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A Circular Stacked Patch Antenna Designed For Ku Band Satellite Applications

Sivasankari N[1] , Poornima Shree S[2], Abirami B S[3]
[1]Associate Professor, Computer science, Mapco Schlenk Engineering College, sivani.sivasankari@gmail.com
Orchid id - 0000-0002-3162-4751
[2]Mapco Schlenk Engineering College
[3]Mapco Schlenk Engineering College

Abstract
A Circular stacked stratum patch antenna is introduced in 15 GHz Ku band (12 –18 GHz) for all satellite communications. The antenna is constructed with four aluminium disks with DGS (defective ground structure). DGS is used in antennas for satellite communication systems to improve bandwidth and gain, especially in Ku-band applications. The return loss of -14 dB and realized gain of 5.01 dB is achieved in the measured and simulated response at a frequency of 15 GHz and the prototype also fulfils the target Ku band application requirement. Antenna designed in 5.01dB gain is used for Very Small Aperture Terminal setup for providing broadband internet in rural areas, where traditional infrastructure like cable isn't present. Geographical constraints, low population density and the high cost of deployment often make cabling impractical in these instances, and herein lies the role of VSAT systems dependent on a powerful Ku-band antenna. Such systems are able to electrically close the gap that separates these areas from access to reliable satellite-based broadband services.
Index Terms—Circular stacked patch antennas, Ku-band, Satellite Communication, High-Frequency,VSAT

INTRODUCTION

The Ku band mostly relies on 15 GHz that aims to provide very fast and low-latency internet service to everyone.By interfacing through Ku band, which finds its application primarily in Satellite communication, High-bandwidth transmission capability qualifies this frequency range to be used for satellite TV, satellite internet, and very small aperture terminal – based systems. The shorter wavelength of Ku band allows for smaller-diameter dish antennas with a better signal strength, but this range is more prone to rain fade issues than the lower frequencies. Apart from facilitating efficient capacity management, the 15 GHz band allows many applications like Air traffic control radar. The 15GHz frequency (the upper end of the Ku-band) is used in some satellite communication systems to achieve a high-frequency downlink transmission. The antennas at 15GHzcan, however, be built smaller, thus being more directional due to the short wavelength, leading to compact terminal designs that will fit properly in VSAT and mobile platforms and even in cramped urban environments. These antennas have been developed within a traditional framework of high gain combined with relatively small apertures, thus improving the signal quality and link reliability of systems.A Yagi-Uda antenna which is arranged in stack manner is defined as configurations where multiple Yagi antennas have been arranged in either a vertical or horizontal stack for increased gain, and overall performance enhancement. A circular disk can be used as a reflector for a Yagi-Uda antenna. The disk can better reflect signals toward the Yagi elements and Improve gain and overall directivity performance. A circular Yagi design can give omnidirectional coverage in the horizontal plane and can be favourable for applications in which signals need to be received from multiple directions. A stacked antenna is defined as a provision of multiple antenna elements, such as dipoles or patches, arranged in a defined geometry-usually in vertical-with the objective of improving the performance metrics of gain, bandwidth and radiation pattern control. Feeding these elements in phase or at specific phase difference includes a combined signal to give directionality and more narrow-focus beam.

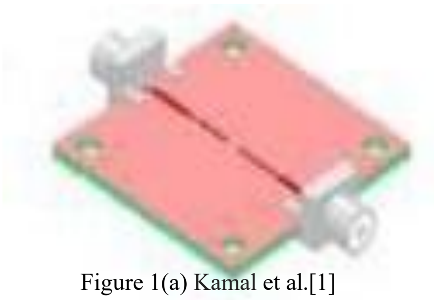


Figure 1(a) Kamal et al.[1]
Microstrip-Ministered Proximity-Coupled Stacked Dual-Port Antenna

Figure 1(b) Ding et al.[8]
Stacked Patch Antenna With Broadband Circular Polarization and Flat Gains

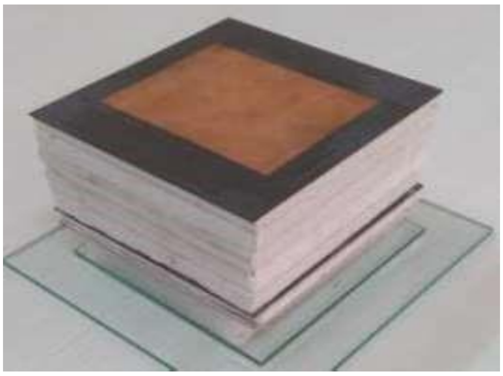


Figure 1(c) Sreenu et al.[9]
Stacked microstrip antenna

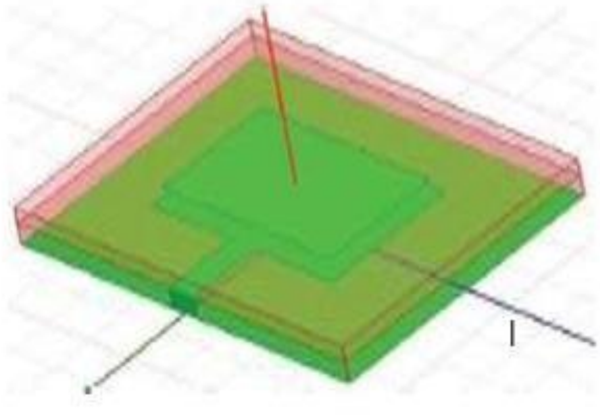


Figure 1(d) Hossain et al.[11]
Stacked microstrip antenna with coaxial probe feed.

