DESIGN AND IMPLEMENTATION OF MICROSTRIP FOR ULTRA WIDE BAND FILTER

A MINOR PROJECT - II REPORT

Submitted By

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BACHELOR OF ENGINEERING

in

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

M.KUMARASAMY COLLEGE OF ENGINEERING
(Autonomous)

KARUR – 639 113

APRIL-2023

M.KUMARASAMY COLLEGE OF ENGINEERING,
KARUR

BONAFIDE CERTIFICATE

Certified that this project report "**DESIGN AND IMPLEMENTATION OF MICROSTRIP FOR ULTRA WIDE BAND FILTER**" is the bonafide work of "**KARTHICKRAJA K (927621BEC073), KARTHIKEYAN S (927621BEC075), MADHESHWARAN S (927621BEC106), KAVIN V (927621BEC080)**", who carried out the project work under my supervision in the academic year 2022-2023- Even semester.

SIGNATURE	**SIGNATURE**
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PROFESSOR,	**ASSISTANT PROFESSOR,**
Department of Electronics and Communication Engineering,	Department of Electronics and Communication Engineering,
M.Kumarasamy College of Engineering,	M.Kumarasamy College of Engineering,
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Karur-639113.	Karur-639113.

This Minor project-II report has been submitted for the **18ECP104L – Minor Project-II** Review held at M. Kumaraswamy 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.

MAPPING OF PROJECT WITH POs AND PSOs

Abstract	Matching with POs, PSOs
Microstrip filters, frequency band ,Low pass	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PO12,PSO1, PSO2.

ACKNOWLEDGEMENT

Our sincere thanks to **Thiru.M.Kumarasamy, Chairman** and **Dr.K.Ramakrishnan, Secretary** of **M.Kumarasamy College of Engineering** for providing extraordinary infrastructure, which helped us to complete this project in time.

It is a great privilege for us to express our gratitude to **Dr.B.S.Murugan., B.Tech., M.Tech., Ph.D., Principal** for providing us right ambiance to carry out this project work.

We would like to thank **Dr.S.Palanivel Rajan, M.E., M.B.A., Ph.D., D.Litt (USA)., Professor and Head**, **Department of Electronics and Communication Engineering** for his unwavering moral support and constant encouragement towards the completion of this project work.

We offer our wholehearted thanks to our Project Supervisor, **DR.V.MARISELVAM,M.E., Ph.D.,Assistant professor,** Department of Electronics and Communication Engineering for his precious guidance, tremendous supervision, kind cooperation, valuable suggestions and support rendered in making our project to be successful.

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

Microstrip filters are essential components in modern communication systems. They are widely used in a variety of applications such as satellite communication, wireless networks, radar systems, and mobile phones. A microstrip filter is a type of electronic filter that uses a thin strip of conductive material on a dielectric substrate to provide filtering characteristics. The substrate can be made of materials such as ceramic, glass, or polymers. The filter operates by selectively passing or rejecting signals in a specific frequency band.Microstrip filters offer several advantages over traditional filters, including low insertion loss, high Q-factor, and compact size. They are also relatively easy to design and fabricate, making them a cost-effective solution for many applications. Additionally, microstrip filters can be easily integrated with other components on a single substrate, reducing the overall size and weight of the system.The design of microstrip filters is a complex task that requires a thorough understanding of the underlying principles and techniques. There are various types of microstrip filters, including low pass, high pass, band pass, and band stop filters, each with their own unique characteristics and applications. With the increasing demand for high-performance communication systems, the development of advanced microstrip filter designs is critical for meeting the growing needs of the industry.

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LIST OF ABBREVIATION

ACRONYM	ABBREVIATIONS
UAV	Unmanned aerial vehicle
UWB	Ultra-Wide Band

CHAPTER 1

INTRODUCTION

1.1 FILTER

A low-pass filter is a type of electronic circuit that allows lowfrequency signals to pass through while blocking or attenuating high-frequency signals. It is commonly used in audio applications to remove unwanted highfrequency noise or to shape the frequency response of a speaker or amplifier. The design of a low-pass filter involves selecting appropriate components such as resistors and capacitors to create a circuit that provides the desired frequency response. Various types of low-pass filters exist, including passive filters that do not require a power source, and active filters that use amplifiers to boost the signal. The design of a low-pass filter requires an understanding of basic circuit theory and knowledge of the intended application.

