IJCRT.ORG ISSN : 2320-2882
INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

A CIRCULARLY POLARIZED STACKED PATCH ANTENNA FOR SATELLITE NAVIGATION

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ABSTRACT

In wireless communication era, for satellite navigation applications a dual band stacked patch antenna with and without slots are proposed to operate at 1.6GHz and 2.4GHz frequencies. A top patch is placed over a bottom patch and a ground plane to form a stack. A single coaxial feed mechanism is used to excite the antenna. In this paper two stacked patch antennas V slot HEXAGON SHAPED and HEXAGON SHAPED were proposed. Comparison of parameters like return loss, VSWR, Gain were done. The antennas dimensions were computed with accuracy. Using HFSS the simulation results were presented.

Key words: VSWR, return loss, polarization, gain.

I. INTRODUCTION

A compact and right-handed circularly polarized antenna with reactive impedance surface and complementary split-ring resonators was proposed by Liu Zhigang et al,.[1] A Multi-mode can be achieved by two layers stacked circular patches, when fed by a single coaxial probe at the axis location of patches to generate RHCP radiation by asymmetric slots. Dual-polarized double E-shaped patch antenna with high isolation is reported by Yanshan et al,[2]. The antenna was a stacked configuration composed of two layers of substrate. Two modified E-shaped patches are printed orthogonally on both sides of the upper substrate. E-shaped patches are excited using two probes, and each probe is connected to one patch separately. Tobroaden the impedance bandwidth a circular patch was printed on the lower substrate. An adaptive technique for steering the direction of minimum axial ratio (AR) (<1 dB) toward the reflected or jamming signal was suggested by Narbudowicz et al,.[3]. It relies on circularly polarized antenna elements without influencing their gain. Its performance noted by using two different antenna geometries, with five different configurations. The advancement of digital beam forming and software defined radio, one can generate the necessary phase shifts in the digital domain, opening up a plethora of new applications for the proposed technique (e.g., multiple AR configurations can be generated simultaneously). A circularly polarized stacked patch antenna with a perpendicular feed substrate was designed by Andrew et al,.[4]. Coupling from the stacked patch to the perpendicular microstrip feed was through a slot in the ground plane of both the stacked patch and the perpendicular substrate. Eight elements has been analyzed for various scan angles, built and tested. Reflection coefficient, realized gain, axial ratio and radiation patterns are measured. A compact circularly polarized (CP) square-ring slotted patch antenna with vias was proposed by Nasimuddin et al.,[5]. Four square-ring-shaped slots are cut symmetrically onto a square patch radiator along its diagonals for wide-angle CP radiation and miniaturization. The size of the antenna can be reduced by grounding the central patches surrounded by the square-ring-shaped slots. Found that the antenna is sensitive to the width/length of the square-ring-shaped slot and the via diameter. Two radiating spirals stacked on a foam substrate are used in the design of a circularly-polarized antenna, design to respect new bandwidth constraints resulting from the emergence of multimedia services in satellite communications. Orthogonal circular polarizations are required for up and down links over large frequency bandwidths suggested by Laheurte[6].Observed that the tacked monofilar square spirals can provide two orthogonal circular polarizations at different frequencies. To obtain a wideband operation, a circularly polarized (CP) vertical patch antenna that employs a microstrip to slot-line transition. The antenna was composed of two vertical patches, which are shaped as helix to obtain a broadband CP performance. The loop structure and the vertical overlap configuration lead to significant size reduction when compared to that of the printed dual-loop antenna was suggested by Ze-Hai Wu, et al.,[7]. Design of a dual-band circularly polarized (CP) transmit array (TA) antenna with a linearly polarized feed was reported by Yuan-Ming et al.,[8]. A shared-aperture dual-band TA was developed, which forms independent beams with right-hand circular polarization (RHCP) or left-hand circular polarization (LHCP) in two frequency bands with a single linearly polarized feed antenna. Four different CP TA prototypes operating at 12 GHz and 14.2 GHz with different senses of CP and different beam directions are designed. Observed a good agreement between the radiation patterns, gain curves,polarizations, and cross polarization levels measured and computed in both frequency bands. A U-slot microstrip antenna with an E shaped stacked patch was presented by Matin et al .,[9] to achieves an impedance bandwidth of 59.7%. The radiation patterns found to be constant throughout the bandwidth. An aperture stacked patch (ASP) antenna with circular polarization was proposed by Oraizi, et al.,[10]. The antenna consists of four parasitic patches, each one being rotated by an angle of 30° relative to its adjacent patches. . A r study has been conducted to explain the radiation mechanism of the antenna.