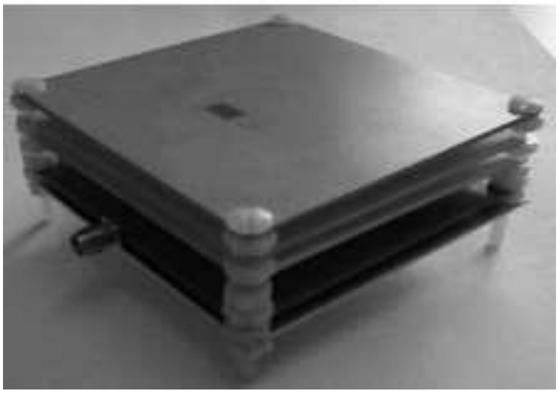


Figure 1 (e) Kramer et al.[14]
Vertically Multilayer-Stacked Yagi Antenna

One kind of turnstile antenna is presented in Fig 2.By the approach of feeding, turnstile antennas become circularly polarized that would serve good application for satellite communications wherein the orientation of polarization ofthe communication signal-axis can vary. Kamal et al.[1] proposes an antenna which is carefully engineered stackedstructure of three dielectric laminates separated air cavities in order to optimize performance at 12 GHz. The top-most substrate is double-sided and applied with FSS patterns, which enhance filtering ability. The middle stratum possesses impedance-matching transmission lines on its top and a partially reactive impedance surface (RIS) at its bottom which boosts additional bandwidth and isolation. The lower substrate has microstrip feed lines embedded in it on the top and semi ground planes beneath the top surface to facilitate the effective near-proximity coupling. The air cavities between these stratum reduce dielectric losses and surfacewave excitation to improve gain and efficiency. Cao etal.[2] suggests grid antennas are more readily installedand transported than their solid counterparts due to theirlighter weight, without sacrificing performance. In openace, the turnstile antenna radiates an omnidirectionalpattern in the horizontal plane, but when bended orvertically stacked, it shows directionality pattern withincreased gain. Zhang and Cheng.[3] presents very wellpopular for FM broadcasting, telemetry, and satellite systems, the turnstile antenna is preferred due to its reduced size and excellent polarizing properties. CrossYagi-
Uda antenna has high capability and bandwidth and that is the very reason to be used before Satellites. It was built for use in the Ultra High frequency region. Wang etal.[4] carefully engineered topology of multilayers in a configuration that is intended to meet good performance in Ku-band frequencies. Idea is to design a primary radiating element installed on a cavity established by a reflective surface and a ground plane to provide a Fabry-Pérot cavity, which enhances the

performance of gain and directivity by constructive interference of its radiated waves. In addition, a metamaterial-based polarization converter is also integrated above the radiator for the conversion of linear polarizations into dual circular polarizations, addressing the requirement for good quality signals supporting dynamic vehicular movements. Further, another Stratum called Metamaterial Absorber is entailed to dampen the unwanted back lobes and decrease surface wave propagation to increase radiation efficiency. Qing Tian et al.[5] employs phased-array installation with multiple radiating elements. Each element carries phase shifters to enable electronic beam steering without mechanical movement. Fast and accurate scanning of the spectrum for energy detection (ED)-based sensing is enabled. It is designed for Ku-band operation, typically for high- frequency satellite communications. Common antenna elements include microstrip patches or slots, again providing compactness and efficiency. Beamforming techniques enhance gain, directivity, and signal detection sensitivity.It enables dynamic real-time spectrum sensing in satellite networks. Saman Zarbakhshand Abdel Sebak.[6] proposes a patch antenna with circular polarization and consists of a top patch, dielectric substrate, and a ground plane. Unlikethe conventional solid metallic patch, the top patch reduces weight while maintaining goodelectromagnetic performance to enhance axial ratio bandwidth and radiation efficiency. The solid dielectricsubstrate enables mechanical support while assuringstable dielectric properties, thereby playing an important role in impedance matching and efficient wave propagation. The solid ground plane acts as a reflector toenhance directivity, minimize back radiation. Jie Zhang etal.[7] tells about wireless communications, amateur radio,and telemetry that include Internet of Things devices andremote-control systems requiring reliable long-range connectivity. The Dual-Band Horn Antenna is 3D printedfor broadcast and receiving purposes. With the aid of 3D printing, antennas can be integrated with other devicecomponents. This 3D printed antenna is also designed forinter-satellite communication(ISC). It has a compactorthomode transducer (OMT) integrated, which provideseffective polarization separation and high channel isolation. Ding et al.[8]designed stacked approach whichis the key mechanism behind its broadband and circularlypolarized properties. Two square patches are stacked above the coaxial-fed square loop at the bottom substrate. These patches are separated from the lower Stratum by a certain gap for proper capacitive coupling between the Stratum. This arrangement helps to achieve better impedance matching by introducing extra resonant modes along with designing an additional circular polarization mode, particularly in upper frequencies. This causes an antenna to achieve a considerably wider impedance along with effective axial-ratio bandwidth. The stacked patches are arranged in a circular manner to achieve weak but balanced coupling, which further enhances the stabilization of gain across the band. Of the several patchshape possibilities tried, it was concluded that the stackedsquare patches were better owing to their straight edgesthat permit better smooth distribution of currents andinteraction with the vertical patches. Overall, the stacked configuration is a significant element for improving bandwidth, gain, and polarization characteristics of theantenna. Sreenu et al. [9] proposes a coaxial feed arrangement for a stacked microstrip patch antenna for GPS applications. The proposed design consists of twoidentical rectangular patches positioned vertically, with foam Stratum and dielectric substrates separating thepatches. A coaxial probe directly feeds the lower one while the upper is parasitically excited. This stacked configuration enhances gain and bandwidth. With an optimized air gap, a gain of 10.32 dB was achieved at1.575 GHz. The structure also provides return loss of -23 dB and VSWR value of 1.13. High gain, low profile, andadoption for GPS base station applications areadvantageous features of the antenna. Sharma et al.[10] presented a research which is optimized for Ku-band applications (12 to 18 GHz) that find a variety ofapplications in satellite communication, broadcasting, andeven radar systems. The antenna is made of rectangular microstrip patch on a dielectric substrate along a ground plane. This configuration is favourable and useful because of its low profile, ease of fabrication, and planar integration. The patch dimensions are designed to radiate efficiently in the Ku-band while maintaining a very low return loss. The coaxial probe feed introduced in the design enhances impedance matching and bandwidth performance. The antenna displays good gain and stable radiation patterns over the frequency ranges of interestand fits well with the high-frequency requirements of satellite communications that demand high-performance,lightweight, low-cost antenna solutions. Hossain et al.[11]presents a stacked microstrip patch antenna structure forimproving functionality beyond that of typical single-stratum designs. This structure consists of two rectangularpatches arranged vertically-stacked; the lower oneperforms as a feeding patch while the upper performs as a radiating patch, and they are separated by dissimilar dielectric substrates. This way, the antenna takes up construction on an multilayer PCB allowing for patchcoupling and consequently, efficiency improvement. In Stacked structure feed is given by both coaxial cable and microstrip line feed. Performance enhancements such as return loss, bandwidth, gain, impedance matching are key improvements brought by the multilayer approach. The return loss and bandwidth improved for coaxial-fed version, while microstrip-fed version can achieve slightly higher gain. The overall enhancement due to different considerations includes enhanced radiation performance, improved VSWR, and appropriateness of the antenna structure for C-band wireless communication applications. Lad et al.[12] designed antenna structure which has been presented as a cross Yagi-Uda array consisting of two units, circularly polarized for UHF satellite communications. Half-wave dipoles with directors as well as a reflector have been used for the construction of each unit in order to increase the directivity. The structure consists of two identical Yagi-Uda antennas arranged perpendicular to one another for circular polarization, optimally spacedat 1.68λ for maximum gain. The boom supports all elements while avoiding lateral radiation. The two-unit array is constructed of light materials (PVC) so as not to interfere with structural stability. Simulation and field tests show that this configuration achieved a gain of 18.6 dBi, a better front-to-back ratio, and a smaller SWR after matching. Some of its main advantages include high gain, elevated link margin, and compatibility with low-power CubeSat communication, making it suitable for ground station systems of amateur satellite missions. Cowley and Green.[13] proposed Antennas based on phased-array designs which operates in the Ku band generates a centric attention towards achieving a particular gain in term of electromagnetics as well as structures, making them conducive to compactness. Consequently, antennas operating in the Ku-band have a frequency range of 12 to 18 GHz; therefore, they are effective and less bulky because of the higher frequency concerned. The designs presented here are based on linear arrays of feed elements using shaped reflectors to steer the beam electronically, instead of mechanical movement. Beam focusing and steering are achieved efficiently for the Ku band application to support satellite communications, broadcasting, and data transmission using sectorised reflectors and a torus-shaped reflector. High gain, low sidelobe levels, and minimum spill over loss characterize these optimum designs. Kramer et al.[14] proposes a vertically multilayer-stacked Yagi antenna meant to be compact and high gain at the frequency of 5.8 GHz. The construction consists of a reflector, a dipole or circular patch driver, and multiple directors on various substrate stratum. This stacking decreases the footprint of the antenna but strongly directs it. There are two versions: one is single polarized dipole, and the other is dual polarized circular patches. With as much as 12 dB gain and 14% bandwidth, it serves excellent isolation between polarizations and allows compact integration. The configuration is very useful for wireless sensors, and high-frequency systems. The study demonstrates the effectiveness of optimization methods in refining antenna parameters for optimal performance. Simulation results confirm the advantages of this approach in achieving superior multiband operation.

