Journal for Educators, Teachers and Trainers
The PROFESIOLab electronic, peer-reviewed, open-access Magazine

ISSN 1989 –9572

DOI: 10.47750/jett.2023.14.06.012

MULTI BAND MEANDERED STACKED MICROSTRIP FRACTALANTENNA

Farha Deeba
Dr. Rajesh Kumar Rai

Journal for Educators, Teachers and Trainers, Vol.14(6)

https://jett.labosfor.com/

Date of reception: 03 June 2023

Date of revision: 29 Oct 2023

Date of acceptance: 20 Nov 2023

Farha Deeba, Dr. Rajesh Kumar Rai (2023). MULTI BAND MEANDERED STACKED MICROSTRIP FRACTALANTENNA. ***Journal for Educators, Teachers and Trainers*****, Vol.14 (6). 123–130.**

Journal for Educators, Teachers and Trainers
The PROFESIOLab electronic, peer-reviewed, open-access Magazine

Journal for Educators, Teachers and Trainers, Vol.14(6)
ISSN1989– 9572
https://jett.labosfor.com/

MULTI BAND MEANDERED STACKED MICROSTRIP FRACTALANTENNA

Farha Deeba, Research Scholar, Madhyanchal Professional University, Bhopal-46204, India

Dr. Rajesh Kumar Rai, Department of Electronic & Communication Engineering, Madhyanchal Professional University, Bhopal-46204, India

ABSTRACT
Antennas with various structures based on the above techniques are designed, fabricated and tested for wireless communication bands between 0.5 GHz and 6 GHz. Probe fed, microstrip line fed rectangular patches along with C-shaped slot and slits on edges are designed for the frequency 2.45 GHz. Probe fed Circular patch with single slit and slot, and multi slits for 0.9 GHz are designed. Also, fractal structures on microstrip patch antenna are designed. Circular patch antenna resonating frequencies at 0.9 GHz, and 2.6 GHz is designed. Hexadecagon (sixteen) sided circular patch antenna is designed with four fractal iterations. Octagonal shaped fractal exhibits wideband operation. With each iterations1 to 3 on Circular patch antenna, size reduction is achieved
KEYWORDS: Multi Band, Meandered, Stacked, Microstrip, Fractal Antenna, microstrip patch antenna's

INTRODUCTION

The microstrip patch antenna's (MPA) compact profile, inexpensive price, and simplicity of manufacturing make it a popular choice. One side of a dielectric substrate is etched with metal to create a patch antenna, while the other side has a ground plane formed by a continuous metal layer of the substrate. Since MPAs are naturally narrowband antennas, they employ a number of bandwidth improvement methods to make them as small as possible, making them ideal for use in discreet applications. Consequently, a great deal of research and study is going on all over the world. Although MP A's bandwidth is very limited, modern wireless communication methods need much larger working bandwidths. Such as 7.6% for the GSM (890–960 MHz) system, 9.5% for the DCS (1710–1880 MHz) system, 7.5% for the PCS (1850–1990 MHz) system, and 12.2% for the UMTS (1920–2170 MHz) system.

The numerous appealing properties of microstrip patch antennas (MPA), including their cheap cost, light weight, tiny profile, and conformability, make them ideal candidates for usage in a wide range of applications. The very low bandwidth—as little as 1%—is, however, the biggest drawback of MPA. These antennas are compatible with active devices and printed strip-line feed networks. All sorts of array designs have made heavy use of micro strip resonant patches, both round and rectangular. Advancements in microstrip antenna technology have recently been driven by a trend toward larger-scale integration, which in turn is a product of the shrinking of electronic circuits.

Micro strip antennas based on photolithographic technology are seen as a significant improvement over conventional antennas, which are bulky and expensive components of electronic systems. the most basic configuration of a microstrip patch antenna, which comprises a ground plane on one side and a radiating patch on the other. The patch, which may take on any form, is often composed of a conducting substance like copper or gold. Photo etching the radiating patch and feed lines into the dielectric substrate is a common practice.

