DUAL BAND OPERATING RADIATOR LOADED WITH CRSRRFOR WIFI & X BAND ITU APPLICATION

A MINOR PROJECT - III REPORT

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BONAFIDE CERTIFICATE

Certified that this **18ECP105L - Minor Project - III** report "**DUAL BAND OPERATING RADIATOR LOADED WITH CRSRR FOR WIFI & X BAND ITU APPLICATION**" is the bonafide work of KEERTHANA.D (927621BEC082), KIRUBASHINI.P (927621BEC089), KIRUTHIGA.M (972621BEC090), LAKSHITHA.S.M (927621BEC100)" who carried out the project work under my supervision in the academic year **2023 -2024 - ODD SEMESTER**.

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This report has been submitted for the **18ECP105L – Minor Project - III** final review held at M. Kumarasamy College of Engineering, Karur on ______________

PROJECT COORDINATOR

INSTITUTION VISION AND MISSION

Vision

To emerge as a leader among the top institutions in the field of technical education.

Mission

M1: Produce smart technocrats with empirical knowledge who can surmount the global challenges.

M2: Create a diverse, fully -engaged, learner -centric campus environment to provide quality education to the students.

M3: Maintain mutually beneficial partnerships with our alumni, industry and professional associations

DEPARTMENT VISION, MISSION, PEO, PO AND PSO

Vision

To empower the Electronics and Communication Engineering students with emerging technologies, professionalism, innovative research and social responsibility.

Mission

M1: Attain the academic excellence through innovative teaching learning process, research areas & laboratories and Consultancy projects.

M2: Inculcate the students in problem solving and lifelong learning ability.

M3: Provide entrepreneurial skills and leadership qualities.

M4: Render the technical knowledge and skills of faculty members.

Program Educational Objectives

PEO1: Core Competence: Graduates will have a successful career in academia or industry associated with Electronics and Communication Engineering

PEO2: Professionalism: Graduates will provide feasible solutions for the challenging problems through comprehensive research and innovation in the allied areas of Electronics and Communication Engineering.

PEO3: Lifelong Learning: Graduates will contribute to the social needs through lifelong learning, practicing professional ethics and leadershipquality

Program Outcomes

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

PSO1: Applying knowledge in various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of Engineering application.

PSO2: Able to solve complex problems in Electronics and Communication Engineering with analytical and managerial skills either independently or in team using latest hardware and software tools to fulfil the industrial expectations.

Abstract	**Matching with POs, PSOs**
WLAN, X-Band, ITU, RCS, CRSRR	PO1, PO3, PO9, PSO1

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ABSTRACT

This article proposes a method for reducing electromagnetic wave interference in narrow band communications (WLAN, WiMAX, and satellite communication) offers dynamic low-profile, low-cost, miniature microstrip-fed line featuring a dual band radiating characteristics. The main objective of this work is to design a dual band radiating patch antenna loaded with rhombus shaped split ring resonators incorporated with circular slots resonating at 6.199 GHz & 8.362GHz. The incorporated metamaterial structures achieve dual-band features because impedance analysis of the proposed antennas evaluates the contribution of conductance and inductance of metallic loading for improving the antenna attributes. The peak realized gain of at the resonating frequencies is 6.06dBi & 4.87dBi.

Keywords: WLAN, WIMAX, satellite communication

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LIST OF ABBREVIATIONS

ACRONYM		ABBREVIATION
WLAN	-	Wireless local area network
SRR	-	Split ring resonators
CSRR	-	Complementary split ring resonators
ITU	-	International telecommunication union
RCS	-	Radar cross section