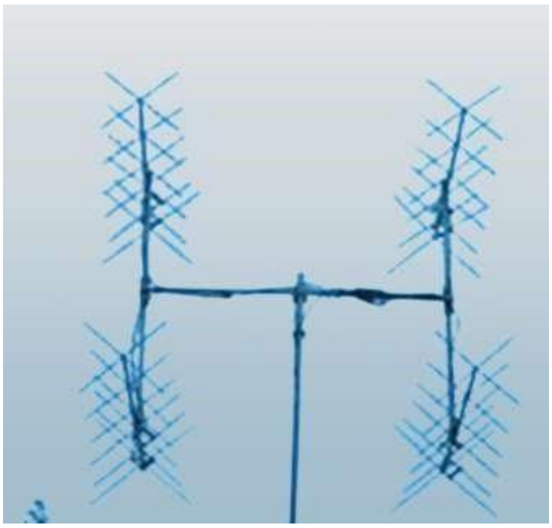
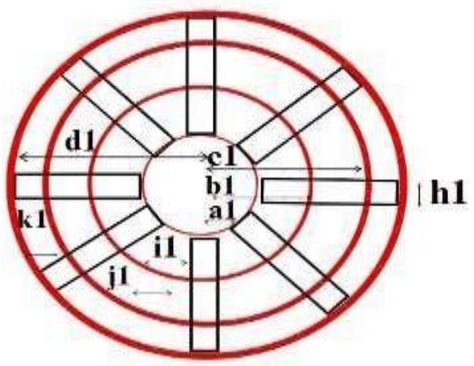


Fig.2 Cross yagi uda antenna

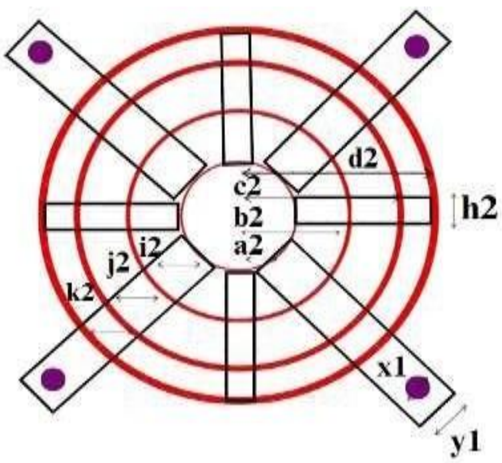
The remaining Sections are organised as follows: section II Antenna Designs and Operational Principals and section III depicts Results and Discussions and section IV depicts conclusion.Antenna Design and Operational Principal

Fig 3 is the structure that includes four stacked aluminium disks with a circular plate attached with Stratum 4 as DGS along a flower slot. For big, high-gain antennas like parabolic reflectors, grid construction is wanted since it helps to impart mechanical strength and stability to the antenna. It lessens the risk of deformation or failure by transferring the weight and stresses more evenly. While keeping the required mechanical properties intact, the grid design is more economical because it uses less material compared to solid constructions. Instead of using a single Stratum, 4 stratum are stacked in order to provide Electromagnetic fields some space and bounce. By carefully spacing the disks, the structure creates controlled cavities through which energy can flow smoothly to enhance gain and diminish reflection. Such elegant coordination in signal flow cannot be provided with a single stratum.