LITERATURE REVIEW

Wang, Y.J. & Koh, Wee Jin & Tan, J.H. & Teo, P.T. & Yeo, P.C. & Lee, Ck. (2001). The demonstration includes a square microstrip patch antenna that is both innovative and constructed using a single layer and one patch. Incorporating an air-filled substrate with a thickness of approximately 0.08 λ₁ and shorting one patch edge with three pins allows this probe-fed small and broadband antenna to achieve an impedance bandwidth (return loss <-10dB) of 67.5% from 3.62 GHz to 7.32 GHz. Analyses, measurement findings, and the specifics of the antenna's design are detailed and examined.

Ooi, B. & Shen, Q.. (2000). This study presents a new idea for a microstrip patch antenna that is E-shaped and supplied via coaxial cable. In comparison to the standard U-slot antenna, the suggested antenna has a substantially wider impedance bandwidth. The suggested E-plane antenna achieves an impedance bandwidth of about 33.8%. An impedance bandwidth of 40% is achieved by compensating the probe inductor with a washer on the proposed antenna. The suggested antenna, like the one that comes with the washer, maintains a very consistent E-plane radiation pattern all the way through the band. In the article, we contrast our suggested antennas with the U-slot antenna.

Islam, Mohammad & Shakib, Mohammed & Misran, Norbahiah& Sun, T. (2009). This study presents the method for reducing size and increasing bandwidth, which enhances the performance of a traditional microstrip patch antenna on a reasonably thin substrate (about 0.01 λ0). The design incorporates state-of-the-art methods such as L-probe feeding, slotted patch, and inverted patch structure with air-filled dielectric. Combining these methods with the new slotted patch produces an antenna element that is small, broadband, has a high gain, and has a low profile. The suggested antenna has a simulated impedance bandwidth of around 22%. A compact dimension of 0.544 λ0 × 0.275 λ0 (where λ0 is the guided wavelength of the center operating frequency) is possessed by the suggested patch. Array applications within the specified frequency range of 1.84-2.29 GHz are well-suited to the design.

Rana, Md & Hossain, Sifat & Rana, Shuvashis& Rahman, Md. (2022). A wide variety of forms and sizes are possible for antennas. An antenna layout that prioritizes performance while being lightweight and unobtrusive is the microstrip patch. Some 6G communication system applications may utilize microstrip patch antennas in the future. Furthermore, other devices may be used to develop 6G communication applications; they include autonomous cars, machine learning, radar, the internet of things (IoT), autonomic vehicles, vehicle-to-vehicle (V2V) communication, autonomous vehicles, autonomous vehicles, wireless communication, and the internet. Conventional 4G wireless applications employed the multiple-input, multiple-output (MIMO) paradigm. A wide variety of antenna types, their geometric structures, analytical methodologies, and dimensions are covered in this work.

Qureshi, Md & Sayeed, Md & Hossain, Md. Azad & Islam, Thohidul. (2023). We have constructed and analyzed the performance of an initial rectangular microstrip patch antenna. The target operating frequency range, which is 28.00 GHz to 29.96 GHz, has been fine-tuned by cutting the slot and edge utilizing a partial ground plane method. The inset-fed microstrip patch antenna described in this study is built on a Teflon substrate with a dielectric constant of 2.1 and has a defective ground structure (DGS). An antenna's efficiency and bandwidth are both enhanced by using a defective ground slot rather than the entire ground plane. We anticipate that the designed antenna will operate at 28.90 GHz in the 5G application, thanks to its broad -10 dB bandwidth of 1.96 GHz. A return loss of -39.42 dB is measured. The antennas are also very small (35 x 39 x 1.57 mm3), have a high gain and directivity over the whole operating spectrum, and have a large bandwidth of 1.96 GHz. The value of VSWR is 1.

MEANDER PATCH

Circular patch with five slits as meander patch (A12) is designed in chapter 3. The Circular patch with multi slit as Meander having radius, a=47.6 mm, on the FR4 dielectric material ε_r =4.4, substrate thickness, h=3.2 mm. It is giving the results of -10.14 dB at 0.885 GHz, - 12.35 dB at 1.82 GHz, -10.74 dB at 2.42 GHz, -13.32 dB at 4.79 GHz, -11.77 dB at 5.23 GHz, and -10 dB at 5.83 GHz. To get required multi band, it is taken for stacking.

