iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** III **Month of publication:** March 2025

DOI: https://doi.org/10.22214/ijraset.2025.67799

Modified Monopole 8 ElementMIMO Antenna Array for Mobile Applications

K. Rojamani[1], A. Manju Priya[2], S. Gomukhi[3], A. Davis Johnson[4], K. Varsha[5]
[1]*Assistant professor, Dept of ECE, Krishna University College of Engg& Tech,Machilipatnam, AP, India*
[2, 3, 4, 5]*UG student, Krishna University College of Engg& Tech, Machilipatnam, AP, India*

Abstract: These days, wireless applications are very necessary, and most of these applications use microwave frequencies, primarily ISM bands (Industrial, Science, Medical), as well as 5G- SUB6 bands. This task offers an antenna with multiple entrances and multiple output antennas (MIMO) over the weekend to work in wireless applications. In this article, MIMO is a 8 quarter Band antenna for wireless services. It operates at the level of 2.2 GHz - 2.65 GHz, 5 GHz - 5.7 GHz, 7.2 GHz- 9 GHz and 12 GHz -14 GHz. The antenna is printed by a FR4 subtract with a thickness of 0.4mm with a relative dielectric permeability of 4.4 and a loss of 0.02 and is intended for the perpendicular edge of the system board. Applicationto popular mobile phones in fullscreen. Simulation result show that the reflection coefficient is less than -6db, with better separation than 20dB at radiation band frequencies. Meet future 5G applications and other wireless Communication needs.
Keywords: MIMO antenna , Amplification, Return loss, DGS

I. INTRODUCTION

As a development in the field of communication engineering and electronic engineering communication systems, smaller sizes and wider bandwidth are important requirements for the latestdevelopment of communication systems for the development of elemental transmitters(antennas). Communication from 7.0 to 11.2 GHz install frequency bands for band X application. The S – strip is a part of the microwave of the electromagnetic spectrum. This is determined by the IEEE of radio waves with variable frequencies of 2-4 GHz and crosses the normal boundary between UHF and SHF at 3.0 GHz. The S- strip is used using weather radar and surface ship radar. Band C name given to a particular part of electromagnetic spectrum, including the length of the microwave waves used for long range communications, the C band (4 - 7 GHz) and its small changes include certain Wi-Fi devices, certain wireless phones, and frequency ranges used for certain weather radar systems. MIMO means several multiple inputs outputs. It is a technology used in wireless communication systems to reach higher data flows and improve reliability by transmitting and receiving.

II. OBJECTIVE

The purpose of this is to design and model the microstrippatch MIMO antenna, which was radiated in the SUB6 strip from the 5G application using the HFSS commercial tool.

III. METHODOLOGY

1) Antennas are designed for the frequency range using design reasons and procedures.
2) The antenna model using HFSS.
3) Simulation and optimization of design parameters.

IV. LITERATURE

1) UWB antennas emerged in the late 19th century, gaining significant advancements after the FCC opened the 3.1 to 10.6 GHz band for commercial use in 2002.
2) The shift to 5G will drive the demand for faster communication speeds, with MIMO technology enhancing smartphone channel capacity and spectrum efficiency.
3) Universe diversity is an effective method to improve wireless communication reliability without increasing throughput or delays.
4) The article examines MIMO systems ‘ structure, theoretical capacity, and the significance of channel estimation,detection and equalization

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue III Mar 2025- Available at www.ijraset.com

5) A robust wireless infrastructure is essential to meet rising mobile demands, with MIMO enhancing efficiency.
6) Future channels must adapt to different environments, requiring fields measurements for validations

V. INTRODUCTION TO HFSS

HFSS is a high- performance full wave electromagnetic (EM) simulator of any 3D compensation modeling of passive devices using the familiar Microsoft windows user interface. Integrate modeling, visualization, solid modeling and automation in a simple environment for training, here, the solution for 3D problem EM is quickly and accurately obtained. Ansoft HFSS employs the finite element method (FEM), adaptive meshing, and brilliant graphics to give you unparalleled performance and insight of all your 3D EM problems. Ansoft HFSS can be used to calculate parameters such as S – parameters, resonant frequency, and fields.