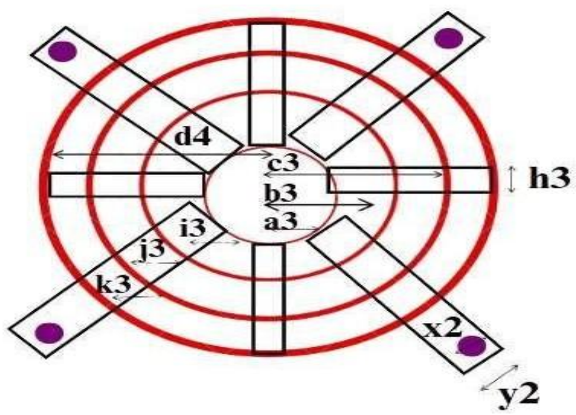
Stratum1

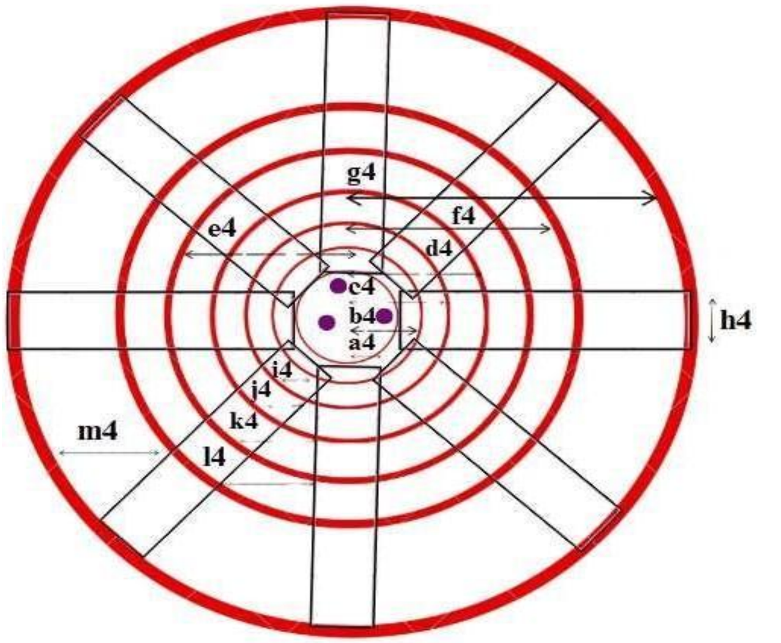


Stratum II



Stratum III

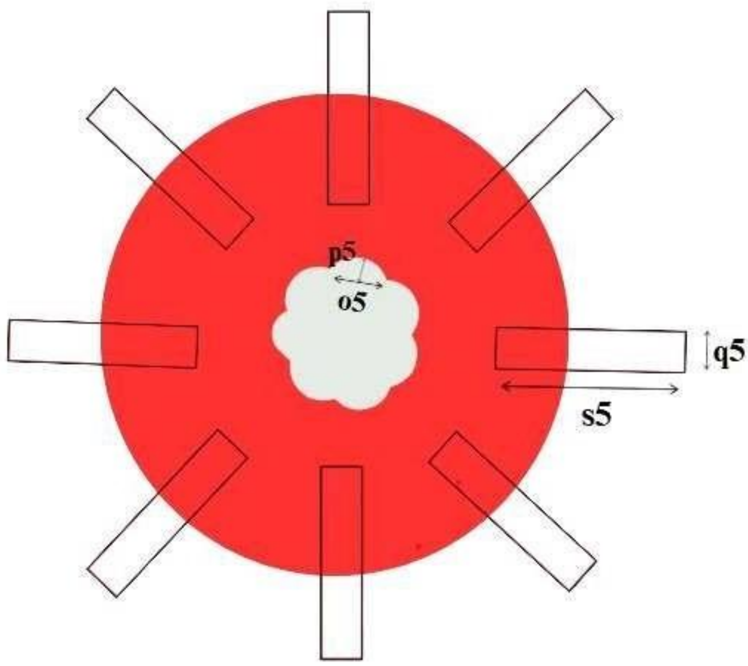




Stratum IV

Stratum V

Front view



Side view

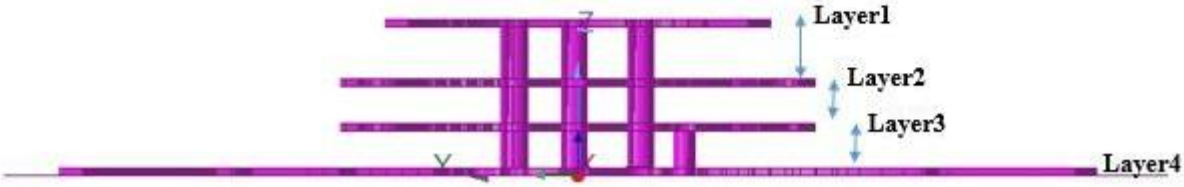


Fig 3 Geometry of proposed antenna structure (a) Front view, (b) Side view and (c) Bottom view

