# Microstrip Slit Antenna for S-band Applications

**Miss.Shubhangi Pawale[1] Prof.Dhede V M[2]**
[1]P.G. Student [2]Assistant Professor
[1,2]Department of Electronics & Communication Engineering
[1,2]JCOE, Kuran

*Abstract*— In this, a circularly polarized asymmetric slits, high gain, a small patch antenna with low axial ratio dedicated for wireless communications is presented. Four V-shaped slits are placed in diagonal directions on the square patch to create circularly polarized (CP) radiation. A proposed antenna has been design with a 1.6 mm thick single layer FR4 substrate with a relative permittivity of 4.4. The simulated 10-dB return loss bandwidth of the proposed antenna is 60.0 MHz with a gain of 5.1 dB. The overall size of the antenna is 56mmx56mmx1.6mm. In addition, effects of with slits to improve return loss and gain are examined and discussed in detail. All the simulations results are carry out using HFSS software package and Simulation results are given, indicating that this antenna realizes the required wireless specifications in terms of frequency bandwidth, gain, circular polarization bandwidth, and vswr.

***Key words:*** Circular Polarization, Axial Ratio, Patch Antennas, Wireless Communication

## I. INTRODUCTION

Recently small size of antenna technologies makes it feasible to develop smaller satellites than those built a decade ago without degrading the performances. The several planned missions based on small, mini, micro and even Pico-satellites, considered as small satellites. The use of these satellites is continuously increasing. Small satellites are popularly used because they require lower cost, low cost mass production while offering greater performance, lower launch costs and greater launch flexibility. Their use includes a single or a constellation of satellites, includes earth observation the testing of components, communication and educational applications [1-3].

There are various and famous techniques to increase the bandwidth of antennas, consisting of increase of the substrate thickness, the use of a low dielectric substrate, the use of various impedance matching and feeding methodologies, the use of multiple resonator cavities, and the use of slot antenna dimensions (Pozer,). However, the bandwidth and the size of an antenna are generally mutually inverse properties, that is, increment of one of the characteristics normally results in degradation of the other. Nowadays, various techniques have been proposed for increasing the bandwidth. A novel single layer wide-band rectangular patch antenna with high impedance bandwidth of greater than 20% has been proved (Yang et al. 2001). Also, Using the shorting pins or shorting walls on the asymmetric arms of a U-shaped patch, U shaped-slot patch, or L-probe feed patch antennas, wideband and two band impedance bandwidth have been performed with small size in (Guo et al., 2002, Chair et al., 2005). Other techniques involves including multilayer structures with parasitic patches of various dimensions like such as E, V and H shapes, which excites at multiple resonant modes. While, these antennas are generally fabricated on thicker substrates (Bao & Ammann, 2007). A W-LAN is a wireless local area network that connects two or number of devices using a wireless distribution method of spread-spectrum within a limited area like a home, school, computer lab or any organization. Number of modern WLANs is worked on IEEE 802.11 standards which are also known as wi-fi. It works in the frequency bands 2.4 – 2.5 GHz. distribution on the microstrip patch. In 1995 Huynh and Lee has showed a broad band single layer probe fed patch antenna with a U-shaped slot on the surface of the rectangular patch[7].

Here, we construct a rectangular micro-strip patch antenna with four v slits are cut in micro-strip patch to increase its axial ratio bandwidth and frequency response and also the gain.

## II. MICROSTRIP ANTENNA DESIGN

The initial design was chosen based on the literature that provided circularly polarized radiation in the broadside direction. A square patch antenna designs are one of the earliest examples of microstrip patch antenna. Various techniques, like offset feeds, truncated corners and diagonal slits were used to produce circular polarization from square or rectangular patch antennas. Fig. 1 shows the top view and cross-sectional view of the proposed asymmetric V shape slits microstrip antenna. The size of the antenna is limited to 56 mm × 56 mm at most. Thus the initial design was chosen of dimensions 56 mm × 56 mm. A probe feed from the bottom is attached to the patch through a hole drilled into the substrate. The coaxial feed location is along the orthogonal X-axis from the center of a patch. Fig 1 introduces the asymmetric V-shaped slits square patch for CP radiation.

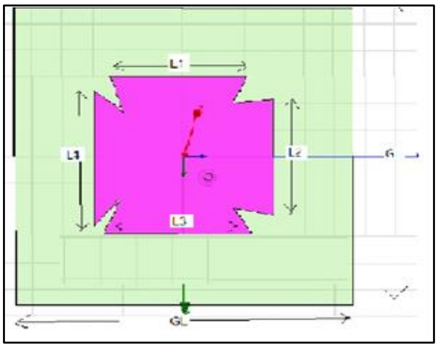


Fig. 1: Proposed antenna geometry (a) top view (b) cross-sectional view

The dimensions of the strips and the corner of the V-shaped asymmetric slits are optimized to create the resonance and circular polarization at 2.45 GHz. The optimized dimension is as follows:

G_L=56 mm, L1=22.6 mm, L2=21.8mm, L3=24.4mm, L4=25.5 mm.