FRACTAL PATCH

Star shaped multisided fractal patch is designed with radius, a is equal to 47.6 mm by assuming resonant frequency, f_r is equal to 0.9 GHz, ε_r is equal to 4.4, $\sqrt{\varepsilon}$ is equal to 2.09, and thickness h is equal to 1.6 mm. with N is equal to 16 sides. The simulation result of S-Parameter S_{11} is, -25dB at 0.99 GHz. It is also added here for stacking to get 0.9 GHz in thefinal result.

STACKED PATCHES

This hexagonal shaped fractal patch is already designed in chapter 5, by stacking with circular meander patch to form as stacked patch. It yields multi band operation. Further to get more performances, it is taken for stacking.

STAR SHAPED FRACTAL, HEXAGONAL FRACTAL STACKED WITH MEANDER PATCH

Stacked with additional patch combining star shaped fractal, hexagonal and meander patch together as antenna (A18) is presented here.

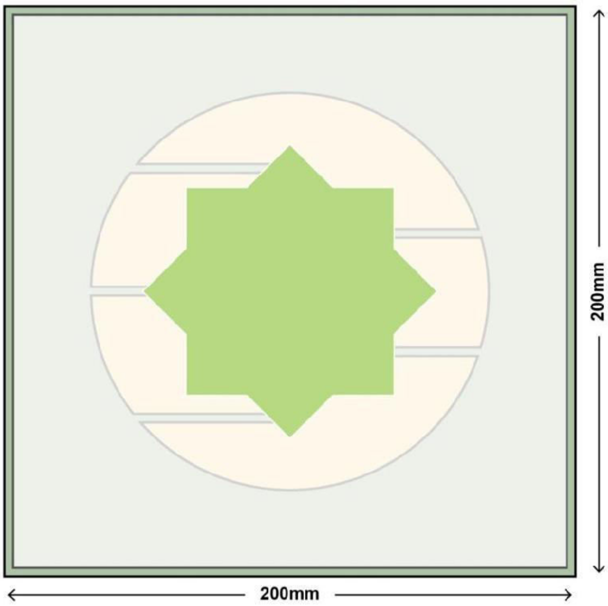

Figure 1: Geometry of star shaped fractal stacked with meander

Working principle of multiband antenna

The stack has the structure as shown in figure 1. The top patch is star shaped fractal, additional patch is hexagonal fractal and the bottom patch is meander. The side view is shown in figure 2.

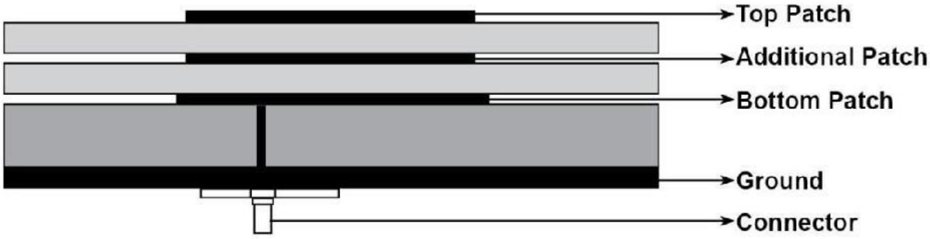

Figure 2: Side view of stacked antenna with additional patch

It consists of star shape fractal on top, hexagonal fractal as additional, and meandered patch as bottom patch. This stacked antenna attains radiation characteristics with utilizing the coupling between the first radiating element 'star shaped fractal' and the second radiating element 'hexagonal fractal', when a power is fed to the bottom meandered patch antenna.

