DESIGN OF TRIBAND MICROSTRIP PATCH ANTENNA USING CST SOFTWARE

A MINOR PROJECT-I REPORT

Submitted by

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BACHELOR OF ENGINEERING

in

DEPARTMENTOF ELECTRONICS AND COMMUNICATION ENGINEERING

M.KUMARASAMY COLLEGE OF ENGINEERING

(Autonomous)

KARUR – 639 113

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M.KUMARASAMY COLLEGE OF ENGINEERING,KARUR

BONAFIDE CERTIFICATE

Certified that this project report "DESIGN OF TRIBAND MICROSTRIP PATCH ANTENNA USING CST SOFTWARE" is the bonafide work of "KEERTHIKA.R(927621BEC086) ,KIRUTHIGA.M(927621BEC090),KIRUTHIGA.V.R(927621BEC091),KRITHIGA.D(927621BEC 097)" who carried out projectwork under my supervision in the academic year 2022-2023.

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This Minor project-I report has been submitted for the **18ECP105L – Minor Project-I**

Review held at M.Kumarasamy College of Engineering, Karur on __________.

PROJECT COORDINATOR

Vision of the Institution

To emerge as a leader among the top institutions in the field of technicaleducation

Mission of the Institution

M1: Produce smart technocrats with empirical knowledge who can surmountthe global challenges

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

M3: Maintain mutually beneficial partnerships with our alumni, industry, andProfessional associations.

Vision of the Department

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

Mission of the Department

M1: Attain the academic excellence through innovative teaching learningprocess, 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 (PEOs):

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 leadership quality

Program Outcomes (POs):

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 engineeringproblems 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 professionalengineering 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 teamwork: 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 andunderstanding 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 (PSOs):

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.

Abstract	**Matching with POs, PSOs**
WLAN, FR-4 substrate, VSWR , S11	PO1, PO3, PO9, PSO1

ABSTRACT

With the boom in wireless communication need for the operating antenna increases drastically. A Distinctive electrical device or a metallic structure which is capable of transmitting electromagnetic waves is termed as antenna.

This paper presents a compact octagonal microstrip patch antenna that is applicable for VSAT, WLAN and 5G applications. The goal of this paper is to design an antenna which can excite triple-band operation in one device. The antenna is designed using CST (Computer Simulation Technology) Studio software. A rectangular ground plane occupies a of size 25 × 25 mm. The substrate is made using FR4(lossy) with the permittivity of 4.3 and thickness of 1.6mm. The thickness of patch is 0.035 mm. It provides three distinct bands. Band I from 11.61 to 13.64GHz with the resonant frequency of 13.12GHz which is applicable for VSAT applications. Band II from 24.47 to 27.80GHz with the resonant frequency of 26.29GHz which is applicable for WLAN applications. Band III from 28.64 to 29.67GHz with the resonant frequency of 29.24GHz which is applicable 5G generation and satellite communications. Our future work is to include metamaterial in patch for improving bands.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACRONYM	ABREVIATIONS
WLAN	Wireless local-area network
VSAT	Very small aperture terminal
CST	Computer Simulation Technology
VSWR	Voltage Standing Wave Ratio

CHAPTER 1
INTRODUCTION

A Distinctive electrical device or a metallic structure which is capable of transmitting electromagnetic waves is termed as antenna. In the past, wireless systems were created for a specific, predetermined task. As a result, these aantenna's antennas also have some set properties, like gain, polarisation, radiation pattern, and frequency band. Reconfigurable antennas (RAs) have received a lot of research attention recently.

Interest for a wide range of applications, including cellular radio systems, radar systems, satellite communication, aeroplanes, and VSAT, 5G communications, as well as smart weapon defence. In mobile and satellite communications, reconfigurable antennas are helpful to support a wide range of protocols (e.g., UMTS, Bluetooth, Wi-Fi, WLAN, VSAT) to reduce strong interference signal and to adapt to changing ambient conditions. On the other hand, for multifunctional functioning, reconfigurability at the antenna level is frequently required. Utilizing portable antenna array systems, this capability is made possible.

CHAPTER 2
OBJECTIVES

- ✓ To Design Triband microstrip patch antenna for WLAN, VSAT and 5G application using CST software

CHAPTER 3
TOOLS USED

CST SOFTWARE:

CST Studio Suite® is a high-performance 3D EM analysis software package for designing, analysing, and optimizing electromagnetic (EM) components and systems.

