Microstrip patch antenna for C band satellite application

Akshay kumar[1], Logeshwaran[2], Arun[3]

[1,2]PG scholar, Anna university regional campus, Madurai, India.
[3]Assistant Professor, Electronics and communication Engineering,
Anna university regional campus, Madurai, India.

---***---

Abstract - *This paper is proposes about microstrip patch antenna in satellite application. The frequency bandwidth of this antenna is 0.3GHz and its return loss is -24.33dB. This antenna has uplink frequency of 5.9GHz and downlink frequency of 5.1GHz. The design of the patch antenna is calculate, simulated and optimized by HFSS software. In military application this c band satellite antenna is mainly focused over the voice as well as data communication. The favorable frequency of this antenna is 4-8GHz and it can be illustrated in various dimension and used for satellite.*

Key Words: **Microstrip, 4-8GHz, C band, Military satellite, HFSS.**

1. INTRODUCTION

An antenna is unavoidable component of all wireless system. It is used to convert electrical signal to EM waves by acting as a medium between RF transceivers and free space. Many of the antennas are operating effectively in small frequency band as it is resonant device. It is very important to tune the antenna with same band of the RF system to which it is connected in order to avoid the impairment of transmission and reception. As it is a passive device it can only direct to the given input signal in particular direction, it does not amplify the signal. This paper also deals with the performance of compact microstrip patch antenna with different substrate like FR4 and Rogger in experiment [1].

In this paper we knows that rogger is used as dielectric and FR4 for same return loss as it is constructed with 2 stacked patches like upper and lower patch separated as FR4 and dielectric materials [2]. In other case both the two patches are manufactured as FR4 materials which reduce the bandwidth due to higher permittivity which is compensated by introducing parasitic patches [3]. In this paper mainly focused to step impedance microstrip line with compact microstrip UWB antenna. Here this UWB antenna is contain capable of supporting large bandwidth [4]. The technique of Quasi metallic wall which is increases the gain of antenna array. Mainly an antenna CB-CPW is used reduce the wave loss and decrease the antenna radiation efficiency [5]. In this system the separate frequency reconfigurable patch antenna systems that no need to require any control signals from the radio is presented [6]. The optimum frequency range of antenna lies between 4-8GHz as well as used to C band for communication signaling. Here the proposed paper is classified into 3 more sections. Section II shown the proposed military based antenna design and its parameters, section III

reveal the simulation results and calculation and section IV and V hardware and finally closing the paper.

2. GEOMETRY AND STRUCTURE OF PROPOSED ANTENNA

As shown in figure.1 the dimension of the proposed C band microstrip antenna is 40X40mm which is fabricated using copper. The side width of the patch antenna is 1.72mm and it is fed with 50 and feed line is connected to standard connector. The design of the patch antenna is proposed using done by ansoft HFSS software.

The proposed design is the first design in the software model by ansoft HFSS software. The software design simulated the ansoft HFSS software and then analyzing the antenna performance in software model. Then fabricate the hardware model for the proposed design that, which refers from the software model of the proposed antenna.
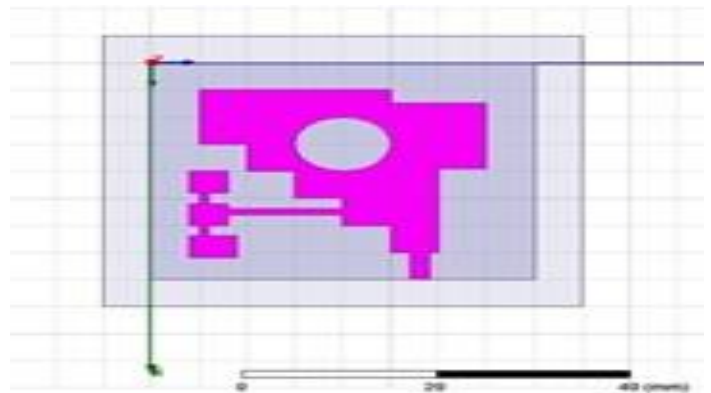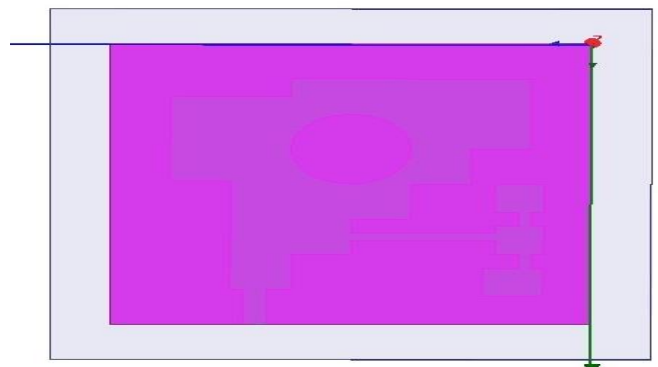