A. *Microstrip Antenna*

A class of antennas that has a gained considerable popularity in recent years in microbial antennas .there are many types of antennas, but they have a common characteristic

1) Very fine flat metal areas are often referred to as patch.
2) Dielectric substrate.
3) Ground plan this is generally much larger than in patch.
4) Feed that provide elements of RF power.

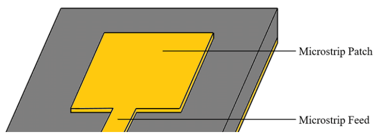
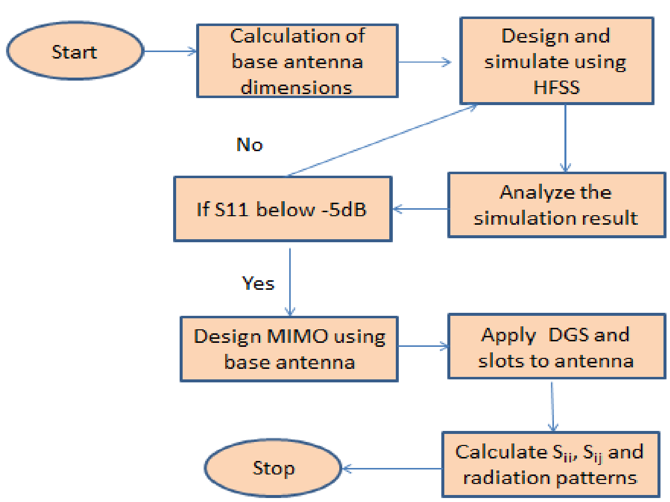


Fig: Microstrip Antenna

B. *Antenna Parameters:*

1) Return loss: the essential characteristics to consider when evaluation an antenna is return loss. It has to do with the largest power transfer theory and impedance matching .ratio of the incident power of the antenna to the force reflected from the source antennas are known as return loss(RL).
2) Radiation pattern:Antennas that emit uniformly in all directions are called isotropic antennas. Isotropic antenna it is suitable for comparison as it is not possible to implement in real life. Elliptical shaped patch antenna is called an elliptical patch antenna.
3) Bandwidth: the ellipse helps you reach a wider bandwidth compared to other forms of patch antenna, this is extremely important for application that require communication over the frequency range.
4) Gain: planar antenna including elliptical shapes are suitable for communication from a satellite perspective, as they provide a medium or high increase in principle communication system.
5) Substrate material: antenna productivity is influenced by the material of the constructed substrate.common materials for substrate include dielectric material such as FR4.
6) Feed mechanisms:feed mechanisms such as microbial lines and coaxial feeds plays a critical role in decisions comparison of antenna impedance and overall performance.

VI. INTRODUCTION TO ANTENNA DESIGN:



A. Double Elliptical Patch Design

DESIGN STAGES:

Step 1: for the practical values of the antenna patch, you can calculate using standard formulas.

Step 2: calculation of width(W).

$$w = \frac{2c}{f_{0\sqrt{\varepsilon_{r+1}}}}$$

Where, C= light speed= c = 3× 10^{11}mm/s ,ε_r= relative permittivity, W = patch width

Step 3: calculation of effective dielectric constant. This is based on the dielectric permeability of height, dielectric width and is calculated from the patch antenna.

$$\varepsilon_{eff} = \frac{\varepsilon_{r+1}}{2} + \frac{\varepsilon_{r-1}}{2}\left[1 + 12\frac{h}{w}\right]^{-\frac{1}{2}}$$

where,

$\varepsilon_{eff=}$ effective permittivity, ε_r= relative permittivity, h= substrate thickness, w = patch width

Step 3: calculation of the effective length$L_{eff} = \frac{0.5c}{2f_{0\sqrt{\varepsilon_{eff}}}}$Where, L_{eff} = effective length

Step 4: calculation of the length extension ΔL,

$$\Delta L = 0.412h\left[\frac{(\varepsilon_{eff} + 0.3)\left(\frac{w}{h} + 0.264\right)}{(e_{eff} - 0.288)\left(\frac{w}{h} + 0.8\right)}\right]$$

