-MAX and UWB applications with 3.6 GHz band-notched function is presented.The proposed antenna is designed and simulated. Also the antenna is fabricated. The simulated results and measured data show an impedance bandwidth about 7.75 GHz (from 1.9 to 9.65 GHz) for UMTS (1:920-2:170 GHz)/Bluetooth(2:4-2:484 GHz)/WiMAX (2:5-2:96 GHz) and UWB (3:1-9:65 GHz) applications with good radiation characteristics.[10]

II ANTENNA DESIGNS

The antenna physical sizes are an important factor in the design process [9] owing to the miniaturization of the modern mobile terminals. Any technique to miniaturize the size of the MPA has received much attention. Designing requires selection of suitable dielectric constant and substrate height of an antenna as these are basics to design an antenna; these are chosen according to the design frequency our designed frequency band is 4Ghz, here the chosen material is RT duroid 5800 .Here designing of antenna is done using CST-Microwave Studio simulation software and the parameters are displayed by the figures. Designing of the patch has to be taken into consideration, the space available on the fuselage where the antenna has to be installed.

1. Substrate Height =3.5 mm
2. Dielectric Constant=2.2
3. Loss Tangent=.0009

designing of RMPA and its iteration done and their respective results are shown by Graph or figure. The Length and Width of Microstrip Patch Antenna has been calculated by the formula given in References books [11],and all other parameter like cut width, cut depth, continue straight path length and width are calculated by iteration on simulation software and dimensions are stored for best simulation results.

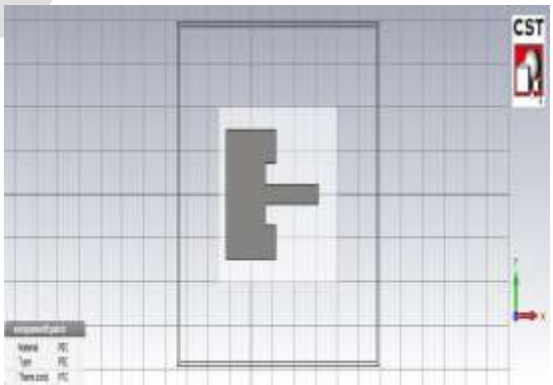

Figure 1Simple RMPA with cut width=14mm, for S-band Communication

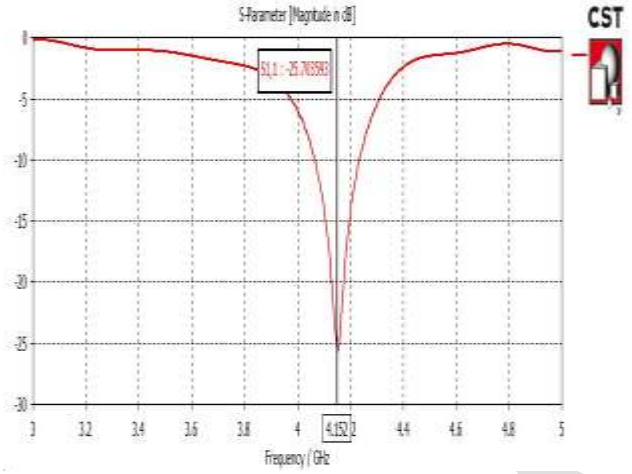

Figure 2.Simulated Return Loss vs. Frequency of Simple RMPA with cut width 14mm is -25.70dB at 4.152GHz

