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Thalavapalayam, Karur – 639 113.

RECTANGULAR MICROSTRIP PATCH ANTENNA USING HFSS

A MINOR PROJECT - II REPORT

Submitted by

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

M.KUMARASAMY COLLEGE OF ENGINEERING

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BONAFIDE CERTIFICATE

Certified that this **18ECP104L - Minor Project II** report on "**RECTANGULAR MICROSTRIP PATCH ANTENNA USING HFSS"** is the bonafide work of "**KEERTHANA S P (927621BEC084), LAKSHANA K (927621BEC099), MADHUSRI J (927621BEC109), RANJANA PRIYA R (927621BEC310)**" Who carried out the project work under my supervision in the academic year 2022 -2023 EVEN SEMESTER.

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This Minor project-II report has been submitted for the **18ECP104L – Minor Project-II** 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 leadership quality

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.

Keywords	**Matching with POs, PSOs**
Rectangular microstrip patch ,FR 4 epoxy substrate, Ansys HFSS.	PO1,PO2,PO3,PO4,PO5,PO6,PO7,PO9,PO10, PO11,PO12, PSO1,PSO2

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We would like to thank our **Minor Project Co-ordinator**, **Dr.E.Dinesh, M.E., Ph.D., Associate Professor**, Department of Electronics and Communication Engineering for his kind cooperation and culminating in the successful completion of this project work. We are glad to thank all the Faculty Members of the Department of Electronics and Communication Engineering for extending a warm helping hand and valuable suggestions throughout the project. Words are boundless to thank our Parents and Friends for their motivation to complete this project successfully.

ABSTRACT

The Microstrip Patch antenna is a single layer design which consists generally of four parts (patch, ground plane, substrate, and the feeding part). Patch antenna can be classified as single-element resonant antenna. Once the frequency is given (such as graphical representation, input impedance, etc) which is fixed. These designed antenna have frequency range in microwave S parameter cover the frequencies of 2GHz,3GHz and 3.5GHz.In this paper ,the rectangular patch antennas are designed and their performance parameters such as return loss, Voltage standing wave ratio, gain, and graphical representation have been designed, Calculated and Compared. Design frequency is 2.4GHz,the copper coated substrate material is FR4-EPOXY having dielectric constant εr 4.4 and thickness is 1.5mm.Using a parametric study found that the proposed antenna design will be useful for application like Wi-Fi, Bluetooth. Antenna is a transducer, which converts electrical energy into electromagnetic energy.

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LIST OF ABBREVIATIONS

ACRONYM	ABBREVIATION
HFSS	High Frequency structure simulator
FR4	Flame retardant
VSWR	Voltage standing wave ratio

CHAPTER 1

INTRODUCTION

Antenna are key component of any wireless system. An antenna is a device that receives or transmit electromagnetic waves. An antenna is a one type of transducer that converts electromagnetic energy in the form of electromagnetic waves. An antenna that is formed out a patch of conductive material on a dielectric surface is known as a patch antenna**.** The dielectric material is mounted on a ground plane, where the ground plane supports the whole structure. Also, the excitation to the antenna is provided using feed lines connected through the patch. As it is formed using a microstrip technique by fabricating on a printed circuit board thus is also known as Microstrip antenna or printed antenna (1). Generally, patch antennas are considered as lowprofile antennas and are used for microwave frequency applications having frequency greater**.**Antenna of Micro-strip patch is the foremost type of published antenna. It has a major part in wireless communication systems. Fabrication can be fluently done using micro strip antenna (4). Ground plane, substrate a radiating patch are there in a structure of this antenna. Patch confines defines radiating point of antenna. Length and range parameters are used for representing patch. Material used to make substrate is FR4 are durable for a long range of frequency. The frequency ranges of antenna is 2.4 GHz.