CHAPTER 1

INTRODUCTION

1.1 Radiating patch antenna

Multiband operating spectrum have impacted Wireless communication technologies with greater accuracy and accessibility. In the recent years, the miniaturization and multi- functionalization of communication devices require that the internal antenna has strong integration capabilities. There are many merits of microstrip patch antenna such as low profile, light weight, simple realization process and low manufacturing cost. The Microstrip Patch antennas are generally narrow band antennas and the design of Microstrip patch antennas for wideband applications is an area of extensive research. generally, microstrip patch antenna consists of a radiating patch, dielectric substrate and a ground plane. There are several types of patches like rectangular, square, circular, pentagon, hexagon, etc. The proposed antenna is designed using a rectangular patch. Height (h) should be greater than 0.025 of a wavelength otherwise, the antenna efficiency will be degraded. The microstrip patch antenna is a strong contender for integration in systems like wireless communication systems, mobile phones, and laptops because of its benefits including low cost, small size, low weight, and ability to combine with microwave integrated circuits. As a result, in the realm of microstrip antenna design, the optimization of diverse independent antenna structures has gained popularity recently. Compact antennas, the radar cross section (RCS), and microstrip antennas have been widely utilized in numerous contemporary communication systems over time. It is widely recognized that microstrip antennas can be fed in a variety of instances, including slot, coaxial, coupled, and microstrip wire. In free space, the wavelength of an electromagnetic wave remains constant at a particular frequency. An antenna's size and shape affect its capacity to radiate.

1.2 Incorporation of metamaterials

Since, metamaterial does not naturally exist, radiating properties of metamaterials can be achieved by altering the material's permeability and/or permittivity characteristics. Thus accomplished by creating a uniform metamaterial metal frameworks. These materials exhibit several qualities, including absent in the natural world. Various frameworks employed in the design for creating several kinds of metamaterials. Metamaterials in offers a new area for analyzing all potential characteristics of material by permitting various cellular configurationsand applying distinct substrate compositions. Here, gain enhancing and the reduction of mutual coupling between the elements are achieved by the application of metamaterial structures. The Modified Double Circular Ring Resonator (MDCRR) and Complementary Split Ring Resonator (CSRR) are the tools utilized to accomplish this. It works by means of duality principle, which states that the E-field excites rather than exits the H-field. On the trace, the E-field must run parallel to the patch shape. As a result, an E-field parallel to the Split Ring Resonator structures' axis can readily depart them since they are distancing themselves from the ground plane. This not only makes the substrate easier to construct, but it also makes it less bulky. In contrast to the SRR structure, which affects the material permeability, the Complimentary Split-Ring Resonator impacts the material permittivity.

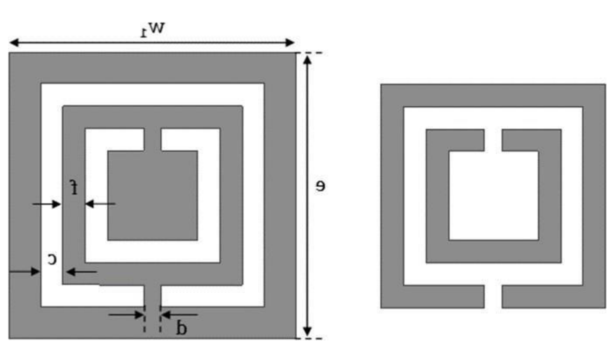

Figure 1: metamaterial structures

CHAPTER 2

OBJECTIVE

Designing and analyzing a rhombus patch antenna loaded with rhombus shaped split ring resonators incorporated with circular slots (CRSRR) for WLAN & ITU applications is the primary goal of this effort. the CST microwave studio suite is being utilized. The main emphasis will be on minimizing patch antenna size for ITU applications with resonance frequencies of at 6.199 GHz & 8.362 GHz. The attenuation of microstrip patch antennas in various ITU applications has increased during the preceding two decades. The study of microstrip antennas is a rapidly growing topic with potential uses in satellite communication and mobile electronics. A specific frequency band's reflection coefficient reduction is the primary goal of antenna design. It will be challenging to simultaneously arrive at the best option because the various signs would have collided. The design must also adhere to a challenging constraint on the far-field pattern in addition to the three goals of return loss minimization, cross polarization minimization, and mutual coupling between the ports.

