iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** VI **Month of publication:** June 2021

DOI: https://doi.org/10.22214/ijraset.2021.34971

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VI Jun 2021- Available at www.ijraset.com

Design of a 24GHz Rectangular Microstrip Patch Antenna for Wireless Applications

Dr. N. Srinivasa Rao[1], Nakka Vijay Kumar[2], Akshita Saxena[3], S. Mohammad Sohail[4]
[1]*Professor and HOD, Dept. of ECE, Matrusri Engineering College*
[2, 3, 4]*UG Student, Dept. of ECE, Matrusri Engineering College*

Abstract: ***The microstrip antenna required for higher frequency application is to be light in weight, easy to fabricate and small in size. As the applications in S-band and Ku-band are increasing with the increase in technology the requirement for higher data rate so the proposed work is to design a 24GHz (ka band) rectangular microstrip antenna with stripline feeding, return loss to be less than -20dB and VSWR less than 0.5. The substrate is chosen to be RT/duroid 5880 with relative permeability 2.2. it is capable of covering satellite application, telemetry. HFSS software tool is used to design the antenna.***
Keywords: Antenna, dielectric, Length,width, patch, return loss, VSWR, HFSS, radiation.

I. INTRODUCTION

Antennas play a very critical role in the era of wireless communication. It acts like a transceiver that is capable of transmitting and receiving electromagnetic (EM) signals into and from free space whenever the impedance of the antenna matches with free space. Antennas are capable of transmitting and receiving both analog and digital signals. Though there are many varieties of antennas available, due to the compatibility, low cost, low profile, light in weight, planner structure, microstrip antennas are preferred in the design.

These suffer from the issues of low power handling capability, narrow bandwidth, but these disadvantages are minute compared to their disadvantages.

Many applications are using the frequencies of S and Ku bands, as the applications are increasing the fading effect due to adjacent channel interference increases so to overcome this problem the antennas are designed at high frequencies.

There doesn't disturb the existing applications, up and down converters are used in transmission and reception end to convert these high frequencies to the existing applications. At high frequencies, losses are also high so substrate material is chosen with a very low loss tangent.

This paper presents microstrip antenna works at 24GHz, HFSS software is used for design and simulation. The design consists of a patch, ground plane, dielectric substrate that have their own uses and applications. The patch and ground plane is made up of conducting material copper and attached to either side of the dielectric substrate. The dielectric substrate is RT/duroid 5880 this substrate is best suited for higher frequency operation.

The patch has many shapes but for simplicity rectangular is chosen. The patch uses stripline feeding. This project used application like satellite, telemetry.

The paper is continued as follows: Section 2 discusses the literature survey, section 3 about the antenna design and analysis, section 4 about the simulation results that were obtained.

II. LITERATURE SURVEY

Ogunlade Michael Adegoke, Ismael Saad Eltoum has presented a design of rectangular microstrip patch antenna at 2.4 GHz WLAN applications [1] uses stripline feeding technique and FR4 epoxy dielectric substrate. another design of flexible microstrip patch antenna of 2.4GHz operation frequency using software HFSS [2] by Shivam Mokha, Shubham Jangir, Shreyas Pimple, which used for mobile application, explain the software uses for antenna designs. Mosin I Memon, Prof.Anurag Paliwal are presented a Microstrip patch antenna Design calculator [3], the calculation of length and width of the patch and dielectric substrate by using theoretical equations, Design and simulation of the microstrip antenna for 2.4 GHz HM remote control system [4], Design and Analysis of 28GHz Rectangular Microstrip Patch Array Antenna. [7], Design of Rectangular Microstrip Patch Antenna.2016 [5].

After making sufficient information from the literature the antenna can be designed by selecting proper frequency and dielectric substrate for suitable application, calculate parameters like length and width by theoretical equations and design in software HFSS.