1.1 DESIGN PROCEDURE USING HFSS

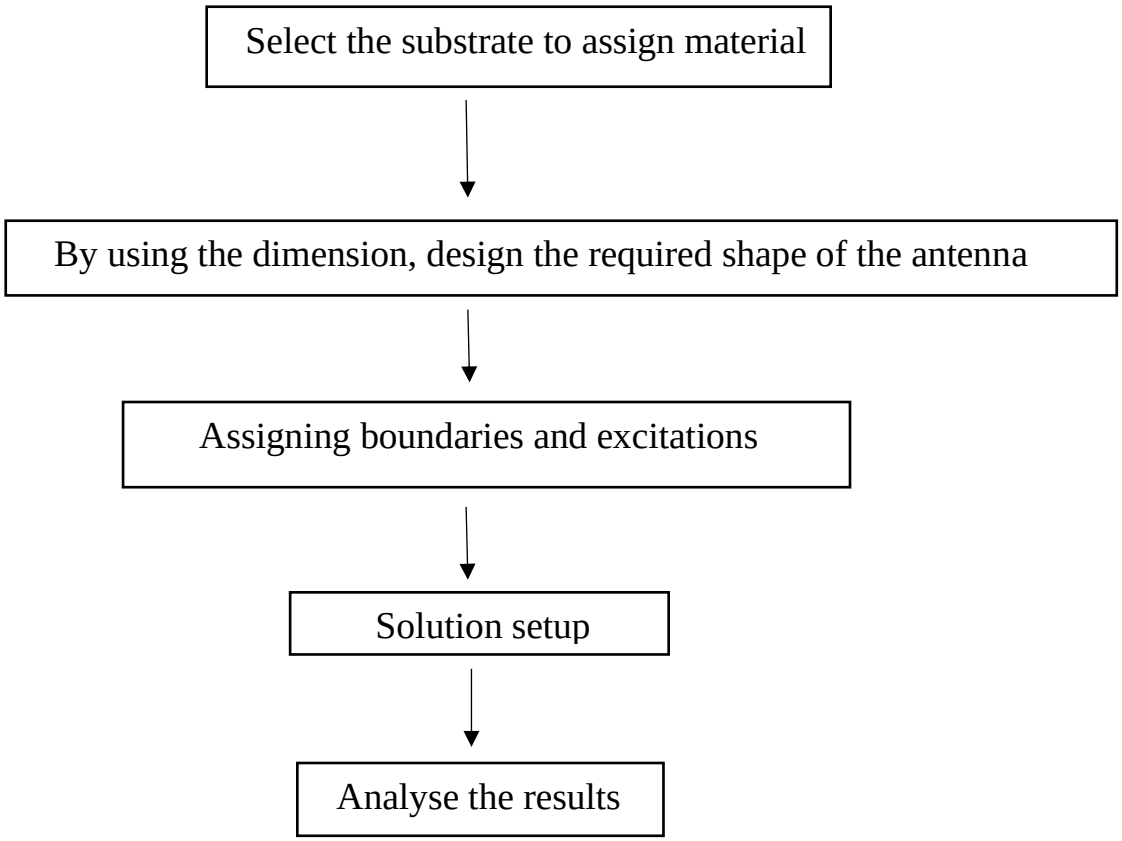

Fig 1.1 Flowchart

Microstrip patch antenna is the most common form of antennas. It consists of a conducting patch on one side of a dielectric substate and a ground plane on other side. The metallic patch is made of conducting material which is FR4 epoxy substrate and it is coated by copper material. By having a dimension of 28 x 39 with a dielectric constant εr = 4.4 and a thickness= 1.5mm. The distance between the substrate and the feed part is 0.8mm (5). After designing, analyze all and the result will be obtained. The results obtained are return loss, voltage standing wave ratio,gain plot.

1.2 COMPONENTS USED IN MICROSTRIP PATCH

The microstrip patch antenna is a single layer design which generally consists of four parts namely,

- Patch
- Ground plane
- Substrate
- Feeding part

➢ PATCH

A Patch antenna is a type of antenna which is mounted on a surface. It consists of Rectangular, circular, geometrical sheet or a patch of metal.

➢ GROUND PLANE

Copper is used in ground plane, patch and microstrip line. In this research different dielectric materials were used for specific cut-off frequency to analyze the performance of the antenna.

➢ SUBSTRATE

A rectangular micros trip patch antenna is a form of antenna which consists of a rectangular patch. This patch is of any planar or non-planar geometry on one side of dielectric substrate and a ground plane on the other side. The substrate which used is FR4 epoxy .