CHAPTER 3
LITERATURE SURVEY

Microstrip antennas have been around since the 1950s, but it wasn't until the 1970s that this technology received more attention. This is mostly because high-quality substrates are readily available. Since then, in depth study and development of microstrip antenna and arrays, utilizing the many benefits like light weight, low volume, low cost, planar configuration, and compatibility with integrated circuits, have resulted in a variety of applications and the topic's establishment as a distinct entity within the larger field of microwave antennas. Microstrip antennas have emerged as one of the most cutting-edge areas of antenna theory and design in recent years. Utilizing printed circuit technology for both the radiating components of an electronic system as well as the circuit components and transmission lines gave rise to the fundamental concept of the microstrip antenna. Because of their ease of usage and compatibility with printed-circuit technology, they are used in a variety of contemporary microwave applications. In its most basic form, a microstrip antenna is simply a rectangular shape (or other forms like circular, triangular, etc.) on top of a substrate with a ground plane backing it. Guglielmo Marconi invented wireless communications in 1895 when he used electromagnetic waves to send the letter "S" in three-dot Morse code over a three-kilometer distance. Beginning with this, wireless communications has grown to be an important component of contemporary society. Wireless communications have altered how societies operate, from satellite transmission through radio and television broadcasting to the now-ubiquitous cell telephone (Schiller, 2000). Guglielmo Marconi travelled 1800 miles across the Atlantic Ocean in 1901, sending telegraphic messages from Cornwall to St. Johan's Newfoundland. His creation made it possible for two persons to converse by exchanging alphanumeric characters encoded in analogue signals via (Stalling, 2004).

Over the past century, wireless communications has experienced its fastest growth era in history. The Wide Area Network, or WLAN, is essential for short-distance communication because of the quick advancements in wireless technology. Users can also utilize the WLAN to access the internet on their portable devices by utilizing 3G or 4G. since it is acknowledged as the world's most affordable high-speed data access and communication network. There are numerous WLAN standards on the market, including 802.11a, 802.11b, and 802.11g. Because it is more expensive, 802.11a is typically seen in business networks. The 2.4 GHz, 3.6 GHz, 4.9 GHz, 5 GHz, and 5.9 GHz WLAN supported frequencies are announced by the 802.11 group. Modern advancements in the WLAN standard have allowed the use to go beyond residential networks to include large buildings, hotels, food courts, and portable.

Frequency Band Designation	**Frequency range (GHz)**
X Band	8 to 12 (8.175 to 8.4)
WLAN	2.5 (2.400 - 2.4835), 5 (5.150 - 5.825)

Table 1: wireless application specification

As seen in figure 1 below, the X band frequency is located between the C band and the Ku band. Its frequency range, as indicated in the table, is 8 GHz to 12 GHz, with wavelengths ranging from 2.5 to 3.8 centimeters. It is a component of the electromagnetic spectrum's SHF (Super High Frequency) range. Many different radiocommunication is done on this band. AM/FM radio, shortwave radio, TV, microwave, radar etc. Here, especially microwave band is important form us. Because it includes the frequency ranges, **2.4 GHz** and **5 GHz** used in Wireless Network Communication.

CHAPTER 4

ANTENNA DESCRIPTION

4.1 Description of conventional antenna

The proposed antenna is designed by using CST studio suite software. For the better performance of the patch antenna, it requires impedance matching circuits. Input impedance of the patch antenna is associated with (w/l) ratio. A microstrip feed line of width 2.11mm has been used in order to achieve a characteristic impedance of 50Ω. The applied feeding technique is inset feeding. The planar antenna which is fed directly by the microstrip inset feed line and placed on the top section of the dielectric substrate and the bottom is directly connected to the ground. The proposed antenna having dimensions 25mm x 24mm x 0.708mm. The antenna has been designed on a dielectric substrate with a relative permittivity of 3.8 and a loss tangent of 0.02. Three distinct resonant frequency bands were indeed obtained by the designed antenna, which displays multiband behavior. The antenna's first band runs at a resonating frequency of 6.199GHz (WLAN) with a return loss of -27.39 dB and its second band resonating at a frequency of 8.365 GHz with a return loss of -14.80 dB. According to the results of the simulation, the antenna can operate over a frequency range of 3.1 GHz to 10.6 GHz with a $|S_{11}| < -10$ or VSWR<2 and three bands notched. The given dimensions of the antenna are calculated using following formulas.

