JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Design of Flexible Antenna for S-Band Satellite Communication Applications

[1]I. Naga Venkata Phani Kumar,[2] K.Sk. Mujeeb Rahaman, [3]K. Bhargav
[1]Student,[2]Student,[3]Student
Department of Electronics and Communication Engineering
R.V.R. & J.C. College of Engineering, Guntur, India

Abstract: This paper presents a Flexible patch antenna for S-Band Satellite Communications and Wireless applications. In Recent times, the flexible antenna has much demand due to its usage in Various applications like wearable devices, military devices etc. The antenna is designed on a flexible material like RT/duriod 5870 which has a dielectric constant(ε_r) of 2.33. The antenna is having overall dimensions of 17mm x 25mm x 0.787mm. The antenna is simulated using Computer Simulation Technology (CST) microwave Studio Software. Due to its flexibility and miniature in size, the antenna has favorable gain and high efficiency. The parameters of the designed antenna like return loss, Gain, VSWR obtained from simulation are much useful for S-band Satellite Communication Applications

Keywords: Flexible patch antenna, S-band(2GHz-4GHz), Satellite Communication, RT/duriod 5870, flexible substrate, VSWR, Return loss.

Introduction:

Flexible antennas are much useful in various applications like S-band Satellite communication, wireless applications. The flexible antennas allow to conform different shapes and surfaces. These antennas are typically made of thin and lightweight materials. The S-band frequency operates in the range of 2GHz-4GHz. S-band frequencies are useful for different applications like radar and satellite communications and optical communication etc.

In this paper we have designed a flexible patch antenna which is much suitable for S-band Satellite Applications. This microstrip patch antenna mainly consists of three layers which are ground, substrate and patch layers. The ground and patch layer should made of the Conductive materials and substrate layer is made of flexible substrate material. To create a flexibility of antenna we have to use flexible substrates like RT/duriod 5870,5880, Polyethylene Terephthalate, Polyimide etc. The proposed designed antenna operates at the frequency 3. 2GHz which is the range of S-band frequencies. The designed antenna has a good bandwidth of 400MHz from 3GHz to 3.4GHz. This antenna has good efficiency i.e., 93 percent at 3.2GHz with a gain approximately 2dB.

Material Description:

1.Conductive material:

The conductive material used in this antenna is Copper. Copper is used in most of the antenna designs due to its high thermal conductivity, excellent electrical conductivity and ease of fabrication. The conductive metal used in ground and patch layers in this antenna is Copper. The properties of copper are shown in Table-I.

Table-I: Properties of Copper material

Parameter	Value
Electronic Mobility	32 $cm^2 V^{-1} s^{-1}$
Current density	~10^6 A cm^{-1}
Tensile strength	587 MPa
Thermal conductivity	400 W $m^{-1} K^{-1}$
Density	2700 kg m^{-3}

2.Substrate material:

The Substrate material used in this antenna design is RT/duriod 5870 with a dielectric constant of 2.33(ε_r=2.33) and loss tangent (tanδ=0.0005). This is a flexible substrate which provides excellent electrical and thermal properties. Rogers is the good material for temperature sensitive projects. It has lowest electrical loss for reinforced PTFE material and low moisture absorption. The properties of the Rogers RT5870 are shown in Table-II.

Table-II: Properties of RT/duriod 5870 material

Parameter	Value
Dielectric constant(ε_r)	2.33
Dissipation factor(tanδ)	0.0005
Moisture absorption	0.2%
Thermal Conductivity	0.22 W/m/K
Density	2.2 gm/cm^3
Dielectric thickness	0.254mm - 1.57mm

Antenna Design:

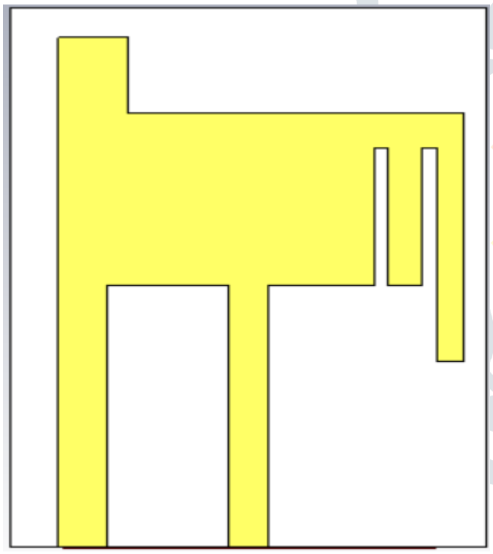

Figure-I: (a) Front View

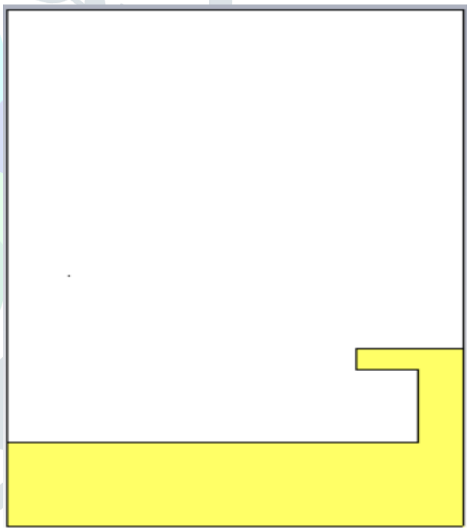

Figure-I: (b) Back View

Figure 1 shows the designed flexible patch antenna with a semiflexible material like RT/duriod 5870 having the thickness of 0.747mm is used as a Substrate. The antenna having dimensions 17mm x 25mm x 0.747mm with a partial ground plane. The antenna Size is small or miniature in size due to modification of etching slots in the main radiator. The feeding technique here used in the antenna is microstrip line feeding in the centre of the antenna as shown in figure. This antenna is simulated in Computer Simulation Technology (CST) Software.

Dimensions of the antenna:

The dimensions of the proposed designed antenna are as shown in figure-II and their values in Table-III.

Table-III: Dimensions of the antenna

parameter	Description	Value
L	Length of the Substrate	25mm
W	Width of the Substrate	17mm
Lg	Length of Ground plane	4.1mm
Wg	Width of the Ground plane	4mm
ht	Thickness of the Ground and patch	0.035mm
hs	Thickness of substrate	0.744mm
Lp	Length of the patch	11.5mm
Wp	Width of the patch	12mm
Wf	Feedline width	1.4mm
Lf	Feedline length	12.1mm
Ws	Slot Width	0.5mm
Ls	Slot Length	6.4mm
Ws1		2.5mm
L1		3.5mm
Lg1		8.6mm
Wr		1.75mm

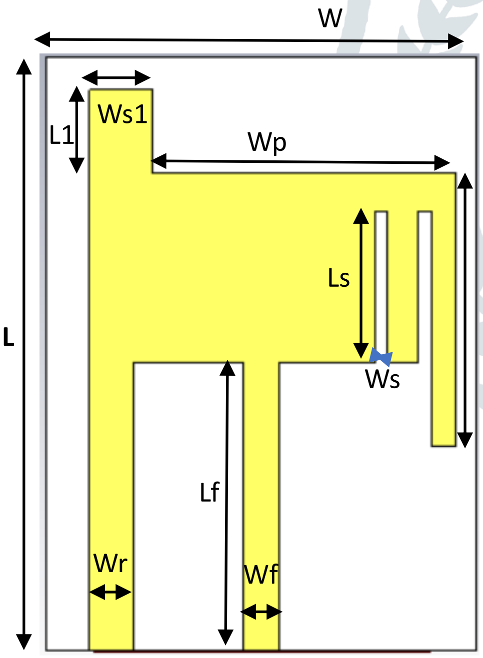

Figure-II (a): Front View

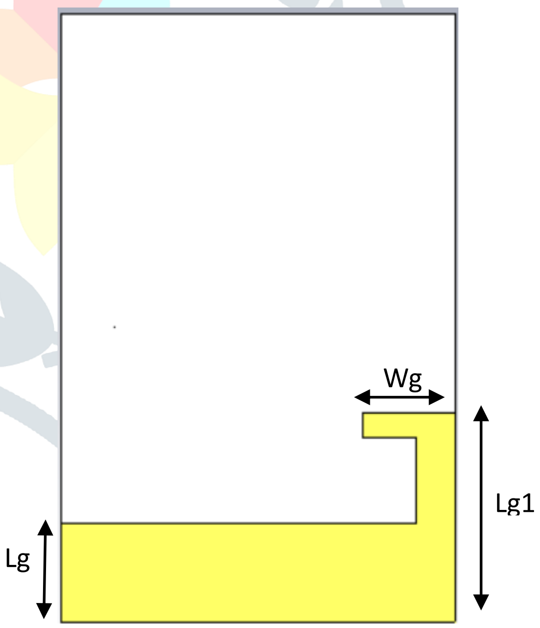

Figure-II (b): Back View

Tool Description:

CST is widely used for designing and analysing the various antennas. It includes a range of tools and features for analysing and optimizing antennas compared to other software tools. It is licensed software where researchers, engineers and designers are used. Here we used a student edition CST software which is free licensed.