©IJRASET: All Rights are Reserved

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VI Jun 2021- Available at www.ijraset.com

III. ANTENNA DESIGN AND ANALYSIS

A. *Parameters to Design Antenna*

They are four essential parameters to design a rectangular microstrip patch antenna

1) Length Of Patch(L)
2) Width Of Patch(W)
3) Operating Frequency(f_r)
4) Dielectric Constant Of The Substrate (ε_r)
5) Height Of Dielectric Substrate(h)

B. *Design Procedure*

Initially, the design of the microstrip antenna is to choose operating frequency according to the application by that choose the proper substrate required. In our design, the working frequency is 24GHz, which is in the Ka-band region and the substrate is RT/duroid 5880. Next accordingly select the shape of the patch here for simplicity rectangular patch is chosen then calculate the required length and width of the patch, choose the height of the dielectric substrate in our design it is 0.254mm. In the next stage select the feeding method used is stripline feeding.

By chosen proper frequency, length, width, dielectric substrate, we can improve the performance of antenna-like

1) Gain
2) Return loss
3) VSWR
4) Radiation pattern
5) Bandwidth

C. *Theoretical Formulas*

The calculation of microstrip patch antenna parameters with the following equations

1) Because parts of fields from the microstrip patch conductor exist in air, we get a parameter effective dielectric constant(ε_{eff}):

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

2) The width of the patch is:

$$w = \frac{c}{2f_r\sqrt{\frac{\varepsilon_r+1}{2}}}$$

3) The actual length of the patch is:

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

Where,

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

The effective length of the patch is:

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}}$$

4) Calculation of ground plane L_g and W_g: The size of the ground plane is greater than the patch dimensions by approximately six times the height of the substrate.

$$L_g = 6h + L$$
$$W_g = 6h + W$$

Where,

h=height of the dielectric substrate
f_r = resonant frequency
c= speed of light in free space
ε_r = relative permittivity of the substrate.

©IJRASET: All Rights are Reserved

After calculation of length and width for 24GHz, then design in software HFSS. According to the values first, draw the ground plane then add RT/duroid 5880 substrate with dielectric constant 2.2 with the thickness of 0.254mm on it. Then by the length and width, draw a rectangular patch on top of the substrate. Stripline feeding is used because field strength is strong at the centre of the patch and add it to the rectangular patch. Then simulate and observe the result.

IV. SIMULATION RESULTS

The proposed antenna has been designed and simulation is validate using the HFSS software tool and select a bandwidth to observe the behaviour of the antenna. The results are explained in terms of Gain, Return Loss, VSWR.

A. Software Model

1) *Design of 24GHz:* Rectangular microstrip Antenna designed with RT/duroid substrate with dielectric constant 2.2 using HFSS software is as shown in figure 1 and 2. Figure 1 shows the top view of the antenna with the dimensions, figure 2 shows the trimetric view of the antenna.

The dimensions of the antenna as shown in table 1.