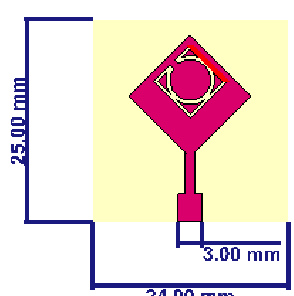

Figure 3: patch loaded with CRSRR

4.2 Proposed antenna structure

Rhombus shaped patch loaded with CRSRR construction is shown in Figure 1. According to Babinet's concept, the CSRR is essentially the dual structure of SRR wherein the characteristics of the electric and magnetic fields, as well as the roles of metal and air, are interchanged. Being a magnetic dipole, the SRR may be triggered by an external magnetic flux; on the other hand, because the CSRR is an electric dipole, it can be activated by an external electric field. Hence, the formulas for calculating effective length, width and dielectric constant were listed below.

$$\varepsilon_{eff} = \frac{\varepsilon_R+1}{2} + \frac{\varepsilon_R-1}{2}\left[\frac{1}{\sqrt{1+12\left(\frac{h}{W}\right)}}\right]$$

$$W = \frac{c}{2f_o\sqrt{\frac{\varepsilon_R+1}{2}}}$$

$$L = \frac{c}{2f_o\sqrt{\varepsilon_{eff}}} - 0.824h\left(\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)}\right)$$

PARAMETERS	**VALUES (mm)**
HEIGHT OF SUBSTRATE(h)	0.708
DIELECTRIC CONSTANT	3.5
WIDTH(W)	25
LENGTH(L)	24
LENGTH OF PATCH(Lp)	10.31

Table 2: designed antenna parameters

CHAPTER 5

RESULTS AND DISCUSSION

RETURN LOSS(S_{11}): The return loss is the proportion of a signal that is reflected as a result of an impedance mismatch. In order to get the effective output return loss should be less than-10dB.A mismatch between the termination or load connected to the line and the characteristic impedance of the line may be to blame for this discontinuity. The proposed antenna exhibits resonant frequency at 6.199GHz with a return loss of- 27.39dB and 8364GHz with a return loss of -14.80dBThe S_{11} vs frequency curve for the optimized parameters is shown below.

