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DESIGN AND SIMULATION OF RECTANGULAR MICROSTRIP PATCH ANTENNA FOR C-BAND APPLICATIONS

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Abstract

This paper represents a compact sized rectangular microstrip patch antenna for C (4.2-6GHz) band applications. This is a dual band patch antenna which operates at uplink frequency (6GHz) and downlink frequency (4.2 GHz) of C-Band. The antenna design consists of a rectangular patch having U-slot. The Patch antenna has overall size of 17mm× 23mm. This antenna is designed on low cost FR-4 substrate (Dielectric constant = 4.3) of thickness h = 1.5 mm.Microstrip patch antenna is excited using line feed technique. The proposed structures were simulated by using the CST microwave simulation software. This proposed antenna is appropriate for the applications of satellite communication systems.

Keywords: *Microstrip Patch antenna, U-shaped Slot, C-Band, CST Software, FR-4 Substrate*

1. INTRODUCTION

In present era, the implication in the structure and escalating the compressed, cheap antennas are stimulated by fast inventions of diverse communication services and other wireless services. [2]Hence, condensed microstrip slot antennas have found improved convention in wireless applications specifically in C band wireless frequency range. Several researchers have focused on improving a variety of antenna considerations such as impedance improvement and size reduction of microstrip antennas. To design procedures that have been deliberated for planar antennas embrace the use of a thick substrates, parasitic patches, E-slot patch, H-shaped patch, U-shaped slot patch, T-shaped parasitic strip and several methods for reducing the size (compact) of the microstrip antenna have already been studied . [3]-[8] It is known that, the resonant frequency of a patch antenna is inversely proportional to dielectric constant. It is also possible to reduce the resonant frequency by using a substrate with high dielectric constant .The rectangular U-slot patch antenna with a line feed had been studied practically. By cutting a square slot at the centre of a rectangular microstrip patch, both compactness and dual frequency operation can be achieved. Broadband devices are mainly operated in our daily lives such like mobile phone, radio, laptop with wireless connection and MSP antennas play a significant task of these devices**.** The most important drawbacks of MSP antennas in basic form are constricted bandwidth and low gain. Then many techniques are used to boost bandwidth and gain of MSP antennas. By using thick substrate with low dielectic constant and compact slotted patch can augment the bandwidth and gain of antennas. The MSP antenna have some excellent features such as low cost, low profile, light weight, high efficiency, simply manufacture and easy to implement with circuits .The design formation components of antenna become miniature in size and have low dispensation cost.[9]-[12]

2. FUNDAMENTAL PARAMETERS TO DESIGN AN MICROSTRIP PATCH ANTENNA

The three essential parameters for the design of a rectangular microstrip patch antenna are:

i. Frequency of operation (f_o): The resonant frequency of the antenna must be selected appropriately. The resonant frequency selected for design is at C band that is at 4 GHz and 6 GHz.

ii. Dielectric constant of the substrate (ε_r): The dielectric material selected for the design is FR4-epoxy which has a dielectric constant of 4.3. A substrate with a high dielectric constant reduces the dimensions of the antenna.

iii. Height of dielectric substrate (h): For the microstrip patch antenna it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate is selected as 1.574mm.[1]

3. GEOMETRICAL DESIGN OF ANTENNA

The conservative rectangular microstrip patch antenna (RMPA) is contrived using a commercially available low

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cost glass epoxy substrate material of thickness h = 0.15 cm with relative permittivity εr =4.3. This antenna is designed by user friendly and the most efficient CST Microwave Studio 2010 software. First, by using some mathematical equations and three essential parameters, length and width of the patch, substrate and ground were calculated. Table I shows the geometrical dimensions of the designed rectangular patch antenna at C-band (4.2GHz-6GHz).Figure1shows the side view geometry of RMPA.The RMPA geometry includes the U shaped radiating element. This antenna is powered through a simple 50 Ohms microstrip line feed. Impedance matching is done by doing optimization of line feed.