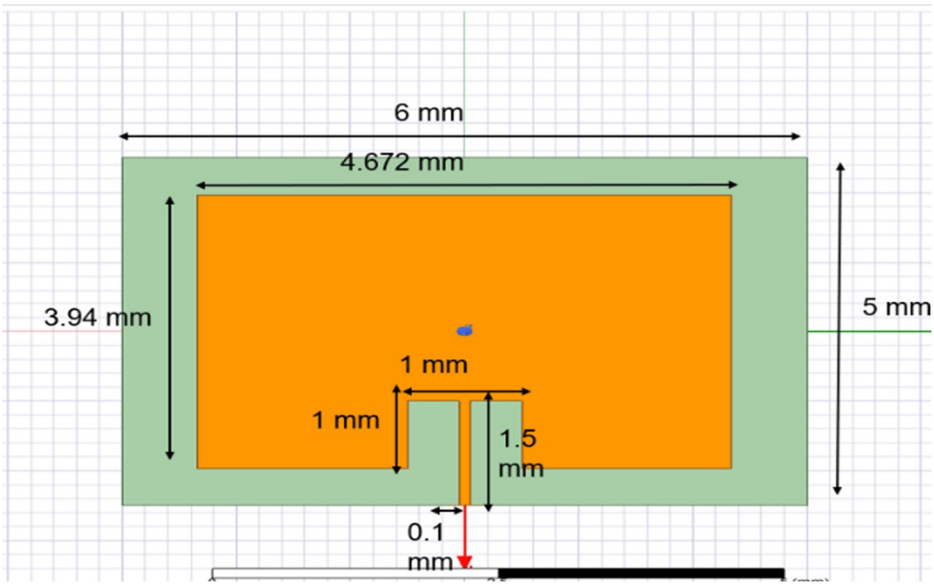


Figure 1: Top view of the enhanced antenna

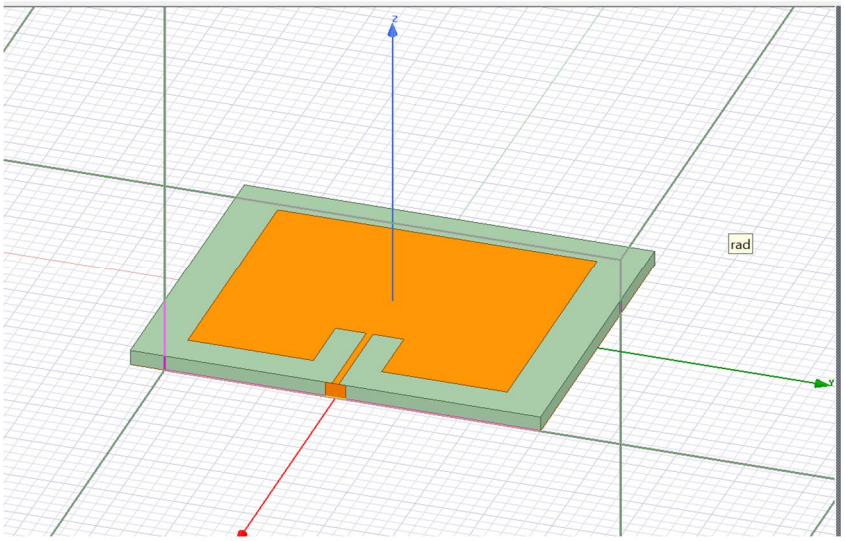


Figure 2: Trimetric view of the enhanced antenna

©IJRASET: All Rights are Reserved

Substrate parameter	values
L	3.94mm
W	4.62mm
H	0.254mm
ε_r	2.2

Table 1: the dimension of the enhanced antenna

B. Results OF 24GH$_Z$

1) Voltage Standing Wave Ratio (VSWR): Figure 3 shows the VSWR graph of the simulated antenna. From the figure, it can be noticed that the VSWR obtained at 24GHz frequency is nearly 0.2, which indicates that the antenna has very few reflections.