Electromagnetic field solvers for applications across the EM spectrum are contained within a single user interface in CST Studio Suite. The solvers can be coupled to perform hybrid simulations, giving engineers the flexibility to analyse whole systems made up of multiple components in an efficient and straightforward way. Co-design with other SIMULIA products allows EM simulation to be integrated into the design flow and drives the development process from the earliest stages.

Common subjects of EM analysis include the performance and efficiency of antennas and filters, electromagnetic compatibility, and interference (EMC/EMI), exposure of the human body to EM fields, electro-mechanical effects in motors and generators, and thermal effects in high-power devices.

CST Studio Suite is used in leading technology and engineering companies around the world. It offers considerable product to market advantages, facilitating shorter development cycles and reduced costs. Simulation enables the use of virtual prototyping. Device performance can be optimized, potential compliance issues identified and mitigated early in the design process, the number of physical prototypes required can be reduced, and the risk of test failures and recalls minimized

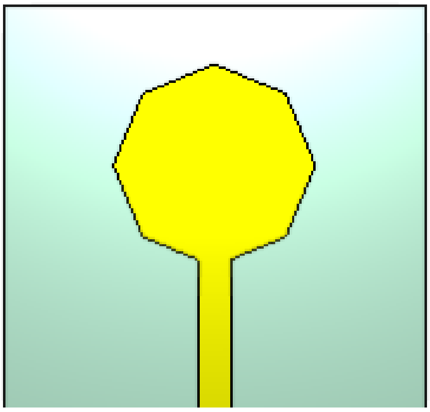
CHAPTER 4

LITERATURE REVIEW

For designing multiband antennas, different techniques were used previously to achieve multiband operating frequency standards. The following study, of different multiband antennas covering the microwave band for WLAN applications is concluded. A defected ground structure (DGS) monopole antenna operating at triple frequencies for WLAN applications is presented. The radiating patch and ground of the antenna were etched on both sides of a printed-circuit board (PCB). The ground plane was modified by two equal-shaped slots on the right and left sides. Similarly, a multiband characteristic of the antenna was generated by a rectangular slot on the upper side of the antenna substrate loaded with differently shaped stubs on each side of the slot. A slotted monopole antenna, having a C-shaped patch introduced by a G-shaped parasitic strip and a partial ground plane, is used to obtain a larger bandwidth of 3.5 GHz at (3.92–7.52 GHz). Two elements of a multiple-input–multiple-output (MIMO) antenna etched with a different slot are reported. Similarly, a triple-band antenna for 2.4, 5.2, and 5.8 GHz applications and a dual-band antenna operating at 2.4 GHz and 5.2 GHz in are presented. Meandering slots etched in the patch and a slotted ground DGS is used, respectively, to obtain the triple and dual-band characteristics. A 28-GHz mm-wave antenna of size 30 mm × 20 mm for 5G is reported, which is the combination of a waveguide aperture and several microstrip patches. Further, the study of antennas covering both microwave and mm-wave bands simultaneously were performed. In a multi-layer antenna system having a dual-element MIMO on the top layer operating in the microwave band, and an antenna array at the bottom layer for the 5G band, is presented. A multiband antenna operating in both microwave and mm-wave is introduced which consists of a monopole antenna operating at 2.4/5.5 GHz and a rectangular patch covering the mm-wave 5G band. It was observed from the comparison table that the available designs have large size; complex geometry, multi-ports, and they can only cover the microwave band, or only mm-wave band, but cannot cover both bands with one feeding. Thus, the challenging part of this work is to design an antenna that can cover both the microwave band and mm-wave band with a single feeding and a compact size.