Simulation Results:

1.Reflection Coefficient:

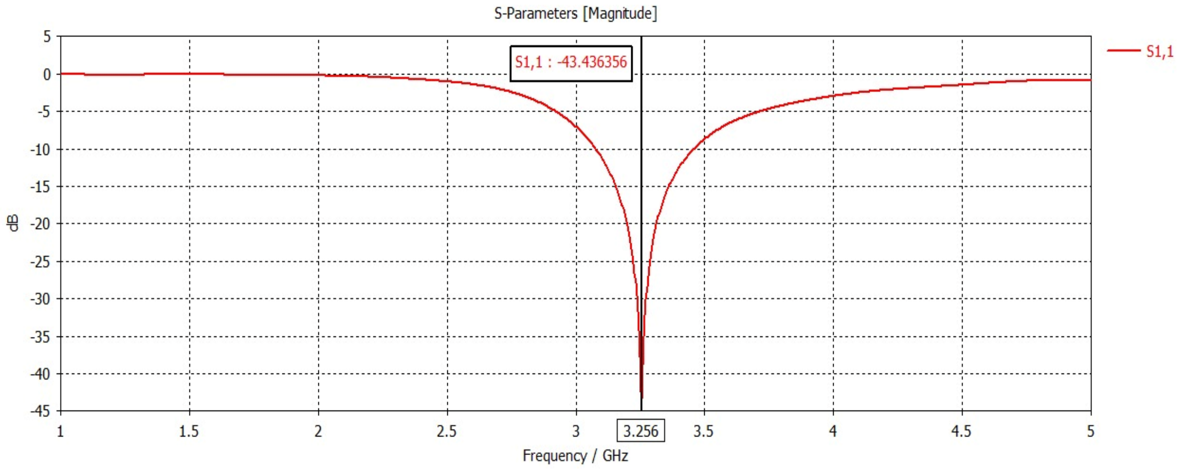

Figure-III (a): Reflection Coefficient(S-Parameters)

From the figure-III(a) we observe that the reflection coefficient of the designed antenna is -43dB at 3.2GHz.Reflection coefficient describes how much of power is reflected back and it describes the performance of antenna.

2. VSWR:

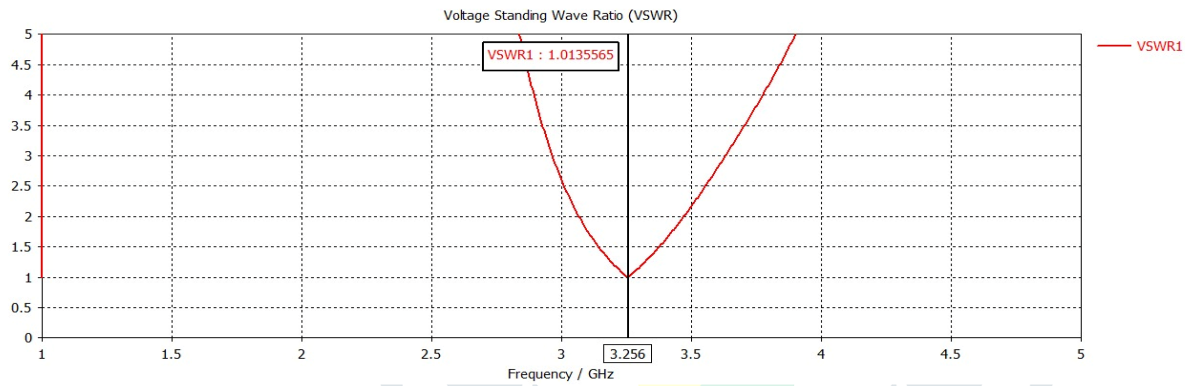

Figure-III (b): VSWR

From figure-III(b) we observe that the VSWR of designed antenna is 1. VSWR stands for Voltage Standing Wave Ratio. If VSWR is 1 then it is said to be perfectly matched antenna. Here we can say that the designed antenna is perfectly matched antenna.