1.2MICROSTRIP FILTER

Microstrip filters are essential components in modern communication systems, providing the necessary frequency selectivity for signal processing and transmission. They are widely used in radio and microwave frequency applications, including wireless communication systems, radar, satellite communication, and many other applications. A microstrip filter is a type of RF filter that is fabricated on a thin, flat substrate using printed circuit technology. The substrate is usually made of a dielectric material such as ceramic or polymer, with a conductive layer on one side The filter consists of a series of conductive traces and coupling elements that are etched onto the substrate. These elements are designed to selectively pass or reject certain frequencies, allowing the filter to provide frequency response according to its integration into a larger system. They are also highly tunable, making it possible to adjust the filter's frequency response to meet specific requirements. Additionally, they can be designed with high selectivity and low insertion loss, making them ideal for many applications where high performance is critical.Overall, microstrip filters are an essential component in modern communication systems, providing the necessary frequency selectivity for signal processing and transmission. With their numerous advantages and flexibility in design, microstrip filters will continue to play a critical role in RF and microwave engineering

FEEDING TECHNIQUES

Microstrip filters are widely used in various communication systems to reject unwanted frequencies and pass desired ones. The feeding techniques used to excite the filter plays a crucial role in its performance. Here are three common feeding techniques for microstrip filte

- Coaxial probe feeding
- Microstrip line feeding
- Aperture couplingsystem

COAXIAL PROBE FEEDING

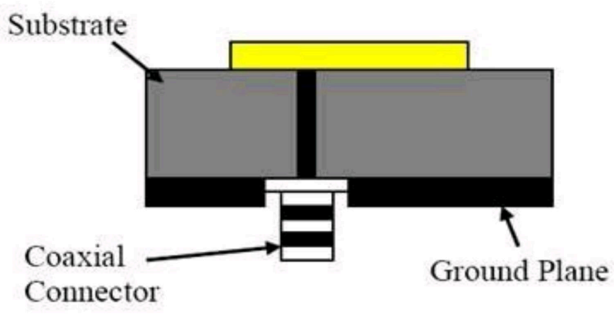

Fig 1.1

In this technique, a coaxial probe is inserted through a hole in the ground plane and placed close to the filter. The center conductor of the coaxial cable is connected to the input port of the filter, while the outer conductor is connected to the ground plane. This technique is simple and easy to implement, but it can cause unwanted radiation and can affect the filter's performance.

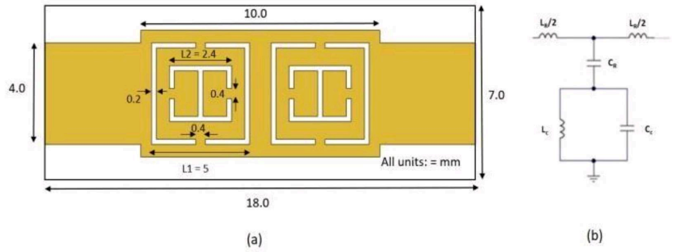

Fig 1.2

In this technique, a microstrip line is used to excite the filter. microstrip line is connected to the input port of the filter and is placed close to the filter. The width and length of the microstrip line are carefully designed to match the

A characteristic impedance of the filter. This technique offers good performance and can be easily integrated with other microstrip circuits**.**