CHAPTER 5

DESIGN DESCRIPTION



5.1 ANTENNA DESIGN

A patch antenna is a type of antenna with a low profile, which can be mounted on a surface. An antenna is a specialized transducer that converts radio-frequency (RF) fields into alternating current (AC) or vice-versa. The objective of this work is to design a miniaturized tri-band antenna which is expected to operate at the resonant frequencyof13.12 GHz,26.29GHz,29.24GHz. The dimensions of the substrate are 25mm x 25mm.The material used in the substrate is FR4 with the permittivity of 4.3and thickness of 1.6mm. The material used in the ground and patch is copper. The patch is in the shape of octagon and the given feeding is microstrip feeding. The given dimensions of the antenna are calculated using following formulae:

A.Width of patch:

$$W = \frac{c}{2f_r\sqrt{\frac{\varepsilon_r + 1}{2}}}$$

B. Effective length:

$$L = \frac{c_o}{2 f_r \sqrt{\varepsilon_{re}}} \quad \text{mm}$$

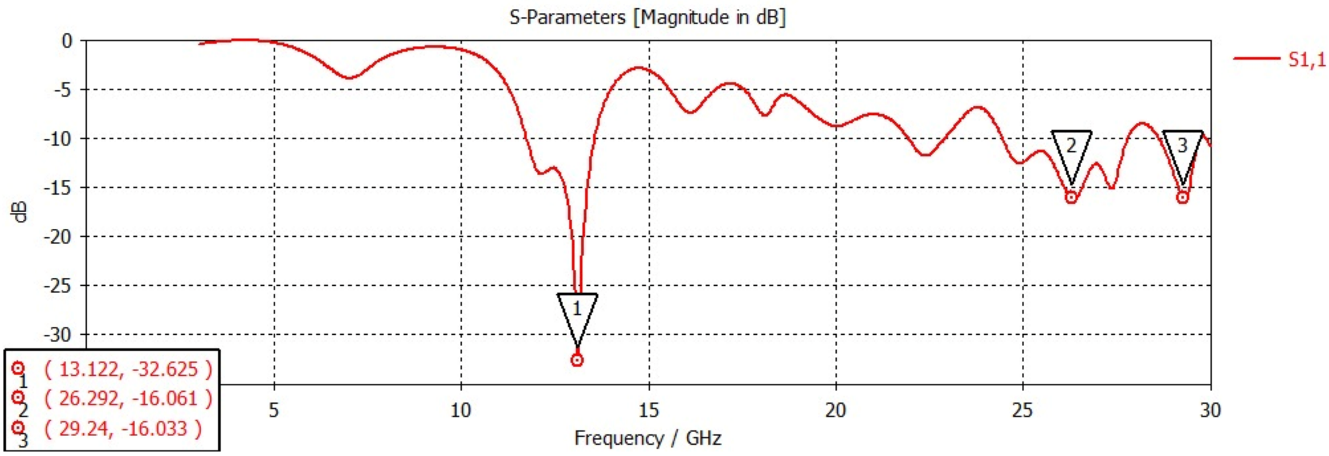
C. Dielectric constant:

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2\sqrt{1 + \frac{12h}{W}}} \quad \text{F/m}$$

CHAPTER 6

RESULTS AND DISCUSSIONS

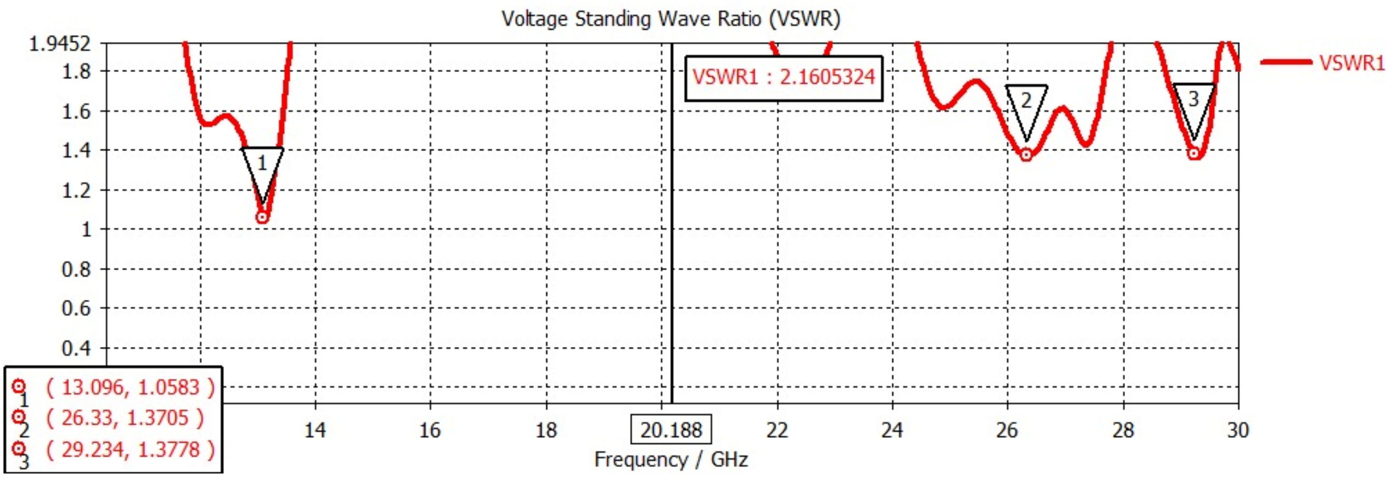
1 .] RETURN LOSS:



6.1: S- PARAMETER RESULT

Return loss(S11) is a measure of how much power is reflected at the antenna port due to mismatch from the transmission line. The return loss should be less than -10 dB because to obtain good efficiency. It provides three bands. Band I from 11.61 to 13.64GHz with the resonant frequency of 13.12GHz. Band II from 24.47 to 27.80GHz with the resonant frequency of 26.29GHz. Band III from 28.64 to 29.67GHz with the resonant frequency of 29.24GH

2. VSWR:



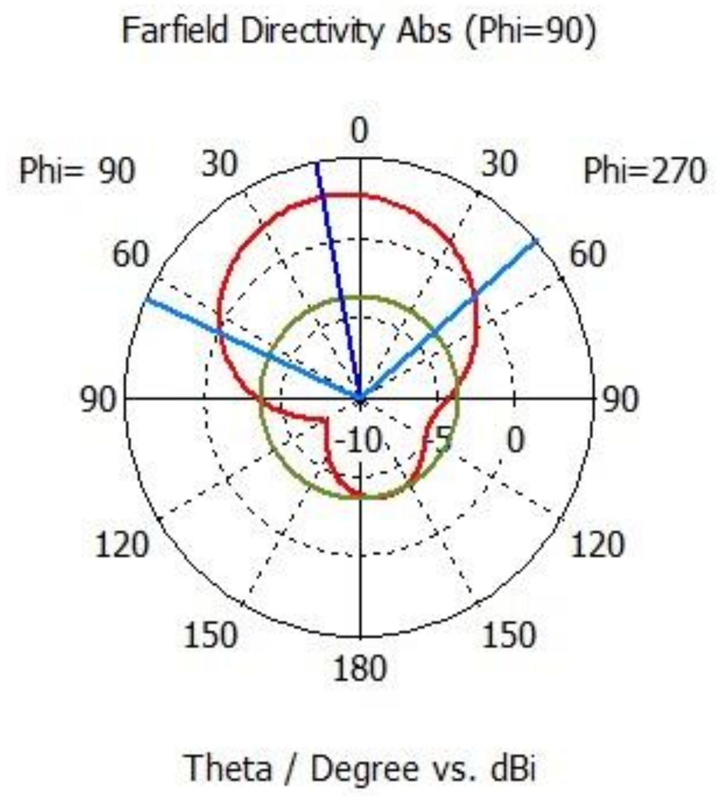
VSWR

6.2: VSWR RESULT

(Voltage Standing Wave Ratio) is a measure of how efficiently radio-frequency power is transmitted from a power source, through a transmission line, into a load (for example, from a power amplifier through a transmission line, to an antenna). In an ideal system, 100% of the energy is transmitted. Generally, the VSWR should be less than -2d B for proper transmission. Band I from 11.61 to 13.64GHz with the resonant frequency of 13.12GHz. Band II from 24.47 to 27.80GHz with the resonant frequency of 26.29GHz. Band III from 28.64 to 29.67GHz with the resonant frequency of 29.24GHz.

FREQUENCY BANDS	S11dB)	VSWR
BAND 1	32 dB	1.05 dB
BAND 2	16 dB	1.3 dB
BAND 3	16 dB	1.3 dB

3. RADIATION PATTERN:



6.3: RADIATION PATTERN

The radiation intensity is important in antenna design, as it gives the power radiated per unit solid angle. There are three lobes in radiation pattern namely, main lobe, left side lobe and right-side lobe. The phi= 90 in main lobe, The phi=90 in right side lobe and phi=270 in left side lobe.