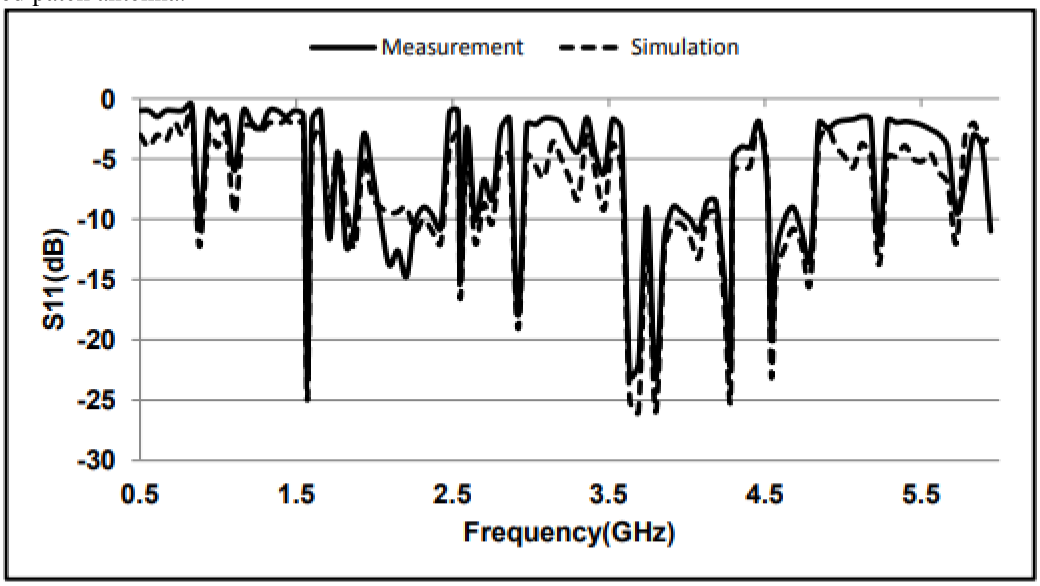

Figure 3: S-Parameter results of star shaped fractal stacked with meander

Reflection coefficient vs frequency as S-parameter is shown in this figure 3, multi band operation is obtained between 0.5 GHz and 6 GHz for the two patches only, top patch star shape, and bottom patch meander.

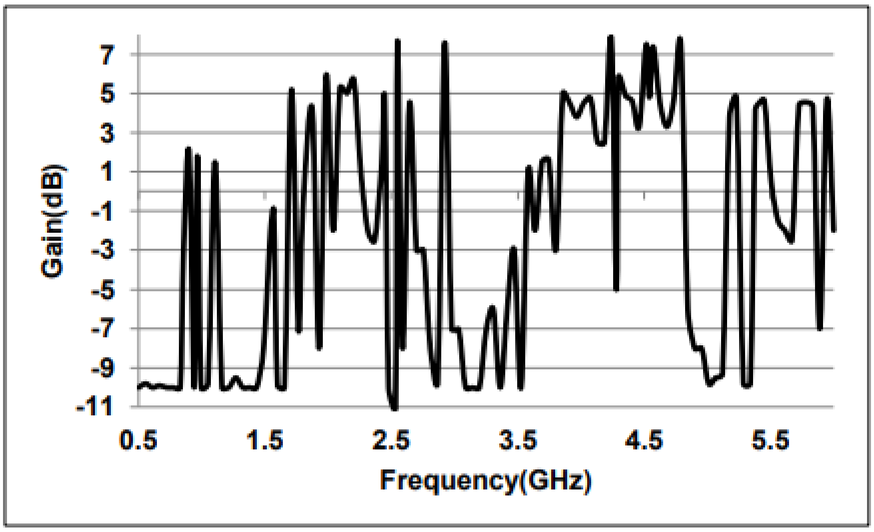

Figure 4: Gain of star shaped fractal stacked with hexagonal patch and meander patch

The S-Parameter values of this combined stacked antenna's simulation and measurement are displayed in the graph of figure 3. The solid line indicates measurement and it follows closely to simulation results. The gain vs frequency variation is shown in figure 4. The radar plot results of star shaped fractal stacked with hexagonal patch and meander patch showing the radiation pattern in figure 5.

