DESGIN A MICROSTRIP ANTENNA FOR PULMONARY EDEMA

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report "**IDENTIFYING PULMONARY EDEMA USING MICROSTRIP ANTENNA**" is Bonafide work of "**KALAISELVI S (61781921103051) and HARINI SREE D B (61781921103043)"** who carried out the project work under my supervision.

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INTERNAL EXAMINER EXTERNAL EXAMINER

ABSTRACT

Pulmonary Edema is also known as **Pulmonary congestion.** Pulmonary edema is a condition caused by too much fluid in the lungs. This fluid collects in the many air sacs in the lungs, making it difficult to breathe. In most cases, heart problems cause pulmonary edema. But fluid can collect in the lungs for other reasons. These include pneumonia, contact with certain toxins, medications, trauma to the chest wall, and traveling to or exercising at high elevations.

In already existing project, they have used FR4 substrate has the dielectric material. The existing project is a combination of Cole-Cole equation of dielectric constant and Debye-Maxwell equation.Debye – Maxwell equation helps to calculate volume of water in fractions in lungs using 2.4GHz antenna.

This proposed method describes the technique to design a microstrip antenna of 2.4GHz for pulmonary edema through simulation process. In general FR-4 substrate is used for these types of applications but CEM-3 substrate used here instead.CEM-3 is less expensive when compared to FR-4. CEM 3 has lower flexural strength and higher thermal expansion.CEM-3 is substrate material developed based on FR-4.

To design the microstrip antenna, CST Studio Suite of 2022 version is used. This application helps to design the microstrip antenna of 2.4GHz using required substrate and helps in simulation also.

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CHAPTER 1

INTRODUCTION

Pulmonary Edema:

Pulmonary edema is a condition caused by too much fluid in the lungs. This fluid collects in the many air sacs in the lungs, making it difficult to breathe.

In most cases, heart problems cause pulmonary edema. But fluid can collect in the lungs for other reasons. These include pneumonia, contact with certain toxins, medications, trauma to the chest wall, and traveling to or exercising at high elevations.

Fig 1.1 shows the Pulmonary edema that develops suddenly (acute pulmonary edema) is a medical emergency that needs immediate care. Pulmonary edema can sometimes cause death. Prompt treatment might help. Treatment for pulmonary edema depends on the cause but generally includes additional oxygen and medications.

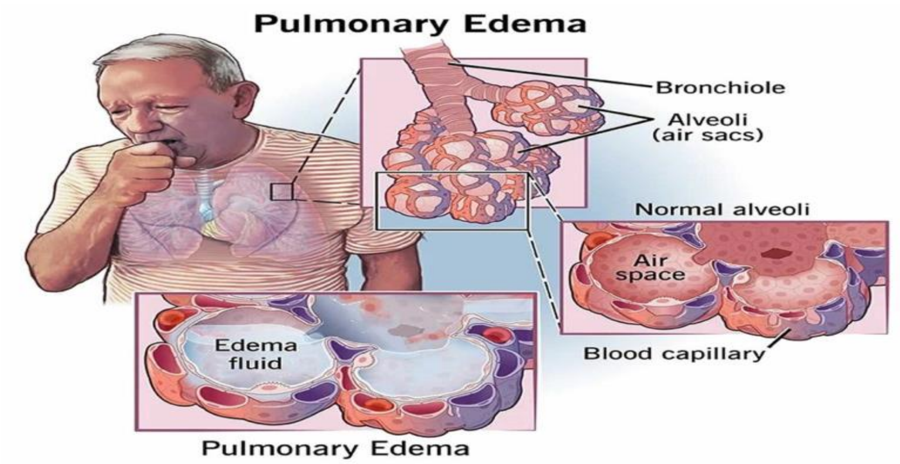


Fig 1.1 Pulmonary Edema

CST Studio Suite:

CST Studio Suite is a high-performance 3D electromagnetic (EM) simulation software for EM and multi-physics simulation used in leading technology and engineering companies around the world. With solvers that span the frequency spectrum, Fig 1.2 shows CST Studio Suite that offers a wide range of tools for designing, analysing, and optimizing products.

CST analyses Electromagnetic systems from statics and low-frequency to high-frequency range, in a fully parametric design environment. CST allows workstation multithreading, GPU and hardware acceleration, and cluster distributed computing and MPI.

Fig 1.2 CST Studio Suite

CEM-3:

CEM stands for Composite Epoxy Material. CEM-3 is considered a standard substrate material, offering sufficient reliability for electronic circuits. Firstly, it boasts a high glass transition temperature and dimensional stability, which helps avoid electrical performance issues due to heat in high-temperature projects. Additionally, CEM-3 is highly processable and compatible with standard PCB processes, simplifying the manufacturing process, increasing efficiency, and reducing production costs. For products with additional concerns about toxic substances, CEM-3 PCB uses non-halogenated flame retardants.

Microstrip Antenna:

Micro strip antennas are low-profile antennas. A metal patch mounted at a ground level with a di-electric material in-between constitutes a Micro strip or Patch Antenna. These are very low size antennas having low radiation. Micro strip antenna consists of a very thin metallic strip placed on a ground plane with a di-electric material in-between. The radiating element and feed lines are placed by the process of photoetching on the di-electric material. Usually, the patch or micro-strip is chosen to be square, circular, or rectangular in shape for the ease of analysis and fabrication. Fig 1.3 shows a micro-strip or patch antenna. When the antenna is excited, the waves generated within the di-electric undergo reflections and the energy is radiated from the edges of the metal patch, which is very low. Basic parameters of Microstrip antenna are:

- Frequency
    - ⇨ $f = 1/T$
- Wavelength
    - ⇨ $\lambda = c/f$
- VSWR
    - ⇨ $VSWR = V_{max}/V_{min}$
- Bandwidth
    - ⇨ $BW = f_H - f_L$
- Power
    - ⇨ $P_r = P_t G_t G_r C^2 / (4\pi R f)^2$
- Gain
    - ⇨ $G = 10\log(P_{out}/P_{in})$