Fig -1: Antenna Design

Fig -2: Ground Plane Structure

2.1. DESIGN EQUATION OF THE PROPOSED ANTENNA

The length (l) and width (w) for designing the proposed microstrip patch antenna is obtained from the following equations from (1) to (4).The microstrip patch antenna width(w) and antenna's effective dielectric constant (ε_{reff}) of the patch can be resolute through the equation (1) and (2).

$$w = \frac{c}{2f}\sqrt{\left(\frac{2}{\varepsilon_r + 1}\right)}, \qquad (1)$$

Where

c = free space velocity of Light

 f = resonant frequency

ε_r = dielectric constant of substrate

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

The extension patch length (Δl) is given by the equation (3) through which the actual patch length (l) can be calculated in from equation (4)

$$\Delta l = 0.412h\frac{(\varepsilon_r + 0.3)\left(\frac{w}{h} + 0.264\right)}{(\varepsilon_r - 0.258)\left(\frac{w}{h} + 0.8\right)} \qquad (3)$$

Where w = width of the Patch

$$l = \frac{c}{2f\sqrt{\varepsilon_{reff}}} - 2\Delta l \qquad (4)$$

The rectangular patch has two slits which cut from its sides. The measurement of the microstrip antenna and the substrate are illustrated in below Table I.

Table -1: Dimensions of Antenna.

| PARAMETERS	DIMENSION (mm)
Patch Length (L)	30mm
Patch Width(W)	30mm
Substrate Length (Ls)	40mm
Substrate Width(Ws)	40mm
Substrate Thickness	1.64mm

3. RESULT AND DISCUSSION

The rectangular patch antenna has been analyzed with HFSS. Fig. 3 reveal the return loss curve properties of the patch antenna, with varying many slots. From the figure it is clear that the addition of slots to the antenna design improved the performance of the antenna. The antenna is specified to work in C band for satellite communication. From Figure 2 the maximum return loss is -24 dB at 7.4 GHz. However there is another frequency of 8.06 GHz with a significant return loss of -21 dB. The antenna gives the best performance in the C band region for a frequency of 7.4 GHz and a return loss of -27.33 dB. The elimination of extra significant frequencies has been done by a bit of compromise on the return loss and making the antenna optimum to work at C band region for satellite based data communication. The radiation pattern of the proposed antenna for far field region in all the configuration slots at a solution frequency range is 7.4 GHz are illustrated in Figure 3, from where it is clearly evident that the radiation pattern in the operation region are stable.

3.1. RETURN LOSS

Simulation result of Returned loss signal for the proposed military based antenna is illustrated in Figure 3.The simulation result of the proposed microstrip patch antenna working frequency is 5.78GHz and 7.48GHz.
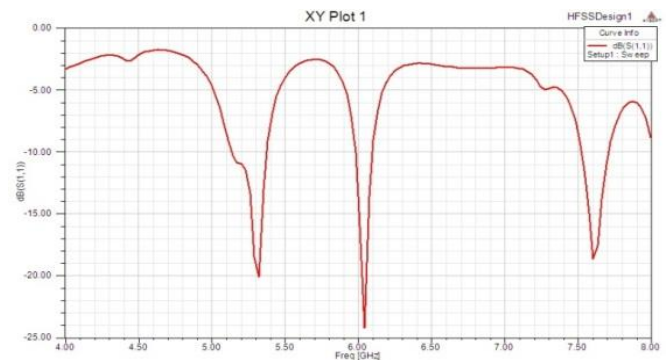
Fig -3: Return loss