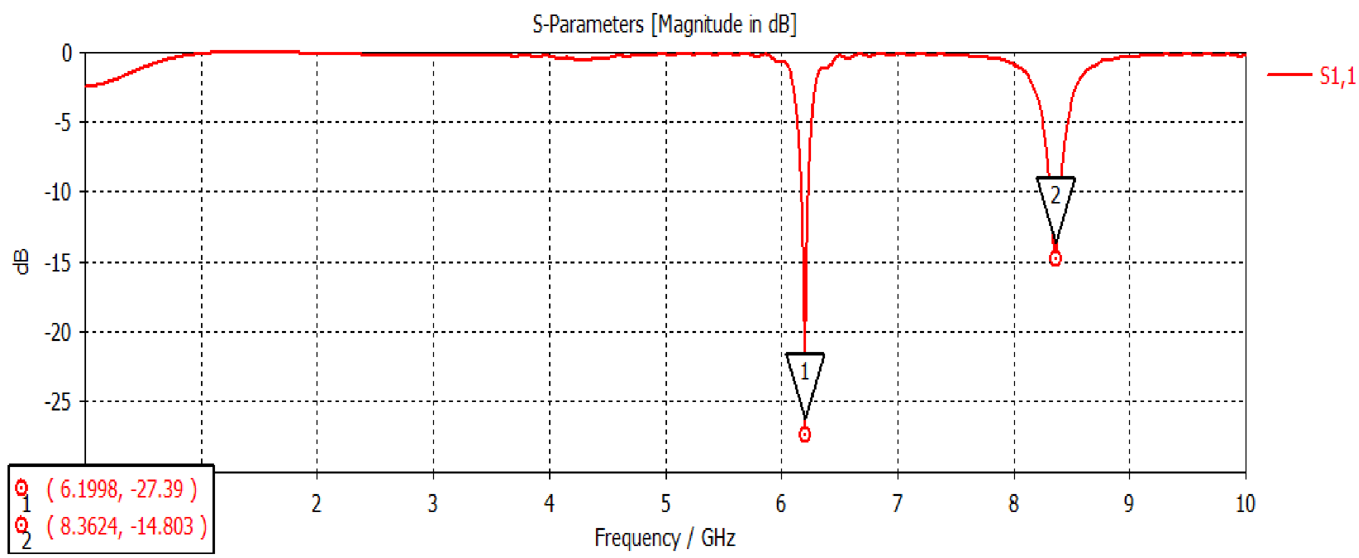

Figure 4: Return loss(S_{11})

VSWR: VSWR stands for Voltage Standing Wave Ratio. “The ratio of the maximum voltage to the minimum voltage in a standing wave is known as Voltage Standing Wave Ratio.” It is also called as SWR. The higher the impedance mismatch, the higher will be the value of VSWR. The impedance matching performance of the antenna with respect to the radio or transmission line. It is linked to is quantified by the VSWR parameter. Voltage Standing Wave Ratio, commonly known as Standing Wave the value of VSWR should be less than 2. Here we got two values of VSRW 1.09 and 1.46.