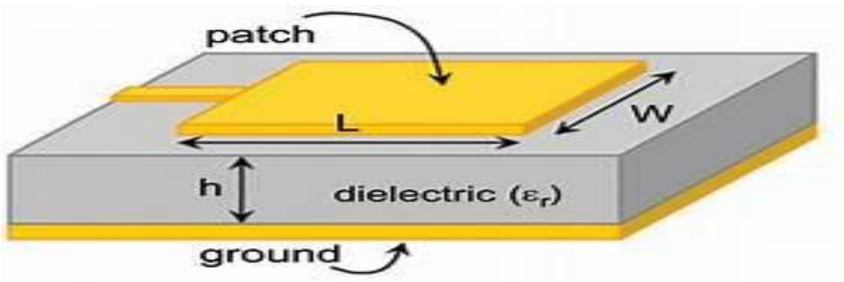


Fig 1.3 Microstrip Antenna

CHAPTER 2

Problem Statement

2.1 Objective:

The basic objective would be to identify pulmonary edema using a microstrip antenna of 2.4 GHz in a simulation platform.

As the first step, the microstrip antenna is designed and is to be executed in the platform to obtain a successful output.

CEM-3 is the main dielectric substrate used in this designing of antenna which is less expensive than FR-4(flame retardant).

2.2 Existing methods:

The most common methodologies to identify pulmonary edema are

- ⇨ Laboratory test:
  - CBC
  - Troponin
- ⇨ Imaging Studies:
  - Chest X ray
  - CT scan
  - Ultrasound

Fig 2.1 Ultrasound

CHAPTER 3

Proposed Method

3.1 Methodology

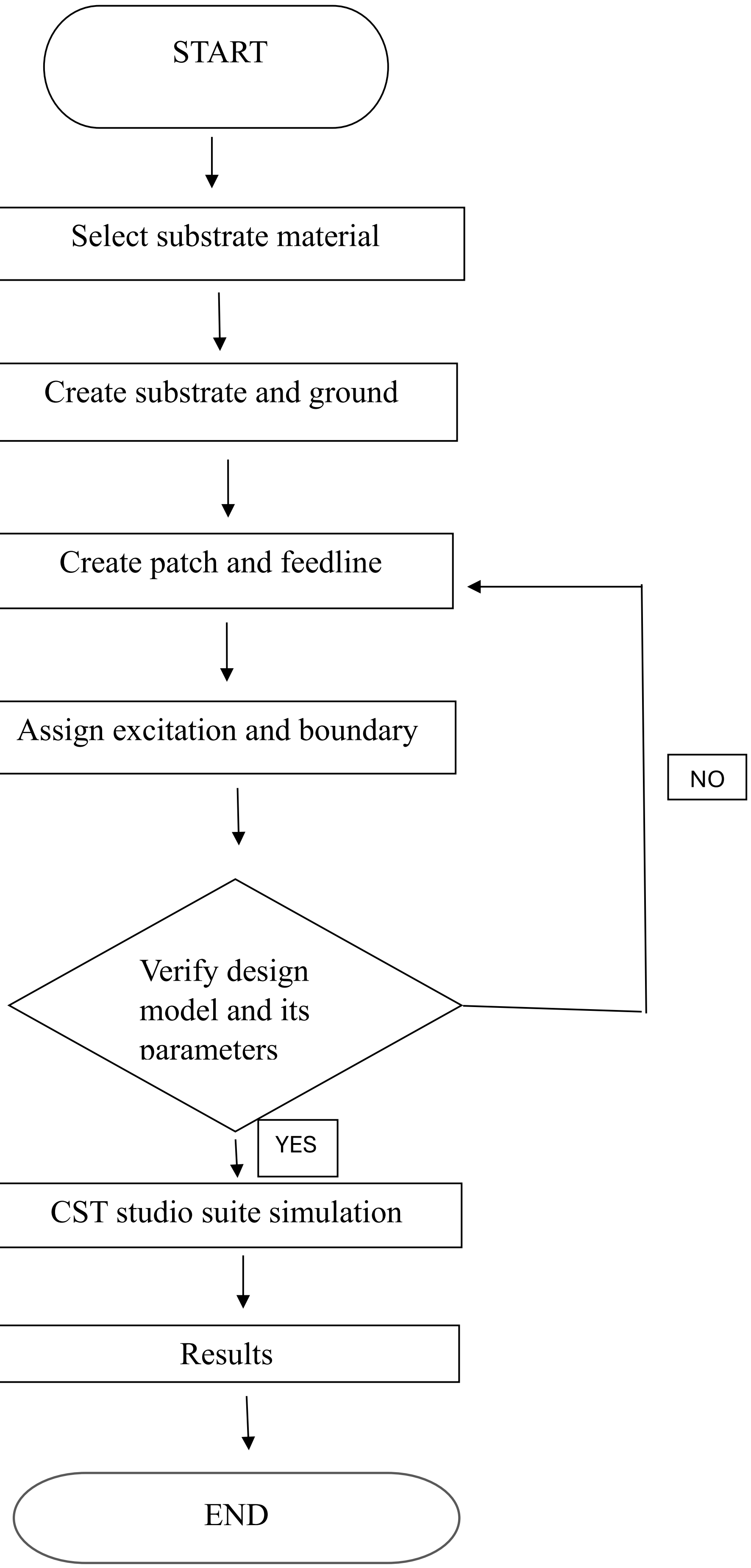
The existing methodology used FR4(flame retardant) has the main dielectric substrate to design the antenna since it is widely used for commercia purpose all over the world. This proposed project is to replace the FR4 substrate by CEM-3 substrate.CEM-3 has similar properties of FR4, moreover the dielectric constant of both substrates is almost the same. Few properties of CEM-3 are shown in Fig 3.1

CEM-3(Composite Epoxy Material) has a good electrical insulation, machinability, and thermal conductivity too. The cost of CEM-3 is **less expensive** than FR4.It is **safer** to use in the bio- medical field. Also, the thermal conductivity of CEM-3 is 1.8W/mk whereas FR4 thermal conductivity is 0.3-0.4 W/mk.