Where, SL is the length extension because of fringing field. The transmission line model even through is applicable to infinite ground planes only but for practical considerations, a finite ground plane is used. However, the size of the ground plane must surrounding board, so the results are similar to those using an infinite floor plan. The dimensions of the mass plan are calculated as follows; where, $L_g = 6h + L$,$W_g = 6h + W$

Where; h= substrate thickness ,L = patch length ,W = patch width ,L_g =ground length ,W_g=ground width

step 7: provide inset feed to improve the S11

B. HFSS DESIGN ITERATIONS:

PATCH DESING STEPS:

Step 1:In this work microstrip lines are integrated to get the final dipole with multiple bends

Step 2: The width of designs are calculated using following equations

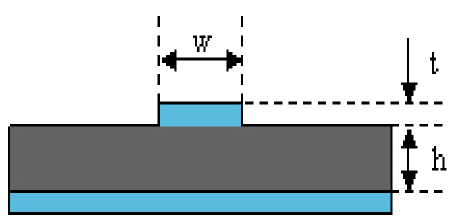


Fig: Microstrip Width& Length Calculation

$$w = \frac{7.48 \times h}{e^{\left(z_0\frac{\sqrt{\varepsilon_r + 1.41}}{87}\right)}} - 1.25 \times t$$

Step 3: the length (L) of the microstrip line is calculated using length(Le)=βL

Step 4: they related with operating wavelength as electric length (Le)=βL

Step 5 : electric length (Le) = $\sqrt{\varepsilon_r}k_0 L$ And length is $L = \frac{L_e}{\sqrt{\varepsilon_r}k_0}$; $k_0 = \frac{2\pi}{\lambda_0}$

Step 6 : Let in terms of degree, i.e. 0^0 to 360^0

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue III Mar 2025- Available at www.ijraset.com

DIMENSIONS OF THE PROPOSED ANTENNA BENDING DIPOLE :

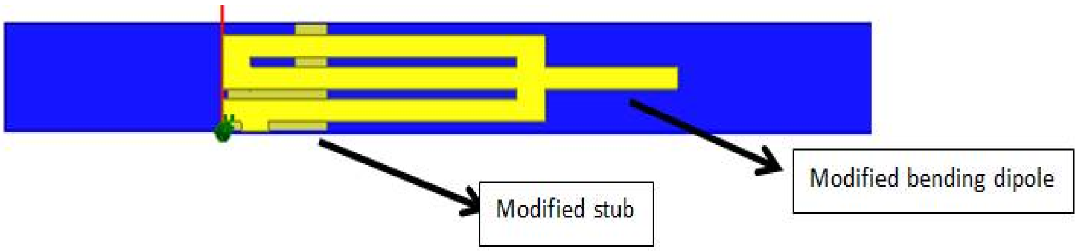
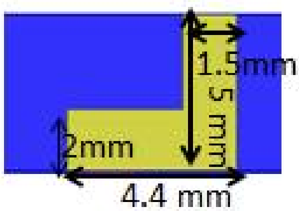


Fig (1): Modified Bending Dipole



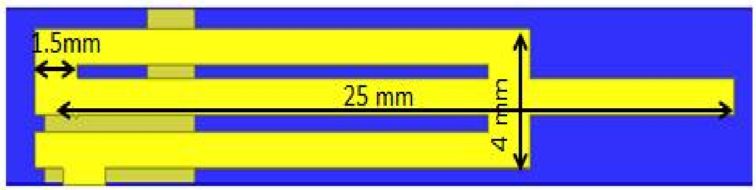


Fig (2): Modified Stub

Fig (3): Modified Bending Dipole with measurement

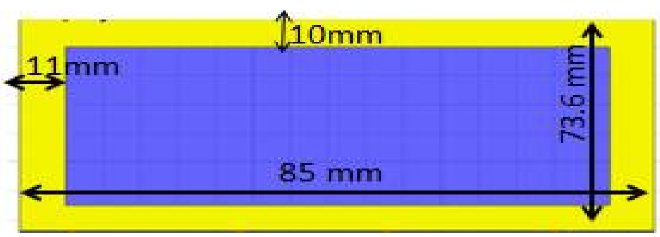


Fig (4): Modified Bending Dipole(bottom view)