➢ FEEDING PART

Feed line: In a radio antenna, is the cable or other transmission line that connects the antenna with the radio transmitter or receiver.

CHAPTER 2

CONSTRUCTION

Patch antenna has 2D geometry. These antennas come in various shapes where its shape is defined by the shape of the metallic patch placed on the dielectric material.

The patches can be rectangular, square, circular, triangular, annular or elliptical in shape. We have a rectangular patch antenna, which is formed by fabricating a rectangular metallic patch on a dielectric coated ground plane. This can be said in simple terms that a dielectric material having a conducting patch is supported by a ground plane. The rectangular patch antenna has a patch,ground plane and an substrate. The dimensions of the rectangular patch antenna is length=28.9 and width=38 with dielectric constant εr4.4 and the thickness is 1.5mm. The frequency range for microstrip patch antenna is 2.4 GHz. The distance between the substrate and the feed part is 0.8mm (5). We provided a radiation pattern. After designing, analyze all and the result will be obtained. The results obtained are return loss, voltage standing wave ratio,gain plot. This antenna will be useful in aircraft,spacecraft and so on..

2.1 ANSYS ELECTRONICS DESKTOP

Ansys Electronics Desktop is a comprehensive platform that enables electrical engineers to design and simulate various electrical, electronic and electromagnetic components, devices and systems. It is a unified interface which creates and analyzes electromagnetic (EM), thermal and circuit designs.

2.2 What is included in Ansys student version?

Students will have access to Ansys HFSS, Ansys Maxwell, Ansys Q3D, and Ansys Icepak, allowing design work on a broad range of electrical and electromechanical systems. Ansys HFSS is a multipurpose, full-wave 3D electromagnetic (EM) simulation software.

2.3 HFSS – High frequency structure simulator

HFSS simulates objects in 3D, for materials composition and shapes of each object. HFSS is one of several commercial tools used for antenna design, and the design of complex radio frequency electronic circuit elements including filters, transmission lines, and packaging. It is of designing and simulating high-frequency electronic products.

CHAPTER 3

MICROSTRIP PATCH ANTENNA OF RECTANGULAR DESIGN

A Rectangular Microstrip Patch Antenna is designed to operate at 2.4 GHz frequency with edge feeding technique. The proposed design is created with the substrate with FR4 epoxy under dielectric constant εr = 4.4.The length of radiating patch is 29 mm and width 39 mm for edge feed.

The dimensions for designing antenna calculated as below

For calculating width of the patch, the following equation is used,

$$W = 1\ 2fr\sqrt{\mu 0\varepsilon 0} \times \sqrt{}\ 2\ \varepsilon r + 1$$

The length can be evaluated as,

$$L = 1\ 2fr\sqrt{\varepsilon eff}\sqrt{\mu 0\varepsilon 0} - 2\Delta L$$

Where,

$$\varepsilon eff = \varepsilon r + 1\ 2 + \varepsilon r - 1\ 2\sqrt{1 + 12\ \mathrm{h}\ w}$$

$$\Delta L = (\varepsilon reff + 0.3)\ (w\ \mathrm{h} + 0.264)\ (\varepsilon reff - 0.258)\ (w\ \mathrm{h} + 0.8) * 0.412$$

CHAPTER 4

DESIGN OF ANTENNA

The microstrip patch antenna is a single layer design which generally consists of four parts namely, Patch, Ground plane, Substrate, Feeding part.