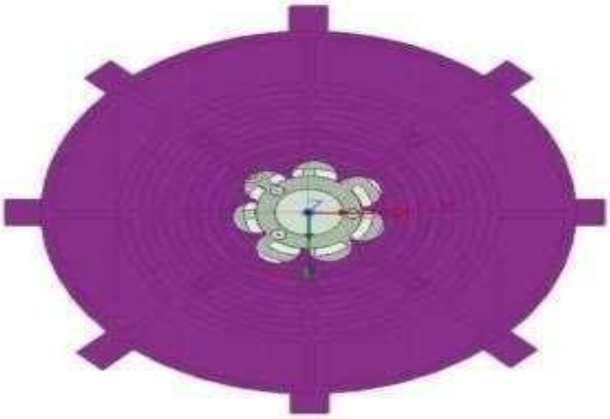


Fig 4 Fabricated Prototype of Antenna

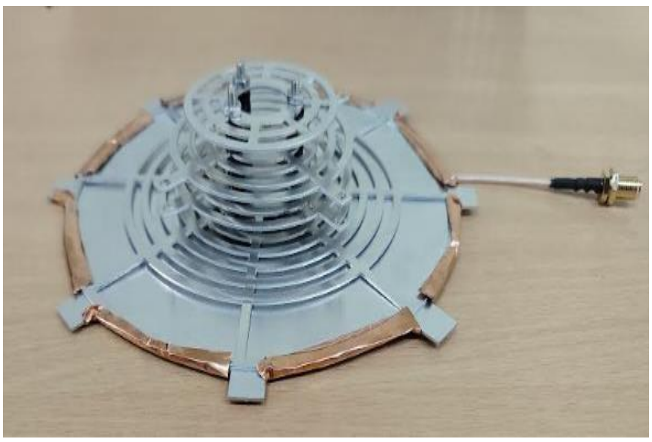


Fig 5 Side view of Fabricated Prototype

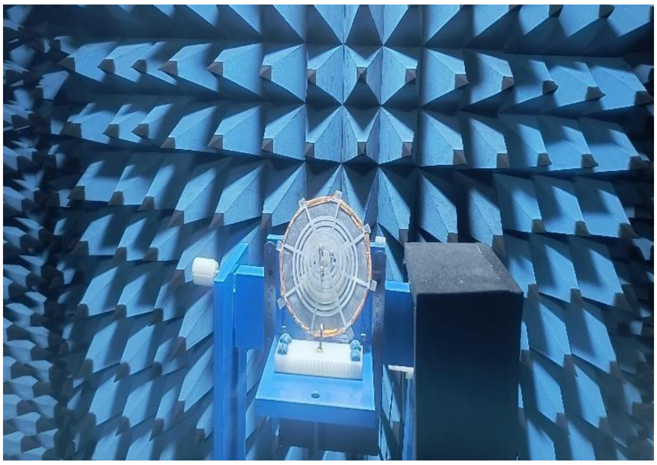


Fig 6 Fabricated Prototype of Antenna in Anechoic chamber

In satellite communications, the ability to send and receive the signals through circularly polarized beam is very effective. It is suitable for satellite internet services and TV transmission. In Fig 3 the design Circular stacked patch antenna, which is of metal-only structure is presented. The antenna is made of four Al Stratum stacked on top of each other vertically with three sets of Aluminium Cylinders in between. In this instance, there isno dielectric substrate for improved heat dissipation. SMA connector is attached in order to measure the results of antenna.

Stratum I

TABLE.1 Dimensionality of Stratum I

Dimensions	Values(mm)
a1	17
b1	20
c1	23
d1	26
e1	3
f1	3
g1	3
h1	3

In Stratum1, there are 4 concentric circles where a1is the radius of inner most circle, b1 is the radius of circle nearer to inner-most, c1 is the radius of third outer circle, d1 is the radius of outermost circle of Stratum1 and i1, j1, k1, h1 are of equal radius where h1 act as length of spoke where the spoke control the surface currents across the Stratum in a defined manner. i1, j1, k1 is spacing between concentric circles of equal length in Stratum1. Though the stratum are stacked, these spoke permit enough current flow to simulate the resonance of a solid patch, a condition that is desired for efficient radiation. Table 1 represents the dimensions and its corresponding values of stratum1. Disk 1 functions as a parasitic patch placed over Disk 2, having somewhat smaller radius and a separation.Coupling provides enhanced antenna effective impedance bandwidth, which is not achievable with a single-patch design. Stratum1 provides electromagnetic coupling, which opportunistically enhances Disk 2's radiating ability. Stratum1 does not have any direct electrical interaction with Stratum 3, it does, however, help balance the resonance environment. It does that by changing the field distribution in the vertical stack, thus facilitating Stratum3's sequential rotation feed structure to deliver phase-shifted signals to Stratum2 more effectively. Being on the uppermost Stratum, Stratum1 cooperates with Stratum4 (the ground) to define the current distribution and fringing fields all over. There is no direct electrical connection between them, but the presence of stratum 1 would assist in keeping the vertical alignment and even current distribution across the stacked structure, which is very important for stable radiation characteristics. The size of the parasitic patch is a bit less than that of the main one, and the gap between the two patches is maintained 8 mm (A1) for the 2 modes to be properly spaced to develop a further range of BW. The separation of the two patches with respect to stratum 3 (A2) and stratum 4 (A3) are both 6 mm. They were selected along with inner and outer radii of Stratum 3 such that a characteristic impedance for sequential circular rotation feed line on Stratum 3 was about 50 Ohm. Stratum1 and Stratum 2 exhibits equal ratio while measuring the difference between concentric circles of each Stratum.

Stratum II and Stratum III

TABLE.2 Dimensionality Table of Stratum2 and Stratum3

Dimensions	Values(mm)
a2, a3	23
b2, b3	26
c2, c3	26
d2,d3	32
e2, e3	3
i2, i3	3
j2, j3	3
k2, k3	3
y1, y2	5
x1, x2	3

In Stratum 2 and Stratum 3 , there are 4 concentric circles where a2,a3 is the radius of inner most circle , b2,b3is the radius of circle nearer to innermost, c2,c3is the radius of third outer circle and d2 and d3 is of radius of outer most circle and h2,h3 is the spoke of arm i2,i3, j2,j3,k2,k3 have equal radius which denotes the difference between concentric circles, y1 is total width of spoke , y2 is of radius circle where punch is given. Table 2 represents the dimensions and its corresponding values of Stratum2 and Stratum3. For ease of height control, Stratum 3 is sandwiched between Stratum 2 and 4. Moving further down to Stratum 3 from Stratum 2 one notices that Stratum 3 contains the curved signal lines which supply power to Stratum 2 along with the Special Phase Shifter. The radius of Stratum 2 and Stratum 3 exhibits equal ratio in all dimensionsal aspects.