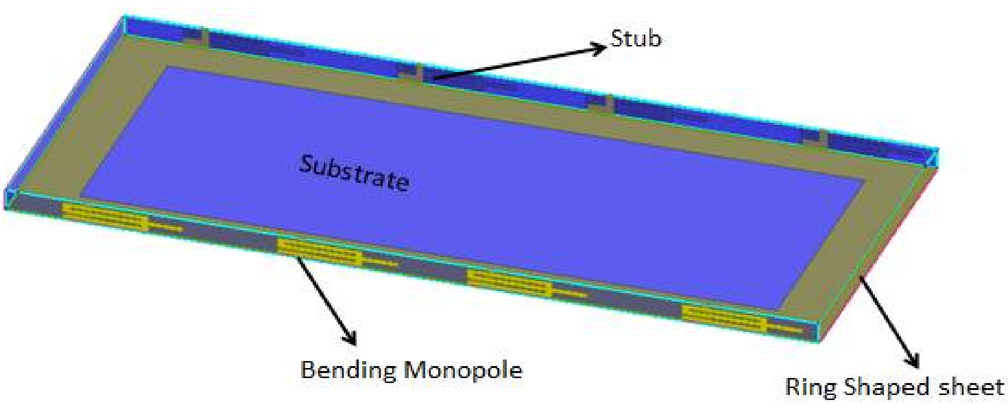


Fig (5): Modified Bending Dipole(3D view)

VII. RESULTS ANDDISCUSSION

This work provides and develops a MIMO 8*8 antenna. The antenna was made of a substrate with a thickness of 0.4mm as the dipole rotates, one side of the board is an inverted cap, and the other side is an inverted shape. The earth is rectangular in shape. This design is modeled with HFSS tool. The modeling results are shown below.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue III Mar 2025- Available at www.ijraset.com

RETURN LOSS (S11) :

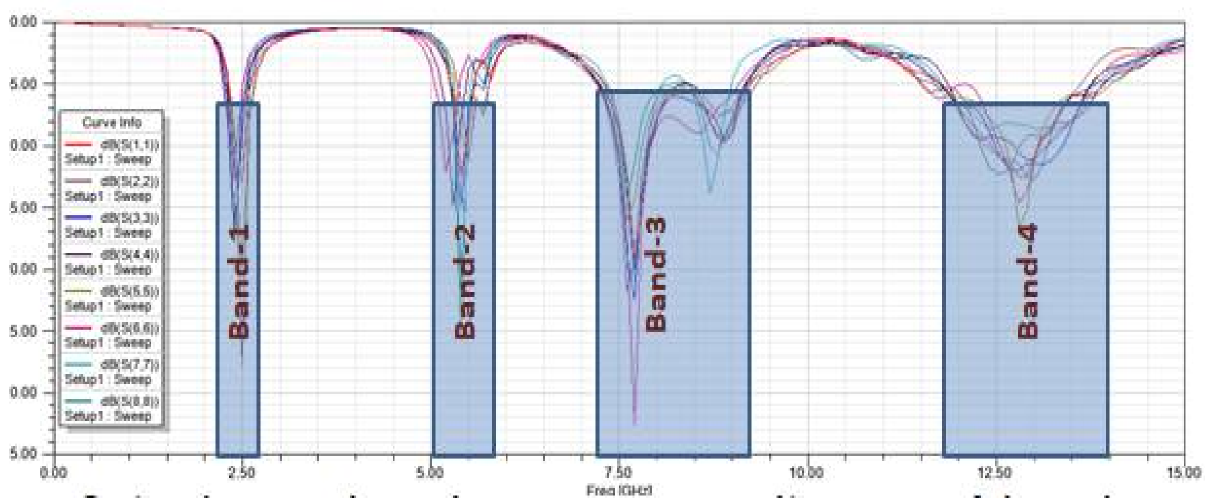


Fig : Return Loss

From above return loss results, the radiation can has 4 bands. The radiation bands are