II. DESIGN AND DIMENSIONS OF ANTENNA

The antenna proposed here is composed with the substrate dimension of 43x43 mm with a height of h=1.6mm and top patch with dimension of 29.2x29.2 mm and diagonals are loaded with rectangularV shaped stubsand other antenna which is designed without rectangular V shaped stubs.

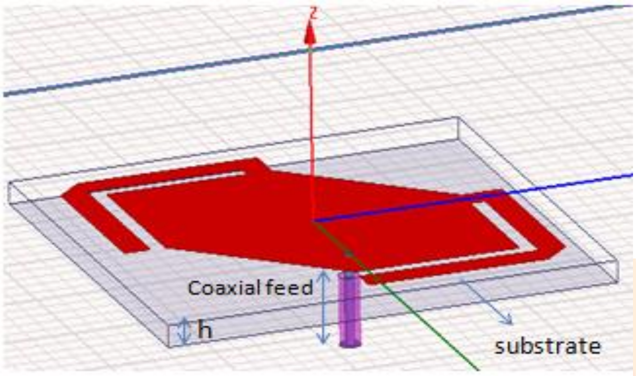


Fig 1: Top Patch Antenna

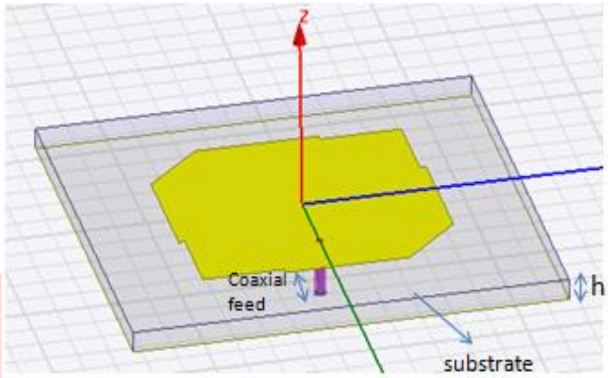


Fig 2: Bottom Patch Antenna

The antenna proposed here is composed with the substrate dimension of 70x70 mm with a height of 3mm and bottom patch with dimension of 43x43 mm. The antenna designed here is with the rectangular patch in which the opposite corners are truncated and on the other side the opposite corners are diagonally slotted with 9.1 mm.

III. DESIGN OF STACKED PATCH ANTENNA

The antenna proposed here is composed with the stacked patch which means it consists of the top patch antenna (upper patch) and the bottom patch antenna (lower patch) which are layered on each other. For constructing the stacked patch antenna, the top patch antenna is placed over the bottom patch antenna and a ground plane is placed under the bottom patch antenna. The stacked patch proposed here is with the dimensions of 43x43 mm for bottom patch antenna and 29.2x9.2 mm for top patch antenna and these are separated by a dielectric material called FR_4 Epoxy. The feeding methodology used here is coaxial feed for easy fabrication. For the coaxial feed the inner conductor and outer conductor are taken with the radii of 0.5mm and 1mm and the feed is given at 11.9 mm with the center position (9.6,0,0). The main advantage of this feeding scheme is that the feed can be placed at any desired position inside the substrate. The proposed antenna is designed by using Ansoft HFSS 13.0 Software. This antenna is simple, easy to fabricate and manufacture.

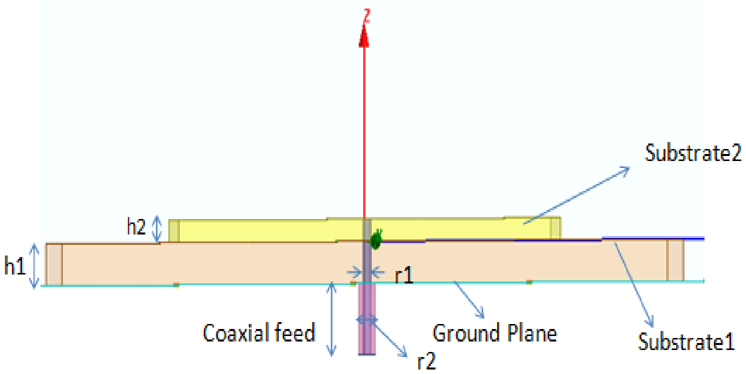


Fig 3: Stacked Patch Antenna Structure

IV. DESIGN EQUATIONS FOR STACKED STRUCTURE

The Stacked Patch Antennas are designed using the following design equations:

$= C/2f_o\sqrt{(\in_r+1)}\ 2$

$\varepsilon_{eff} = (\varepsilon_r + 1)/ 2 + (\varepsilon_r - 1) /2 [1 + 12 h/ w] ^ -1/2$

$L_{eff} = C/2f_o\sqrt{\varepsilon_{eff}}$

$\Delta L = 0.412h (\varepsilon_{eff} + 0.3) (w / h + 0.264) /(\varepsilon_{eff} - 0.258) (w/ h + 0.8)$

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

L = Length of the patch

W = Width of the patch

L_{eff}=Effective length

ε_{eff}= Effective Dielectric constant

ΔL= Length extension

ε_r= Dielectric constant of substrate

f_o= Resonant frequency

C = Velocity of light

V. DESIGN AND ANALYSIS OF V SLOT HEXAGON SHAPE STACKED PATCH ANTENNA

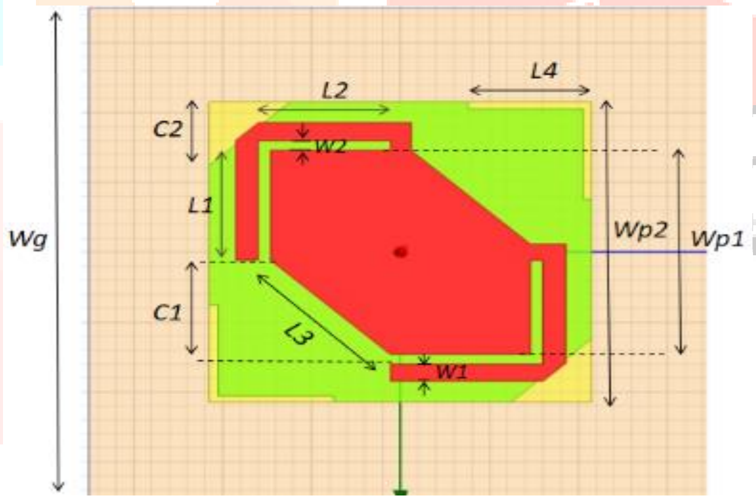


Fig 4: Geometry of V slot Hexagon shape Stacked Patch Antenna

Table 1: Antenna Dimensions (mm)

Parameter	Value(mm)	parameter	Value(mm)
Wg(ground)	70	W5	1
Wp1(top patch)	29.2	C1	13.4
Wp2(bottom patch)	43	C2	9.1
L1	17.2	D1	11.9
L2	15	R1	0.5
L3	13.4	R2	1
L4	13	H1	1.6
L5	7.5	H2	3
W1	2.5	W4	1
W2	1.4	W3	0