Test Item	Unit	Test Method (IPC-TM-65)	Test Condition	Specification (IPC-4101D)	Typical Value
Peel Strength (1 oz.)	N/mm	2.4.8	125°C/Float 260°C/10 Sec	>0.70 ——- ≥1.05	1.62 1.60
Thermal Stress	Sec	2.4.13.1	Float 260°C/unetched	≥10	120
Bow / Twist	%	2.4.22.1	A	≤1.0	0.17 /0.35
Flexural Strength	N/mm^2	2.4.4	Length direction/ Cross direction	>276 >186	450 390
Flammability	Rating	UL94	UL94	UL94 V-0	V-0
Glass Transition (Tg)	°C	2.4.25	E-2/105 DSC	>130	136
Surface Resistivity	MΩ	2.5.17.1	C-96/35/90	≥1.0×10°	1.0×10
Volume Resistivity	MΩ-cm	2.5.17.1	C-96/35/90	≥1.0×10°	1.0×10
Dielectric Constant	——	2.5.5.2	Etched/@1 MHZ	<5.4	4.6
Loss Tangent	——-	2.5.5.2	Etched/@1 MHZ	<0.035	0.020
Arc Resistance	Sec	2.5.1	D-48/50-D-0.5/23	>60	125
Moisture Absorption	%	2.6.2.1	D-24/23	≤0.50	0.20
Z-Axis Expansion	ppm/"C %	2.4.24	Alpha 1 ——- Alpha 2 ———— 50-260°C	——	36 270 3.94

Fig 3.1 CEM-3 Characteristics

3.2 FLOWCHART



3.3 Procedure

1. Install the software CST Studio Suite 2022 version and open the software.
2. Click on project template and select Microware & RF/Optical as displayed in Fig 3.3.1

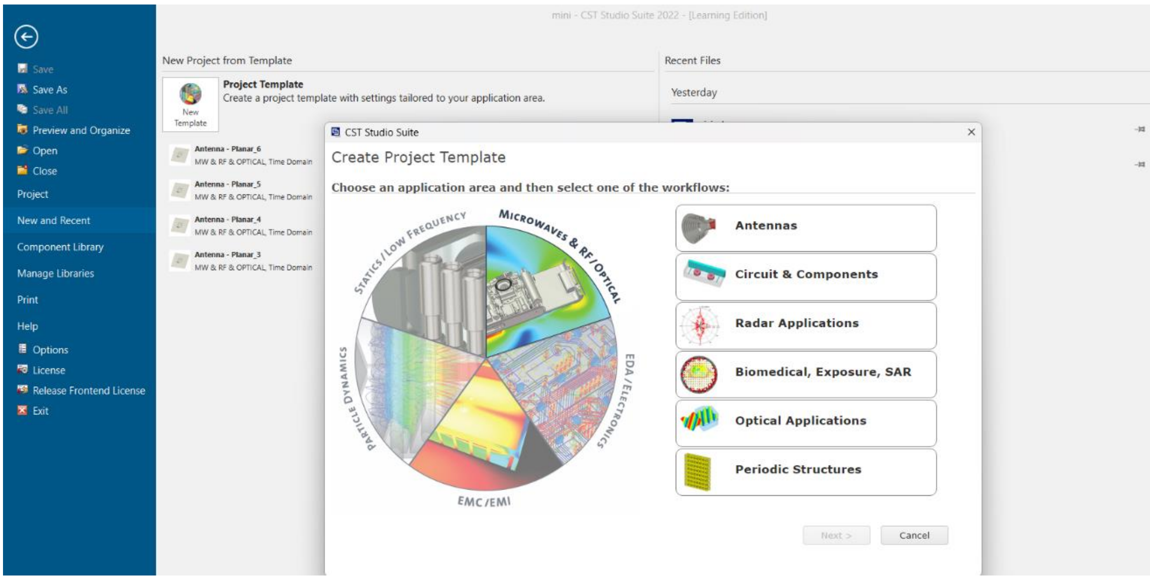


Fig 3.3.1 Project Antenna

3.Click on Antenna and next planar.