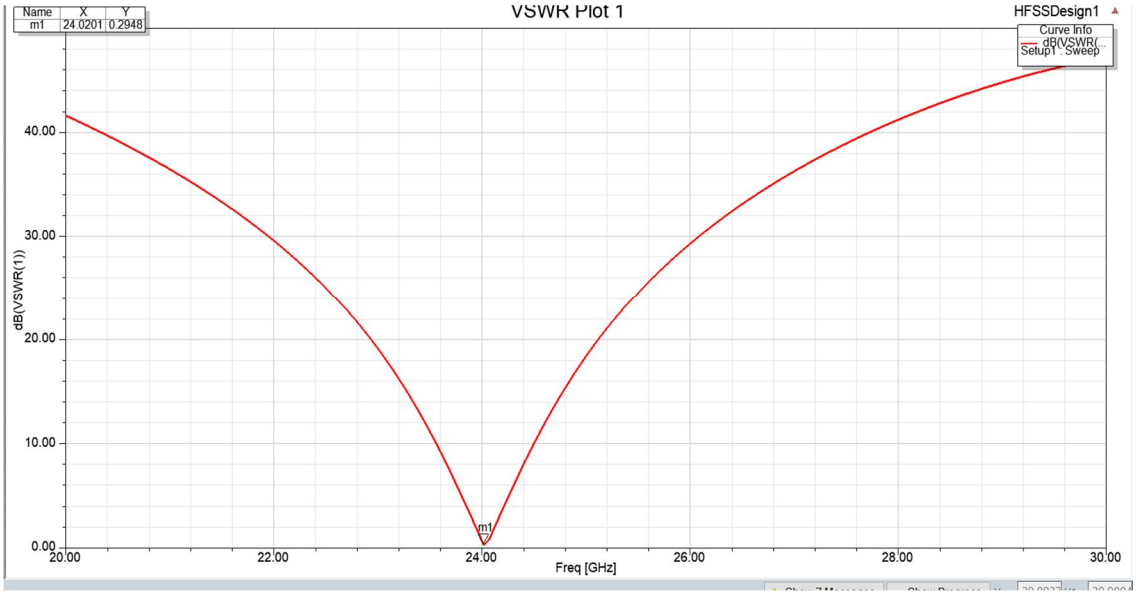


Figure 3: VSWR Graph

2) S-Parameters: Figure 4 shows the S-parameter graph. S-parameter indicates the reflections from the antenna. It also indicates for what frequencies the antenna is going to radiate. From figure 4 it can be observed that the antenna radiates at 24GHz. And the reflection coefficient is -35.4dBi.

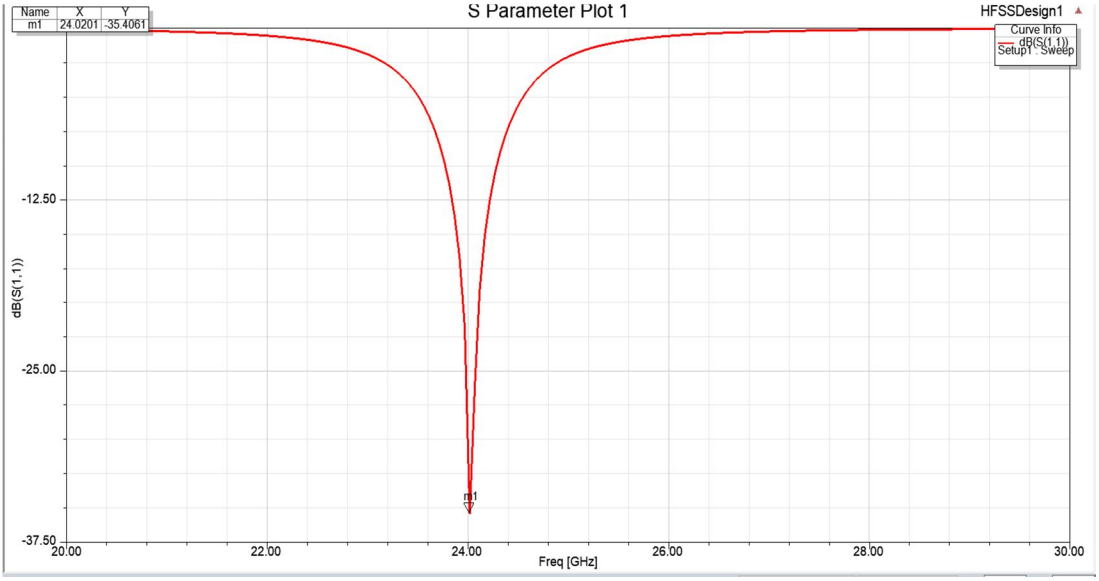


Figure 4: S-Parameter Graph

©IJRASET: All Rights are Reserved

3) Gain: Figure 5 shows the polar pattern of the gain. It is observed that at 24 GHz frequency the gain obtained was 7.5dBi.