3.2. VSWR

The result of VSWR of the C band micro strip antenna is illustrated in the Figure 4, the simulated VSWR value is below the 2 for all bands.
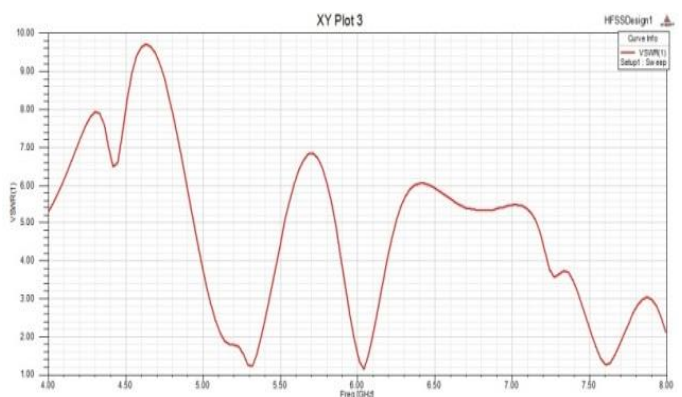
Fig -4: VSWR

3.3. RADIATION PATTERN

The simulation result of 3D radiation patterns is illustrated in the figure 5, Current distribution and radiation pattern is reveal in the figure 6 and 7.
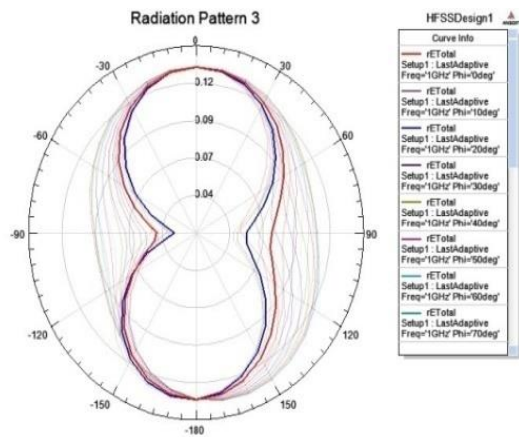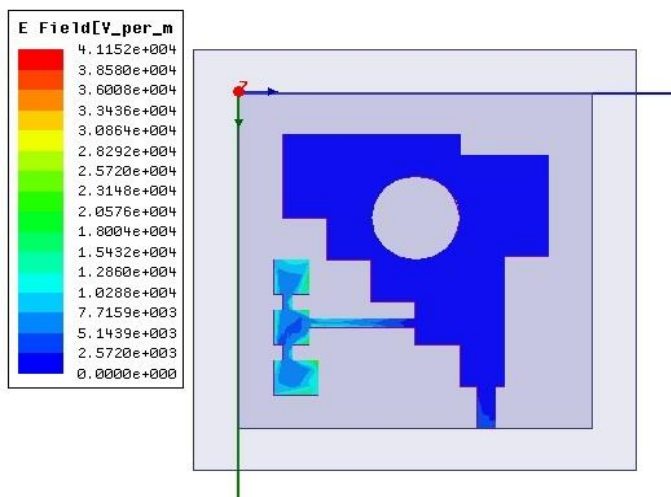

Fig -5: Radiation pattern
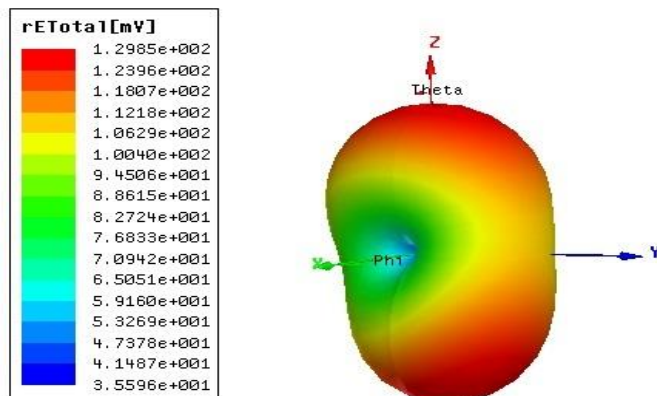

Fig -6: Current Distribution

Fig -7: 3D Polar plot

4. SUMMERY OF RESULT

Table -2: Resulted Values for C Band.