4. Enter the required min and max frequencies as referred in Fig 3.3.2.

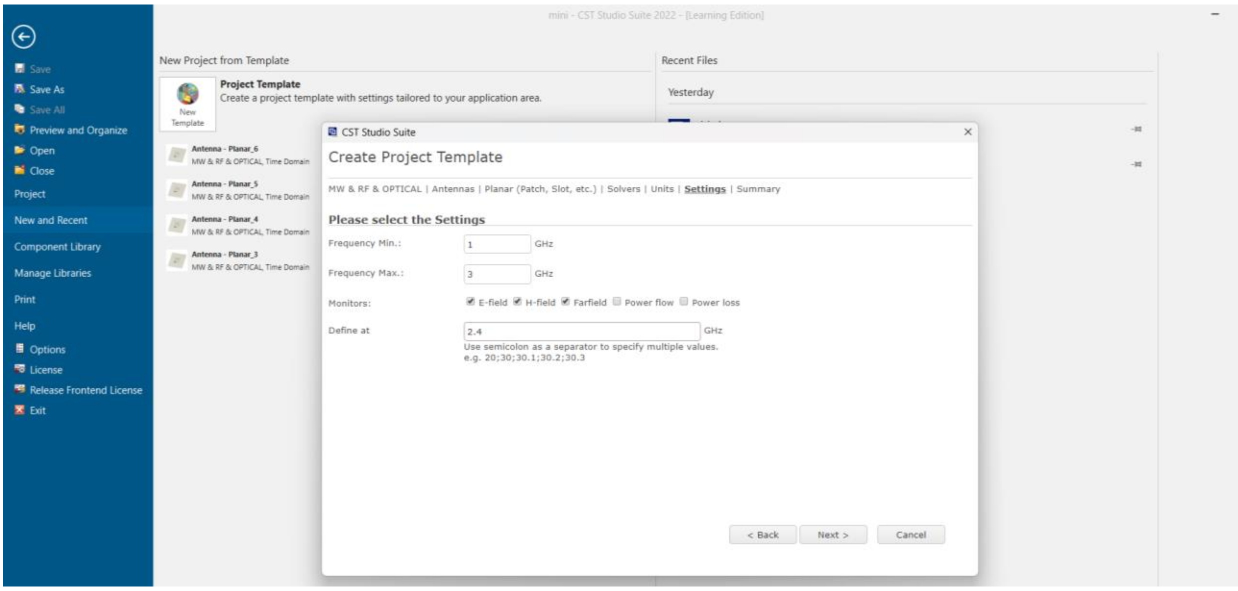


Fig 3.3.2 Max and Min frequencies

5. Enter the required measurements as shown Fig 3.3.3 to construct the antenna.

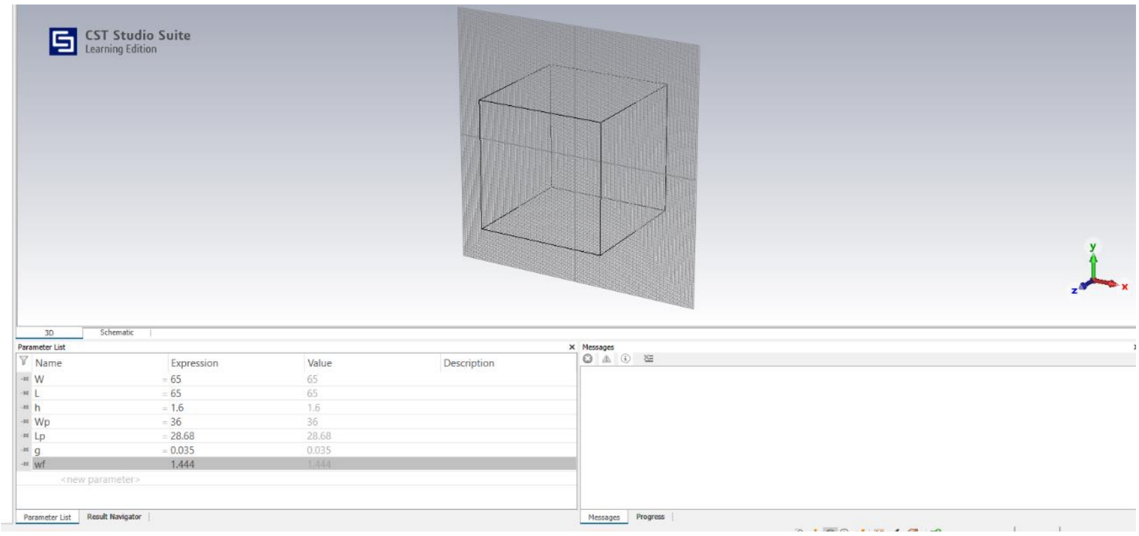


Fig 3.3.3 Required Measurements

6.Select the CEM-3 substrate and assign the coordinates as referred in Fig 3.3.4.

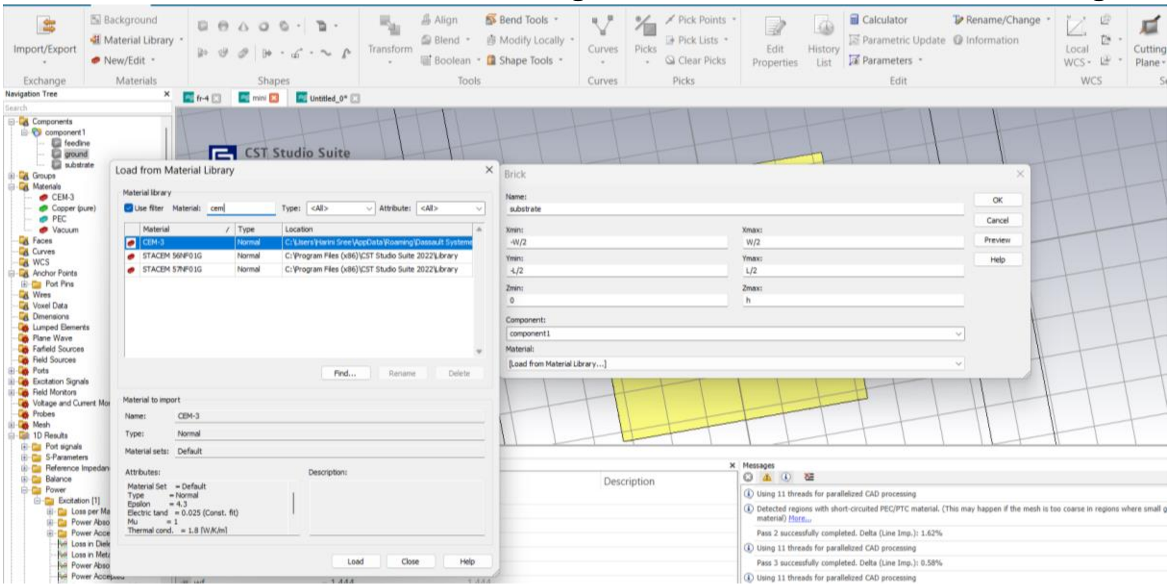


Fig 3.3.4 Assigning of Coordinates

7. Similarly select ground, feedline & patch materials and assign their coordinates.
8. Using Boolean option add feedline and patch.
9. Select the underneath of patch area and click on Pick Face.
10. Remove the local transform.