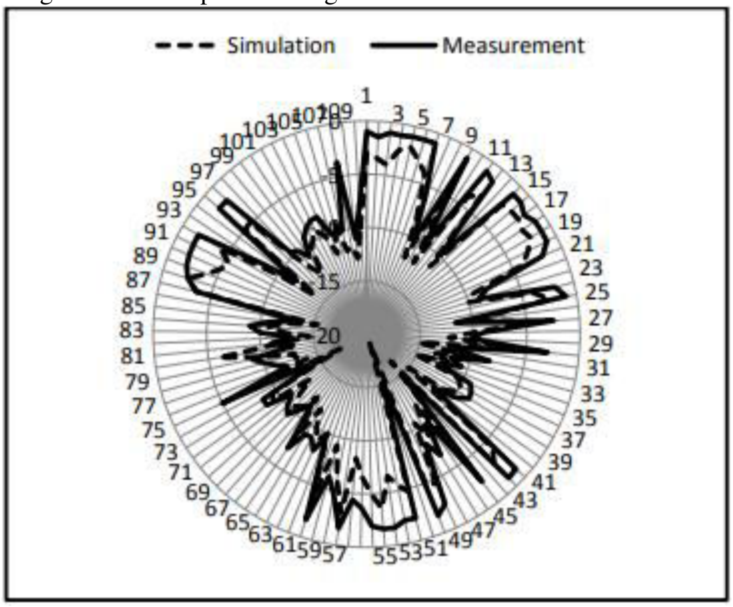

Figure 5: Radar plot results of star shaped fractal stacked with hexagonal patch and meander patch.

VSWR vs frequency display is given in figure 6, which shows less than 2 values are obtained for most of the resonant frequencies.

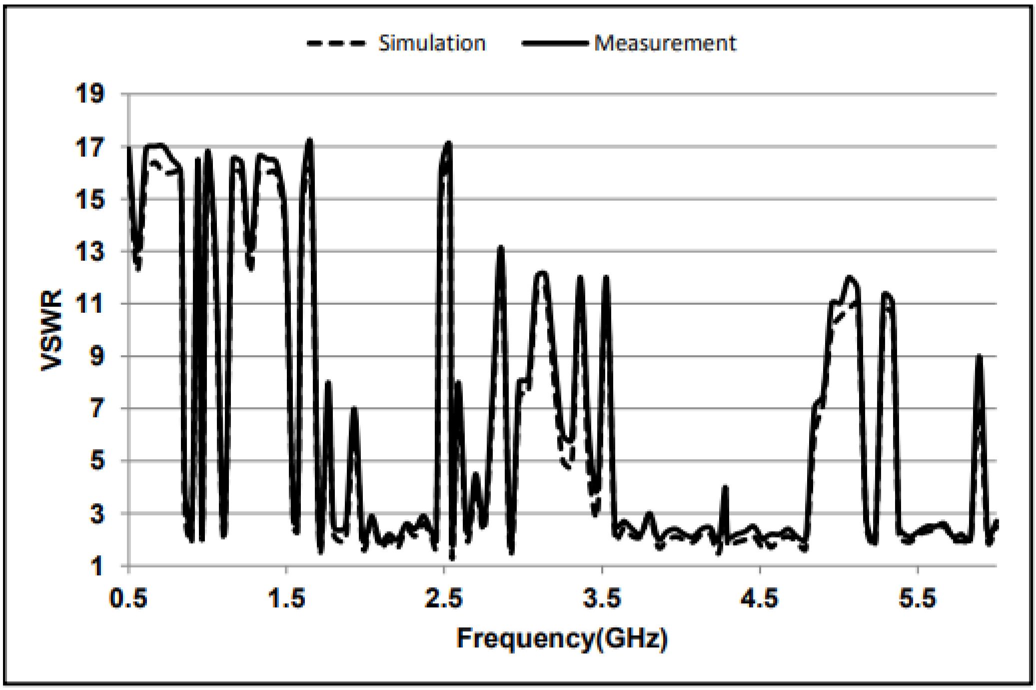

Figure 6: VSWR results of star shaped fractal stacked with hexagonal patch and meander patch