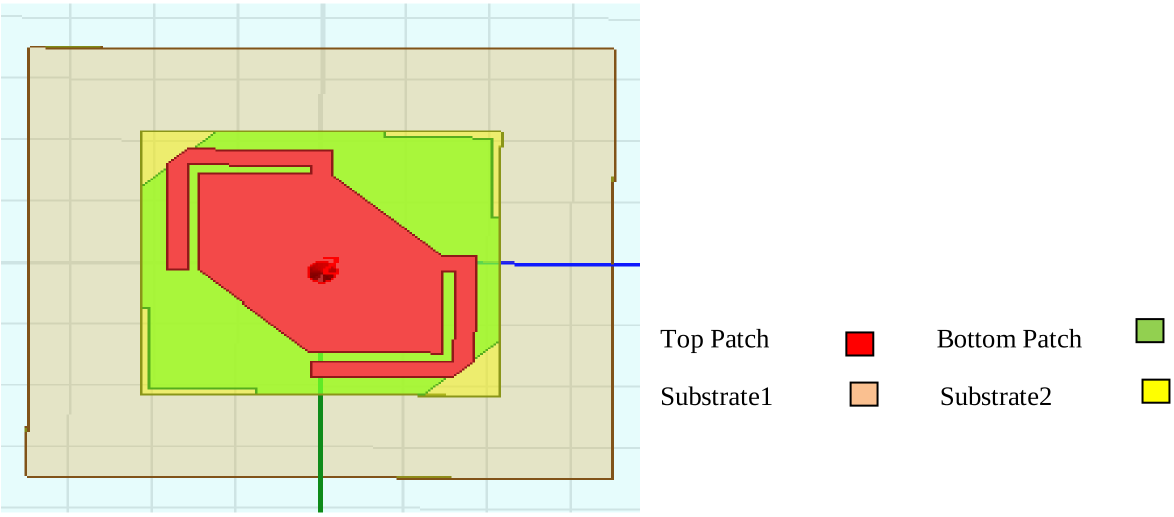


Fig 5: V slot Hexagon Shape Stacked Patch Antenna

VI. SIMULATION RESULTS

a) **Return Loss (S11):**

The simulated results for the Return Loss at the frequencies 1.6GHz and 2.24GHz are obtained as -22.49 and -12.99.

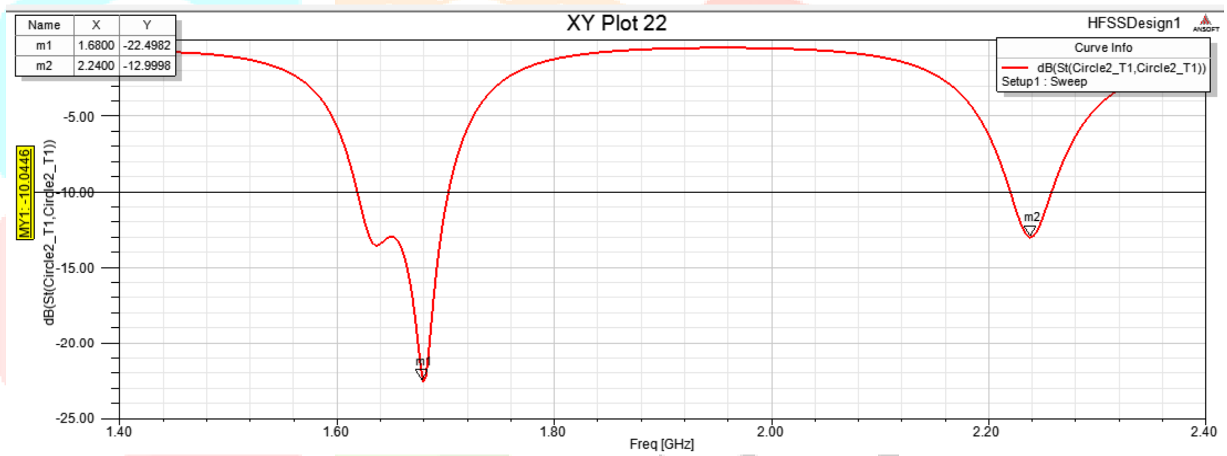


Fig 6: Return loss (S11) for the V slot Hexagon Shape Stacked Patch Antenna

b) **VSWR:**

The simulated results for the VSWR for the frequencies 1.6GHz and 2.24GHz are obtained as 1.18 and 1.61.

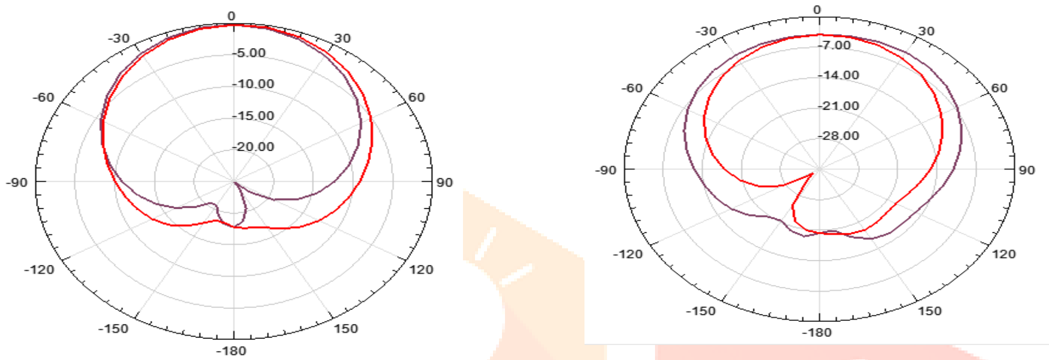
c) **GAIN:**

The gain observed for the antenna at resonating frequencies 1.6GHz and 2.24GHz are 3.35 dB and 2.99dB.