11. Under simulation tab, Click on Waveguide ports as shown in Fig 3.3.5 and enter the required measurements.

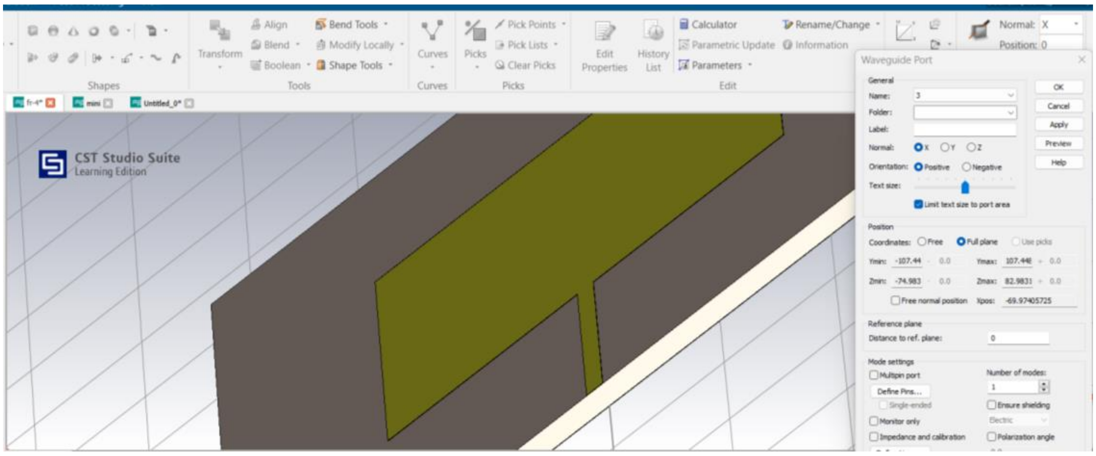


Fig 3.3.5 Waveguide Ports

12. Fig 3.3.6 shows the required microstrip antenna that's been designed successfully.

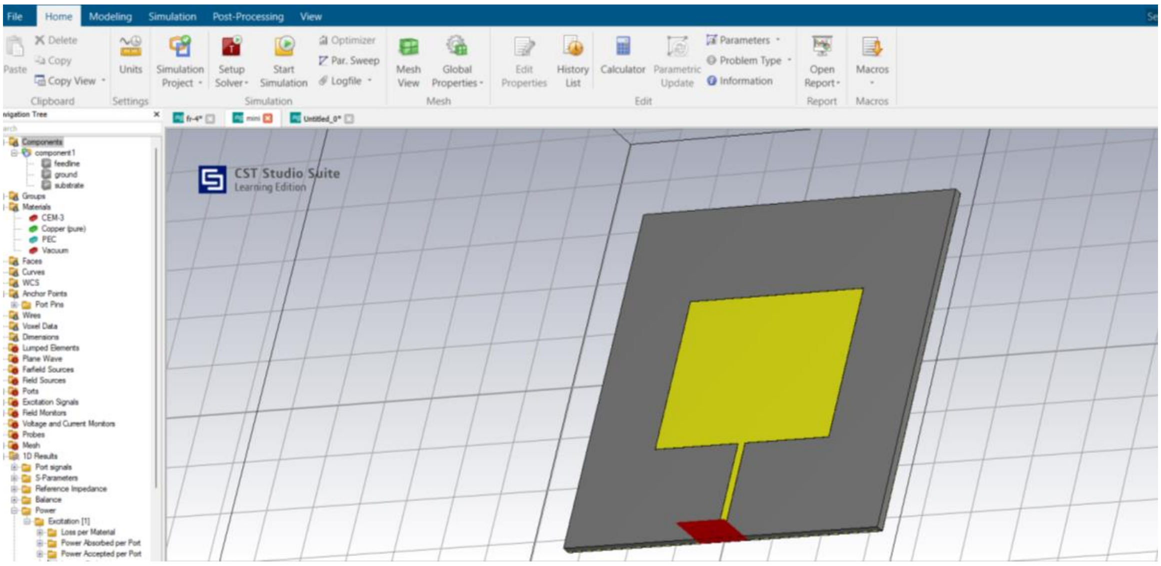


Fig 3.3.6 Microstrip Antenna

CHAPTER 4

Simulation & Output

4.1 Simulation:

To simulate the designed microstrip antenna follow below steps:

1. Click on Setup Solver under Simulation tab as displayed in Fig 4.1.1.

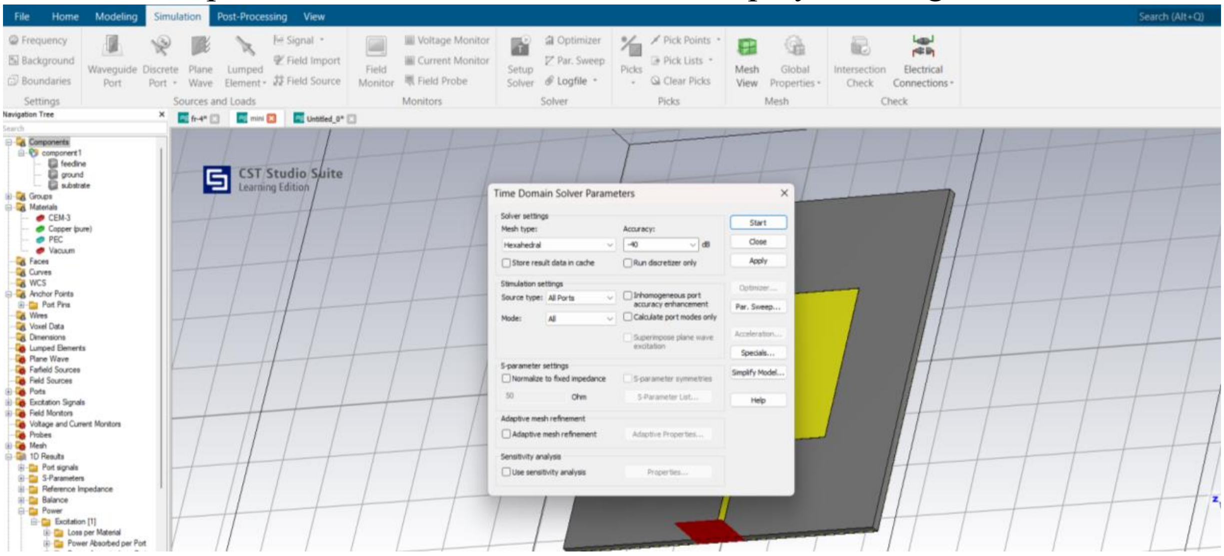


Fig 4.1.1 Setup Solver

2.Click on Start to simulate the designed antenna as referred in Fig 4.1.2.