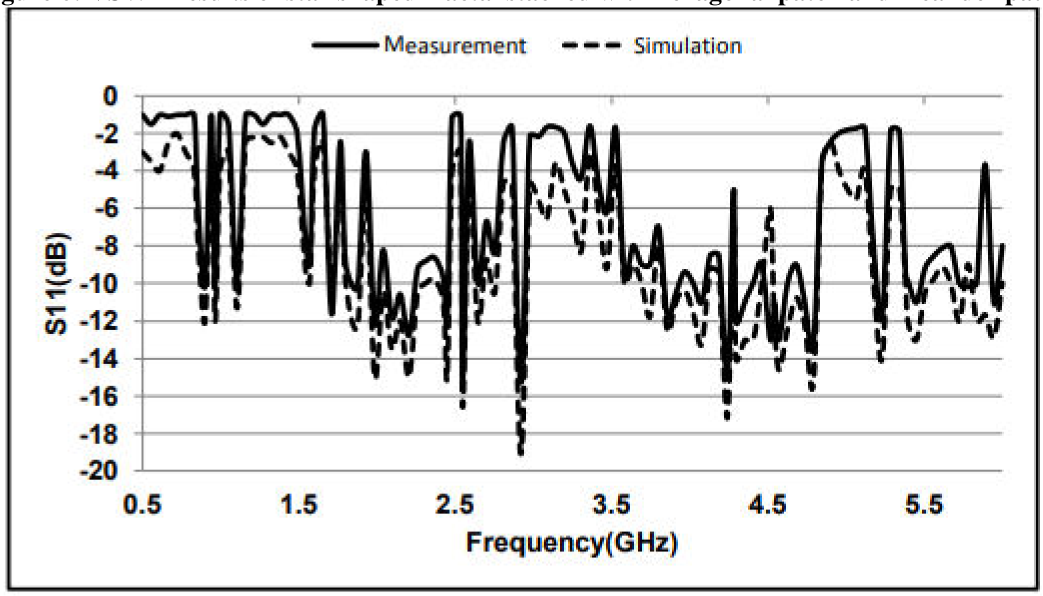

Figure 7: S-Parameter results of star shaped fractal stacked with hexagonal patch and meander patch

In this figure 7, reflection coefficient vs frequency curve shows the multiband operation with maximum gain, 10 dB return loss. Far field radiation pattern of XZ plane, YZ plane is given in two-dimensional view in figure 8 and 9

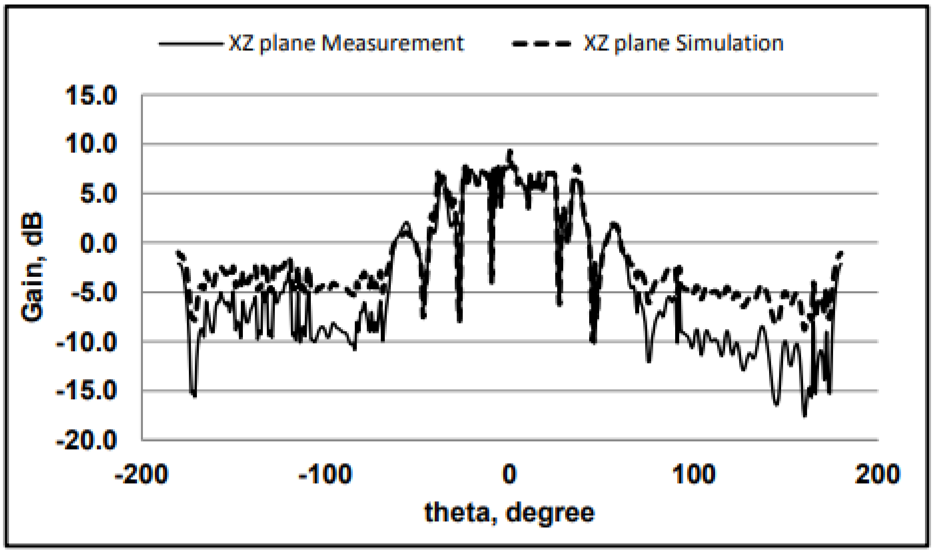

Figure 8: Radiation pattern of star shaped fractal stacked with hexagonal patch and meander patch in XZ plane