Stratum IV

TABLE.3 Dimensionality Table of S IV

Dimensions	Values(mm)
a4	52
b4	55
c4	58
d4	61
e4	64
f4	67
g4	70
h4	3
i4	3
J4	3
k4	3
l4	3
m4	3

Stratum 4 acts out a ground plane. The feed line which is coaxial starts from the circular slot of Stratum4 and is shorted

to the feed point on Stratum 1.
The arc length of sequential circular rotation feed between radial stubs approximately represents one-quarter of a wavelength at its center frequency, 15 GHz. For sequential rotation feeding, this requires the desired phase quadrature A1 is the distance between stratum 1 and Stratum 2. A2 is the distance between Stratum2 and Stratum3. A3 represents the distance between Stratum 3 and Stratum 4. Besides providing tuning, together with the cylinders, the stubs serve as mechanical supports that reduce the risk prone to failures during structural vibration. Uniform concentric Circular stacks are arranged for weight reduction purposes. It should be noted that all stacks are perfectly aligned at the four Stratum. In order to avoid warpage, Al of 1 mm thickness with a line width of 5mm is used in each Stratum. However, in the innermost disk, a larger line width of 5 mmhas been applied to allow for the Gaps. Now the basic properties of this weight-reduced antenna can be evaluated. The proposed antenna design consists of three small holes punctured each of diameter 3 mm punched at uniform angular intervals of 120° along the inner structure of Stratum 1– 3 along with the ground plane so as to facilitate assembly. In Stratum 4 , there are 7 concentric circles where a4 is the radius of inner most circle , b4 is radius of circle nearer to innermost, c4 is the third outer circle and d4 is the circle between c4 and e4 ,e4 is potratred as third circle seen from outside , f4 is nearer to outermost circle g4, g4is last outermost circle ,h4 is the width of spoke which gives mechanical support for Stratum to withstand,i4,j4,k4,l4,m4 is given equal and uniform spaces to avoid collision between heat and stress distribution. Table 3 represents the dimensions and its corresponding values of Stratum IV.

Stratum V

.

TABLE.4 Dimensionality Table of Stratum 5

Dimensions	Values(mm)
p5	3
o5	3
q5	3
s5	40

Table 4 represents the dimensions and its corresponding values of Stratum V. Stratum5, it acts as DGS, which is attached to bottom view of Stratum 4 to ensure higher gain .Stratum 5 is attached to Stratum 4 with the help of copper foil without the need of puncting in Stratum 4 .The reason for using copper is that it is one of the best electrically conducting metals. This results in less resistance and maximum efficiency in transmitting signals within the antenna. p5 is of base length of semi-circle ,o5 stands as a height of semi-circular arc, q5 is the width of spoke in Stratum5 and s5 is the length of spoke in Stratum5.

Results and Discussion

In order to verify the concept, a prototype antenna with circle-edged rectangular cuts to enhance bandwidth was built for use in the 15 GHz band, as given in Fig 3. Typical computer numerical control (CNC) machining was used to create the four aluminium disks. Between these stratum were three sets of commercially available rods, one of which had the feeding mechanism built into it. Our designed prototype antenna's measured and simulated $S11$ parameter and VSWR is given in Fig 4 and Fig 5 respectively. The resonances of driving and parasitic patches made along with the effective coupling effects between the stratum, are the main causes of the broadband matching. Within the designated 15 GHz range, the measured and simulated broadside realized gains are 5.01dB, and the overall efficiency is 99% in simulations. The measured results largely match the simulations, with minor variations presumably due to manual soldering and installation of the feeding.
The simulated and measured S-parameter plot is presented in Fig 6.The decibel (dB) plot of $|S11|$ versus frequency is plotted from 1.2 to 30 GHz. Lower levels of $S11$ indicate better impedance matching, implying that less power is reflected back.It displays a sharp dip around 15 GHz, further proving the excellent radiation potential. Fig 7 plots the simulated |s11| result. It depicts the return loss at -14 dB, with very little signal reflected back to the source. Hence only 3.98% of the power is reflected back, and the remaining 97% is radiated which indicated good impedance matching.

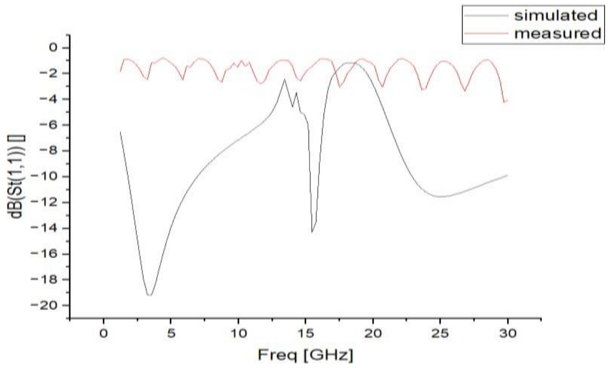


Fig7 Plot of Sparameter

VSWR has become one of the chief parameters for performance of RF power transmission in a power source, from a transmission line to a load, as in the case of the antenna. It also defines the efficiency of transferring power from the antenna to the feed line, thus giving an idea about the degree of impedance matching carried out for the antenna with respect to the feed line. Fig8 represents the plot of VSWR. At frequency of 15 GHz, the value of VSWR is 1.24, which has very high signal efficiency and good performance for Ku-band applications. A VSWR value of 1.24 means that no wave is reflected back.