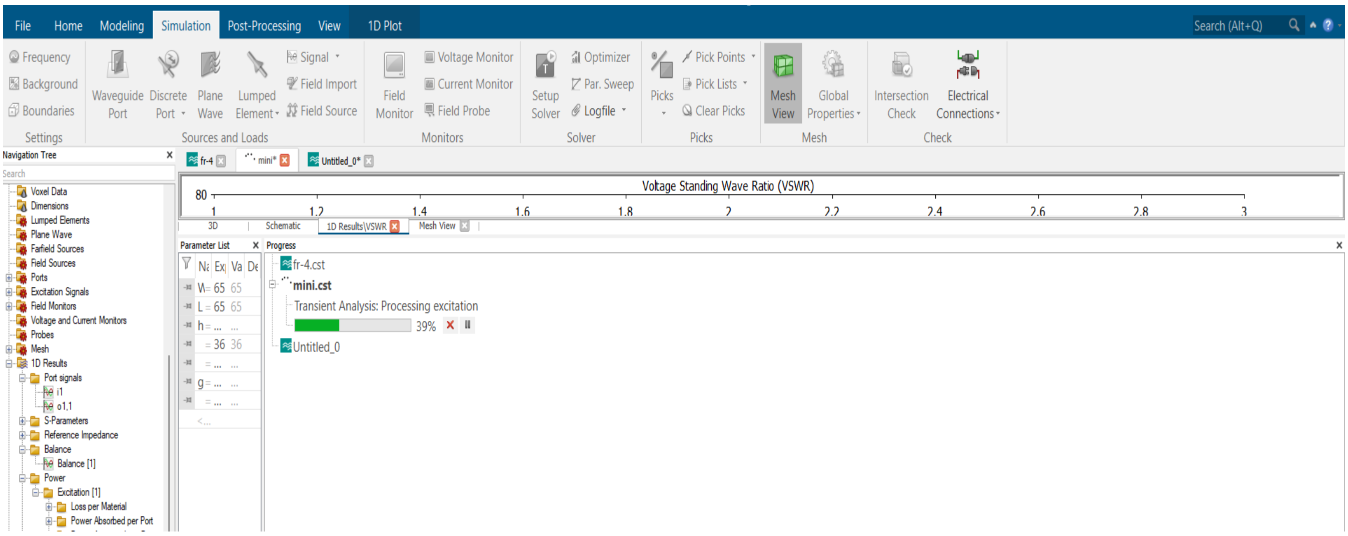


Fig 4.1.2 Simulation Process

4.2 Output:

S parameter: 2.39GHz

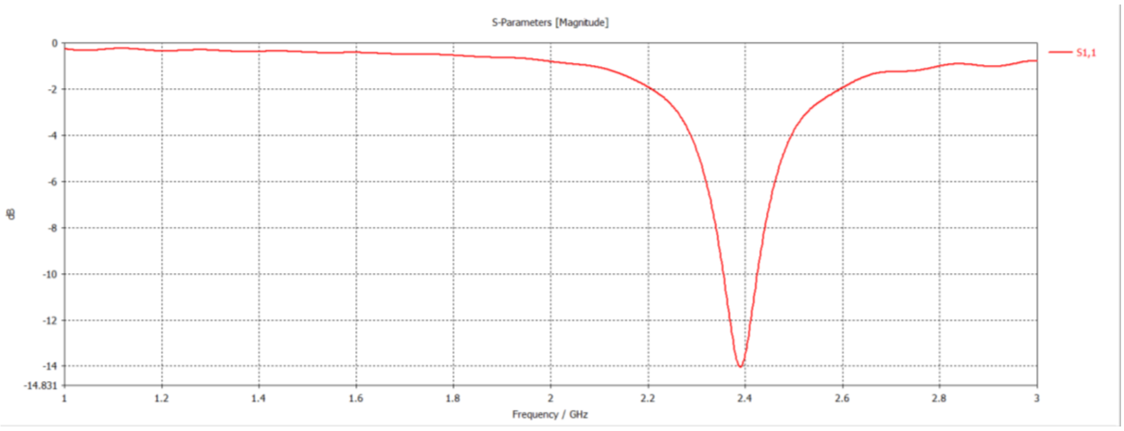


Fig 4.2.1

Reference Impedance: 75.5 Ʊ/Ω

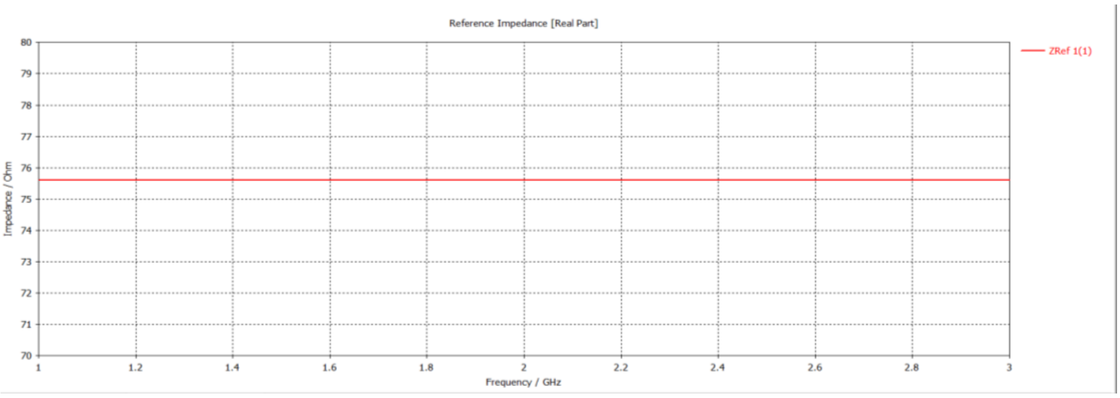


Fig 4.2.2

S parameters Balance: 2.39GHz