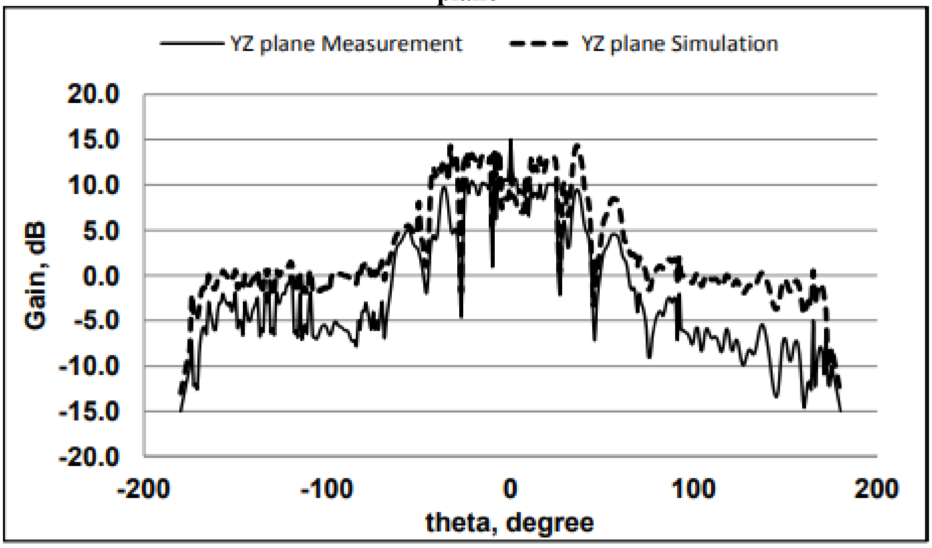

Figure 9: Radiation pattern of star shaped fractal stacked with hexagonal patch and meander patch in YZ plane

CONCLUSION

Multi slit circular patch as meandered patch, Star shaped fractal patch resonating frequency at 0.9 GHz, and hexagonal fractal patch are combined as one antenna by stacking together and designed. This stacked combination antenna gives multiband operation between 0.5 GHz and 6 GHz with maximum gain of 7.74 dB. The simulation and measurement results are in close uniformity.

Microstrip antenna meandered and stacked design and analysis for wireless communication application are given in this chapter. It is concluded that low profile antenna can be utilized for wideband applications with fractal, meandering method and stacking method. The next chapter proposes the conclusion of analysis, design of microstrip antenna by using probe feed multi band stacked methods. The future work of this research is also discussed.

REFERENCE

1. Wang, Y.J. & Koh, Wee Jin & Tan, J.H. & Teo, P.T. & Yeo, P.C. & Lee, Ck. (2001). A compact and broadband microstrip patch antenna. 219 - 222. 10.1109/RAWCON.2001.947619.
2. Ooi, B. & Shen, Q. (2000). A novel E-shaped broadband microstrip patch antenna. Microwave and Optical Technology Letters. 27. 348 - 352. 10.1002/1098-2760(20001205)27:5<348: AID-MOP17>3.0.CO;2-V.
3. Islam, Mohammad & Shakib, Mohammed & Misran, Norbahiah& Sun, T.. (2009). Broadband microstrip patch antenna. European Journal of Scientific Research. 27. 174-180.

4. Rana, Md & Hossain, Sifat & Rana, Shuvashis& Rahman, Md. (2022). Microstrip patch antennas for various applications: a review. Indonesian Journal of Electrical Engineering and Computer Science. 29. 1511-1519. 10.11591/ijeecs.v29.i3.pp1511-1519.
5. Qureshi, Md & Sayeed, Md & Hossain, Md. Azad & Islam, Thohidul. (2023). Design and Performance Analysis of a Broadband Rectengular Microstrip Patch Antenna for 5G Application. 1-6. 10.1109/PCEMS58491.2023.10136053.
6. Singh, Pushpendra & Ray, Kanad & Rawat, Sanyog. (2016). Design of Nature Inspired Broadband Microstrip Patch Antenna for Satellite Communication. 10.1007/978-3-319-27400-3_33.
7. Shanmuganantham, T. & Raghavan, Srividya. (2009). Design of a compact broadband microstrip patch antenna with probe feeding for wireless applications. AEU - International Journal of Electronics and Communications. 63. 653-659. 10.1016/j.aeue.2008.05.009.
8. Rawat, Sanyog & Sharma, Kamalesh. (2014). A compact broadband microstrip patch antenna with defective ground structure for C-Band applications. Central European Journal of Engineering. 4. 10.2478/s13531-013-0162-1.
9. Islam, Mohammad & Shakib, Mohammed & Misran, Norbahiah. (2009). Broadband E–H shaped microstrip patch antenna for wireless systems. Progress in Electromagnetics Research-pier - PROG ELECTROMAGN RES. 98. 163-173. 10.2528/PIER09082302.
10. Cao, Yufan& Cai, Yang & Cao, W.-Q & Xi, Baokun& Qian, Zuping& Wu, Tao & Zhu, Lei. (2019). Broadband and High Gain Microstrip Patch Antenna Loaded with Parasitic Mushroom-Type Structure. IEEE Antennas and Wireless Propagation Letters. PP. 1-1. 10.1109/LAWP.2019.2917909.