Formula used for calculation:

$|\Gamma| = 10^{|S11|/20} = 10^{-14/20}$

$= 0.1995$

VSWR = $1+|\Gamma| / 1-|\Gamma|$ VSWR = $1+0.1995 / 1-0.1995$
= ~1.24

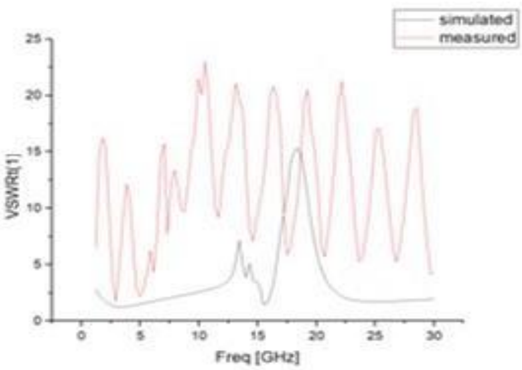


Fig8 Plot of VSWR

The antenna gain refers to the amount of power per unit area that an antenna generates in a given direction and relates this capability, usually defined as its directional function, to a reference isotropic antenna which radiates power equally in all directions. Our proposed antenna results in a gain of 5.01 dB which means that the antenna directs radio frequency energy better in a certain direction compared to a reference antenna. The low noise amplifier (LNA) used in a Ku-band receiver is employed to impose a gain of 5 dB at the early stage of the signal chain, thereby enhancing the SNR of the Kuband receiver. 3D Gain of An Antenna is shown in Fig 9.

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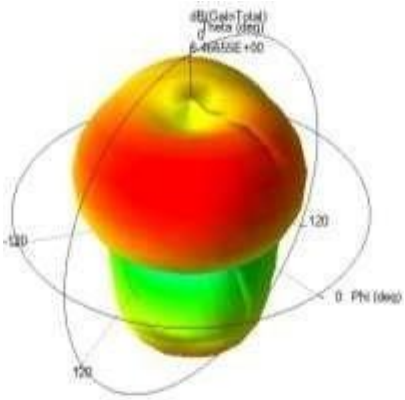

Fig 9 3D Gain Plot of Antenna

The electric field strength means the intensity of an electric component of electromagnetic waves.The Value of 1.162*10^3, demands that the object synchronously receives the field strength and the signal at a high power as it operates very closely to the RF source. Fig 10 plots the E-field of Antenna.

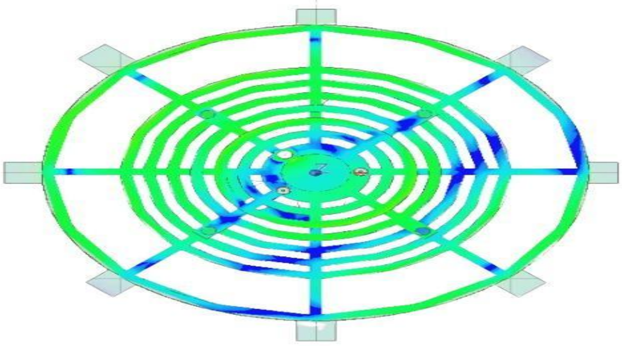

Fig 10 E-field of Antenna

A better H-field value is obtained for radiated waves with a value of 2.22 A/m.The magnetic field concerns charges and currents in motion. In antenna theory, the H-field is usually referred to as the tangential component of the magnetic field across the aperture of the antenna. Fig 11 plots the H-field of antenna.

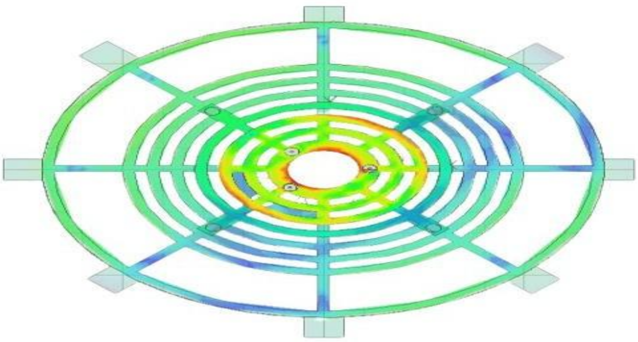

Fig 11 H field of Antenna

By comparing with previous works Our Proposed Antenna is better in aspect of efficiency. Compared to the designs available prior, this proposed design for a circular stacked patch antenna provides better efficiency specifically for Ku-band applications. Other works in the literature, such as Kamal et al.[1] and Sharma et al.[10], suffer from limited return loss and bulky structures that compromise efficiency and flexibility. Besides, the stacked aluminum configuration design without dielectric substrates aids heat dissipation and structural integrity. Zhang et al.[3] and Ding et al.[8] have antennas with low gain (3.2-3.6 dB) and high VSWR; in contrast, Our antenna performance indicates gain of 5.01 dB and a low VSWR of 1.24 towards enhanced signal transmission and impedance matching. A Defected Ground Structure improves both gain and bandwidth, solving the above-mentioned shortcomings. With a simulated efficiency of 99%, this antenna is considered as a potential candidate for compact Ku-band satellite communication systems.

Table 5 offers a comprehensive comparison with the previous works.