CHAPTER 7

APPLICATIONS

Band I from 11.61 to 13.64GHz with the resonant frequency of 13.12GHz which is applicable for Dish antenna for **VSAT** application and used as **fixed satellite broadcast services**.

Band II from 24.47 to 27.80GHz with the resonant frequency of 26.29GHz which is applicable for **WLAN applications**.

Band III from 28.64 to 29.67GHz with the resonant frequency of 29.24GHz which is applicable **5genegration, Military forces** and **Satellite communications.**

CHAPTER 8

CONCLUSION

Our future is Inclusion of Meta materials in patch for improving the number of bands and to get the appropriate radiation pattern.

9.REFERENCE

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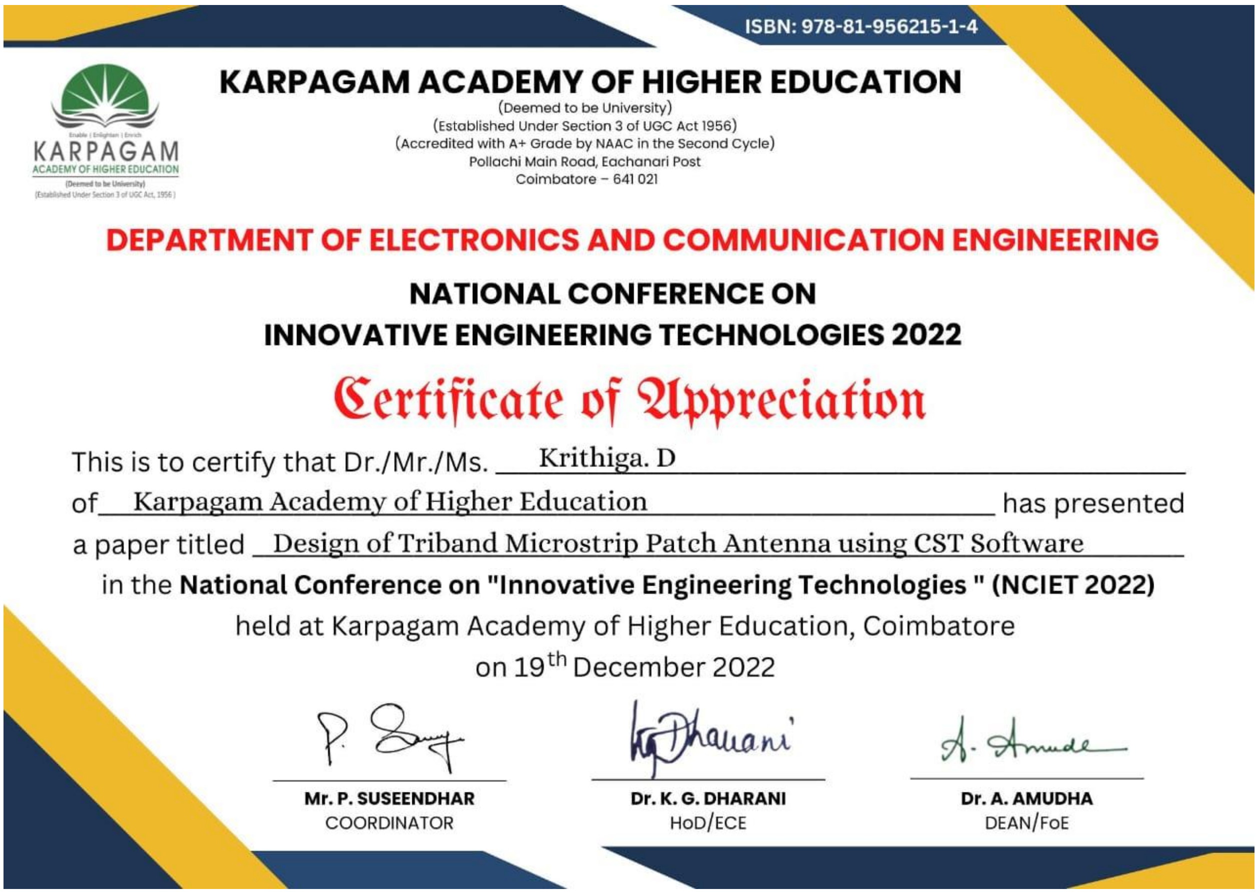

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