Band	Frequency range	Bandwidth	Application
Band -1	2.2GHz - 2.65GHz	450MHz	ISM band (5G)
Band -2	5 GHz - 5.7 GHz	700MHz	5G- Sub 6
Band -3	7.2GHz - 9GHz	1800MHz	C band, DTH
Band - 4	12GHz - 14GHz	2000MHz	X band

Fig. Return loss (S11)

THE ISOLATION (Sij):

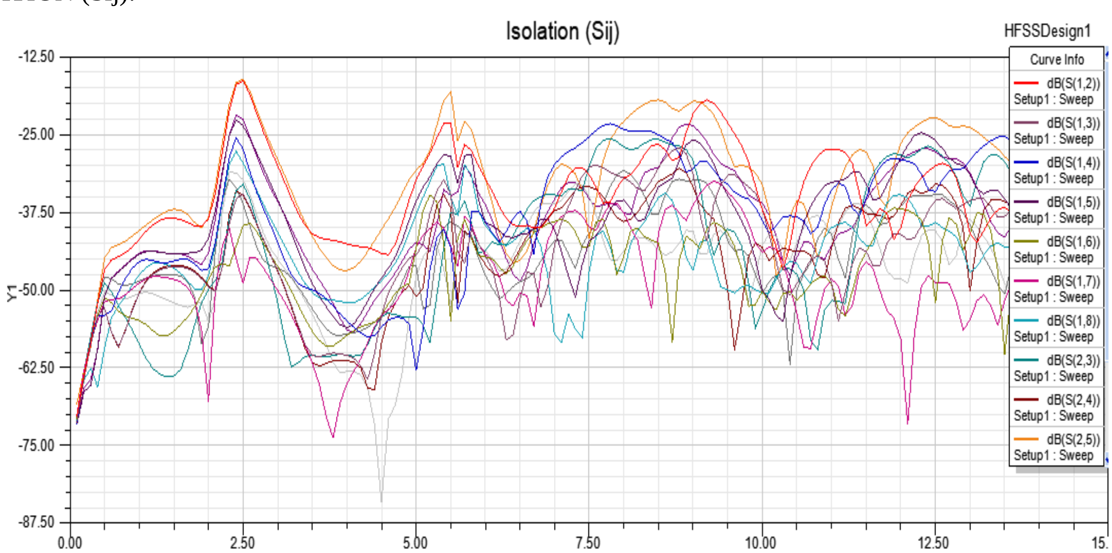


Fig: Isolation (Sij)

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue III Mar 2025- Available at www.ijraset.com

From above graph, one can say that the isolation is very good, because the Sij values are very much below -25dB