APERTURE COUPLING

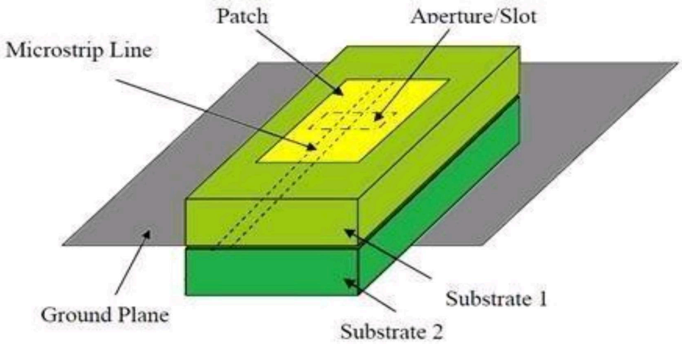

Fig 1.3

In this technique, an aperture is made in the ground plane and a microstrip line is placed over it. The microstrip line is connected to the input port of the filter, and the aperture acts as a coupling mechanism to transfer the signal to the filter. This technique offers good performance and can provide high coupling efficiency. However, it is more complicated than the other two techniques and requires careful design**.**

1.3 FILTER DESIGN

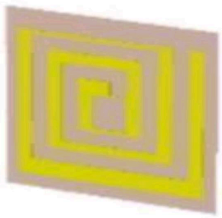

Fig 1.4

To design a microstrip low pass filter with a cutoff frequency of 500 MHz, you can follow these steps:Determine the specifications of the filter, such as the desired cutoff frequency, insertion loss, and return loss.Choose a suitable substrate material for the microstrip transmission line. The substrate should have a dielectric constant and loss tangent to minimize signal loss and dispersion. Popular substrate materials include Rogers RT/duroid and FR4.Calculate the dimensions of the microstrip transmission line based on the desired cutoff frequency and the substrate properties. You can use a microstrip line calculator, such as the one provided by Microwave101, to determine the width and length of the transmission line.Choose a suitable low pass filter topology, such as a Butterworth or Chebyshev filter. The topology will determine the order of the filter and the ripple in the passband and stopband.Determine the component values for the filter based on the chosen topology and the desired specifications. You can use a filter design tool, such as the one provided by RFMentor, to determine the values of the inductors and capacitors.Simulate the filter design using a software tool, such as Keysight ADS or Ansys HFSS, to verify its performance. You can also use a network analyzer to measure the actual performance of the filter.Fabricate the filter on the chosen substrate material using standard PCB manufacturing techniques. Be sure to follow the design guidelines for microstrip transmission lines component placement. Test the fabricated filter to ensure that it meets the desired specifications. You can use a spectrum analyzer to measure the insertion loss and return loss of the filter, as well as its frequency response to the desired specifications. You can use a spectrum analyzer to measure the insertion loss and return loss of the filter, as well as its frequency response. Some common characteristics of filters include cutoff frequency, passband ripple, stopband attenuation, and phase response. The cutoff frequency is the frequency at which the filter begins to attenuate the signal, while the passband ripple and stopband attenuation describe how much the filter allows or blocks the signal in the passband and stopband regions, respectively. The phase response of a filter describes how much the filter delays or advances different frequency components of the signal.In conclusion, filter design is a critical aspect of many electronic systems and involves a careful balance of theory, analysis, and practical considerations.

TABLE 1:

PARAMETERS	VALUES
SL (Substrate Length)	20mm
SW (Substrate Width)	22mm
Substrate thickness	4mm
L (Length of the spiral)	16mm
W (width of the spiral)	18mm
A (Gap between windings)	2mm

CHAPTER 2

OBJECTIVE:

The objective of a microstrip lowpass filter is to selectively attenuate or reject high-frequency signals while allowing low-frequency signals to pass through with minimal loss. Microstrip lowpass filters are an essential component in many communication systems, particularly those that require precise frequency control and noise reduction.The design of a microstrip lowpass filter involves selecting the appropriate substrate material, conductor width, and dielectric constant to achieve the desired cutoff frequency and attenuation characteristics. The goal is to create a filter with a sharp roll-off in frequency response, minimal insertion loss, and high stopband rejection.The performance of a microstrip lowpass filter is evaluated using several metrics, including the cutoff frequency, insertion loss, return loss, and stopband rejection. These parameters are critical in determining the suitability of the filter for a given application. In addition to its performance characteristics, the size, weight, and cost of a microstrip lowpass filter are also important factors to consider. The use of microstrip technology allows for a compact and lightweight filter design that is suitable for integration into complex systems. The manufacturing process is also relatively simple, which can help to reduce production costs.Overall, the objective of a microstrip lowpass filter is to provide an effective means of reducing unwanted high-frequency signals in a communication.