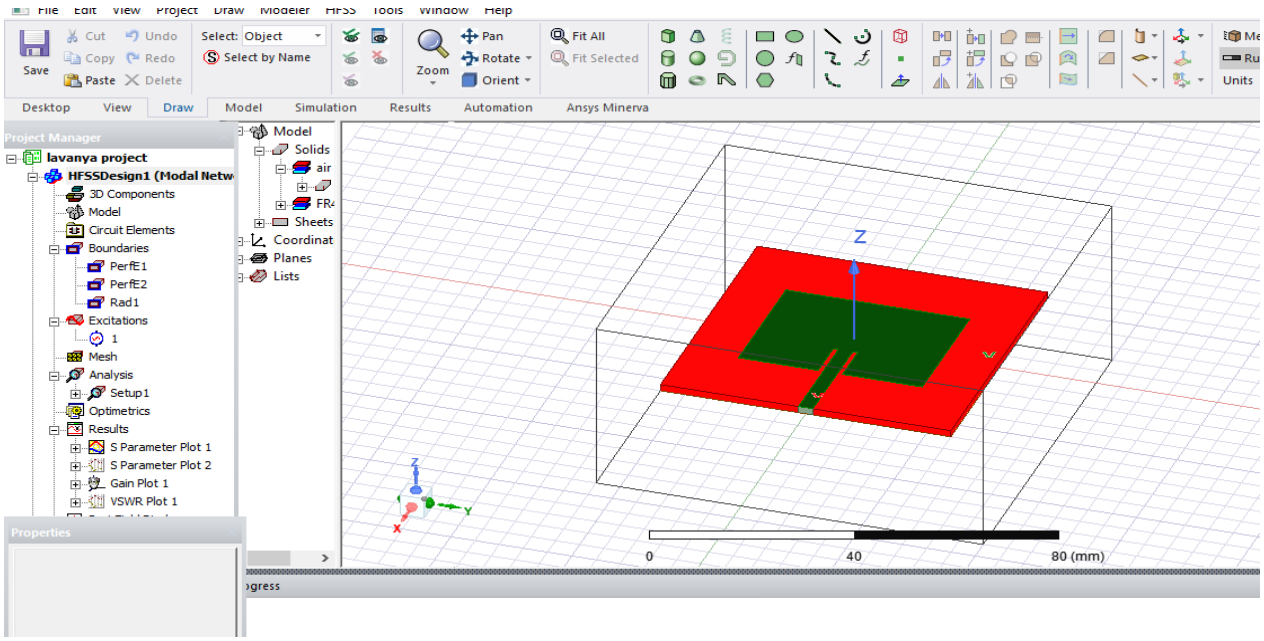

Fig 4.1 Antenna design

CHAPTER 5

GAIN PLOT

This describes how much amount of power is radiated from the antenna. The maximum radiation is obtained based in the frequency applied. If the value obtained is not optimized then the performance of antenna is low.

