DESIGN AND FABRICATION OF MICRO STRIP ANTENNA FOR CUBESAT APPLICATIONS

Tharun.K
BE, Electronics and Communication Engineering, Sathyabama Institute of Science and Technology, Chennai
jaitharunchinna@gmail.com

Vivekanand.V
BE, Electronics and Communication Engineering, Sathyabama Institute of Science and Technology, Chennai
viveks4567@gmail.com

T. Ravi
Associate Professor, School of Electrical and Electronics Engineering, Sathyabama Institute of Science and Technology, Chennai
ravivlsi123@gmail.com

M.Sugadev
Associate Professor, School of Electrical and Electronics Engineering, Sathyabama Institute of Science and Technology, Chennai

Abstract: In this work we have designed an antenna for 450 MHz in UHF band using rectangular micro-strip patch antenna. It is used for most complex multi band characteristics. Micro-strip antenna has two elementary systems for cubesat. Micro-strip antenna consists of conducting patch on a ground plane separated by dielectric substrate radiation from ground plane has different dielectric configurations. Two antennas are including slot and micro-strip patch antenna. Slot antennas can be placed around solar cells and the slots are narrow enough to be fit into the space between solar cells. Launching the large conventional satellite takes more time and expensive to design the satellite. Cubesats has been proposed to serve the purpose in satellite application cubesat has no more than 1.33kg/unit which reduces the size of satellite and make it less expensive. The proposed antenna at 450Mhz in UHF band and we have achieved 4.2771 of average of gain with parameters of 60*60*1.6mm.

Keywords: Cubesat, UHF band, Ultrawideband, Gain, Directivity, Return loss, VSWR.

1. INTRODUCTION

A cubesat is a type where it is used in space research is made up of multiples 10*10*10 cm cubic units. It have a mass of no more than 1.33 kilograms per unit and often it is used in commercial of electronics and structures. Primary it is in space station and secondary it is a payloads on a launch vehicle. It covers the UHF band for amateur satellite communications 400-470MHz. It is compatible with endurosat solar panels. Gain >0 dBi.
Maximum radio frequency output power is 3.5 watts. Recently they are being designed by many universities globally to demonstrate the technology as well as involve more researchers into this study. The link which is placed side by side laterally and the communication happens simultaneously. NASA two satellite nodes demonstrated space craft network operation using two or more space crafts in an autonomously configured space network which allows crosslink communications and scientific measurements. The main challenging factor in design is the need of nadir pointing attitude for earth observation it can be made possible using high gain directive antennas and hence employee lower transmitting power to achieve good results and less transmitting power.

Jordipuig-suari has been developed the cubesat where it is been working in LEO and it is small in size and less in cost to make a satellite and it will be communicate between the link earth and cubesat in antenna. In this mission to deploy the picosatellite has resulted in the development launcher system that was hopelessly complicated and it can only to be work for most of the time. Bob twigs known that the projects are going slow he has been sought the DARPA funding the result and redesign the mechanism of the satellite [3].

QB50 it is proposed in international network of 50 cubesats for multipoint the measurements in the lower thermosphere (90-350)kms and re-entry research. QB50 where founded by the European commission as a part of FP7. Where 2U cubesats been in the size of 10*10*20 cm are been developed in 1U [4]. QB50 has been launched in the 2012. Insight mission is upcoming satellite to be launched in the May of 2018 cubesat to be landed in mars to provide relay communication from insight to earth during entry and landing[7]. This is the first mission where cubesat technology going to deep in space where MarCO is mars cube one each one is a six unit cubesat 14.4 inches by 9.5 inches by 4.6 inches.

Ms. Sayalidixit[2015]: Analysed micro strip antenna with good antenna parameters has been designed and fabricated at two different resonant frequencies (8.12Ghz and 9.42Ghz) and the return loss -17db and -44db thus a good antenna parameters and wide bandwidth at resonant frequencies is well suitable for satellite applications. VSWR is 1.26db and 1.2db.

Ambresh.P.A: A technique in which slits are introduced on the radiating edges of rectangular patch antenna and using high dielectric constant which reduces the size of the antenna. The two resonant frequency 2.03Ghz and 3.79Ghz. VSWR is 1.850 and 1.108. Return loss is -15db and -11.27db. A high dielectric constant makes the antenna to work at low frequencies and slits plays a vital role not only in obtaining good antenna parameters. Gain is 2.00db and 1.90db for two frequency.

Vaishalikamboj[2016]: A single layered coaxial fed micro strip antenna with polygon, rectangular and square slots are placed for miniaturization and for obtaining good radiation properties[6]. The resonant frequency is 3.16Ghz and return loss is -26.78db. Slots at effective positions makes antenna to radiate effectively and decreases the size. Gain is 4.44db and VSWR is 1.69.