CHAPTER 3

LITERATURE REVIEW

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 communicationshas 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.802.16 is a set of growing IEEE standards that apply to a wide range of spectrum from 2 to 66 Ghz, currently including both licenced and unlicensed bands. Access (ULBAN) fits under 802.16 d/e. A quick summary of some of the many 802.16 specifications is provided in the following table.

TABLE 2:

STANDARD	COMMENTS
802.16	Wireless UBAN ,Hipper Access
802.16d	WIMAX, HiperMAN (fixed)
802.16e	WIMAX, (fixed and mobile)

CHAPTER 4

TOOLS USED:

CST SOFTWARE

CST Studio Suite is used in leading technology and engineering companies around the world.

CST Studio Suite is a high performance **3D EM analysis** software package for designing, analyzing 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 analyze 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.

It offers considerable product to market advantages, facilitating shorter development cycles and reduced costs. Simulation enables the use of virtual prototyping.

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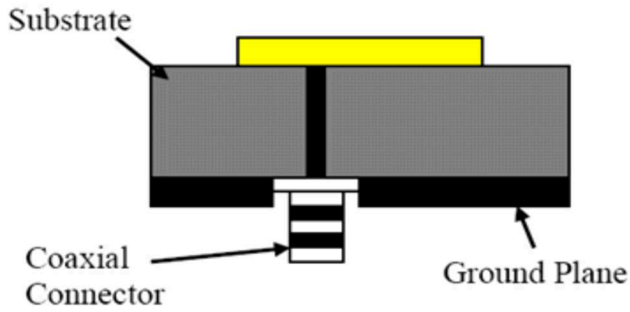

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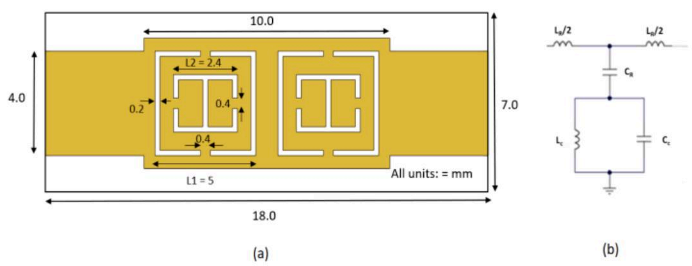

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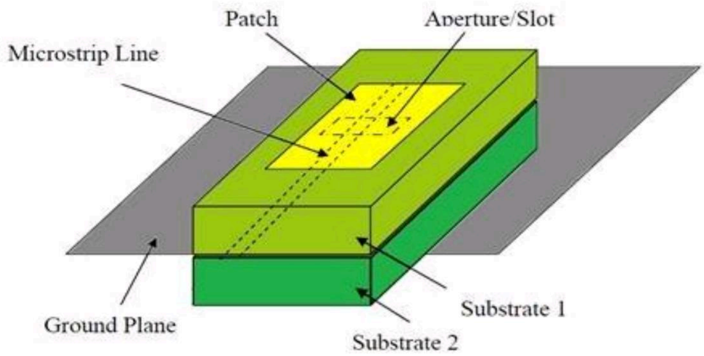

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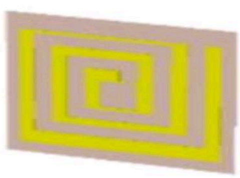

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CHAPTER 5
RESULT AND DISCUSSION

S-PARAMETER(MAGNITUDE IN dB)