Fig 7: Gain for the V slot Hexagon Shape Stacked Patch Antenna at 1.6GHz

Fig 8: Gain for the V slot Hexagon Shape Stacked Patch Antenna at 2.24GHz

d) **RADIATION PATTERN:**



(a) (b)

Fig 9: Normalized Radiation Pattern for V slot Hexagon Shape Stacked Patch antenna at(a) 1.6GHz(b)2.2.4GHz

e) **AXIAL RATIO:**

The Axial Ratio for the frequencies of 1.6GHz and 2.24GHz are 0.55 and 0.43.

Fig 10: Axial Ratio for V slot Hexagon Shape Stacked Patch Antenna at 1.6GHz and 2.24GHz

VII. DESIGN AND ANALYSIS OF HEXAGON SHAPE STACKED PATCH ANTENNA

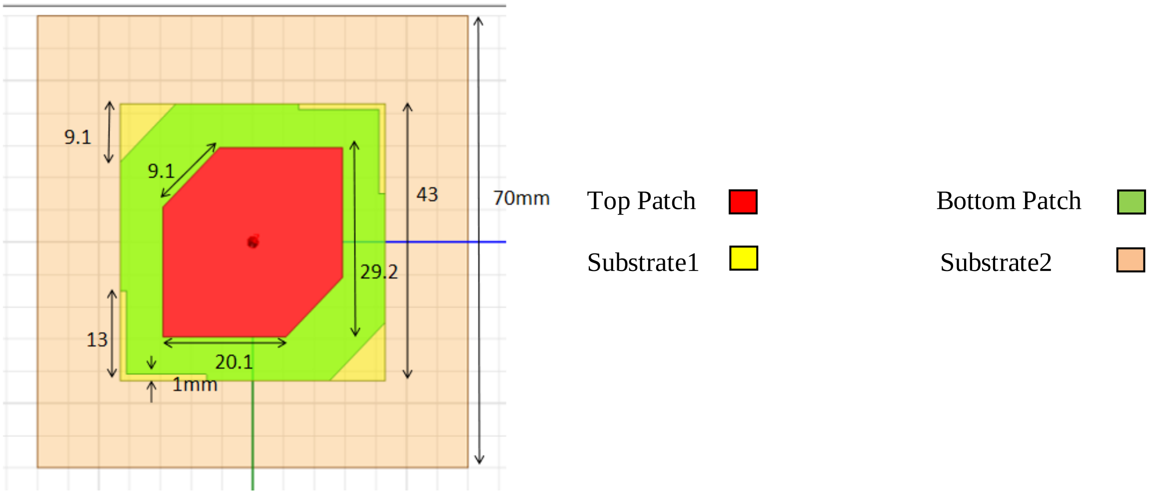


Fig 11: Geometry of Hexagon Shape Stacked Patch Antenna

VIII. SIMULATION RESULTS

a) **Return Loss (S11):** The simulated results for the Return Loss at the frequencies 1.6GHz and 2.27GHz are obtained as -22.46 and -14.29.