Constantine G. Kakoyiannis/2008: A tapered peripheral slit micro strip antenna has designed with miniature size and but in capability for circular polarization. Gain is 0.7db. Dual feed technique in antenna produces circular polarization which is most essential characteristic of cubesat. Dielectric loading have a detrimental effect on band width. Directivity is 4.9db[9].

Kamal sarabandi [2006]: proposed has compact wideband UHF patch antenna on a reactive impedance substrate. Antenna designed at three frequencies covering the 410-480Mhz. UHF antenna is operating frequency range 420-450 Mhz gain is 5.2 is to desired for terrestrial communication. Frequency 480Mhz gain is 5.9. Return loss is -10db[8].

Antenna types are printed circuit board (or) whip antenna, raised-strip antenna, conventional whip antenna, helix antenna, patch antenna.
2. PROPOSED MICROSTRIP ANTENNA

Microstrip antenna is also known as printed antennas is to be fabricate the printed circuit board. It is mostly used in microwave frequencies. Microstrip antennas where it is individual consists of patch of metal foil and been in different shapes on the printed circuit board in the metal foil of ground plane on the other side of the board. Where it is been designed for narrowband communication at UHF and microwave ranges.

The advantage of microstrip antenna is light weight, small in size, not expensive, easy to design and manufacture. For low frequency size is larger at 450Mhz 60*60*1.66mm.

Proposed UHF Microstrip antenna:

To design the microstrip antenna using cubesat application. Done with the resonant frequency, gain, return loss, directivity. Our antenna is designed in 3 bands UHF, s-band, SHF.
Antenna design at 450Mhz has been finally designed with the hexagonal shapes with the material of using fr4. Fr4 is easy to design and fabricate the antenna parameters. Working in mobile communications, military uses, weather purposes. Where it is acting in different bands in Ultra high frequency(UHF) 30-500Mhz, S-band parameter 2-4Ghz, Super high frequency(SHF) 3-300Ghz. Gain, directivity, return loss, VSWR has good in antenna design. Cubesat acting in low frequencies due to high dielectric resonant where it will be maintain in LEO.

| Parameter                  | Value         |
|----------------------------|---------------|
| Length of the patch        | 20mm          |
| Width of the patch         | 21.5mm        |
| Length of the substrate    | 38mm          |
| Width of the substrate     | 38mm          |
| Height of the substrate    | 1.6mm         |
| Feed type                  | microstrip line feed |
| Feed position              | 17.5, 0, 0    |

- **Patch Width**
  
  \[ W = \frac{C}{2f \sqrt{\varepsilon + \frac{i}{f}}} \]
  
  - \( W \) = width of the patch
  - \( C \) = velocity of light (3mm)
  - \( f \) = Resonant frequency
  - \( \varepsilon \) = Dielectric constant of substrate

- **Patch Length**
  
  \[ L = L_{\text{eff}} - 2\Delta L \]
  
  - \( L \) = length of the patch
  - \( L_{\text{eff}} \) = Effective length, and it is given by
\[ L_{\text{eff}} = \frac{c}{2f\sqrt{\varepsilon_{\text{reff}}}} \]

\[ \Delta L = 0.412h \left( \frac{(\varepsilon_{\text{reff}} + 0.3)(\frac{c}{h} + 0.264)}{(\varepsilon_{\text{reff}} - 0.258)(\frac{c}{h} + 0.8)} \right) \]

- \( \varepsilon_{\text{reff}} \) = Effective dielectric constant
- **Substrate Length and Width**
  - \( L_g = L + 6h \)
  - \( W_{g_s} = W + 6h \)
  - \( h = \frac{0.0606\lambda}{\sqrt{\varepsilon_r}} \)

3. **RESULTS AND DISCUSSION**

The antenna is stimulated in HFSS (high frequency simulated system) software.

A. **S11 Return loss:**

Return loss is the loss of power in the signal returned/reflected by the discontinuity in a transmission line or optical fiber. It is usually expressed as a ratio in decibels (db).

![Fig 3: Return loss at 450Mhz is -13.4234.](image)

B. **VSWR (voltage standing wave ratio):**

The parameter VSWR is a measure that numerically describes how well the antenna is impedance matched to the radio or transmission line it is connected to. VSWR stands for voltage standing wave ratio, and is also referred to as standing wave ratio.
Fig 3.1: VSWR at 450Mhz is 1.66

a. Gain:

An antenna power gain or simply gain is a key performance number which combines the antenna directivity and electrical efficiency. In a transmitting antenna, the gain describes how well the antenna converts input power into radio waves headed in a specified direction. Gain is represented in terms of db.