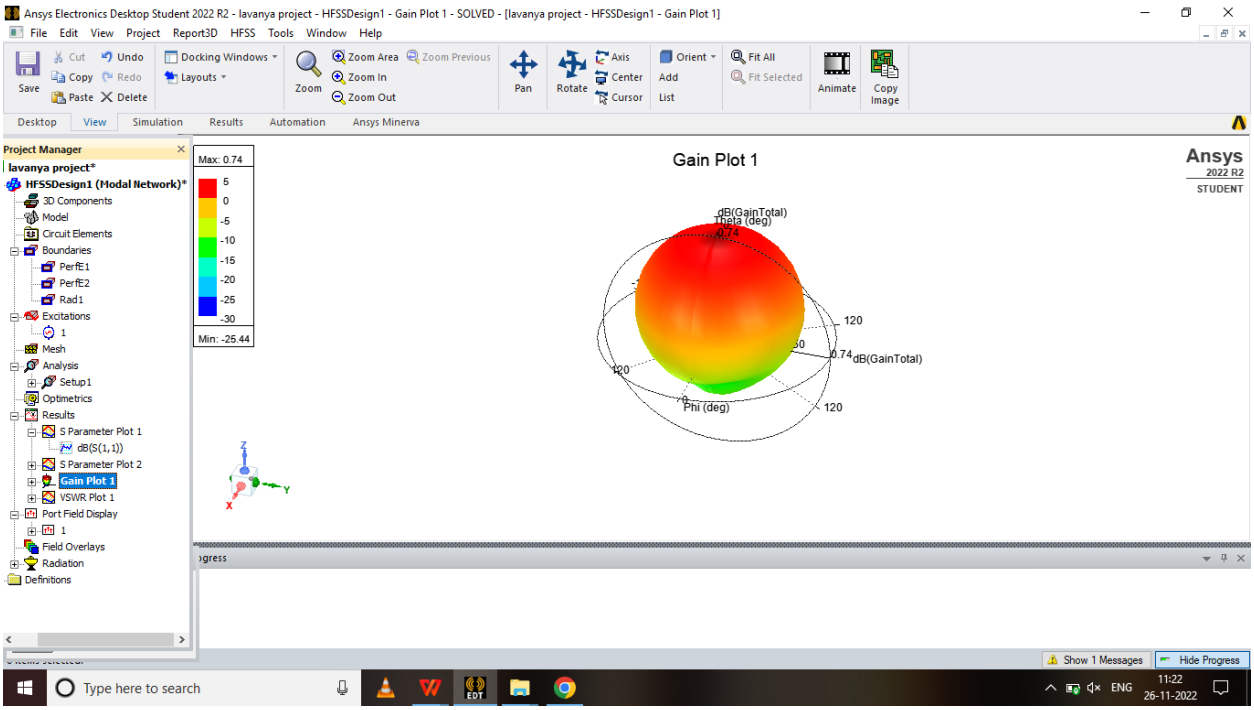

Fig 5.1 Gain plot

CHAPTER 6

VSWR

VSWR is known as Voltage Standing Wave Ratio.This is analyzed to known about the impedance matching of antenna.

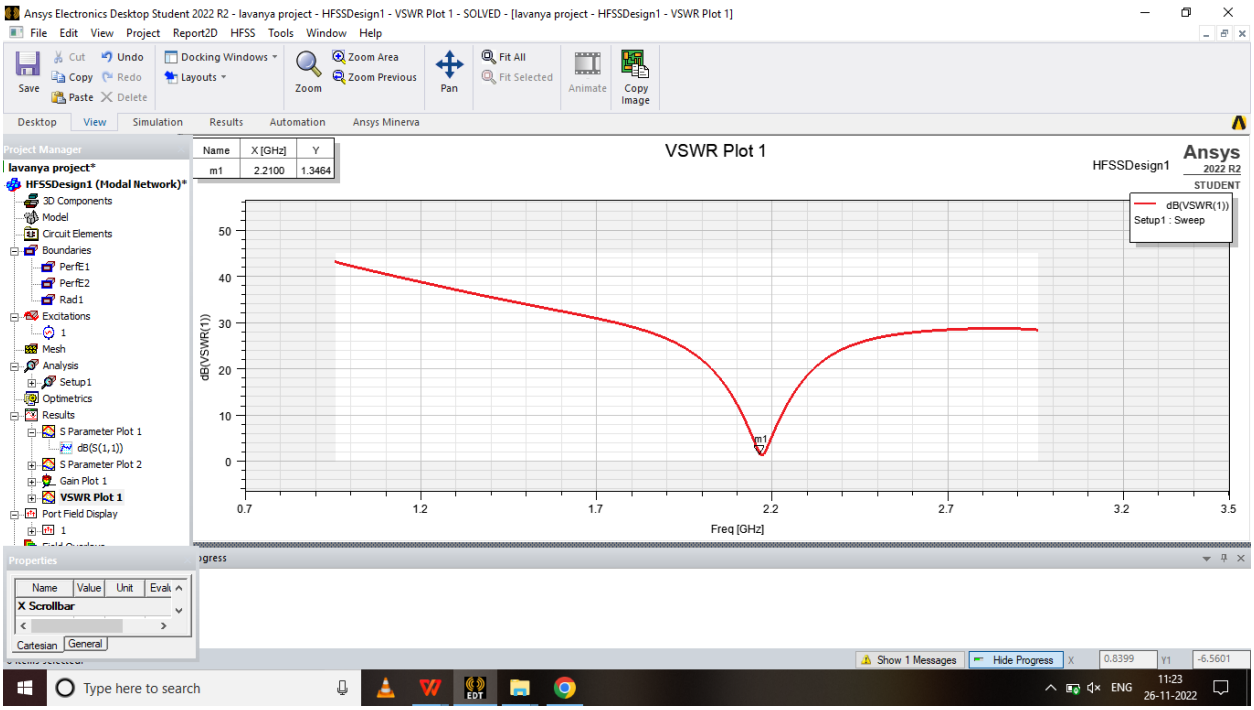

Fig 6.1 VSWR

From the above result it is analyze that in 2GHz - 5.5GHz range of frequency, there will be a constant value of VSWR.