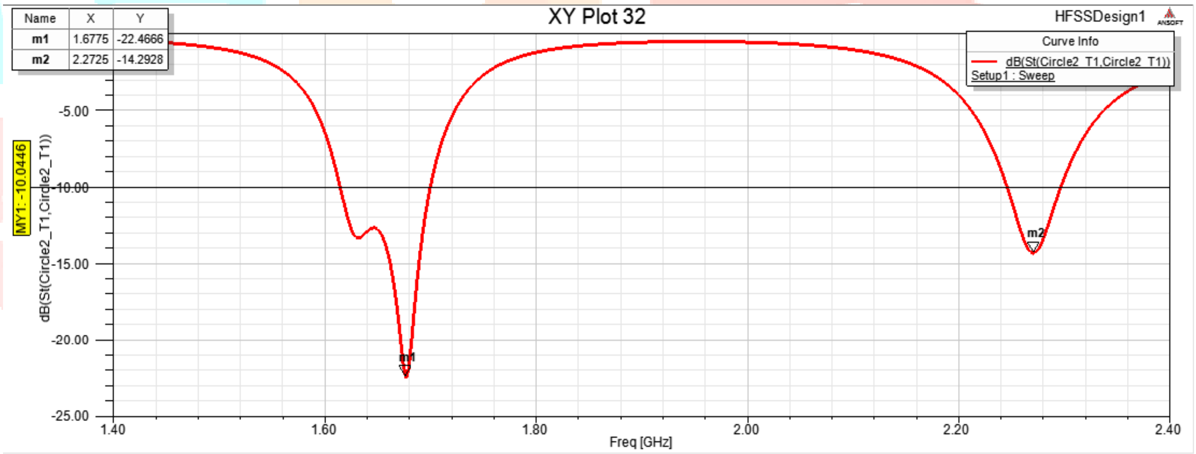


Fig 12: Return loss (S11) for the Hexagon Shape Stacked Patch Antenna

b) **VSWR:** The simulated results for the VSWR for the frequencies 1.6GHz and 2.27GHz are obtained as 1.17 and 1.47.

c) **GAIN:** The gain observed for the antenna at resonating frequencies 1.6GHz and 2.27GHz are 3.75 dB and 4.03dB.

Fig 13: Gain for the Hexagon Shape Stacked Patch Antenna at 1.6GHz

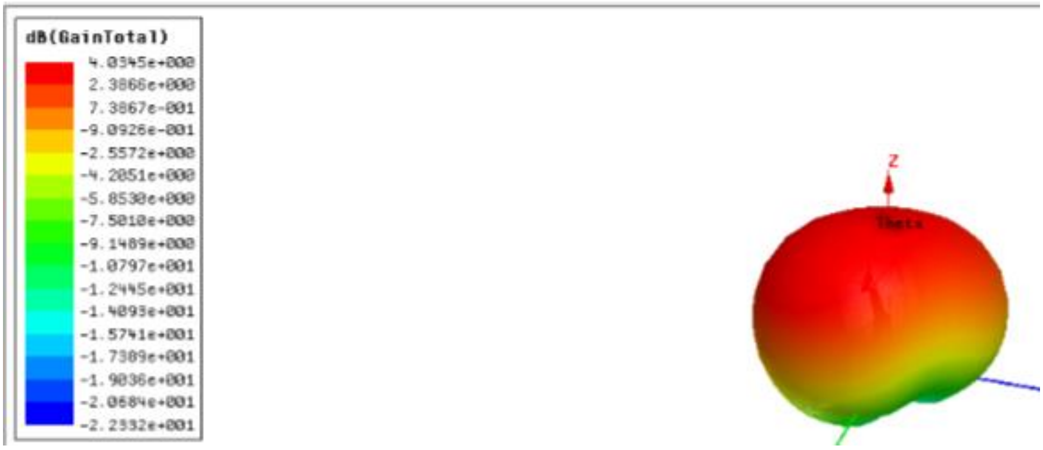
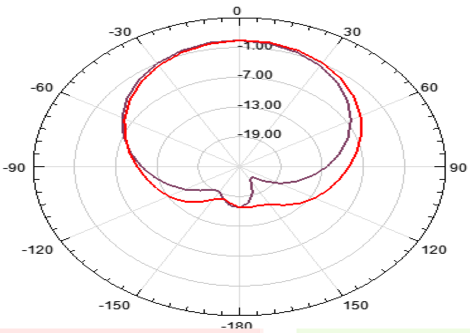
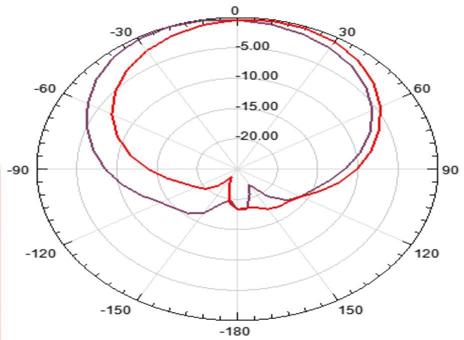