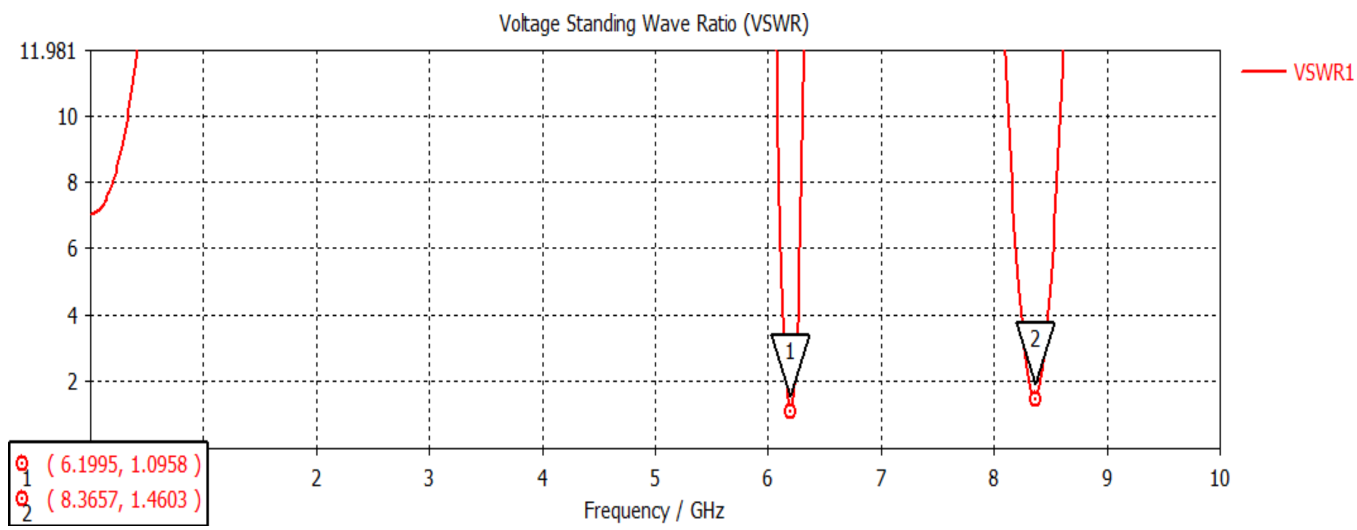

Figure 5:VSWR

FAR FIELD PATTERN &GAIN: The field, which is far from the antenna, is called as far-field. It is also called as radiation field, as the radiation effect is high. The antenna's tendency to emit more or less in any direction in comparison to a theoretical antenna is known as antenna gain. The field, which is nearer to the antenna, is called as near-field. It has an inductive effect and hence itis also known as inductive field, though it has some radiation components. An antenna would radiate uniformly in all directions if it could be constructed into a perfect sphere. It is also called as radiation field, as the radiation effect is high in this area. Many of the antenna parameters along with the antenna directivity and the radiation pattern of the antenna are considered in this region only.

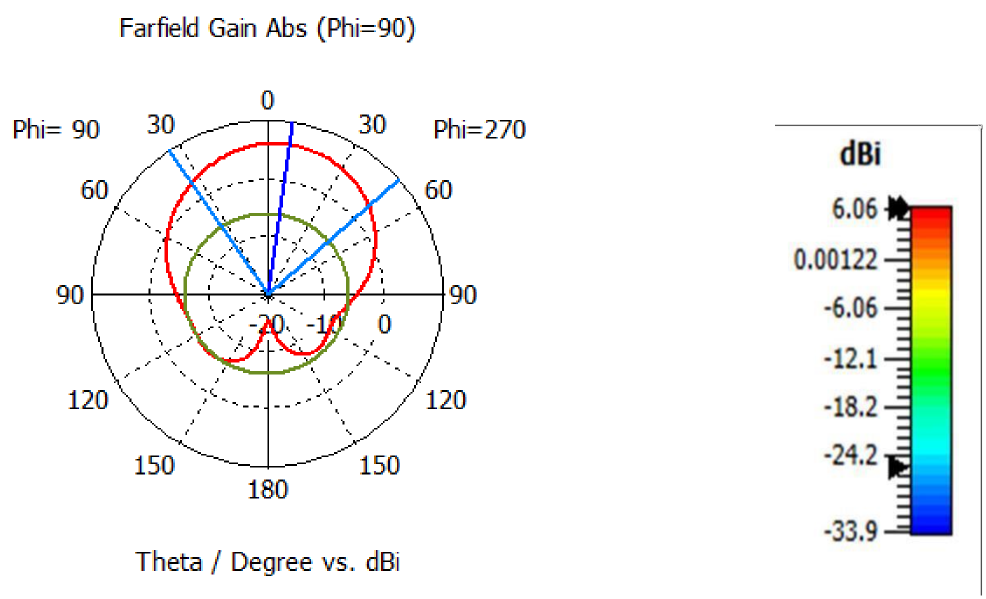

Figure 6:Far field pattern& Gain (6.199GHz)