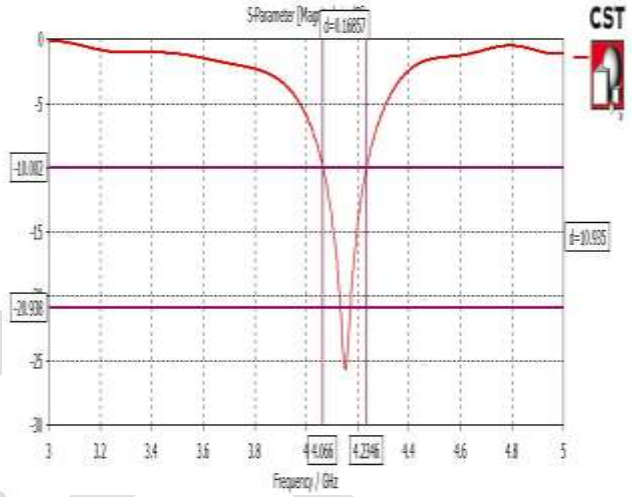

Figure 3.Bandwidth of Simple RMPA with cut width 14mm is 168.57MHz

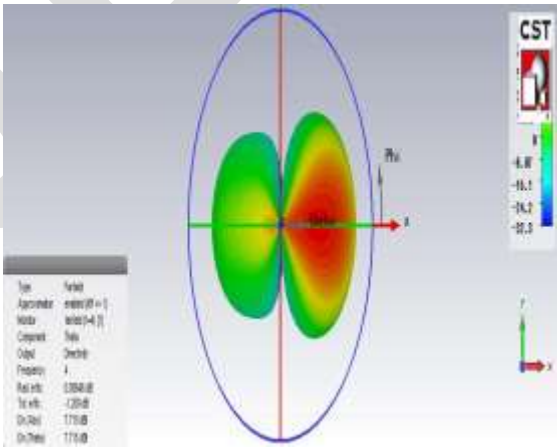

Figure 4. Total Directivity of Simple RMPA with cut width 14mm is 7.715dBi

TABLE I. PARAMETER OF SIMPLE RMPA AT CUT WIDTH 14MM FOR –SATELLITE COMMUNICATION

Frequency(4GHz)	Return loss(dB)	Bandwidth(MHz)	Total Directivity(dBi)
4.152	25.70	168.57	7.715

As it is very clear from the Fig. 1, Fig. 2, Fig. 3, Fig. 4, and Table I that, antenna is working on 4.152GHz and giving return loss 25.70dB, Directivity 7.715dbi, bandwidth of 168.57MHz which is very good for working of an antenna. Now cut width depth increased to 16 mm has been introduced into the simple microstrip patch antenna as shown in Fig. 6. This width is lowering the losses continuously, which is very important aspect to design this antenna system.