## III. METHODOLOGY

The formulas for calculating the length, width and value of air gap are taken from [8]. The value of resonant frequency

 

(Fr) is 2.44 GHz and dielectric constant of the substrate (εr) is 4.4 and Height of dielectric substrate (h) is 1.6mm.

Next step is to calculate the other parameters like length and width of micro strip patch is given as follows:

– Step 1: Width of micro strip patch is given below:

$$w = \frac{c}{2f_0\sqrt{\frac{\varepsilon_r+1}{2}}} \quad (1)$$

– Step 2: Length of micro strip patch is given below:

$$\Delta L = (0.412*h)\frac{(\varepsilon_{reff}+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{w}{h}+0.813\right)} \quad (2)$$

– Step 3: The resonant frequency for any mode is given by:

$$f_0 = \frac{c}{2\sqrt{\varepsilon_{reff}}}\left[\left(\frac{m}{l}\right)^2+\left(\frac{n}{m}\right)^2\right]^{1/2} \quad (3)$$

## IV. RESULTS AND DISCUSSION

The designed V-shaped asymmetric square patch with rectangular slit was simulated for validate the design. The simulated reflection coefficient of The proposed antenna design is simulated in Ansoft hfss software. Simulated and 10-dB return loss bandwidth are 60 (2.43-2.49GHz)

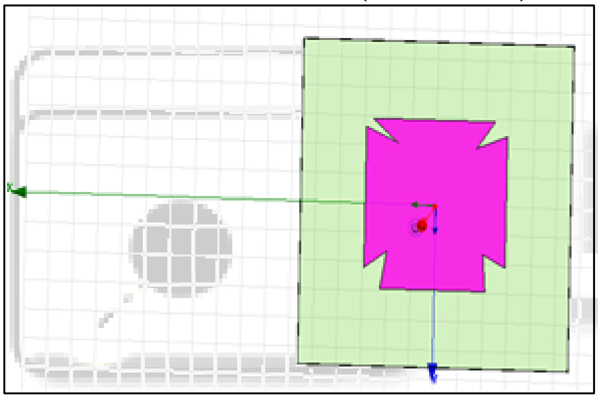

Fig. 2: Proposed antenna geometry

Fig.3 shows the return loss of the antenna.it shows that return loss is -22.49 at resonant frequency 2.46 Ghz.

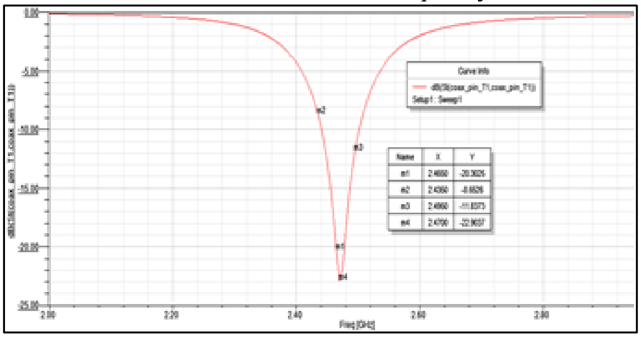

Fig. 3: Return loss

Fig. 4 a and b shows the 3-D plot of radiation pattern and polar plot of radiation pattern. It shows the maximum gain of 5.1 dbi.

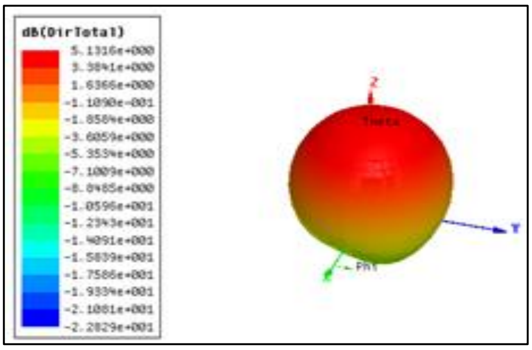

Fig. 4(a): 3-D plot of radiation pattern

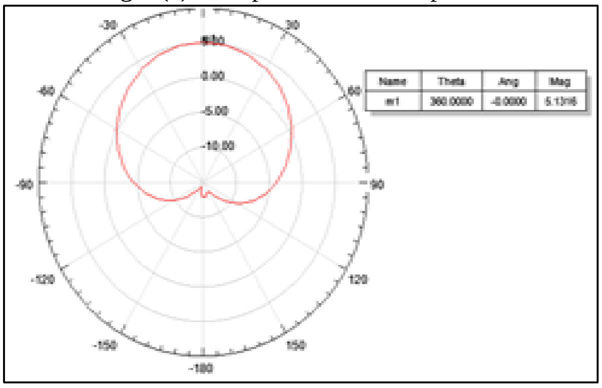

Fig. 4(b): Radiation pattern of antenna

Fig. 5 shows the VSWR of the antenna.it shows the less than <2 at 2.46 Ghz frequency and the fig.6 shows the axial ratio of the antenna at 2.46ghz frequency.