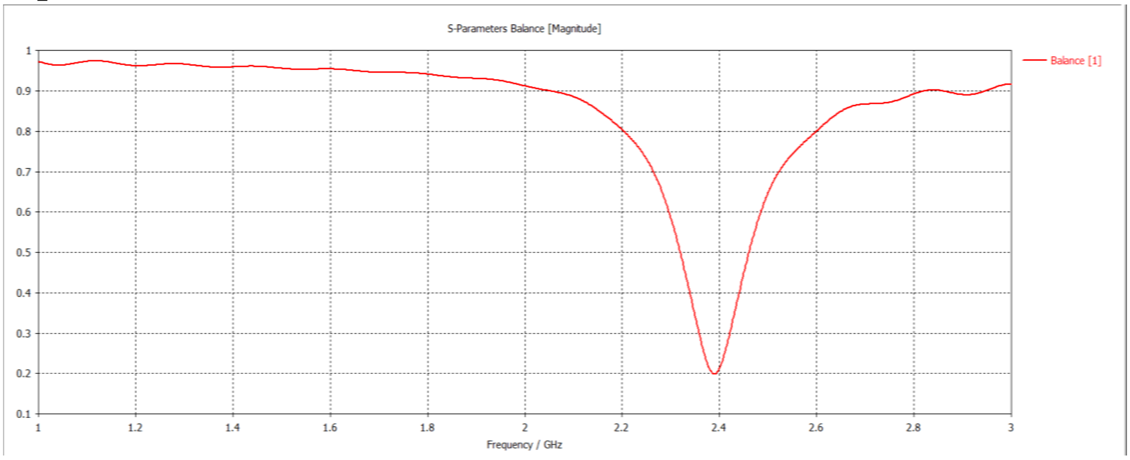


Fig 4.2.3

Power in W (Real Part):

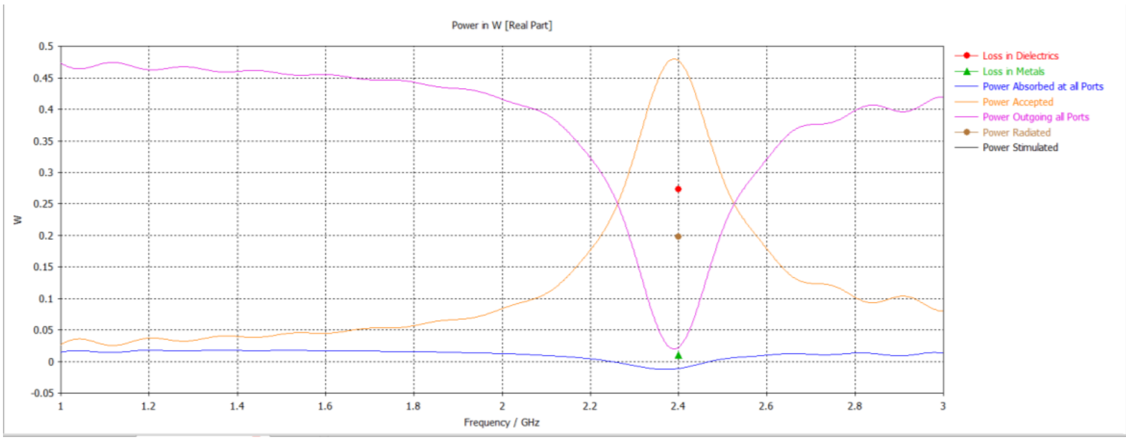


Fig 4.2.4

Field Energy (Magnitude):

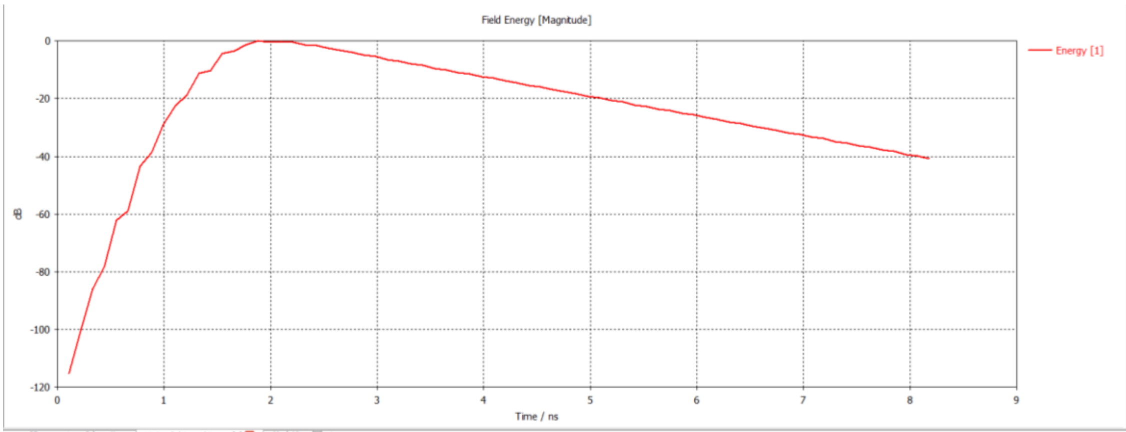


Fig 4.2.5

VSWR: ~1

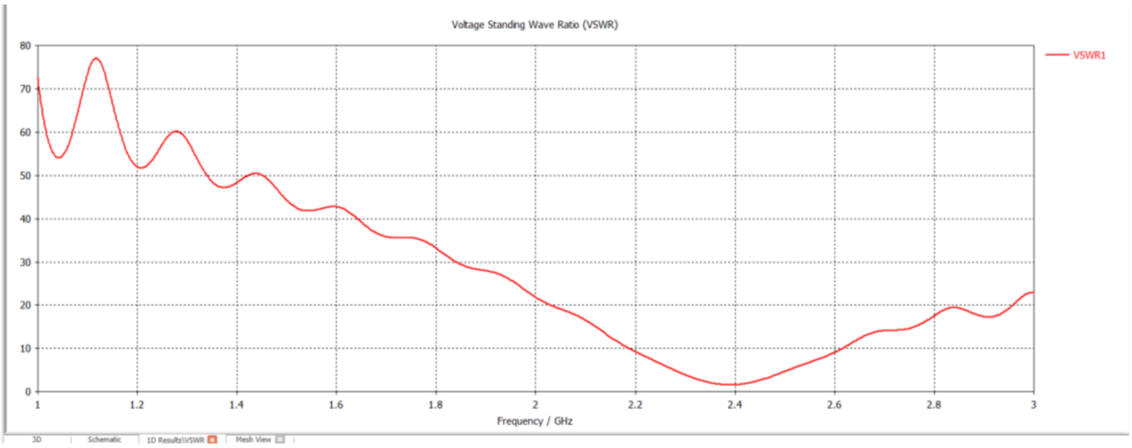


Fig 4.2.6

Radiation Pattern:

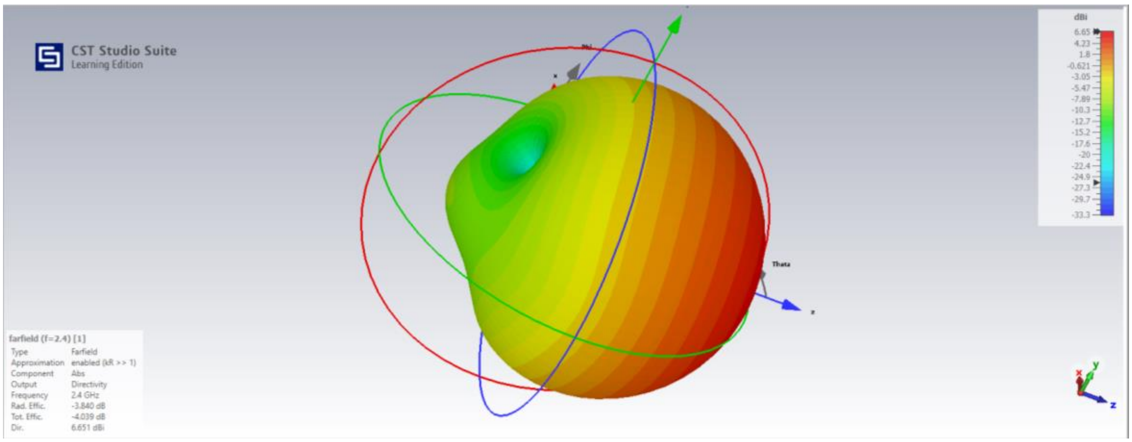


Fig 4.2.7(i)

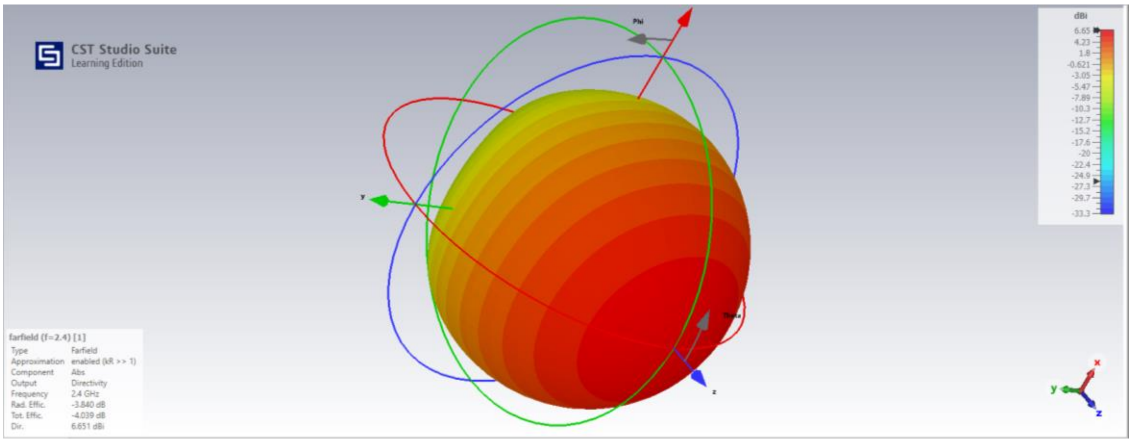


Fig 4.2.7(ii)

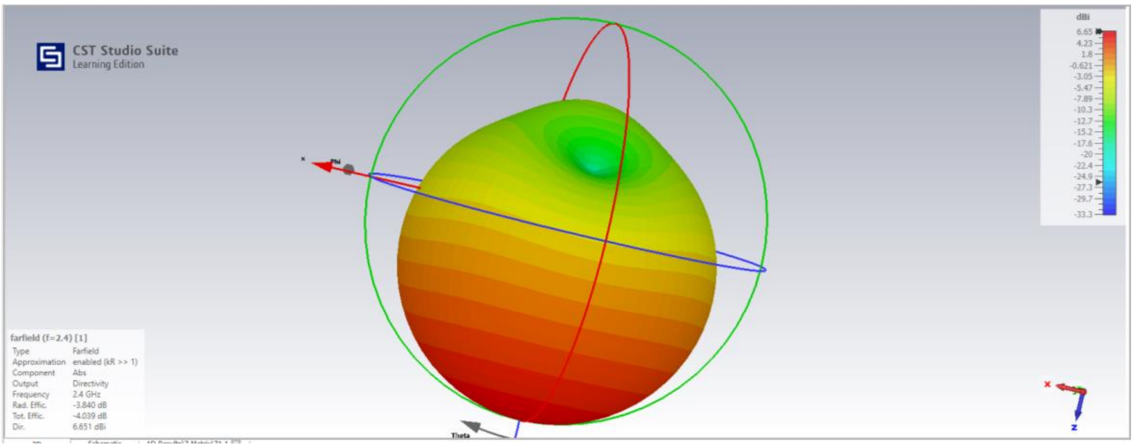


Fig 4.2.7(iii)

CHAPTER 5

Conclusion

In conclusion, the design and analysis of the microstrip antenna for the 2.4GHz frequency band have provided valuable insights into the intricacies of antenna engineering. Through simulations measurements, several important observations have been made.

Firstly, the chosen microstrip antenna design, characterized by its compact size and simplicity, had demonstrated promising performance in terms of impedance matching, radiation pattern and gain. By carefully tuning the dimensions and substrate properties, resonance at the desired frequency of 2.4GHz was achieved, ensuring efficient transmission and reception of electromagnetic waves.

Secondly, the study highlighted the impact of various design parameters such as substrate material, patch dimensions, and feeding techniques on antenna performance. Optimization of these parameters is crucial to maximize antenna efficiency and achieve desired specifications such as bandwidth and radiation characteristics.

In conclusion, the microstrip antenna design for 2.4GHz presents a promising solution for wireless communication systems, offering a balance between performance, size, and manufacturability. Further research could explore advanced techniques for enhancing antenna efficiency, bandwidth, and radiation characteristics to meet the evolving demands of wireless communication technologies. Overall, the insights

gained from this mini project contribute to the ongoing advancement of microstrip antenna technology and its applications in modern wireless systems.

CHAPTER 6

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