Fig 14: Gain for the Hexagon Shape Stacked Patch Antenna at 2.27GHz

d) **RADIATION PATTERN:**



(a)



(b)

Fig 15: Normalized Radiation Pattern for Hexagon Shape Stacked Patch Antenna at (a) 1.6GHz (b)2.27GHz

e) **AXIAL RATIO:** The Axial Ratio for the frequencies of 1.6GHz and 2.27GHz are 0.66 and 0.69

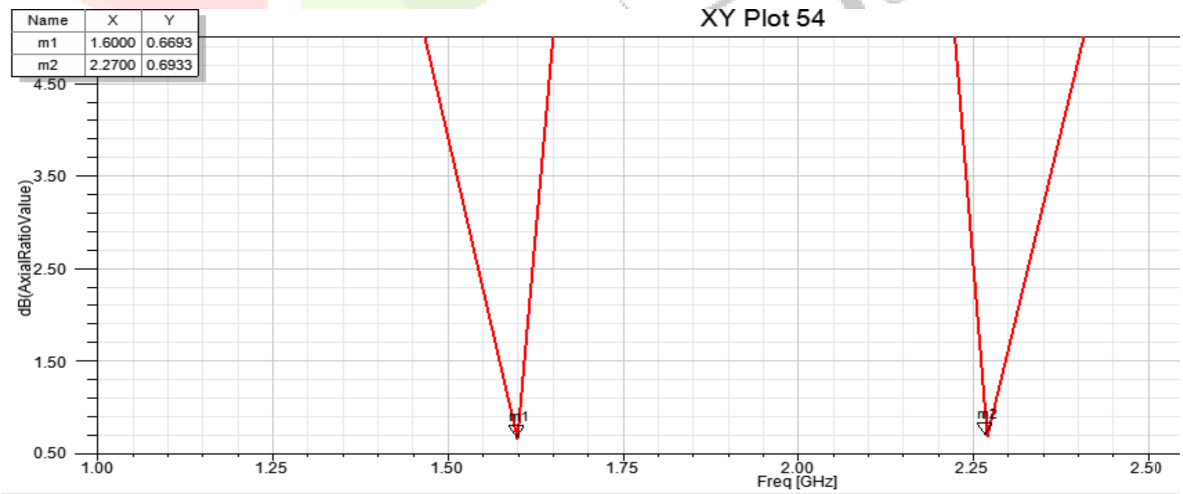


Fig 16: Axial Ratio for the Hexagon Shape Stacked Patch Antenna at 1.6GHz and 2.27GHz

IX. Return Loss (S11) Comparison for V slot Hexagon Shape Antenna and Hexagon Shape Antenna

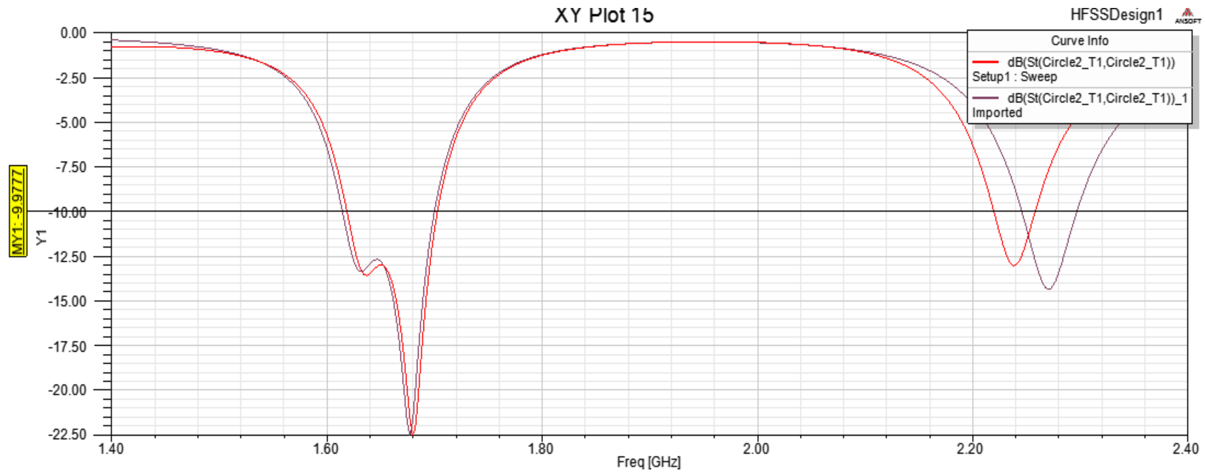
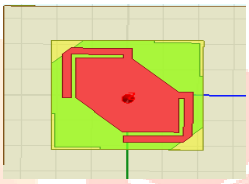
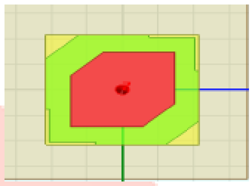