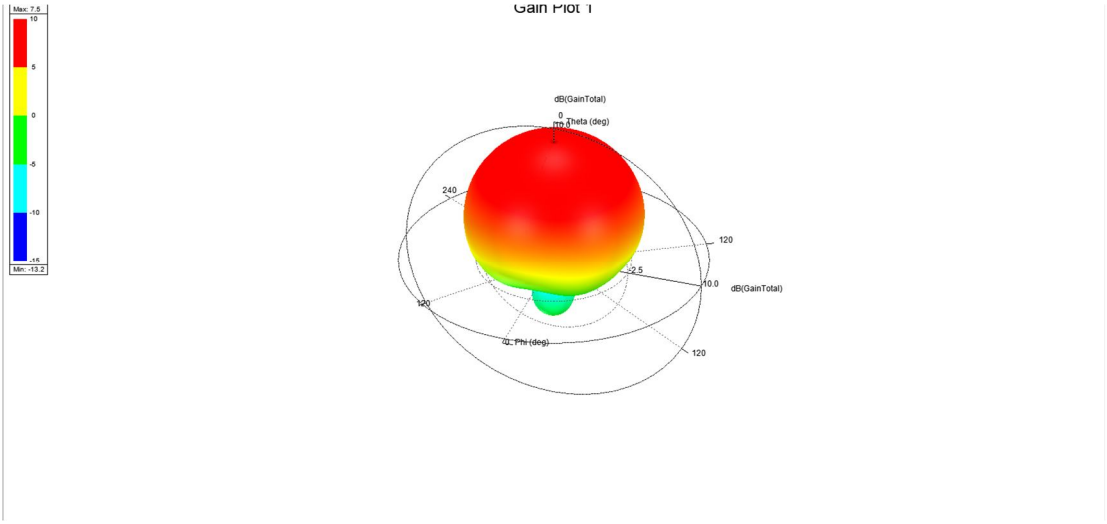


Figure 5: 3D Polar Plot of Gain

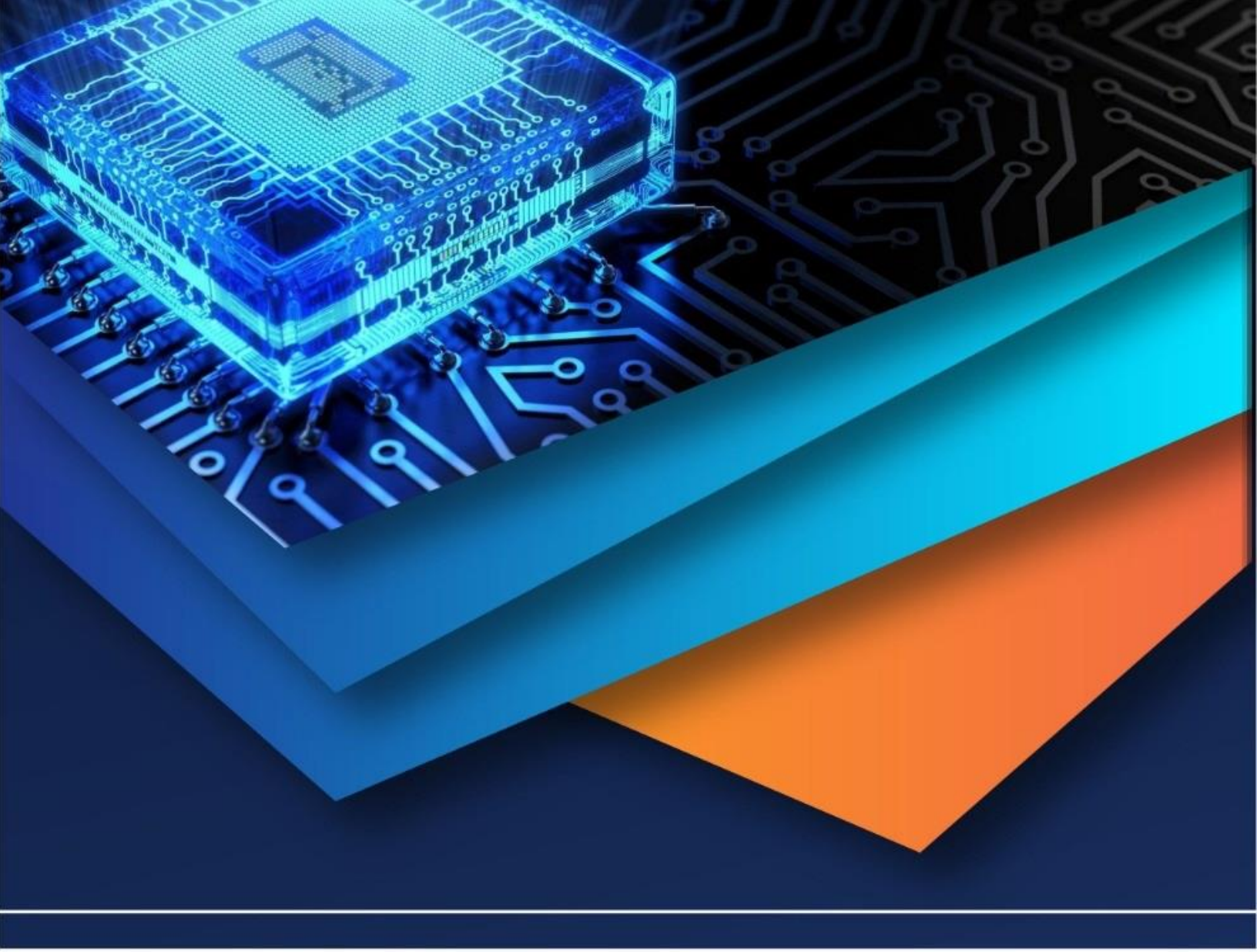
V. CONCLUSION

The proposed rectangular microstrip antenna with stripline feeding works at frequency 24GHz with the dielectric substrate RT/duroid 5880 with dielectric constant 2.2 which work for higher frequency operation. The patch length and width is 3.94mm and 4.96mm, with a dielectric height is 0.254mm respectively. The 24GHz the gain is 7.5dB, S_{11} is -35.4dB, VSWR is 0.2 dB. This good gain and S11 might be useful for satellite application.

VI. REFERENCES

[1] Ogunlade Michael Adegoke, Ismael Saad Eltoum, "Analysis and design of rectangular microstrip patch antenna at 2.4 GHz WLAN applications.", IJERT, Vol. 3-2014.
[2] Shivam Mokha, Shubham Jangir, Shreyas Pimple, "Design of flexible microstrip patch antenna of 2.4GHz operation frequency using HFSS."2015.
[3] Mosin I Memon, Prof.Anurag Paliwal, "Microstrip patch antenna Design calculator." Vol. 2 Issue 9, September – 2013.
[4] Deng Qun, Zhang Weiqiang, Jiang Jintao," Design and simulation of the microstrip antenna for 2.4 GHz HM remote control system". (ICSEM-13),2013.