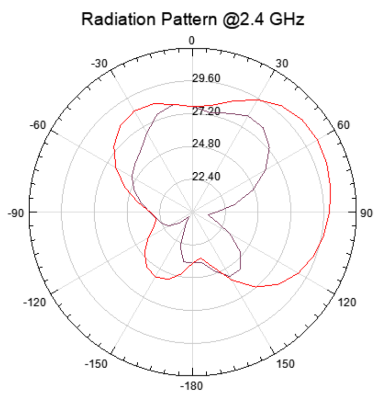


Fig 1(A): Radiation pattern @2.4GHz

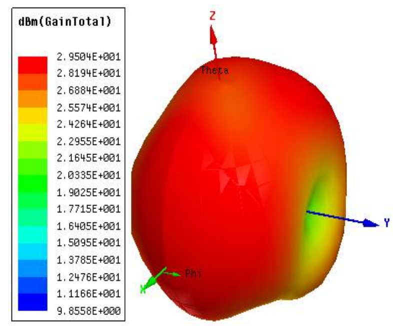


Fig 1(B): Radiation polar plot @2.4GHz

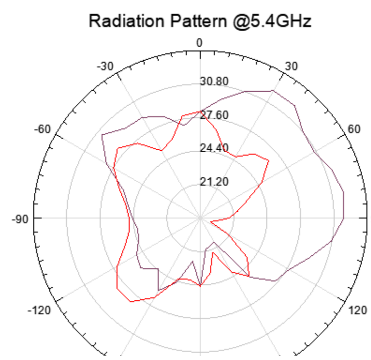


Fig 2(A): Radiation pattern @5.4GHz

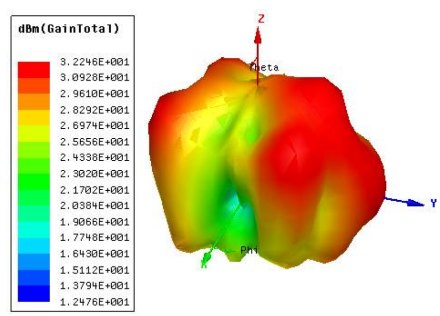


Fig 2(B): Radiation polar plot @5.4GHz

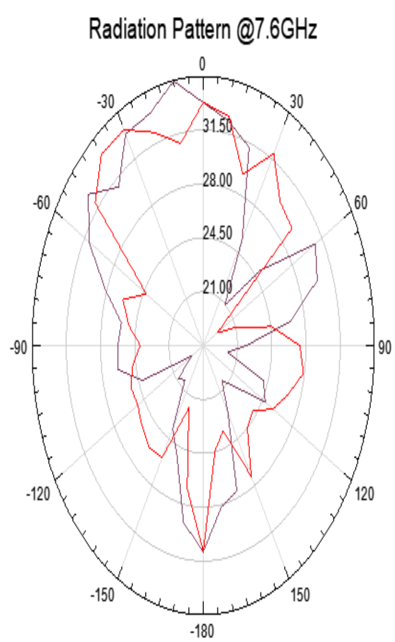


Fig 3(A): Radiation pattern @7.6G

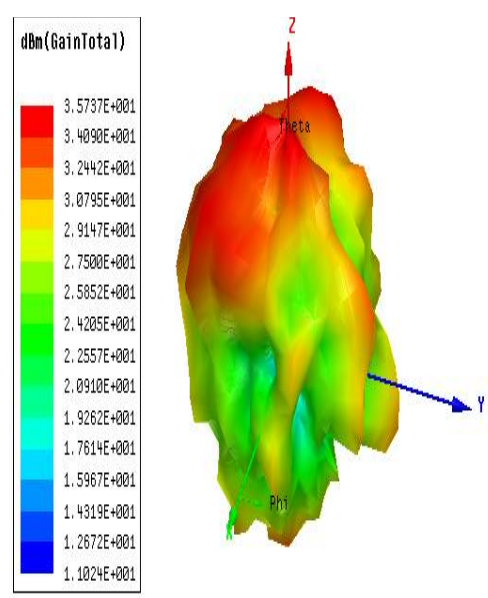


Fig 3(B): Radiation polar plot @7.6 GHz

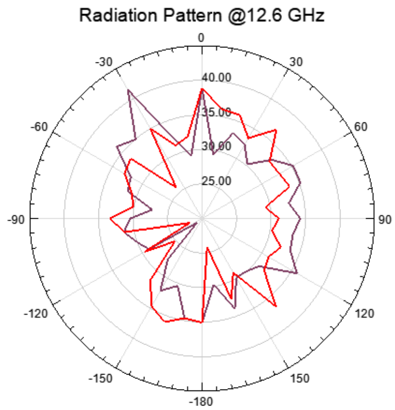


Fig 4(A) : Radiation pattern @12.6GHz

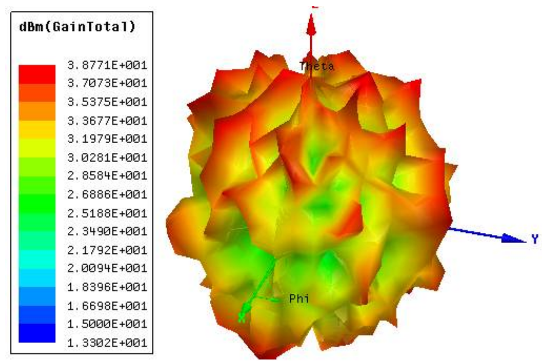


Fig 4(B) : Radiation polar plot @12.6GHz

From above results the return loss S11, give the radiation band. It is ranging from 2.28 to 6.38 GHz. The bandwidth of the band is 4.1 GHz. The MIMO is efficiently radiating in the 4 bands 5G :ISM & Sub -6, C band and X band. The return loss(Sii) and isolation(Sij) measurements suggest that the antenna design provides good signal return() and minimal interference.