Fig 16: Comparison of Return Loss (S11) for V slot Hexagon Shape Antenna and Hexagon Shape Antenna

Open Hexagon ■ Hexagon ■

Table 2: Comparison Table for Various Parameters of V slot Hexagon Shape Antenna and Hexagon Shape Antenna at Resonating Frequencies

Antenna Structure				
Resonating Frequencies (GHz)	1.68	2.24	1.67	2.27
Return Loss (dB)	-22.49	-12.99	-22.46	-14.29
VSWR	1.18	1.61	1.17	1.47
Gain (dB)	3.35	2.99	3.75	4.03
Axial Ratio	0.55	0.33	0.66	0.69

X. CONCLUSION

Both the stacked patch antennas i.e., V slot Hexagon Shape Antenna and Hexagon Shape Antenna are exhibiting circularly polarized radiation pattern. The stacked antennas with and without slot are having good Return Loss, VSWR, Gain and Axial Ratio at resonant frequencies 1.6GHz and 2.4GHzs, which suitable for navigation applications.

REFERENCES

[1] Zhigang, L., Shunyu, F., Shouzheng, Z, Dong, C., Jie, C., Lu, F., & Yang, L., "BeiDou navigation terminal multi-mode asymmetric slots circularly polarized microstrip antenna*".3rd Asia-Pacific Conference on Antennas and Propagation,* 2014.

[2] Gou, Y., Yang, S., Zhu, Q., &Nie, Z, "A Compact Dual-Polarized Double E-Shaped Patch Antenna With High Isolation*". IEEE Transactions on Antennas and Propagation,* VOL. 61, NO. 8, AUGUST 2013.

[3]Narbudowicz, A., Ammann, M. J., & Heberling, D**, "**Reconfigurable Axial Ratio in Compact GNSS Antennas**"**. *IEEE Transactions on Antennas and Propagation*, VOL.64, NO.10, OCTOBER 2016.

[4]Weily, A. R., &Nikolic, N, "Circularly Polarized Stacked Patch Antenna With Perpendicular Feed Substrate*"***.** *IEEE Transactions on Antennas and Propagation,* VOL. 61, NO. 10, 2013.

[5] Nasimuddin, Qing, X., & Chen, Z. N, "A Compact Circularly Polarized Slotted Patch Antenna for GNSS Applications". *IEEE Transactions on Antennas and Propagation*, VOL. 62, NO. 12, DECEMBER 2014.

[6] Laheurte, J.-M, " Dual-frequency circularly polarized antennas based on stacked monofilar square spirals". *IEEE Transactions on Antennas and Propagation,* VOL. 51, NO.3, MARCH 2003.

[7] Ze-Hai Wu, & Yung, E. K.-N, "Wideband Circularly Polarized Vertical Patch Antenna". *IEEE Transactions on Antennas and Propagation,* VOL. 56, NO. 11, NOVEMBER 2008.

[8] Cai, Y.-M., Li, K., Li, W., Gao, S., Yin, Y., Zhao, L., & Hu, W, "Dual-Band Circularly Polarized Transmitarray With Single Linearly Polarized Feed".*IEEE Transactions on Antennas and Propagation,* VOL. 68, NO.6, 2020.

[9] Matin, M. A., Sharif, B. S., &Tsimenidis, C. C, "Probe Fed Stacked Patch Antenna for Wideband Applications". *IEEE Transactions on Antennas and Propagation*, VOL. 55, NO. 8, AUGUST 2007.

[10] Oraizi, H., &Pazoki, R, "Wideband Circularly Polarized Aperture-Fed Rotated Stacked Patch Antenna". *IEEE Transactions on Antennas and Propagation,* VOL. 61, NO.3, 2013.