[5] Houda Werfelli, Khaoula Tayari, Mondher Chaoui, Mongi Lahiani "Design of Rectangular Microstrip Patch Antenna.2016.
[6] Prasanna Ramachandran, T.S.Keshav, Laxmikant Minz Vamsikrishna Parupalli and Shaibal Chakravarty. "Antenna Design, Simulation and Fabrication" 2006-2007.
[7] Mohamed Bakry El_Mashade & E.A.Hegazy "Design and Analysis of 28GHz Rectangular Microstrip Patch Array Antenna." Volume 17, 2018.
[8] Ashish Kumar, Bimal Garg," Rectangular Microstrip Patch Antenna Loaded With Double Orthogonal Crossed Slits In-Ground Plane ", International Journal of Advanced Technology & Engineering Research.2011.
[9] Ms Laveena Mirchandani and Ms Lavina Solanki-" A Rectangular Micro Strip Patch Antenna For Ultra Wide Band Applications Using HFSS", IOSR-JEEE, Vol-12,2017.
[10] Lin, Y. C. and K. J. Hung, Compact ultra-wideband rectangular aperture antenna and band-notched designs," IEEE Trans. Antennas Propagation, Vol. 54, No. 11, 3077, 2006.
[11] C.A.BALANIS,ANTENNA THEORY ANALYSIS AND DESIGN ,JONE WILEY,c1997.

©IJRASET: All Rights are Reserved



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)