Table I: Geometrical Dimensions for Antenna Design

Sr. No.	Antenna Dimensions	Values
1.	Substrate Length (Ls)	26.4mm
2.	Substrate Width(Ws)	32.44mm
3.	Substrate Thickness	1.5 mm
4.	Patch Length (L)	16.6mm
5.	Patch Width(W)	22.64mm
6.	Dielectric Constant	4.3
7.	f_{r1}, f_{r2}	4.2 Ghz,6Ghz
8.	Slot Length	8.3mm
9.	Slot Width	5mm

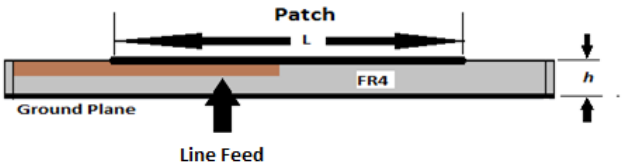

Fig 1: Side View of Patch Antenna

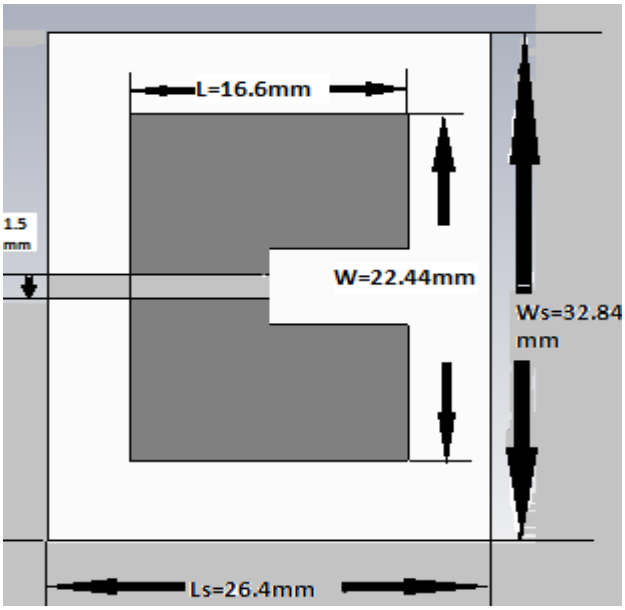

Fig 2: Geometrical Design of Rectangular Microstrip Patch Antenna

4. RESULTS AND DISCUSSION

Figure 3 and 4 show the simulated results of the proposed antenna. The antenna has been simulated using CST Microwave Studio 2010 software. Graph between Return losses and frequency is obtained. As shown in below figures propose antenna operates at two operating frequencies which is the range of C-band. One is at 4.2 GHz which is the downlink frequency of C-band and another one is 6 GHz that is defined for the uplink frequency of C-band.