Fig 3.2: Gain at 450Mhz is 4.277e+000

b. Directivity:

Directivity is a fundamental antenna parameter. It is a measure of how directional antenna radiation pattern is. An antenna that radiates equally in all directions would have effectively zero directionally, and the directivity of this type of antenna would be 1.

Fig3.3: Directivity at 450Mhz is 6.7783
c. Electric field:

The electric field \([E]\), flows from the positive charge to negative charge placed on the elements by voltage applied to the antenna.

![Electric field](image)

Fig 3.4: Electric field 6.4031

f. Magnetic field:

The magnetic field \([H]\) is a vector quantity has a magnitude and direction around a wire of moving charge.

![Magnetic field](image)

Fig 3.5: Magnetic field 9.048

g. 2D pattern:

Two dimensional or planar arrays with uniform spacing and with phased weights. The extension of two dimensional arrays is straightforward.

![2D pattern](image)

Fig 3.6: from the radiation this is acting at 90 degrees in bidirectional.
Fig 3.6.1: From the radiation pattern it is acting at 0 degrees is going in bidirectional.

Fig 3.6.2: This pattern is acting at 180 degrees and moving in bidirectional.

Fig 3.6.3: Radiation pattern is moving in bidirectional and is acting at 360 degrees.
Fig 3.7: Fabrication of antenna design (450MHz) has been done this design the process is working in gain, directivity, VSWR, return loss. Return loss is increasing in when frequencies are increased.

4. CONCLUSION

Microstrip antenna has been done with cubesat application using the UHF band. Antenna design (450MHz) working in 3 bands UHF, S-band, SHF band. This antenna is very compact in size. It is very useful in monoethic application and also in mobile satellite radar, biomedical. The resonant frequency is 450MHz and the return loss -13.4234. omni-directional radiation characteristics. VSWR is 1.66 with this frequency the antenna of the patch has been settled in this frequency. Directivity 6.7783db and the Gain is 4.2771db.

REFERENCES

[1] S. Gao, K. Clark, M. Unwin, J. Zackrisson, W. A. Shiroma, J. M. Akagi, K. Maynard, P. Garner, L. Boccia, G. Amendola, G. Massa, C. Underwood, M. Brenchley, M. Pointer, and M. N. Sweeting, “Antennas for modern small satellites,” IEEE Antennas Propag. Mag., vol. 51, no. 4, pp. 40–56, 2009.
[2] M. A. Swartwout. (2016, Aug. 31). CubeSat database.[Online].Available: https://sites.google.com/a/slu.edu/swartwout/home/cubesat-database
[3] Ravi.T and Kannan.V “Effect of N-type cntfet on double edge triggered D flip-flop based PISO shift register” IEEE Proceedings of the International Conference On Emerging Trends in Science Engineering and Technology: Recent Advancements on Science and Engineering Innovation, INCOSET 2012, Dec-2012, pp. 344-349.
[4] R.Ramya and T.Ravi, “Design of cache memory mapping techniques for low power processor” ARPN Journal of Engineering and Applied Sciences, VOL. 10, NO. 11, JUNE 2015, pp:4783-4788.
[5] State of the Art of Small Spacecraft Technology [Online]. Available: https://sst-soa.arc.nasa.gov/03-power
[6] Ravi.T, Kannan.V “Modeling and performance analysis of ballistic carbon nanotube field effect transistor (CNTFET)” International Conference on Recent Advances in Space Technology Services & Climate change – RSTS&CC-2010, November – 2010, pp. 327-331.
[7] P. A. Ambresh, P. M. Hadalgi and P. V.Hunagund, Gulbarga-India. “Compact Omni-Directional Patch Antenna For S-Band Frequency Spectra ”International Journal of Advances in Engineering & Technology, Sept 2011. ISSN:2231-1963
[8] Micheal Priyanka.M and Ravi.T, “Survey on role of memristor in electronics “2015 International Conference on Control Instrumentation Communication and Computational Technologies, ICCICCT 2015, 18-19 Dec 2015, Pp:738-744.
[9] Brij Bhushan Ojha, S.Karthikeyan, “Design of an interconnection network using VLSI photonics: Issues and challenges ” International Journal of Pure and Applied Mathematics, Volume 118 No. 17 2018, PP: 211-224
[10] S. Vimalsree and S. Karthikeyan, "A Low Power Multibit Flip Flop Merging Technique Using WSN Nodes", ARPN, vol. no:11, No.15, August 2016, Page no: 9358-9363.