3. Gain and Directivity:

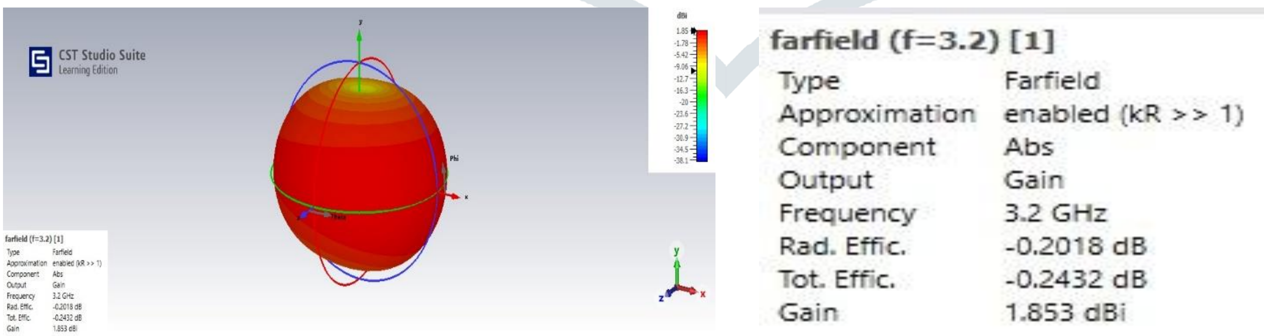

Figure-III(C): Gain of the designed antenna

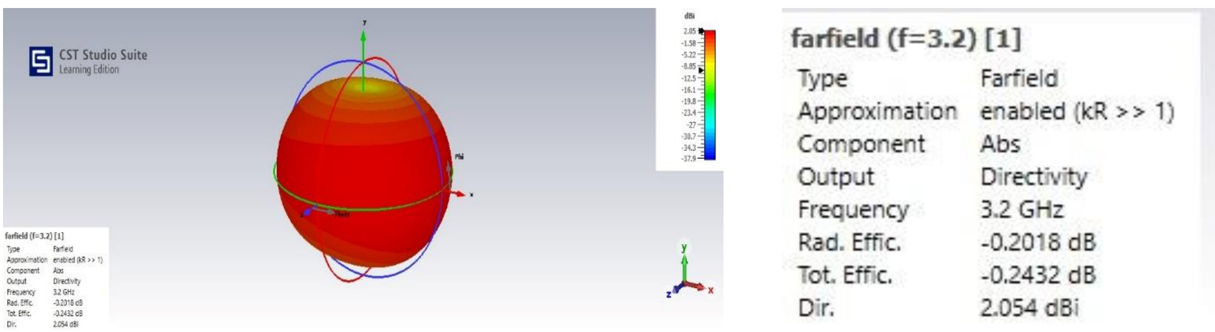

Figure-III(d): Directivity of designed antenna

From the figure-III (c) we observe that the Gain of designed antenna is 1.85dB at 3.2GHz. Gain describes the ability of antenna to radiate in any direction. From figure-III(d) we observe that the directivity of designed antenna is 2.0dB. Then the efficiency of the designed antenna is 93% at 3. 2GHz.Efficiency is the ratio of gain to the directivity of designed antenna.

4. Radiation Pattern:

From above figure we can observe that the radiation pattern of designed antenna is bidirectional in E-plane and omnidirectional in H-plane.

Conclusion:

In this paper it has been concluded a low-profile and miniaturized flexible patch antenna is designed for S-band satellite communications and wireless applications. It operates at 3.2GHz which is at S-band Frequency range and its return loss is -43dB.The efficiency of the designed antenna is 93% at 3.2GHz.Comparing to the existing model of antenna, the results of this antenna is used in various applications like aerospace, rockets, microwave ovens, missiles.

References:

[1] Amor Smida 1,2, Amjad Iqbal 3,4, (Student Member, IEEE), Abdullah J. ALazemi 5, (Member, IEEE), Mohamed I Waly 6,7, Ridha Ghayoula 8,9, and Sunghwan Kim 1, "Wideband Wearable antenna for Biomedical Telemetry applications", IEEE Access r 10.1109/ACCESS.2020.2967413.

[2] Teguh Praludi, Yana Taryana, Ken Paramayudha, Budi Prawara, Yusnita Rahayu, Chaeriah Bin Ali Wael, Yaya Sulaeman, Bagus Edy Sukoco, Ros Sariningrum, Hendrawan Kurniadin, Wahid Nova Nugraha, "Design of Flexible 3.2GHz Microstrip patch antenna for S-band Communication", JET, Vol. 21, No. 2, December 2021, pp. 140-145.

[3] S. Sankaralingam and B. Gupta, "A circular disk microstrip WLAN antenna for wearable applications," in Proc. Annu. IEEE India Conf., Dec. 2009, pp. 1–4.

[4] M.N. Riaz, A. Buriro, A. Mahboob, "A Ground based Fractal antenna for C and S -band Applications" International journal of Advanced Computer Science and Applications, 2019, IJACSA, vol. 10, no. 1, pp. 314-321.