BAND WIDTH	5.1 – 5.3 GHz	5.9 – 6.1GHz
RETURN LOSS	-20 dB	-24 dB
UPLINK	5.3GHz	
DOWNLINK	6GHz	

4.1. HARDWARE DESIGN

Hardware design of the proposed microstrip patch antenna shown in Figure 8 and 9. It is printed on FR-4 material having relative and loss tangent of 4.4mm and 0.02mm respectively. The port through which the input is given has an input impedance of 50. This type of Antenna will be used in variety of applications in future wireless communication.

Fig -8: Radiating patch side of hardware design

Fig -9: Ground plane side of hardware design

5. CONCLUSION

In this paper, C band antenna has been designed and simulated. Their returned signal loss and radiation pattern for far field has been proposed in the paper. The software results introduced that the C Band patch antenna attain a high return loss beyond 24 dB. This antenna can therefore facing the different requirements for satellite based Military communication applications. The VSWR as well as signal return loss improvement factor will be studied now to get high gain and small size with larger packing efficiency onboard military satellite devices. In future work the layout of antenna feed lines and associated components in order to decrease the dimension of overall system. Future scope will give the enhancement process for the width of such an antenna.

REFERENCES

[1] B. Ghosh, S.M. Haque, and D. Mitra, (2011),"Minituarization of Slot Antennas Using Slit and Strip Loading", IEEE Transactions on Antennas and Propagation, vol. 59, pp. 3922-3927.

[2] G. Chand, R. Kumar, M. Gupta, and D. Gupta, (2010),"Improvement in Gain and Bandwidth of Rectangular Patch Loaded with Orthogonal Crossed Slits", IJECT, vol. 1(1), pp. 34–39.

[3] M.W. Shute, and C.S. Brown, (2002), "A study of the polarization properties of a rectangular polarization-maintaining fiber", Journal of Light wave Technology, vol. 7(12), pp. 2013-2017.

[4] W. Mazhar, M.A. Tarar, F.A. Tahir, S. Ullah, and F.A.Bhatti, (2013),"Compact Microstrip Patch Antenna for Ultra-wide band Applications", PIERS Proceedings, pp. 1100-1104.

[5] M. Nedil, M.A. Habib, T.A. Denidni, and H. Boutayeb, (2008), "Quasi-Metallic-Wall Technique for Increasing the Efficiency of CB-CPW Antennas", Progress in Electromagnetic Research, vol. 78, pp. 437–455.

[6] Y.S. Li, W.X. Li, and Q.B. Ye,(2012), "Compact Reconfigurable UWB An-tenna Integrated with Stepped Impedance Stub Loaded Resonators and Switches". Progress in Electromagnetic Research C, vol. 27, pp. 239– 253.

[7] J.R. James, and P.S. Hall, (1989), Handbook of Microstrip Antennas, vol. 1.IEEE, Peter Peregrinus Ltd: Clarendon, pp.1–17.

[8] M. Tanaka, and Jae-Hyeuk Jang, (2003), "Wearable microstrip antenna", An-tennas and Propagation Society International Symposium, vol. 2, pp. 704–707.

[9] C. Kamtongdee, and N. Wongkasem, (2009),"A novel design of compcat 2.4 GHz microstrip antennas", 6th International Conference ECTI-CON, vol. 2, pp. 766- 769.

[10] N. Gupta, and V.R. Gupta, (2005), "Reduced Size, dual frequency band antenna for wireless communication", IEEE International Conference on Personal Wireless Communications, pp. 321-323.