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A Diamond Shape Slot Rectangular Microstrip Patch Antenna for C- Band Satellite Communication

Prerna Gupta
Arya College of Engg & IT
jaipur.prerna@gmail.com

Heena Gupta
Arya College of Engg & IT
heenagupta2k10@yahoo.in

Abstract—A microstrip patch antennaconsisting of a rectangular patch with diamond shape slot incorporated into patch for C-Band Communication is presented in this paper. The proposed antenna achieves an impedance bandwidth of 4.4 GHz (3.6 GHz to 8 GHz). Maximum return loss is achieved at 4.7 GHz i.e. -63.4 dB. Good return loss and radiation pattern characteristics are obtained in the frequency band of interest. The antenna has a planar rectangular geometry with microstrip line feed and diamond shape slot. The proposed antenna is designed on low cost FR-4 substrate. The antenna is designed and simulated using High Frequency Structural Simulator (HFSS). An extensive analysis of return loss, radiation pettern, gain and efficiency of the proposed antenna is shown in this paper.

Keywords—*Micro-strip, Satellite communication, HFSS, C-Band*

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I. INTRODUCTION

In high-performance applications like spacecrafts, aircraft, missile and satellite, where size, weight, cost, performance, and ease of installation are major constraints, low profile antennas may be required. To meet these requirements, microstrip antennas are used. These antennas are low cost, have a low profile and are easily fabricated. This technology has boosted with the rapid rise of wireless communication technologies.

During the last decade, the cost of the microstrip antenna has reduced, because of the advancement of its technology and increasing investment in this sector commercially. Due to small size and low profile of the microstrip antenna, the satellite communication applications are benefited hugely. These microstrip antennas also have relatively high value of return losses. Research shows that cutting slots in radiating patch and small ground plane shift the operating frequency and increase resonating frequencies [1].

On similar lines this paper describes an antenna for satellite communication using equally spaced four circular slots in radiating patch. C band in communication engineering is defined from 4 to 8 GHz and the antenna's optimum working range lies in this range [6].

The paper is partitioned into three sections. Section I shows the antenna design and its parameters, section II shows the simulated results and analysis and last section gives conclusion of the paper.

II. ANTENNA DESIGN AND ITS PARAMETERS

The proposed antenna design is shown in figure 1. It is designed on FR-4 substrate having relative permittivity εr of 4.4 and loss tangent of 0.021 and thickness of h=1.6

mm. It consists of a microstrip-feed rectangular patch antenna resonates at 5 GHz. The input is given through the port which has an input impedance of 50 ohms. The rectangular patch has diamond shape slot. The dimensions of the microstrip patch and the substrate are shown in Table 1.

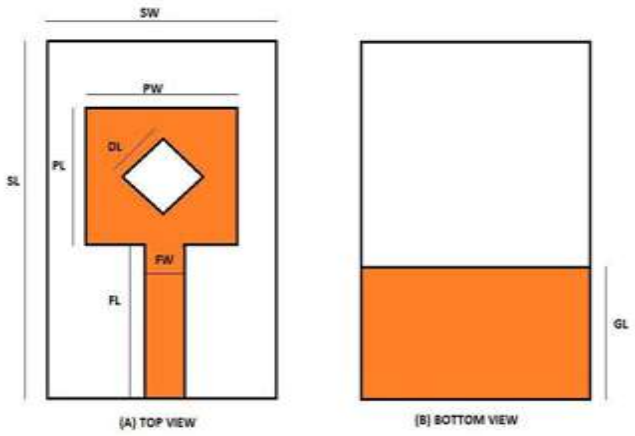

Fig.1 Top and Bottom view of Antenna

TABLE.1Dimensions of Micro strip Antenna

Parameter	Values(mm)	Parameter	Values(mm)
SL	30	POPW	5
SW SH	20 1.6	FL FW	12 2.9
BOX2l	50	PL	12
BOX2w	40	PW	14
BOX2h	21.6	GL	10
DL	4		

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SIMULATION RESULTS AND CALCULATION

A. RETURN LOSS

The rectangular patch antenna has been simulated and analysed with HFSS. Figure 2 shows the return loss curve properties of the antenna, with different varying slots. Two resonance modes are observed, one centred around 4.7 GHz and other around 6.9 GHz.

From the figure it is shown that cutting slot in radiating patch and small length of ground plane in the antenna design gives the improvement of the performance of the antenna.

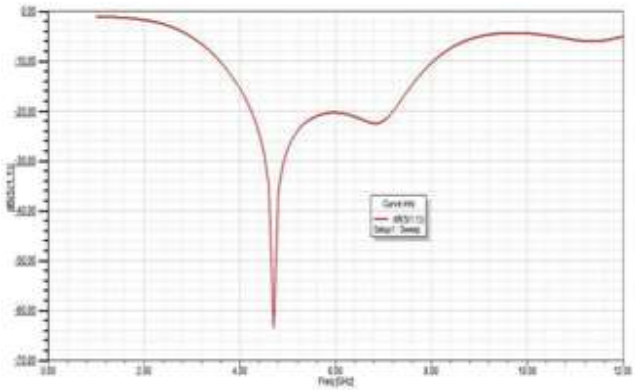

Fig.2 Reflection Coefficient of Proposed Antenna

From figure 2 it can be noticed that the maximum return loss is -63.4 dB at 4.7 GHz. The antenna gives the best performance in the C band (4 to 8 GHz) region for satellite communication [2].