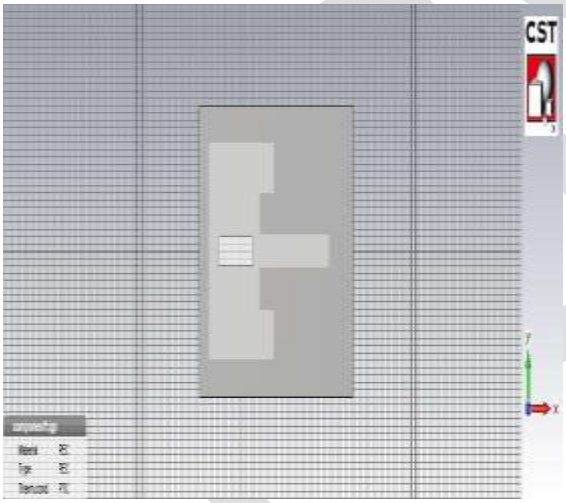

Figure 6.RMPA with I shaped DGS used for S-band Communication

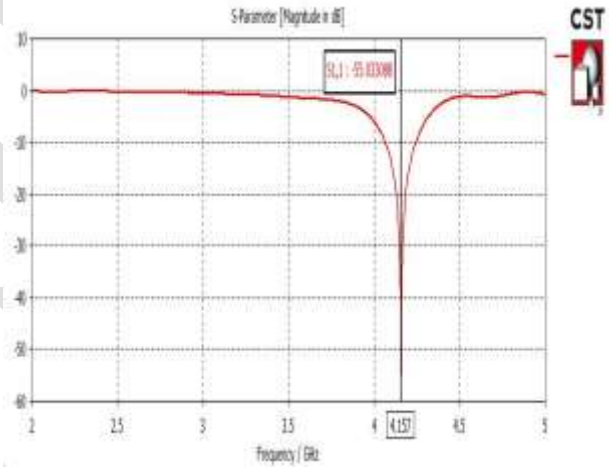

Figure 7.Simulated Return-loss of RMPA with I shaped DGS is 55.03dB at 4.157GHz

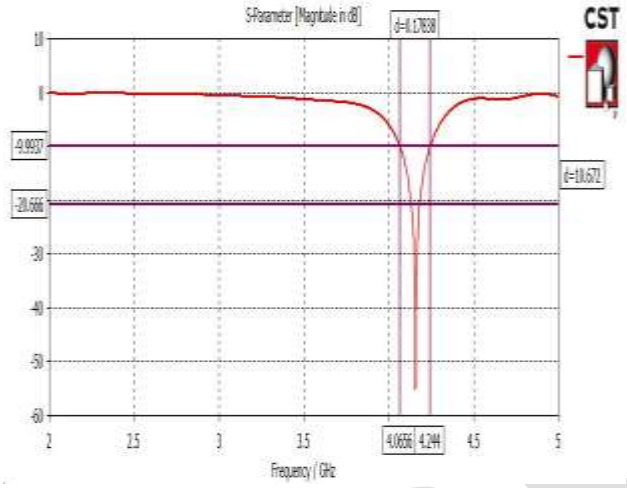

Figure 8. Bandwidth of RMPA with I shape DGS is 178.38 MHz

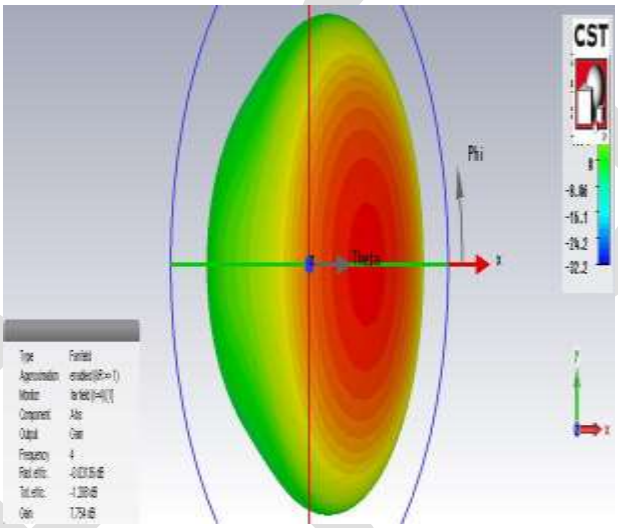

Figure 9.Total directivity of RMPA with I shape DGS is 7.754dbi

TABLE II. PARAMETER OF SLIT -SLOT RMPA FOR ISM-BAND COMMUNICATION

Frequency(4GHz)	Return-Loss(dB)	Bandwidth(MHz)	Total Directivity(dBi)
4.157	55.03	178.38	7.754

III .CONCLUSION

The paper concludes from above figures and tables that the when cut width increases to 16mm from 14mm Antenna characteristics has been improved like return loss are decreased,bandwidth are almost same and, due to this improvement in parameters maximum output is achieved. In this paper improvement in return loss in great amount this will give the maximum output and bandwidth is also increases in great extent, the great satisfaction on patch antenna designing system.

IV. RESULT

Comparative study of both the antenna is done as shown, in Fig. 6 and Fig. 1 the size is reduced. From Fig. 2 and Fig. 7 the Return-loss of antenna is decreased about 114.12%Antenna directivity is increased from7.754dbi to 7.735dbi same clear from Fig. 4 and Fig. 9, antenna total efficiency are almost same as shown in figure 4 and 9, bandwidth is increased to 178.38MHz from 168.57 due to decrement of losses up to 114.12%, shown in Fig. 3 and Fig. 8 and, all these results can be justified from Table I and Table II .the bandwidth of these antennas are too much higher for satellite communication this is main important advantage of this antenna.

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