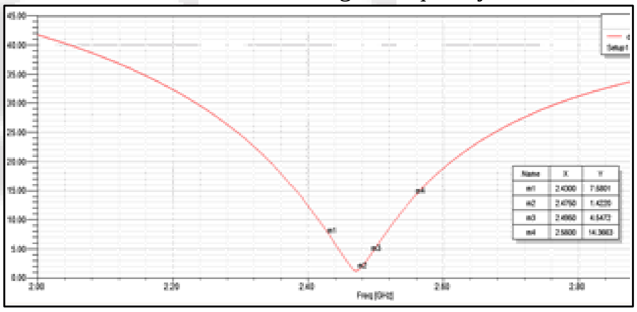

Fig. 5: VSWR

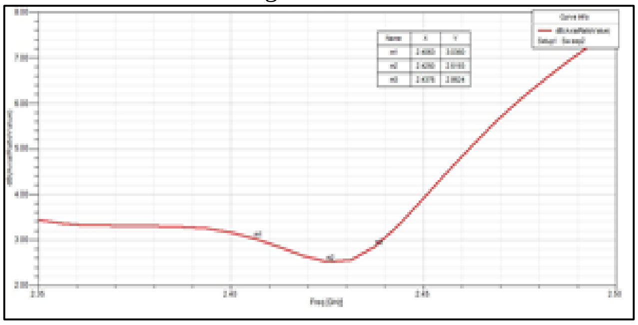

Fig. 6: Axial ratio

Figure 6 depicts the simulated AR value is 2.51db at resonant freq. of the antenna.

In addition, effects of with V-shaped slits and without slits are examined and discussed in detail. Table 1 shows with V-shaped slit antenna, return loss and the gain are increased slightly.

| Sr. No. | Shape of MSA | Freq. (GHZ) | Return Loss(dB) | VSWR | BW (MHZ) | Axial Ratio (dB) | Directivity (dB) |
|---|---|---|---|---|---|---|---|
| 1. | RMSA without slits | 2.48 | -25.99 | 1.12 | 65 | 1.39 | 5.0 |
| 2. | V-shaped asymmetric square patch | 2.46 | -22.49 | 1.16 | 60 | 2.51 | 5.1 |

Table 1: Comparison Table

 

## V. CONCLUSION

Using this, a compact Circular polarized V-shaped asymmetric slit MSP antenna was proposed. Slits are inserted on four corners of the patch. The antenna exhibits an effective bandwidth of 60MHz from 2.43-2.49 GHz for 10-dB return loss and AR<3 dB at 31MHz. The simulated gain of the antenna is around 5.1dBi and the 3-dB axial ratio beam width is about 180deg. The overall dimension of the antenna is 56mm×56mm×1.6mm at 2.45GHz and thus can be considered as a suitable for various like WLAN applications, ISM-band (2.43-2.49Ghz) and S-band applications.

## REFERENCES

[1] S. P. Neeck, T. J. Magner, and G. E. Paules, "NASA's smalsatellite missions for Earth observation," Acta Astronautica, vol.56, pp. 187-192, 2005.
[2] Y. Zhen and Y. Ruliang, "Feasibility study of using small satellite synthetic aperture radar for global 3D imaging," in Geoscience and Remote Sensing Symposium, 2002. IGARSS'02. 2002 IEEE International, 2002, pp. 3162-3164.
[3] A. Wicks, A. da Silva Curiel, J. Ward, and M. Fouquet," Advancing small satellite earth observation: operational spacecraft, planned missions and future concepts," 2000.
[4] C. A. Balanis, Antenna Theory, 2nd ed. New York: Wiley, 1997.
[5] E. Arnieri, L. Boccia, G. Amendola, and G. Di Massa, "A compact high gain antenna for small satellite applications," IEEE Transactions on Antennas and Propagation, vol. 55, pp. 277-282, Feb 2007.
[6] P. Khotso, R. Lehmensiek, and R. R. van Zyl, "Circularly polarized circular microstrip patch antenna loaded with four shorting posts for nanosatellite applications," Microwave and Optical Technology Letters, vol. 54, pp. 8-11, 2012.
[7] L. H. Abderrahmane, M. Benyettou, and M. Sweeting, "An S band antenna system used for communication on earth observation microsatellite," in Aerospace Conference, 2006 IEEE, 2006, p. 6 pp.
[8] HFSS v 11 Software.