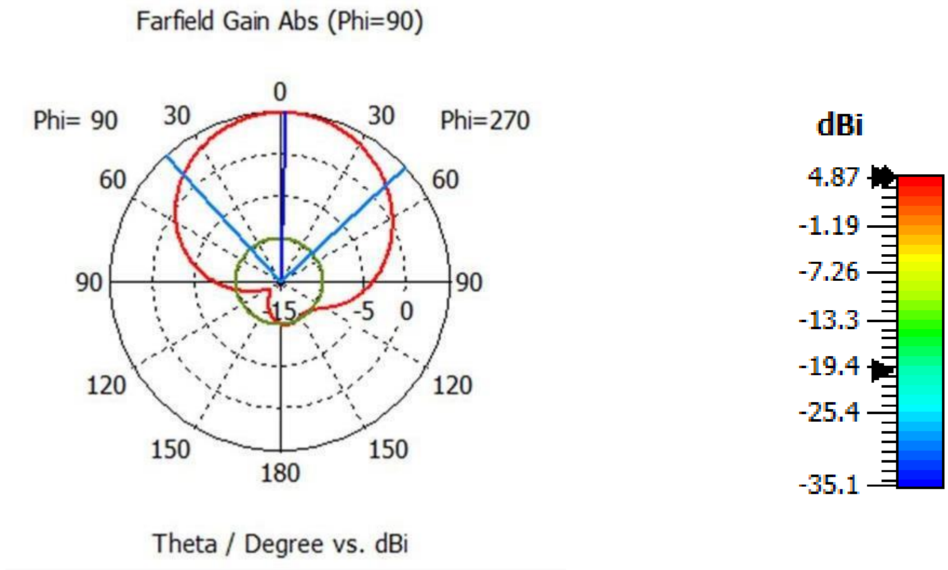

Figure 7: Far field pattern & Gain (8.365GHz)

According to the results of the simulation, the antenna can operate over a frequency range of 3.1 GHz to 10.6 GHz with a $|S_{11}|< -10$ or VSWR<2 and three bands notched. Dual band-notching effect at the frequency bands [6.17-6.23], [8.31-8.41] with resonating frequencies 6.199GHz (WIFI) and 8.362GHz (Satellite connection), respectively.

FREQUENCY RANGE (GHz)	**RESONATING FREQUENCY (GHz)**	**RETURN LOSS(S_{11}) (dB)**	**VSWR**
6.17-6.23	6.199	-27.39	1.09
8.31-8.41	8.365	-14.80	1.46

Table 3: Results & discussion

OUTCOME

There are many aspects that impacts the performance of the radiating structure(patch) such as dimensions, selection of the substrate, feed technique and the Operating frequency can take their position in effecting the performance. The microstrip patch antennas with rhombus-shaped patch incorporated with CRSRR antenna has an improved bandwidth and proving the reliability of such dual band antennas and patch dimension miniaturization for certain of the CRSRR's inner locations. The parametric analysis demonstrates how the radiation properties are affected by the CRSRR's location on the patch. After simulation, the obtained results are the proposed antenna exhibits resonant frequencies at 6.199GHz and 8.365GHz which is invaded in various wireless applications such as WLAN & X band ITU application, respectively.

FUTURE SCOPE

It is crucial to consider substrate, impedance, and input technology in to consideration as vital factors. Antenna performance is also impacted by the feed line end's optimum position. In the future, employing array antennas and other input methods might make it feasible to boost the gain. Advances in antenna design are currently vital elements of every wireless system due to the massive increase in demand for wireless communication and data transfer using personal communications (PCS) devices and smartphones. A few distinctive type of antenna that can meet most wireless communication needs is the microstrip antenna.. These antennas are widely used by both mobile devices and base stations.

REFERENCES

1. Shah, C. R., “Performance and comparative analysis of SISO, SIMO, MISO and MIMO,”International Journal of Wirel. Commun. Simul., Vol. 9, No. 1, 1–4, 2017.

2. Alrubei, M. A. T., I. A. Alshimaysawe, A. N. Hassan, and A. H. K. Khwayyir, “Capacity analysis and performance comparison of SISO, SIMO, MISO & MIMO systems,” Journal of Physics Conference Series, Vol. 1530, No. 1, 12077, 2020.

3. Bialkowski, M. E., “Research into multiple-element antennas to enhance performance of wireless communication systems,” International Conference on Microwaves, Radar & Wireless Communications, 1071–1082, 2006.

4. Zhang, H. and H. Dai, “On the capacity of distributed MIMO systems,” Conference on Information Sciences and Systems, 1–5, Princeton University, 2004.

5/Shr, K. T., H. D. Chen, Y. and H. Huang, “A low-complexity Viterbi decoder for space-time trellis code,” IEEE Transactions on Circuits and Systems I: Regular Papers, Vol. 57, No. 4, 873– 885, 2010.

6. Ghayoula, E., A. Bouallegue, and R. Ghayoula, “Capacity and performance of MIMO systemsfor wireless communications,” Journal of Engineering Science and Technology Review, Vol. 7, No. 3, 108–111, 2014.

7. Garg R 2001 Microstrip antenna design handbook. Artech House ISBN 0-89006 513-6.

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