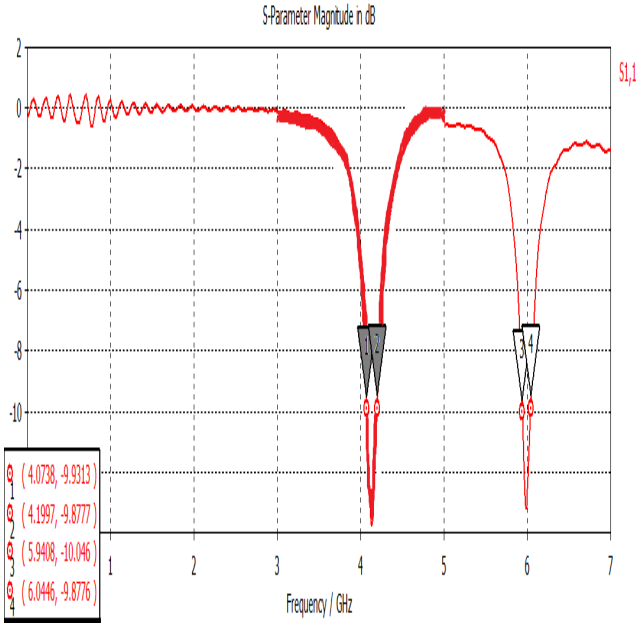

Fig 3: Return Loss for Downlink Frequency

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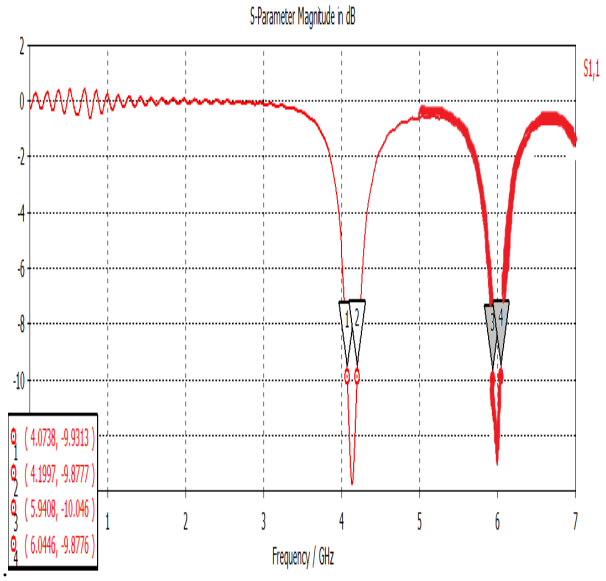

Fig 4: Return Loss for uplink frequency

Figure 5 and 6 show the radiation pattern with gain values of the proposed antenna at uplink and downlink frequencies.In this case,bandwidth values are obtained between the points where -10 dB line cuts the curve between return loss and frequency.Figure 7 and 8 show the smith chart for 4.2 GHz and 6GHz frequency.These figures reveal that designed microstrip patch antenna is perfectly matched at 50 Ohms without using any external source for impedance matching.Table II shows the summary of all the resultant values obtained after following an optimization and simulation process**.**