A low-pass filter is an electronic circuit that allows low-frequency signals to pass through while attenuating high-frequency signals. In terms of S-parameters, a low-pass filter can be represented as a network of S-parameters that exhibit low-pass filtering characteristics.The S-parameters of a LPF can be obtained by cascading the S-parameters of the individual circuit elements that make up the filter. The individual circuit elements may include capacitors, inductors, and resistors. The S-parameters of these circuit elements can be determined experimentally or through simulation using software such as SPICE.To design a LPF using S-parameters, the cutoff frequency of the filter must be determined. The cutoff frequency is the frequency at which the filter begins to attenuate the signal. The cutoff frequency can be calculated using the formula:$f_c = 1/(2\pi RC)$

where f_c is the cutoff frequency, R is the resistance of the circuit element, and C is the capacitance of the circuit element.Once the cutoff frequency is determined, the S-parameters of the circuit elements can be cascaded to obtain the S-parameters of the entire low-pass filter. The S-parameters can then be plotted using software such as MATLAB to visualize the frequency response of the filter.In general, a low-pass filter will have a frequency response that exhibits a gradual roll-off in signal amplitude as the frequency increases. At the cutoff frequency, the signal amplitude will be attenuated by 3 dB. Above the cutoff frequency, the signal amplitude will continue to be attenuated at a rate determined by the characteristics of the individual circuit elements that make up the filter.

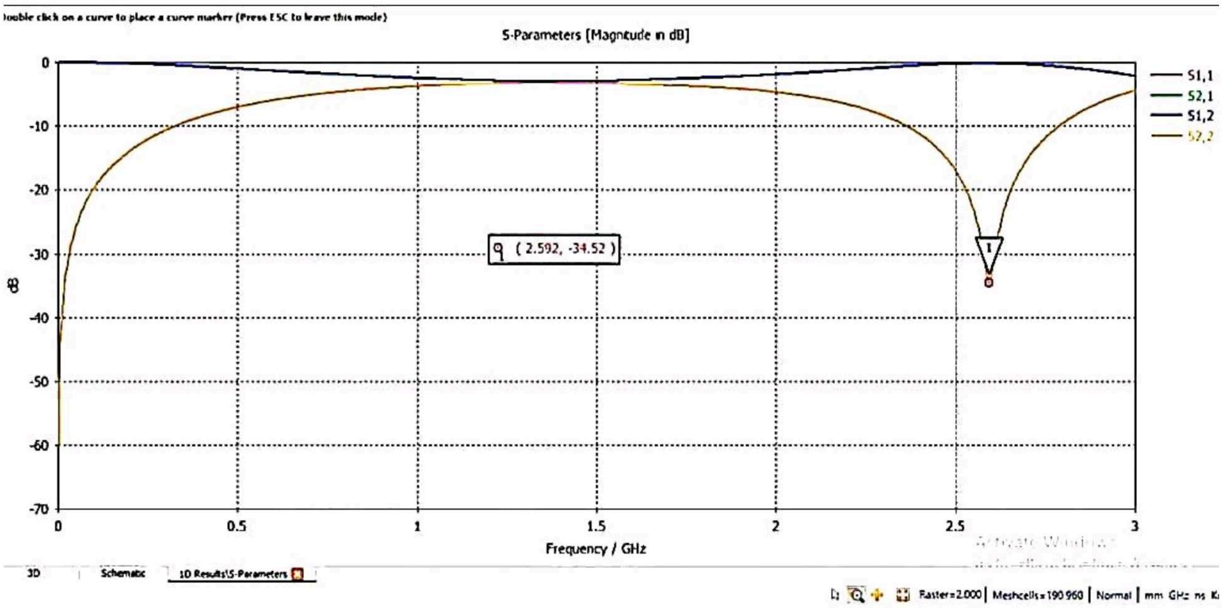


Fig 5.1 S Parameter

FAR FIELD:

The field, which is far from the filter, is called as far-field. It is also called as radiation field, as the radiation effect is high. The radiation intensity when measured nearer tothe antenna, differs from what is away from the antenna.