B. VARIATION OF GAIN WITH FREQUENCY

Gain versus frequency curve of proposed antenna is shown in figure 3. Satisfactory Gain of 0.4 dB to 4.30 dB has been achieved from 3 GHz to 8 GHz frequency band. It can be noticed that gain is increased as the frequency is increased.

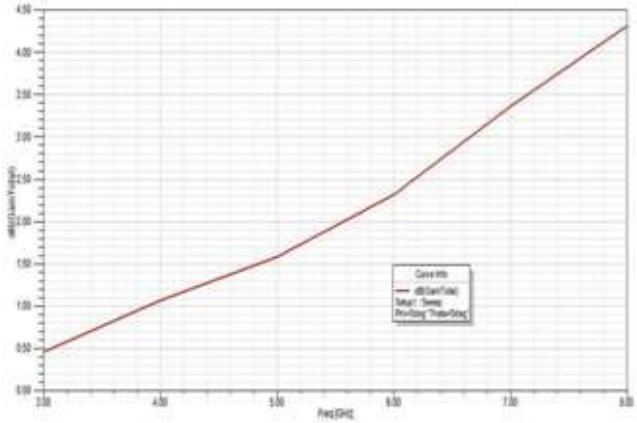

Fig.3 Simulated gain v/s frequency curve for proposed antenna

C. VSWR

Figure 4 shows the variation of Voltage standing wave ratio with frequency for proposed antenna. We have found satisfactory VSWR which is close to 1 for proposed antenna in operational bandwidth. The smaller the VSWR is, the better the antenna is matched to the transmission line and more power delivered to antenna.

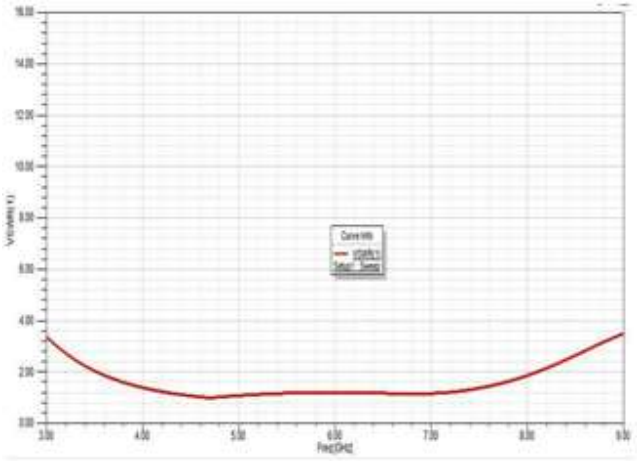

Fig.4. Simulated VSWR curve for proposed antenna

D. 3-D PLOLAR PLOT

The following figure shows simulated 3-D polar plot of gain of proposed antenna at 5 GHz. The contour diagram shows high intensity of radiated power which has been showed by different color scaling. Red color shows high field intensity at frequency of 5 GHz.. Following figure shows that the maximum gain is 3.0717 dB at 5 GHz.

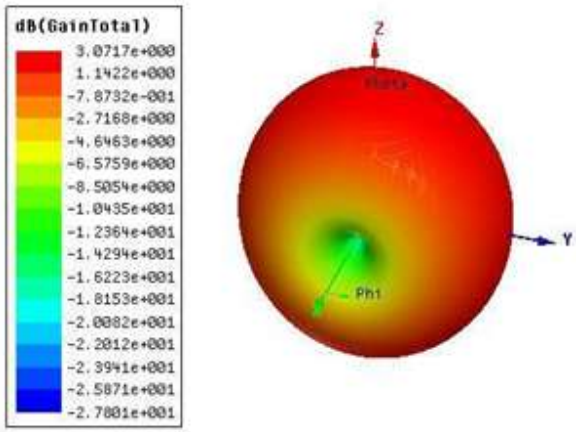

Fig.5 3-D Polar plot of gain at 5 GHz for proposed antenna

IV. CONCLUSION

In this paper, a rectangular patch antenna with microstrip line feed, has been discussed. The designated C Band antenna has a bandwidth from 3.6 GHz to 8 GHz. Diamond

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shape slot has been introduced on the patch to improve return loss. The return loss and radiation pattern for far field have been illustrated in the paper. The simulation results show that the C Band antenna achieves a high return loss beyond -63.4 dB. This antenna results can meet the various requirements for satellite communication applications. The gain and return loss improvement technology will be studied in future with relatively small size.

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