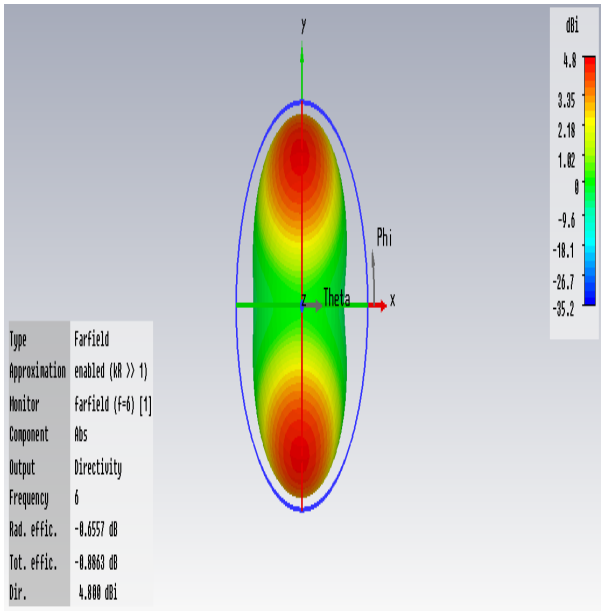

Fig 5: Directivity/Gain Plot for Uplink Frequency

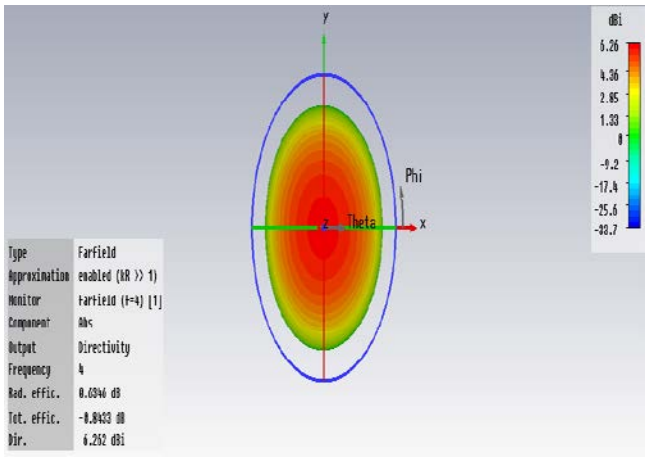

Fig 6:Directivity/Gain Plot for Downlink Frequency

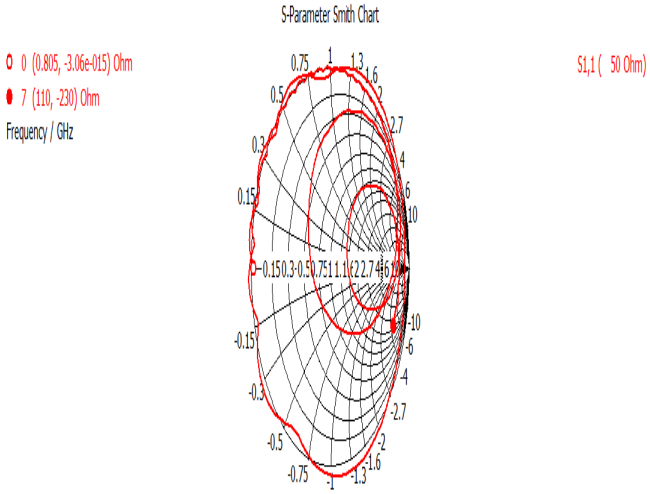

Fig:7 Smith Chart for Uplink Frequency

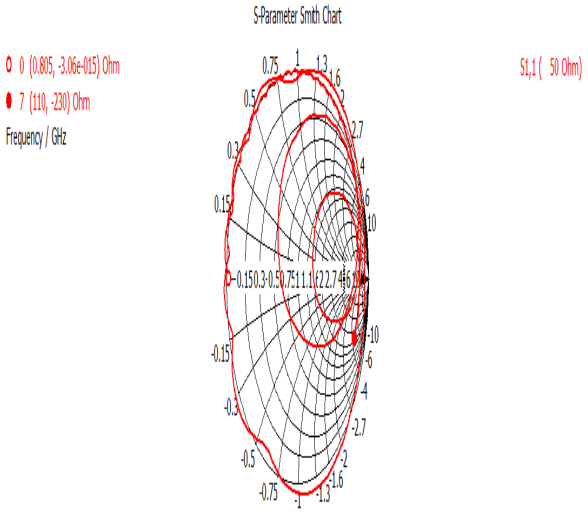

Fig:8 Smith Chart for Downlink Frequency

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SUMMARY OF RESULTS:

Table II: Optimized Values for C-Band

Sr. No.	Band	C-4GHz	C-6 GHz
1.	Resonant Frequency	4.2 GHz	6 GHz
2.	Bandwidth	105 MHz	68 MHz
3.	Bandwidth %	10.5 %	6.8 %
4.	Gain	6.2 dBi	4.8 dBi
5.	Impedance	50 Ohm	50 Ohm
6.	Return Loss	-14 dB	-13 dB

5. CONCLUSION AND FUTURE SCOPE

A rectangular patch antenna by is designed and simulated using CST software. The designed antenna is incredibly effortless in appearance and diminutive in volume covering the C band(4 Ghz-6Ghz) on a glass epoxy FR-4 substrate with dielectric constant of 4.3 with thickness 1.5 mm.This antenna can be used for satellite applications in C band. Simulation outcomes demonstrate that the antenna has 50 ohms impedance and resonating at both uplink(6 Ghz) and downlink (4.2 Ghz) frequencies with return loss of -14dB and -13 dB respectively .The antenna performance considerations such as return loss, VSWR, impedance bandwidth, gain have been calculated. Simulated results illustrate that the proposed antenna could be a superior candidate for C band applications. Future work involves the improvement procedures for the bandwidth of such antennas. Designs using diverse substrate and structure can be taken into deliberation for the future research. Different patches, dimensions and feeding techniques may also influence the performance of the antenna.

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