- From $S_{ii,}$ it is concluded that proposed model offers better return loss
- From S_{ij}, it is concluded that proposed modeloffers better isolation
- The size of the antenna is best suitable to cellular and mobile applications

VIII. CONCLUSION

In this work a microstrip MIMO antenna is designed, simulated and simulated recorded. In this work, the antenna is successfully radiating in four radiating bands which includes the Sub6 band of the 5G communication, ISM band, C band and X band. The proposed antenna has FR4 subtract. The final design has dimensions of 85 x 73.6mm^2, of ring shaped structure. It is suitable for the smartphone applications. It radiates in 2.2 to 2.65 GHz, 5 to 5.7 GHz, 7.2 to 9 GHz and 12 to 14 GHz successfully. The radiating band covers the s- band, c- band, and X – band applications. It also includes ISM bands. The S – band consists of the mobile, blue – tooth, Wi-Fi applications. The C- band is a commercial band, that consist satellite applications and military applications

IX. FUTURE SCOPE OF PROPOSED WORK:

The proposed work can be further development by modifying the boards of different constant constants. Elliptical antennas can be replaced with different shapes. Other grounds structures can be used to improve throughput. Reconstructed antennas can be obtained by adding a resonator with a contact diode or a vessel. This can be used to develop rectangular (rectifier antenna) and other applications

REFERENCES

[1] Gupta. M,Mathur. V," Multiband Multiple Elliptical Microstrip Patch Antenna With Circular Polarization" . Wireless Perscommun Vol. 102, pp. 355 – 368, 2018
[2] Amit A. Desmukh, AmitaMhatre, Chinmaykudoo, Shefalipawar, "E – Shape Microstrip Antenna Backed by Paris of Slots Cut Ground Plane For Wideband Response",Procedia Computer Science, Vol.143, pp.101 – 107, 2018
[3] VenkataA.P. Chavali * And Amit A.Desmukh, "Wideband and Circularly Polarized Designed of Modified E – Shape Microstrip Antennas for GSM and GPS Applications", Progress in Electromagnetics Research C, Vol.121, pp.107 – 125, 2022
[4] Jerry V. Jose, AruldasS.Rekh, and ManayanickalJ.Jose,"Double – Elliptical Shaped Miniaturized Microstrip Patch Antenna For Ultra- Wide Band Applications", Progress In Electromagnetic Research, Vol. 97, pp.95 – 107, 2019
[5] Bilal Aghoutane et al., 'Analysis , Design and Fabrication of a Square Slot Loaded (SSL) Millimeter – Wave Patch Antenna Array For 5G Applications", Journal of Circuits, Systems and Computers, Vol. 30,no. 05, 2021
[6] ChRaghavendra, M. Neelaveniammal, B.T.P. Madhav, 'Metamaterial Inspired Square Gap Defected Ground Structured Wideband Dielectric Resonator Antenna For Microwave Application, Heliyon, Vol.9 , no. 2,2023
[7] MadhavB.T.P , Monika, Kumar M, B. Prudhvinadh, "Dual Band Reconfigurable Compact Circular Slot Antenna For WIMAX and X- Band Applications" Radio Electronics and Communication Systems. Vol. 62, pp. 474 – 485, 2019