CHAPTER 7

RETURN LOSS

Power loss is represented by return loss. It is caused because of channel or transmission line discontinuities. Signals are returned due to this in transmission process.

Return Loss (dB) = –10*log10 (PR/PI)

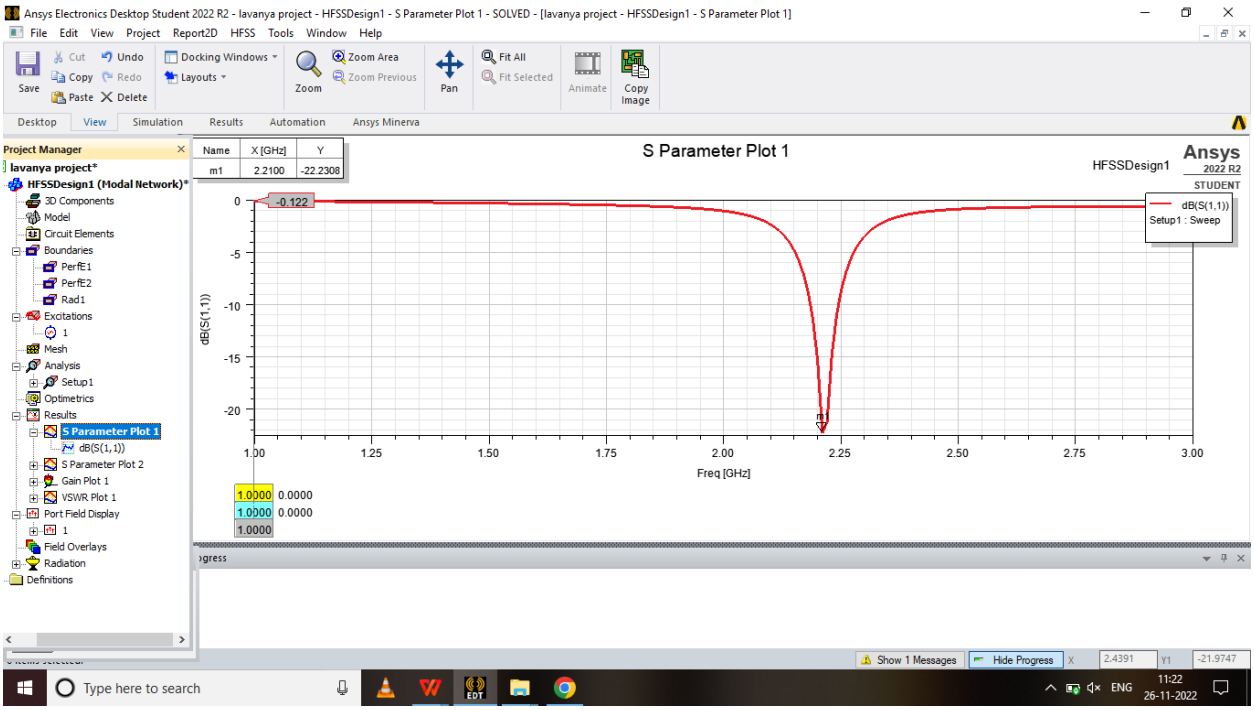

Fig 7.1 Return loss

From the above result, it is shows return loss is very narrow at the radiated 2.4GHz frequency. This indicates that the antenna exhibits perfect radiation.

CHAPTER 8

CONCLUSION

A Rectangular Microstrip Patch Antenna, resonant at frequency fo =2.4 GHz, is designed and simulated on glass epoxy FR-4 substrate. The microstrip patch dimensions obtained from the simulation are used to fabricate the antenna. The simulation of rectangular Microstrip Patch antenna by using HFSS software.

The microstrip patch antenna is a single layer design which generally consists of four parts namely, Patch, Ground plane, Substrate, Feeding part. Generally, patch antennas are considered as low profile antennas and are used for microwave frequency applications having frequency greater than 100 MHZ**.** The length and width of the patch determines the characteristics of the antenna. The dimensions of a microstrip patch antenna depend on the resonant frequency and value of the dielectric constant. By this the rectangular microstrip patch antenna has been designed.

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