Literature Survey	S-parameter (in dB)	VSWR	Gain(in dB)	Efficienc y	Polarization
Kamal et al.[1]	-10	1.2	7	>90%	Dual-polarized (Linear)
Cao et al.[2]	-6	<3	>4.08dBic	>80%	Circularly Polarized
Zhang et al.[3]	-17	<3.5	12.5	64%	Linearly Polarized
Wang et al.[4]	-13	0.93	4.1	>85%	Circularly Polarized(Dual band)
Qing Tian et al.[5]	-11	0.7	9.4	>75%	Linearly Polarized
Saman Zarbakhsh and Abdel Sebak.[6]	-10.9	0.4	6.8	>90%	Circularly Polarized
Zhang et al.[7]	-17	1.32	7.1	>85%	Dual-polarized (Linear)
Ding et al.[8]	-12	1.11	3.2	>70%	Linearly Polarized
Sreenu et al.[9]	-14	2.1	4.3	>80%	Linearly Polarized
Sharma et al.[10]	-11.3	1.65	5.4	>80%	NA
Hossain et al.[11]	-11	1.43	4.1	>60%	Linearly Polarized
Lad et al.[12]	-19	1.76	3.7	>70%	NA
Cowley and Green.[13]	-12.8	1.98	3.1	>50%	Linearly Polarized
Kramer et al.[14]	>-10	1.01	4.9	>60%	NA
Proposed Design	-14	1.23	5.01	99%	Linearly Polarized

CONCLUSION

A design of a Circular stacked patch antenna is presented within satellite payloads. The design, resembling a structure made of a four-part Al disk with Stratum 4 attached to circular plate with flower slot pattern to increase BW, eliminated the dielectric substrate for construction. Disk-shaped structures were incorporated, however, to enhance the mechanical strength of the structure against vibration and stresses. Three sets of Cylinders support the disks in these requests to achieve mutual support between them .To prove the validation of the design, a prototype antenna was built or tested. It has an in-band realized gain of 5.01dB.They fulfill the specifications of the Ku-band application.

REFERENCES

1. Kamal, Shahanawaz, and Padmanava Sen."Microstrip-Ministered Proximity-Coupled Stacked Dual-Port Antenna for 6G Applications," in IEEE Access, vol. 12, pp. 2817-2829, 2024,doi: 10.1109/ACCESS.2023.3348548.
2. Cao, Zhongyao, Le Chang, Yue Li, Kunpeng Wei, and Zhijun Zhang, "Compact Mobile Terminal Antenna With Endfire Circularly Polarized Beam for Satellite Communications," in IEEE Transactions on Antennas and Propagation, vol. 71, no. 12, pp. 9980-9985, Dec. 2023, doi: 10.1109/TAP.2023.3325204
3. Zhang, Jin Fan, and Yu Jian Cheng. " K-/Ka-Band Planar Shared-Aperture Beam-Scanning Array Antenna for Simultaneous Transmitting and Receiving Low Earth Orbit Satellite Communication Terminal", in IEEE Transactions on Antennas and Propagation, vol. 71, no. 8, pp. 6617-6627, Aug. 2023, doi: 10.1109/TAP.2023.3284163.
4. Wang, Wensong Wang, Jie Liu, Chao Zhou, Bo Yin, and Ping. "Dual-band dual-circularly polarized Fabry- Pérot cavity MIMO antenna using CMM-based polarization converter and MMA for vehicular satellite communications." in IEEE Transactions on Vehicular Technology, vol. 72, no. 7, pp. 8844-8856, July 2023, doi: 10.1109/TVT.2023.3245203.
5. Qing Tian, Yuhang Wu, FengShen, Fuhui Zhou, Qihui Wu, and Octavia A. Dobre, "ED-Based Spectrum Sensing for the Satellite Communication Networks Using Phased-Array Antennas," in *IEEE Communications Letters*, vol. 27, no. 7, pp. 1834-1838, July 2023, doi: 10.1109/LCOMM.2023.3274656.
6. Saman Zarbakhsh and Abdel R. Sebak, "Multifunctional Drone-Based Antenna for Satellite Communication," *IEEE Transactions on Antennas and Propagation*, vol. 70, no. 8, pp. 7223-7227, Aug. 2022, doi: 10.1109/TAP.2022.3145463
7. Zhang, Jie, Xiuping Li, Hua Zhu, Yuhan Huang, and Zihang Qi ,"Dual-band dual-polarization horn antenna array based on orthomode transducers with high isolation for satellite communication." in *IEEE Transactions on Antennas and Propagation*, vol. 70, no. 10, pp. 9247-9259, Oct. 2022, doi: 10.1109/TAP.2022.3177473.
8. Ding, Kang, Yanjie Wu, Kun-Hua Wen, Duo-Long Wu, and Jian-Feng Li. "A stacked patch antenna with broadband circular polarization and flat gains." in *IEEE Access*, vol. 9, pp. 30275-30282, 2021, doi: 10.1109/ACCESS.2021.3059948.
9. Sreenu, Sunkaraboina, Vadde Seetharama Rao, and M. Sekhar. "Stacked microstrip antenna for global positioning system." In *2017 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC)*, pp. 1-3, doi: 10.1109/ICCIC.2017.8524498.
10. Sharma, Iti, Amish Kumar Jha, and Sumit Gupta. "Design and Analysis of KUBAND Microstrip Rectangular Patch Antenna." *2016 International Conference on Micro-Electronics and Telecommunication Engineering (ICMETE)*, pp. 89-92. IEEE, 2016, doi: 10.1109/ICMETE.2016.95.
11. Hossain, Md Bappy, and Sham Datto. "Improvement of antenna performance using stacked microstrip patch antenna." In *2016 2nd International Conference on Electrical, Computer & Telecommunication Engineering (ICECTE)*, pp. 1-4. IEEE, 2016, doi: 10.1109/ICECTE.2016.7879605.
12. Lad, Rupesh, Pritesh Chhajed, Lokeshsingh Bais, Shyam Dahiwal, Sukhada Saoji, Vaibhav Rekhate, Pushkar Chaudhari et al. "design and performance evaluation of two-unit yagi-uda array for UHF satellite communication." *International Journal of Wireless & Mobile Networks* 6, no. 5 (2014): 145.
13. Cowley and Green, "Phased-Array Antennas for Inter-Satellite Links," in *Proc. 2010 Australian Communications Theory Workshop (AusCTW)*, Feb. 2010, pp. 102–106, doi: 10.1109/AUSCTW.2010.5426772.
14. Kramer, Djerafi and K. Wu, "Vertically Multilayer-Stacked Yagi Antenna With Single and Dual Polarizations," in *IEEE Transactions on Antennas and Propagation*, vol. 58, no. 4, pp. 1022-1030, April 2010, doi: 10.1109/TAP.2010.2041155.