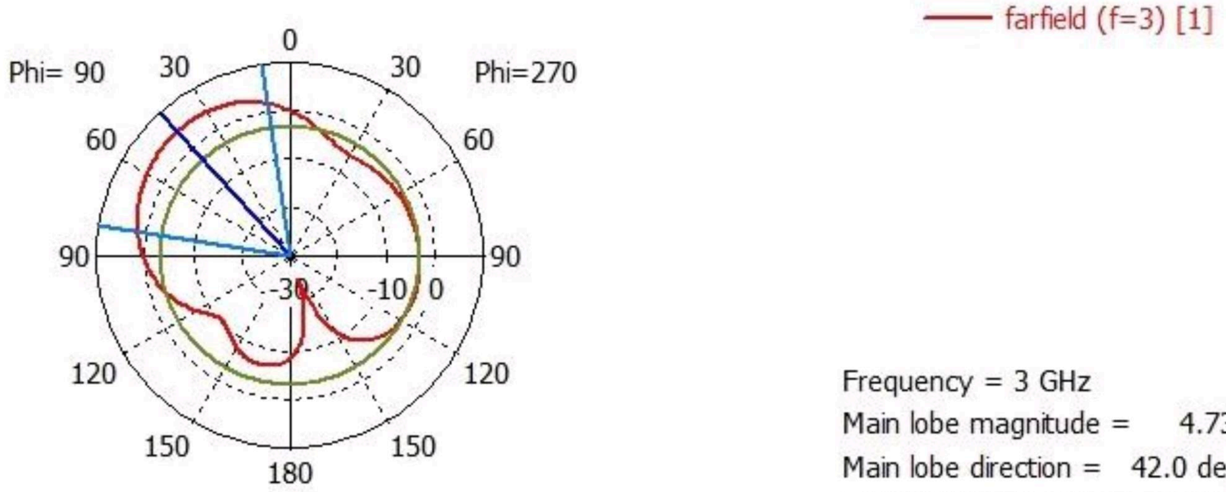
Though the area is away from the antenna, it is considered effective, as the radiation intensityis still high there.

The field, which is nearer to the antenna, is called as **near-field**. It has an inductive effect andhence it is also known as **inductive field**, though it has some radiation components.

The field, which is far from the antenna, is called as **far-field**. It is also called as **radiationfield**, as the radiation effect is high in this area.

Many of the antenna parameters along with the antenna directivity and the radiation patternof the antenna are consideredin this region only.

Farfield Directivity Abs (Phi=90)



Theta / Degree vs. dBi

Frequency = 3 GHz
Main lobe magnitude = 4.73 dBi
Main lobe direction = 42.0 deg.
Angular width (3 dB) = 72.4 deg.
Side lobe level = -7.8 dB

CHAPTER 6
CONCLUSION

Filter design is a critical aspect of signal processing and is used to extract relevant information from raw data. The selection of filter type, frequency response, and cutoff frequency depends on the specific application and desired output. There are several types of filters, including low-pass, high-pass, bandpass, and notch filters, each with its unique characteristics and advantages.In conclusion, filter design plays a crucial role in many signal processing applications, from audio and image processing to communication systems and biomedical signal analysis. The choice of filter type and design parameters depends on the specific application and desired output. It is essential to understand the signal characteristics, noise sources, and system requirements to choose an appropriate filter type and design. The advancement in digital signal processing techniques has made filter design more accessible, efficient, and flexible, allowing for the realization of complex filters with high precision and accuracy. Low-pass filters, high-pass filters, band-pass filters, and band-stop filters are the most commonly used filters. Low-pass filters allow low-frequency signals to pass through and attenuate high-frequency signals, while high-pass filters allow high-frequency signals to pass through and attenuate low-frequency signals. Band-pass filters only allow signals within a certain frequency range to pass through, while band-stop filters attenuate signals within a certain frequency range.Filter design involves choosing the appropriate filter type and designing the filter parameters to meet specific requirements, such as cutoff frequency, attenuation, and transition bandwidth. Various design techniques are used, such as Butterworth, Chebyshev, and Elliptic filters, each with its own characteristics and tradeoffs.In conclusion, filter design is an essential aspect of signal processing, and the choice of filter type and design technique depends on the specific application requirements. Careful consideration of the tradeoffs between filter characteristics such as attenuation, transition bandwidth, and phase response is crucial to ensure optimal filter performance.

CHAPTER 8
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