BIO DATA

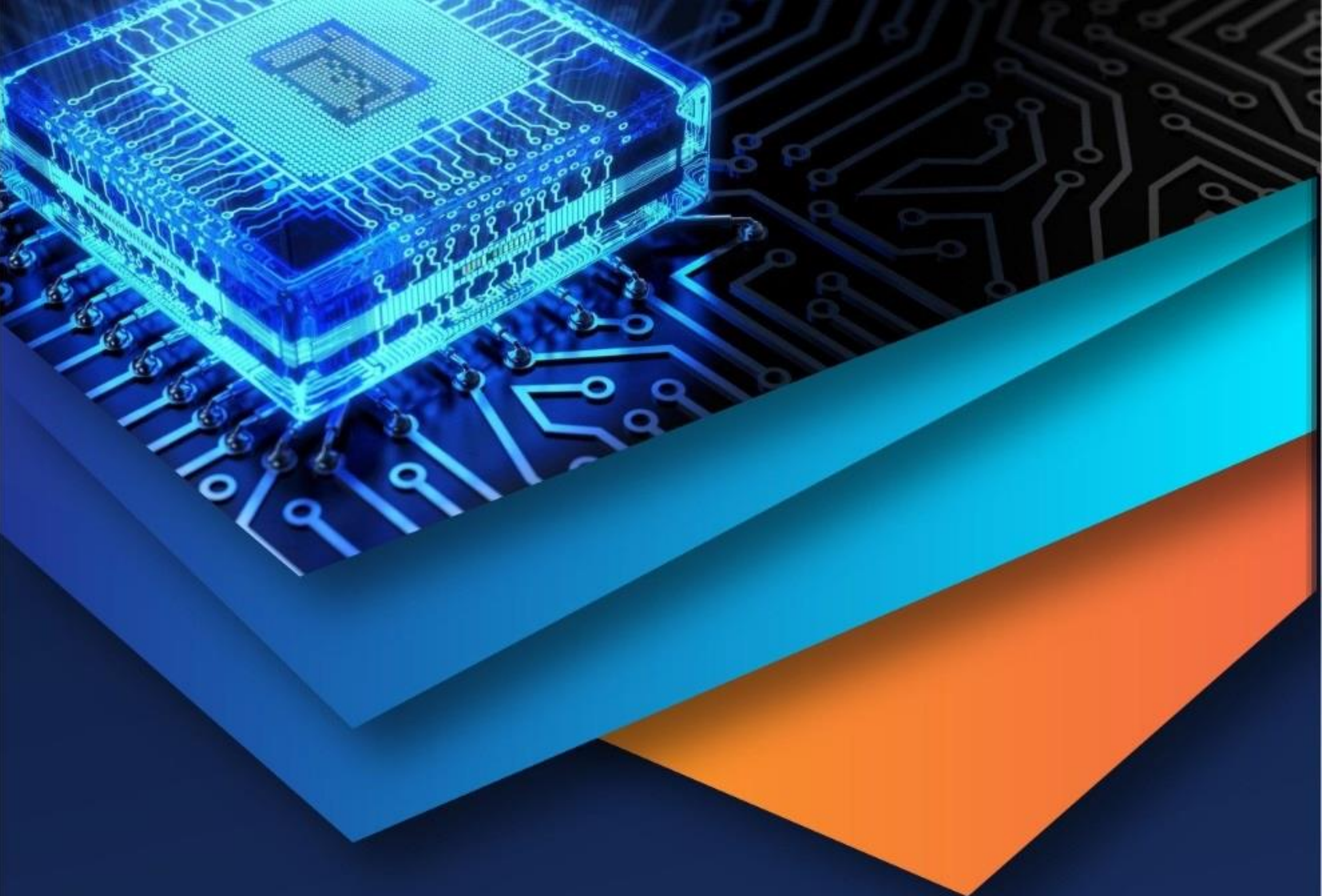
Mrs.K.ROJAMANI, Assistant Professor in the Department of Electronics and Communication Engineering ,Krishna University College of Engineering and Technology, Machilipatnam, Andhra Pradesh, India

Ms.A.MANJU PRIYA, Student ofKrishna University College of Engineering and Technology, Machilipatnam, Andhra Pradesh, India

Ms.S.GOMUKHI, Student of Krishna University College of Engineering and Technology, Machilipatnam, Andhra Pradesh, India

Mr.A.DAVISJOHNSON, Student of Krishna University College ofEngineering and Technology, Machilipatnam, Andhra Pradesh, India

Ms.K.VARSHA, Student ofKrishna University College of Engineering and Technology, Machilipatnam, Andhra Pradesh, India



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY